INDIANA

DEPARTMENT

—OF—

GEOLOGY AND NATURAL RESOURCES.

Twenty-third Annual Report,

1898.

W. S. BLATCHLEY,

State Geologist.

INDIANAPOLIS:

WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.

1899.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
January 27, 1899.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, January 28, 1899.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

W. H. HART,
Auditor of State.

January 28, 1899.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

CHAS. E. WILSON,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, January 28, 1899.

UNION B. HUNT,
Secretary of State.

Received the within report and delivered to the printer this 28th day of January, 1899.

THOS. J. CARTER,
Clerk Printing Bureau.

State of Indiana, Department of Geology and Natural Resources.

INDIANAPOLIS, IND., January 25, 1899.

HON. JAMES A. MOUNT, *Governor of Indiana:*

DEAR SIR—I transmit to you herewith the manuscript of my fourth annual report, the same being the 23d Report of the Department of Geology and Natural Resources of the State. In the main it comprises the results of a careful survey of the coal area of Indiana—the principal energies of this department for the past three years having been devoted to such survey. It also embodies the results of the work accomplished by the Divisions of Mines, Natural Gas, etc., during the calendar year, 1898.

Respectfully,

W. S. BLATCHLEY,
State Geologist.

ASSISTANTS.

GEO. H. ASHLEY, Indianapolis, Ind . . .	In charge of Coal Survey.
C. E. SIEBENTHAL, Bloomington, Ind. . .	Assistant on Coal Survey.
E. M. KINDLE, Franklin, Ind	Assistant on Coal Survey.
JAS. A. PRICE, Bloomfield, Ind	Assistant on Coal Survey.
J. T. SCOVELL, Terre Haute, Ind.	Assistant on Coal Survey.
W. A. NOYES, Terre Haute, Ind.	Chemist.
J. C. LEACH, Kokomo, Ind	Supervisor of Natural Gas.
C. F. HALL, Danville, Ind	Supervisor of Oil Inspection.
ROBERT FISHER, Brazil, Ind.	Inspector of Mines.
JAMES EPPERSON, Linton, Ind.	Assistant Inspector of Mines.
ISADORE KESSLER	Stenographer.

TABLE OF CONTENTS.

INTRODUCTORY. By W. S. Blatchley.

THE COAL DEPOSITS OF INDIANA. By George Hall Ashley.

PART III. DETAILED GEOLOGY OF INDIANA COAL.

PART IV. MINES, MINING AND UTILIZATION OF COAL.

REPORT OF THE STATE INSPECTOR OF MINES FOR 1898.
By Robert Fisher.

REPORT OF NATURAL GAS SUPERVISOR.
By J. C. Leach.

REPORT OF STATE SUPERVISOR OF OIL INSPECTION.
By C. F. Hall.

LIST OF LITHOGRAPH MAPS.

COAL MAPS.

LIST OF SKETCH MAPS.

WARREN COUNTY.

FOUNTAIN COUNTY.

PARKE COUNTY.

VERMILLION COUNTY.

OWEN COUNTY.

CLAY COUNTY.

VIGO COUNTY.

GREENE COUNTY.

SULLIVAN COUNTY.

MARTIN COUNTY.

DAVIESS COUNTY.

KNOX COUNTY.

DUBOIS COUNTY.

PIKE COUNTY.

GIBSON COUNTY.

PERRY COUNTY.

SPENCER COUNTY.

WARRICK COUNTY.

LIST OF PLATES, OTHER THAN SKETCH MAPS.

INTRODUCTORY.

The present report on the Coal Deposits of Indiana was planned and decided upon almost four years ago, and upon the gathering of data for it and its preparation have been expended most of the energies and resources of the Department of Geology since July 1, 1896.

The gradual lowering of the rock pressure throughout the Indiana gas field, together with the diminution of the supply of gas all about the margins of that field were proofs sufficient that the supply of that valuable fuel for manufacturing purposes would soon end. The problem of how best to retain within our State most, if not all, of the many factories which had been erected since 1888 was the one which confronted this department. The only way the problem could be successfully solved was to show the owners of those factories that within the bounds of Indiana was a supply of fuel sufficient to last for centuries, and of a quality equal almost to that of any other State.

No report on the coal area of Indiana had been published since 1878. During the twenty years which had elapsed thousands of bores had been put down to prove the presence or absence of veins of workable thickness, and hundreds of shafts had been sunk to known deposits. Many valuable facts had thus become available which, if gathered and properly arranged, would enable one to show much more accurately than was possible with the limited data available for the reports previous to 1878, the area, conditions and fuel value of the coal deposits of the State.

After planning the survey of the coal area, difficulty was experienced in finding a suitable party to put in charge of it. The finances of the department were limited, the total appropriation allotted by the Legislature being less than one-fourth what a careful estimate had shown the work on the coal area should cost. Reports on the clay, building stone and petroleum interests of the State were in progress, and the time and means at the disposal of the Geologist were largely taken up in forwarding these and in performing the routine work of the office.

After much correspondence, Dr. Geo. H. Ashley, of California, was secured and given full charge of the coal survey. Dr. Ashley is a graduate of Cornell and Leland Stanford Universities, and previous to coming to Indiana had done much geological work in New York, Arkansas and California. His specialty is economic geology—especially that of coal deposits. A good draughtsman and an expert in drawing, he has been able to illustrate the text in such a manner as to greatly enhance its value. The large maps, seven in number, which accompany the report, were prepared by him, and they, with the single and double page plates, show much more clearly than could otherwise be done the extent and thickness of the great workable coal deposits of the State.

To Dr. Ashley, and the assistants who have so ably aided him in securing and preparing the data, full credit should therefore be given for whatever merit the report contains. It is believed that the facts therein given will fully justify the preparation of the work at the present time. It is also believed that the owners and operators of all Indiana factories will, by a careful examination of its pages, find that the State contains a coal supply suitable in quality and sufficient in quantity to supply their needs for many centuries to come.

REPORT OF MINE INSPECTOR.

The report of the State Mine Inspector, Mr. Robert Fisher, shows that 5,177,044 tons of coal were mined in Indiana in 1898. This was an increase of 948,958 tons over the output of 1897, and was 628,233 tons more than was mined in the State in any previous year.

This increase was due to the absence of the usual strikes on the part of the miners in the leading coal districts in the State, and to a largely increased demand for Indiana coal during the last three months of the year. This demand was in part brought about by the shortness of the supply of natural gas, and a consequent storage of coal for winter use. There is no doubt but that the demand for Indiana coal will gradually increase as the supply of gas grows less, and the chances are that the output will reach 10,000,000 tons per annum before the year 1910. The output would have been greater last year, especially in Greene county, could the railways have moved the coal as fast as it was mined.

According to the report of Mr. Fisher the following is the relative rank of the seventeen coal-producing counties for the year 1898, to-

gether with the output of each and the total number of miners employed in mines working ten or more men:

		Tons.	No of Men.
1.	Clay	1,018,497	2,588
2.	Vigo	819,440	1,030
3.	Sullivan	677,442	720
4.	Parke	612,144	1,042
5.	Greene	518,722	805
6.	Vermillion	399,947	650
7.	Pike	240,821	400
8.	Vanderburgh	193,802	257
9.	Daviess	181,060	357
10.	Warrick	111,924	176
11.	Fountain	111,901	118
12.	Knox	50,457	103
13.	Gibson	47,286	75
14.	Perry	27,087	56
15.	Owen	8,813	20
16.	Martin	5,052	19
17.	Dubois	2,649	10
		5,027,044	8,426

Mines operating less than ten men produced 150,000 tons and employed about 900 additional miners, so that a total of 9,325 miners were employed in the State in 1898.

REPORT OF STATE SUPERVISOR OF NATURAL GAS.

The report of the State Supervisor of Natural Gas, Mr. J. C. Leach, for the year 1898, will be found in the present volume. This report but emphasizes what has been affirmed by this department from year to year, namely, that the supply of natural gas in Indiana is constantly decreasing and that the end of that valuable fuel, at least for manufacturing purposes, will soon be here.

Residents of Lebanon, Crawfordsville, Ft. Wayne, Anderson, Indianapolis, and many others Indiana cities, realized, as never before, the shortness of the supply during the cold week of February last. In three days more coal was sold to private consumers in Indianapolis than had been sold for ten years. Every available form of wagon was pressed into service in delivering the solid fuel, and many, even of the richer classes, suffered severely from its lack.

During the last five years all pipe lines have been extending their mains toward the center or "heart" of the Indiana field, until now that center is reduced to less than 150 square miles. All the porous Trenton or gas-producing rock in the Indiana field is more or less intimately connected, and whatever tends to reduce the supply in one part of the field, has the same effect upon all parts. This is shown by the reduction of pressure in the practically undeveloped center. Wells therein, drilled for local use, showed in November, 1898, a pressure of but 181 pounds as against 264 in 1895, a loss of 83 pounds in three years. This shows that the supply of gas in the center has been greatly lessened, and when pierced by the pipe lines now headed toward it, will supply the demand but a short time.

The average rock pressure of the entire field in November, 1897, was 191 pounds; in November, 1898, 173 pounds, a loss of 18 pounds during the year. The average pressure at which salt water overcomes the gas and necessitates the abandonment of the well is probably between 130 and 150 pounds; in the western portion of the field, already abandoned, it was 250 pounds; in the eastern, 90 pounds.

Petroleum or crude oil will probably replace the gas in the higher portions of the porous Trenton rock in a large part of the present gas-producing area, and while it lasts, will be utilized as fuel. However, the supply of petroleum, like that of gas, is limited, and every barrel pumped lessens the supply just that amount. Neither gas nor oil are at present being formed in any appreciable quantities in the Trenton limestone, and the time will come, and that soon, when the stored reservoirs of these two great fuels within our State will have been drained, and only the dregs be left as a reminder of the plenty that has been.

The many factories of the gas field have several courses of action open to them, which will enable them to remain where they are now located when the present supply of gaseous fuel shall have failed. They can either utilize petroleum in liquid form or, where the liquid would yield impurities in burning harmful to their wares, can make petroleum gas. They can ship in coal from the Indiana field, as their situation within seventy to ninety miles of the central coal basin of the State will give them advantages which, though far inferior to those they now possess, will still enable them to compete with many factories of the east where fuel has to be transported a much greater distance. They can burn this coal as a solid fuel or, where the character of their wares will prevent this, can make it into gas at the factories. Better still, they can manufacture gas in the coal field, thereby utilizing much of the coal wasted, and under the improved systems of pumping, can force it under pressure to their furnaces.

If necessary to remove their factories, there are many places in Indiana which offer equal, if not superior, advantages to those found in any other State. The three great elements which must ever be taken into consideration in locating a factory of any kind are, (a) transportation facilities; (b) fuel supply; (c) quantity and quality of raw material. If a factory can be located where two of these elements or factors are present, the owner is lucky; if, where all three of them are found, he can, other things being equal, defy competition.

The transportation facilities and fuel are present in many parts of the coal area of Indiana. That the fuel is plentiful and of excellent quality the present report will show. Places like Terre Haute, at the head of navigation on the Wabash and with eight railways radiating in all directions; Brazil, located in the very center of the block coal district and with three railways, and Linton, the second mining town in the State, with two railways, offer unexcelled sites for factories of many kinds. Besides these, Washington, Daviess county; Petersburg, Pike county; Clinton, Vermillion county, and many other places are located in the center of large coal deposits, and offer excellent outlets by rail.

Again, if the factory owner has a decided preference for Pittsburg or West Virginia coal over that of Indiana, he need not remove to those states to secure it. Several points, notably Madison, on the Ohio river, offer most excellent advantages of transportation, and also Pittsburg or West Virginia coals almost as cheap as at the mines. On account of the low freight rate by river, Pittsburg coal (one-third nut and two-thirds slack), is delivered at the factory doors of Madison for $1.15 per ton. The freight rates by water for the completed product of factories is but one-third or less that by rail. The Kentucky river, emptying into the Ohio but twelve mile above Madison is, at present, navigable almost to the coal and iron deposits of eastern Kentucky and a recent appropriation has been made by Congress to render it navigable to those deposits. Much fine timber, suitable for manufacturing, is rafted down the Kentucky, and more will become available as the river is improved. All these facilities tend to make Madison a most excellent site for future factories.

The facts given in this report and the preceding ones of this department all tend to show that Indiana is posssessed of raw material, fuel and transportation facilities, equal to if not surpassing those of other States in the Union. Whether she uses these possessions to the best advantage—keeps the factories now within her bounds and increases their numbers many fold—will depend almost wholly upon the energies and public-spiritedness of the citizens of those localities where the fuels and raw materials are located. This department can but call the attention of the world to the resources of the different localities of the State. The people of those localities must, by their own endeavors and by showing a willingness to invest local capital, attract to their midst the wealth and population of other portions of the world.

PETROLEUM PRODUCTION IN INDIANA IN 1898.

The total production of petroleum in Indiana during the year 1898 was but 3,751,307 barrels as against 4,353,138 in 1897, and 4,680,732 in 1896. This was a loss of 601,831 barrels, or nearly 14 per cent. as compared with the output of 1897. This loss was in part due to the low price of the product during the first half of the year, which prevented the sinking of many new bores in the fields already developed. The main loss of production was due, however, to the fact that no new area of production was discovered during the year and the outlines of the older fields were but little extended. On January 1, 1899, there were 3,628 wells producing oil in the State, as against 3,648 on January 1, 1898, a loss of 20 during the year over and above the new bores put down.

The wells first sunk in the older fields are gradually losing in output, and unless virgin territory of large size is soon developed the annual production of petrolum in the State will dwindle in a few years to less than 1,000,000 barrels. The average increase in price from 43 cents in 1897 to 62 cents in 1898, brings the price of the product much nearer its true value, and will undoubtedly lead to more extended boring in the territory already known, and also to more extended wild-catting, which will probably open up new fields of importance, especially within the area now producing natural gas.

The statistics of the Indiana production for the year 1898, are as follows:

TOTAL PRODUCTION OF PETROLEUM IN INDIANA FROM 1891 TO 1898 BY MONTHS.

[Barrels.]

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.
January	6,171	15,841	111,824	259,000	300,568	365,582	290,746	317,014
February	5,981	18,946	96,025	232,107	230,559	241,743	309,922	272,780
March	5,159	24,794	134,549	282,376	310,303	386,586	341,961	325,301
April	4,973	26,184	146,493	287,330	352,077	395,032	328,779	310,034
May	5,757	31,033	186,939	321,502	397,001	417,963	340,023	311,208
June	8,136	40,888	209,616	333,479	403,569	434,167	369,803	320,477
July	10,809	49,203	221,666	327,349	434,376	422,968	375,249	314,861
August	11,403	56,109	248,353	345,031	420,132	407,238	371,921	332,777
September	16,500	66,034	245,615	319,588	409,109	415,675	362,528	326,264
October	19,029	95,699	252,568	339,424	393,153	394,283	408,179	319,490
November	20,801	129,270	245,607	304,030	373,789	337,331	430,958	200,644
December	21,715	144,067	236,038	337,450	361,436	362,164	423,069	300,457
Total	136,634	698,068	2,335,293	3,688,666	4,386,132	4,680,732	4,353,138	3,751,307

PRODUCTION OF PETROLEUM IN INDIANA FROM 1889 TO 1898.

	1889.	1890.	1891.	1892.	1893.	1834.	1895.	1896.	1897.	1898.
Total production (barrels of 42 gallons)	33,375	63,496	136,634	698,068	2,335,293	3,688,666	4,386,132	4,680,732	4,353,138	3,751,307
Total value at wells of all oils produced, excluding pipage	$10,881 00	$32,462 00	$54,787 00	$260,620 00	$1,050,882 00	$1,774,260 00	$2,807,124 00	$2,954,411 00	$1,871,849 00	$2,325,810 00
Value per barrel	32[illegible]	51[illegible]	40	37	45	48	64	63	43	62

Production of petroleum in the main Indiana petroleum field by months in 1898:

	Bbls.
January	255,474.11
February	226,779.41
March	270,156.78
April	253,370.99
May	253,499.34
June	261,465.89
July	264,763.60
August	284,550.83
September	286,728.58
October	283,182.31
November	269,423.31
December	267.426.26
Total	3,176,821.41

Production of petroleum in the Peru petroleum field by months in 1898:

	Bbls.
January	48,770.56
February	33,619.70
March	37,274.91
April	43,866.48
May	45,456.88
June	46,556.71
July	40,213.55
August	39,397.27
September	31,922.24
October	30,105.93
November	23,697.90
December	25,789.86
Total	446,671.99

Production of petroleum in the Broad Ripple, Indiana, oil field by months in 1898:

	Bbls.
January	3,905
February	5,747
March	10,735
April	11,103
May	11,838
June	12,321
July	9,775
August	8,535
September	7,525
October	6,202
November	7,303
December	7,098
Total	102,087

Production of petroleum in all other Indiana oil fields in 1898, by months:

	Bbls.
January	8,868.48
February	6,633.83
March	7,138.25
April	1,694.09
May	413.00
June	232.67
July	108.42
August	295.11
September	89.00
October	
November	219.54
December	142,96
Total	25,835.44

THE
COAL DEPOSITS OF INDIANA

By GEORGE HALL ASHLEY.

INTRODUCTION.

IMPORTANCE OF FUEL AND COAL.

Fuel has been recognized by mankind of all ages as one of the most important factors of his existence. At the first its use may almost be said to have marked man off from the lower animals. With it he could successfully cope with adverse conditions in nature. Fuel enabled him to prepare foods, otherwise not eatable, to live in climates otherwise uninhabitable, to see in the night as in the day time. With it the ores of the earth yielded up their metals and prepared the way to civilization. Little wonder is it, then, that fire took a conspicuous part in his worship, and that primitive man all over the world should place fire, or the sun, as the apparent source of heat among his divinities. At first he obtained his fuel from the surrounding forest. But the time came early in human history when here and there the combustible nature of coal was discovered. Yet for a long time the abundance of wood fuel and the difficulty with which coal ignites practically restricted the use of the latter to the one purpose to which it proved much better adapted than wood, namely, in metallurgy.

The real importance of coal as apart from wood, however, dates from the invention and development of the steam engine, especially in the middle of the eighteenth century. The remarkable development of industries that took place at that time and the marvelous advance that material civilization has made during the nineteenth century would hardly have been possible without coal. Indeed, attention is frequently called to the fact that the present material prosperity of nations is proportional to the coal development of each. The assertion is frequently made that England owes her supremacy as a nation to her coal beds, and who can say how much of the boasted wealth of the United States would exist had she possessed no coal beds.

Furthermore, there has been a movement going on of late that promises greater prosperity to those States possessing coal. That is the recent tendency of great manufacturing concerns to leave the large cities and commercial centers and settle in the smaller towns as close as possible to supplies of their raw materials. Coal may be said to be one of the raw materials in almost any kind of manufacture, and usually just in proportion that power plays a part in the process. It follows as a matter of course that, other things being equal, this movement will tend toward those States whose coal resources are the best and most favorably known abroad. The recognition of this fact has been one of the factors leading to the prosecution and publication of the present survey and report.

DEVELOPMENT OF COAL INDUSTRY IN INDIANA.

It is highly probable that the presence of coal in Indiana was known to all the earlier inhabitants of the State, Indians or others, though whether its use and fuel properties were known to them is a doubtful question. As far as I have been able to learn, the discovery of coal in Indiana was made in 1763, by Col. Croghan, who noticed coal on the Wabash river. The next earliest records I have found of coal in Indiana are in the field notes of the surveyors who ran the township and section lines in the first ten years of the present century, 1804 being the earliest now recalled. According to an inquiry conducted some years ago by Mr. Thos. Wilson while Inspector of Mines, the first coal mined in the State was by Mr. Alpha Frisbee by stripping on Little Pigeon creek, seven miles east of Newburg and three miles from the Ohio river. Dr. J. T. Scovell reports finding an advertisement of coal for sale in a paper in 1832. Earlier than either of these is the report that, in 1812, when Mr. Robert Fulton made his first trip down the Ohio in his steamboat the "Orleans," he stopped at Fulton, near Cannelton, Perry county, and obtained some coal, whether for use as a fuel or as a curiosity is not known.

Inquiry over the field shows that by 1840 coal was being regularly mined at many places over the State, in most cases only for blacksmiths' use, but in many instances for shipment. As far as known, such coal was mined by stripping or drifting on the outcrop. Mr. Wilson gives the date of the first shaft as 1850, sunk by Mr. John

Hutchinson one mile east of Newburg, on the bank of the Ohio river. The first charter granted by the Legislature for the mining of coal was in 1837 to the American Cannel Coal Company, of Cannelton, Perry county. The famous "block coal" of Clay county appears to have first been recognized as such in 1851. Mr. Hays, of Center Point, reports finding it in a well on Mrs. Huff's place in section 16, township 11 north, range 6 west. About the same time Mr. Ferguson called attention to the block nature of some coal found by Mr. Rardon near Brazil. It was first shipped out of the county in 1852 by Mr. John Weaver and Capt. Ezra Olds, being obtained from the bed of Otter creek. Its subsequent history, as of the coal in other counties, will be treated under those counties.

From this time on mining operations on a large scale began to develop rapidly until in 1879 the coal industry demanded the attention of the Legislature, which passed certain laws for the regulation of the mines, and provided for a Mine Inspector. At this time the output of the State was over one million tons and a like number of dollars were invested in mining property. In 1886 Indiana, with a production of two million tons, stood seventh among the coal producing States of the Union. In 1889, as shown by the Eleventh Federal Census, Indiana stood eighth, with a production of nearly 3,000,000 tons. In 1896 Indiana stands eighth, with a production of 4,068,124 tons and an invested capital estimated at $1,750,000.

In this connection the following chronology of coal mining, in the main from a compilation by Mr. H. H. Stock, is of interest as showing the historical development of coal mining and usage and the relative position of the events just enumerated.

A CHRONOLOGY OF COAL MINING.

COMPILED FROM THE FOLLOWING SOURCES, BY PROF. H. H. STOCK, WITH MANY SUBTRACTIONS AND WITH SOME ADDITIONS FROM INDIANA'S COAL HISTORY BY G. H. ASHLEY.

The Coal Trade Journal, "The Story of American Coals," by W. N. Nicholls; *The Bond Record*, "Anthracite Coal," by William Griffith; *The Mineral Industry*, Vols. I, II and IV; "Iron in All Ages," by James M. Swank; *Colliery Guardian*, "Annals of Coal Mining," by Robert I. Galloway; "Coal, Its Antiquity, Discovery and Early Development in the Wyoming Valley," a lecture by Mr. Geo. B. Kulp.

B. C.

1000. Possible reference to coal by Solomon's proverbs. Charcoal probably meant.

330. Coal mentioned by Theophrastus in his book of Stones as being used by blacksmiths in Greece and Italy.

——. Coal used by the Chinese before the Christian era, but there is no record of the date.

54. The presence of coal in Britain and western Europe, probably known to the Romans during the time of Julius Caesar, but not worked to any extent.

A. D.

852. Possible mention of coal mining by the Abbot of Petersboro, tenth century. Coal mining in Zwickkau, Germany.

1190. First definite mention of coal mining in England, by the Bishop of Durham.

1200. Coal mined in Belgium.

1239. First license for digging coals granted by Henry III.

1240. First shipment of coal to London.

1305. First mention of Welsh coal mining.

1306. Use of coal prohibited in London on account of smoke.

1325. Coal exported from England to France.

1350. Chimneys came into use in England, and mine gases first noticed.

1526-28. First metallurgical use of coal in England.

1552. First notice of the possible exhaustion of the English coal fields, the export of coal prohibited to husband the supply and to harass the French, to whom the coal was principally shipped.

1583. First coal trust or coal combination to control the price of coal, and first combination of coal workers to control the workmen employed.

1589. Patent granted for use of coal in iron or lead smelting (failed).

1600. Coal supersedes wood as a domestic fuel in England. Boring for coal introduced. Wagonways introduced.

1606. An act passed binding colliers to perpetual service at a given works. Not fully repealed until 1794.

1632. Gunpowder used in German mines.

1640. First record of English fire boss.

1650. Dud Dudley made strenuous efforts to use coal in iron smelting.

1665. Ventilatng furnace used in Belgium.

1695. Savery fire engine used for raising water. Lead and tin first smelted with coal in England.

1698. First mention of coal in America by Father Hennepin on the Illinois River, near Fort Creve Coeur.

1701. Coal discovered in Virginia by Col. Burd.

1705. First fatal colliery explosion at St. Mary's Church, Gateshead, England.

1708. First English book on coal mining, "The compleat collier, or the whole art of sinking, getting and working coal, etc., mines, etc., as now used in the Northern parts, especially about New Castle and Sunderland, by F. C."

1750. Coal mined in Virginia.

1755. Coal discovered in Ohio by Mr. Lewis Evans.

1759. Presence of coal in Western Pennsylvania mentioned in diary of Col. W. Burd.

1760. Anthracite discovered in Rhode Island.

1762. Anthracite first noted at Wyoming, Pa.

1763. Coal noticed on the Wabash river, by Col. Croghan.

1766. Air coursing introduced. Steel mill invented for purposes of lighting.

1768. Anthracite used in the Wyoming Valley, Pa.

1775. First ark of anthracite shipped from Wilkesbarre, Pa., to Carlisle Barracks, Pa., via the Susquehanna river.

1784. Mining begun in Pittsburg region through grants of mining privileges made by the Penns.

1792. First notice of mine records being preserved in England.

1800. Method of manufacturing coal gas discovered.

1800. Wm. Morris took a load of anthracite to Philadelphia but could not dispose of it.

1804. Coal discovered west of the Mississippi river, along the Yellowstone, by the Missouri river expedition and by Capt. Pike on the Osage river, Kansas.

1804. Coal noted in land surveys in Indiana, and its position marked on maps.

1812. First convention to consider means of suppressing fire damp, held in England.

1812. Coal dug at Fulton, Perry county, Ind., and taken aboard steamboat "Orleans" by Robert Fulton.

1828. First cargo of bituminous coal from a Pennsylvania mine, shipped from Karthaus, Clearfield county, Pa., to Philadelphia.

1831. Dr. Geissenhainer applied for a patent for making iron with anthracite.

1832. Coal advertised as for sale in Indiana, being mined a little at numerous points in the State.

1836. Franklin Institute, of Philadelphia, offered a prize to the one who should first make over 20 tons of pig iron from anthracite. (Not awarded.)

1837. The American Cannel Coal Co., of Cannelton, Ind., incorporated.

1840. Coal being shipped in small quantities by flat-boats from points along the Wabash, Ohio and White rivers.

1841. Manufacture of Connellsville coke begun.

1850. First coal shaft in Indiana, sunk by John Hutchinson near Newberg, Warrick county.

1851. Indiana block coal discovered.

1852. Indiana block coal first shipped out of county.

1855. Anthracite leads charcoal in the manufacture of pig iron.

1860. First use of coke in a Pittsburg blast furnace.

1869. Coke first leads charcoal in manufacture of pig iron.

1875. Coke leads anthracite in the manufacture of pig iron.

PREVIOUS GEOLOGICAL WORK ON COAL OF INDIANA.

Fortunately for the rapid prosecution of the present survey of the Indiana coal field, a preliminary examination of the field was made in the earlier years of the Geological Survey. I call it preliminary, notwithstanding the fact that probably three or four times as much time and effort seems to have been given to making it as has been possible with the present survey. As to the quality of the work, it must be remembered that the members of the earlier survey were working in entirely new territory, at a time when the small local demand for coal had not led to the opening of nearly as many small mines as at present. They had practically to make their own maps, and, take it all in all, it is not to be wondered at that many errors should be found by the members of a later survey, working as they did with their predecessors' reports in their hands, with maps ranging from fair to excellent on which to put their data, with the better knowledge of the coal beds from examinations in a much larger number of extensively worked mines, and with possibly certain advantages in methods that have been developed in the thirty years since the earlier work began. Nor do the members of the present survey claim

any undue merit for being able to present more accurate maps, a more detailed stratigraphic column, or in general a more accurate review of local details, sections, etc. We realize too well that in the very limited time at our command it is unavoidable that many errors will be found in our work.

Without considering the observations of several geologists in Indiana in the early part of the century (1807, Maclure; 1818, Stitson; 1823, Long), the first definite information about the Indiana coal fields was obtained when Mr. David Dale Owen, in conformity to an order of the Legislature, made a geological reconnoissance of the State in 1837 and 1838. The report for 1837 was published at Indianapolis in 1838. It comprised 38 pages. It was revised and republished in 69 pages in 1859. The report for 1838 was first published in 54 pages in 1839 and revised and republished in 1859. In these Mr. Owen gives in a general way the eastern boundary of the coal measures and mentions coal at several places.

The following year (1839) Mr. Owen made a geological exploration for the government of part of Iowa, Wisconsin and Illinois. In his report, published at Washington in 1844, he gives a chart of the Great Illinois Coal Field (Plate IV), which on a very small scale shows by a map the extent and position of the coal measures of Indiana.

In 1843 Lawrence Byrem published a geological map of the Western States, which I understand is a republication of a geological chart of the Ohio Valley prepared by D. D. Owen for publication in 1846.

In the same year (1843) Mr. Owen had a note on "Fossil Palm Trees in Posey County," besides papers published in 1843 and 1846 on the Geology of the Western States.

In his Geology of New York, part 4 (fourth or western district), James Hall gives a geological map of the Middle and Western States (Albany, 1843). The same year he published notes on a "Section from Cleveland, Ohio, to the Mississippi River, in a Southeast Direction."

In 1848 (2d ed., 1855), Mr. Richard C. Taylor published a map of the Illinois-Indiana coal field in his "Statistics of Coal."

In the same year Mr. David Christy, in "Letters on Geology," published at Rossville, gives a section of the Lower Carboniferous as exposed between Paoli and French Lick, Orange county, and notes the geo-synclinal structure of the coal field across Indiana and Illinois.

In 1853 a geological map of the United States was published by Jules Marcou.

In 1853 Mr. R. T. Brown made an official report to the Indiana Board of Agriculture on a "Geological Survey of the State of Indiana."

From this time on Indiana coal-measure geology is included in numerous general publications which need not be mentioned, as they seldom include any original matter.

In 1859 the State Legislature passed an act for a "Geological Reconnoissance of the State, which should prepare the way for a more full and systematic system hereafter." David Dale Owen was appointed State Geologist, but by arrangement the work was placed in the hands of his brother, Richard Owen; at first temporarily, but permanently on the death of D. D. Owen. His report, published in 1862, treats very briefly nearly all the coal counties and includes a report on the same counties by Leo Lesquereux, the well known paleo-botanist. The same report also includes the report of Joseph Lesley on the fractional township 7 south, range 3 west, in Perry county. The original report by Mr. Lesley included a topographical and geological map of the area. This was never published and later disappeared. It is of no small interest that Mr. Owen, almost simultaneously with the starting of the reconnoissance of the State, should start a detailed topographic, geological map of the State. The cost of such a map Mr. Lesley estimated to be $150 per township, field and office work included, it apparently being one of the objects of the survey to determine the cost of carrying on such work over the State. Unfortunately, the lapsing of the survey prevented further work of the kind, and as a result the State has probably paid out in the past for successive partial reports on the same areas more than enough to have made complete detailed maps and reports, showing topography, location, extent and value of all rocks or minerals of economic importance, surface geology or distribution of soils, etc.

In 1865 a geological map of Indiana on a scale of five miles to one inch was published at Cincinnati by Mr. N. Sayler.

In 1869 the office of State Geologist was revived and Mr. E. T. Cox appointed to that position. Immediately a detailed survey, or rather examination, of the coal field counties was begun and under Mr. Cox and Mr. Collett, with the assistance of Mr. Frank Bradley, Mr. R. T. Brown, Mr. B. C. Hobbs and others, was carried on until 1883, when the last report of the coal counties appeared.

The character of the field work in the various counties varied greatly. Several of the counties never received more than a preliminary survey. Thus, in Warrick county, three sections were obtained, the coal from one mine analyzed and four pages of descriptive text given. On the other hand, in some of the counties the field work occupied several times as much time as could be devoted to it by the present survey, and the reports on those counties were, as a rule, correspondingly complete and detailed. In such cases the abundant columnar sections obtained, especially those by Mr. Collett, have proved of inestimable service in the present survey. The correllation of the coals and the location of points on the map appear to have been to too large an extent guess work, and this factor of unreliability prevented more than an occasional use of those parts of the reports.

Under each county will be found references to the previous reports on those counties and by whom made. Since 1879 the Mine Inspectors' reports have proven a valuable source of information, particularly in often showing the depth and thickness of the coal at mines whose abandonment has prevented the obtaining of that often useful information. These have also been largely drawn on in preparing the lists of old mines. In the twentieth annual report Mr. W. S. Blatchley discussed the clays and shales of the coal measure area and Mr. T. C. Hopkins treated the sandstones suitable for building purposes. In the twenty-first annual report appeared a report on Vigo county by Dr. J. C. Scovell, in which the coals of that county were somewhat fully treated.

Since 1883 geological maps of the State, showing the distribution of the coal measures, have been published by Mr. Collett and others. No attempt at colored geological maps was made in connection with the reports of the coal counties. As stated above, the field work was more of the character of an examination than of a survey, the maps as a rule showing only the points at which data were obtained, without attempting to show the distribution of particular coal beds or formations. A large part of the errors in stratigraphy of the earlier survey are doubtless due to lack of surveying methods, or the systematic tracing of the coal beds and their accompanying strata.

In 1886 the discovery of natural gas in Indiana and its enormous development in the following years practically destroyed a large part of the home market for Indiana coal and seriously crippled the industry in this State. Indiana was then compelled to seek outside markets, where she had to compete with coals which had every advantage in the way of freight rates, etc., and the fact that under those conditions the coal output has steadily increased with a large share of the output going out of the State speaks in no uncertain terms of the value of Indiana coal and its appreciation by those who use it.

The discovery of natural gas brought a great influx of manufactures and changed the State from a nearly purely agricultural one to a manufacturing State of some importance.

For several years now there have been signs of a rapid depletion of the gas, becoming each year more apparent, and the practical exhaustion of the gas field in the near future is now generally admitted. With the appreciation of that fact began to come a demand from many directions for information about the coal of Indiana, and especially from two directions. First, from manufacturers who have never used Indiana coal or fear the supply of it may be as transitory as the gas has been; second, from those who appreciate that with the failure of the gas gradually opening up the home market, the demand for and output of Indiana coal ought to be doubled, and hence desire information about the coal fields with a view of their increased development to meet the increased demand. There was nothing with which this rapidly increasing demand could be met. The old reports on the coal counties were scattered through near a dozen volumes, now all out of print. Furthermore, for many obvious reasons, a reprint of those old reports would not be desirable. It was, therefore, decided by W. S. Blatchley, the State Geologist, to prepare a new report, which, while using such materials of the old reports as were found to be reliable, was to be based largely on an original investigation of the field. It was further planned that it should be accompanied with maps, cross sections and other matter necessary to show with some accuracy the distribution of the coal beds, horizontally and vertically, and in general be prepared to answer the questions that were constantly being asked.

Character of Field Work.—As noted above, as a result of the test made by Mr. Lesley in 1860, he estimated that the cost of a thorough survey of the State would average about $150 per township, or about $35,000 for the work of the whole coal area, a small amount as compared with what has been given by many of the States. Appreciating the ultimate value of work thoroughly and well done, Mr. Blatchley made great efforts in 1897 to have the Legislature make an allowance of $10,000 for each of two years for a survey of the coal field. Failing in this, it was necessary to fall back on the general fund, which would allow for the whole work only about one-seventh of the amount which had been estimated as necessary to do the work as it should be done. To do the work under those conditions required that each man, while in the field, should survey on an average fifteen square miles a day. The impossibility of making an accurate detailed survey and study of the coal at such a speed is too readily recognized to need comment. The result is most prominently seen in two ways: In the amount of information obtained which could not, through lack of time, be verified, and in the number of areas where complexity of

structure, variability of coals, or other conditions would have required more time for their unraveling or working out than could be given them.

Under the circumstances it was thought best not to attempt uniformity of work regardless of coal values, but to put a much larger share of our time and effort on those areas that gave promise of containing commercially workable coals, and less to those areas where the coal was thin. For similar reasons the writer has, as a rule, personally examined those counties or parts of counties which development or reports showed to contain the main areas of workable coals, though trips were made in each of the other counties except Warren and Posey, and all areas of extensive mining examined. The field work began in August, 1896, the writer spending three months in the field. In 1897, in addition to the writer, were Mr. Claude E. Siebenthal, who spent the whole season in the field; Mr. Edward M. Kindle, who spent August and September in field work, and Dr. J. T. Scovell, who spent about ten days with the writer in Vigo county, with the geology of which he was very familiar. Dr. Thomas Watson joined the survey in July, but was almost immediately called home by serious sickness in his family. In 1898 the writer spent two months in the field, and Mr. J. A. Price and Mr. Kindle about thee months each, beginning in April.

In connection with the field work the members of the survey wish to unite in thanking all who have in any way assisted in the work. We have met everywhere only kindness and a readiness to help, probably over 5,000 of our citizens having rendered assistance in one way or another. This has been especially true of those connected with the larger mines, who not only accompanied us through the mines, but often offered us freely drill records and other information of value, or accompanied us for from half a day to a day or two to better point out the relations of things as they had worked them out. We are also under obligations to most of the railroads of the coal area for favors, and to many business and newspaper men of that part of the State. Nor should the writer fail to express his thanks to the other members of the survey for their hearty co-operation in this part of the work and the fidelity and care with which the work was done.

The Report.—The table of contents gives a very complete outline of the report. Suffice to say here that the report is for convenience divided into four parts.

Part I discusses the general geology of coal. In the manner of presentation and in the amount of space given to the various subheads I have been largely governed by the character of the questions asked me in the field by those who will doubtless take a real interest in the report.

Part II discusses the general geology of the Indiana coal field and is intended in part to serve with Parts I and IV, as an introduction to Part III; and, secondly, by giving a general synopsis of the stratigraphy and distribution of the coals over the field, to answer the purposes of the general reader, who will seldom care to wade through the mass of details given in Part III.

Part III deals with the local details of the character, stratigraphy and distribution of the coals. It is intended largely for reference, and to that end seeks to give all the information obtained. In the discussion of Part II, little or no attention was paid to artificial geographical lines. In Part III, for the purpose of reference, the artificial geographical lines are made the basis of the discussion, which is taken up by counties and under those by congressional townships.

With this part is given a colored geological map of the whole coal area, on a scale of two miles to the inch, published in seven sheets. Then on a scale four times as great, or one mile to the inch, are given sketch maps of the principal coal and mining areas. These usually form page or double page plates, and are placed at the head of the discussion of the townships represented. They are often accompanied by cross sections. Realizing the advantages of graphic representation for purposes of comparison, diagrams of the more typical columnar sections of the rocks, and on a larger scale of the coals, are made and placed together so that the comparisons are readily made. The practice of doing this while carrying on the survey was found to be of great assistance in recognizing characteristic features of the coals or of the larger sections, and it is hoped the plan will prove helpful to an appreciation of those features by the reader.

For suggestions as to the manner of treatment I must acknowledge my obligations to a greater or less degree to practically all of the recent coal reports of other States, and while the excellent county reports of Pennsylvania have been most conspicuously followed as far as the limited time permitted, yet in certain features the treatment will be found to be new, whether at a loss or a gain in the value of the report is for the reader to decide.

Part IV discusses and illustrates the methods of mining, marketing and utilizing coal followed in Indiana, together with some notices of methods not used here now, but which in some cases might prove a good change over those now used. It is given partly for the benefit of those not familiar with that phase of the subject, and partly for

those who, while perhaps engaged in mining, are not acquainted with the methods used in other mines or other districts, and may find some helpful suggestions in it. It also gives tables of mines, and other related matter and statistics, as well as including the Mine Inspector's report.

While the work of preparing the report, maps, drawings, etc., rested entirely with the writer, he wishes to acknowledge much assistance from several sources.

First. In most cases the assistants prepared short summaries of data obtained by them to serve as a key to their note books and field sheets, and while in most cases this material could not be incorporated in the final report to any extent, in three or four counties the matter thus prepared, when incorporated, formed from one-fourth to one-half of the completed report on those counties.

Second. Mr. Price, while still a member of the survey, practically prepared the drawings of Pike and Dubois counties on Sheet E and Spencer County on Sheet F.

But a still larger amount of purely voluntary assistance was received as follows:

Mrs. G. H. Ashley, Division XI of report, Sheet G of geological map, several of the sketch maps, and all or the major part of several hundred of the columnar and coal sections and text figures, almost all of the sandstones, clays and coals of all the figures, and sections, proof-reading, etc.

Mr. J. A. Price, complete reports on Dubois and Spencer counties. We were fortunate in being able to arrange with Mr. Price after he had left the survey to prepare full reports on the counties surveyed by him, as it not only made possible very much better reports on those counties than the limited time at the writer's disposal would have allowed, but by the time thus gained permitted a little better work on the other county reports.

Mr. James Epperson, Division XLVIII of the report. The material gathered by the writer for this chapter covered such a long period that it was thought best to regather most of it in the last month or so before the report went to press, and Mr. Epperson kindly volunteered to do the work.

Acknowledgment should be made to both Mr. Fisher and Mr. Epperson for many favors, suggestions and helps received. Much gratitude is due the State Geologist for the kindly interest shown throughout the work and the complete freedom accorded.

PART I.—GEOLOGY OF COAL.

I. COAL AS A ROCK.

Section 1. Composition of Coal.

1. Definition of Coal.—Coal is the name applied to a related group of massive, uncrystalline, black or brown bedded minerals or rocks, which are composed largely of carbon with some oxygen and hydrogen and a few other elements, and are economically important as fuel.

2. Composition of Coal.—Coal is by some writers treated as a mineral, by others as a rock. As coal lacks the definite chemical composition which minerals are generally considered to have, it will be treated here as a rock. Coal is a mixture of certain elements, or compounds of these elements. The principal element is carbon, a common form of which is charcoal. The diamond and graphite are other forms of the same element. Oxygen and hydrogen, the two gases which combined form water, are the next most abundant elements. With these are traces of the elements nitrogen, sulphur, and more or less of other substances that will not burn and are grouped together as the ash. The ash will include traces of silica, potash and soda, sometimes alumina and iron, and in impure coal some shale or dirt. The way these elements differ in different coals is shown in the following table:

3. Table Showing Composition of Different Coals.

		Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Sulphur.	Ash.	Analysts.
1	Coal, Eastern Pennsylvania....	90.45	2.43	2.45	......	......	4.67	Regnault.
2	Coal, Clay county, Ind	82 70	4.77	9.39	1.62	0.45	1.07	Cox.
3	Coal, Ohio	73.80	5.79	16.58	1.52	0.41	1.90	Wormley.
4	Coal, Breckinridge, Ky	68.13	6.49	5.83	2.27	2.48	12.30	Peters.
5	Coal, Bovey	66.31	5.63	22.86	0.57	2.36	2.27	Vaux.
6	Peat	59.47	6.52	31.51	2.51	......	....	Websky.

4. How the Elements Occur.—In studying coal it is found that while some of the matter is in the elementary stage, much of it is in the form of compounds. Thus, part of the carbon is uncombined, when it is known as the "free carbon" or "fixed carbon," while the rest

of it is combined, partly with the hydrogen, making the hydro-carbons, as marsh gas, tar, etc., and partly with the oxygen making the gas carbon monoxide. The hydro-carbons are gases or become so on heating. Part of the hydrogen and oxygen will be found combined in the form of water. The sulphur occurs principally as a simple compound with iron, forming the mineral known as pyrite, a mineral closely resembling gold in its yellow color. The "sulphur balls" frequently noticed in the coal are an impure form of the same mineral.

These elements and compounds may then be grouped as:

1. Fixed carbon,
2. Gases that will burn or the volatile combustible material,
3. Water, will not burn,
4. Sulphur, considered by itself for reasons given below,
5. Ash.

5. Proximate Analysis.—An analysis of the coal which shows the proportion of the above parts of the coal is known as a proximate analysis. It is easier to make than an ultimate analysis, or one which determines the proportions of the elements, and is much better for determining the value of coal for fuel purposes.

The subjoined table will give an idea of the variation of the above constituents in different coals.

Table Showing Proximate Analyses of Different Coals.

		Fixed Carbon.	Gas.	Water.	Sulphur.	Ash.	Analysts.
1	Coal, Eastern Pennsylvania	86.38	3.08	4.12	0.50	5.92	McCreath.
2	Coal, Clay county, Ind	55.25	39.85	3.40	......	1.50	Cox.
3	Coal, Pittsburg, Pa......................	54.56	37.74	1.79	1.50	4.47	McCreath.
4	Coal, Fountain county, Ind	47.50	47.00	4.50	......	1.00	Cox.
5	Coal, Carbon City, Colo.................	41.25	46.00	3.50	......	9.35	Cox.

Section 2. Chemical and Physical Properties of Coal.

6. Combustion.—The most valuable property of any coal is its power to produce heat by the oxidation or burning of its constituent parts. If these parts are examined it will be found that two of them will not unite with oxygen or burn, as they are already practically burnt substances, or highly refractory, the water and the ash. The weight of ash in any coal is that much unburnable matter and reduces

the heat value of the coal that much. The water not only reduces the heat value by not burning, but absorbs a part of the heat produced by the other components while being evaporated. The sulphur yields a small amount of heat, but its value in this direction is more than offset by its injurious effects in the commercial use of the coal, as will be shown further on.

The combustible volatile matter yields the most heat for its weight, but in the ordinary usage of coal much of this is lost. For most of the purposes to which coal is put the fixed carbon is the most valuable element. Future practice may modify or change the truth of this statement.*

7. IGNITING OF COALS.—In general it may be stated that those coals containing a large proportion of gas ignite readily, while those containing a small proportion of gas ignite with difficulty.

8. CAKING.—Some coals when heated have the property of softening, becoming viscid and running together into a solid mass. Coals are sometimes classed on this basis as "caking or cementing coals," and as "non-caking," "free-burning," or "splint coals." The former coal is generally preferred by the blacksmith on account of its forming a "hollow fire," and hence is sometimes referred to as "blacksmith coal." The term "blacksmith coal" is, however, often used in speaking of a part of a bed of caking coal on account of its freedom from sulphur and other impurities. In parts of Indiana a caking coal is spoken of as a "bituminous" coal in contrast with what are known as "block coals," which in general are non-caking or splint coals. In the general usage of the term "block coal" this may be misleading, as will be shown later. The caking or non-caking property of coals seems to be the result of physical conditions more than of chemical, as a comparison of chemical analyses of the two kinds of coal fails to reveal any constant and noticeable difference. If caking and non-caking coals be compared, it will generally be found: First, the caking coal is a bright coal, while the non-caking or splint coal has a dull fracture; second, the non-caking coal splits more readily parallel to the plane of bedding, and if these planes along which it splits be examined they will be found to resemble sheets of charred shavings still showing the fibre, like charcoal; and if one of these sheets be examined chemically it is found to resemble charcoal further in having a very high percentage of carbon. An analysis by Mr. Cox of the carbonaceous matter between the laminae gave as follows:

*See "Utilization of Coal," Part IV.

Fixed carbon	83.40
Gas	13.30
Ash, white	0.80
Water	2.50

These charcoal-like sheets are very abundant in a non-caking coal, and it is supposed that its non-caking property is due to their presence, as being almost like charcoal they will, of course, not run together, nor will they allow the more bituminous parts of the coal to run together.

9. COKING.—By heating a caking coal out of contact of air, or burning it with a very meager air supply, the volatile materials are driven off, leaving a hard cake, lighter than the coal used, though of somewhat greater bulk, and for certain uses very valuable as a fuel. Those coals which will thus make coke are often known as "coking coals." Practically all caking coals are coking coals, but not all will make commercially valuable coke.

10. HARDNESS.—Coals vary in hardness from 1.2 to 1.8. That is, from a little harder than talc, which can be scratched readily with the finger nail and is taken as 1 in the table of hardness, almost to the hardness of rock salt, which is taken as 2 in such a table. The hardness of a coal influences its value to a large degree. A soft coal crumbles readily in mining, entailing some loss; there is further loss in screening and handling, and a still further loss in shipping and delivering. Often soft coals of excellent quality and thickness are allowed to lie undeveloped, or at most supply only a local trade, because of the loss in shipping. Such coals can be made of value by proper treatment, as will be discussed in Part IV of this report. Often coals which appear hard and firm will soften and crumble to fine coal when exposed to the weather. This is due to the presence of sulphur and other impurities, or to the gas contained.

11. FRACTURE.—Coals vary greatly in fracture. The hardest coals break often with a conchoidal or shell-like fracture. More common are the coals breaking into more or less cubical blocks, sometimes with bright faces, often with dull, but most commonly with alternate bright and dull bands. Such coal tends to cleave along the dull lines when struck. Examined in the mine, it is found that the laminations agree with the bedding.

Section 3. Varieties of Coal.

12. Basis for Divisions.—Based on the differences above considered, different kinds of coal have, for convenience, been given different names. These are based principally on the different proportions of fixed carbon and volatile compounds contained.

13. Anthracite or "stone coal" is coal number 1 of the above analyses. As shown, it has a high percentage of fixed carbon, from 78 to 88 per cent., with from 3 to 7 per cent. of volatile matter, usually some sulphur, and from 4 to 12 per cent. of ash. It usually has a high lustre, sometimes approaching metallic, a gray-black color, sometimes iridescent (peacock colors), a hardness of from 2 to 2.5, and when pure will weigh about 100 pounds to the cubic foot. It often has a conchoidal fracture. It burns with a feeble blue flame.

14. Bituminous.—This is the most abundant coal, and is well known as a soft coal burning with a yellow flame and usually with much smoke. Coals 2 and 3 of the above tables are bituminous coals. As shown, they have a large per centage of volatile matter, often 40 to 60 per cent.; ash 1 to 8 per cent., usually less than anthracite; sulphur, 1 to 3 per cent.

Bituminous coals are usually divided into three groups: (1) Caking coal, as above defined; (2) "non-caking," or free burning splint coal; (3) "cannel coal." Bituminous coals are sometimes classed as "cubical" or "block" coals, from their tendency to break readily into cubical blocks. In Indiana, however, the term block coal is restricted to coals in which a regular system of joints is developed in a high degree.

15. Cannel Coal is a lustreless, very compact and even textured coal with a large conchoidal fracture. It does not differ much in composition from ordinary bituminous coal, though usually having a larger percentage of gas, as shown in Coal (4) P. 3. It burns like a candle, whence the name, taking fire readily and burning with a yellow flame without melting. It does not smut the hands, and aside from its use as a fuel or as a source of gas, is used for many of the common purposes to which rock is put, for house and barn foundations, stepping stones, etc., as around Cannelsburg, in Daviess county. It is valuable as an oil and gas producing coal. Its difference from bituminous coal seems to be due to a difference in origin, as will be noticed later. Cannel coal often grades into bituminous shale, or even into non-bituminous shale.

16. Lignite or "brown coal" varies from brown to black in color, often shows woody structure, contains a large amount of moisture and other volatile matter, and is usually very soft and easily crumbled. Coals (5) of the above tables.

17. Peat is the name given to the thick mass of vegetable matter occurring in swampy regions to-day, and which is believed to represent one of the first stages in the formation of coal. Coal (6) of the first table. In the northern part of the State peat beds are met with having a thickness up to 50 ft.

18. Graphite is a carbonaceous deposit consisting practically of nothing but fixed carbon, and believed to belong to the coal series, though not used as a fuel.

19. Intermediate Kinds of Coal.—No line can be drawn between the different kinds of coal, as all intermediate grades can be found. Thus, between anthracite and bituminous are recognized semi-anthracite or semi-bituminous coals according as they approach more nearly anthracite or bituminous.

20. Kinds of Coal in Indiana.—Passing over the peat which occurs in certain parts of Indiana, all the coal of this State is bituminous. No anthracite coal is known to occur in Indiana, and the conditions seem to warrant the statement that anthracite will never be found in Indiana. All three varieties of bituminous coal occur here—caking, non-caking or splint, and cannel coal.

Section 4. Impurities of Coal.

21. Sulphur.—Of the impurities in coal, sulphur is probably the most important, as it is the most injurious. A coal containing sulphur will not stand the weather, but will tend to slack and disintegrate. Such a coal will not bear transportation nor long storage, even under cover. The sulphur usually occurs in the coal as pyrite (iron sulphide), of a bright yellow color. Pyrite tends to take up oxygen from the air or from water, changing to iron sulphate, which readily crumbles. Sometimes this oxidation takes place so rapidly in the coal mine that spontaneous combustion results from the heat generated. Sulphur in the coal also tends to make the coal clinker and stick to the grate bars. A coal containing sulphur can not be used for blacksmithing or working iron, because the iron will take up the sulphur, thus becoming "short," that is, brittle and less easily worked.

22. PHOSPHORUS is also injurious to iron and will prevent any coal containing it from being used in metallurgy. Among the other impurities which go to form the ash are silica, potash, and sometimes alumina, as already noted.

23. The gas NITROGEN, being a non-combustible gas, adds that much weight without assisting the combustion, and to that extent acts as an impurity.

24. OXYGEN might be included under the same head in so far as it is an unnecessary ingredient; for, while it may be of value to assist the oxidation or burning of the carbonaceous part, that office can just as well be filled by the oxygen of the air.

25. The WATER, in like manner, has been shown to be an impurity viewed from the use of coal as a fuel.

II. OCCURRENCE OF COAL.

Section 1. The Coal Bed.

26. COAL OCCURS IN BEDS.—If we enter a coal mine by a shaft or slope which exposes the rocks, we note as we go down that the rocks of different kinds lie above each other in horizontal or nearly horizontal layers. When the coal is reached it is found to extend horizontally and parallel with the other layers. In some places the coal is exposed in the face of a vertical cliff (see frontispiece), where it is still more apparent that the coal is simply a bed or layer lying between other layers and having much in common with them, notwithstanding the difference in composition. It will be noted that when the other rocks of the cliff are not horizontal, but dip or slope up or down, the coal will dip up or down at the same angle. Again, if the thickness of the coal be accurately measured at convenient distances along the face of the cliff, it will be found to vary, sometimes considerably, particularly if the section is a long one. If the accompanying layers above or below be measured at the same time, they will be found to vary also, though probably not just as the coal did. Note also that the layers of rock and coal seldom have the same slope as the hill in which they are exposed, though sometimes a slight rise toward the center of the hill is noticed.

We are led to conclude that as far as Indiana is concerned the rocks lie in more or less nearly horizontal layers; that the coal occurs in similar layers, agreeing with the other rocky layers in position, and in variability.

27. EXTENT OF COAL BEDS.—It is not an unknown thing in the State, in places where coal mining has been carried on extensively for some time, to find connected mines where one may travel from one to several miles underground. The evidence in such a case is conclusive that the coal bed has at least that extent, especially when the coal has been personally observed with a lantern for the whole distance. Again, if a set of drillings, made more or less in a line, be examined, it will be observed that certain of the thicker beds of coal can be identified in one after another in succession, as shown on Plates XXIII, etc. In this way it is often possible to trace a coal bed across a county or even farther. Leaving our own State for a moment, if we should start from Pittsburg and travel up the Monongahela river, or any of its tributaries, we may note a conspicuous horizontal black band, broken at short intervals by openings from which tramways lead to long buildings or "tipples" extending out over the river. It is the well-known Pittsburg coal bed, and has been traced over an area 225 miles long by 100 miles wide. On the other hand, if we visit the Iowa coal field, we find it exceptional to be able to trace a coal bed more than four or five miles. Again, in Part III, are shown a number of deep borings in Knox and Daviess counties. Note that while near the top the thicker beds can be traced from one to another, the lower beds can not be so traced. Evidently, then, a coal bed may vary in extent from a few acres to several thousand square miles. In Indiana there seem to occur beds of both limited and of great extent.

In this report, where coal beds of different areas are correlated, we should not be interpreted as intending to imply thereby that beds so correlated extend continuously from one area to another. They may do so. It is possible that some of the main coal beds of Indiana do extend over several thousand square miles. But when the average thickness of most of the beds in Indiana is considered (in the neighborhood of four feet); when the fluctuations in thickness and character of the accompanying rocky layers, as well as that of the coal, is considered, and when the conditions necessary to the laying down of coal are considered (as given in the next chapter), it is difficult to conceive of the conditions necessary to the laying down of a coal bed as existing simultaneously and uniformly over all the coal field covering most of Illinois and part of Indiana and Kentucky so as to result in the deposition of a nearly uniform, continuous sheet of coal.

28. Coal Basins.—In the preceding paragraphs it has been stated in a general way that coal beds are of variable extent and thickness. Is there any regularity in these variations? From one standpoint there is not, still there is one factor that so constantly accompanies the coal that it must be considered as the normal method of coal occurrence and so should be considered here. That is the occurrence of coal in basins.

Fig. 1. Ideal Section of Coal in Basin.

If a bed of coal which still retains its normal condition be examined, it is found that

First—It has an area of greatest thickness from which it regularly becomes thinner in every direction. It may entirely thin out or it may simply become too thin to mine profitably.

Second—Where such a body of thick coal is of small extent, if a cross section be made of it, it is commonly found that the section of the coal has broadly the shape of a saucer as shown below, the thickest coal lying at a lower level than the thin coal.

The miners commonly speak of the part of the basin where the coal is lowest and thickest as the "swamp" and where it rises and becomes thinner as the "hill."

These basins may have an extent of only a few acres, when they are commonly known as "pockets." In Indiana, however, pockets are more commonly due to certain irregular causes, which will be discussed in a later chapter. In Crawford No. 1 mine, in Parke county, four small basins are being worked, each being drainless and requiring to be separately pumped from. More common are basins of from 20 to 30 acres up, each basin being worked by a separate shaft.

In Indiana it is a general condition that the basins increase in extent as we rise through the coal measures, so that in the lower bituminous beds in the upper part of the series the basin structure is hardly discernable, the original basin having covered several hundred to several thousand square miles, the coal maintaining over that area a remarkable uniformity of thickness and of detail (except as irregularly disturbed). Often clay bands a fraction of an inch thick, or even knife-edge partings are found over a coal basin of hundreds or thousands of square miles. This is well illustrated in Coal VI, as described

beyond. Yet, if one of these beds be traced far enough it can be seen to gradually thin out, as illustrated by the group of sections showing feathering out of Coal VI between Coxville and Mecca. See Part II, Plate XI.

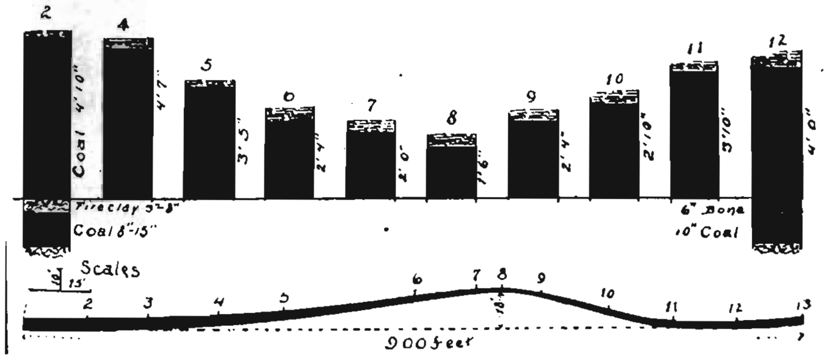


Fig. 2. Sections showing the thinning of the coal in passing from one basin to another. From measurements made in Crawford No. 1 mine, Parke county.

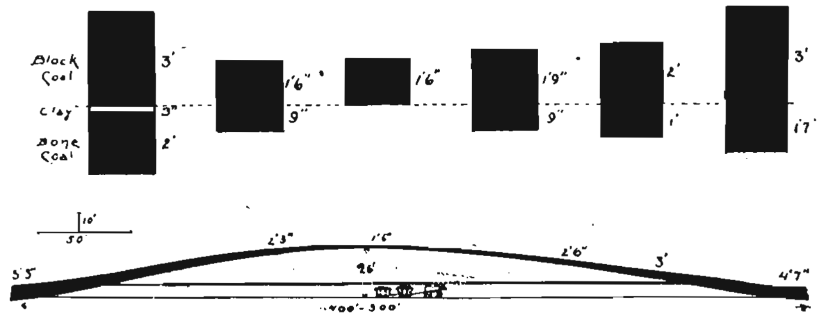


Fig. 3. Same, from measurements in Gartsherrie No. 5 mine in Clay county.

A coal basin can best be studied from a small basin. In Indiana no such perfect exposure of a coal basin in section has been found as was recently illustrated in the Geological Reports of Iowa,* but measurements were taken at a number of places in the mines showing practically the same conditions. Two of these are given by diagram here, illustrating the thinning of the coal over the hills. The first is from Crawford No. 1 mine, in Parke county, the second was obtained, partly from a 26-ft. cut, and partly from the air-course running parallel, in Gartsherrie No. 5 mine of the Brazil Block Coal Company, in Clay county.

* Iowa Geol. Surv., Vol. II, 1894, p. 53.

In these cases the entries were driven over the hills at points where the coal in crossing was thickest, drillings showing much thinner coal on top of the hill at other points.

In some cases the basins are widely separated and the intervening hill may be completely barren of coal. In other cases, and more commonly, the basins are fairly close together and at least a few inches of coal over the hills connect one basin with another. Sometimes places will be found between two basins where no marked hill exists and a good thickness of coal extends at that point from one basin to another.

29. Coal Horizons.—The constant recurrence of a similar succession of coals in borings and mine shafts, in which the coals from one to another bear about the same relative importance to each other, would seem to show that, if there are not continuous coal beds, there are at least widespread coal horizons. By a "coal horizon" we mean a particular horizon at which, over a more or less wide area, the conditions have been favorable for the laying down of coal, whether coal was laid down over all of that area or not. Take an illustration: Between 80 and 90 ft. below the coal bed so extensively worked in early days east of Washington, Daviess county, is very frequently found an impure limestone from a foot to four feet thick; below this are usually from a few inches to several feet of shales, either wholly black and bituminous or frequently with only the botttom few inches bituminous, and often splitting into thin sheets of some size. This shale usually carries fish scales and certain brachiopods. Immediately below this shale usually occurs a bed of coal, and below it in turn is a thick bed of fire-clay. This bed of coal is at points in that county over 7 ft. thick, and still thicker in adjacent counties, yet in places it is only represented by a black bituminous shale. In other borings not even that much may be found, and its horizon may be indicated only by the fire-clay and limestone, or even by the limestone alone. In such a case we identify a continuous coal horizon, though the coal bed is not only not continuous, but may be wanting over large areas.

30. Thickness of Coal Beds.—In estimating the thicknesss of a coal bed several methods may be followed. The first method, which seems to have been generally followed by the earlier survey on the coal of this State, is to take the average of single measurements made in each mine, or often to average the greatest thickness of coal at the different mines. Second, to take the average at each mine of all the coal being worked, by measuring the coal in each room being worked, adding, and dividing by the number of diggers, or where that has not been done making an estimate from the orders given for posts of different length to support the roof, making due allowance if the floor is raised or the roof comes down before the posts are used. We have tried to follow this method in this report, with the result of reducing the average thickness in various districts from 6 to 18 in. from the earlier reports. In many mines lying idle or just opened a single measurement must suffice. Third, or true method, to average the coal over the entire area it covers. Practically this can not be done. The nearest approach would be an estimate based on mine measurements, as above, with the additional information to be gained from drillings of the unworked area.

An average of the coal being mined in Indiana would probably not be far from 4 ft. The "block" coal mines average 3 ft. 1 in. and the "bituminous" mines between 4 and 5 ft. The thickest coal being mined in the State is about 10 ft., the thinnest average of the mines on the inspector's list, 2 ft. 9 in., with "country banks" mining as low as 1 ft., or even less by stripping. Some of the coal beds maintain a thickness of from 5 to 8 ft. over considerable areas, while in other parts of the field they will be too thin to mine. The average of all the beds over the whole area would probably run well under 2 ft.

31. Thickness of Coal in Other Places.—As compared with other places, we find that in Alabama, out of 35 coal beds, 8 are over 4 ft. In Arkansas the mean thickness is estimated at 3 ft. In Illinois and Kentucky, about as in Indiana. In Iowa, 4½ ft. In Missouri probably the average would not be over 3 ft., though local "pockets" sometimes show a thickness of 20 or more feet over a few acres. In Michigan, 3 to 4 ft. In Ohio the beds average from 4 to 4½ ft. In Pennsylvania the "Mammoth" coal bed attains a maximum thickness of 50 to 101 ft., and above that is Coal F, 16 to 24 ft.; then Coal G, 15 to 16 ft., and so on, with some thin seams between, the total thickness at some places of all the beds being over 150 ft. The Pittsburg bed is about 10 ft. thick, ranging from 16 ft. to 2 or 3 ft., but usually has only from 5 to 8 ft. of workable coal.

In northeastern Canada coal beds are reported up to about 40 ft. in thickness.

In South Wales occur 100 coal beds, with a total thickness of 120 ft., 70 of these beds being worked. In the well-known Newcastle (Eng.) region the coal beds aggregate 60 ft. In Belgium the thickest bed is 3 ft. In Silesia occurs one bed 50 ft. thick.

32. Joint Structure of Coal. Block Coal.—Bituminous coal is sometimes called "block coal," from its property of commonly breaking up into cubical blocks. These blocks are the result of the exist-

ence in the coal of vertical cracks or joints, combined with a tendency of coal to split or break parallel with its bedding. In some coal these joint faces are only a few square inches or even less in area; in others they extend the whole depth of the coal and may have a lateral extent of scores of yards. In the first case the coal is apt to mine in small cubes of from a cubic inch up to a cubic foot or more. In the latter case the coal may be mined in great blocks the full depth of the coal bed, and too heavy to be handled. These joint faces may show no regularity of direction, or they may have nearly fixed directions for a hundred square miles. They would appear to be due to different causes.

Such joint faces are very common in other rocks in nature, especially being well developed in very fine-grained rocks, as shale or limestones. The finer the grain, as a rule, the more perfect and regular the system of joints. Where well developed, these joints are of great assistance in quarrying or mining. In shales such joints have been observed all over the coal area, and are known in other places to extend entirely through beds of shale 100 ft. or more thick, so that the bed will look as though some gigantic cleaver had cut it into cubes or blocks of up to thousands of cubic feet capacity.

Where such joints in rocks are very perfectly and regularly developed, it is found that there are two sets of joints more or less at right angles to each other. If the rock has a dip or downward slope it is found that one set of joints have the direction of the dip, and are known as the "dip joints" or as the "end" or "butt," while the others are at right angles to the dip, and since they follow the "strike" of the rock, are known as "strike joints" or as the "face," "slyne," "cleat" or "bord." It is found that strike joints and dip joints differ in this, that while the strike joint may be continuous for hundreds of feet, the dip joints commonly only extend from one strike joint to the next. In the coal of Indiana it is found that over most of the field the coal is broken up by irregular joints of small extent so that it mines out in irregular cubes of from a cubic foot or a little over, down.

Over a much smaller area, principally confined to the eastern margin of the coal field, these joints are developed in great perfection and with great regularity. In this State the term "block coal" is commonly restricted to such coal, and coal in which the joints are not regular is locally known as "bituminous."

Block coal may be a caking coal, a non-caking or splint coal, or cannel coal. It is most commonly a splint coal, and the two are sometimes, though erroneously, regarded as synonymous.

The miner commonly speaks of the joints as "slips," calling the strike joints "face slips" and the dip joints "butt slips."

The development of the coal industry of Indiana has been so intimately connected with "Indiana Block Coal" that we feel justified in presenting a somewhat detailed study of the peculiar characteristics of "block coal."

Block coal reaches its most perfect development and occurs in the largest basins in the region about Brazil, Clay county. In that area two beds are principally worked, known respectively as the "upper" and "lower block coal beds." A bed still above has been mined a

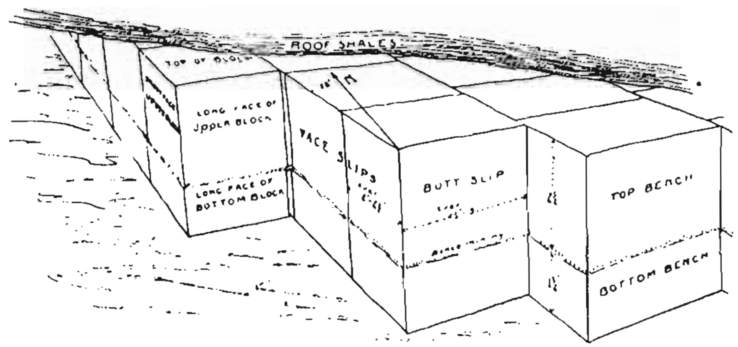


Fig. 4. Diagrammatic representation of "upper block" coal, as developed near Brazil.

little in two or three mines. It is commonly referred to as the "rider." In the following figure is shown in diagram the main normal characteristics of the upper block coal. These may be stated as follows:

1. Normally two sets of slips, face and butt. In places where the slips are only poorly developed it sometimes happens that only the face slips are developed with any regularity.

2. Face slips normally are continuous, often for considerable distances. On this account it has sometimes been the practice to drive the main entries parallel with the face slips.

3. Butt slips extend only from one face slip to the next.

4. Face slips normally have, in Indiana, the direction of N. 28°—30° W., the butt slips running N. 60°—62° E. These directions will hold with great persistency where the coal is in a large basin and not interrupted with irregularities. In very small basins, however, they may be very irregular. In general they tend to run parallel to the axis of a basin in its lowest part. In mining entries, where it is desired to run them in the thickest coal, which will be found in the "swamp" or lowest part of the basin, the proper direction can sometimes be determined by noting the direction into which the slips tend to bend

from their normal direction. This bending is only noted near the lowest part of the basin. Again, if a "hill" is approached, the slips tend to turn so as to be at right angles to it. Where entries are driven parallel to the slips it may result in their assuming an entirely new direction, often the change being so gradual as not to be noticed until the entry has been driven some distance. Their direction is also influenced by other irregularities in the coal, as will be described later.

5. Slips normally vertical. When the coal bed has been subjected to horizontal pressure, the slips follow the general law of joints in rocks under those conditions—they become regularly inclined to the vertical. In places in the block coal fields where the coal has been subjected to great horizontal pressure, as notably southwest of Asherville, Clay county, one set of slips may regularly be inclined 20° to 30° from the vertical, when they are commonly called "water slips." Again, if the coal bed is going to change its dip, it is frequently found that, if it is going to dip down, the top of the slip will dip so as to be at right angles to the new direction—that is, the top will bend away from the observer; if the bed is going to rise, the top will bend toward the observer.

6. Slips normally confined to coal. In cases where the coal is overlain or underlain by bone coal, even though separated by a parting of fire-clay, the slip will commonly run through it, as well as the main body of coal. As a rule, the roof will be smooth and unbroken, or if affected by joints, they will be found to be distinct from the slip in the coal. However, in the case of the inclined or "water slips," the joints extend indefinitely above and below the coal. Extending as they may above the coal to the surface they make convenient planes for the passage of water, hence the name.

7. Slips may, but as a rule do not, extend continuously through the coal. In the upper block coal there is a line of soft coal a foot or so from the bottom, at which the slips tend to offset a little. In the bottom block coal the offset is 6 to 18 in. below the top.

8. The slip may be "tight" and filled with some spar, so that the coal is as liable to break across the slip as to break with it, or it may be "open" so as to admit a knife blade. Sometimes the slips are open enough to admit the hand or even the arm, and cases are reported open to the extent of 10 in. or a foot. This usually occurs only near the outcrop of the coal. In Crawford shaft, old No. 2, north of Harmony, Clay county, it is said that in places it almost seemed as though one could crawl around between the blocks. Very often the blocks of coal are separated at the slip, but the space is filled with clay, or only occasionally with sand; they are then called "clay or mud slips."

Mr. John Andrews reports clay-filled slips 1 ft. broad in the old Eureka mine, a mile north of Brazil. It may be noted that even with these very open slips the roof is smooth and unbroken.

9. The distance between the face slips is usually somewhat greater than between the butt slips, so that "the long way of the block" is along the butt slip. The distance between the face slips will average from $2\frac{1}{2}$ to 3 ft., between the butt slips 2 to $2\frac{1}{2}$ ft. The largest blocks noticed were in Crawford shaft No. 1 (new), where the blocks are up to more than twice the usual size. The size of the block is thus about 2x$2\frac{1}{2}$x— thickness of bed, or $2\frac{1}{2}$x3x— thickness of bed. The blocks are smaller when the bed gets thinner, in many cases.

10. Block coal generally tends to split parallel to the bedding very readily, but across the bedding with great difficulty. Such planes of splitting show very markedly the charcoal-like character spoken of in the preceding chapter. For the general appearance of block coal after being split up to facilitate handling, see plates in Part IV. When struck with the hammer these board-like blocks sound much as when a piece of wood is struck.

Section 2. Rocks Accompanying Coal.

33. THE SUB-COAL LAYER.—The characteristic layer underlying coal is commonly known as fire-clay, though often called fire-brick clay. It is usually a plastic, unctuous clay, containing some free sand. It may vary from a few inches to a dozen feet in thickness, though from 1 ft. to 3 or 4 ft. is more common. The fire-clay is usually white, often quite soft, though occasionally very tough, and usually has the property of resisting high temperature, whence the name. This is due to its being free from iron, sulphur and the alkalies, which act as fluxes, and rich in alumina, which is a highly refractory substance. Often these under-clays are filled with more or less nearly vertical or branching stem-like impressions.

Sandstone and shales are not infrequent under the coal, especially the former, and all intermediate grades are found, from a pure fire-clay through sandy fire-clay to what is practically sandstone. That this sandstone takes the place of the fire-clay is shown by its showing the stems penetrating it. This underlying sandstone thus taking the place of fire-clay when very fine grained is commonly known as "gannister," and in some places has been extensively ground down and used for the hearths of iron furnaces.

34. Shale Overlying Coal.—The strata overlying coal may be shale, sandstone, limestone or other rocks, but in a majority of cases is a dark or often black bituminous shale. In some cases the black shale is so full of bitumen or oil that it will burn and would pay to distill for oil. These overlying shales frequently show an abundance of plant remains—leaves, stems, ferns; and often the great flattened stems, of ancient trees, being many feet across and several score of feet long; showing perfectly the scars where the fronds were attached. In some of the mines of the State the roof appears to have been the site of a jungle, judging from the matted mass of well preserved plant remains shown.

Occasionally the black shale over the coal is cut by smooth vertical joints into rectangular blocks often of large size. Sometimes again these block will split parallel to the bedding into great rectangular sheets many feet in length and width while perhaps only one-fourth to one-sixteenth of an inch thick. Such shales were aptly called by Prof. Cox "sheety shales." This sheety shale usually appears to be a marine or sea deposit, containing generally fish scales and bones, sea inhabiting shells, etc., and frequently contains many concretionary boulders of pyrite, especially just at the top of and partially imbedded in the coal. Often these shales are so rich in bitumen that on drying by exposure to the air they show a decided tendency to bend or buckle. The suggestion is made that their bituminous matter comes from the underlying coal bed, possibly from the erosion of a shoreward portion of that bed or possibly in part from the top of the freshly deposited coal being stirred up by tidal action and finally redeposited with a large admixture of mud as a water deposit.

The concretionary pyrite boulders mentioned above, or as they are commonly known in the mines, "sulphur balls," "hard heads," or "nigger heads," often attain a diameter of 7 or 8 ft., and being very hard, seriously interfere with mining. Where they occur in the roof, they seem to be almost always associated with the black sheety shale, making the roof knobby and irregular, and extending down into the coal as far as 4 ft. below the regular top of the coal. In some mines they are distinct from each other and occur some distance apart, when they appear like the bottoms of black kettles attached to the roof. In other mines they do not appear as distinct boulders, but the black shale roof seems to be entirely concretionary in structure, the concretions of all sizes running together, and being as irregular on their lower face as the surface of violently boiling water, only on a vastly larger scale. These pyrite concretions are not usually regularly distributed; some parts of a mine will often be comparatively free from them, while in other

parts of the same mine they occur in great abundance. In some places they are abundant in the body of the black shale, but do not project below its lower surface. While usually tending to come down when the coal has been mined from under them, in places they can only be brought down by the use of powder and with great difficulty.

35. Bone Coal.—A very common accompaniment of the coal, sometimes overlying, sometimes underlying, or found within the coal bed, is a substance, half coal, half shale, known as "bone coal," "rash coal" or "coal rash," "shaly coal," "slaty coal," "black jack," and by other names. It is a mixture of carbon as in coal, with shale in varying proportions. On the one hand it may change to a pure coal, on the other to a bituminous shale, and on over into a non-bituminous shale. It may be so rich in coal as to be almost undistinguishable from coal until burnt, when, instead of leaving a small quantity of ash, it may leave in the stove a chunk a little larger if anything than the original. When broken across the bedding, if of poor grade, it will look like shale with fine streaks of bright coal through it. If very rich, when broken across the bedding it may have the bright black fracture of pure coal, but if split parallel to the bedding it will be found to split easily and to show a smooth surface like shale or a school slate, instead of the usual carbonaceous or rough surface of coal. The presence of bone coal in or associated with a regular bed of coal detracts greatly from the value of the good coal, due to the fact that usually it is impossible to prevent some of the bone coal becoming mixed with the pure coal during the operation of mining. This fact should be kept in mind in estimating the value of a given bed of coal for purposes of mining. Many coal beds make an excellent showing when mined on a small scale, where proper care and oversight may be exercised and the bone coal kept out of the coal sold; but when mined on a large scale it becomes very difficult or impossible to exercise the same careful oversight, and the character and reputation of the coal suffers as a consequence.

36. Other Rocks Associated with Coal.—Beside the fire-clay and more or less bituminous shales, there are also associated with coal and making up the larger part of what is known as the coal measures, light-colored shales, sandstones, limestones and iron ores, with smaller quantities of other rocks, as chert.

37. Shales.—Of the rocks just mentioned, shales predominate in the coal measures of Indiana. The bituminous shales have just been described. These usually grade into the lighter colored shales, the

predominating colors being drab, blue or gray. When freshly exposed they are usually hard and tough and more or less massive, requiring to be blasted or worked much as the seemingly harder rocks. As soon as exposed to the weather they soften and crumble into a mass of more or less plastic clay. This is commonly called "slacking." In composition these shales may be nearly pure clay shale with an unctuous or greasy feeling, when they are commonly known as "soapstone" (strictly soapstone is a mineral that is not known to occur in Indiana), or, by the addition of sand in larger and larger quantities they may gradually grade over into a shaly or argillaceous sandstone, or even into a pure massive sandstone. On the other hand, by the increase of limy matter, they may grade over into limestone. Continuous beds of shale from 50 to 75 ft. thick are of common occurrence, such shales usually being rather light colored. Some shales characteristically divide into thin flakes or leaves, when they are called "fissile shales." Again, many shales, when mined, break up more or less into little cubes. Of these two the latter are generally more suitable for making brick. It is also found that a somewhat sandy shale is better for making brick than a pure clay shale, as the latter tends to shrink and lose its shape in burning.

A sandy shale may be largely made up of sand particles, but so fine that they are not recognized by the naked eye and the shale would pass as a clay shale unless carefully examined. From this the sand grains may increase until, on the most casual examination, it is evidently a sandy shale. A more or less even mixture of sand and clay that might with equal propriety be called a sandy shale or a shaly sandstone is quite common in the coal measures. Its presence often leads to an apparent disagreement where two persons report on the same section of rocks, as it is apt to be quoted as one or the other, according to the personal practice of the writers. This may explain many seeming disagreements when the present report is compared with other reports.

Especially in the northern part of the coal field there is abundantly found a peculiar combination of shale and sandstone known as "fake," "sand slate" and by other less common names. It consists of thin alternating layers of sandstone and shale, the layers often being like thin flakes, and giving a markedly banded appearance to a fresh cross section of the stone. A weathered bluff of it closely resembles a bluff of fissile shale, as the shaly flakes tend to weather out, leaving the thin projecting flakes of white sandstone, but with a coating of the dark shale which makes them appear as shale until broken across. In the block coal field this rock often immediately overlies the coal, making

the roof. In such cases it presents several peculiarities, among which may be mentioned that it shows a greater tendency to "cut" and flake down in narrow places, like the entries, than in broad places, like the rooms; and in falling, instead of falling so that the space rises perpendicularly above the coal with a more or less nearly level top, as most shales do, it tends to come away in small flakes, leaving the roof arch-shaped with a peculiar and characteristic breaking down along the center of the arch, resembling in a striking manner the partial breaking up of the surface of the ground by a mole, only of course on a much larger scale and inverted.

The term "fake" has been used in our notes while making the survey as a convenient term, and its use in the report will apply to the rock just described.

In many places under or overlying a bed of limestone will be noticed a shaly-like layer, though usually lacking the stratification of a shale. It was commonly reported as "clod" or marl in the earlier reports. Examination frequently shows it to contain fossils similar to those contained in the accompanying limestone. It will also usually be noticed that the line of contact between it and the limestone is very irregular; indeed, in some places the limestone loses entirely the character of a layer and appears as lenticular masses or boulders in the structureless shale or "clod." In such cases it is evident that the clayey shale is only the residuum left by the decomposition of the limestone. In some cases this entirely replaces the limestone, and should then be recognized as of the same horizon.

The term "slate" is frequently used by persons in the coal field, but those using it differ greatly as to what is meant by the term, much as they do in defining soapstone. Slate has a definite meaning in the markets as well as in the nomenclature of scientific terms, and as slate as so defined is not found in Indiana, the use of the word will be avoided in this report.

38. SANDSTONE.—The sandstones are next to the clays in abundance in the coal area. As a rule the sandstones of the coal area of Indiana are shaly and crumble readily, not being valuable for building purposes. In one horizon, however, and locally in other horizons, the sandstone is purer, massive, and will resist weathering, and locally has the other requisite properties for a building stone.* In Indiana, as with many of the other coal areas, the main sandstone horizon lies near the bottom of the series of rocks containing coal, and in Indiana along the eastern edge of the coal area. In places in this horizon the

* Geol. Surv. of Ind., 1895, pp. 186-368.

sandstone becomes a coarse grit and is strongly cross-bedded. Cross-bedding is apt to be a characteristic of sandstone associated with the coal. Often those sandstones higher up in the coal series will appear quite thick and massive at one locality, while a short distance away they are replaced by shales, or no trace of them appears. It is quite a common thing with sandstone in the coal measures that its lower surface does not lie smoothly and evenly upon the layer below, but the contact is more or less irregular. In some cases the contact is only very slightly wavy, in other cases the underlying rock seems to have been carved into little hills and valleys before the laying down of the sandstone, and sometimes it will be observed that the sandstone occurs only in the hollows carved in the underlying rocks. One of the principal sandstones of the coal measures of Indiana occurs most commonly in such a way, often presenting a thickness of from 75 ft. to 200 ft. in these hollows cut in the underlying rocks, while outside the hollows it may have a thickness of only 10 to 50 ft., or not be recognized at all. This sandstone, however, as at Coxville, Mecca, Silver Island, etc., may prove to be entirely of later age than the coal-bearing rocks. This sandstone has been largely quarried in Indiana.

39. Limestones.—Limestones form but a small part of the strata associated with coal. They seldom exceed four to five feet in thickness, but, notwithstanding, are often remarkably persistent over large areas, and thus may be of great assistance in correlating the coal beds. The limestones of the coal measures are generally very impure, sometimes sandy, sometimes shaly, often dark-colored or black from the presence of bituminous matter. These impure limestones are quite commonly called "bastard" limestone in the coal regions. As already described under shales, they will sometimes decay, the lime being dissolved out, leaving behind a sandy or shaly or mixed layer to take its place, the small shrinkage in such cases showing how largely the limestone was composed of shale or sand. Generally the limestone beds are quite distinct, but sometimes they are found to grade over into calcareous shales both horizontally and vertically. The limestones are usually quite full of shells or fossils, and an examination of these shells reveals that they are all shells found only in the sea. It may be of interest to note that the black sheety shale frequently associated with limestone in the coal measures also shows marine fossils, cephalopods, fish remains, etc.

40. Grit, Conglomerate.—As already mentioned, the sandstones of the coal measures are usually coarse-grained and cross-bedded, showing evidence of having been deposited by rapid currents. Locally

the coarseness increases until quite a proportion of the grains are small pebbles up to a half inch or an inch in diameter. This is especially true of the massive sandstone just within the eastern edge of the coal area. In a few places true conglomerates are met with. These are usually quite limited in extent and generally occur just at the bottom of a sandstone bed, and in connection with what are called non-conformities.

41. Typical Section.—With the exception of the fire-clay which usually underlies the coal, and the black shale which usually overlies the coal, the shales, sandstones and limestones do not seem to follow any marked order of succession. This is evident from an examination of the columnar sections given beyond. The varied relations of the different strata to each other and to the coal, the proportion of coal to the other rocks and many other features in connection with the occurrence of coal can well be studied in the following record of a deep well bored at Vincennes, Knox county. This is believed to pass entirely through the coal measures at about their deepest point in Indiana. The boring being done with a core drill and by experienced drillers, is probably as reliable as any record can be made.

The writer has in part verified the record by examination of the cores obtained. Harrison Park in Vincennes

		Thickness of Strata.		Coals and Spaces.		Depth.	
		Ft.	In.	Ft.	In.	Ft.	In.
1	Soil	2	0	......	......	......	......
2	Sand and gravel	40	0	......	......	......	......
3	Gravel with mixture of clay	17	0	......	......	......	......
4	Hard cemented gravel	4	3	71	3	71	3
5	Sandstone, soft, yellow	9	0	......	......	......	......
6	Sandstone, light	45	1	......	......	......	......
7	Sandstone, mixed with clay shale	1	0	......	......	......	......
8	Sandstone, light colored	15	5	......	......	......	......
9	Shale, blue clayey	23	8	......	......	......	......
10	Shale, dark clayey	4	0	......	......	......	......
11	Shale, clayey and sandy mixed	54	8	......	......	......	......
12	Sandstone, gray	12	3	......	......	......	......
13	Shale, black	1	8	166	9	238	0
14	COAL	0	7	0	7	238	7
15	Shale, soft clayey (fire clay)	1	6	......	......	......	......
16	Shale, hard blue, clayey	4	0	......	......	......	......
17	Shale, light colored, clayey	3	0	......	......	......	......
18	Shale, brittle, clayey	7	11	......	......	......	......
19	Shale, red	2	0	......	......	......	......
20	Limestone and clay shale mixed	2	9	......	......	......	......
21	Shale, clayey	3	6	......	......	......	......
22	Shale, red	3	0	......	......	......	......
23	Shale, clayey, streaked with limestone	6	0	......	......	......	......
24	Limestone	5	0	......	......	......	......
25	Shale, clayey	1	7	......	......	......	......
26	Shale, sandy	39	1	79	4	317	11
27	COAL	0	9	0	9	318	8
28	Shale, sandy, streaks of sandstone	22	9	......	......	......	......
29	Sandstone	25	3	......	......	......	......
30	Shale, hard, clayey	16	2	64	0	382	10
31	COAL	4	1	4	1	386	11
32	Shale, very soft, clayey, limestone spots	13	8	13	8	400	8

		Thickness of Strata.		Coals and Spaces.		Depth.	
		Ft.	In.	Ft.	In.	Ft.	In.
33	COAL VI	2	11	2	11	403	7
34	Shale, clayey	0	7				
35	"Hard stone"	1	5				
36	Shale, dark	0	3	2	3	405	10
37	COAL 2. VI	2	9	2	9	408	7
38	Shale, dark	0	2				
39	Shale and coal mixed	0	2				
40	Shale, soft, clayey	2	0				
41	Shale, hard, clayey, with lime	3	6				
42	Shale, light, clayey	10	0				
43	Shale, sandy, with layers of sandstone	28	5				
44	Shale, dark, "slaty," with limestone bands	14	4	58	7	467	1
45	COAL V b	1	9	1	9	468	10
46	"Hard rock"	0	3				
47	Shale, clayey	5	0				
48	Shale, coarse brittle, clayey, limestone streaks	1	7				
49	Shale, black	1	8				
50	Shale, clayey	0	10	9	4	478	2
51	COAL V	3	9	3	9	481	11
52	Shale, soft, clayey	3	0				
53	"Hard rock with streaks of lime"	2	0				
54	Shale, sandy and clayey mixed	13	1				
55	Sandstone, soft, yellow	11	9				
56	Sandstone, light colored	9	8				
57	Shale, sandy, with thin layers of sandstone	4	8				
58	Shale, sandy	36	9				
59	Shale, blue, clayey	30	2				
60	Shale, slaty, black, with limestone bands	8	6	119	7	601	6
61	COAL, cannel, mixed with bituminous shale	2	1	2	1	603	7
62	Shale, dark colored	0	10	0	10	604	5
63	COAL IV a	1	1	1	1	605	6
64	Shale, soft, clayey	0	6				
65	Shale, hard, sandy	3	6				
66	Shale, soft, sandy	5	0				
67	Shale, clayey	4	9	13	9	619	3
68	COAL IV	0	9	0	9	620	0
69	Shale, soft, clayey	2	7				
70	Shale, black, mixed with coal	0	5				
71	Shale, hard, clayey	0	1	3	1	623	1
72	COAL 2. IV	2	0	2	0	625	1
73	Shale, coarse sandy, with dark shale	12	0				
74	Shale, dark blue	22	0				
75	Shale, black, "slaty"	10	0				
76	Coal, mixed with shale	0	2	44	2	669	3
77	COAL III a	0	10	0	10	670	1
78	Shale, soft, clayey	4	2				
79	Shale, hard, clayey	4	4				
80	Shale, soft, clayey	2	6				
81	Shale, black, "slaty"	3	10	14	10	684	11
82	COAL III	3	10	3	10	686	4
83	Shale, soft	0	6				
84	Shale, hard, blue clayey	7	0	7	6	693	10
85	COAL	0	6	0	6	69[illegible]	[illegible]
86	Shale, hard, dark blue	0	7				
87	Shale, black, clayey	0	7	1	2	695	6
88	COAL	3	0	3	0	698	6
89	Shale, light clayey	1	6				
90	Shale, dark	0	8				
91	Shale, clayey	6	0				
92	Shale, sandy	5	4				
93	Shale, clayey	6	0				
94	Shale, black	2	0	21	6	720	0
95	COAL	0	1	0	1	720	1
96	Shale, black	0	10				
97	Sandstone, soft, brown	1	0				
98	Sandstone, gray	0	6				
99	Sandstone, soft, brown	3	0				
100	Sandstone, gray	4	2				
101	Shale, sandy	9	8				
102	Shale, clayey	9	10	29	0	751	1
103	Shale, black, and coal	2	0	2	0		
104	COAL	1	1	1	1	754	2
105	Shale, soft, clayey	4	4				
106	Shale, sandy	8	9				
107	Sandstone, soft, gray	9	1				
108	Shale, sandy	25	6	47	8	801	10

Taken as a whole, the section shows most strikingly the lack of regularity, which is one of the most characteristic features of the coal and associated rocks. In thickness the coal beds vary from 1 in. to 4 ft. 1 in., some of them in succession being 7 in., 9 in., 4 ft. 1 in., 2 ft. 11 in., 2 ft. 9 in., 2 ft., and so on. Notice also that there is not only no regularity of thickness but no regularity of increase or decrease of thickness as the depth increases. The common idea that the coal beds get thicker at greater and greater depths is quite evidently not sustained by this section, and a comparison of the different deep borings given beyond shows that the idea is entirely erroneous. Of interest here as showing the lateral variation is a comparison of Coals 33 and 37 and the space between as found in this boring and as found in two shafts sunk only a short distance away. In one of these shafts the section is as follows:

	Ft.	*In.*
COAL	5	3
Shale, etc.	0	8
COAL	2	0

In the other shaft the section of the same coal is:

	Ft.	*In.*
COAL	2	0
Shale	0	4
COAL	4	0
"Rock"	1	6
COAL	2	0

This coal crops out on the eastern side of Knox county, and a typical section at Edwardsport is as follows:

	Ft.	*In.*
COAL	2	6
Parting	0	½
COAL	0	9
Parting	0	¼
COAL	2	0
Parting	0	1
COAL, poor	0	10

A little farther east in Daviess county the same coal shows no partings, the section being:

COAL .... 5 ft.

These sections show clearly the variability of a coal bed laterally.

To take up next the spaces between the coals, the same lack of regularity is apparent. These spaces vary from 1 ft. 2 in. to 119 ft. 7 in. A series of these spaces, omitting the inches, would be as follows: 79 ft., 64 ft., 13 ft., 2 ft., 58 ft., 9 ft., 119 ft., 10 in., and so on. Comparing the spaces with the thickness of the coals it can be seen what a small proportion of the thickness is coal. Thus, out of the 800 ft. the coal occupies 32 ft. 7 in., or about one-twenty-fifth, or, considering only the space between the first and last coal, about one-twenty-first is coal. This may be shown in another way by comparing a number of the coals with the space to the next coal above. Thus: Coal 27 is less than one-one-hundredth of the space above in thickness; Coal 31 is about one-sixteenth of the space above it; Coal 45 is about one-thirty-fourth of the space above it; Coal 51 is between one-half and one-third of the space above it; Coal 61 is about one-fifty-seventh of the space above it, and so on.

Examining next the composition of the spaces it will be noticed that most of the coals are underlain by what is described as "soft clay shale," most of which would commonly be designated fire-clay. Coal 45, however, is underlain by "hard rock." In this section all the coals are overlain by shale or fire-clay, in a majority of cases the shale being black or dark. Examination of the sections given beyond does not show such uniformity. The preponderance of shale in the coal measures is well shown in the section. Examining the sections for any uniformity in order of material we find above Coal 27 shale, limestone, shale, limestone, shale to next coal above. Above Coal 31 comes shale, sandstone, shale. Above Coals 33 and 45 only shale. Above Coal 51 shale and "hard rock." Above Coal 61 shale, sandstone, shale, "hard rock" (limestone and chert?), shale to coal above, etc. The only regularity here shown is that coal is usually associated normally with shale, sandstone and limestone seeming to require quite different conditions for their laying down than the coal, the shale apparently requiring conditions more nearly similar to the conditions for making coal.

III. ORIGIN OF COAL.

42. Origin from Plants.—It is the generally accepted belief that coal is of vegetable origin. What is the evidence that has led to that belief?

43. Testimony of Plant Remains.—Nearly every miner has recognized the presence at the top of the coal bed or in the shale overlying, impressions and remains of leaves and stems of plants. Sometimes these overlie the coal in the greatest profusion. Often are found preserved in great perfection the fronds of delicate ferns, at other times the leaves of less familiar plants. Sometimes, too, the impressions show surfaces of some length covered with a regular network of peculiar-looking scars.

In many of the mines where the coal has been stripped, or in quarrying the sandstone associated with the coal, trunks of large trees rise from the coal bed, their roots being imbedded in the fire-clay. Mr. Kindle* mentions such an one at the Moore quarry, in Indiana, near French Lick, where one trunk 12 in. in diameter was exposed to a height of 6 ft. In this case the bark was "altered to coal," while the interior of the trunk had been replaced with sandstone. This quarry has disclosed several such trunks standing upright, and similar trunks have been met with at other places through the coal area of this State. Such tree trunks are found in Ohio, Pennsylvania, and in connection with the coal beds in most of the coal areas. Sometimes such trunks have a length as high as 75 ft., and they have been found 3 ft. in diameter. Again, in places trunks and stems of large plants are found in such crowds as to suggest an old jungle. Furthermore, it is not uncommon to find stems and other vegetable remains in the coal itself. As a rule, these trunks are not of familiar trees, but resemble the ferns and tree ferns, the scouring rushes or horse tails, some plants now only known in the tropics, and some plants which do not exist at present. These facts all testify that, whatever its origin, coal was laid down in the presence of vegetable growth, in many cases having been laid down about the foot of growing trees and shrubs.

44. Testimony of Composition, Structure and Variation.—Wood is about one-half carbon and the other half oxygen and hydrogen in about the ratio of 22 of oxygen to 3 of hydrogen. In addition to these there is about 5 per cent. of ash, which, on analysis, is found to be made up principally of silicia and alumina, with some

*Twentieth Annual Report, 1896, p. 349.

lime, iron trioxide, chlorine and oxides of potassium, sodium, magnesium, manganese and phosphorus. Comparing this with the first table of analysis of coals it is evident that the main difference is one of proportions, the coal having a higher percentage of carbon and less oxygen and hydrogen. In the case of peat, which is universally recognized as vegetation, the difference in percentage is not very marked. Thus a light-brown peat, as analysed by Websky, gave practically the same composition as wood, a dark-brown or black peat gave 59 per cent. of carbon and a correspondingly smaller amount of oxygen and hydrogen. Lignite or brown coal, which is often readily seen to be a charcoal-like mass of stems and vegetable matter, gives 64-65 per cent. of carbon, with another decrease of hydrogen and oxygen. The cannel and bituminous coals are but a step further, the carbon having risen to from 70-85 per cent., and if microscopic slides be carefully and properly made, the peculiar cell structure of plants can usually be made out, even of bituminous or anthracite coal. In anthracite the carbon has increased to 90 per cent. or over. In graphite there is nothing but carbon left, or the carbon forms 100 per cent. In these cases we could consider that there was an increase in the amount of carbon, or we would get the same result by withdrawing the hydrogen and oxygen, for then the proportion of carbon would increase as the gases decreased.

A very simple experiment may be performed which is suggestive of how these differences might be brought about. If a piece of wood be heated in a closed vessel, preferably of glass, as a test tube, it will be noted first that moisture collects on the sides of the test tube, and then for a moment a white cloud like steam rises from the end of the tube. Examination will show that it is steam. If the operation be stopped at this point it is evident that the wood now contains a smaller percentage of oxygen and hydrogen, since some of these elements have passed off in the form of water, and a corresponding increase in the percentage of carbon. The wood now corresponds about with peat in composition. If the operation be continued, it is quickly noticed that gases are coming off which will burn if a match be applied, and a black, tarry-looking substance begins to collect near the top of the test tube. If tested, the combustible gas will be found to be similar to the combustible volatile matter driven off from a soft coal, the tarry substance being the same as the tar obtained from coal at the gas works. If the operation be stopped at different stages while the gas is being driven off, the wood will be found to agree in composition with different grades of bituminous coal, or, toward the last, with anthracite coal. If all the gas be driven off there is left pure carbon in the form of charcoal, which agrees in composition with graphite. In this experiment the change has been produced by high heat in a short time. A low heat extending over a long time tends to produce the same changes.

Instances are known where timbers left in deserted mines for several hundred years, shut off from air and soaking in water, have been found changed to true brown coal.*

45. Conditions of Coal Formation.—If wood decays in the air, the carbon unites not only with the oxygen of the wood but also with the oxygen of the air, so that all the carbon may unite with oxygen and pass away in the form of gas. When, however, it decays under water or earth, much of the carbon must remain uncombined and the gases formed will remain or not according to the completeness of the protection afforded by the covering. Thus, in a region long covered with forest, the vegetable remains may amount to only a few inches, while in a swamp near by there may have accumulated 40 to 50 ft. of vegetable matter, as is often found when such swamps are drained, or the attempt is made to build a railroad over one. Such an accumulation of half-decomposed vegetable matter is called, if impure, muck; if more pure, peat. Usually such accumulations result mainly from the growth of spongy mosses of the genus Sphagnum. Such peat beds in formation are abundant to-day, often covering several hundred square miles and 50 ft. or more deep.

A study of all the facts leads to the conclusion that in past times the conditions have been more favorable for vegetable growth than to-day. That from time to time fresh water swamps or series of swamps covered vast areas, usually, it is supposed, near the sea level and border. That, following a period of swampy conditions, the land surface would rise, allowing the accumulated peat to be washed away, or it would sink, allowing the ocean to cover the bed with mud and sand, and occasionally beds of limestone to be laid down upon the coal.

We would then have, in addition to the decomposition going on, a steady consolidating under the weight of the mud and sand being laid down. When the filling has gone far enough, or if the land rises a little, the conditions favorable to coal formation may return and another bed of peat be laid down. This may continue until several hundred feet of peat, mud and sand have accumulated, and under the pressure and heat from the interior of the earth have begun to turn to coal, shale and sandstone, respectively. Let this process go on for untold centuries, and the coal will slowly lose more and more of the volatile con-

* Zeits. d. deutsch. geol. Gesel., Band, XXV, 364-366, 1873.

stituents, and become much reduced in thickness and increased in hardness, and the shale and sandstone will become firmer and harder. It has been estimated that one foot of coal represents from 6 to 8 ft. of closely compacted vegetable matter.

The impurities of the coal may in many cases come entirely from the plants, or they may have been washed in. As regards the first case, it has been found that all the impurities of a good coal occur in the ash of plants and are there in sufficient quantity. The freedom of the fire-clay from impurities has already been mentioned. An ordinary clay contains iron, potash, soda and other impurities. The carbonic acid formed by the overlying vegetable matter acts upon these substances, the iron in the form of iron oxide is partly reduced, in which condition it can be carried away in solution; the alkalies are also removed by this acid. So that the fire-clay underlying coal is in itself testimony for the vegetable origin of the coal, the impurities of the clay having in large part been transferred to the coal through the action of the vegetation which formed the coal.

46. Origin of Cannel Coal.—The evidence is strong that most coals were formed from vegetation growing where the coal occurs. In the case of cannel coal, however, the coal seems to have been deposited much as a shale is deposited. That is, it is simply a consolidated layer of fine carbonaceous mud. Cannel coal is believed to be a deposit made in the more open deep water-ways of the coal swamp by the washing in of finely comminuted vegetable matter from other portions of the swamp. Having such an origin, it is evident that clay mud may also be washed in and the cannel coal may grade over into bituminous shale, or even into light-colored non-bituminous shale, or the clay mud may be washed in at the same time as the carbonaceous mud, making the coal too shaly to be used for fuel purposes. As a matter of fact, that is what occurs in the majority of cases, so that while oily, bituminous shales or very impure cannel coal is not rare, it is only rarely that the conditions have favored the washing in of carbonaceous matter only, without the clay, resulting in a pure cannel coal. Cannel coal is apt to be a local deposit of variable thickness.

Some of the local evidence upon which this theory is based may be given. At a cut on the E. & R. Ry., near Burn City, Daviess county, occurs an impure cannel coal. It is reported by those in the neighborhood who have burned the coal that it did not seem to make any more ashes than other coals. A few feet higher this has graded over into a coal similar in appearance but which leaves about half its original bulk as ash. Still higher, the black color gradually turns to gray, and the coal has graded over into an ordinary gray clay shale.

Again, over the Alum Cave coal, is frequently a cannel-like bituminous shale, in which fish scales are abundant, indicating the prevalence of open water conditions at the time. Again, if a piece of the cannel coal from Cannelburg be examined closely, it will be seen that it does not show the alterations of bright and dark lines referred to above; they more closely resemble a very fine-grained black shale in structure. Where the beds are examined the cannel coal beds are more distinctly stratified like other rocks. Occasionally skeletons of leaves are found in cannel coal, giving evidence of transportation. And finally, deposits similar in appearance and properties to cannel coal are often found being deposited in the open water of the swamps and marshes of to-day.

IV. COAL—PRESENT POSITION AND STRUCTURE.

47. Coal Subject to Many Irregularities.—It is a common impression among those not well acquainted with the actual occurrence of coal, that it generally lies in horizontal sheets between horizontal sheets of the associated rocks, much as a black blanket might be spread out between a number of other blankets of different colors. Experience has shown, however, that such regularity seldom exists, and a surprisingly large percentage of the cost of mining coal can be credited to these irregularities. These irregularities are of three classes, named in the order of their importance:

1. Irregularities of original deposition.
2. Irregularities due to subsequent erosions.
3. Irregularities due to the differential movements of the earth's crust.

Section 1. Irregularities of Original Deposition.

Under this head will come a certain kind of variation in thickness and of level, due to the coal having been originally deposited in basins. As already described in I, in a coal basin the coal is normally thicker in the center of the basin and thinner on the edges. At the same place was described the elevation of the coal bed over the dividing ridge between two coal basins. While these two conditions are usually normal, the extent and shape of these basins, as well as the thickness and quality of the coal, are subject to great variations. As already pointed out, a basin may have an extent of only a few acres or of several hundred square miles. A mine started in it may be "worked out" in a few months and not pay the cost of starting, or it may be worked a score or more years, or until the limits of the company's territory have been reached in every direction. In shape a basin will tend to vary, much as modern swamps vary in shape; sometimes being nearly round and again being long and narrow. These irregularities would seem to be due originally to irregularities of the ground, the swamps and coal being restricted to the hollows and lower land much as to-day. Where such a hollow was caused by the erosion of a stream or current the coal basin will be long, narrow and crooked. In another case the depression containing the coal was caused by a slight sinking of the earth's crust at that point. In this case the basin is apt to be more or less regular in shape and of considerable extent.

The following two figures may help to explain the difference in level between the "swamps" and "hill" as previously described. In

Fig. 5. Ideal section of a peat bog filling a rolling basin or hollow in the sandstone.

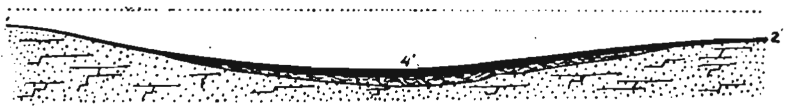


Fig. 6. Same, after submergence has allowed the laying down of sediments over it and its subsequent compression has taken place, allowing 1 foot of coal to be formed from each 8 feet of peat.

figure 5 a depression eroded from the sandstone is supposed to be filled to a level with vegetable matter, the depth at different points being indicated on the figure. Suppose now that subsidence allows the deposition of mud and other materials over this mass of vegetation; under the pressure of the superimposed beds, and through the loss of water and some of the gaseous matter shrinkage takes place, until finally the vegetable mass has been changed to coal, occupying say one-eighth of the original thickness, as shown in Fig. 6. It is evident that the originally level bed of vegetation will become saucer-shaped, the 32 ft. of matter at the center resulting in 4 ft. of coal in the "swamp," while the 8 ft. and 16 ft. of matter on the edges of the

depression shrink to 1 and 2 ft. respectively, but due to the difference in the actual amount of shrinkage, the coal at these points is left at a much higher level than in the center of the basin.

49. Unconformability.—In the preceding paragraph mention was made of the coal basins having resulted in some cases in consequence of irregularities of the surface on which the coal was laid down. Such irregularities are usually good evidence that the surface in question had been lifted above the water level and become subject to erosion by rain, streams or sea water. If the elevation above water level is considerable, the rain and rivers may carve the surface into very noticeable hills and valleys, or it may only result in a gently rolling plain. The subsidence which follows may be sufficient to bring all the surface under water in the latter case and the coal would be laid down over all the area, as in Fig. 1; or it may in the former case only be sufficient to bring the valleys and lower ground under water. Deposits laid down in these hollows will then be restricted in extent to the submerged part of the area, and if seen in cross section will be observed as abutting against the old valley banks. In either case, such a condition is called unconformability. Coal laid down in such half-submerged depressions would, of course, occur in basins separated by areas containing no coal, and the coal would often be found to end rather abruptly against the valley bank. Such unconformabilities showing brief elevations of areas above water and their erosion by sub-aerial forces are common in the coal measures at many horizons. They serve to emphasize the restlessness, as it might be called, of the earth's surface during the coal measure age, to which attention has already been called by the frequent changes in the coal measure rocks in a vertical section. In this paragraph we are only concerned with unconformability in so far as it restricts the original laying down of the coal. In a following paragraph will be discussed the effect on the distribution of the coal of a land period and crosion following the laying down of the coal bed.

50. Splitting Beds.—In some places the material between two coal beds thins out and the two beds come together, making, perhaps, one seam of good, workable thickness with only a thin parting, usually of fire-clay, running through it. Mining carried on in such double beds is liable to be limited by the separation of the component benches, the separated beds not paying to mine. Most of the thicker coal beds have partings of fire-clay indicating double beds or more, and such seams are liable to have the benches comprising them separate. In Indiana, the beds worked at Linton, Greene county, and at Cannelburg,

Daviess county, are notable examples, the coal beds worked at both these places dividing, and the parts are found to be 10 ft. to 15 ft. apart in a short distance.

51. HORSEBACKS.—Occasionally in a mine a ridge is encountered rising from the bottom and cutting the coal out. These are commonly known as "horsebacks." They appear to be due generally to currents which had deposited the material they carried in these ridges before the coal was laid down. True horsebacks, as thus defined, appear to be rare in Indiana. What are often termed "horsebacks" by the miners are here described under the head of "rolls."

52. ROCK PARTINGS.—As stated above, most of the thicker coal beds of this and other States are found to have fire-clay bands running through them, indicating a double bed. Differing somewhat from such partings are lenticular beds of shale, sandstone or other rocks which are sometimes found in a bed of coal. Such partings are usually brought in during the deposition of the coal material by water cur-

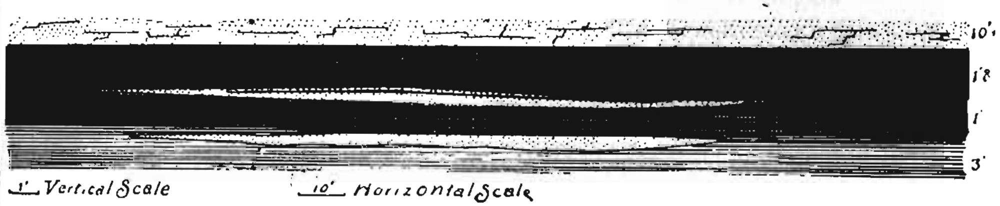


Fig. 7. Sketch showing sandstone parting in coal bed. From measurements in bluff near Shoals, Martin county.

rents, and, in contradistinction to the clay partings, they are usually quite local, being in the form of lenticular sheets which usually thin out within at the most a few hundred feet. They sometimes attain a thickness of several feet in the center of what is usually a solid bed of coal.

53. ROLLS, OF CONTEMPORANEOUS ORIGIN.—In general, rolls may be described as rock fillings of channels cut down into the coal. These channels may have been cut after the deposition of the coal bed and during a temporary land period, or they may have existed during the deposition of the coal, as open water channels. We are concerned here only with the latter. In large swamps to-day there commonly occur open water channels or even large irregular areas of open water. Open water channels are perhaps the more common, and, as a rule, they are kept open largely by the current of the water

flowing through them. In time, these channels tend to become filled up, sometimes with vegetable matter forming cannel coal, but often with mud or sand. In cases these may have filled up while the coal deposit was being formed on either side of them. Generally, however, it would seem that the filling had taken place just at the end of the coal forming period. The character of such a channel filling is shown by the following two figures. (See also Plate III, Fig. 1.)

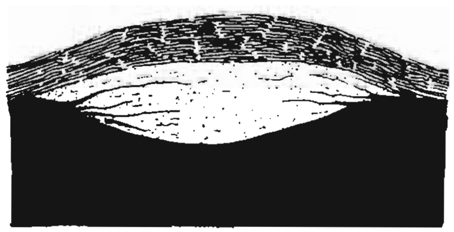


Fig. 8. Sketch of "roll" or sandstone filled channel which must have existed during or very soon after the deposition of the coal. From Crawford No. 1 mine in Parke county.

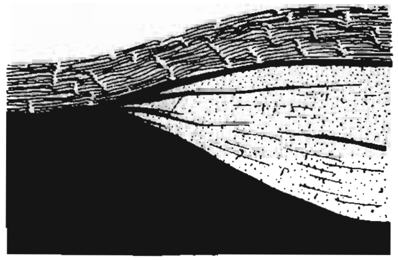


Fig. 9. Same, from old mine near Lafayette furnace, Clay county.

The two main characteristics as distinguishing such channels from somewhat similar channels to be described later (see paragraph 56) are: First—The usual roof of the coal extends over these channel fillings. Second—Lenticular sheets of coal extend out from the coal along the edge of the channel, especially from near the top, into the material of the channel filling, as shown in figures. These "streamers," or feeders, or fingers, as they are sometimes called, were evidently part of the loose vegetable matter of the main bed washed in sheets out into the partly filled channel.

In general, it would seem that when the sinking had become temporarily rapid so as to stop the deposition of coal material, and the submergence had allowed sand or mud carrying currents to flow all over the recently laid down vegetable mass, the sand or mud naturally lodged in the depressions of these old current channels, filling them, the new currents sweeping some of the vegetable matter in at the same time.

These conditions might continue until a similar deposit of sand or mud had been laid down over all the area or, what is more common, the sinking continues, bringing in deeper water, feebler currents and a change in the material carried by them from sand to fine mud, as in Figs. 8 and 9, where both the coal and old channel filling are covered by shale.

A third fairly constant characteristic of such a filling is shown in Figs. 8 and 9, where it will be observed that the roof bends up over the channel filling; also that some of the thin sheets of coal in the filling bend upward instead of being flat or bending downward, as they must have at first. The explanation would seem to be that the coal bed had only been partly compressed when the roof was laid down on it and when the thin sheets of coal were washed out, and, due to the difference of material, the coal had afterward suffered compression more than the harder filling of the channel. Three other points sometimes observed would seem to favor that explanation. It is frequently found that the coal on either side of such a filling is a little thicker than the bed is elsewhere, suggesting that the coal has been squeezed out from under the filling. Again, where the under clay is soft, it is sometimes found that the coal below the filling has been forced down into the clay several inches. Again, below and close to such a filling the coal is usually much disturbed, or "troubled," as the miner would say, such coal not mining in large blocks or lumps, but largely going into screened coal. (See Fig. 17.)

From the practical standpoint these channel fillings, or "rolls," as they are commonly called, affect mining principally in: First—Cutting out the coal; sometimes they extend to the bottom of the bed; and, second, in rendering the roof bad and unsafe, as they are liable to separate from the regular roof at some of the coal partings and come down in great masses, often with fatal results. They are sometimes V-shaped, but more often broadly U-shaped, or flatter still, as shown in Fig. 1 of Plate III.

Section 2. Irregularities Due to Subsequent Erosion.

The lateral extent and in places the vertical extent or thickness of the coal have been largely governed by the factor of subsequent erosion. This may be divided according to time into—

1. The erosion which has resulted in the present shape of the ground.
2. Preglacial erosion, now hidden.
3. Subsequent erosions during the laying down of the coal measures.

54. Recent Erosion, or the Erosion Which Has Resulted in the Present Shape of the Ground.—The question of during just what ages since the coal measures this erosion has been in progress is an interesting one, but we are principally concerned now with the final result. If we study any single coal bed in Indiana we find,

Fig. 10. Sketch to show removal of coal across recent stream valley. Also showing why outcrops are often found on one side of a valley and not on the other.

as we go eastward, it tends to get nearer and nearer the surface. Finally it outcrops in the bottoms of creeks and can be worked by slopes and drifts; still going eastward it is found higher and higher in the banks or adjacent hills, until finally it crops out in the side of a hill with a rise that would carry it over any hills to the east. At its most eastern outcrop it is often or usually just as thick as to the west. Evidently the coal bed formerly extended an unknown distance further east, but has been washed away in the slow lowering of the land during past ages by the streams and their tributaries. In this way untold millions of tons of Indiana coal have been washed away and the process is still going on, as is evidenced by the "float" coal found in creek bottoms where the coal is being washed from some outcrop. This is shown in the cross sections on the large sheets; refer also to Part II, under structure of Indiana coal field.

In addition to the removal of large bodies of coal due to the eastward rise of the coal and general erosion, and as part of that same process, is the removal of large quantities of coal by the streams in cutting out their present channels.

Thus, with conditions as in Fig. 10, it is quite generally appreciated that the coal formerly extended across the valley, but has been removed by the stream in cutting its channel, but often where conditions favor an exposure on one side of the valley and not on the other, as in the figure, the unexposed side of the valley is neglected for many years after the exposed side is all worked out under the impression that no coal exists there. Where good, workable coal is exposed along one side of a valley, it should be assumed to be on the other side until drillings made well back from the bank have shown it is not there. The reason why coal is often found on one side of a stream and is apparently wanting on the other side will be given further on.

55. Preglacial Erosion.—As will be described more fully further on, most of Indiana, in common with a large area in the northern part of the United States, was, at a comparatively recent period, geolog-

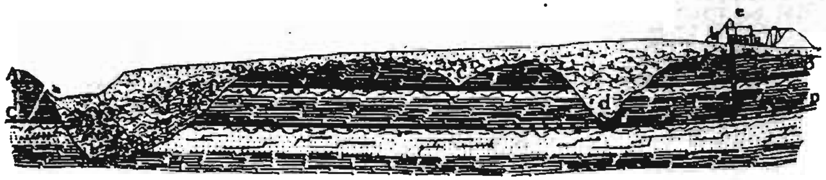


Fig. 11. Sketch showing present land surface and underlying preglacial surface, and the effect of the latter on the distribution of the coal. At (a) is represented a recent water channel. At (b) is its preglacial predecessor, larger and deeper. The old channel is seen to have cut out large areas of both coal beds. At (c) is a small channel only reaching the upper bed. At (d) is a deep channel, not revealed on the surface, which cuts out a considerable belt of the upper bed and just cuts into the lower bed, making there a "clay roll." It is easy to see how a drilling at (d) might lead to the conclusion that there was no coal in that district.

ically speaking, invaded by one or more great ice sheets or glaciers. These pushed their way from the north southward across the State, scraping off great quantities of loose earth and soft rock, and then, as they retreated, redeposited this material so as to practically fill up all the valleys and former irregularities, frequently or generally leaving little or no trace of the old valleys. In this way it frequently happens that a stretch of country apparently level and unbroken was before the Ice Age a rugged country with broad, deep valleys from across which large amounts of coal have been removed. Fig. 11 shows such a valley at *d*, a smaller one at *c* and a larger one at *b*. In the latter case a recent stream is beginning to clear out the old channel. In Fig. 10 is a somewhat similar case, only that the stream has progressed farther in the clearing out process. In some cases these hidden valleys can be traced for considerable distances, being revealed by drilling and mining operations. The filling is usually found to consist of clay and sand with boulders or pebbles, gravel, sticks, parts of trees, sometimes chunks of coal, etc.

These preglacial valleys, where hidden, may render large tracts of what on the surface appears to be valuable coal lands, practically worthless. In the Indiana coal field the preglacial valleys were both deeper and broader than the present valleys, so that the coal cut out and removed by the preglacial drainage far exceeded that removed by the present streams.

56. Erosion of Carboniferous Age.—The channels of streams of carboniferous age resemble somewhat the hidden channels of preglacial age, except that the material filling them is a thoroughly consolidated sandstone or shale, more usually the former. The evidence is abundant that at numerous times during the laying down of the coal beds and associated rocks, elevation brought the recently deposited coal beds and the other rocks above the water level, and streams eroded channels for themselves, sometimes just into the coal, sometimes entirely through it. The following figure shows a characteristic channel of this description. These channel fillings are usually known as rolls.

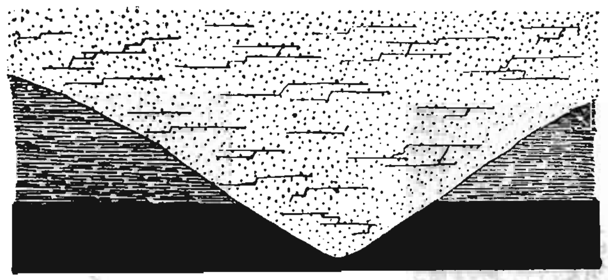


Fig. 12. Carboniferous erosion in coal. Buell mine, Sullivan county

In many cases, instead of simply cutting out a narrow channel, as in Fig. 12, broad areas will be slightly eroded, the normal roof being removed and the top of the coal being more or less carried away. The filling of these channels or broad washes is usually sandstone. It will generally be noted that where the roof of a certain bed of coal is normally shale, if at any point the shale roof seems to thin out and a sandstone comes down on the coal, the coal is not as thick as elsewhere, and often the sandstone roof is somewhat wavy, as though the erosion had been irregular. Fig. 13 will help to show the conditions. In these cases a broad current would seem to be the agent rather than a stream.

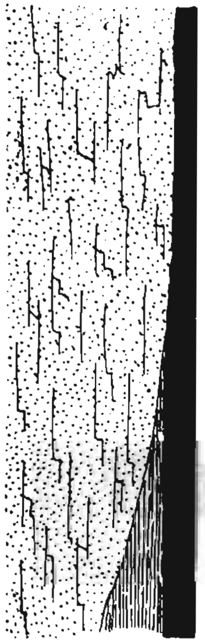


Fig. 13. Broad wash erosion of carboniferous age.

Fig. 14. Redeposition of parts of eroded coal bed. From bluff on Sand creek, Parke county. One inch equals seven feet.

In some cases the erosion has been more pronounced and only traces of the coal bed are left. In other cases none of the coal left appears to be in its original position, but appears as scattered masses and fragments probably at some distance from where first deposited. Fig. 14, from a long bluff on Sand creek, in Parke county, shows well such a redeposition of some of the coal.

Section 3. Irregularities Due to Movements of the Earth's Crust.

These show themselves as, first, lack of horizontality of the coal and accompanying beds; and, second, as breaks or faults of the strata, with accompanying phenomena.

57. Dip.—It is the exception rather than the rule to find coal beds lying horizontally even for short distances. To a certain extent this is an advantage, as it allows a mine to be drained. This inclination from the horizontal is called the "dip" of the rocks, and where small is measured as so many feet to the mile, or, if somewhat larger, as so many feet to the hundred feet. If still higher it is usual to give the dip in degrees. Coal beds usually have a major and a minor dip; that is, considering a coal bed over a large area it may gradually be found at lower and lower levels in a certain direction; though examined at any point the dip may be found to be in any direction. In Indiana, the major dip over most of the field is a little south of west. In this case the major dip seems to be the result of slow subsidence of the earth's crust affecting most of Illinois, Indiana and Kentucky. (See Part II.) If the minor dips be examined it is found that as a rule the rocks dip away from lines which might be drawn, and often toward other lines, thus forming long arches, or anticlines as they are technically known, and long troughs or synclines. A line showing the highest part of the arch at different points is called the axis of the anticline, and correspondingly is used the term—axis of the syncline. These anticlines and synclines seem to be wrinkles in the earth's crust produced during the progress of the broader earth movements.

In Indiana the major dip will range from 3 to 100 ft. per mile, while the minor dips may be 100 or 200 ft. in a mile, or, for short distances, 30 to 40 ft. in 100; or, for a space of a very few feet, even higher. The dip of the coal affects the practical operation of mining principally in connection with drainage and haulage. In countries where the rocky strata have been highly folded so as to more or less nearly "stand on end" the coal beds are of course similarly inclined and require entirely different methods of mining. The anthracite coal beds of Pennsylvania are illustrations of highly inclined or "dipping beds."

58. FAULTS. In the report on Sullivan county made in 1871 by Mr. Collett, he writes as follows:* "An interesting feature of this mine (Badger Bros.' shaft) was the discovery of a *vertical* dyke or wall of intrusive clay, one foot wide, running a little east of north. This is the only fault, though here only a separation, that I have met with in the coals of Indiana," etc.

In a general review of the geology of the State made by Mr. Cox, in his last report published in 1879, he says:† "Here the elements concerned in the building up of strata leave no trace of violent cataclysms, and the rocks presented to view lie regularly bedded at an inclination or dip to the westward and northward, so gentle that its existence can only be made known by observations extended to points that are far distant from one another. *Not a single true fault,*‡ or upward or downward break and displacement of the strata has yet been discovered."

In view of such statements repeated by the members of the earlier surveys, it has seemed well to give more than a passing mention to the subject of faults, etc. Instead of the entire absence of faults and similar disturbances which we have been led to expect by the early reports, the members of the present survey found true faults a very common phenomena, in some districts hardly a mine being free from them and ranging in downthrow from a few inches to forty feet.

59. FAULTS, NORMAL.—The term fault is often used by the miners and others to describe any kind of an irregularity in the coal, especially of places where the coal is more or less cut off, whether this be by a true fault, an erosion channel or from other cause. Strictly, a fault is a fracture or break extending across the strata accompanied by a greater or less displacement along the line of fracture. Faults are usually classed as normal or reversed faults. The normal fault is the more common in Indiana, as elsewhere. In the normal fault the action seems to have been accompanied by tension and it will be noted that if the displaced strata be brought to the same level a separation has taken place. This is shown in Plate II. In the reversed fault compression has acted forcing the strata together endways and usually causing more or less of an overlapping of the ends of the strata on

* 1871, Sec. Ann. Rep., Geol. Surv. of Ind., p. 205.
† 1879, 8th, 9th and 10th Ann. Rep., Geol. Surv. of Ind., p. 3.
‡ Italics mine.—G. H. A.

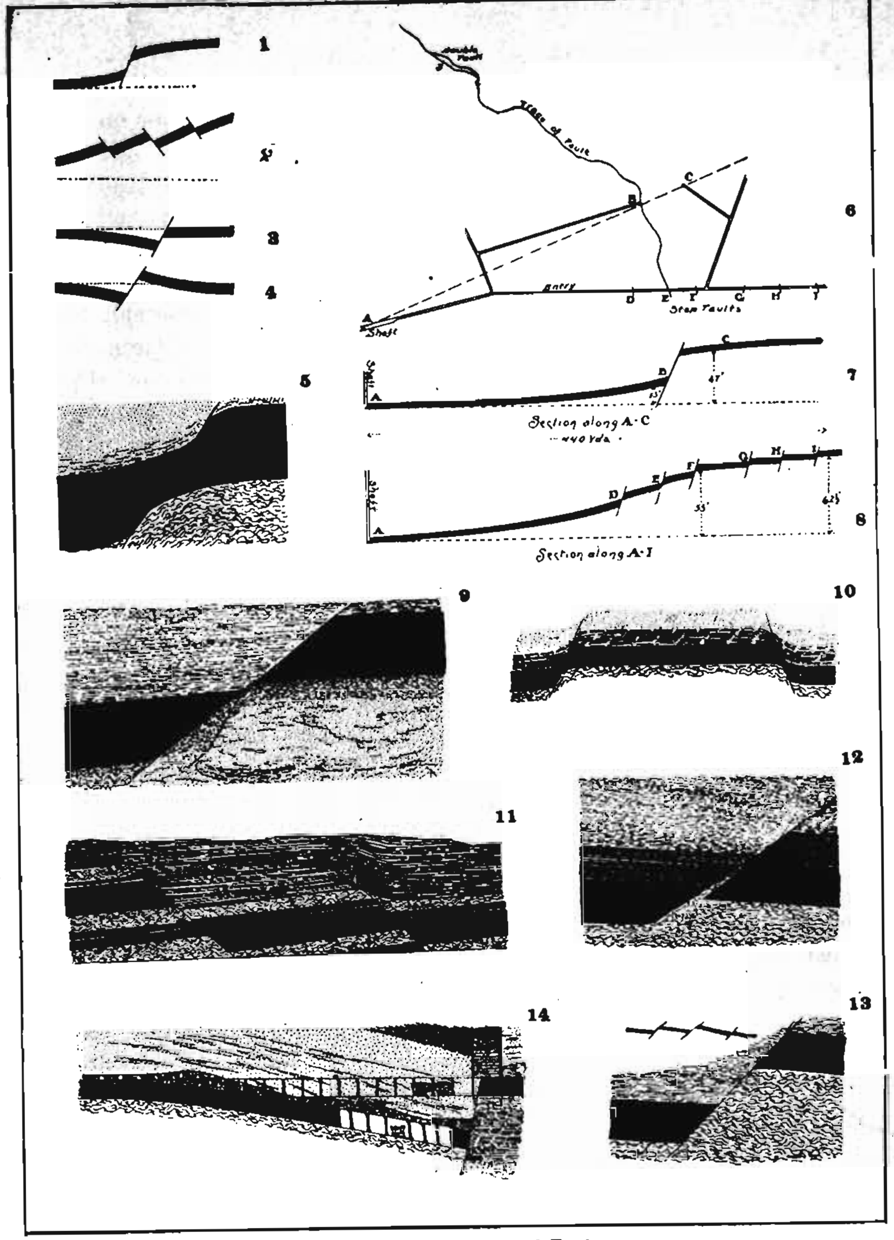


PLATE II. Typical Normal Faults.

Fig. 1. Type of monoclinal fault. See Figs. 5 to 10 inclusive.
Fig. 2. Broken arch type of fault. See Figs. 11 to 13 inclusive.
Fig. 3. Type of fault shown in Fig. 14.
Fig. 4. Type of fault shown in Fig. 2 of Plate III.
Fig. 5. Fault in Fairview mine, Clay county.
Figs. 6-8. Fault in B. B. C. Co.'s No. 10 shaft. Map and section.
Fig. 9. Fault on Otter creek, three miles north of Brazil. From photo.
Fig. 10. Double fault in Peerless mine, Vigo county.
Fig. 11. Double fault on Big Vermillion river, near Hanging Rock.
Fig. 12. Fault on north fork Otter creek, near Coal Bluff, Vigo county.
Fig. 13. One of series of faults in Fairview mine.
Fig. 14. Fault crossing shaft in Jackson mine, Clay county.

one side of the break over the ends of the corresponding strata on the other side, as in Figs. 12 and 13 of Plate III.

A normal fault may result in a sharp, clean break, with a displacement of from a few inches up. In the coal fields of Indiana vertical displacements of 30 to 40 ft. are as large as have been observed. Figs. 4, 7, 9 of Plate II are typical of simple normal faults such as are common in the coal field of Indiana. Such faults are often traceable for long distances, especially those of large downthrow or displacement. In some cases the same fault has been found in adjacent mines. Occasionally the displacement takes place by a series of small displacements known as a double fault, as in Fig. 11 of Plate II, or as a step fault, as in Fig. 8 of Plate II. Figs. 6, 7 and 8 of Plate II show the case of a simple fault of 32 ft. vertical downthrow breaking up into a series of small faults. At *j* in Fig. 6 the large fault is for a short distance broken horizontally with a horizontal displacement which runs out at either end. The irregularity of the line of fault horizontally is well shown in the same figure taken from the mine map of their shaft No. 10, by permission of the Brazil Block Coal Company.

In many cases the line of fracture has not been a straight line, as in the figures above referred to, but seems to have been irregular, and in some cases the movement seems to have been to some extent horizontal. As the spaces have usually been filled with clay, they are commonly known as clay veins and will be discussed under that head.

Faults of this type are sometimes known as gravity faults, as gravity is the principal factor in their production. It will be noted also that, as a rule, the line of fracture is nearly vertical, due to the fact that the line of displacement has usually followed a joint plane, which, in such a region as this, tends to be vertical. They may be assigned to two causes: First, the uneven settling of the whole basin during the laying down of the coal measures or afterwards. An examination at distances apart of corresponding coals at different points shows this settling to have been very irregular. The field contains many instances of where at one point two beds are fully 50 to 100 ft. apart, while a few miles away they may be only 5 to 10 ft. apart or less. At the first point, then, the strata have sunk perhaps 50 to 75 ft. more than at the second point, since the lying down of the lower coal. This differential movement may tend to produce straining in the strata between the two places, which is relieved either by bending or shearing of the rocks. A second cause which may account for some of the smaller faults is suggested to be the irregular settling over basin-shaped bodies of coal, and the interruption which such settling encounters along the lines of channels which have been cut in the coal and filled with sandstone. This is merely suggested as a possible cause for some of the small faults.

A second type of fault may be distinguished as having its "hade," or direction of dip of the plane of fracture, in an opposite direction from the general dip of the strata; see Fig. 2 of Plate II. Figs. 11, 12 and 13 of Plate II are of this type. Such faults are common in the plateau district of the western States.

These faults, taken as a whole, do not appear to have any uniformity in the direction of downthrow or of strike. However, if only the larger faults be considered, a majority of them trend between northwest and northeast and have the downthrow to the west. There are so many notable exceptions that it cannot be considered as a rule. Thus, in Martin county, from Shoals westward, the dip is nearly everywhere observed to be strongly to the west, yet so many faults with the downthrow to the east occur in that region that the strata are higher five miles west of Shoals than at Shoals.

Figs. 14 of Plate II and 2 of Plate III illustrate two other types of faults as shown in Figs. 3 and 4 of Plate II. The difference between the faults of the first two types and those of the last two are very well shown in the effect on the driving of entries in the mines. Thus a six-foot fault of the first type necessitates driving the entry up or down until it is at least 6 ft. above or below its old level, according as the fault is approached. A six-foot fault of the third type can be passed with little or no change of level in the entry.

60. Faults, Reversed.—Reversed faults that could be recognized were not found abundantly, though it is suspected that a large part of the faults described as clay veins are really of the character of reversed faults. The writer had the opportunity to examine and sketch only one notable fault of this kind of which the character was unmistakable. This was in Columbia No. 4 mine of the Columbia Coal Company in Clay county. In this case the compression has been great enough to force the lower block coal bed up a diagonal shearing plane an unknown distance above the upper block coal bed lying 20 ft. above it; see Fig. 13, Plate III. In this case the whole field for several miles shows the result of the compression in many ways as described in Part III of this report. Of the numerous faults of this type described to the writer, but which could not be examined, the one shown in Fig. 15 from the Eaton mine in Sullivan county is selected for presentation. The figure is from a sketch by Mr. Winterbottom, and makes no pretext to be reliable in detail. The coal attains a local

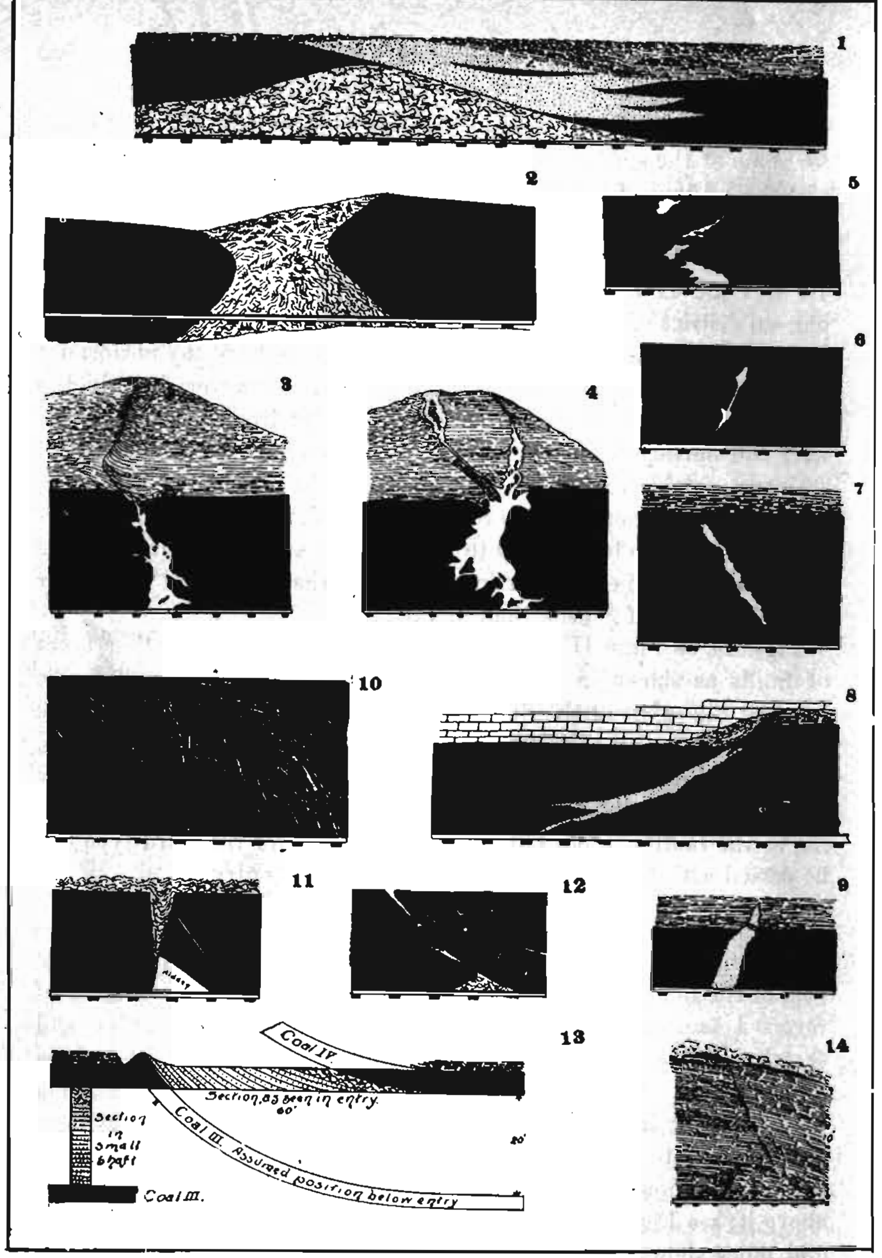


PLATE III. Irregularities due to faulting; clay, sandstone and coal veins; overthrust faults and crushed structure.

Fig. 1. Combined fault and "roll," Monarch mine, Clay county.
Fig. 2. Fault of type 4, Dugger mine, Sullivan county.
Figs. 3-4. Clay veins resulting from faults. Parke County Coal Co.'s No. 6 shaft, Parke county.
Fig. 5. Clay in old fault plane, Wimsett mine, Vermillion county.
Fig. 6. Clay vein, Dugger mine, ten feet from and running parallel to a large fault.
Fig. 7. Sandstone vein, Ray mine, Vigo county. Displacement shown in another entry.
Fig. 8. Sandstone vein, Mecca No. 1 mine, Parke county.
Fig. 9. Sandstone vein, Brazil Block Coal Co.'s No. 8 mine, Clay county.
Fig. 10. Showing structure of coal bed thickened to nearly four times normal thickness by lateral pressure, in region of overthrust faults, Columbia No. 3 mine, Clay county.
Figs. 11-12. Coal bed greatly disturbed, Lee's mine, Vermillion county.
Fig. 13. Overthrust fault, Columbia No. 4 mine, Clay county.
Fig. 14. Coal vein, exposed in 26-ft. cut in Brazil Block Coal Co.'s No. 5 mine.

thickness of 12 ft. In this case it would seem that the cause might be of a local nature and due to the coal being forced out laterally from under the "rock roll" shown at the left.

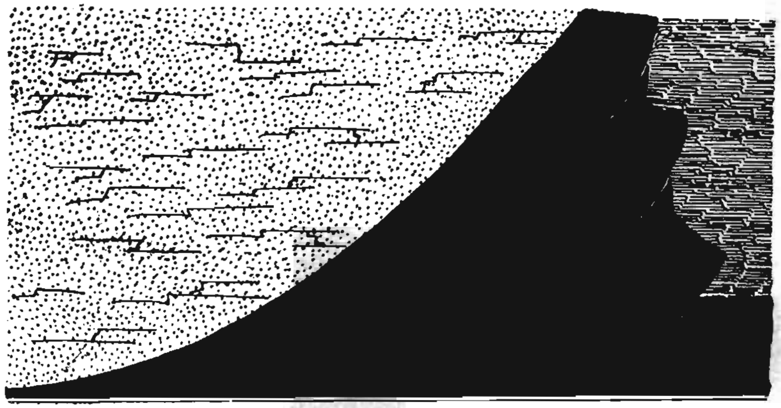


Fig. 15. Thickened coal bed in Eaton mine, from rough sketch by Mr. Winterbottom. Coal in shaft 12 feet thick. Regular thickness of bed, 3 feet.

61. CLAY VEINS.—"Clay veins" are abundantly found in the mines of Indiana. They are usually very irregular bands of clay extending more or less vertically through the coal and accompanying strata. In some cases they are clearly the result of faulting, as in Figs. 3 and 4, Plate III, or, as in the case of the vein shown in Fig. 6, Plate III, their association with neighboring faults show that they are due to the action of the same forces. In some cases, as in Fig. 7, Plate III, the vein shows no displacement in one part of a mine, but may show a noticeable downthrow in some other part of the mine. While in a few places the clay seems simply to fill the space made by the separation of the rocks on either side of the line of faulting; in most cases the coal and rock close to the fault on either side seem to have been broken up or even reduced to a fine state, and when the clay was forced up through this mass it extended out into it, following lines of least resistance, and catching up masses of it in the main clay body. This is shown in Figs. 3 and 4 of Plate III. In some cases the clay vein does not appear to extend clear through the coal, as in Fig. 6, Plate III, or the clay may appear in irregular detached masses in the coal, as in Fig. 5, Plate III. In either case the clay appears to be entirely separated from any source of supply. Minute examination will, however, usually reveal traces of the break having been much

more extensive than it appears; in other words, the break closed up again after being partly filled with clay. In the cases illustrated by Fig. 2, Plate III, the vein is only in part clay, the upper part consisting of broken-up shale. As might be expected, this shale forms a treacherous roof.

62. Coal Veins, Sandstone Veins, "Rock Spars."—Of somewhat similar appearance to the clay veins are what are commonly known in the mines as "rock spars." These veins are characterized by a filling of sandstone, coal or other material than clay, sandstone

Fig. 16. Contact between coal and sandstone vein. (Natural size.)

being most commonly met with, and by more regular bounding faces. In the case of most—if, indeed, not all—of the clay veins the plastic clay seems to have been forced into its present position by pressure. In the case of the sandstone and coal veins, however, the filling material seems, in many cases, to have been carried into surface crevices by water or wind. Of the figures given, this is best shown by Fig. 14 of Plate III, where the coal vein seen in the entry (see Fig. 3) can be traced up to an old erosion level, where an irregular layer of coal, quite clearly washed in, lies over the top of the crevice containing the coal. As with many of the clay veins, the crevice at the line of the section has closed while only partly filled. Sandstone veins or "rock spars" were not met with abundantly, though occasionally single mines or small districts have encountered a great many. In other cases sandstone and shale make up part of the filling of fault veins, as in Figs. 1 and 2, Plate III, or all of the vein, as in Figs. 7 or 8, Plate III, in the latter case the fault structure being shown in another part of the mine. In the case of Fig. 9, Plate III, the cause is obscure. As usual the sandstone is very hard and closely knit with the coal along their line of contact, as shown in Fig. 16.

63. Thickened Beds.—In some places, usually in regions of reversed faults, the pressure has, in places, instead of breaking the strata and shoving them over each other, simply crushed the coal horizontally, with the result of increasing greatly its apparent thickness.

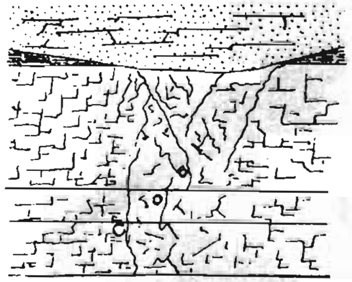


Fig. 17. A "trouble," showing effect on structure of coal from slight squeezing under sandstone roll, Fortner mine, Clay county.

Thus a 3 or 4 ft. bed may locally be increased to 10 or 12 ft. Fig. 10, Plate III, shows the structure of a portion of such a thickened bed in the Columbia No. 3 mine of the Columbia Coal Co., Clay county. Fig. 17 shows the appearance of a "trouble," as the miners call it, where the regular structure of the coal is destroyed by pressure due to any of the causes previously discussed.

V. GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF COAL.

Coal deposits are widely distributed over the earth, the largest deposits occurring in the United States, Great Britain and China.

64. Along the Atlantic Border there is an area of 18,000 square miles of coal in Nova Scotia and New Brunswick. In Rhode Island is a small area of 500 square miles. Other small areas are found to the south, notably in Virginia and North Carolina.

65. Appalachian Coal Field.—The main supply of coal in the United States is obtained from the Mississippi valley. Four coal fields occur in this area. Of these the most important is the one known as the Appalachian coal field, including the coal of Pennsylvania, Ohio, West Virginia, eastern Kentucky, western Virginia, Tennessee and

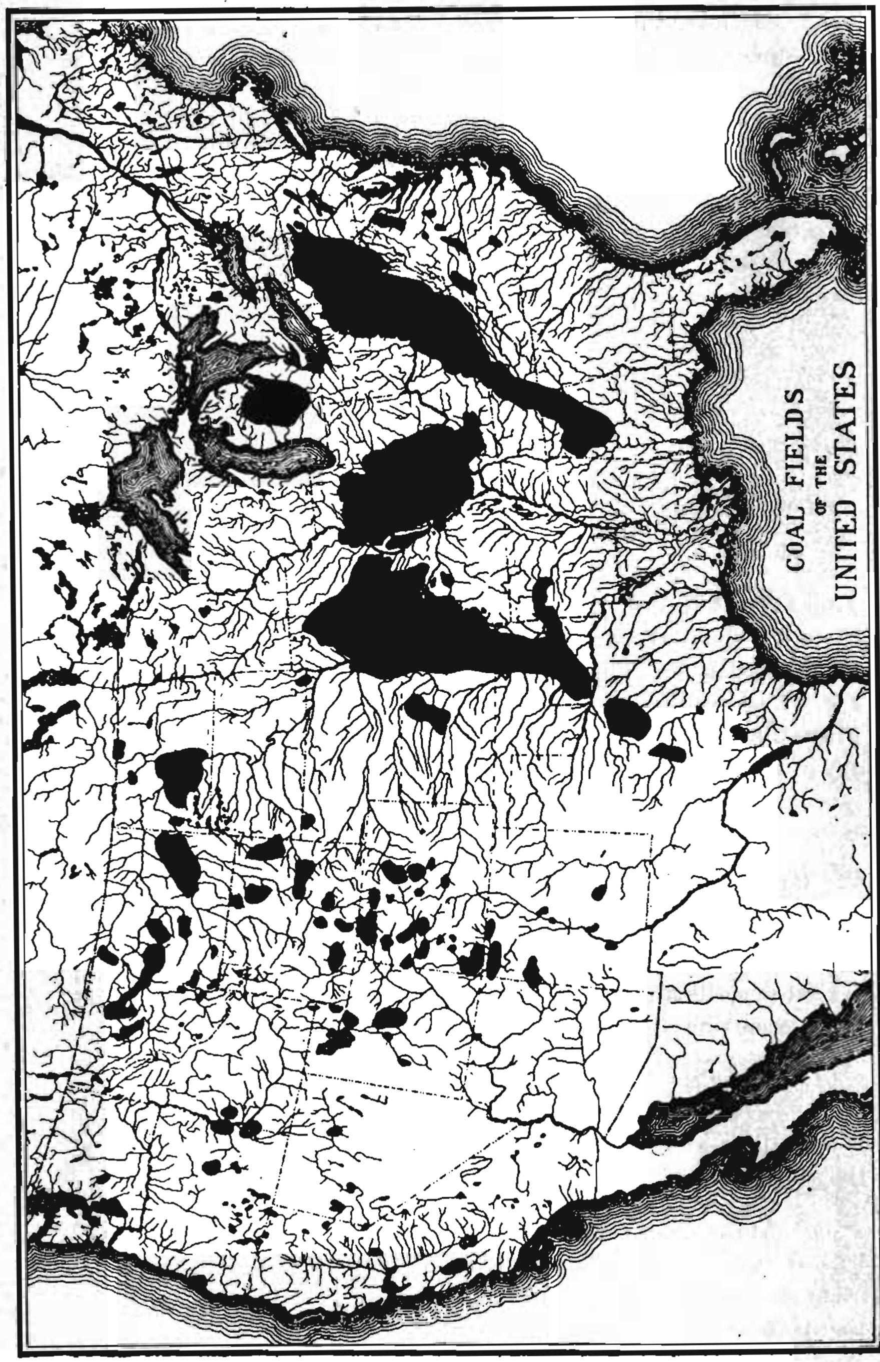


PLATE IV.

Alabama, and covering an area some 700 miles long by nearly 100 miles wide, or nearly 60,000 square miles. It occupies a long trough lying between the Appalachian mountains and the Cincinnati-Nashville-Ouachita arch, the rocks on either side dipping towards the center of this trough.

66. In Michigan occurs a small isolated basin having an area of 6,700 square miles, or about equal to the area of the coal field of Indiana. It is, however, a very shallow basin, and a considerable part of the area is made up of the lowest part of the coal measures which, as in Indiana and elsewhere, is almost barren of coal. One or two workable basins are mined on a limited scale.

In the center of the Mississippi valley occurs the great interior coal field, often divided into the eastern and western fields.

67. The Eastern Interior Coal Field, or, as it is sometimes known, the Illinois Coal Field, covers an area of 47,000 square miles, and comprises central and southern Illinois, southwestern Indiana and northwestern Kentucky. It is with this field that we shall be principally concerned in this paper. The coal occurs in an elliptical basin with a center in Illinois, towards which the rocks of the basin slope. This basin will be described more in detail in Part II.

68. The Western Interior Coal Field is only separated from the eastern by the erosion of the Mississippi river, which runs along an arch. This area of some 78,000 square miles includes southern Iowa, northwestern Missouri, the eastern edge of Nebraska, Kansas and Indian Territory, western Arkansas and, as shown on the map, extending in a tongue down into Texas.

69. In the Western Half of the United States coal occurs in scattered patches over an aggregate area of many thousand square miles and is found in all the Western and Pacific coast States and Territories. These deposits also occur in British Columbia and western Canada. Some coal occurs in Cuba, Peru and at other points south of the United States.

70. In Europe, Great Britain has 12,000 square miles, Spain 4,000 square miles, France 2,000 square miles, Belgium 518 square miles, while some coal is found in Germany and Sweden.

71. In Asia workable coal beds occur in Japan, China, and India, also in Australia and New Zealand, and the Philippine Islands.

72. Coals of Different Ages.—It has been found, however, that these coals were not all deposited at the same time. By studying the order in which the layers of rock lie one above the other, and by using the fact that long study has proven, that the life of the world has steadily changed from age to age, geologists have been able to work out an historical order for all the rocks of the world. And by means of the fossils and plant remains enclosed in the rocks, they are able to decide the relative position or time of laying down of any chosen group of rocks.

In this way it has been found that the larger part of the coal of the world was laid down at about the same time, and from that fact they have called that age the Carboniferous or carbon-bearing age, or shortly the Carbonic age. In this study they have shown that the coal of central and eastern North America was laid down several ages, representing probably many million years, before the coal of western America. They have been able to show that the coals which are hardest and heaviest and contain the largest percentage of carbon and the smallest percentage of the volatile gases were deposited the longest time ago, as a general rule.

The following table shows the names given to the successive geological time periods, the kind of coal most characteristic of each and the places where the coal of that age occurs:

Table Showing Geological Distribution of Coal.

Geological Ages.	Characteristic Coal.	Where Found.
Quaternary	Peat	Wide spread.
Tertiary	Lignite or brown coal	Wide spread, especially in Vermont, Texas, California, Germany, the Philippine Islands, and many Western States.
Cretaceous	Bituminous	Colorado, New Mexico, Wyoming, North and South Dakota, Montana, Washington, Oregon, British Columbia, Canada north of Montreal, New Zealand, Germany.
Jurassic	Bituminous	A little in a few places.
Triassic	Bituminous	Virginia, North Carolina, Australia and India.
Carbonic	Bituminous, Anthracite	Eastern America, Great Britain, Spain, France, Germany, Russia, Belgium, Japan, China, India, Australia.
Devonian, Silurian, Cambrian		Traces of coal in a few places.

One of the main facts of value in the above table is in its showing what experience has proven, that no coal of commercial value has ever been found in rocks underlying the carboniferous. And it will be further of interest to note that coal is found only in part of the Carboniferous. Thus the Carboniferous has been divided into:

Permian—
  Limestones, sandstones and shales.
Carboniferous or Pennsylvanian Series—
  Shales, sandstones, limestones, COAL and iron ore.
Lower or Eo-Carboniferous or Mississippian Series—
  Limestones, sandstones and shale (limestone predominating in Indiana).

As shown, coal of commercial value is practically restricted to the middle division. And as the lower part of the middle division is usually a very thick sandstone, often gritty, or even approaching a conglomerate with which are usually associated only thin and unimportant coal beds, the middle division is often divided up into

The coal measures,
The millstone grit.

The commercially valuable coal of Indiana is practically restricted to that division of the Carbonic rocks known as the coal measures.

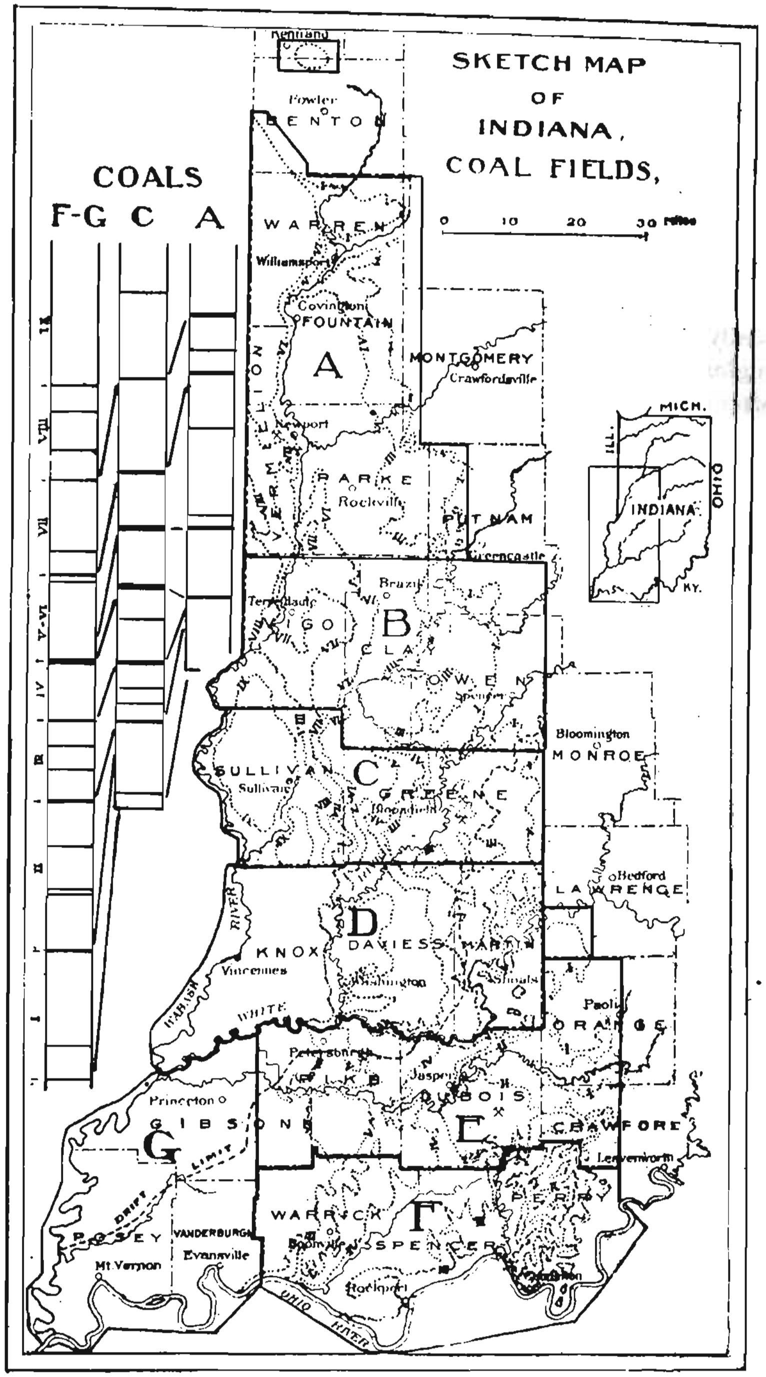


PLATE V. Sketch map of Indiana coal field to show general relation to State and relations of sheets of colored geological map, etc.

PART II.—GENERAL GEOLOGY OF THE COAL MEASURES IN INDIANA.

VI. GEOGRAPHIC POSITION OF COAL MEASURES IN INDIANA.

73. GEOGRAPHIC POSITION.—If on a map of Indiana the position of every point at which a bed of true coal has been found be marked, it will be evident that coal is confined to the southwestern part of the State. More careful examination shows that the following counties are practically entirely underlain by the coal or coal measures:

County.	*Area in Square Miles.*
Vermillion	249
Parke	480
Vigo	415
Clay	360
Sullivan	443
Knox	540
Daviess	424
Gibson	450
Pike	338
Dubois	426
Posey	420
Vanderburgh	240
Warrick	388
Spencer	389

The coal measures also underlie the principal part of the following counties:

County.	*Coal Area in Square Miles.*
Warren	300
Fountain	315
Owen	150
Greene	360
Martin	280
Perry	216

The edge of the coal measures lap over the bounds of the following additional counties:

County.	Coal Area in Square Miles.
Benton	80
Montgomery	9
Putnam	125
Lawrence	20
Orange	42
Crawford	60

Total coal area of State, 7,560 square miles, of which probably less than 7,000 square miles are underlain by coal, if, indeed, that area does not run down close to 6,000 square miles.

There are thus fourteen counties entirely underlain by coal, six counties mostly underlain by coal, six counties containing small quantities of coal, or a total of twenty-six counties containing coal, with a total area of 7,500 square miles. The coal area of the State has a maximum length north and south of about 200 miles and a maximum width from east to west of about 100 miles, being narrow to the north and broad to the south.

The accompanying sketch map of the State, Plate V, will show a little more in detail the relative position of the coal field to the rest of the State.

VII. PHYSICAL FEATURES OF INDIANA COAL AREA.

74. Altitude.—In altitude the area of the coal measures range from below 400 to 800 ft. above tide, most of the area coming between the 400 and 700 ft. contours.

In the north part of the region in Warren county all but the valleys are above 700 ft. Through Fountain, Vermillion and Parke counties the average is over 600 ft., running under 500 in Wabash valley and over 700 in highest ground. Clay county will average a little lower, nearer 600 ft., while Owen will average nearer 700 ft. Vigo and Sullivan will not average much over 500 ft.; Greene county, while but little over 500 ft. west of White river, will approach 700 ft. on an average east of the river. Knox and Daviess counties will average below 500 ft., while Martin county will range from a little over 400 ft. to over 800 ft. Gibson, Pike, Posey, Vanderburgh, Warrick and Spencer will average between 400 and 500 ft., getting lower to the southwest. Dubois will average about 600 ft., while the coal measure area in Orange, Crawford and Perry counties will run over 700 ft. The lowest point in the area is at the junction of the Ohio and

Wabash, 311 ft. above tide. Elevations of over 800 ft. are reached all along the eastern and northern rim of the coal area.

75. Relief Types.—The southwestern part of Indiana shows great diversity in its surface features, some areas being so flat as to be drained only at great expense, while other regions are so broken and hilly as to be in large part unsuitable for cultivation. Of the more level types of surface, very common are the bottoms found along the rivers and streams. Considered from the standpoint of source, these are of three types:

76. (1) River Bottoms produced by the lateral swinging of streams which have nearly or quite reached their base level. Though in general this is the commonest kind of a river bottom, in this area it is not common, and when it exists is usually of limited width. From the standpoint of our subject it is characterized by the thinness of the superficial deposits, the coal measure rocks being found at but a few feet below the surface, and often outcropping in the banks of the immediate channel of the stream or river. Such bottoms usually occur along the upper courses of streams in the unglaciated regions.

77. (2) River bottoms formed by unstratified drift filling a preglacial valley. These are perhaps the most common of the stream bottoms. They are usually characterized by a considerable depth of superficial material, by a lack of outcrops of coal measure rocks, and by their large size as compared to the size of the streams flowing through them. With the larger streams, the old valley filling, the surface of which makes the present bottom, is often 100 ft. deep. In other words, a shaft sunk in one of these bottoms to an underlying coal bed must pass through from 50 to 100 ft. of soft material, which will require to be curbed and which may render the sinking a matter of some difficulty and embarrassment. These are often of considerable extent, and not uncommon are bottoms of a stream which are from one to five miles broad. Of course, over such areas no coal outcrops are found, and they often render it difficult to trace the relations of the coal on either side. They are usually prairie lands, and in an early day were wet and marshy much of the time, though extensive ditching has now drained most of these areas.

78. (3) River bottoms made by the filling of preglacial valleys by glacial deposits brought in by water. This type is common in the unglaciated area, and has a notable example in the drift area in the Wabash valley. These fillings appear to have been made by the

washing in of glacial material during a depression of the land. The present surface is probably in most cases not the original surface of the filling. In many cases the original filling appears to have been from 25 to 100 ft. deeper than the present filling, the land at the time the filling was made having been at least that much lower than at present. Later, an elevation of the land started the streams to clearing out their old channels. This proceeded until base level was reached, when lateral swinging by the streams produced the level surfaces now existing. Where the present stream is small compared to the size of the ancient valley, the first stage of the clearing-out process may not yet be complete, and the old deposits still flank the margins of the valley as terraces. (See description of terraces along Wabash river in report on Vigo county.)

79. An interesting variation of this type of topography is found all around the glacial boundary. As the ice sheet moved southward or southeastward, it pushed across the lower courses of many of the streams, damming them up. The ice stayed at, or near, its extreme limits long enough to have the bodies of water thus made silt up full. In many cases the streams thus dammed up were of considerable size, as for example, the Patoka river above Jasper, and the body of water thus created was also of large size—up to several scores of square miles. Oftentimes the higher points of the pre-existing topography project, island-like, above level deposits surrounding them. These are typically found in northwestern Dubois county. In some cases these level fillings are still preserved, and then resemble closely the river bottoms of Class 3. In such cases the drainage has usually formed a new channel, having flowed out at the lowest point of the rim of the basin in which the water accumulated. In Greene county are found some interesting cases, where the water appears to have escaped by channels under the ice, and the surface water to-day runs into sink-holes in the level fillings and escapes by channels at the bottom of the deposits. In many cases where such fillings have existed, the streams resume their old courses after the retreat of the glacier, and while in some cases they have removed all of their old filling, in other cases traces of it still show in the form of terraces on the banks.

An examination of the deposits forming the bottoms of the streams in the drift area show that quite commonly these bottoms belong to both Classes 2 and 3.

80. Upland Levels.—In the glacial area away from the larger streams it is usual to find wide areas of the divides practically level. Examination shows that these level lands are drift deposits, usually

of considerable depth. They appear to be remnants of the old level surface left by the glacier in its retreat. As yet they have not been reached by surface drainage, the water sinking into the soil and escaping by numerous underground channels. In some places the drainage lines are rapidly encroaching on these areas. Mr. Scovell cites cases in Vigo county where six to ten little streams head up into one 20-acre tract. These level stretches commonly are prairie land, and as in the case of Grand Prairie, in Vermillion county, are often of considerable extent. No outcrops of coal or rock occur in them, and as wells for water seldom go to the underlying coal measures, information about the coal in such areas is generally very scattering, or more commonly entirely lacking. This topographic type is common on the divides all over the glaciated part of the coal field, but is increasingly found from the south northward, until in Warren county it covers a large part of the county.

81. Glacial Sub-Level Topography.—Probably the larger part of the glaciated area would be a modification of the preceding type produced by the encroachment of surface drainage. In this type the surface, while nearly level, has had drainage lines developed in it and so consists of gentle slopes to the streams and smaller drains, with often sharp bluffs along the lower courses of the larger streams. The upper courses of the streams are not marked. In some cases there is a gentle slope to the stream which has hardly any appreciable banks. In other cases the slope to the stream is not perceptible and the stream has cut a narrow V-shaped channel. As a rule the streams are still cutting in the glacial deposits and so seldom disclose outcrops of coal or coal-measure rocks. Here and there, especially where the drainage is following new lines, the coal-measure rocks have been reached. In many cases such exposures seem to be due to the stream in its downward cutting having encountered some high point in the pre-glacial surface.

82. Bluff Topography in Glacial Area.—In the region adjacent to the Wabash and its principal tributaries the preceding type has been considerably modified. A study of the topography of the country adjoining this river as compared with that found along White river, Eel river and other streams suggests that conditions existed somewhat similar to those found in the Colorado canon region of Arizona. That is, the erosion in the stream bed has been proportionally greater than the erosion of the banks. As a result, the adjacent country, instead of sloping gently to the river, approaches the river with a fair slope and then reaches the immediate valley at an elevation of

from 100 to 200 ft. above the river, necessitating a rapid descent by means of bluffs. In the same way the tributary streams have taken advantage of the low points of discharge to cut their channels some distance below the normally lowest point of their valley slope. Where such tributary streams are large and are flowing in channels of post-glacial age, their banks are sometimes very precipitous or perpendicular. This U-shaped type of valley is not uncommon in the glaciated part of North America, but is usually the result of the backward cutting of streams flowing in new channels. This can hardly be the case with the Wabash, and we are led to suspect that at some previous time the area drained by the Wabash was much larger than at present. Whether the Wabash was formerly an outlet of Lake Michigan or Lake Erie, as some have thought, can not be determined with the present facts at hand. It certainly appears that the Wabash was the outlet of Lake Erie during the last part of the Ice Age, the north-eastern outlet being still closed by the retreating ice, yet that the channel should have received its extra depth during that time hardly seems credible. It is possible that a closer study may show that other factors not yet generally considered have been largely influential.

83. SANDSTONE TOPOGRAPHY IN GLACIAL AREA.—At the base of the coal measures all along its eastern margin occurs a massive bed of sandstone 40 to over 100 ft. thick. Over most of the area of its outcrop it has greatly influenced the topography. In Warren and Fountain counties it is buried too deeply to make its presence felt at the surface. Through Parke county and southward it would seem to have formed prominent ridges or high land, as it does now in the unglaciated area. In Parke county these were completely overridden by the ice and planed down so that they do not now show as distinct ridges above the old level left by the glacier. But the glacial deposit left over the area, while thin, was deep enough to turn many of the streams out of their old courses and start them cutting new ones across the top of these old ridges. The result has been to produce a number of narrow, rock-bound gorges, cut almost perpendicularly down from the level upland. In extreme cases the depth of the gorge may be much more than its width at the top, and as they follow all the windings of the original superimposed stream, the resulting topography is about the wildest and most picturesque to be found in the State. To the southward, in Clay, Putnam, Owen and Greene, the topography along the outcrop of this sandstone is a combination of the glacial topography to the westward, with its flat ridges, and the sandstone topography outside the glacial areas, the latter type becoming more

and more dominant to the southward, or as the glacial boundary is approached. In this mixed type the divides are still level and high, but they have been deeply cut into by the erosion, which has formed between them ravines from 100 to 250 or more feet deep. Going southward the ravines occupy a larger share of the region, the flat divides become narrower, then begin to break down in places, and finally become irregular, sharp crests as the glacial boundary is reached, showing little or none of the influence of the ice.

84. SANDSTONE TYPE OUTSIDE OF THE GLACIAL BOUNDARY.—This type of topography exists all along the eastern edge of the coal measures from southeastern Owen county southward to Perry county. It is characterized by having but little flat land, and that mostly river bottoms of the third class, as enumerated above. The drainage lines are completely developed, the divides being sharp crests and irregular, the streams running in deep ravines from 100 to 300 ft. deep, the banks generally too steep for cultivation, except near the top and bottom, where they round up to the summit of the ridge or round outward to meet the bottom land. As far as possible the roads follow the top of the ridges or keep in the valleys, and, as shown on the maps, serve as a good index of the broken character of the country. As might be imagined, such a type of country is very favorable for rock exposure, and it is possible there to trace the horizon of any chosen rock or coal bed with a considerable degree of accuracy. On the other hand, in view of the fact that from the nature of the country, with its labyrinth of deep ravines, it requires much effort and time to trace the lines of outcrop, and as the area possesses but little workable coal, it has proved more of a detriment than an advantage. It has been a common experience with all the members of the survey that, after working in the flat country to the west, where the mapping of the outcrop lines has had such a large element of conjecture in it, upon entering this area, where outcrops could be traced with much certainty, to devote much more time to it proportionally than the value of the coal found would warrant.

85. TOPOGRAPHY OF PRODUCTIVE COAL MEASURES OUTSIDE OF GLACIAL BOUNDARY.—Most of the column of rocks above this basal sandstone is a very variable mixture of shales, sandstones, clays, coals and limestone. Of these the shales generally predominate, and the result is that within the eastern sandstone rim, but outside the glacial boundary, the topography, while resembling the last type in general plan, is more of a rolling character, the ridges having been reduced by erosion until they are fairly low, with gentle slopes running to the

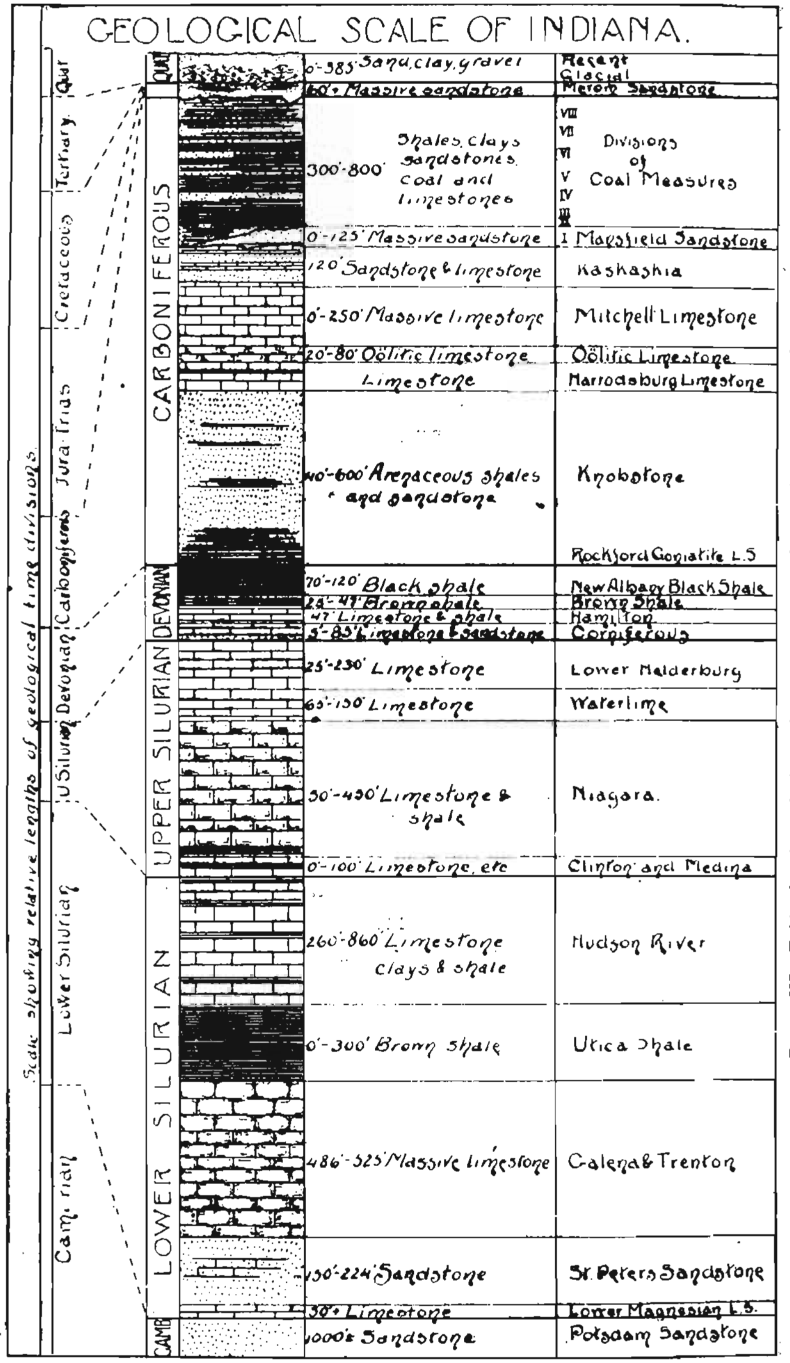


PLATE VI. Table showing relations of coal measures to the stratigraphy of the State.

streams and generally suitable for farming. The ridges will generally vary between 50 and 100 ft. above the stream channels, so that the drainage is good. The depth of surface material formed by the disintegration of the underlying rocks is greater than in the sandstone area, rock exposures are generally small, and often as much scattered as in many parts of the glaciated area. On the whole, however, this type of country yields the information desired by a survey like the present with a degree of fullness that renders it possible to obtain the stratigraphy and to trace the outcrops of the coals in a fairly satisfactory manner.

In a general way, an examination of the roads as given on the maps will serve as an index to the character of the topography of any area. This is not always true, as in many of the hilliest sections it is the practice to make the roads conform strictly to the section or fractional section lines without any reference to topographic features. In a multitude of cases a better method of rendering a road valueless could hardly be devised. On the other hand, in some districts where the roads as shown on the maps would suggest a broken, uncultivated country, a visit reveals a rich farming region with gentle topographic features, in which the residents appreciate the use and purpose of roads, and have employed engineering skill in their laying out and construction, with the result of good roads of great permanence and carrying capacity.

In a still greater measure the topography is indicated by the lines of outcrop on the maps. Where those lines are dendritic in form, it may safely be assumed that the topography is marked and probably quite rugged. Where two outcrop lines occur close together, a steep slope is indicated, unless the coals are very close together. In parts of the area the outcrop lines serve very well to indicate the topography to those who are accustomed to contour maps.

VIII. STRATIGRAPHIC POSITION OF COAL MEASURES IN INDIANA.

Thousands of dollars have been wasted in this State in the past in the fruitless attempt to find coal where coal not only did not exist, but where a knowledge of the geology of coal would have conclusively shown beforehand that no coal could have been found. Unlike gas or oil, fairly definite statements can be made as to the distribution of coal. Thus, it can be stated that all workable coal will be found within such and such limits; that outside of those limits no coal exists except a few scattered very thin seams found just beyond the limits given. The coal of the State is all confined to rocks of a particular geological age, characterized by certain forms of animal and vegetable life, and, to a slight extent, by the rocks. The geological formations that overlie or underlie may also be distinguished, either by the character of the rocks forming them, or more accurately by the animal and vegetable remains contained.

To prevent, if possible, the waste of many more thousands of dollars in the fruitless search for coal, it may be well to make a brief comprehensive study of the rocks above and below the coal measures, as well as of the coal measures themselves, the fossils by which they may be recognized, and their structural position and distribution.

86. The accompanying table,* Plate VI, shows a columnar section of all the rocks of the State, the time period during which each group was laid down, a statement of the character of the dominating rocks of each group, and in the last column the names given to the more important subdivisions. In the first column is placed a time scale, of the time from the laying down of the earliest rocks known to underlie Indiana to the present, showing the relative estimated length of each of the major time divisions, and connection with the rest of the table shows, in a measure, during what part of geological history Indiana was under water and receiving deposits, and the time it was, as far as we know, above water and undergoing erosion. The rocks preceding the Carboniferous Age will be treated very briefly.

87. POTSDAM SANDSTONE.—It has been customary to label a sandstone which has been met with in several drillings that passed through the Trenton limestone as Potsdam sandstone. It is probable that Potsdam sandstone has only been reached in the well at Laporte, and at a depth of probably 600 ft. below the bottom of the Trenton. The drill there entered it some 323 ft. without reaching bottom. It does not crop out in this State.

88. The LOWER MAGNESIUM LIMESTONE is thought to be represented by the last 50 ft. of limestone penetrated by the boring at

*In this table and the accompanying description I have drawn largely on the valuable paper on The Natural Gas Field of Indiana, by Dr. A. J. Phinney, in the 11th Annual Report of the U. S. Geol. Surv., for that part of the table preceding the Carboniferous. The averages used in drawing the columnar section were personally obtained by a study of all the deep well records obtainable. For the lower or Sub-carboniferous I am especially indebted to the recent reports of Messrs. Hopkins, Siebenthal and Kindle contained in the 20th and 21st annual reports of the Geological Survey of Indiana. The present survey is alone responsible for the coal measures and overlying beds.

Bloomington, and possibly was reached in the boring at Greenwood, Johnson county. It appears as a gray sandy limestone. Does not outcrop in this State.

89. The ST. PETERS SANDSTONE has been penetrated by a number of drillings that have passed through the Trenton limestone. It varies from a pure sandstone to a sandy limestone, usually of a light color. Does not outcrop in this State. Outcrops in Illinois and Wisconsin. It is the source of the "Blue Lick water" of several of the deep wells. Thickness, 150 to 224 ft., with doubt.

90. The GALENA AND TRENTON LIMESTONE has become popularly known as the reservoir of the natural gas and oil. It is a massive thickness of limestone, with a little shale in places. It probably underlies the whole State, with an average thickness of close to 500 ft. It does not outcrop in this State, but is well known from outcrops in nearly every direction beyond our borders. The upper part of the Trenton, which contains the oil and gas, is thought to correspond to the Galena limestone of Illinois.

91. THE UTICA SHALE is a persistent dark brown or black shale, though tending in some places to grade over into the lighter colored Hudson river shale. It varies up to a reported thickness of nearly 400 ft., but grows thinner to the northwest, and seems to entirely disappear before reaching outcrop in Illinois and Wisconsin.

92. The HUDSON RIVER OR CINCINNATI rocks are the lowest rocks outcropping in Indiana. They outcrop only in the southeast corner of the State. They consist of bluish-green shale, bluish limestone, and clays. The limestone is most prominent in the upper part of the series, with a much greater thickness of shales below. The whole formation thins to the northwest, the limestone being more persistent than the shales. The formation varies from 260 to 860 ft. in thickness, with an average of over 400 ft. The upper part of the series is very fossiliferous and has been long and extensively studied.

93. THE CLINTON AND MEDINA periods, which are represented by such thick deposits further east, are, in this State, hardly recognizable, and some doubt still exists as to the correctness of assigning certain beds to the Medina. The Clinton is usually represented by a light colored limestone, often not over 10 ft. thick, and often wanting altogether.

94. The NIAGARA rocks consist of a characteristic bed of bluish-green shale, very persistent at the base of the formation, with a thick-

ness of from 2 to 40 ft., though disappearing to the northwest, and a great thickness of limestone overlying. The overlying limestone varies from a subcrystalline buff to bluish crypto-crystalline, or bluish-green shaly limestone, or even passing into calcareous shale. From a thickness of 100 ft. along the Ohio, these limestones range up to 440 ft. in the northern and northwestern part of the State. The upper part of this limestone has been correlated with the Guelph of Canada.

95. The LOWER HELDERBERG AND WATERLIME are closely related limestones, varying from 25 to 230 ft. and 65 to 150 ft., respectively. Traces of Gypsum are found in the formation in places. Exposures of the Lower Helderberg show a buff to gray cherty limestone. The formations are confined principally to the northern part of the State.

96. The CORNIFEROUS period is represented in Indiana by sandstones 15 to 20 ft. thick, thought to correlate with the Schoharie group of New York, and limestones 5 to 65 ft. thick, correlated with the Upper Helderberg. The formation increases in thickness to the northward.

97. THE HAMILTON group is taken by Mr. Phinny to be represented by a 20-ft. bed of brown, calcareous shale and an overlying 27-ft. bed of dark-gray limestone.

98. The NEW ALBANY BLACK SHALE and a persistent underlying brown shale form the top of the Devonian in this State, and have been recognized in all the deep wells drilled in the State west of its eastern outcrop. This is the formation furnishing the gas and oil found in the coal field up to the present. This black shale contains a great deal of bitumen, enough so that when set fire to on the outcrop, it has been known to burn for weeks.

99. The LIFE during the Ordovician (Lower Silurian), Silurian and Devonian ages has largely been confined to the lower animals; at first to the invertebrates exclusively, then in the Lower Silurian traces of fish appear. In the Upper Silurian they become more plentiful. Among plants, seaweeds predominate. In the Devonian, fishes become a marked feature of the life, while the coming of reptiles is foreshadowed. The great mass of the fossil remains, however, still continues to be largely shells and other low forms of sea life.

100. The history of these periods probably starts with Indiana all under water, this water probably having a small average depth, so that slight oscillation will produce widespread changes in the character of

the deposits. Toward the close of the Lower Silurian a movement of some importance began. It consisted of a gentle uplifting of the rocks laid down along the eastern border of the State and a slow subsidence of the western part of the State. The movement of uplift continued until a broad arch of land had appeared, known now as the Cincinnati-Nashville arch, and extending from northwest to southeast across Indiana, passing by Cincinnati, Nashville, and extending southwest through Arkansas into the Indian Territory. The movement of sinking, which centered in Illinois, was to continue by irregular but almost imperceptible degrees all through the Upper Silurian, Devonian and Carboniferous, until the old sea bottom had sunk several thousand feet, the deposits laid down in the basin so formed at times about keeping pace with the sinking. Several times the movement seems to have been stopped or reversed temporarily. In Carboniferous times they more than kept pace, so that the basin became filled to sea level, and slight oscillations would either lift a great area just above the water level or sink it just below. The last part of this history will be given beyond; but it is of interest to see that the initial steps for the formation of the coal were taken several ages before the coal appeared.

101. The LOWER CARBONIFEROUS OR EO-CARBONIFEROUS was ushered in in Indiana by the laying down of the thin bed of limestone and shale known as "Rockford goniatite limestone." Above this lies the great thickness of alternating sandy shales and sandstones known as the "Knobstone." This formation reaches a thickness of 600 ft. Above the Knobstone lies a great thickness of limestones. These are divided from the bottom upward into:

102. The HARRODSBURG LIMESTONE of Keokuk age, consisting of limestones and shale, with a thickness of from 60 to 90 ft. It is characterized by the presence of great numbers of geodes.

103. The BEDFORD OOLITIC LIMESTONE, well known as a building stone, is a formation of calcareous sand, having a thickness of from 25 to nearly 100 ft. It usually appears as a massive bed of a buff or blue color, with an even and rather fine grain. The grains have been shown to consist largely of fossils, foraminifera and bryozoa of almost microscopic size.

104. The MITCHELL LIMESTONE OR ST. LOUIS LIMESTONE is a series of impure limestones, calcareous shales and fossiliferous limestones, with a total thickness of from 150 to 250 ft. This is the limestone in which most of the well-known caves of Indiana occur.

105. The CHESTER OR KASKASKIA GROUP, which immediately underlies the coal measures, varies somewhat along its outcrop. In Orange and Martin counties, Mr. Kindle found three limestones separated from each other by sandstones. The lower limestone he describes as a light ash color, a close, fine texture stone, breaking with subconchoidal fracture. In places it contains nodules of chert. The thickness is given as 18 ft. The two sandstones, separated by the middle limestone, are of medium coarseness, buff to light gray or white in color, and in places contain coal seams 6 in. thick. One of these coal seams has been mined in the southwest quarter of the southwest quarter of section 24 (2 N. 2 W.). The middle limestone is usually a close textured, semi-crystalline, gray limestone, usually fossiliferous. In places it is oolitic in structure. It varies in thickness from 30 ft. down to 5 or 6 ft. The upper limestone is a dark to light gray crystalline limestone, composed largely of crinoid stems. Chert bands are common in it in places.

106. The COAL MEASURES consist principally of shale, but with an intermingling of sandstone, clay, coal and limestone. As the stratigraphy of the coal measures is considered at some length just beyond, it will be unnecessary to discuss that at this point.

107. The MEROM SANDSTONE.—Division IX. Just as the main body of the coal measures is underlain with unconformability by a massive sandstone, so it is also overlain with unconformability by a massive sandstone. In the earlier reports this sandstone was designated the "Merom sandstone" from its excellent exposure at that point. It there, as in the counties to the south, lies on an eroded surface of the coal measures, its lowest member consisting of a calcareous conglomerate containing shale, coal, pebbles of sandstone, etc. To the north, in Parke and Fountain counties and Vermilion county, Illinois, occur a number of extensive channels cut down into the coal measures, to depths ranging up to 200 ft., and filled with a sandstone very similar in many respects to the sandstone at Merom, Sullivan county. Though no such readily distinguishable channels were found in the southern part of the coal field, the position of the sandstone there relative to the coal below it indicates extensive erosion. If we are correct in correlating the massive sandstone of the channel fillings in the north part of the coal area with the overlying massive sandstone of the southern part of the area, it would appear that this sandstone was laid down at no inconsiderable time after the laying down of the coal measures proper. The great depth and width of the stream channels cut out of the coal measures prior to its deposition suggest a long time

interval. So far as known, no fossils have been found associated with this sandstone in Indiana. In Illinois, however, some fossils were some time ago found in some shale thought to be of the same age as the Merom sandstone. The possible Triassic age of the fossils led Mr. Collett to suggest that the Merom sandstone might be of a Triassic age. Concerning these fossils he says:* "Adjoining this locality, Section 25, Township 19, Range 13, Vermilion county, Illinois., Dr. J. C. Winslow, of Danville, Ill., discovered a bed of fossils which is named in his honor 'Winslow Bluff.' They occur in a bed of black, brown, gray, red and pink shales, backed with sandstone, filling a depression denuded by forces acting at the close of the coal age, which has carried away the regular deposits, including probably three seams of coal. They consisted of separate vertebræ, teeth and other elements of several skeletons, amounting to about 93 bones and fragments, and were submitted by the writer to that distinguished comparative anatomist, Prof. E. D. Cope. After a careful study, Prof. Cope found that they comprised two new genera and species of Reptilia and two of fishes. In a paper read by him and published in proceedings of Academy of Natural Sciences of Philadelphia, September 28, 1875, page 404, the professor says that 'a remarkable peculiarity of the vertebræ of the series is the longitudinal axial perforation of the centrum. They present the character observed in *Archegosaurus* and other *Stegecephalus* Batrachia; but which also exists, according to Gunther, in the living Rhynchocephalous lizard—the *Sphenodon* of New Zealand. The bones of the limbs and scapular arches are so decidedly reptilian, and so unlike those of any Batrachia with which we are yet acquainted, that I am disposed to refer them to the former class. And as there are several points in which the fossils resemble the order *Rhynchocephalia*, I refer them provisionally to that neighborhood. They constitute the first definite indication of the existence of animals of that type in the Western hemisphere. Associated with these Saurians we found teeth of two species of fishes, which are important in evidence of the position of the beds in which they occur. One of these is a new species of *Ceratodus*, Agass., and the other a *Diplodus*. The former genus is characteristic of the Triassic period in Europe, one species having been found in the Oolite. It still lives in North Australia. In both these respects the *Rhynchocephalian* lizards present a remarkable coincidence. *They also belong to the horizon of the Trias in Europe*, and the only living species is found in New Zealand. Thus it would seem that a fragment of this fauna, so

*7th Ann. Rep., Geol Surv. of Ind., p. 256.

ancient in the Northern hemisphere, and so remarkably preserved in the Southern, has been brought to light in (the Wabash valley) Illinois.' He names the new Reptilia, *Cricodus heterolitus*, and *Clepsydrops collettii*, the fishes *Ceratodus basilatus* and *Diplodus vinsolvii*, and adds that while the first are so distinctly of Triassic type, that the last has not before been found above the Carboniferous, and waits further material before venturing a decision whether they belong to *Triassic* or *Permian* time."

We can only say at this time, the question is still an open one. If the correlation of the channel sandstones of Parke county which fill channels that cut down to and through Coal III, correlate with the similar sandstones of adjacent Illinois and southwestern Indiana, then it will be seen that previous to their laying down, the coal measures of the State have been tilted at an angle that would place nearly their whole thickness above sea level in Parke county, while a score or a little over of miles to the southwest, nearly the whole of the coal measure column, as preserved in this State, seems to have been under water. This exposed condition of the eastern part of the measures seems to have resulted in the strata, from Division VI up, having been carried away, with valleys extending down into the measures to Division III.*

108. Glacial Deposits.—The fact is a familiar one to nearly every one in Indiana, that, except over a small triangular area in the southern part of the State, the hard or consolidated rocks of the State are overlain by a considerable thickness of soft sands, clay and gravels. These make up the general surface soil, and are the only materials penetrated by the majority of the wells of the State. This soil differs, however, from the soil of the States farther south, first, in its unusual thickness, and second, in that much of its material is entirely different from the rocks immediately underlying it, or even exposed in the same drainage basin. In thickness these unconsolidated deposits vary from nothing up to nearly 400 ft. In material they consist of boulders, angular, rounded, or with both flat and rounded surfaces, scattered irregularly in a bed of sandy clay known as "boulder clay," till, or commonly in Indiana as "hard pan," together with usually smaller deposits of sand and gravel. A plate in XL, showing coal at Crawford No. 1 mine, illustrates a fairly typical exposure of boulder clay. A study of the drillings in the body of the text will show the way these materials vary in thickness and in proportional amount.

*Note.—These sandstone filled valleys were thought, at the time Mr. Collett wrote the above, to be ridges of Mansfield sandstone projecting up through the coal measures. Their true character was first noted by Mr. Hopkins in 1895.

The boulders in this boulder clay may vary in size from pebbles an inch in diameter and down up to many feet in diameter. An examination quickly reveals a large proportion of boulders of granite and similar igneous and metamorphic rocks, none of which are found as regular deposits in Indiana. An examination of some of the larger ones will often show one or more flat sides that seem to have been planed off and to have been much scratched in the process. Further, there are often found in Indiana exposures of the harder of the underlying rocks whose upper surface appears to have been planed and scratched in a manner very similar to the smooth faces of the boulders. Again, examination of a considerable bluff of this boulder clay shows that as a rule the materials have not been laid down with any regularity or apparent bedding. These deposits have been very extensively studied during the past 20 years, and it is now generally recognized that they were laid down by great glaciers or moving fields of ice, which, starting from different points in the Dominion of Canada, and at different times, pushed their way southward like enormous planes, gathering and grinding up great quantities of rock and dirt and carrying it forward to be dropped at a greater or less distance to the south of their original position. In this way granite boulders from Canada are found scattered over most of Indiana.

In the coal area these glacial deposits cover all except the eastern edge of Greene county, most of Martin county, the southwest corner of Daviess county, from whence the limiting line extends from northeast to southwest across northwestern Dubois, northern Pike, central Gibson and northwestern Posey counties, the area to the east and south of this line never having been covered by the ice.

The thickness of the glacial deposits increases from south to north. At the southern edge they thin out very gradually, so that it is often difficult to determine the exact former extension of the ice sheet. Careful study by many geologists has shown that the greater thickness to the north is in part due to that part of the State having been invaded more than once by ice. In some of these later invasions the ice sheet seems, after reaching a certain extent, to have melted as fast as it moved forward, so that its front line for a time stood still, and the rock and dirt carried forward to that line was heaped up, forming more or less of an irregular ridge. Such a ridge is called a "moraine." Such a moraine crosses northern Vigo county and southwestern and central Parke county. To the south of that the drift will average about 30 ft. deep; to the north it increases until in Benton county it averages 200 ft. The white clay covering the glacial area south of the moraine in Vigo county is thought by Mr. Frank Leverett, of the

U. S. Survey, who has studied the area extensively, to have possibly resulted from the advance of a glacier of which no trace now exists in Indiana, on account of its not having advanced far enough to escape being covered up by the later glacier that reached Vigo county.

The relation of these glacial or drift deposits to the older rocks is one of marked unconformability. The general land surface of southwestern Indiana would appear to have stood at least 100 ft. higher above sea level before the ice age than at present. The evidence of this is seen in the fact that the present drainage level is about that height above the preglacial drainage. Thus, the Wabash river in southwestern Indiana flows on the top of about 100 ft. of glacial deposits that filled its old channel, and the same of the other streams. But between the ice age and the present time the southwestern part of the State has evidently stood at a much lower level than at present. One result of this was to allow the streams laden with dirt from the glacier or from the fresh glacial deposits, to fill up the stream valleys that, starting in the glacial area, run southward through an unglacial area. In some cases these valleys, as with the east fork of White river, appear to have been filled up probably 100 ft. or more above their present level. Traces of these old deposits can be seen along the banks of such streams many score of feet above the channel of to-day. In these cases, as far as observed, the streams flowed to the west, so as to have been dammed up by the ice sheet, and these deposits may have been made while the water was thus backed up. As a secondary result of this filling, when the streams began to cut down their channels again after an elevation of the land, it is frequently found that they did not cut directly down into their old channels, but often started a new channel, especially if by so doing they could cut off a loop and so shorten their courses. Good examples of this are found in Martin county, as described under that county.

IX. SUBDIVISIONS OF THE COAL MEASURES IN INDIANA.

109. The Coal Measures.—It has been customary in the past, as shown by the geological maps of Indiana issued by the State Survey, to divide the coal measures of the State into three divisions as follows:

3. Upper or barren coal measures.
2. Middle or productive coal measures.
1. Lower coal measures or millstone grit.

In making such a division it was usually stated that the divisions were purely artificial and made for convenience only. These divisions have never been very strongly insisted on, except perhaps between 1 and 2, and as an unconformability exists at that horizon, the division was well made. Recent studies have shown, however, that certain workable coals usually placed in Division 2 belong well up in 3, as that has usually been defined. As the separation of Division 2 and 3 was purely on the lack of workable coals in 3, it would seem better to put the two divisions together. A massive sandstone, the Merom, which we usually put in Division 3, may well be considered by itself, as it lies unconformably on the coal measures wherever found, and further, some question has been raised as to whether it is really of carboniferous age.

Furthermore, deep drillings in the coal area have seemed to show that the massive sandstone known as the millstone grit occupies in Indiana only a limited area along the border of the coal field, and to the west is largely replaced by shales containing coal beds. While in some cases there is little doubt that these shales and coal beds lie in eroded depressions in the millstone grit, in others there is a question as to whether the massive sandstone, being a shore deposit, was not represented by shales and coal beds at a short distance, which were laid down at the same time, and so horizontally equivalent. Again, over much of the coal field unconformability between 1 and 2 is not noticeable, the sandstone of 1 is not so distinct in its structure and character from massive sandstones of much later date as we had been led to suppose, as may be judged by the fact that it was frequently confused with higher coal measure sandstones by the first survey, and finally, there are other unconformabilities at higher levels that are but little less marked. Hence it has been thought best to treat the coal measures of the State as a unit, to be divided up into as many divisions as the facts will warrant. In the economic discussion of the coal measures it is of considerable importance that some satisfactory method be adopted whereby it will be possible to indicate the vertical position in the coal measures of any particular coal or rock bed.

110. Previous System.—In his first geological report on the coals of Indiana, Mr. Cox adopted, as a temporary expedient, the use of letters to designate the different coal beds. He says:* "In advance of a more thorough study of the coal measures of this State, it is a matter of some importance to be able to decide upon a system of numbering that will not prove objectionable before the completion of the survey, and yet enable us to show at a glance, in each section, the equivalent beds of coal. For the present, therefore, I have thought best to omit the system of numbers, and adopt instead thereof, corresponding letters for equivalent coal beds. By this means we may construct, after completing the detailed survey of the coal measures, a general vertical section that will be harmonious in all its parts." He accordingly called the lower bed A and the successively higher beds B, F, G, H, I, J, K, L, M and N; A, F, I, K, L and M or N being the principal beds. B was sometimes applied below the millstone grit, sometimes above; M of many of the counties is equivalent to N in the other counties. A 4-ft. coal bed lying above N was not recognized as higher than L or M. It was called O in 1896 by Mr. Scovell, who first recognized its true position.†

111. Inadequacy of Old System.—The system as started has been retained up to the present, though, probably due to the below indicated causes, it has largely fallen into disuse. In starting the present survey it was our own purpose to retain that system, and for a considerable length of time this was done and the attempt made to make all local sections fit the section given by Mr. Cox for the State in his second report. Several difficulties were, however, encountered: First—We found about twice as many coal beds as the system, as applied, gave room for. Second—The application of the system to the coal beds found contained so many errors as to make the past application at great variance to our own. To illustrate: Let us take the four northeast townships of Sullivan county as given on the map accompanying the report for 1870. Prof. Collett starts with the section at Sullivan. Of 37 points which came within our notice, at which he had referred the coal to the upper coal at Sullivan, the present survey seemed to show that 14 were correctly correlated, 5 should have been the first coal above, 15 the first coal below, and 3

*1st Ann. Rep. Geol. Surv. of Ind., pp. 18-19.
†21st Ann. Rep. Dept. of Geol., etc, 1897, p. 517.

the second coal below. Of coal at 17 points correlated with the coal at Sullivan at 265 ft., we found 3 to be correct, 4 should have been the coal above and 10 should have been the next coal below. These errors were found to be so abundant through most of the field that their correction would almost amount to the application of a new system. Third, and most important—The exact equivalency of the coal beds has yet to be proven in a large proportion of cases, especially with the lower coals. Many only slightly familiar with the coal fields imagine the problem of determining the exact correlation or equivalency of the coal beds a simple matter. It would be so were the popular idea of the regularity of the coal beds a true one. But as one becomes more and more familiar with the lack of regularity in the coal measures, he will have less and less confidence in exact correlations. He finds a coal which appears to underlie all of one county with an average thickness of from 4 to 6 ft., in an adjacent county averaging from 4 to 6 in., and only developed in certain localities. In places two beds are two or three score of feet apart, while not many miles distant they are mined as a single bed of coal. In many cases coal beds which have long been considered as distinct beds, one 40-50 ft. above the other, have been shown by mining to be the same bed. It is often the case that a section of the coal and roof taken at one part of a mine will be entirely dissimilar to that taken at another part of the mine. Thus, it is quite common to find a shale roof in one part of a mine and a sandstone roof in another part, or a limestone roof. As a result of this constant variability it has been found very difficult or often impossible to prepare type columnar sections of the lower coals, and frequently when prepared, their unreliability has been clearly demonstrated by the first test made of them. As before stated, the coals and strata of the upper part of the coal measures are more regular, but even with the information at present obtainable there are large areas where the correlation of the coal is extremely uncertain, and there is hardly a township in the whole area in which the vertical position of all the coals found at different points is beyond question.

In view of these facts it became evident before the survey was half completed that the old system would have to be entirely remodeled or a distinctly new system adopted. The latter course was thought to be the better. In arriving at a decision it was found of advantage to examine the systems in use elsewhere, and the extent to which they met or failed to meet the conditions existing here.

112. Methods of Naming Coal Beds.—Three methods of naming coal beds are in common use: First—That of naming them from some locality, as geological formations are named, or from some pecu-

liarity of the coal bed itself; as, Pittsburg bed, Red Ash bed, etc. Second—By the use of numbers, as in Illinois and Kentucky. Third—By the use of letters, as in this State since the first survey. In some places the first of these methods is combined with one of the others.

The principal advantages of the first method over the others are two: First—The discovery of new beds does not introduce confusion into the system; and, second, where the correlation of a bed is in doubt, it can simply be given a new name. There are also two principal objections, and these apply as well to the present method of nomenclature all through stratigraphical geology. First—The names in themselves give no hint of the relations of the beds of coals; and, second, there is likely to follow a multiplication of names which may become very confusing.

113. Requirements of a Good System.—The last two methods are simple, the first is elastic. An ideal method should be both simple and elastic. It is doubtful if any method can be found at once perfectly simple and perfectly elastic. The proportion of simplicity to elasticity must be determined by the state of our knowledge of the field. In an unexplored field the system must be very elastic to allow each new discovery to be put in its proper place in the system, while in a field that has been thoroughly and completely explored, the system may well be wholly inelastic for the sake of simplicity. Our state of knowledge of the Indiana coal field would seem to warrant our selecting a system in which simplicity should take precedence over elasticity; in other words, which shall be, first, simple; second, elastic. To obtain both means a double system. That it may be first simple, some simple system must be applied to those principal features about which our knowledge would seem to be complete enough to warrant the application of a perfectly inelastic system. The elastic portion of the system must then take care of the rest as best it can.

114. Basis of Simple System in Indiana.—In this connection the work of the present survey has brought out the following points:

1. No single stratum of rock or coal in the coal measures, with possibly the exception of the basal sandstones, is persistent over the whole coal field, or even between the extreme points of its extent.
2. That, as a rule, the coal beds are a little more persistent than any of their accompanying rock strata.
3. That a thick coal bed is usually more persistent than a thin bed.

4. That the upper beds of the coal measures are usually more persistent than the lower, their accompanying strata also being more persistent than the strata accompanying the lower beds.
5. That often when a coal is lacking, the position of its horizon is shown by the accompanying strata.
6. That the horizon of certain coals can be traced persistently, if time and detailed study be given to it.

115. System Adopted.—For the simple part of our system it is proposed to divide the coal measures vertically into eight spaces or divisions to be designated by the Roman numerals I, II, III, etc., these divisions to be based on the position of some principal coal beds or horizons. In order to give definiteness to the system, it will be based on the vertical position of the worked coals as found in northern Clay and Vigo counties, that region being chosen principally because of the abundant developments in that area having rendered the relative position of the principal beds quite certain, in many cases two or three of the beds chosen being found in the same shaft.

Along the eastern edge of Clay county, and in general along the eastern edge of the Indiana coal field, occurs a very persistent massive sandstone. This is sometimes a fine conglomerate or grit and was called the Millstone grit or conglomerate by the first survey, or more recently the Mansfield sandstone. This sandstone is frequently underlain by one or two coal beds of minor importance. The sandstone and accompanying underlying coals are separated from the rocks both above and below by slight unconformabilities. It thus becomes a distinguishable division of the coal measures and the vertical space which it is supposed to occupy will be called Division I.

The main worked coals all occur above Division I; of these there are four in northern Clay county and two additional beds in Vigo county, while in southern Indiana coals occur between the lower block coal in Clay county and the Mansfield sandstone. The minor beds occurring in the same space, some of which are very locally of good, workable thickness, will not be now considered.

We have here, then, the basis for seven space divisions. Of these the uppermost coals can be traced with considerable certainty. The coal at West Terre Haute being persistent and traceable the whole length of its outcrop. The next coal below it, locally known as the "big vein," while not so persistent as the coal above, has, we believe, been traced as a horizon from the Ohio river to northern Warren county. The "rider" at Brazil, while not very important or readily recognized in the northern part of the field, to the south appears as a continuous coal bed for 100 miles and can be traced readily and with great certainty. Descending from this the coals appear in smaller and smaller basins and correlation is attended with more and more uncertainty, so that the conviction has grown upon the members of the survey that the lower coals do not occur at widespread horizons, and therefore any attempts at exact correllation between distant points will be fruitless. However, as workable beds are found in this space, and as some of these beds are of great importance, it becomes desirable to extend our system to them. As it is found that workable coals occur at such distances below the "rider," as traced, as to divide the rocks into from one to three divisions, according to the aggregate thickness, it will be convenient to divide the time space represented by these rocks into three divisions to be known as Divisions II, III and IV. The upper and lower block coals will be known as Coals IV and III, respectively. The rider, most typically developed at Petersburg, Pike county, where it is 8 to 10 ft. thick, will be called Coal V. The "big vein," worked at Turner, Stanton, Seeleyville, Coal Bluff, Coxville, etc., will be known as Coal VI.

The space from any one of these coals to the next will be known as a division. Thus, Division VI will comprise all of the rocks from Coal VI to Coal VII, including Coal VI.

Above the "big vein" at Seeleyville is a coal bed of frequently or generally workable thickness. It is the bed worked above drainage at Clinton and Lyford, and believed to be the bed extensively worked at Terre Haute. A workable bed at a similar height is commonly found, though on account of the presence of the thicker "big vein" it is but little worked commercially. The space from the big vein to it will constitute Division VI. Still above the bed last mentioned is a coal bed which locally along Coal creek, Vigo county, and Brouilett's creek, Vermillion county, is of workable thickness. Division VII will extend to this coal bed from the bed last mentioned.

At Merom, Sullivan county, the coal worked by shafts is believed to be at this horizon. Near the top of the bluff at the same place is a massive sandstone, called in the old reports the Merom sandstone. It lies unconformably upon the rocks below, and as no coal has ever been reported as found in it or above it, it is taken as marking the top of the coal-bearing rocks of the State. The space from it down to the coal mined by shafts at about river level at Merom will be taken as Division VIII.

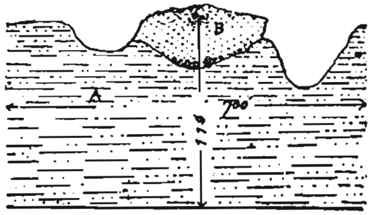
The age of the Merom sandstone is in doubt, but temporarily it, with any overlying rocks, exclusive of the drift, will be considered as in Division IX. It will be noted that with the exception of Divisions II and IX, a major coal is taken as the bottom of each division, so that in representing the outcrop of any division on the map, the bounding lines will practically represent the lines of outcrop of the coals at the top and bottom of the division. The coal at the botttom of the division in each case will be considered to be in that division, and in general will be designated by the number of the division in which it is included. Thus, the "big vein" at Seeleyville, etc., will be called Coal VI, the rider at Brazil, Coal V; the top block at Brazil, Coal IV, etc.

In the majority of cases one or more minor coal beds occur between the major beds. In all cases where more than one coal is assigned to a division, the coals will be distinguished by the addition of a, b, c to the Roman numeral. Thus, three coals in Division V would be called Coals V, Va, Vb. In cases where it is known that a coal bed or group of beds are above a certain division, as say Division II, and below another division, as say Division VI, but data is lacking for any closer adjustment to the time scale, it may be named by the combination of two or more divisions; as, in the case above, it might be called Coal III—V.

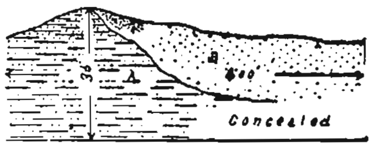
In order to make a reference to a minor coal definite, there could be added the name of the basin in which it occurs, or of some locality at which a typical section containing it is found. Thus, a comparative study could be made between Coals VIb of the Turner-Coxville basin and Coal VIa of the Petersburg-Evansville basin, the basins in this case being named from the towns at their extreme limits. Or they could be designated VIa (Stanton) and VIb (Petersburg), referring to typical sections at those places.

X. EPITOME OF STRATIGRAPHY.

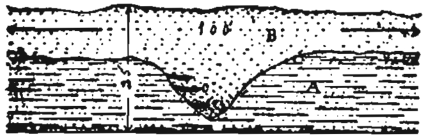
116. RELATION OF COAL MEASURES TO LOWER CARBONIFEROUS.—The relation of the coal measures to the Lower Carboniferous is everywhere one of unconformity, evidently quite a time period intervening between the laying down of the Kaskaskia and the lowest beds of the coal measures. This is best shown by the accompanying figures, Plates VII and VIII.



1. Black rock.

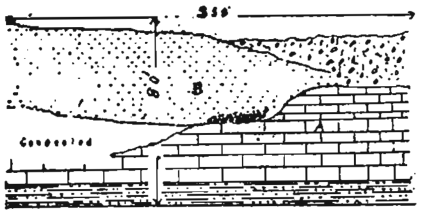


2. Little Pine creek.

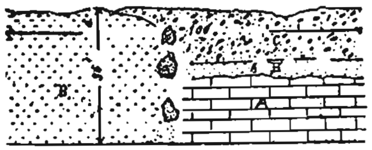


3. Turkey run.

4. Sugar creek.



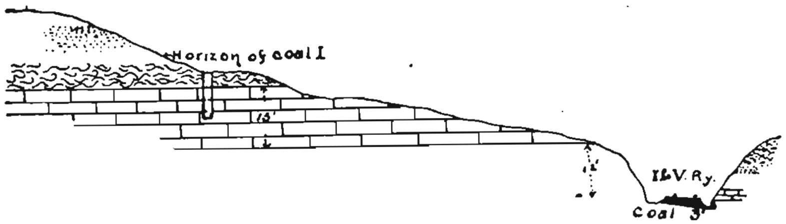
5. Ramp creek.



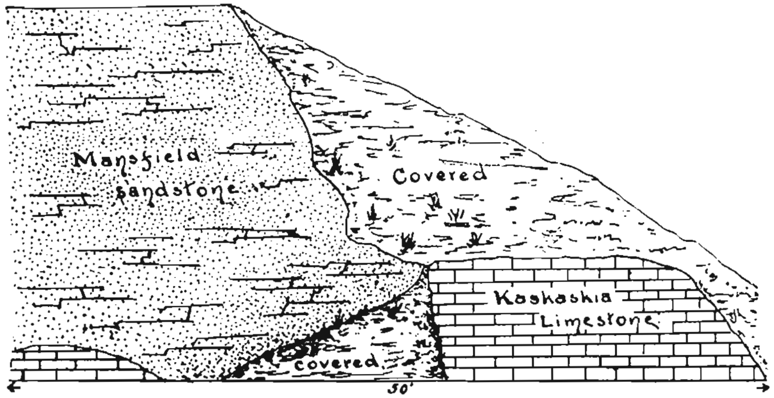
6. Byrd branch.

PLATE VII. Sections illustrating the unconformity by erosion between the lower carboniferous and the coal measures, by T. C. Hopkins. (Area of Sheet A.)

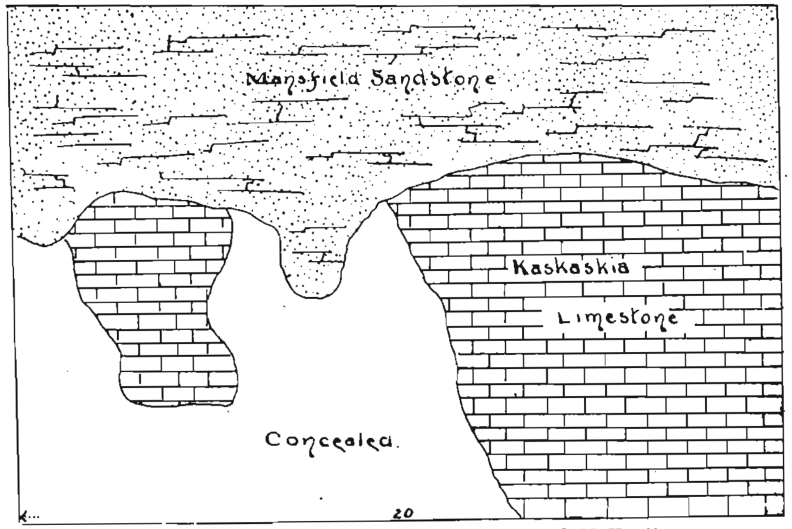
The evidence of this nonconformity is shown in four different ways: (1) The observed relations as shown in the figures; (2) the materials of the lowest members of the coal measures are largely derived from the underlying rocks, Keokuk material especially being recognized; (3) the irregular thickness and entire disappearance over large areas of the uppermost division of the Lower Carboniferous; (4) irregularities in thickness of Division I of coal measures.



At Nelson's cut, near Freedom, Owen county. (C. E. Siebenthal.)



Near Pleasant Valley, Martin county. (E. M. Kindle.)



Near J. E. Poehline's coal mine, Perry county. (E. M. Kindle.)

PLATE VIII. Same, area of sheets B to F. (From sketches by C. E. Siebenthal and E. M. Kindle.)

As the Lower Carboniferous rocks underlying the coal measures are quite commonly limestones, with their characteristic fossils, this nonconformity is often readily observed by noting the relative level of the limestone and coal measure sandstone. In many cases there may be room for doubt as to whether this is due to unconformity, high dip or fault, yet in some cases the contact of the two is clearly visible, the upper surface of the lower showing the effects of the erosion, while the lowest part of the upper member, as shown in the figures, is not unfrequently a conglomerate. Thus, in Fig. 4 of Plate VII, the top of the Lower Carboniferous in the figure to the left is 65 ft. above drainage, while a short distance up stream the limestone is below drainage.

The Kaskaskia was the last member of the Lower Carboniferous to be laid down. In the south part of the area it shows a section of limestones and sandstones of nearly or fully 150 ft. Going northward this becomes thinner and seems to disappear in Putnam county, from which point northward the coal measures rest on the lower members of the Lower Carboniferous, the Knobstone underlying a large part of the north end of the coal field. How much of this thinning to the north is due to pre-coal measure erosion and how much to an original thinning out of the deposits in that direction can not be told with the information at hand. It seems probable that the latter factor is much the most important. Thus, in Orange and Martin counties, the upper bed of the Kaskaskia is a limestone 10 to 20 ft. thick and lying but a few feet below the horizon of Coal I. In Greene county this limestone bed gradually thins down to an irregular bed wanting in many places and showing a thickness of very few feet in other places, and, as before, just below Coal I. Going north into Putnam county this upper limestone appears to have entirely run out and the coal measures rest on the upper Kaskaskia sandstone. As this sandstone has no small resemblance to the sandstone of Division I, it appears to have been taken to be a part of what is now called Division I. As this tendency to thin to the north is also observed in the other formations of the Lower Carboniferous, it seems safe to assume shore conditions to the north during the Lower Carboniferous period, and that this shore line gradually shifted to the south. It would seem, therefore, as though the land period following the laying down of the Lower Carboniferous was but the culmination of a tendency long active. How far to the south and west the shore line advanced cannot be told, but evidently beyond the present borders of the coal measures.

From a third standpoint the evidence lies in the materials composing the massive sandstone of Division I. In places this sandstone is quite gritty and examination shows that at least some of this coarse-grained material is composed of more or less comminuted pieces (?) of geodes, or of the geodes themselves, presumably from the top of the Knobstone or bottom of the Keokuk or Harrodsburg rocks. See further under Martin county.

One of the strongest points of evidence is found in the varying thickness of Division I, due to the uneven bed upon which it was deposited. As an illustration of this may be taken the varying thickness of Division I about Cannelton in Perry county. Near Rock Island, Coal II, or the main Cannelton coal, is at least 125 ft. above the Lower Carboniferous rocks. To the north and west this distance is found to vary greatly, so that at places the Lower Carboniferous limestone is found within 20 to 30 ft. vertically of the entries on Coal II, and at one point the limestone was observed only about 10 ft. below Coal II. It is said that on the south side of the Ohio at one of the mines the coal ran out squarely against the limestone; however, this may have been due to a fault.

Section 1. Division I.

117. This division corresponds with what was in the early days called the "Millstone Grit." In the earlier State reports it is commonly referred to as the "conglomerate sandstone," or "conglomerate." In 1896 Mr. T. C. Hopkins, who studied it as a source of building stone, called it the Mansfield sandstone, as it was there typically exposed and extensively quarried. As a matter of fact, neither the gritty facies nor the exposure at Mansfield are typical of the larger part of the sandstone of this division. Fossils collected in this division by Mr. E. M. Kindle and determined by Mr. I. C. White indicate that in stratigraphic position it corresponds with the Pottsville conglomerate of the Pennsylvania rocks, so that the use of the term "millstone grit" in a stratigraphic sense appears to have been correct. Considering, however, that in Indiana this formation is a grit at only a few spots, the use of the lithological term in a stratigraphic sense is misleading and undesirable. Furthermore, we are interested here principally in the coal associated with this sandstone, and neither "millstone grit," "conglomerate" or "Mansfield sandstone" properly include the accompanying coal and shale. While, therefore, "Mans-

field sandstone" will often be used to designate the massive bed or beds of sandstone in this formation, the term "Division I" will be used for the formation as a whole.

The bounds of this division are determined by two unconformities. The lower one was mentioned above, the upper one, which is not so marked, will be spoken of below. As a matter of practice, however, it is only here and there that these unconformities can be detected and other means must be employed. For the lower border the presence of the thick beds of Lower Carboniferous limestone with their characteristic fossils makes a certain downward limit. In using the limestone an error is liable to arise through the fact that the limestone is often overlain by unfossiliferous shales or sandstones of Lower Carboniferous age. At its upper limit no such reliable criterion exists, and often an arbitrary bound must be made, based principally upon the presence of a workable bed of coal and an abundance of shales overlying the sandstone.

118. Principal Features of Division I.—Plate IX, Figs. 111 to 131. As suggested by the names previously used, this formation is principally sandstone. This sandstone, which generally appears as a single bed, is commonly coarse-grained, cross-bedded, yellow or brown. Locally the grain becomes fine enough to serve as a whetstone, while not far away it becomes a coarse grit or fine conglomerate. Sometimes a somewhat coarser conglomerate occurs at its base, but is then only a foot or two thick and of a very limited lateral extent. The crossbedding, commonly one of its most characteristic features, is often absent, making it possible to use the stone for building and structural purposes. The yellow color is the most common, but it is frequently found approaching a white and more often it becomes a dark brown, resembling the well-known Portland building stone.* In thickness this sandstone varies from 0 up to over 140 ft. It is commonly without marked bedding planes, and often presents vertical or overhanging cliffs nearly or quite its full thickness.

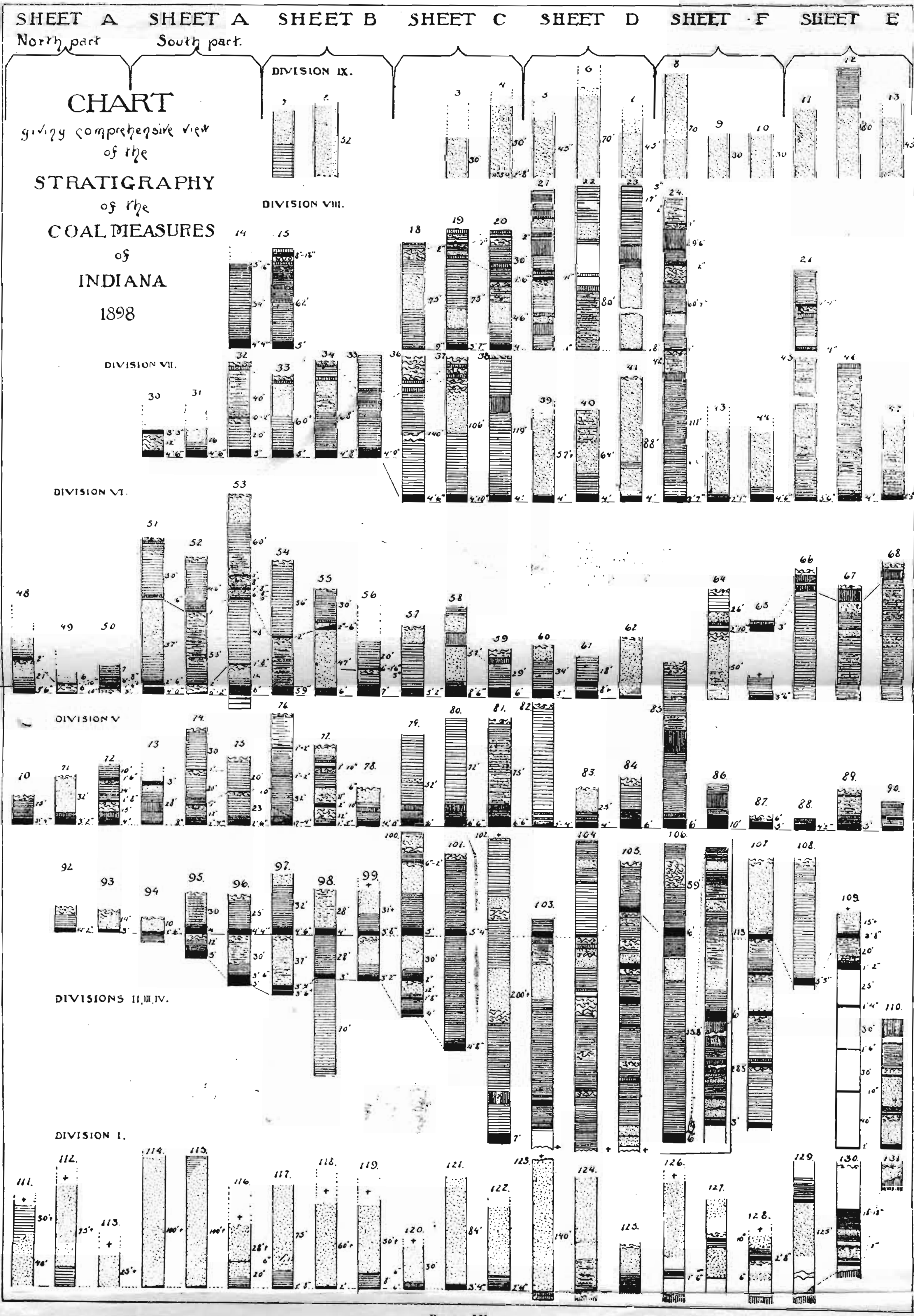
In some places this single bed of sandstone comprises all of Division I, but generally there are shales, coal and iron ore found at or near its base and to the south at a horizon above its base. The shales are usually only a few feet thick, but in places thicken up to 10 or 20 ft. They are generally of a dark blue color or black. The iron ore found at the base of this division is somewhat abundant in Greene county, and elsewhere, but is lacking in quality, containing too great an admixture of sand for profitable working. In many localities the bed is more nearly a ferruginous sandstone than an iron ore. It has been worked to same extent and at one time or another 14 blast furnaces have been erected to work this and other iron ores of the State. This ore was not able to compete with richer and purer ores, and as a result most of these furnaces have gone to ruin, while the last one went out of blast in 1893.

*Of this stone as a building stone, see the report of Mr. T. C. Hopkins, in the 20th report of this Department, and of its use as a whetstone, the report of Mr. E. M. Kindle in the same volume.

The coal in this division is confined to one horizon near the bottom of the division, and in the south to two horizons not far apart. While in a few places the coal at this main horizon runs up to a thickness of 3 or 4 ft. and is of an excellent quality, as a rule the coal is both too thin and too poor to work commercially. It is inclined to be very pockety in its distribution, especially to the north and south, its best development being reached in Martin county. In many places it consists in part of bone coal, which may locally become a cannel coal.

119. Division I in the Area of Sheet A.—A reference to the map and legend of Sheet A will show at once its distribution in Warren, Fountain, Parke, Montgomery and Putnam counties. In general, the area of outcrop will be seen to have an east of south direction, through eastern Warren, Fountain and Parke counties, and overlapping slightly into southwestern Montgomery and western Putnam counties. In width the outcrop varies from a quarter of a mile in the face of the hills west of Walnut creek in Putnam county to 12 to 15 miles in northern Putnam and Parke and in Warren counties. The heavy mantle of drift renders it impossible, over most of the area, to draw the limiting lines accurately and in detail. Where Division I extends down the valleys of streams flowing to the west or south, its outcrop can be more accurately mapped. Its influence on the general topography in this area is minor, and is principally seen in making more abrupt banks along the streams, with often vertical bluffs. This is most noticeable in Parke county, where it results in much picturesque scenery. Where fairly complete sections are obtained in this area, Division I shows principally as a massive sandstone 75 to 100 ft. thick, resting on the Lower Carboniferous.

Coal I is found at a few places, generally only a few inches or a foot thick, in Warren and Fountain counties. It would appear to occur there only in very limited lenticular pockets laid down in hollows of the underlying surface. There is hardly a place in these two counties where the coal has been worked with any regularity even for local trade, most of the openings going no further than to determine the thickness and character of the bed.



SHEET A
North part
SHEET A
South part.
SHEET B
SHEET C
SHEET D
SHEET F
SHEET E
CHART
giving comprehensive view
of the
STRATIGRAPHY
of the
COAL MEASURES
of
INDIANA
1898
DIVISION IX.
DIVISION VIII.
DIVISION VII.
DIVISION VI.
DIVISION V
DIVISIONS II, III, IV.
DIVISION I.

PLATE IX.

In Parke and Putnam counties Coal I becomes somewhat more regular, and in some pockets thickens up to 2 or even 3 ft., or, including bone coal, to 4 ft. in one or two places. As a rule these thicker beds are very limited and often in a few feet or yards will run down to a thickness of less than a foot. Many of these pockets will serve the local trade near them, but hardly any will meet a large local demand, and at no place was this coal seen of sufficient thickness or extent to be mined commercially.

120. Division I, Sheet B.—The area of outcrop on this sheet runs in a nearly north and south line with an extreme width of up to 20 miles. The thickness of the drift is, in this area, much reduced, so that the sandstone has become the main factor in determining the topography. The result is that the outcropping belt presents almost everywhere, but more especially toward its eastern limit, a rugged type of surface with narrow ridges and ravines and the intervening slopes generally steep. It thus becomes possible here to show the area of outcrop of this division with much more accuracy and detail than could be done on Sheet A. Division I in this area appears to have a larger pencentage of shale than to the north. Perpendicular bluffs of more than 10 or 12 ft. are not common, and none were found yielding complete sections of the division.

An interesting feature of the coal in this area is the presence in a few localities of two beds, separated by up to 10 ft. or more of shale and sandstone. The two beds appear to be parts of the same bed at most places. Coal I in this area, while reaching a thickness at points of 2 or 3 ft., is seldom of a thickness and quality to indicate even a fair local trade. It is too often the case that where the quality is desirable it is too thin to work, while where of workable thickness it is not of marketable quality. In some townships no coal over a foot thick was seen or reported. In southwestern Owen county Coal I is often partly bone or cannel, and at some points will answer well for local trade. Practically no workable coal is found in this area, except it be in connection with the fire-clay or shale or other accompanying material.

West of its outcrop this division appears to have an irregular and limited existence, as wells or drillings at many places a little to the west find its sandstone replaced by shale.

121. Division I, Sheet C.—The outcrop of Division I as shown on Sheet C, spreads over about the eastern two-thirds of Greene county. Near the east county line it appears crowning the highest ridges. Going westward it gradually descends, but still keeps above

drainage until White river is reached. Its exposure west of White river is due to the higher formations having been cut out by preglacial erosion, so that it is there largely below drainage and covered by a thick mantle of recent sediments or drift. As on the sheet just north, while small bluffs of the sandstone are common, and hillsides show half exposed ledges of sandstone, but few if any vertical cliffs are found exposing nearly the whole of the division. The eastern edge of the county is not in the limits of the drift, and the rugged topography there makes possible the mapping of the lower limit of the division with considerable accuracy. As White river is approached the glaciated area is reached, but only slight evidences of its existence are seen in the here and there more rounded contours.

Coal I becomes more regular in this county except near its eastern limit, where it is generally wanting or only a few inches thick. At a few places it reaches a thickness and extent which may permit a small amount of commercial working under more favorable conditions than now exist. It was formerly worked and shipped by rail near Owensburg, where 18 or 20 in. thick, and in a few neighborhoods is extensively worked for local trade. Its thickness is generally under 2 ft., and very frequently under 1 ft.; and while at a few places it attains a thickness of 3 ft., under existing trade conditions it may safely be said that no commercially workable coal exists there except it be worked with the underlying clay or overlying shale or sandstone. In quality the coal is usually a semi-block, occasionally being mined without powder, but generally requiring shooting, and while often of good quality is generally reported as rather poor and not suited for blacksmithing.

122. Division I, Sheet D.—The outcrop of Division I on this sheet is almost entirely confined to Martin county. As regards the exposures of sandstone the conditions here are similar to those on Sheet C, except on White river and especially around Shoals. Along White river are found not only excellent exposures of the sandstone, but at numerous points are abundantly exposed the gritty or conglomeritic facies. At the Pinnacle a little north of West Shoals the sandstone shows a solid perpendicular face, variously estimated at from 110 to 170 ft. thick. At points west of Shoals the ground is literally paved with geodes, usually quite small but sometimes as large as the fist or larger, which appear to have weathered out of the sandstone. In places these can be seen in the sandstone.

Coal I, while generally not workable, is of workable thickness, extent and quality south of White river a few miles west of Shoals, and at a few other places. The roof, while sometimes of sandstone, is more often of shale a few feet thick and then sandstone. At a few points Coal Ia appears above Coal I, but was nowhere seen of workable thickness. Coal I here reaches a thickness of over 3 ft. of good, workable coal, though at most openings it will run under 2 ft. in thickness. Over large areas the coal is wanting and at the same horizon appears a bed of kaolin. This is certain to be utilized in the future, and it is quite probable that when that time comes some of Coal I will be used in its development.

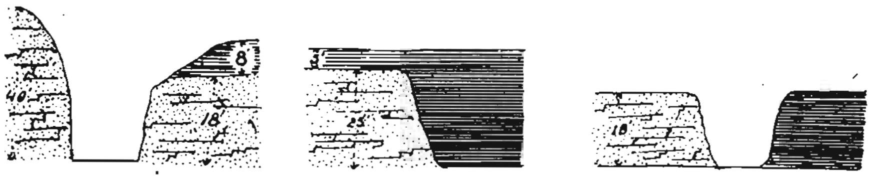
123. DIVISION I, SHEETS E AND F.—The sandstone of Division I is here still a very important factor in making the topography, which is in this area extremely rugged. The coal here, however, becomes thinner and more pockety and appears at two horizons, of which the upper is the most important. Yet workable coal can hardly be said to have been found at either horizon. The sandstone is somewhat broken up, as the upper coal as we go to the south, appears to be getting farther and farther from the lower, and the sandstone that comes between is often more important than the sandstone above Ia. There are many stratigraphic questions still unanswered in this area and the area of Sheet F. The principal one is as to whether this lower sandstone thins to the north, and possibly also the underlying coals and shales, while the upper one persists, or is it the lower sandstone that persists, or as a third alternative does Coal Ia and its accompanying shales thin out, allowing the two sandstone members to come together and form what appears as a single body of sandstone to the north? Near the Ohio river Coal I is only found at a few places and appears to be generally absent, and, what is of especial interest, when found it appears to be above the conglomeritic facies of the sandstone. Coal Ia here is quite persistent, but lies much nearer the top than the bottom of what is thought to correspond with Division I to the north. If the workable coal at Shoals represents either or both of these coals as is generally assumed, it becomes evident that the conglomerates in Martin county and in Perry county are not at the same horizon. If they are at the same horizon, then what have been assumed to be coals I and Ia really belong above the Mansfield sandstone, and the Mansfield sandstone near the Ohio river occurs only here and there in some depression eroded out of the Lower Carboniferous. While this view has many things in its favor, I am inclined to take the former view and to consider the gritty or conglomeritic facies as the result of local conditions purely, and liable to be found at very different horizons. Thus the abundance of geodes in Martin county in the conglomeritic sandstone suggests the neighborhood of the mouth of a river from the east.

One of the main factors rendering the solution of these questions difficult is the unconformity existing between the Lower Carboniferous and Division I. In Perry county, near Cannelton, where extensive operations on Coal II make it possible to use that coal as a base line, the fact that Division I varies from 10 ft. to 125 ft. or more in a short distance is clearly recognized and no confusion results. But to the north where Coal II is not generally worked or workable and rock exposures are seldom extensive, and generally small and scattering, these irregularities cannot all be allowed for, and among the four or five sandstone horizons with which the geologist starts from the Ohio, he readily loses his way stratigraphically, and when he reaches Clay or Parke county where he has but one sandstone and the stratigraphy is simple, he finds it impossible to decide which of the sandstones of the Ohio river region has persisted. Practically no workable coal exists at either the horizon of Coal I or of Coal Ia in the area of these sheets. The division in this area contains some sandstone of value, as indicated in the reports of Mr. Hopkins and Mr. Kindle in 1896.

Section 2. Divisions II, III, IV and V (In Part) from Brazil Northward.

124. GENERAL FEATURES.—An examination of Figs. 92 to 110 of Plate IX shows quite clearly a marked change in Divisions II to IV from north to south, assuming our correlation of Coal V to be correct. The correlation of Coal V from Clay county southward is given with much confidence. From Clay county northward it was impossible to trace it with the desired accuracy, and correlation was based principally upon the presence just above it of a limestone and other rocks, telling of marine conditions which followed the laying down of the coal, and upon its relation to what was thought to be there Coal VI. For this reason Division V from Clay county northward will be discussed with Divisions II to IV. Another reason for that treatment lies in the fact that from Clay county northward, what has been taken for Coal V is principally found closely associated with Coal IV; the two coals being commonly found at the same mines and in the same drillings, and it shares with Coal IV many of the block or non-caking features.

As shown by the figures, there appears to have been a very marked increase in the thickness and number of coals contained in the coal measures between Coal V and Division I from north to south. In Warren county Coal V appears to lie unconformably directly on Division I, while to the south they become separated by several hundred feet. In arriving at an explanation of this, two facts should be kept in mind. The first is that an unconformity exists between Division I and the overlying divisions, and that this unconformity becomes most marked to the north. It was thought to have been observed by Mr. Kindle in Perry county, where shales of Division II appear to lie against the sandstone of Division I. In the mines of Clay county it is the irregularities in the upper surface of Division I that produce the pockety or basin nature of the block coals about Brazil, the lower block coal there resting in places directly upon ridges of the sandstone of Division I, and partly on the half-filled hollows between. Further north, especially in Warren county, this unconformity is better marked and more readily recognized. The accompanying figures from Pine



Figs. 18-20. Showing nonconformity between Mansfield sandstone and coal measures along Pine creek and its branches.

creek or its tributaries will illustrate the appearance there. In the second place it was assumed by the first survey and at first by this survey, that the worked coals in this part of the coal measure section were at the same horizon all over the field. As the work has progressed, however, there has been more and more impressed upon the members of the survey the feeling that the atttempt to correlate the worked coals of these lower horizons of one district with those of another must be done with the utmost caution, and that such correlations must never be assumed to have more than a homotaxic value. That is, that in calling coals in different districts each Coal III, it is not assumed that they were being laid down at exactly the same time, but only at about the same time relative to other coals, just as we might say of two events that they both occurred in the third century, though possibly coming nearly 100 years apart. Then, as the work was carried toward the Ohio river with a constantly increasing number of coals, it began to be questioned whether the correlations assumed were even homotaxial, or if it were not more probable that the lower coals there were laid down during a land period to the north and had no representatives in the northern countries.

With all the evidence in it must be admitted that there are many facts favoring the theory that deposits were being laid down simultaneously to the north and south, but that sedimentation was much the more rapid to the south, and that the coal immediately underlying the lower block coal at Brazil is at least the homotaxic representative of the first coal above Division I all through the southern countries. On the other hand, the evidence is just as strong or stronger in favor of the theory that uplift followed or occurred during the laying down of the Mansfield sandstone, this uplift being greatest to the north. That this was followed by coal forming conditions to the south and west, land erosion meanwhile taking place to the north. Gradually the coal forming conditions spread northward and eastward and probably culminated during the time of Division V, at which time the overlap reached nearly or quite to the original northeastern bound of Division I. In view of the doubt existing we have compromised by naming the coals as though the first theory were correct, but accompanying that by the caution that this is done purely for convenience, and must not be taken to imply intended correlation.

The number of coal horizons in Divisions II to IV at different localities varies from 0 to 14 or 15. While some of these horizons have been traced over one or more hundred square miles with great certainty, and over much larger areas with some doubt, it would seem probable that the majority of the horizons are only local and that were it possible to exactly correlate the different sections obtained there would probably be found to be many more horizons than the number given above. The intervening rocks are so variable that no constant characters were recognizable. It has been thought best to take the area around Brazil as the type locality for these divisions, on account of the value and extensive working of the coal, and describe the coals first to the north, including Division V, then to the south.

125. Divisions II-V, Brazil Basin.—East of the meridian of Brazil are found three coals, the lower two of which are commonly workable, and in a few cases, all three coals. These coals have been designated Coals V, IV and III, and are locally known as the "rider," "upper block" and "lower block." Of these the middle coal, or Coal IV, is the most persistent. For illustration of the stratigraphy of this district, see Figs. 336-341, 361-366, 406-413, and Plate XXXI.

These show Coal V to have a thickness of from 0 to 4 ft., with an average of probably less than 2 ft. Overlying the coal are two different covers which have led to a little question in regard to the correlation of the coal. One of these is the characteristic roof of Coal V to the south. Immediately over the coal is a bed of black bituminous shale, splitting into large sheets and characterized by the presence of fish scales and other fish remains, aviculopectens and other marine forms, often pyritized, the whole indicating that that coal period was immediately followed by subsidence and marine conditions. Over that black shale is a limestone which here seems to be quite pockety, often reaching a thickness of 12 or 15 ft. and as often thinning out entirely. Sometimes these changes take place quite rapidly. Above the limestone comes either sandstone or shale, no regularity being apparent. In the other case the cover is a thickness of 20 or 30 ft. or more of clay shale, very suitable for clay work and largely used by the clay factories around Brazil. As a rule, in this case no limestone or black shale appears, but in the record of the old Brazil shaft the limestone appears about 30 ft. above the coal with the clay shale between.

In a drilling at the Gladstone mine at Lodi, Clay county, and exposed near by in the bank of Otter creek, are found two coals about 20 ft. apart and the lower one about 75 ft. above Coal IV. These seldom run over 2 ft. in thickness, are each overlain by a few feet of black sheety shale, resembling that over Coal V, and generally by a thin bed of ferruginous or clayey limestone, commonly only a few inches thick. They are separated principally by shale and appear to lie about 25 ft. below Coal VI. These coals resemble Coal V so closely that care should be taken to distinguish them. At Seeleyville a drill record reports still another coal above what is considered to be Coal V, making four coals in Division V at that point.

Coal V has been worked at only a few points in this area, the principal reasons being: Too thin; so near the surface as to be of limited distribution, and often without roof; too poor quality, the lower one-fourth or one-third being generally bone coal; the unusual excellence of the underlying coals.

Division IV in this area contains one coal horizon, though at one point a second horizon was reported. The space between Coals IV and V varies from 2 to 36 ft., with an average of about 20 ft. Where the two beds are closest together they are separated only by a clay, locally known as "white top." At these points Coal V appears to dip down sharply, and the clay would appear to be its under-clay. A possible illustration of this is seen at the Chicago Sewer Pipe Works, south of Brazil, as shown in Fig. 479. The strata between are the fire-clay of Coal V, two sandstones, unconformable with each other, and shale. In many of the sections no sandstone appears. However, there appears to be a regular sandstone horizon at which the sandstone lies unconformably on a lower sandstone or the shale or, these having been cut out, it lies directly on the coal, making the roof. This unconformity is well shown at quarries on either side of Otter creek, just east of the C. & I. C. R. R. bridge. In nearly every mine the roof is in part

shale and in part sandstone. Of the two roofs the shale is the weaker, often making a very poor roof, but, on the other hand, the coal under it is more regular and the more easily worked. Where the thickness of the shale is small it tends to come down, as is usual in such a case.

Coal IV, in this area, varies from 5 ft. down, and averages in the worked parts of the mine a little over 3 ft., being a little thicker than Coal III, with which it averages 3 ft. 1 in. It will therefore average about 3 ft. 2 or 3 in. The early reports gave an average of 4 ft. 4 in. The average for the whole field, not including areas where coal is cut out, will probably not be much, if any, over 2 ft., as in parts of the field not one 40 acres in 4 is workable. This coal almost invariably shows, usually a little below the middle, a band locally known as the "bench mining," composed sometimes of a 2-in. band of bony coal, sometimes of a band of hard, brittle coal that chips out readily, and at one place the writer noted a little clay at the height of the bench mining. The block nature of this coal was noticed in Part I. A feature existing in most cases is that in this bed the slips are most open at the top, and tend to offset at the bench mining, and often to become obscure below, while in Coal III the slips are more open at the bottom. The coal is non-caking, very free from sulphur and ash, and with the coal just below it, is more widely and favorably known than any other Indiana coal. Notwithstanding the thinness of these two beds about Brazil, they are and long have been extensively worked. In 1895 the yield of the Brazil block coal field, not including southern Clay county, but including the Center Point and Caseyville mines, was 1,340,321 tons out of 4,202,084 tons for the State, or nearly one-third. The question so often asked of how long this coal will last is a difficult one to answer. That the supply is limited, and that those portions of the field where mining is and has been carried on most extensively, are slowly but surely nearing exhaustion, must be admitted. But there are several factors which will tend to lengthen the life of the field very much. In the first place most of the companies at present operating in this field hold coal lands in this or adjacent fields that may prove more profitable than is commonly thought. In the second place, there are large areas in this field now considered to contain no workable coal. Considering the basin character of the coal in this district, with the consequent liability of drilling to strike the thin coal on the ridges, also the presence of preglacial cut-outs, so liable to render the testimony of drillings deceptive, it seems more than probable that some and possibly much of this barren territory may yet be found to contain workable coal. Next, the introduction of washing plants in the caking field is producing a coal which will serve some purposes as well as the block coal and at less cost, and this withdrawal of demand will lengthen the life of the field. In the fourth place, while most of the basins now being worked are small, with much coal considered unworkable, there is a tendency, and with improved methods and machinery this will be accelerated, to constantly work thinner and thinner coals, so that much coal now considered unworkable will be worked later. Fifth, as the supply in this field approaches exhaustion, there will be a tendency to shift mining operations from this to other fields where similar or somewhat similar coals can be more easily won. On the whole it seems safe to say that the Brazil block coal field will last another 25 years, and possibly 50 years, with a diminished output. Closer than that it hardly seems wise to go. It should be remembered that those figures apply only to the Brazil field, and not to the block field as a whole, nor is it intended to imply that the Brazil field will be utterly exhausted in that time. There will probably be mines operating in this field for the next hundred years or more, but as an important source of coal it is estimated that this field will be exhausted in between 25 and 50 years.

Division III in this field contains only one coal, known as the "lower block coal." The space between Coals III and IV varies from about 10 ft. to 50 ft., but usually is between 25 and 35 ft., with an average of about 30 ft. The intermediate rocks are usually the fire-clay under Coal IV and shale, or the peculiar alternation of shale and sandstone in thin leaves, known as "fake." The clay under Coal IV is usually very sandy and is much used around Brazil in the manufacture of certain clay products. It tends to grade down into a sandstone, which, however, appears to have but slight downward extent. In places the "fake" makes the roof, tending to stand in the rooms but to flake down in the entries, while elsewhere the shale is the roof. Less trouble is had with the roof of Coal III than with that of Coal IV.

Coal III, or the lower block coal, varies from 4 ft. 6 in. in thickness down. It averages in working places about 3 ft. or possibly a little less. Its thickness is quite variable, as it tends to lie in rather smaller basins than Coal IV. It is nearly everywhere characterized by a smooth or knife-edge parting, less than half a foot from the top. The coal above this is usually a semi-caking coal, and in mining this coal tends to stick to the roof, breaking into small blocks when it falls or is wedged down. The lower or main bench is much like Coal IV, but, if anything, of a little better quality. One of the characters by which this bed may be most readily recognized is the presence immediately under it of a rash or bone coal and underlying good coal.

Coal II, as it will be convenient to term the underlying coal and bone, appears to be a distinct bed from Coal III, though in places they are so intimately associated that several inches of the bone coal adheres to Coal III and is taken up in mining. In most cases there is a little clay between Coals III and II, which may be a fraction of an inch thick, or thicken up to 8 or 10 ft. or even more. In thickness this coal varies from 0 to 3 ft. 6 in., being generally about half bone coal and half good coal, the latter having been found by experience to be too soft to ship. In some cases the good coal is absent, in others the bone coal. This coal seems to be confined to the hollows in the top of Division I, as it and its underlying clay always tend to run out as the ridge or edge of a basin is approached.

The block coals around Brazil lie in basins of from a few acres up to several square miles, as was the old basin north of Harmony. The coal is thickest in the center of the basin or swamp and thins to the rise, but is thought to nearly always extend over the ridges in a thin bed to the next basin. This fact and the remarkable persistence of the details of the coals indicate that the basins of the Brazil field are but parts of a large basin, their form being due to the irregularities of the surface upon which they were deposited. This major basin (which is taken as defining the Brazil block coal field) appears to lie between Raccoon creek in Parke county on the north and Eel river on the south, within the limits of outcrop of Divisions II to V, as given on the map.

126. Divisions II to V, on Sheet A.—As soon as Raccoon creek is crossed, going north, all certainty in the correlation in these divisions ceases and the application of the numbers to the coals is for convenience rather than to indicate exact correlation with the coal of the type locality just described. No constant character in the coals themselves was found. In the Minshall mining district there appear to be three coals, as in the Brazil coal field, but with a limestone between the upper and middle coals. It has been thought that this limestone is the same as the limestone found at points up Williams creek, on Sand creek, on Sugar creek near West Union, on Sugar Mill creek near the Fountain county line, at Yeddo, on Wabash Mill creek at the Falls, around Silverwood, Coal Creek P. O. (Snoddy's Mills), and elsewhere, so that the determination of the division to which it belongs involves the stratigraphy of most of Parke and Fountain counties. The principal coal of this area lies a little below this limestone. It is the coal worked at Minshall, Williams creek, Sand creek, Sugar Mill creek, Yeddo and Silverwood. Above the limestone is a coal

which reaches a thickness of 2 ft. 6 in. or 3 ft., and has been worked at some places. Below the coal under the limestone is a coal which is worked for local trade at a few places, but in parts of Fountain county becomes 5 or 6 ft. thick in places. Do these three coals correspond to the three block coals around Brazil, or is the limestone at the same horizon as the limestone over the rider at Brazil? That is a question that we are not able to answer satisfactorily. As stated, the peculiar characteristics of the block coals about Brazil were not observed in this area. On that basis we were led to assume that the coals of this area belonged in an entirely different basin, wholly disconnected from the Brazil basin, and that being so, it is possible there is no exact correspondence, and we are free to assign the coals to divisions without regard to the coals at Brazil. Practically, that has been done. In calling the coal under the limestone Coal V, it has been done upon the theory that the limestone, from its tendency to be persistent, is more likely to correspond with the limestone overlying Coal V in Clay county and all the counties to the south than to occur in Division IV, where no limestone appears in sections anywhere to the south. In view of the many facts suggesting that the two coals below the limestone are Coals IV and III, it must be acknowledged that our action is simply a compromise.

Assuming that the limestone belongs in Division V, it becomes necessary to suppose that Division III has been overlapped in most of this area, though pockets of it may still be expected, especially to the west, and it does seem to be found at Coxville, Mecca, Hillsdale, and probably elsewhere.

Division V, in Parke county, may then be said to show three coals, the lowest one a coal of excellent quality, at Minshall and Sand creek, with a thickness of from 3 to 5 or even 6 ft., overlain by shale and then by limestone. At times the limestone lies directly on the coal, making the roof; again it is found up to 20 ft. above the coal, with shale between, often but not always black. This coal is not persistently workable coal, as at Coxville, Mecca, West Union and at other places where seen, it was too thin to work, and sometimes runs out altogether, but on the whole it is the most valuable coal in these divisions in Parke county. A short distance above the limestone occurs Coal Va, a coal which has been worked commercially north of West Union, on Sugar creek. As a rule, it has a thickness of less than 2 ft. and is not workable. Coal Vb is not of a workable thickness at any point, as far as recognized, though dug a little for neighborhood use at a few points. Coals Va and Vb, near Mecca, where their stratigraphic relations are most certain, resemble the same coals in the

northwest corner of Clay county and northeast corner of Vigo county, being usually overlain by black sheety shale, and that in turn by a few inches or a foot of ferruginous limestone. They lie usually 10 to 20 ft. apart, separated principally by shale, and about 30 ft. below Coal VI. At several points in southwestern Parke reports indicate the presence of from one to three coals between Coal Vb and VI. These are minor coals of no practical value.

Division IV appears to underlie all of the area in Parke county shaded for these divisions on the colored map. The division usually has a thickness of about 20 ft., varying from 6 to 30 ft. or over. It contains one coal which, while usually subordinate to Coal V, is locally of good thickness and quality. Thus at Mecca it has a thickness of 4 ft. Up Sugar Mill creek it reaches a thickness of 5 or 6 ft., and at a few other places it has locally a workable thickness. At Mecca, on Sugar Mill creek, and at Sand creek, it appears to occur in considerable bodies. At many places it was observed to be thin or almost entirely lacking. It frequently exhibits a sandstone roof, but has a shale roof at most of the points where mined.

Coal III is found along the western part of Parke county, where it is developed from 3 ft. to 6 ft. thick. It is the lower bed worked at Mecca where it is in part overlain by limestone. It lies from 2 ft. to 30 ft. below Coal IV, and its presence here has rendered doubtful the assumption of its absence further east and north. The presence of the limestone over it here and at Hillsdale adds strength to this feeling of doubt. In this same line may be mentioned the occurrence of a limestone on Coal creek at the Fountain county line below Coal V and its limestone, and presumably in Division IV. These are some of the facts that would make it appear that the limestone we have placed in Division V really belongs in Division IV or even below. In the latter case it might be the equivalent of a limestone found in the southern counties just below Coal IV. These suggestions are thrown out for future students of this field. We have preferred to assume lack of persistence rather than the opposite.

Passing into Fountain county we find the same conditions continuing. Coal V is the important coal in the southern part of the county, ranging from 5 to 7 ft. near Silverwood, Yeddo and east of Kingman, accompanied by its limestone. Going northward, both coal and limestone appear to lose in importance, and at Coal Creek P. O. and Veedersburg, Coal IV is the worked coal, attaining a thickness of 6 or 7 ft. at the former place, and apparently over a large area. The coal east of Coal Creek, on Prairie creek, shows a 3 or 4 in. parting of clay, with 1 ft. 6 in. to 2 ft. of poor coal above and 3 ft. 8 in. to 4 ft. 10 in.

of good coal below. Mr. Cox reports the two benches at one point here as reaching a thickness of 10 ft. This coal is also of workable thickness around Silverwood and north of Veedersburg. The shale overlying it around Veedersburg is highly suitable for paving brick, and much of this coal will doubtless be mined in connection with the shale.

Division III was not certainly recognized in Fountain county, though it is possible it occurs in borings near Silverwood. Crossing the Wabash into Warren county, the lowest coal of the three occurring there underlies a limestone which has been assumed with some doubt to be at the same horizon as that met in Parke and Fountain counties. It is commonly a black limestone, associated with black shales. A similar black limestone was found in Parke county, on Sugar creek, and was there thought to be at the same horizon as the more common lighter colored limestone. This lowest coal, therefore, is called Coal V. It reaches a workable thickness on Fall creek, west of the Indiana mineral springs, and barely a workable thickness northwest of Covington and at one or two other points. As the result of a preceding erosion, and the consequent inequalities of the surface immediately preceding its laying down, it appears to be very irregular in distribution, and often lacking. It averages over 3 ft. on Fall creek. In places it appears to lie almost immediately on the sandstone of Division I. At other places 20 or 30 ft. of black shale lie under it, apparently filling up the hollow worn in the Mansfield sandstone. A short distance from the north county line of Warren county this coal seems to have run out, and what is called Coal VI lies on the sandstone of Division I.

As far as known, no coals in these divisions occur further north. A small basin of coal seems to exist in the southern edge of Newton county, but as no developments have yet been made there, and the coal is deeply buried under drift, its stratigraphical position can not be given.

Section 3. Divisions II, III and IV South of Brazil Basin.

127. Lancaster—Clay City Basin.—This coal basin lies east of Eel river, in the southern part of Clay and western part of Owen counties. Over most of the area two coals are found in Divisions III and IV, which are thought to correspond to Coals III and IV of the Brazil field. Nothing corresponding to Coal II was found associated with Coal III, nor did it have the smooth parting near the top, as far as could be ascertained. In like manner the bench mining of Coal IV, around Brazil, though reported at a few places in this area, was not found persistently. Drillings around Clay City, and also southeast of Clay City, report one or two small coals above Coal IV; whether either or both of them belonged in Division IV or in Division V could not be decided. Coal IV is usually of a workable thickness in this area, in the center of basins ranging from 3 to 4 ft. Coal III ranges up to over 6 ft., but is generally thinner than Coal IV. Both are solid coals, approaching the Brazil block coal in block quality and purity, though not reaching as high a standard in either respect. The roof in most cases, with both beds, is shale, very poor in some places, but good in others. Some sandy shale roof is met with. The two beds vary from 10 to 30 ft. apart, averaging less than 20 ft., the material between being shale, as a rule. Coal IV is worked, especially around Clay City. Coal III is thickest in Owen county about Patricksburg or Lancaster and at other points. Where these coals reach the unusual thickness of 5 ft. or 6 ft. they are apt to lose somewhat in quality. They tend to occur in smaller basins here than around Brazil. While in places the lower of these two coals is seen to lie directly on the Mansfield sandstone, at other places drillings indicate the removal of the sandstone and its replacement with shale; so that in some cases drillings 90 or 100 ft. below Coal III strike only shale.

128. Linton Basin.—Sufficient data was not obtained to show with any degree of certainty the lateral extent of the coal so extensively mined at Linton, but there seems to be a slight resemblance between the Linton coal and what has been correlated as Coal IV over practically all the outcrop of that division in Greene county and extending north into Clay county in the southwestern townships. Taking the section at Linton as a type we find that there Division IV contains two coals—Coal IV, with an average thickness of over 5 ft.; an excellent semi-caking coal, very free from sulphur and other impurities, though hardly equal to the best of the block coal in that respect. The roof is shale, and good. Some 50 ft. above it occurs Coal IVa, 1 to 2 ft. thick. The space between, while in many cases mostly shale, often contains a massive sandstone. Above Coal IVa is shale with a considerable thickness of sandstone, which is quarried some where it outcrops. Coal IVa lies about 50 ft. below Coal V. Coal IV in this area is split in the middle, and, though in most of this area the bed appears to be solid, a couple of miles west or southwest of Linton the two benches begin to separate, and a mile or two further west drillings show the separation to have become from 13 to 17 ft. While sometimes underlain with a little fire-clay, at most of the mines here the

coal lies on a micaceous sandstone 20 or 30 ft. thick. Below that, in Division III, are two beds from 1 to 2 ft. thick, and then 70 or 80 ft. below Coal IV is a bed showing about 3 ft. of coal in two benches, separated by a foot or 18 in. of shale or limestone. A little northwest of Linton drillings show Coal IV to have a thickness of almost 6 ft., but going northward it runs down to about 4 ft. Crossing into Clay county it is traced north to Splunge creek, with a thickness of 3 to 4 ft., overlain by sandstone. At one point it was seen in two benches, each 3 ft. thick, separated by 1 ft. of fire-clay, and a drilling to the west in Sullivan county reported Coal IV as 5 ft. 4 in. thick. At the drilling mentioned Coal III was reported as 4 ft. 8 in. thick, 75 ft. below Coal IV. At the other point mentioned Coal III was reported as 5 ft. thick at a depth of 25 ft. below Coal IV. South of Linton, near Marco, some drillings report a 4 ft. 6 in. to 5 ft. 6 in. coal, which, it is thought, may be Coal IV.

The correllation of the coals around Linton with those around Switz City and west of Worthington, and especially east of White river in Greene county, is done with some uncertainty. Toward Worthington Coals III and IV appear to come nearer together, often being less than 20 ft. apart, resembling in that respect Coals III and IV across Eel river in Clay county. East of Linton, Coal IV appears to get thinner, and though here and there reported of good thickness, at most points it is not of sufficient thickness to promise well for future developments. Its nearness to the surface will also serve to prevent extensive developments in that quarter. East of the river the coal found above the Mansfield sandstone, called Coal III, though its correlation with Coal III at Brazil, or even Linton, is uncertain, is a coal which, though locally reaching a thickness of 3 or 4 ft., is, for the most part, too thin and too pockety to work or attract attention. It is possible some small basins will prove extensive enough to pay for development.

Passing south into the area of Sheet D, Coal IV loses somewhat in importance, though workable over large areas, while Coal III gains, giving two workable coals in these divisions in this area. Coal IV at most of the openings at which it was seen will average a little over 3 ft. and up to 4 ft. It usually shows a clay band ¼ of an inch to 4 in. thick near the center. It is often a semi-block coal, though not usually, and generally tends to be rather sulphury. The roof is usually shale overlain by sandstone. In a few places Division IV appears to contain an additional coal lying either not far above Coal IV or not far below Coal V. We were not entirely satisfied that the coals found in these positions were not really Coal V. If it prove to be so, then in places the space between Coal IV and Coal V runs down to 2 ft., though normally from 60 to 80 ft. apart. In general, Division IV and Coal IV have considerable resemblance to the corresponding strata in western Greene county. The heavy sanstone, so pronounced in Wright township of Greene county is even more prominent in southern Daviess county, culminating at High Rock in a thickness of massive coarse-grained sandstone, of 65 ft. So massive is this sandstone in places in this county and Pike and Dubois county that it was thought by the earlier members of the State survey to be the millstone grit or Mansfield sandstone, and the stratigraphy was made to fit, with the result of assuming the absence of any coals between Coal V and Coal I in southern Daviess and Pike and Dubois counties. The presence of two other beds of massive sandstones between this one and the Mansfield helped to confirm the error. The High Rock sandstone, then, is at present correlated with sandstone at this horizon as far north as the quarries on South Otter creek below the C. & E. I. R. R. bridge near Brazil and on into Parke and Fountain counties.

Coal III in this area becomes of some importance, reaching a thickness of 6 ft. at Cannelburg. At this point it is of special interest, as it there appears to be a double bed, the upper half or more being a good cannel coal. Whether this cannel coal is a separate bed which is here locally associated with the lower bed could not be definitely decided. The evidence suggests that it may be, as east of Cannelburg the two parts of the worked bed separate so as to become a dozen feet or more apart. Generally the coal called Coal III here contains no cannel, though not infrequently it is accompanied by more or less bone coal which may represent the cannel coal of Cannelton. As a rule this coal is solid, but shows a parting near the middle at a number of places. It appears to be freer of sulphur than Coal IV. The rest of the division in the nothern and central part of the area of this map is largely shale, with at least one thin coal above Coal III, and probably two or more. As the south part of Daviess county is approached there appear to be three coals between Coals III and IV. The uppermost of these is characterized by resembling Coal V in being overlain by black sheety shale and limestone. As it reaches a workable thickness in places it was without question considered by the earlier survey to be at the horizon of Coal V. The same error was at first made by the present survey. South of White river, however, Coal V is everywhere a thick coal, while this coal occurring about 75 ft. below is usually thin, and after being once distinguished is not likely to be confused. Between this coal and the next one below is generally a sandstone. Between the second and third coals is usually shale.

Drillings at Vincennes, Washington and east of Washington show a large increase in the number of coals in these divisions with an increase in the thickness of the coal-bearing measures. This increase in the number of coals is more apparent to the south, where most of them seem to reach daylight.

After crossing White river, the number of outcropping coals seems to increase somewhat, so that the first coal above the Mansfield sandstone is conveniently called Coal II. Whether Coal II of the area south of White river is the same as Coal III at Cannelburg has not been satisfactorily determined. Division IV here contains usually one coal which will average well under 3 ft. It is 3 ft. thick at some points and running up to 4 ft., but on the whole appears to be thinner and more pockety than north of White river. It is from 50 to 75 ft. below Coal V, the strata between being shale and sandstone. Division III has three coals, III, IIIa, IIIb. Coal IIIb, as in Daviess county, is usually overlain by black sheety shale and limestone. As a rule, it is thin, but of a good quality. Coal IIIa resembles Coal IV in its stratigraphic relations. It is usually a thin coal, but reaches a workable thickness in a number of areas. It is usually overlain by shale or sandstone, the sandstone between it and the next coal above often being massive and of a thickness that often led to its being correlated as Mansfield sandstone. Coal III in this area resembles Coal IIIb somewhat, though averaging somewhat thicker. It is usually overlain by black shale and limestone, with principally shale above to the next coal. Division II appears to increase in importance as the Ohio river is approached, finding its greatest development in southern Perry county. At this point Coal II is the well known Cannelton bed. It is of good workable thickness, up to 5 ft., but lies in basins of limited extent.

In northern Dubois, as in southern Daviess county, only one limestone is found in Division III, while in southern Dubois and Spencer county limestones are found over both Coals III and IIIb. This has led to much uncertainty as to the correctness of the correlation of the coals at many points. In western Pike and Gibson counties deep borings indicate a thickness of the coal measures in that division similar to that observed in Daviess and Knox counties, except that the coals reported are often quite thick. As these are all from churn drillings made for gas, the thicknesses given can hardly be considered strictly reliable.

Section 4. Division V, South of Clay County.

129. Division V, from Clay county northward, has appeared to be a division of some thickness, containing from one to three or possibly six coals, none of which are persistently workable. Its limits and the coals belonging to it have had to be arbitrarily assigned from point to point, often with much uncertainty, based principally upon the theory that limestones found all through from Clay county northward were at the same horizon. Much the same difficulty exists in correlating the rider in the Brazil field, which has been called Coal V, as developed near Clay City and at Alum Cave in Sullivan county. However, from those points southward, the problem is comparatively simple, as the division contains but one coal, which was laid down in a more or less nearly continuous basin to the Ohio river and beyond, and was followed by a uniform set of conditions, resulting in the overlying rocks showing a remarkable uniformity over that whole distance. The time during which the coal bed was forming must have been considerable, as this bed at a number of points reaches a reported thickness of 11 ft. and measures 7, 8 or 9 ft. over considerable areas, while over still larger areas it is uniformly found to be over 5 ft. thick. The coal forming period seems to have been followed by a comparatively rapid sinking of the whole basin. This was accompanied by an overflowing of the area by the sea and for a time sediments accumulated slowly in the form of very fine mud with a large mixture of fish remains and a limited variety of shells, orthocera, nautili and aviculopecten being the most common. It would seem as though at first the life was limited to those forms, like the fishes and the shells mentioned, that possessed more or less freedom of motion and hence were the first to take possession of the new feeding ground. A little later the more slowly moving forms, especially brachiopods, arrived in great numbers, and their remains ere long accumulated to form beds of limestone. Then further movements of the surface change the conditions, so that abundant deposits of mud or sand are spread over this submerged area. In some cases this fauna remains for some time and these shales are full of shells; more generally the changed conditions drive, the bulk of the life to new feeding grounds, probably farther west. As a result of these conditions, we find the coal first overlain with a black bituminous shale, usually breaking up into thin sheets often many feet square, with a somewhat meager fauna as described. This shale accumulated to a depth of from a few inches to several feet, sometimes, though not often, being over 6 ft. thick. It

is apt to contain a large number of pyrite concretions, "niggerheads," often 6 or 8 ft. in diameter, and often the shells in it are replaced by pyrite. Lying above it is usually a limestone from a few inches to 10 or 15 ft. thick, full of brachiopods. Overlying this is shale or sandstone, in some cases the lower part of the shale being full of fossils.

As stated, from southern Clay county to the Ohio river and beyond appears to have been a continuous basin during the laying down of this coal.

The distance from Coal V to Coal VI varies greatly, as shown by the sections on Plate IX. At Middlebury, in Clay county, the two coals are only 20 or 30 ft. apart. In southwestern Clay and northeastern Sullivan counties they average about 50 ft. or more apart. In northwestern Greene they again approach to within 30 ft. of each other, then going southward at Dugger we find them again over 50 ft. apart; two or three miles further they are over 70 ft. apart. At Edwardsport they run from 65 ft. north of town, to 25 ft. south of town. At Washington the variation is from 8 to 9 ft. to 80 or 90 ft., the larger space occurring east of Washington, the smaller south; 40 to 50 ft. is not an uncommon space in this region. Going south into Pike county, Coal VI has nearly run out, and the space between it and Coal V becomes smaller, running from 20 ft. to a more common space of 6 to 10 ft., and apparently at some of the mines the two coals are separated only by a thin parting, the double coals at such a point having the characteristic roof of Coal VI. Coal VI is last seen in northern Warrick county, so that from that point southward the exact proportion of the strata between Coals V and VII that belongs in Division V is somewhat conjectural, but probably lies within 20 ft.

As to the makeup of Division V in this basin, the following section will be typical of a majority of the sections:

	Ft. Aver.	*Ft.*
1. Shale with some admixture of sandstone	20	10 to 80
2. Limestone, often with clay parting	4	0 to 15
3. Black bituminous sheety shale	2	1 to 8
4. COAL V..................................	5+	1 to 11

Coal V has a thickness of 3 or 4 ft. in the outlier at Middlebury, in Clay county. Starting at Splunge creek, in Clay county, where the thickness is but a little over a foot, it gradually increases in thickness until about Alum Cave and to the eastward it runs from 6 to 9 ft., with a reported thickness of 11 ft. See frontispiece for an illustration

showing a typical outcrop of this coal in this area. The overlying black sheety shale and limestone are perhaps even better shown in Part IV. Only about 6 ft. of the coal is taken in mining. Along the edge of Greene and Sullivan it shows a thickness of from 5 to 7 ft., though the quality does not appear to be very good at most places. Along White river and east in Daviess county its thickness is irregular, reaching 7 ft. just southwest and west of Washington, where it is of excellent quality; also several miles farther down the river, where the quality is poor, but over most of the area ranging from 1 to 4 ft. with an average over much of the eastern part of its outcrop of less than 2 ft. Around Washington its roof, while generally black, is not so sheety as at many points, nor so full of concretions, so that it has been generally mistaken for Coal VI. Entering Pike county, it reaches its greatest development around Petersburg, the coal being mined for a thickness of 8 and 9 ft. and here and there reaching a thickness of 10 and 11 ft. The coal appears to be generally without partings, but at the Woolley mine has a parting of several inches. As this parting is developed in one or two other areas, becoming sometimes over 3 ft. thick, it has suggested an interpretation of some drillings made in Petersburg, which show two beds at about the horizon of Coal V, separated by up to 6 or 8 ft. If these are the two benches of Coal V, then Coal V, in at least two of these drillings, shows a thickness of 12 ft. At the Woolley mine there is 6 ft. of coal below the parting and 3 ft. above. Over most of Pike county Coal V is found with a thickness of seldom less than 4 ft. 6 in., and averaging over 5 ft., apparently having originally been in a continuous or nearly continuous sheet. The limestone is not as persistent as further north, and in some places the roof is a clay shale, which in some cases appears to be the roof of Coal VI, in others it occurs under the black shale. Its relation to the black shale is well shown in the Blackburn mine, near Petersburg, where it can be seen to be a lenticular mass of some extent, 3 or 4 ft. thick in the center, but thinning out at the edges and everywhere overlain by the black shale. In some cases the black shale over this clay shale nearly or quite thins out. One of the best exposures, showing Coal VI but a few feet above Coal V, is seen at the Hartwell mine, near Augusta.

Passing south into Warrick county, the conditions continue much as in Pike county. In the northeastern part of its outcrop in this county Coal V usually shows a parting, usually less than 6 in., but northwest of Folsomville increasing to 3 ft. 6 in. or more. A good thickness is maintained as far as Boonville, where the coal on its eastern crop runs up to 7 or 9 ft., but west and south of there the thickness averages nearer 4 ft.

In general the quality of Coal V is fair. In many areas it appears to contain numerous irregular streaks of dirt or shale, making the coal yield a large percentage of ash. Such coal could be largely improved by washing, and the introduction of washing plants would render available many acres where the coal is above the average in thickness and other workable features, but not acceptable to the market for the reason mentioned. At other places the coal is of a much better grade and sells readily with the other coals of the State, while locally it is above the average of the caking coals.

The roof of this coal is usually above the average. Rooms 40 ft. wide in places were seen that had stood 7 and 8 years without a prop, and did not show the first signs of flaking down. The same thing is shown in another way, and that is that openings made to this coal or exposures made by creeks tend to stay open or exposed longer than most of the coals of the State, rather than to fall in and fill up.

With the facts just presented it will be better understood why the survey, working north from White river, where they had grown accustomed to consider this coal the thickest and one of the most important in the State, felt that it ought to be found in northern Clay county and to the north, and finding there a coal overlain by a limestone and sometimes with black shale in the same relative position as Coal V, hastened to call it Coal V. Upon this the assumption has been based that Coal V is co-extensive with the area of the coal measures in this State within the limits of its eastern line of outcrop. It may therefore be well to express the caution that, while this may be so, it is also possible that Coal V as last described is limited to the basin just defined and that what is called Coal V around Brazil and to the northward is an entirely different coal, though occupying about the same relative position and having many of the same characters as the one called Coal V to the south.

Section 5. Division VI.

130. This division, from the standpoint of supplying coal, is one of the most important in the State, if indeed it does not at present supply more coal than any other division, there being in 1897 more large mines working Coal VI than any other seam except Coal IV. The group of strata which have been arbitrarily designated as Division VI can be readily traced from the north part of Vermillion county and with less certainty from the northernmost coal mined in Indiana to the Ohio river. The division is everywhere limited at the top by

Coal VII, the most persistent bed in the State, and at the bottom by Coal VI over most of its area, though as the Ohio river is approached Coal VI runs out and the division contains no coal. Further north the division contains from one to five coals, the lowest of which is generaly workable, while of the others one reaches a thickness of 6 ft. in places, while another reaches a workable thickness at a few places. In thickness the division varies from about 20 ft. (?) to 175 ft. or over. As a rule it is over 40 ft. thick. The data is suggestive that west of its outcrop Coal VI lies in a more or less continuous basin. Along its outcrop it is easy to divide it into four areas, within which it presents somewhat similar conditions, though these do not appear to be sharply marked basins, as it is generally possible to trace the coal more or less continuously from one to another. The first of these areas extends from the north limit of the coal field to Clinton in Vermillion county and Coxville in Parke county. In this area the coal, while readily traceable by the stratigraphy, is seldom workable. It may be called the Vermillion river area.

The second area extends from Clinton and Coxville to south of the T. H. & I. Ry. in Vigo and Clay counties, a small outlier at Middlebury, Clay county, belonging to this area. Within these limits the coal is known as the "Big Vein," and averages between 6 and 7 ft. thick. We may call this the "Big Vein" area.

The third area starts from northern Sullivan county and runs to Edwardsport, in Knox county. It might be called the Sullivan county area. Here the coal runs from 5 to 7 ft. in thickness.

The fourth area runs from Edwardsport to northern Warrick county, and may be called the Washington area, as the coal has been most extensively worked at Washington, in Daviess county.

131. Stratigraphy of First or Vermillion River Area.—This region is included entirely in the area of Sheet A. Though supposed to include all of western Warren county, only the lower part of the division is found there, and it is necessary to go south into the regions of the Big and Little Vermillion rivers to get complete sections. The division here shows a thickness of about 100 ft. or a little over, with three regular coal horizons, and coal appearing at one or two points at a fourth horizon, above the others. The strata show (see Plates XX and XXI, first, the fire-clay below Coal VII, then sometimes a band of limestone, then black shale with coal less than 1 ft. thick at one or two points. Then comes 30 or 40 ft. of shale, with sometimes a little sandstone to Coal VIb. This coal appears to start in between the two rivers, being very thin, but to the south be-

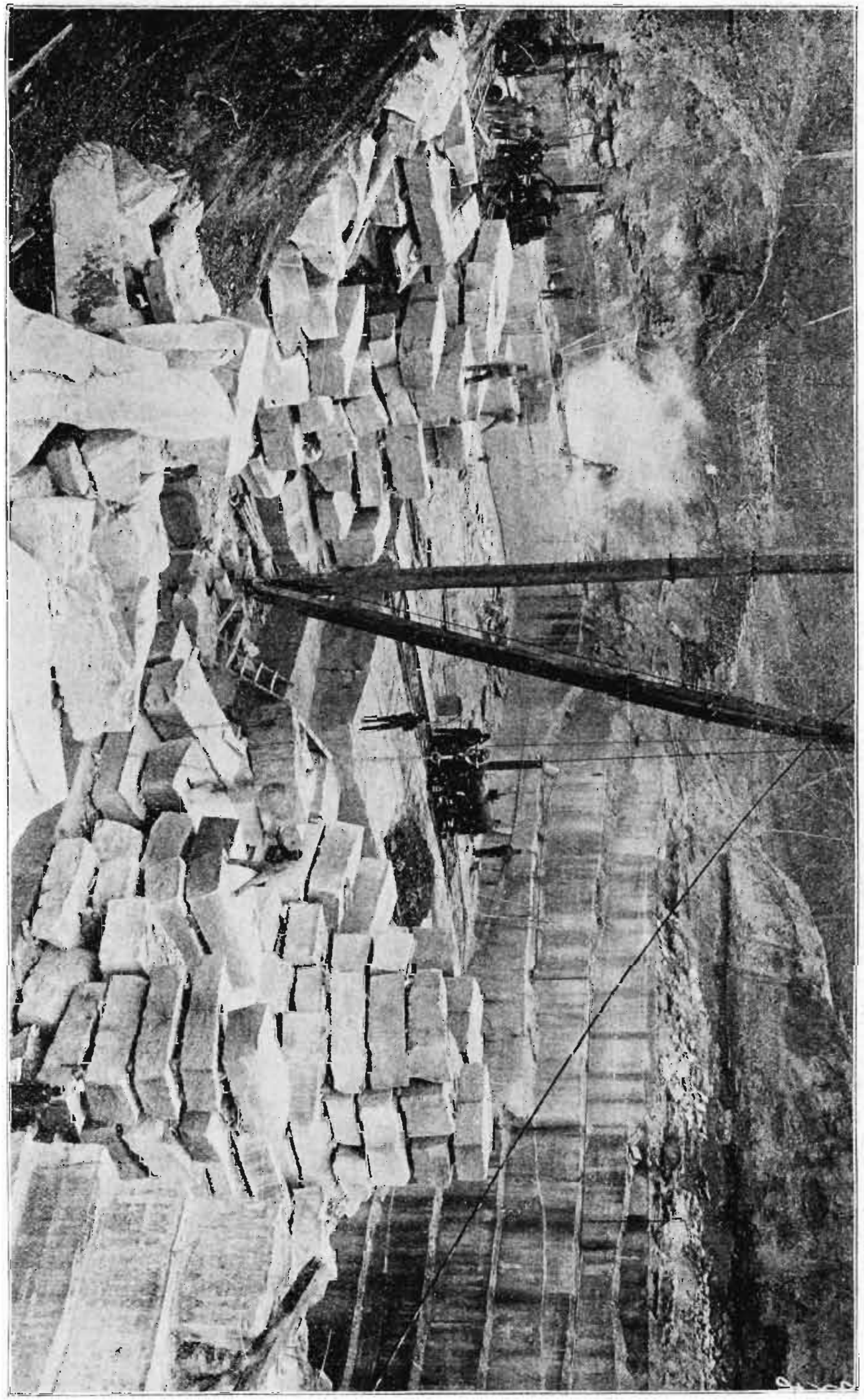
comes more prominent, finally becoming workable, and, though not persistent, is thought to have been traced almost to the Ohio river, if not quite. It is overlain by a foot or two of black sheety shale, and that in turn by a thin bed of limestone. The limestone is probably a little more persistent than the coal. On the Big Vermillion the coal is only a few inches thick, as a rule, or is not present at all, its horizon being indicated by the black shale and limestone. It appears to have been laid down under somewhat similar conditions to Coal V in the southern counties, and was often mistaken for Coal V in the old reports. This coal horizon was never recognized by the older surveyors, it either being overlooked or assigned to some other horizon.

Below Coal VIb occurs some 40 ft. of very variable strata, being shale at points and sandstone at other points. In places it is a compact sandstone, extensively quarried for building purposes, and at others a sandy clay shale, extensively quarried for the manufacture of clay products. That these are not two distinct beds lying unconformably together is readily shown by the two facies grading into each other at numerous places and sometimes within very narrow limits; so quickly, indeed, does the change take place at points that a fault would be suspected were not the exposure too clear to admit of such a proposition. The two facies are well exposed at the Portland sandstone quarry, near Worthy, and at the clay factories at West Montezuma and Highland.*

Below this sandstone is usually 10 to 20 ft. of shale to Coal VIa. This coal here lies but a few feet above Coal VI, and in at least one place they are reported to be separated by only a thin clay band. Coal VIa resembles Coal VIb in being overlain by a black bituminous sheety shale and generally by a little limestone. This limestone is seldom more than 1 ft. thick and more often is less than 6 in. thick, or wanting altogether. It is apt to be very shaly and ferruginous, being often spoken of as an iron ore. This coal and its accompanying strata persist over this area and most of the second area. It is a very persistent bed, with a general average of about 1 ft. 6 in., and to the south always showing a clay band in the middle. It is the coal called "Coal M" by Mr. Cox in his report on Clay county. In northern Vermillion county it has a thickness of 2 ft. 6 in. to 3 ft., usually showing its parting, and has been somewhat extensively mined near Eugene. In Warren county it is usually thin, though running up to 2 ft. 8 in. and at one point to 3 ft. 7 in. In general its quality is excellent, and it is mined at a large number of places, especially as a

*See Plate X. Note the outcrop of Coal VIb in the upper right hand corner of the plate.

PLATE X. Massive coal measure sandstone in Division VI at Worthy, Vermillion county. (From Hopkins' report on sandstones.)



blacksmith coal. The space between Coals VI and VIa varies from a few inches to 20 ft., but in this area is usually under 10 ft. and frequently under 6 ft. Where thin the space is all fire-clay, otherwise some sandstone and shale occur in addition. At points on the Big Vermillion and again in Clay county a thin, irregular bed of coal is found in this space. It is usually only a few inches and nowhere over 1 ft. thick, lying in lenticular pockets of limited extent.

Coal VI in this area is an irregular, pockety coal, only here and there workable, though at such times ranging from 3 to 6 ft. In Warren county it varies from 4 ft. 2 in. down to nothing. In northern Vermillion county it ranges from 4 ft. 6 in. down. In Parke county in this area from 6 ft. down. For this area as a whole it will probably average between 1 and 2 ft. Due to its liability to be found of good thickness at points in this area, caution should be exercised to ascertain the extent of the coal of workable thickness there before preparing for extensive mining. For the same reasons it is not possible to predict with any degree of certainty the thickness of this coal in unexplored areas.

The correlation of the two coals in Warren county, designated Coals VI and VIa, with the coals correspondingly named in Vermillion county is far from certain. Stratigraphically, there is much similarity, and, assuming the coal below them to be Coal V, the two coals would normally be Coals VI and a higher coal.

132. THE TRANSITION from the first area to the second is well exhibited in the numerous ravines along the west side of Raccoon creek, in Parke county, from Mecca to Coxville. Plate XI shows the gradual thinning of the coal from Coxville northward, until finally the lower bench disappears; then the upper bench continues to decrease in thickness until, before Mecca is reached, it has become pockety or absent, a set of conditions that continue to the north end of the coal field. Coal VIa assists greatly in tracing this change.

133. THE SECOND AREA differs from the first, principally, in the thickness and workability of Coal VI. The measures in this division acquire a thickness of over 175 ft. along the Wabash, from Clinton to Terre Haute. To the eastward they are usually not so thick.

Coal VIb thickens up to 4 ft., though usually not over 2 or 3 ft. thick. At the Buckeye shaft, near Clinton, three thin beds of coal are reported to have been found at about the horizon of Coal VIb. As these are found nowhere else, their presence here is problematical.

Coal VIa is found all over the eastern part of the area, but is lacking in the western part. Where found, it is very uniformly from 1 ft. to 1 ft. 6 in. thick, with a clay parting about the middle and the black

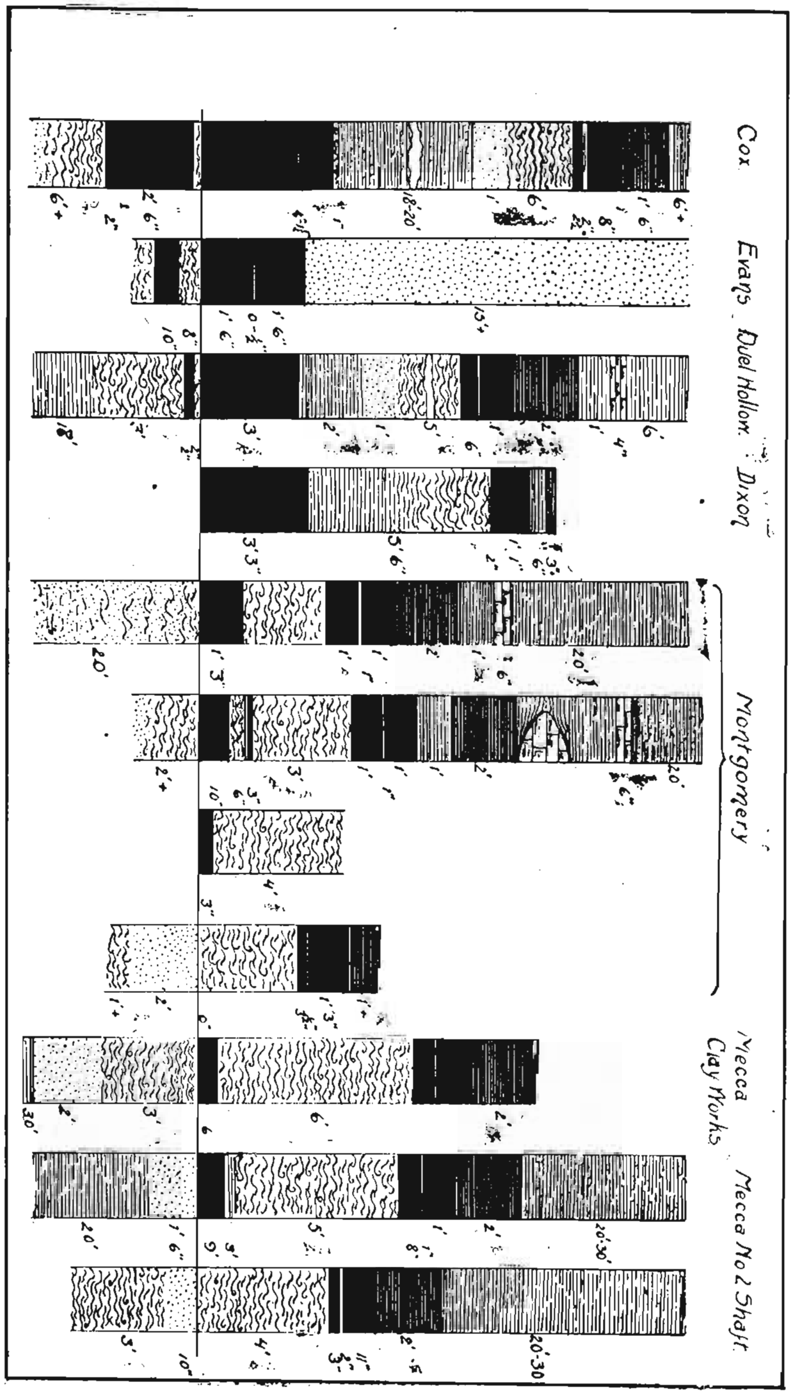


PLATE XI. Figures showing gradual thinning out of Coal VI between Coxville and Mecca, Parke county.

sheety shale roof with the thin overlying ferruginous limestone. It is generally reported an excellent blacksmith coal. It lies usually not many feet above Coal VI, but varies up to 20 ft. above, with traces of a thin coal between at a few points.

Coal VI in this area appears to have originally been a continuous sheet, though now much cut out along the edges by the present and pre-glacial erosion. The coal runs from 5 to 9 ft. in thickness, averaging between 6 and 7 ft. It is commonly divided by a band which, where thickest, is seen to be about one-half shale and one-half clay. In places this clay or "dirt band" runs out, but as a rule it is a conspicuous feature of the coal, being found at or below the center of the coal; about 4 ft. of coal above and 3 ft. below would be a fair average, though there is much variation from this. The next most constant feature is a thin band of pyrite 1 ft. to 1 ft. 6 in. from the top. Another pyrite band often occurs near the bottom of the coal, and in places a band termed the "blue band," of bony, dirty coal, with some pyrite, is found between the main band and the lower sulphur band. At many places in northeastern Vigo county and Clay county there is a tendency for the single main dirt band to split into two, with several inches of coal coming between them.

This band of coal, from 2 to 6 in. thick, was seen to come in and pinch out at several places. At the Bell mine, east of Coal Bluff, in Vigo county, it is reported that the dirt band increased until it had a thickness of 2 ft. At the Ray mine, east of Seeleyville, the coal has two bands, dividing it into three nearly equal parts, while at the Parke County Coal Co.'s No. 10 mine there is reported to be no band at all. So that it will be seen that while this coal has a tendency to show a definitely banded cross-section, there is much variation from the type.

This coal is a strong steam coal, not as free from dirt and sulphur as some of the coals discussed. Much care is required to secure the removal of the dirt and sulphur, but where that is well done it makes one of the best steam coals of the State.

The roof of this coal is usually a blue shale overlain by sandstone. Usually the roof is from fair to good. In places much trouble is had with the lack of any roof but drift. The floor is fire-clay, with often a little bone coal or black shale lying between the coal and clay. This clay has a strong tendency to creep, making it necessary at many of the mines to lay out the mine so as to overcome the difficulty.

134. SOUTH OF THE T. H. & I. RAILWAY, over most of Vigo and Clay counties, within the limits of outcrop of Division VI, the country is not favorable to outcrops, and little is known of this division. It appears to grow thinner, however, so as to average under 4 ft. However, at the outlier at Middlebury it shows no signs of thinning, ranging up to a reported thickness of 11 ft. Drillings at Lockport, or Riley, and at Pimento, or Hartford, give Coal VI a thickness of from 6 to 7 ft. At Middletown, Vigo county, drilling shows only 3 ft. 6 in. of coal, and in the northeast corner of Sullivan County Coal VI is from 2 ft. to 4 ft. 6 in., as reported in drillings. The exact status of this coal in this area is therefore very uncertain.

Coal VIb in Riley and Pierson townships of Vigo county attains its greatest development, ranging there from 3 to 6 ft. in thickness, overlain as usual with black sheety shale and up to 10 ft. of limestone.

At the south side of Vigo county Division VI very rapidly changes from a thickness of 130 ft. or over at Pimento to 40 ft. at Farmersburg. The space between Coal VII and VIb has decreased greatly at points east of Pimento, so that at one point there only a few inches of fire-clay came between Coal VII and the limestone over Coal VIb.

135. THE THIRD AREA from Farmersburg to Edwardsport presents a basin of coal of remarkable uniformity. Division VI is in this area only from 30 to 40 ft. thick; and except in the north edge of Sullivan county, where Coal VI has really not acquired the thickness and details characteristic of the area, it is the only coal in the division. Coal VIb disappears in the north edge of Sullivan county, being there close to Coal VII, from which it is only separated by the fire-clay, limestone and a little shale, or, in one case, by only 1 ft. 6 in. of limestone. In places the limestone acquires a considerable thickness, and it is fairly persistent near the top of Division VI all through this area. Below it comes a massive sandstone lying unconformably on the roof shales of Coal VI. Stratigraphically this is the same sandstone as is quarried at Worthy, Vermillion county. It would appear that at the end of the coal-forming period, the area involved settled enough to put an end to the formation of coal deposits and allow fairly clean clay mud to be deposited over the area. After these had reached a depth of from 10 to 20 ft., elevation took place and the freshly laid down mud or shale was soon carved into erosion channels, often of some width and frequently deep enough to cut into the recently deposited coal. Subsidence followed with the influx of sand which filled up these hollows, and as sinking progressed gradually accumulated as a bed of sandstone. Some question has arisen as to whether the channels found in Parke, Fountain and Vermillion counties were not formed at this time rather than later, and that the sandstone filling the channels is really the same as this sandstone lying above Coal VI, in Division VI.

Coal VI in this area ranges from 5 to 8 ft. in thickness, with an average of about 6 ft. Three clay bands appear in the coal with great persistency, dividing the seam into four benches that maintain great uniformity of thickness and, in a less degree, in quality. The lowest parting comes about 1 ft. from the bottom, and the bottom coal is apt to be shaly, so that in most of the mines it is not taken up. The other two partings are from 4 to 10 in. apart and lie about midway of the rest of the coal. The thin bench in the middle of the coal is often used to mine in as in many cases it is of poor quality, and where removed the bench above will often sag down of its own weight, until it can be easily broken up and removed, after which the bottom bench can be wedged up. As indicating how persistent these benches are in this field, it may not be out of place to give in tabular form the thickness at a number of the mines and openings in this area.

NAME AND LOCATION.	TOTAL.		UPPER.		MINING.		LOWER.		BOTTOM.	
	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.
T. 9 N., R. 9 W.—										
Berlin, Sec. 1	5	4	2	0	0	6	2	2	0	8
Farmersburg, Sec. 2	5	2	1	8	0	8	2	0	0	10
Currysville, Sec. 35	5	6	2	0	0	10	2	0	1	0
Shelburn, Sec. 34	7	0	2	8	0	8	2	6	1	2
Lofton, Sec. 25	5	9	1	6	1	6	2	9	1	0
T. 8 N., R. 9 W.—										
Sullivan, Sec. 27	5	2	1	10	0	6	1	10	1	0
T. 6 N., R. 9 W.—										
Carlisle, Sec. 10	5	3	2	0	0	7	1	6	1	2
T. 6 N., R. 8 W.—										
Ward, Sec. 12	4	9	1	0	0	5	2	2	1	0
Padgett, Sec. 13	5	0	1	0	0	6	2	4	1	0
T. 5 and 4 N., R. 8 W.—										
Roots and Bensing, Sec. 14-5-8.	4	10	0	10	0	5	2	0	0	10
Edwardsport C. & M. Co., Sec. 36-5-8	6	3	2	6	0	9	2	0	0	10
Harrington Coal Co., Sec. 2-4-8	6	6	2	4	0	9	2	1	1	2
Thurston, Sec. 2-4-8	5	6	1	6	0	6	2	4	1	2
T. 9 N., R. 8 W.—										
Hymera, Sec. 35	6	10	2	6	0	6	2	10	1	0
Stark, Sec. 35	5	6	2	0	0	6	2	0	1	0
Dick, Sec. 30	5	7	2	1	0	6	2	0	1	0
T. 8 N., R. 8 W.—										
Shepherd, Sec. 3	6	0	2	3	0	6	2	6	1	0
Star City, Sec. 6	6	0	2	2	0	8	2	2	1	0
Jackson Hill, Sec. 10	6	0	2	0	0	6	2	2	1	2
Bush Creek, Sec. 31	5	2	2	0?	0	8	2	0	0	0 ?
Farnsworth, Sec. 32	5	10	2	0	0	6	2	0	1	2
Buell, Sec. 35	5	4	2	2	0	6	1	10	0	8
Ring, Sec. 3	5	4	2	0	0	6	2	0	0	3
Wilson, Sec. 15	6	4	2	9	0	4	2	0	1	0
Pigg, Sec. 36	5	2	2	0	0	6	2	6	0	0
Zaeyer & Allman, Sec. 31	5	10	2	0	0	10	2	0	1	0
T. 7 N., R. 8 W.—										
Dugger, Sec. 12	6	0+	2	6	0	4	2	2	1	0
Co-operative, Sec. 2	6	3	2	4	0	4	2	4	1	3
Superior, Sec. 10	6	0+	2	4	0	6	2	2	1	0
Carbon Hill, Sec. 24	6	0	2	3	0	6	2	3	1	0

The partings run from ¼ in. to 2 in. or a little over, and will average about 1 in. thick. In the entries of many of the mines these are very distinct, often resembling parallel chalk marks on the black coal walls. In some of the mines the bottom bench is little more than a bone coal, while in others it is regularly mined with the other benches.

In quality this coal is much the same as in the "Big Vein" area. It tends to carry much sulphur, but usually in a form that allows of its easy removal with a little trouble, when the coal will be found to be a strong steam coal. Most of this coal would be greatly improved by washing.

The roof is from fair to good, being usually good for a time, but tending to come down badly in entries long used. The floor is quite commonly a black shale, occasionally containing thin bands of good coal.

136. THE SOUTHERN AREA from Washington south to the Ohio river appears to continue the stratigraphy of the area just considered, except that Coal VI runs out, Coal VIb comes in again, and the limestone over Coal VIb becomes very persistent. Coal VIb, while found at points all the way from White river to, or almost to the Ohio, is nowhere workable, nor is it quite persistent. The limestone over it here very frequently lies directly on the coal and varies from a foot or less to 10 or 12 ft. in thickness. One of the best exposures of the limestone is just east of Newbury, in Warrick county. The space from Coal VII to Coal VIb runs from 20 ft. down, but will generally be only a few feet, in many cases only a foot or two of limestone, with or without a little clay intervening. Coal VIb attains its greatest thickness near Petersburg and Millersburg, reaching at those points 2 ft. 10 in. and 3 ft., respectively.

Coal VI, which was found to be thin in the south part of Edwardsport, appears to acquire a workable thickness only east of Washington, in Daviess county, and there it has practically been worked out, all of the coal now coming from that locality coming from Coal V. It there reaches a thickness of 4 ft. or over, and is of excellent quality. Southwest of Washington it appears as a rider over the seam being worked, being only a foot or two thick. In Pike county it is, in most cases, absent, and where seen was, in a majority of instances, less than a foot thick, though occasionally, as at Hartwell, thickening up to 2 or 3 or even 3 ft. 6 in. This coal was last seen in going south, near Scalesville, in northern Warrick county.

Section 6. Division VII.

137. This division, with but few local exceptions, shows only one workable coal, and that the most persistent in the State. The division ranges from 60 ft. to over 140 ft. in thickness. In the northern part shales predominate, in the southern part sandstones. This fact, taken in connection with differences in the roof rocks of Coal VII and other features of the stratigraphy, seem to imply that the assumption that what is called Coal VII is all at the same horizon, may not be quite correct. In the north part of the area Coal VII can be traced with little question from the "Horseshoe," on the Little Vermillion river, to West Terre Haute. The strata here are mostly shales, with often sandstone above, and near the top are two beds of limestone. Coal VII in this area runs from 4 ft. to 5 ft. in thickness, without regular partings, though locally sulphur bands are often persistent, and overlain with a dark or light shale in the north, but from Clinton to Terre Haute with black bituminous sheety shale, like that over Coal V, but which is frequently a true bone coal; this will run from 1 to 2 ft. in addition to the 5 ft. of good coal. The fire-clay under this coal is apt to be soft when wet, and then exhibits a decided tendency to creep. Drillings around Clinton indicate that there is a coal horizon there about 20 ft. above Coal VII, and at places there also appears in the black shale or bone coal over the coal a band of bone that in places becomes a fair grade of coal. Neither of these coals are of workable thickness or commercial importance. At the "Horseshoe" there appears a 3 ft. 3 in. bed of coal only 12 ft. above Coal VII, which we have drawn in this division, but with the expectation that further study, especially in Illinois, will show that the upper bed is Coal VIII.

From Terre Haute eastward and southward the conditions are found to have changed, yet it is believed that the strata are correctly tied up. Thus, it is thought that Coal VI has been traced from Clinton, in Parke county, then down into eastern Vigo county and elsewhere without question. It is also believed, though with less certainty, that the correlation of Coal VIb at Seeleyville with VIb of Vermillion county is correct. Coal VII in Vermillion county lies 40 or 50 ft. above Coal VIb, while the upper workable coal at Seeleyville lies about 30 ft. above Coal VIb. In this case Division VI is used to bridge over the uncertain ground. From Seeleyville to Farmersburg, across which much uncertainty exists concerning Coal VI, Division VII serves as a bridge. Furthermore, the double limestones in the top of this division in Vermillion and western Vigo counties appear in their proper place in the sections in Sullivan county. Thus it appears well settled that whether Coal VII from Terre Haute south to the Ohio river was laid down in exactly a continuous basin with Coal VII north of Terre Haute, they occur at, at least, approximately the same horizon.

From Seeleyville south Coal VII continues nearly everywhere workable, seldom under 3 ft. thick, or over 4 ft., though around Seeleyville and in northern Sullivan county running up to 5 or 6 ft. in thickness. This coal was called "N" in Mr. Cox's reports on Clay and Daviess counties and Mr. Collett's report on Pike county, but in Mr. Collett's reports on Sullivan, Knox and other places, was called "M." Locally it was called by other letters. From Seeleyville southward its roof is irregularly shale and sandstone, with standstone predominating in the division. The conditions following the laying down of the coal seem to have been subsidence, with the deposition of mud or shale, then uplift and extensive erosion, then sinking, with influx of sandy deposits. The roof is often or even characteristically very irregular and full of rolls, so much as to seriously interfere with the mining of the coal at most points where it has been mined, and in some cases the lowest part of these rolls consists of a conglomerate. These rolls not only render the roof uneven, but greatly reduce the average thickness of the coal, so that coal which it would appear would normally have been 4 or 5 ft. thick will average less than 3 ft.

The quality of the coal usually appears to be excellent in the area from Seeleyville southward, being unusually rich and free from sulphur, but not a good coal to stand transportation. Partly for the reason given, but principally because of the proximity of Coal VI of much greater and more regular thickness, and of a better quality to ship to market, Coal VII is not very extensively mined in Indiana. In northern Warrick county the roof is again a black shale and not of a good quality.

Section 7. Division VIII.

138. The old survey recognized but one workable horizon above Coal VI. In 1896 Mr. Scovell correctly determined that a workable coal in Brouillet's creek and Coal creek valleys was above Coal VII or Coal "N," and he applied to it the name of Coal "O." This coal horizon now becomes the basis of Division VIII and will be called Coal VIII.

Division VIII has a thickness of from 50 to over 100 ft. It contains from one to four coals, only the lowest of which is ever workable and only over limited areas in the northern part of the field. Shales predominate, though with a goodly mixture of sandstone and more than the average of limestone. Coal VIII has a thickness of 4 ft. or over up Brouillet's creek in Vermillion county. The roof is much like the roof of Coal VII in the same area, being black bony shale one or two feet thick. The coal continues workable southward into Vigo county along Coal creek, but before reaching the center of the county it becomes too thin to work. It continues so over all the area to the south except in western Sullivan county, where it reaches a total thickness of 3 or 4 ft., but so broken up by partings and the benches so poor as not to furnish more than a small amount of coal of workable character. The coals above seem to be of very uncertain character, seldom more than one of them being present at any one point. They are usually overlain by black sheety shale with limestone above, and are frequently of too bony a character to recommend themselves. However, in many places they are of good quality and where readily gotten at are often dug in a small way. The limestones near the top of this division are very persistent and can be traced from southwestern Vigo county to the Ohio river west of Evansville, where they are quarried at many points for road material.

Section 8. Division IX.

139. This is the division containing the Merom sandstone and any overlying Carboniferous or Permo-Carboniferous strata, assuming at present that no younger rocks occur there. This division contains no coal, except it be in the basal conglomerate, obtained by erosion from the underlying strata. It generally shows only sandstone in a massive bed up to 75 ft. thick. Shale appears in places.

XI. PALEONTOLOGY OF THE INDIANA COAL FIELDS.

M. M. AND G. H. ASHLEY.

140. At the time of the early geological work upon the Indiana coal fields it was a commonly accepted belief that certain life forms accompanied certain coal beds, and the finding of certain fossils at two distant places was considered proof of the identity of the accompanying coals. On this basis some of the coal beds of Pennsylvania were by some believed to have originally extended not only all along the Alleghany mountains, but to have covered a vast area stretching to the west of the Mississippi. In this State the services of Mr. Leo Lesquereux, the highest authority on Paleobotany living at that time, were secured, and he accompanied Mr. Richard Owen on his trip through the coal field in 1860. He not only traced the Mahoning sandstone of Pennsylvania through the coal field, but determined the stratigraphical position of all the coals met on their reconnaissance.

When, under Mr. Cox in 1869 and 1870, the coal counties began to be examined with more care, it became evident at once that not only were the former determinations unreliable, but to a large degree incorrect. This Mr. Cox points out at some length in a paper read by him before the American Association for the Advancement of Science in 1871. Nevertheless in the following years considerable attention was given to the collecting and identifying of the coal measure fossils, and to a slight degree they appear to have been considered of value in unraveling the stratigraphy, especially by Mr. Collett. The lists of fossils so collected were usually placed in the columnar sections.

At the time of beginning the present survey it was the writer's feeling that while the off-hand determination of species might prove of litttle stratigraphic value, by a detailed study of all the minute features of all the fossils found, combined with a study of distribution at different times and of the probable migrations which had taken place, it might be possible to trace the changing or modifying of some of the forms which continued, the dropping out of other forms from time to time, and the gradual appearance of new forms, so that the fossils would become of the highest stratigraphic value. For several reasons it soon became evident that it would be impossible to make such a study. The fossils in the coal measures are not overabundant and when found are usually very difficult to get out or to preserve. Those in the limestone are usually very fragmentary, requiring not alone considerable labor but much time to chisel them out, with but few, if any, perfect specimens obtainable. In the shale the plant remains are often abundant and well preserved, but in such friable material that in most cases special measures would have to be adopted to secure their safe transportation to the laboratory. In view of these facts it was soon evident that the fossils must largely be studied in place, and it became further evident that to do the work with the thoroughness necessary to secure results of value, this part of the survey alone would require many times the amount of time allotted for the whole work.

Therefore no systematic attempt was made to either collect or study the fossils, nor was any direct use made of them in working out the stratigraphy. A possible exception to this general statement was the use constantly made of them to determine the conditions surrounding the laying down of the different rocks. In this way groups of fossils have been of much indirect help in distinguishing a given coal bed from the bed next above or below. But with every recurrence of the conditions surrounding that given bed there is found a return of the old fauna. To distinguish the different returns would be the desideratum sought. To save space it has been the plan to omit all names of fossils from the columnar sections, but in response to many requests the fossils reported in former State reports are here tabulated. In doing this an effort has been made to so arrange the matter that there should be shown, first, the vertical distribution as far as known (of course, it will be understood that when a fossil is reported to have been found in Division I and Division VIII, it is assumed to have existed all the time between); second, the horizontal distributions; third, the habitat or environment of each species as expressed by the character of the rock in which it is found.

The following tables in the main have been prepared by Mrs. Ashley. There is given under each county, first, a list of localities at which fossils have been found, then a list of the fossils arranged to show the distribution among the several localities, the divisions in which they occur and the character of the rock in which they occur. In these lists all mention of fossils in which specific names are not given are omitted; and all cases where doubt existed, as to the horizon at which a fossil occurs, or some other factor, have been omitted. Following the county tables is given a summary table which practically gives all the facts of interest to the general reader. In this table the X is used in all cases where the given species has been reported less than five times at any horizon or in any rock; if reported more than four times, the number is given.

The tables are given for what they are worth. The attempt to ascertain to what general conclusions they led was abandoned after a brief study, as it was evident from our knowledge of the field that the data were not of a character or of a quality to secure safe results. To give a single illustration: From the table it might appear that what we have called the marine black shale fauna was as much or more characteristic of Division VI than of Division V, whereas our field notes would suggest that this fauna is found many times in Division V for every once it is found in Division VI. Such discrepancies, which are abundant all through the table, are due principally to two causes: first, lack of balance in the character of the work done in different parts of the field, some areas or divisions having had their life worked out with some completeness, while others have barely been touched or entirely neglected; second, even in the areas best worked out, it would seem that at only a few of the places where fossils were found were specific determinations made, or at least published, the majority of the places being passed with a notice of "fossiliferous" shale or limestone or whatever the rock might be, or by such statements as, "The black shale contains the fossils usually found accompanying this coal," with a mention often of generic names, which, as stated, are omitted from this table.

The broad vertical and horizontal distribution of the more commonly reported species is readily noted from the table, also the existence of two faunas, the first characterized by the presence of fish remains, cephalopods, and such pelagic forms as aviculopectens. This I have interpreted as an "advance guard" fauna, or a fauna which, from a greater ability to move rapidly into new territory, would be the first to appear after an incursion of the sea. They in turn would be followed by the more abundant but slower-moving brachiopod fauna which ushers in a period of limestone forming. It will often happen that the former fauna will persist after the encroachment of the brachiopod fauna, the limestone showing a certain mingling of the two faunas. It is probable that closer study would result in dividing the fauna into still finer subdivisions. No division has yet been made of the flora. The predominance of Lepidodendrons in the sandstones and many similar possible facts are matters of note in the field work, but there are as yet too few data at hand to allow the formulating of definite or general laws in regard to the matter.

150. Abbreviations: S. S.—sandstone; L. S.—limestone; sh.—shale; Bl.—black; Bl. sh. L.—black shale with land flora; Bl. sh. M.—marine black shale fauna; calc. sh. or cl.—calcareous shale or clay, in

the latter case usually the decomposition product of a limestone; Fe.—iron or ferruginous, Fe. L. S.—ferruginous limestone; sandy shale is marked shale, and shaly sandstone is called sandstone; Cl. sh.—clay shale.

151. Clay County.

List of localities—

1. Elkins' place, Bowling Green, shales above Coal I.
2. John Andrews, Sec. 30, T. 13 N., R. 6 W., limestone over Coal V.
3. South of Staunton, black sheety shale over Coal VIa.
4. Peter Barrick's, southeast of Clay City, in ironstones in shales over Coal IV.
5. A. Harstein, north of Coal City, limestone over Coal V.
6. A. Phipp's bank, S. W. of S. W. of Sec. 30-10-6, black sheety shale over Coal V.
7. Mr. Gray, Sec. 3-9-6, limestone over Coal V.
8. Markland shaft, Clay City, shale over worked coal, Coal III.

Localities	1	2	3	4	5	6	7	8
Divisions	I	V	VI	IV?	V	V	V	III?
PLANTÆ.								
Asterophyllites equisetiformis, Cl. sh				×				×
Cordaites borassifolius, Cl. sh				×				×
Cordaites diversifolius, Cl. sh								×
Neuropteris hirsuta, Cl. sh				×				×
Neuropteris hirsuta, Bl. sh. L	×							
Neuropteris loshi, Bl. sh. L	×							
Neuropteris rarinervis, sh				×				×
Pecopteris arborescens, Bl. sh. L	×							
Sphenophyllum schlotheimi, Cl. sh				×				×
Sphenophyllum schlotheimi, Bl sh. L	×							
MOLLUSCOIDEA.								
Brachiopoda.								
Chonetes mesolobus, L. S		×	×		×		×	
Chonetes granulifer, L. S							×	
Derbya crassa, L. S							×	
Productus cora, L. S		×			×		×	
Productus costatus, L. S							×	
Productus longispina, L. S		×	×		×		×	
Productus punctatus, L. S					×		×	
Productus semireticulatus, L. S		×						
Rhipidomella pecosi, L. S		×	×		×			
Reticularia perplexa, L. S					×			
Seminula argentea, L. S					×			
Spirifer cameratus, L. S					×		×	
Spirifer cameratus, Bl. sh. M			×					

CLAY COUNTY—Continued.

Localities	1	2	3	4	5	6	7	8
Divisions	I	V	VI	IV?	V	V	V	III?
MOLLUSCA.								
Lamellibranchiata.								
Aviculopecten rectilaterarius, Bl. sh. M			×			×		
Aviculopecten fragilis, Bl. sh. M			×					
Myalina perniformis, Bl. sh. M			×					
Nuculana bellistriata, L. S							×	
Gastropoda.								
Bellerophon carbonarius, Bl. sh M			×					
Pleurotomaria grayvillensis, Bl. sh. M			×					
Cephalopoda.								
Nautilus decoratus, Bl. sh. M			×			×		
Orthoceras rushense, Bl. sh. M			×			×		
PALEOSTRACA.								
Phillipsia sangamonensis, L. S							×?	
PISCES.								
Petrodus occidentalis, Bl. sh. M						×		

152. Daviess County.

List of Localities—

1. Near Murry's, on White river, limestone and calcareous shale over Coal V.
2. Scale's mill, on Sugar creek, below Alfordsville, limestone above Coal IIIb.
3. Critchlow bank, east of Epsom, calcareous shale over Coal V.
4. High Rock on White river, cherty limestone above Coal V.
5. Wilson's mine, near Washington, limestone above Coal VI.
6. Washington, roof shales of Coal VI.

Localities	1	2	3	4	5	6
Divisions	V	III	V	V	VI	VI
PLANTÆ.						
Alethopteris lonchitica (?), Cl. sh						×
Asterophylites sublaevis (?), Cl. sh						×
Neuropteris hirsuta, Cl. sh						×
Neuropteris loshi, Cl. sh						×
Pecopteris arborescens, Cl. sh						×
Sigillaria reniformis Cl, sh						×
Sphenophyllum scholotheimi, Cl. sh						×

DAVIESS COUNTY—Continued.

LOCALITIES	1	2	3	4	5	6
DIVISIONS	V	III	V	V	VI	VI
CŒLENTERATA.						
Lophophyllum proliferum, Calc. sh	×	....	....	....	....	....
MOLLUSCOIDEA.						
Brachiopoda.						
Chonetes mesolobus, L. S	×	×	....	×	×	....
Chonetes mesolobus, Calc. sh	×	....	×	....	....	....
Productus cora, L. S	×	×	....	×	...	....
Productus cora, Calc. sh	×	....	....	....	....	....
Productus longispina, L. S	×	....	....	....	×	....
Productus longispina, Calc. sh	×	....	....	....	....	....
Productus punctatus, L. S	×	×	....	×	....	....
Productus punctatus, Calc. sh	×	....	....	....	....	....
Productus semireticulatus, L. S	×	×	....	×	×	....
Productus semireticulatus, Calc. sh	×	....	×	....	....	....
Reticularia perplexa, L. S	....	×	....	....	....	....
Rhipidomella pecosi, L. S	....	....	....	....	×	....
Seminula argentea, L. S	....	....	....	....	×	....
Spirifer cameratus, L. S	....	×	....	×	×	....
MOLLUSCA.						
Lamellabranchiata.						
Aviculopecten providencensis, L. S	×	....	....	....	....	....
Aviculopecten providencensis, Calc. sh	×	....	....	....	....	....
Gastropoda.						
Bellerophon carbonarius, L. S	×	....	....	....	×	....
Bellerophon carbonarius, Calc. sh	×	....	....	....	....	....
Bellerophon montfortanus, L. S	....	....	....	....	×	....
Bellerophon percarinatus, L. S	....	....	....	....	×	....
Cephalopoda.						
Orthoceras rushense, Calc. sh	×	....	×	....	....	....
Orthoceras rushense, L. S	×	....	×	....	×	....
PALEOSTRACA.						
Entomostraca.						
Euproops danae (?), Cl. sh	....	....	....	....	....	×

153. Dubois County.

List of localities—

1. Keshner's mill, Sec. 18-2-5, limestone over Coal IIIb.
2. S. Dillon's, Secs. 5 and 8-2-5, limestone over Coal IIIb.
3. Near Kellersville, limestone over Coal IIIb.
4. Knoxville, east end of mill dam, shale Div. I.
5. Same, bituminous limestone, Div. I.
6. Mrs. Conley's, Sec. 16-2-3, limestone over Coal III.
7. N. E. ¼ of Sec. 21-2-3, bituminous limestone over Coal III.
8. Anderson Valley, Sec. 34-3-4.
9. Kemp, Secs. 31 and 32-3-5, limestone over Coal (?).

LOCALITIES	1	2	3	4	5	6	7	8	9
DIVISIONS	III	III	III	I	I	III	III	I	?
PLANTÆ.									
Alethopteris serlii, Cl. sh	....	....	....	×	....	....	....	....	....
Cordaites borassifolia, Cl. sh	....	....	....	×	....	....	....	....	....
PROTOZOA.									
Fusilina cylindrica, L. S.	....	....	....	....	....	....	....	×	....
MOLLUSCOIDEA.									
Brachiopoda.									
Derbya crassa, L. S	....	....	....	....	....	....	....	×	....
Dielasma bovidens, L. S	....	....	....	....	....	....	....	×	....
Productus cora, L. S	....	....	....	....	....	....	....	×	....
Productus costatus, L. S.	....	×	....	....	×	×	×	....	....
Productus longispina, L. S	....	....	....	....	....	....	....	×	....
Productus punctatus, L. S.	×	×	....	....	....	....	....	×	×
Productus semireticulatus, L. S.	×	×	×	....	....	....	....	....	×
Reticularia perplexa, L. S.	....	×	....	....	....	....	....	×	....
Seminula argentea, L. S.	×	×	....	×	×	....	×	×	....
Spirifer cameratus, L. S	×	×	×	....	×	×	×	×	×
Spiriferina cristata, L. S.	....	....	....	....	....	....	....	×	....
MOLLUSCA.									
Lamellabranchiata.									
Aviculopecten indianensis, L. S.	....	×	....	....	....	....	....	....	....
Aviculopecten providencensis, L. S.	....	....	....	....	....	....	....	×	....
PISCES.									
Edestus vorax, L. S.	....	....	....	....	....	....	....	....	....

154. Fountain County.

List of localities—

1. Thomas mine, Silver Island, limestone over Coal V.
2. Coal Creek P. O., shale over Coal IV.
3. Silver island, limestone over Coal V.
4. Yeddo, limestone over Coal V.

LOCALITIES	1	2	3	4
DIVISIONS	V	IV	V	V
PLANTÆ.				
Alethopteris lonchitica, Sh	....	×	....	....
Neuropteris hirsuta, Sh	....	×	....	....
Sphenopteris crenata, Sh	....	×	....	....
MOLLUSCOIDEA.				
Brachiopoda.				
Chonetes mesolobus, L. S	×	....	....	....
Productus longispina, L. S	×	....	×	×
Productus nebraskaensis, L. S	....	....	....	×
Productus punctatus, L. S	×	....	....	....
Productus semireticulatus, L. S.	....	....	×	....
Seminula argentea, L. S	×	....	....	×
Spirifer cameratus, L. S	×	....	....	×
MOLLUSCA.				
Gastropoda.				
Bellerophon carbonarius, L. S	×	....	....	....

155. Gibson County.

List of localities—

1. Hazelton.
2. "Dripping Spring," W. A. Walter's land, Sec. 33-2-12, shaly limestone VIIIa.
3. Northeast of Tafftown, Secs. 4 and 5-2-10, bituminous limestone, Div. VIII.
4. Kurtz bank, Sec. 5-2-10, Div. VIII.
5. Patoka, Sec. 25-1-11, bituminous limestone.

Localities	1	2	3	4	5
Divisions	VIII	VIII	VIII	VIII	VIII
COELENTERATA.					
Lophophyllum proliferum, L. S	...	×	...	...	×
Lophophyllum proliferum, L. S. cl	×	...	...	...	...
MOLLUSCOIDEA.					
Brachiopoda.					
Chonetes verneuilianus, Bl. sh	...	...	...	×	...
Orbiculoidea discus, Bl. sh	...	...	...	...	...
Productus costatus, L. S	...	...	...	...	×
Productus longispina, L. S	...	...	×	...	×
Productus longispina, L. S. cl	×	...	...	...	...
Productus semireticulatus, L. S	...	×	×	...	...
Productus semireticulatus, L. S. cl	×	...	...	...	...
Reticularia perplexa, L. S	...	×	...	...	...
Seminula argentea, L. S	...	...	×	...	...
Seminula argentea, L. S. cl	×	...	...	...	...
Seminula argentea, Bl. sh	...	...	...	×	...
Spirifer cameratus, L. S	...	...	...	...	×
Spirifer cameratus, L. S. cl	×	...	...	...	...
Spiriferina cristata, L. S	...	...	×	...	×
MOLLUSCA.					
Lamellibranchiata.					
Nucula inflata, L. S	...	...	...	...	×
Nucula inflata, Bl. sh	...	...	...	×	...
Nuculana bellistriata, Bl. sh	...	...	...	×	...
Gastropoda.					
Bellerophon carbonarius, L. S	...	...	...	...	×
Bellerophon carbonarius, L. S. cl	×	...	...	...	...
Bellerophon carbonarius, Bl. sh	...	...	...	×	...
Bellerophon montfortanus, L. S	...	...	...	...	×
Bellerophon montfortanus, Bl. sh	...	...	...	×	...
Bellerophon montfortanus, L. S. cl	×	...	...	...	...
Bellerphon percarinatus, L. S. cl	×	...	...	...	...
Macrochilina primigenia, Bl. sh	...	...	...	×	...
Macrochilina primigenia, L. S	...	...	...	...	×
Pleurotomaria gravillensis, Bl. sh	...	...	...	×	...
Pleurotomaria sphærulata, L. S. cl	×	...	...	...	...
Pleurotomaria sphærulata, Bl. sh	...	...	...	×	...
Pleurotomaria sphærulata, L. S	...	...	...	...	×
Pleurotomaria tabulata, L. S. cl	×	...	...	...	...
Pleurotomaria tabulata, Bl. sh	...	...	...	×	...
Cephalopoda.					
Orthoceras rushense, Bl. sh	...	...	...	×	...
PISCES.					
Petrodus occidentalis, Bl. sh	...	...	...	...	...

156. Greene County.

List of localities (Cox, '69)—

1. Phillips' mine, Sec. 20-6-4, shales associated with Coal I.
2. Limestone accompanying Coal V, in T. 8 N., R. 7 W.

Localities	1	2
Divisions	I	V
PLANTÆ.		
Calamites canniformis, Cl. sh	×	...
MOLLUSCOIDEA.		
Brachiopoda.		
Chonetes mesolobus, L. S	...	×
Derbya robustus, L. S	...	×
Productus carbonarius, L. S	...	×
Productus cora, L. S	...	×
Productus semireticulatus, L. S	...	×
Seminula argentea, L. S	...	...
Spirifer cameratus, L. S	...	×
MOLLUSCA.		
Lamellibranchiata.		
Nucula inflata, L. S	...	×
Gastropoda.		
Bellerophon carbonarius, L. S	...	×

157. Knox County.

List of localities—

1. Allen & Foulk's bank, Sec. 9-1-8, clay shale, Div. VII.
2. Edwardsport, Sec. 1-9-4, limestone and calcareous shale, Div. V.
3. Cox hill, Sec. 8-4-8, limestone, Div. V.
4. Edwardsport, Sec. 1-4-9, limestone, Div. V.

Localities	1	2	3	4
Divisions	VII	V	VIII	V
PLANTÆ.				
Alethopteris serlii, Cl. sh	×	...	...	...
Cordaites borassifolia, Cl. sh	×	...	...	...
Neuropteris hirsuta, Cl. sh	×	...	...	...
Pecopteris arborescens, Cl. sh	×	...	...	...
Sphenophyllum schlotheimi, Cl. sh	×	...	...	...
CŒLENTERATA.				
Lophophyllum proliferum, L. S., Calc. sh	...	×	...	...

KNOX COUNTY—Continued.

Localities	1	2	3	4
Divisions	VII	V	VIII	V
MOLLUSCOIDEA.				
Brachiopoda.				
Chonetes mesolobus, L. S	......	×	×	×
Chonetes granulifer, L S	......	......	......	×
Derbya crassa, L S and Calc. sh	......	×	......	......
Productus cora, L. S	......	......	......	×
Productus costatus, L. S. and Calc. sh	......	×	......	......
Productus longispina, L. S	......	......	×	×
Productus longispina, L. S and Calc. sh	......	×	......	......
Productus punctatus, L. S	......	......	×	×
Productus punctatus, L. S and Calc. sh	......	×	......	......
Productus semireticulatus, L S	......	......	×	×
Productus semireticulatus, L. S. and Calc. sh	......	×	......	......
Pugnax utah, L. S	......	......	×	......
Pugnax utah, L. S. and Calc. sh	......	×	......	......
Reticularia perplexa, L S	......	......	×	......
Seminula argentea, L S	......	......	×	......
Spirifer cameratus, L. S. and Calc. sh	......	×	......	......
Spiriferina cristata, L. S. and Calc. sh	......	×	......	......
Gastropoda.				
Bellerophon carbonarius, L. S. and Calc. sh	......	×	......	......
Bellerophon carbonarius, L S	......	......	......	×
Cephalopoda.				
Orthoceras rushense, L. S. and Calc. sh	......	×	......	......
Orthoceras rushense, L. S	......	......	......	×

158. Martin County.

List of localities (Cox, '70 and '69)—

1. Crim's coal bank, Sec. 7-2-3, roof shales of Coal I (?).
2. Rollin's coal bank, Sec. 9-5-3, bluish clay shale with Coal I (?).

Localities	1	2
Divisions	I?	I?
PLANTÆ.		
Asterophyllites sublevis, Cl. sh	....	×
Calamites canniformis, Cl. sh	....	×
Cordaites borassifolius, Cl. sh	×	....
Lepidodendron elegans, Cl. sh	×	....
Neuropteris loschi, Cl. sh	....	×
Neuropteris hirsuta, Cl. sh	....	×
Pecopteris arborescens, Cl. sh	....	×
Sigillaria menardi, Cl. sh	×	....
Sphenophyllum schlotheimi, Cl. sh	....	×

159. Orange County.

List of localities—

1. Thos. N. Bronxton quarry, Sec. 5-1-2, in Mansfield sandstone.
2. Osborn quarry, at French Lick, Mansfield sandstone.
3. Bedster quarry, Mansfield sandstone.
4. Dishman quarry, Sec. 23-3-2, Mansfield sandstone.
5. Mansfield sandstone in county in general (Cox, '75, p. 7).

Localities	1	2	3	4	5
Divisions	I	I	I	I	I
PLANTÆ.					
Lepidodendron clypeatum, c. f., S. S	....	....	×	....	....
Lepidodendron dichotomum, S. S	....	....	....	....	×
Lepidodendron rushvillense, S. S	....	....	....	....	×
Lepidodendron veltheimianum, S. S	....	....	....	×	....
Lepidodendron vestitum, S. S	×	....	....	....	....
Lepidophloris crassicaulis, S. S	....	....	....	....	×
Neuropteris biformis, S. S	....	×	....	×	....
Neuropteris elrodi, S. S	....	....	....	....	×
Pseudopecopteris latifolia, S. S	....	....	....	....	×
Pseudopecopteris muricata, S. S	....	×?	....	×	....
Sphenopteris hoeninghausii, S. S	....	....	....	×	....
Sphenopteris tridactylites, S. S	×	....	....	....	×
Ulodendron minus, S. S	....	....	....	....	×
INSECTA.					
Paoli vestusta, S. S	×	....	....	....	....

160. Owen County.

List of localities—

1. Outcrops of Coal V, with black sheety shale and argillaceous and bituminous limestone over; near Clay City.

Locality	1
Division	V
CŒLENTERATA.	
Lophophyllum proliferum, L. S	×
MOLLUSCOIDEA.	
Brachiopoda.	
Productus cora, L. S	×
Productus costatus, L. S	×
Productus longispina, L. S	×
Productus semireticulatus, L. S	×
Reticularia perplexa, L. S	×
Seminula argentea, L. S	×
Spirifer cameratus, L. S	×
PISCES.	
Petrodus occidentalis, Bl. sh. M	×

161. Parke County.

List of localities (1-5, E. T. Cox)—

1. Sand and Sugar creeks, limestone over Coal V.
2. Jose Butler, Sec. 7-15-8, concretionary limestone over Coal VIa.
3. Same, black sheety shale over Coal VIa.
4. Same, black sheety shale over Coal Va.
5. Same, black shale passing into limestone, over Coal V.
6. Jackman, Sec. 7-14-7, limestone over Coal V.

Localities	1	2	3	4	5	6
Divisions	V	VI	VI	V	V	V
Cœlenterata.						
Lophophyllum proliferum, L. S.	×	....	....	....	×	....
Echinodermata.						
Eupachycrinus tuberculatus, L. S.	×	....	....	....	....	....
Molluscoidea.						
Brachiopoda.						
Chonetes mesolobus, L. S.	×	....	....	....	×	×
Productus cora, L. S.	×	....	....	....	×	....
Productus costatus, L S.	....	×	....	....	×	....
Productus longispina, L. S.	×	....	....	....	×	....
Productus muricatus, L. S.	....	×	....	....	....	....
Productus nebraskaensis, L. S.	....	....	....	....	....	....
Productus semireticulatus, L. S.	×	....	....	....	....	....
Reticularia perplexa, L. S.	....	....	....	....	....	....
Seminula argentea, L. S.	×	×	....	....	....	....
Spirifer cameratus, L. S.	×	×	....	....	×	....
Mollusca.						
Lamellibranchiata.						
Aviculopecten rectilaterarius, Bl. sh. M.	....	....	×	....	....	....
Cardinia fragilis (?), Bl. sh. M.	....	....	×	×	....	....
Gastropoda.						
Bellerophon carbonarius, L. S.	×	....	....	....	×	×
Bellerophon montfortanus, L. S.	....	....	....	....	×	....
Bellerophon percarinatus, L. S.	×	....	....	....	....	....
Cephalopoda.						
Orthoceras rushense, L. S.	×	....	....	....	×	....
Orthoceras rushense, Bl. sh. M.	....	....	....	×	....	....
Pisces.						
Petrodus occidentalis, Bl. sh. M	....	....	×	....	....	....

162. Perry County.

List of localities—

1. Godfried Everard's, Secs. 10 and 11-5-2, bituminous brown shales over Coal I.
2. Cannelton, clay shales overlying Coal II.

Localities	1	2
Divisions	I	II
Plantæ.		
Neuropteris hirsuta, Dk. sh. L.	×	....
Neuropteris loshi, Dk. sh. L.	×	....
Molluscoidea.		
Brachiopoda.		
Lingula umbonata, Cl. sh	....	×

163. Pike County.

List of localities—

1. Hosea Alexander's, Sec. 4-15-8, gray clay shale overlying Coal VII.
2. Sand hill, Sec. 22-1 N., 8, clay shale overlying Coal VII.
3. Same, ferruginous limestone over Coal VIa.
4. Dr. Posey's, Sec. 12-1 N., 8, magnesian limestone over Coal V.
5. River bank, Sec. 13-1 N., 8, ferruginous limestone over Coal VIa.
6. G. W. Thomas, Sec. 31-1 S., 6, dark shale and black sheety shale overlying Coal IIIb.
7. T. C. Milburn, Sec. 35-1 S., 7, shales (?) over Coal IIIb.
8. Wells & Whitman's mine, clay shale overlying Coal V.
9. Powers and Tevault farms, Secs. 16 and 17-3 S., 7, magnesian limestone over Coal V.

Localities	1	2	3	4	5	6	7	8	9
Divisions	VII	VI	VI	V	VI	III	V	V	V
PLANTÆ.									
Alethopteris serlii, Cl. sh.							×		
Asterophyllites longifolius, Cl. sh.	×								
Cordaites borassifolia, Cl. sh.	×								
Cordaites borassifolia, Bl. sh.					×				
Cordaites diversifolius, Cl. sh.	×								
Neuropteris collinsi, Cl. sh.							×		
Neuropteris hirsuta, Cl. sh.	×						×		
Neuropteris rarinervis, Cl. sh.	×						×		
Pecopteris arborescens, Cl. sh.	×						×		
Sphenophyllum schlotheimi, Cl. sh.	×								
Trigonocarpum oliviforme, S. S.						×			
COELENTERATA.									
Chetetes milleporaceus, L. S.			×		×				
Lophophyllum proliferum, L. S.			×						
MOLLUSCOIDEA.									
BRACHIOPODA.									
Chonetes mesolobus, L. S.									×
Lingula umbonata, Bl. sh.					×				
Orbiculoidea missouriensis, Bl. sh. M.					×				
Productus costatus, L. S.				×					
Productus punctatus, L. S.			×	×				×	×
Productus semireticulatus, L. S.				×				×	×
Reticularia perplexa, L. S.			×	×					
Seminula argentea, L. S.			×						
Spirifer cameratus, L. S.				×					
MOLLUSCA.									
LAMELLIBRANCHIATA.									
Aviculopecten providencensis, L. S.				×					
Pseudomonotis hawni (?), L. S.									×
CEPHALOPODA.									
Nautilus decoratus, L. S., Bl. sh. M.				×				×	×
PISCES.									
Petrodus occidentalis, Bl. sh. M.					×				

164. Posey County.

List of localities—

1. New Harmony cut-off, Div. VIII (Sampson collection).
2. Gluck's, S. W. ¼ Sec. 32-6-11, calcareous shale, Div. VIII.
3. Helfert's, St. Wendell, black sheety shale, Div. VIII.
4. New Harmony, Div. VIII.
5. Macadoo creek, Div. VIII.
6. Blairville, on Big creek, Div. VIII.

Localities	1	2	3	4	5	6
Divisions	VIII	VIII	VIII	VIII	VIII	VIII
PLANTÆ.						
Asterophycus coxi, S. S.				×		
Didymophyllum oweni, S. S.				×		
Didymophyllum oweni, Sh.						×
Paleophycus milleri, L. S.				×		
PROTOZOA.						
Lophophyllum proliferum	×					
MOLLUSCOIDEA.						
BRACHIOPODA.						
Productus costatus	×					
Productus longispina	×					
Productus punctatus	×					
Reticularia perplexa, Calc. sh.	×	×				
Rhipidomella pecosi, Calc. sh.	×	×				
Seminula argentea	×					
Spirifer cameratus	×					
MOLLUSCA.						
LAMELLIBRANCHIATA.						
Cardiomorpha missouriensis, Bl. sh. M.			×			
Monopteria longispina, Sh.					×	
Nucula inflata, Bl. sh. M.			×			
Pernopecten aviculatus	×					
GASTEROPODA.						
Bellerophon carbonarius	×					
Bellerophon montfortanus	×					
Bellerophon percarinatus	×					
Pleurotomaria carbonarius	×					
Pleurotomaria grayvillensis	×					
Pleurotomaria sphærula	×					
Pleurotomaria tabulata	×					
CEPHALOPODA.						
Orthoceras rushense	×					
PISCES.						
Petrodus occidentalis, Bl. sh. M.			×			

165. Sullivan County.

List of localities—

1. Ferree's, Sec. 4-7-9, shelly limestone, Div. VIII.
2. Merom hill, Sec. 18-7-10, limestone.
3. Merom hill, Sec. 18-7-10, clay shale.
4. Turman's creek and branches, T. 8-10, productal limestone, Div. VIII.
5. Eli Dix's, Sec. 35-9-10, black clod.

6. Badger's mill, Sec. 25-9-11, productal limestone, and plant in rock not designated, Div. VIII.
7. On Parker creek, Sec. (?)-9-10, limestone (?), Div. VIII.
8. On Parker creek, Sec. (?)-9-10, clay shale, Div. VIII.
9. Mr. G. G. Taylor, Sec. 19-6-9, bluish-gray limestone, Div. VIII.
10. Pioneer shaft, Sec. 27-9-9, clay shale, Div. VII.
11. Shelburn shaft, Sec. 34-9-9, calcareous roof shales, Div. VIII.
12. Standard shaft, Sec. 27-9-9, limestone clay, Div. VIII.
13. Standard shaft, Sec. 27-9-9, clay shale, Div. VII.
14. Banholzer's shaft, Sec. 30-9-8, limestone clay, Div. VI.
15. Barnes' bank, Sec. 13-8-8, limestone, Div. V.
16. D. Ring and Jno. Everhart, Secs. 3 and 4-8-8, dark calcareous clay, Div. VI.
17. D. Ring and Jno. Everhart, Secs. 3 and 4-8-8, limestone, Div. V.
18. Berlin's shaft, Sec. 1-8-9, clay shale, Div. VII.

SULLIVAN COUNTY—Continued.

Localities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Divisions	VIII	VIII	VIII	VIII	VIII	VIII	VIII	VIII	VIII	VII	VIII	VIII	VII	VI	V	VI	V	VII
PLANTÆ.																		
Annularia longifolia, Cl. sh										×								
Annularia sphenophylloides, Cl. sh										×								
Asterophyllites equisetiformis, Cl. sh										×								
Asterophyllites longifolius, Cl. sh													×					
Calamites canniformis, Cl. sh																		
Cordaites borassifolius, Cl. sh						×		×		×								
Cordaites diversifolius, Cl. sh										×			×					
Lepidodendron elegans, Cl. sh													×					
Neuropteris hirsuta, Cl. sh								×		×			×					
Neuropteris loshi, Cl. sh													×					
Neuropteris rarinervis, Cl. sh								×		×								
Pecopteris arborescens, Cl. sh										×								×
Sigillaria reniformis, Cl. sh										×								×
Sphenophyllum schlotheimi, Cl. sh										×			×					×
Stigmaria ficoides, Cl. sh										×								
Syringodendron pachyderma, Cl. sh																		×
PROTOZOA.																		
Fusilina cylindrica, L. S	×																	
CŒLENTERATA.																		
Lophophyllum proliferum, L. S	×																	
Lophophyllum proliferum, Calc. sh											×							
MOLLUSCOIDEA.																		
Brachiopoda.																		
Chonetes mesolobus, L. S		×				×	×					×						
Dielasma bovidens, L. S		×							×									
Lingula spatulata, L. S							×											
Orbiculoidea discus, L. S						×												

SULLIVAN COUNTY—Continued.

Localities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Divisions	VIII	VIII	VIII	VIII	VIII	VIII	VIII	VIII	VIII	VII	VIII	VIII	VII	VI	V	VI	V	VII
Orbiculoidea missouriensis, L. S.							×											
Productus cora, L. S.		×				×(?)												
Productus cora, Calc. sh.											×							
Productus longispina, L. S.		×		×											×			
Productus longispina, L. S. cl												×						
Productus longispina, Calc. sh.											×							
Productus punctatus, L. S.		×		×		×												
Productus semireticulatus, L. S.				×		×									×			
Reticularia perplexa, L. S.	×	×				×								×	×			
Reticularia perplexa, Calc. sh											×?							
Seminula argentea, L. S.	×			×		×												
Seminula argentea, Calc. sh											×							
Seminula argentea, L. S. cl																×		
Spirifer cameratus, L. S.		×		×		×			×						×		×	
Spirifer cameratus, L. S. cl												×						
Spiriferina cristata, L. S.		×																
MOLLUSCA.																		
Lamellibranchiata.																		
Aviculopecten rectilaterarius, Calc. sh.											×							
Cardinia fragilis, L. S					×	×												
Cardinia fragilis, L. S. cl												×						
Nucula inflata, L. S. cl					×							×						
Nuculana bellistriata, cl					×													
Nuculana bellistriata, L. S. cl												×						
Scaphoda.																		
Dentalium sublæve, L. S.		×	×															
Gasteropoda.																		
Bellerophon carbonarius, L. S.						×	×		×									
Bellerophon carbonarius, L. S. cl												×					×	
Bellerophon carbonarius, Calc. sh.											×							
Bellerophon montfortanus, L. S.						×	×											
Bellerophon montfortanus, L. S. cl												×						
Bellerophon percarinatus, Calc. sh.											×							
Euomphalus subrugosus, L. S.																		
Macrochilina gracilis, L. S.			×			×												
Pleurotomaria carbonarius, L. S.						×												
Pleurotomaria tabulata, L. S						×												
Cephalopoda.																		
Nautilus decoratus, L. S							×		×		×							
Nautilus decoratus, Calc. sh											×							
Nautilus decoratus, L. S. cl												×						
Orthoceras rushense, Calc. sh											×							
PALEOSTRACA.																		
Phillipsia (Griffithides) scitula, Calc. sh.											×							
PISCES.																		
Petrodus occidentalis, L. S.						×												

166. Vanderburgh County.

List of localities—

1. Phillip Koch Sons' and others, Sec. 14-6-1, in limestone, Div. VIII.
2. Stimson's spring, Sec. 28-6-11, limestone, Div. VIII.
3. Michael Gluck's lime kiln, Sec. 32-6-11, in calcareous shale, Div. VIII.
4. Geo. Helfert's, Sec. 7-5-11, in black shale covering Coal VIIIa.

Localities	1	2	3	4
Divisions	VIII	VIII	VIII	VIIIa
CŒLENTERATA.				
Campophyllum torquinum, L. S	×			
Lophophyllum proliferum, L. S	×			
MOLLUSCOIDEA.				
Brachiopoda.				
Derbya crassa, L. S	×			
Dielasma bovidens, L. S	×			
Productus longispinus, L. S	×			
Pugnax utah, L. S	×			
Reticularia perplexa, L. S	×	×		
Reticularia perplexa, Calc. sh			×	
Seminula argentea, L. S	×			
Spiriferina cristata, L. S	×			
Spiriferina cristata, Calc. sh			×	
MOLLUSCA.				
Lamellibranchiata.				
Cardiamorpha missouriensis, Bl. sh. M				×
Nucula inflata, Bl. sh. M				×
PISCES.				
Petrodus occidentalis, Bl. sh. M				×

167. Vermillion County.

List of localities—

1. Horseshoe, black sheety shale over Coal VIII (?).
2. Horseshoe, limestone over Coal VII.
3. Above Horseshoe, pyritous ironstone in roof of Coal VII.
4. A mile below Horseshoe, shales above Coal VIb.
5. Mouth of Jonathan's creek, black roof shales of Coal VIb.
6. Same, clay shale below Coal VIb.

7. Same, ironstone bands in clay shales below Coal VIb.
8. Bluffs south of Newport, ferruginous limestones with Coal VIa.
9. Hawley & Helt's mine, head of Helt's prairie, clay shale between Coal VIa and its usual black shale roof.
10. Nebecker & White's coal banks on Norton's creek, ironstones in shale overlying Coal VII.
11. Near Newport, in sandstone of old channel filling, Div. IX (?).
12. Between Perrysville and Covington, shales in Div. IV (?).
13. Perrysville, limestone over Coal V.
14. Same, black shales with Coal V.
15. Same, calcareous shales with Coal V.

VERMILLION COUNTY—Continued.

LOCALITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DIVISIONS	VIII	VII	VII	VI	VI	VI	VI	VI	VI	VII	IX?	IV	V	V	V
PLANTÆ.															
Alethopteris serlii, Cl. sh												×			
Cordaites borassifolia, Cl. sh												×			
Neuropteris hirsuta, Cl. sh						×						×			
Syringodendron porteri, S. S.											×				
PROTOZOA.															
Fusilina cylindrica, L. S.													×		
CŒLENTERATA.															
Lothophyllum proliferum, Calc. sh															×
MOLLUSCOIDEA.															
BRACHIOPODA.															
Ambocoelia planiconvexa, Bl. sh. M														×	
Chonetes mesolobus, Fe. L. S								×							
Chonetes mesolobus, Calc. sh															×
Chonetes mesolobus, L. S.								×					×		
Chonetes mesolobus, Bl. sh. M														×	
Cleiothyris roissyi, Sh				×											
Derbya crassa, Sh				×											
Derbya crassa, Fe. L. S								×							
Derbya crassa, L. S													×		
Dielasma bovidens, Sh				×											
Orbiculoidea missouriensis, Bl. sh. M	×														
Orbiculoidea missouriensis, Fe. L. S.										×					
Orbiculoidea missouriensis, L. S													×		
Productus longispina, L. S		×													
Productus longispina, Fe. L. S.										×					
Productus longispina, Sh				×											
Productus punctatus, Sh				×											
Productus semireticulatus, L. S													×		
Productus scabriculus, Sh				×											
Pugnax utah, L. S													×		
Seminula argentea, sh				×											
Seminula argentea, L. S.													×		
Seminula argentea, Calc. sh.															×
Spirifer cameratus, Cl. sh				×											
Spirifer cameratus, Fe. L. S.							×	×							
Spirifer cameratus, L. S.													×		
Spirifer cameratus, Calc. sh.															×
Spiriferina cristata, sh.				×											
Spiriferina cristata, L. S.													×		
MOLLUSCA.															
LAMELLIBRANCHIATA.															
Aviculopecten coxanus, Calc. sh.															×
Aviculopecten rectilaterarius, Fe. L. S.								×		×					
Aviculopecten rectilaterarius, Bl. sh. M.														×	
Aviculopecten rectilaterarius, Cl. sh.									×						
Cardiamorphia missouriensis, Fe. L. S.					×										
Cardinia fragilis, Fe. L. S.										×					
Cardinia fragilis, Bl. sh. M.								×							
Pernopecten aviculatus, Fe. L. S.								×							
Solenomya radiata, Calc. sh.															×
GASTEROPODA.															
Bellerophon montfortanus, Fe. L. S.							×								
Bellerophon percarinatus, sh				×											
Euomphalus subrugosus, L. S.													×		
Pleurotomaria carbonarius, Calc. sh.															×
Trachydomia nodosa, L. S.													×		
CEPHALOPODA.															
Orthoceras rushense, Bl. sh. M.								×						×	
Orthoceras rushense, Fe. L. S.					×		×								
PALEOSTRACA.															
ARTHROPODA.															
Phillipsia sangamonensis (?), L. S.													×		
Phillipsia scitula, L. S.													×		
ENTOMOSTRACA.															
Leaia tricarinata, Bl. sh. M.															
PISCES.															
Petrodus occidentalis, Bl. sh.					×			×						×	
Petrodus occidentalis, Fe. L. S.										×					
Petrodus occidentalis, Fe			×												

168. Vigo County.

List of localities—

1. Barrick & Son's mine, Sec. 30-12-9, limestone above Coal VII.
2. Bigelow & Co.'s mine, Sec. 24-12-10, gray clay shale above Coal VII.
3. Coal creek, general section, Sec. 19-13-9, in limestone below Coal VIII.
4. Durkey's Ferry, Sec. 21-13-9, in clay shale over Coal VII.
5. Mr. J. S. Wyeth, at Hartford, Sec. 14-10-9, clay shale over Coal VII.
6. South Fork Otter creek, near Grant Station, in limestone concretions in roof shale of Coal VIa.

Localities	1	2	3	4	5	6
Divisions	VII	VII	VII	VII	VII	VI
PLANTÆ.						
Alethopteris grandifolia, Cl. sh				×		
Alethopteris niagarensis, Cl. sh				×		
Annularia longifolia, Cl. sh					×	
Annularia sphenophylloides, Cl. sh				×		
Calamites canniformis, Cl. sh				×	×	
Cordaites borassifolius, Cl. sh				×		
Cordaites diversifolius, Cl. sh				×		
Cyclopteris elegans, Cl. sh					×	
Hymenophyllites pinnatifidus, Cl. sh					×	
Lepidodendron elegans, Cl. sh				×		
Neuropteris collinsi, Cl. sh				×		
Neuropteris hirsuta, Cl. sh				×	×	
Neuropteris loshi, Cl. sh					×	
Neuropteris rarinervis, Cl. sh				×	×	
Pecopteris arborescens, Cl. sh				×	×	
Pseudopecopteris callosa, Cl. sh				×		
Sigillaria menardi, Cl. sh					×(?)	
Sigillaria obovata, Cl. sh					×	
Sigillaria oculata, Cl. sh					×	
Sphenopteris alata, Cl. sh					×	
Sphenophyllum schlotheimi, Cl. sh				×	×	
Spirangium corrugatum, Cl. sh				×		
Spirangium prendeli, Cl. sh				×		
Trigonocarpum oliviforme, Cl. sh				×		
Trigonocarpum ornatum, Cl. sh				×		
Trigonocarpum triloculare, Cl. sh				×		
Ulodendron punctatum, Cl. sh				×		
MOLLUSCOIDEA.						
Brachiopoda.						
Productus cora, L. S			×			
Productus punctatus, L. S	×		×			×
MOLLUSCA.						
Lamellibranchiata.						
Aviculopecten rectilaterarius, L. S		×				×
Gastropoda.						
Bellerophon carbonarius, Sh		×				
Euomphalus subrugosus, Sh		×				
PALEOSTRACA.						
Leaia tricarinata, Cl. sh				×		
PISCES.						
Petrodus occidentalis, L. S						×

169. Warren County.

List of localities—

1. Rock creek, Sec. 18-21-8, black bituminous limestone, Div. V.
2. Rock creek, Sec. 18-21-8, calcareous iron ore, Div. IV.
3. Main's mill, Redwood creek, Sec. 35-21-9, black limestone, Div. V.
4. Main's mill, Redwood creek, Sec. 35-21-9, carbonate of iron, Div. V.
5. Marshfield Coal Co.'s shaft, Sec. 9-20-9, clay shale, Div. VI.
6. Hooper & Barringer's shaft, Sec. 8-20-9, clay shale, Div. VI.
7. West Lebanon shaft, Sec. 13-21-9, clay shale, Div. VI.
8. Briscoe's Coal Bank, Sec. 29-23-8, clay shale, Div. VII.
9. Pine creek, Sec. 22-22-8, limestone, Div. V.

Localities	1	2	3	4	5	6	7	8	9
Divisions	V	IV	V	V	VI	VI	VI	VII	V
PLANTÆ.									
Alethopteris lonchitica, Cl. sh								×	
Alethopteris serlii, Cl. sh								×	
Annularia longifolia, Cl. sh					×	×			
Asterophyllites equisetiformis, Cl. sh						×		×	
Cardiocarpum ingens, Cl. sh								×	
Cordaites borassifolia, Cl. sh						×	×	×	
Sphenopteris spinosa, Cl. sh							×		
Lepidodendron clypeatum, Cl. sh							×		
Neuropteris collinsi, Cl. sh					×				
Neuropteris hirsuta, Cl. sh					×			×	
Neuropteris rarinervis, Cl. sh					×			×	
Pecopteris arborescens, Cl. sh								×	
Sigillaria reniformis, Cl. sh						×	×		
Sphenophyllum schlotheimi, Cl. sh					×	×	×	×	
Ulodendron punctatum, Cl. sh							×		
CŒLENTERATA.									
Lophophyllum proliferum, L. S			×						
MOLLUSCOIDEA.									
Brachiopoda.									
Chonetes mesolobus, L. S	×		×						
Productus cora, L. S			×						
Productus costatus, L. S		×	×						
Productus costatus, Fe		×							
Productus longispina, L. S			×	×					
Productus semireticulatus, L. S	×								
Reticularia perplexa, L. S	×		×						
Reticularia perplexa, Fe		×							
Seminula argentea, L. S			×						
Spirifer cameratus, L. S	×		×						
MOLLUSCA.									
Gastropoda.									
Soleniscus fusiformis, L. S			×						
Nautilus decoratus, L. S									×
PALEOSTRACA.									
Phillipsia scitula, L. S			×						
PISCES.									
Helodus carbonarius, L. S			×						

170. Warrick County.

List of localities—

1. Beardsley's mine, Sec. 29-3-6, Div. III, black shale overlying Coal IIIb.
2. Miller's mine, Sec. 28-3-7, Div. V, ferruginous limestone over Coal V.
3. Chandler shaft, Chandler, Div. VI, limestone below Coal VII.

Localities	1	2	3
Divisions	III	V	VI
PROTOZOA.			
Lophophyllum proliferum, Bl. sh. M	×	......	......
MOLLOSCOIDEA.			
Brachiopoda.			
Chonetes mesolobus, Bl. sh. M	×	......	......
Productus costatus, L. S	......	×	......
Productus punctatus, L. S	......	×	......
Productus semireticulatus, Bl. sh. M	×	......	......
Reticularia perplexa, Bl. sh. M	×	......	......
Reticularia perplexa, L. S	......	×	×
Spirifer cameratus, Bl. sh. M	×	......	......
Spirifer cameratus, L. S	......	×	×
MOLLUSCA.			
Lamellibranchiata			
Aviculopecten rectilaterarius, Bl. sh. M	×	......	......
Gasteropoda.			
Bellerophon carbonarius, Bl. sh. M	×	......	......
Bellerophon percarinatus, Bl. sh. M	×	......	......
Macrochilina primogenia, Bl. sh. M	×	......	......
Pleurotomaria carbonarius, Bl. sh. M	×	......	......
Soleniscus fusiformis, Bl. sh M	×	......	......
Soleniscus paludinalformis, Bl. sh. M	×	......	......
Cephalopoda.			
Nautilus decoratus, Bl. sh. M	×	......	......
Orthoceras rushense, Bl. sh. M	×	......	......
PISCES.			
Edestus vorax, Bl. sh. M	×	......	......
Petrodus occidentalis, Bl. sh. M	×	......	......

171. Summary Table.

		Division I (and II).	Division III.	Division IV.	Division V.	Division VI.	Division VII.	Division VIII.	Division IX.	Sandstone.	Black Shale, Land.	Clay Shale.	Black Shale, Marine.	Calc. Clay or Shale.	Limestone.	Sheet A.	Sheet B.	Sheet C.	Sheet D.	Sheet E.	Sheet F.	Sheet G.
	PLANTÆ.																					
1	Alethopteris grandifolia Newberry						×					×					×					
2	Alethopteris lonchitica Schlotheim			×		×	×					×				×			×			
3	Alethopteris niagarensis						×					×					×					
4	Alethopteris serlii Brongniart			×	×		×					5				×			×	×		
5	Annularia longifolia Brongniart					×	×					×				×	×	×				
6	Annularia sphenophylloides Zenker						×					×					×					
7	Asterophycus coxi Lesq							×		×										×		×
8	Asterophyllites equisetiformis Schlotheim					×	×					5				×	×	×				
9	Asterophyllites longifolius Sternberg						×					×						×		×		
10	Asterophyllites sublævis Lesq					×						×							×			
11	Calamites canniformis Schlotheim					×	×					×					×		×			
12	Cardiocarpon ingens Lesq						×					×				×						
	Cordaites angustifolius (see 14)																					
13	Cordaites borassifolius Sternberg	×	×	×		×	5	×				12				×	×	×	×	×		
14	Cordaites diversifolius Lesq						×					5					×	×		×		
15	Cyclopteris elegans Lesq						×					×					×					
16	Didymophyllum oweni Lesq							×		×		×										×
	Hymenophyllites alata (see 41)																					
17	Hymenophyllites pinnatifidus Lesq						×					×					×					
	Hymenophyllites spinosus (see 44)																					
18	Lepidodendron clypeatum Lesq	×				×				×		×				×				×		
19	Lepidodendron dichotomum Sternberg	×								×										×		
20	Lepidodendron elegans Sternberg						×	×				×					×		×			
21	Lepidodendron rushvillense Andrews	×								×										×		
22	Lepidodendron veltheimanum Sternberg	×								×										×		
23	Lepidodendron vestitum Lesq	×								×										×		
24	Lepidophloros crassicaulis Corda	×								×										×		
25	Neuropteris biformis Lesq	×								×										×		
26	Neuropteris collinsi Lesq				×	×	×					×				×	×			×		
27	Neuropteris elrodi Lesq	×																		×		
28	Neuropteris hirsuta Lesq	×		×	×	×	7	×			5	17				×	×	×	×	×	×	

SUMMARY TABLE—Continued.

		Division I (and II).	Division III.	Division IV.	Division V.	Division VI.	Division VII.	Division VIII.	Division IX.	Sandstone.	Black Shale, Land.	Clay Shale.	Black Shale, Marine.	Calc. Clay or Shale.	Limestone.	Sheet A.	Sheet B.	Sheet C.	Sheet D.	Sheet E.	Sheet F.	Sheet G.
29	Neuropteris loshi Brongniart					×	×				×	×					×	×	×		×	
30	Neuropteris rarinervis Bunbury				×	×	5	×				10				×	×	×		×		
31	Palæophycus milleri Lesq							×							×							×
	Paleoxyris (see 46, 47).																					
32	Pecopteris arborescens Schlotheim				×	×	7					10	×			×	×	×	×	×		
	Pecopteris callosa (see 33).																					
33	Pseudopecopteris callosa Lesq						×					×					×					
34	Pseudopecopteris latifolia Brongniart	×								×										×		
35	Pseudopecopteris muricata Brongn	×								×										×		
36	Sigillaria menardi Brongn						×					×					×		×			
37	Sigillaria obovata Lesq						×					×					×					
38	Sigillaria oculata Schlotheim						×					×					×					
39	Sigillaria reniformis Brongn					×	×					5				×		×	×			
40	Sphenophyllum schlotheimi Brongn	×				×	8				×	15				×	×	×	×	×		
41	Sphenop·eris alata Brongn						×					×					×					
42	Sphenopteris crenata Lindley and Hutton			×								×				×						
43	Sphenopteris hoeninghausi Brongn	×								×										×		
	Sphenopteris latifolia (see 34).																					
44	Sphenopteris spinosa Goeppert					×						×				×						
45	Sphenopteris tridactylites Brongn	×								×										×		
46	Spiranginum corrugatum Lesq						×					×					×					
47	Spiranginum prendeli Lesq						×					×					×					
48	Stigmaria ficoides Brongn						×					×						×				
49	Syringodendron pachyderma Brongn						×					×						×				
50	Syringodendron porteri Lesq								×	×						×						
51	Trigonocarpum oliviforme Lindley and Hutton		×				×			×		×					×			×		
52	Trigonocarpum ornatum Newberry						×					×					×					
53	Trigonocarpum triloculare Hildreth						×					×					×					
54	Ulodendron punctatum Lindley and Hutton					×	×					×				×	×					
55	Ulodendron minus Lindley and Hutton	×								×										×		
	PROTOZOA.																					
56	Fusilina cylindrica Fischer				×			×							×	×		×				

		Division I (and II).	Division III.	Division IV.	Division V.	Division VI.	Division VII.	Division VIII.	Division IX.	Sandstone.	Black Shale, Land.	Clay Shale.	Black Shale, Marine.	Calc. Clay or Shale.	Limestone.	Sheet A.	Sheet B.	Sheet C.	Sheet D.	Sheet E.	Sheet F.	Sheet G.
	CŒLENTERATA.																					
57	Campophyllum torquium Owen							×							×							×
58	Chetetes milleporaceus Edwards and Haime					×									×					×		
	Cyathaxonta prolifora (see 59).																					
59	Lophophyllum proliferum McChesney		×		7	×		5					×	5	10	×	×	×	×	×	×	×
	ECHINODERMATA.																					
60	Eupacyorinus tuberoulatus Meek and Worthen				×										×	×						
	MOLLUSCOIDEA.																					
	BRACHIOPODA.																					
61	Ambocœlia planoconvexus Shumard				×								×			×						
	Athyris roissyi (see 65).																					
	Athyris subtilita (see 85).																					
62	Chonetes granulifer Owen				×										×		×		×			
63	Chonetes mesolobus Nor. and Prat		×		18	×		5					×	×	24	×	×	×	×		×	
	Chonetes smithi (see 62).																					
64	Chonetes verneuilianus Nor. and Prat							×					×									×
65	Cleiothyris roissyi L'Eveillé					×						×				×						
66	Derbya crassa Meek and Hayden				×	×		×				×		×	5	×	×		×			×
67	Derbya robusta Hall				×										×			×				
68	Dielasma bovidens Morton					×		×				×			×	×		×				×
	Discina convexa (see 71).																					
	Discina nitida (see 72).																					
	Hemipronites crassus (see 70).																					
	Hemipronites crenistria (see 70).																					
69	Lingula spatulata Vanuxem							×							×			×				
70	Lingula umbonata Cox	×				×						×	×							×	×	
71	Orbiculoidea convexa Hall							×							×			×				
72	Orbiculoidea missouriensis Shumard				×	×	×	×					×		×	×		×		×		
	Orthis carbonaria (see 84).																					
	Orthis pecosi (see 84).																					
	Orthis umbraculum (see 67).																					
73	Productus carbonarius de Konniek				×										×			×				
74	Productus cora d'Orb		×		11		×	×						×	14	×	×	×	×			
75	Productus costatus Sowerby (?)			×	7	×		×						×	11	×	×	×	×	×	×	×
76	Productus longispina Sowerby (?)				16	×	×	9				×		6	21	×	×	×	×			×
77	Productus muricatus Norwood and Prat					×									×	×						
78	Productus nebraskaensis Owen				×										×	×						
79	Productus punctatus Martin		×		9	×	×	5				×		×	18	×	×	×	×	×	×	×
	Productus rogersi (see 78).																					
80	Productus scabriculus Martin					×						×				×						
81	Productus semireticulatus Martin		×		15	×		5					×	×	21	×	×	×	×	×	×	×
	Productus wabashensis (see 76).																					
82	Pugnax utah Marcou				×			×						×	×	×			×			×
83	Reticularia perplexa McChesney		×	×	6	×		10					×	×	20	×	×	×	×	×	×	×

SUMMARY TABLE—Continued.

No.		Division I (and II).	Division III.	Division IV.	Division V.	Division VI.	Division VII.	Division VIII.	Division IX.	Sandstone.	Black Shale, Land.	Clay Shale.	Black Shale, Marine.	Calc. Clay or Shale.	Limestone.	Sheet A.	Sheet B.	Sheet C.	Sheet D.	Sheet E.	Sheet F.	Sheet G.
84	Rhipidomella pecosi Marcou				×	×		×						×	×		×	×	×		×	
	Rhynchonella osagensis (see 82).																					
85	Seminula argentea Shephard				7	×		9				×	×	×	16	×	×	×	×	×		×
86	Spirifer cameratus Morton		×		17	6	×	6				×	×	×	28	×	×	×	×	×	×	×
	Spirifer lineatus (see 83).																					
	Spirifer planoconvexus (see 61).																					
87	Spiriferina cristata Schlotheim				×	×		5				×		×	7	×		×	×			×
	Spiriferina kentuckyensis (see 87).																					
	Terebratula bovidens (see 68).																					
	MOLLUSCA.																					
	LAMELLIBRANCHIATA.																					
88	Aviculopecten coxanus Meek and Worthen				×									×		×						
89	Aviculopecten providensensis Cox				×									×	×			×	×			
90	Aviculopecten rectilaterarius Cox		×		×	5	×	×				×	5	×	×	×	×	×			×	
91	Cardiomorpha missouriensis Shumard					×		×					×		×	×						×
92	Cardinia fragilis Cox				×	×	×	×					×	×	×	×	×	×				
	Entolium aviculatum (see 98).																					
	Leda bellistriata (see 97).																					
93	Macrodon carbonarius Cox					×						×				×						
94	Monopteria longispina Cox							×				×				×						
95	Myalina perniformis Cox					×							×			×						
96	Nucula inflata				×			5					×	×	×			×	×			×
97	Nuculana bellistriata Stevens				×			×					×	×	×		×	×				×
98	Pernopecten aviculatus Swallow					×		×					×		×	×						×
99	Solenomya radiata M. and W				×									×		×						
	SCAPHOPODA.																					
100	Dentalium sublæve Hall							×							×			×				
	GASTEROPODA.																					
101	Bellerophon carbonarius Cox		×		10	×		7					×	5	13	×	×	×	×	3	×	×
102	Bellerophon montfortanus Nor. and Prat				×	×		5					×	×	6	×		×	×			×
103	Bellerophon percarinatus Conrad		×		×	×		×				×	×	×	×	×		×	×		×	×
104	Euomphalus subrugosus M. and W				×		×					×			×	×	×					
	Euomphalus rugosus (see 104).																					
	Macrocheilus fusiforme (see 111).																					
	Macrocheilus gracile (see 105).																					
	Macrocheilus paludinæformis (see 112).																					
	Macrocheilus primigenium (see 106).																					
105	Macrochilina gracilis Cox							×							×			×				
106	Macrochilina primogenia Conrad		×					×					×		×						×	×
	Naticopsis nodosa (see 113).																					
107	Pleurotomaria carbonaria Nor. and Prat		×		×			×					×		×	×		×			×	×
108	Pleurotomaria grayvillensis Nor. and Prat					×		×					×				×					×
109	Pleurotomaria sphærulata Conrad							×					×	×	×							×
110	Pleurotomaria tabulata Conrad							×					×	×	×			×				×
111	Soleniscus fusiformis Hall		×		×								×		×	×					×	
112	Soleniscus paludinæformis Hall		×										×								×	
113	Trachydomia nodosum M. and W					×									×	×						
	CEPHALOPODA.																					
114	Nautilus decoratus Cox		×		×	×		5					×	×	6	×	×	×		×	×	
115	Orthoceras rushense McChesney		×		10	5		×					7	×	8	×	×	×	×	×	×	
	ARTHOPODA.																					
	CLASS CRUSTACEA.																					
	PALEOSTRACA.																					
116	Euproops danæ M. and W					×						×							×			
117	Phillipsia bufo M. and W			×										×	×	×						
118	Phillipsia sangamonensis, M. and W																					
119	Phillipsia scitula M. and W			×	×			×						×	×	×	×		×			
	ENTOMOSTRACA.																					
120	Leaia tricarinata M. and W						×					×					×					
	INSECTA.																					
121	Paoli vetusta S. I. Smith	×								×										×		
	PISCES.																					
122	Edestus vorax Leidy		×										×								×	
123	Helodus carbonarius Newberry and Worthen				×										×	×						
124	Petrodus occidentalis N. and W		×		×	5	×	×					10		×	×	×	×		×	×	×

XII. GENERAL STRUCTURE OF THE INDIANA COAL FIELD.

172. Minor Structure.—Visiting any point in the coal field where the bedded rocks are exposed it would appear at first sight that the rocks lie perfectly horizontal. Of course, a few places might be visited where very limited exposures will reveal a marked inclination or dip of the strata, but this is not usual. However, if the exposure visited is of considerable extent, or if an extensive exposure be visited and examined for several hundred yards or a larger part of a mile, it will become evident that perfect horizontality is the exception rather than the rule, and that while the inclinations can hardly be compared with the surface slopes, yet at almost every point there is sufficient inclination for water to run down readily. Extensive examinations of that kind show that while there is a preponderance of southwestern dips, yet locally the dips are liable to be in any direction. This is illustrated in Fig. 21, where the outcrop of an 8-ft. coal bed is shown in

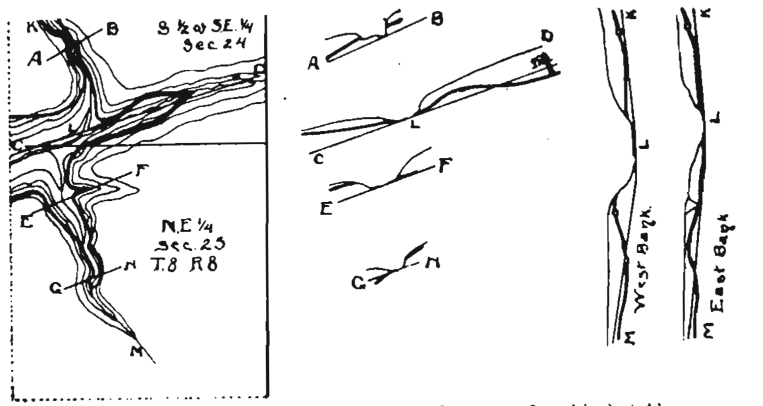


Fig. 21. Sketch map and sections showing local flextures of coal bed at Alum cave, Sullivan county.

its relation to 5 (?) ft. contours and its foldings in the different directions shown by the cross sections. Much the same thing would be seen if contour maps were made of any of the coal beds in any of the large mines. In the block coal field, of course, the original basin structure of the coal beds largely remains and renders a cross section of one of the beds, taken for any distance, to appear like a succession of waves. In the higher coals these irregularities are due to the latter movements, largely due, it is supposed, to irregular settling.

It is interesting to note that the larger folds have in many cases had a decided effect in determining the surface topography. This will be first observed by noting that in such cases a particular coal bed or rock stratum is observed to maintain approximately a given position relative to a stream, and that this will often be found to be true of streams flowing down the opposite sides of a hill, indicated anticlinal structure in the hill. While it would hardly be a safe rule to say that in this area the subdrift topography is governed by the structure, yet it seems safe to say that a large number of the principal divides and many of the minor ones are slightly anticlinal in structure. It is to be regretted that time and opportunity did not permit the determining instrumentally of the level of a sufficient number of points to have worked out somewhat in detail the system of folds of the second order, counting the little local folds figured above as of the third order. While the barometer was used to some extent in the work, it was found that with the method of work followed it could not be relied on sufficiently to be of any value in this connection. The few railroad levels obtainable are given on the maps and serve as a basis for determining the folding of the second order. In addition many suggestions as to the structure are obtained by assuming a uniform rate of fall for the larger streams and noting the relative position of given strata to the stream level at different points.

173. Major Structure.—A glance at the cross sections accompanying the colored maps will suffice to show that the structure of the first order is monoclinal. That is, the strata here are part of the western limb of what is known as the Cincinnati arch, or they may just as well be considered as part of the eastern slope of the Illinois basin or syncline. A generalized section of the strata from east to west along the fortieth parallel will show the position of the Indiana coal fields relative to the main structural features of the Eastern United States. See Fig. 22.

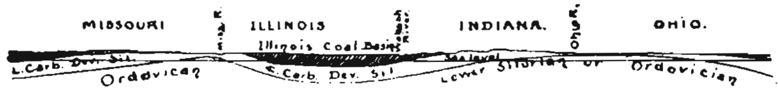


Fig. 22. Sketch of section along 39° N. lat., showing relative position of Illinois coal basin

174. General Strike.—As it is easiest to determine the direction of dip by determining the strike, we will first determine that. If southwestern Indiana were a level plain it would be easy to find the direction of strike by noting the direction of outcrop. As a matter of fact that part of the State is far from a level, so that coals that out-

crop at levels but a little over 300 ft. on the Ohio river have to reach over 600 ft. before they can be exposed in northern Warren county. Nevertheless there is one case in which that method can be used. If the eastern outcrop of the coal measures (Division I) be traced on a topograph map of Indiana, such as that compiled by Mr. Frank Leverett* it will be noted that it overlaps at a number of points the 800 ft. contour. It was suggested in a former chapter that these levels reached by the highest points of the Mansfield sandstone are parts of a tertiary (?) base level. It will be noted that Division I reaches 800 ft. or a little over east of Taswell in Crawford county; on the divide between Lost river and Patoka river in Orange county; on the divide between White river and Lost river in southeastern Lawrence county; at several places on the divide between the east and west forks of White river in northern Martin county, northeastern Greene county and southeastern Owen county. It again reaches 800 ft. on the divide between Eel river and Raccoon creek in northwestern Putnam county and between Raccoon and Sugar creeks in northeastern Parke and southwestern Montgomery counties. From there northwest to where the coal leaves the State the elevation is reduced by the erosion of the Wabash valley, which there enters from the northeast. Next, if a line be drawn connecting the points where the line of outcrop reaches 800 ft. it will be found to have a general direction of about N. 12½ degrees W. Of course this direction will not be maintained across the valleys of the Wabash or the Ohio at either end, where the general level has been greatly reduced, and the principal becomes inoperative. Another method of determining the strike consists in connecting points where certain selected strata reach the same altitude regardless of whether they outcrop or not. This method can be used also, regardless of the topography. To secure the result sought by this method the approximate elevations of the different coals were placed on a large State map, much as they are given on the colored sheets, and wherever the same bed was found to have approximately the same elevation at two points lines were drawn connecting these points. While, as might be expected, the lines so drawn are found to vary by as much as 20 degrees, or even more for the shortest lines, yet there is found to be an unexpected agreement between the longer lines. Without going into details, it may be said that this method gave the following results: From the northern outcrops to the Terre Haute and Indianapolis railway the strike is a little over 10 degrees west of north; from there to the Baltimore and Ohio Southwestern railway the strike is a little under

* 18th Ann. Rep. U. S. Geol. Surv., Part IV, Pl. XXXIII.

10 degrees west of north, making about an average of N. 10 degrees W. to this point. From this point to the Air Line railroad the strike is nearly north and south, while from the Air Line railroad to the Ohio river the strike appears to be a few degrees to the west of south. In further studying the results an interesting fact is brought out, that is the difference due to the thickening of the measures to the south. Thus, it will be observed that Division I continues an east-of-south strike as far south as Crawford county, beyond which the valley of the Ohio and lack of ascertained levels prevent the determining of its strike. But on going to the west it is quickly observed that the lines representing the higher coals have a more nearly north and south strike, with a west-of-south strike appearing as far north as Daviess county, so that for the upper coals, lines drawn from Vigo and Clay counties to Warrick and Vanderburgh counties average about due north and south. From Daviess and Knox counties to the Ohio river there is a decided west-of-south strike.

175. THE DIRECTION OF DIP.—If these figures be converted into direction of dip, the results may be summarized as follows:

Division I. Along whole outcrop, average of dip	S. 77½° W.
Divisions I-IV. Sheet A	S. 78° W.
Divisions I-IV. Sheets B, C and D	S. 82° W.
Divisions I-IV. Sheets D and E	W.
Divisions I-IV. Sheets E and F	N. 88° W.
Divisions V-VIII. Sheets A and B	S. 86° W.
Divisions V-VIII. Sheets B to F	W.
Divisions V-VIII. Sheets D to F	N. 80° W.+

These figures give evidence of the basin-like character of the slope.

176. THE AMOUNT OF DIP.—By referring to the figures given in the rectangles, it becomes possible to estimate the dip at various points. In the following table are grouped the figures indicating the dip at a number of places. It will be understood that the farther apart are the points considered the more nearly does the dip so obtained represent the general or average dip, but on the other hand there is much greater liability of error arising from mistakes in correlation. As the lower coals are seldom sought by deep shafts or recognizable with certainty where passed through in deep boring, the figures obtained are more characteristic of the area underlain by the upper or more workable coals than of the whole area, and probably give a little too high an average.

Points Compared.	*Coal.*	*Elevations.*		*Total Dip.*	*Mi.*	*Dip in Ft. Per Mi.*
Williamstown to West Lebanon	V	625	— 575	= 50	÷ 5	= 10
Stone Bluff to Covington	IV	625	— 530	= 95	÷ 8	= 11
Yeddo to Silver Island	V	650	— 500	= 150	÷ 9	= 15+
W. Montezuma to Illiana	VII	600	— 485	= 115	÷ 7½	= 16+
Coxville to S. W. of Clinton	VI	530	— 300	= 230	÷ 6	= 38+
Wicksville to Lodi	IV	620	— 440	= 180	÷ 5	= 36
Coal Bluff to Grant	VI	550	— 435	= 115	÷ 5	= 23
Grant to W. Terre Haute	VII	515	— 450	= 65	÷ 10	= 6+
Harmony to Terre Haute	IV	625	— 200	= 425	÷ 20	= 21
Stanton to Terre Haute	VI	600	— 300	= 300	÷ 12	= 25
Stanton to Seeleyville	VI	600	— 485	= 115	÷ 4½	= 23+
Brazil to Seeleyville	IV	570	— 370	= 200	÷ 8½	= 24
Cory to Riley	VIa	600	— 525	= 75	÷ 5	= 15
Middlebury to Farmersburg	VI	640	— 375	= 265	÷ 14	= 18—
Three-quarter miles east to Farmersburg	VI	450	— 375	= 75	÷ ¾	= 100
Five miles east to Farmersburg	VII	573	— 413	= 160	÷ 5	= 32
Hymera to Currysville	VI	525	— 280	= 245	÷ 5	= 49
Shoals to Mt. Pleasant	I	460	— 475	= —15	÷ 5	= —3
Washington to Vincennes	VI	484	— 34	= 450	÷ 20	= 22+
Edwardsport to Vincennes	V	460	— (—30)	= 490	÷ 18	= 27
Petersburg to Princeton	V	375	— 100	= 275	÷ 20	= 18
Oakland to Princeton	V	350	— 400	= 250	÷ 12	= 20
Francisco to Princeton	VII	415	— 258	= 157	÷ 7	= 28—
Ayrshire to Oakland	V	450	— 350	= 100	÷ 5	= 20
Taswell to Huntingburg	II	800	— 456	= 344	÷ 24	= 14+
Boonville to Evansville	V	440	— 125	= 315	÷ 20	= 16—
Chandler to Evansville	V	367	— 125	= 242	÷ 11	= 22
Tennyson to Evansville	IV	464	— 24	= 440	÷ 27	= 16

The dips will be seen to run from 100 ft. to the mile down, averaging per mile about 24 ft. A study of the sections shows that the dips in the western part of the field appear to be higher than those in the eastern part, but the suggestion also comes that this may be largely due to what appears to be a sharp monoclinal fold to the west along a line just east, in a general way, of the E. & T. H. and C. & E. I. R. R. It shows itself most clearly in southern Vermillion and Parke counties and northern Sullivan county. It is probable that fuller data would show an average dip of less than 20 ft.

Examining the data for evidence of folds transverse to the strike, it is of interest to note the elevations of Coal VI in a north-and-south line from Newport to Sullivan: Newport, 500 ft., Alta 500, Geneva 400, S. W. of Clinton 300, Terre Haute 300, Hartford 380, Farmersburg 373, Currysville 280, Shelburn 275, Sullivan 275. These figures give evidence of a syncline in northern Vigo county and an anticline in southern Vigo. The anticline in southern Vigo county would appear to correspond with an obscure anticline in eastern Clay county south of Bowling Green, but in western Clay county a syncline seems to come between. This is best seen by comparing Coal VI along the E. & T. H. R. R. and Coal V 10 miles to the east. At Currysville Coal VI is 280 ft. above tide; going north to Farmersburg and Hartford, it rises to 373 and 380 ft., respectively. Ten miles east of Currysville Coal V is not far from 600 ft. above tide, being nearly up to the top of the divide between Eel river and the Wabash. Going north to the mouth of Splunge creek, about opposite Hartford, it is found to have descended almost to the level of Eel river, or to a level of about 530 ft. above tide. Evidence of this rapid north dip is not wanting in the northeastern corner of Sullivan county. Many other apparent anticlines were found, mostly small, but indicated by the relation to the drainage; but no attempts to trace out such folds were successful. Not that the folds are not there, or, being there, can not be traced: for I am confident that when an accurate topographic map of the coal area shall have been made, but little difficulty will be experienced in finding and establishing probably a very interesting series of folds. Much could be done with a proper equipment of barometers, aided by a system of lines run with the transit.

Attention was called, in Part I, to the abundance of micro-structural features, faults, etc. The attempt to reduce these to a system was not successful. As stated there, while a majority of the faults noticed generally approach the strike in direction, the number of exceptions is too large to admit of making any rule in regard to the direction of the fault line. In the same way the direction of downfall is so variable that no rule can be given, though it is thought that the majority downthrow in the direction of the dip. It may be possible, in places of unusual change of level, generally assigned to dip, that faulting is responsible for much of it. This is known to be true in one or two cases.

The theory has already been expressed elsewhere that the basin structure of the lower coal is due largely to the irregular surface upon which the coal measures were laid down, this being an erosion surface, but that as deposits gradually filled up these inequalities, a given earth movement would produce a given result with greater and greater uniformity and over increasing areas, until in the time of Divisions VI, VII and VIII similar conditions would exist simultaneously along most or all of a belt of surface entirely crossing the southwestern part of the State, so that coals and limestones especially can be traced continuously for 150 miles.

In connection with the basin character of the lower coals, one suggestion that came as a possible explanation of the block structure of those coals was that it was due to the increased length the top of the bed has, when compressed into the form of an arc or basin, over its length before compression as the chord of the same arc. While the theorum was not proven, it neither appeared to be disproven.

XIII. DISTRIBUTION OF WORKABLE COALS.

177. Sheet A.—Turning to Sheet A of the geological map, the area shaded to represent the outcrop of Division I contains no commercially workable coal. Toward the southern end of this area some coal occurs that may be worked for local trade.

In Warren county workable coal is found on Fall creek, northwest of Williamsport. The data indicates an area of several square miles, and possibly much more; Coal V is the main coal. Considerable coal has been dug on the east side of Kent township, northwest of Covington, but the coals are thin, as a rule. Coals V, VI and VIa underlie most of western Warren county and doubtless are workable in places. As, however, they are 100-200 ft. deep, and overlain by a very heavy mantle of drift, and as the drillings so far made have failed to find them of workable thickness, it is difficult to predict how much, if any, of them are workable. Developments here will be apt to be slow.

In Fountain county workable coal is found along the C. & I. C. Railroad, from Stone Bluff to Veedersburg (Coal IV). This basin may have considerable extent, but the coal is apt to run under a workable thickness over much of it unless the shale overlying it is taken at the same time. As this shale is an excellent brick shale, its presence may render much of this coal workable that would otherwise be considered too thin. Little or nothing is known of the coal west and northwest of Veedersburg, but there is probably no small amount of workable coal there. East of the C. & I. C. R. R. (C. & E. I. R. R.) there appears to be no workable coal known as far south as Stean Corner P. O. Around Yeddo there appears to be a basin of 5-ft. coal (Coal V), amounting to several thousand acres, extending especially to the south. Four miles east of Kingman the same coal is also workable. Whether this is part of the basin at Yeddo is not known. If it is, there is a large body of coal there. Probably the best basin in the county lies in the southern part of Wabash and northern part of Fulton of the civic townships. Coal IV, there, for several square miles runs from 5 to 7 ft. thick. A few hundred acres have been worked out around Coal Creek P. O. (Snoddy's Mills). Exposures along Prairie creek show up to 7 ft. and over of coal, though not all workable. Considering the quality, thickness and geographical position of the coal, this is one of the best undeveloped fields in the State.

East, west and northwest of Silverwood appears to be a considerable body of Coal V, running up to 7 ft. thick. This appears to underlie a

large part of what is called Silver island. Quite a little of the south end has been or is being worked out. A large sandstone-filled channel cuts off this area from the area to the north. It would appear as though considerable workable coal might yet be found within 2 or 3 miles of Cate's Station. Probably little or no workable coal will be found in this county below the level of the Wabash river, and, as a general rule, if a drilling does not strike coal within 100 or 150 ft., it will be useless to go farther. Something should be added if a drilling is started on high ground.

Montgomery and Putnam counties appear to contain no workable coal.

Parke county shows a square mile or more of good block or semi-block coal on Sugar Mill creek, west of Grange Corners (Coal IV). Along Sugar creek the coal is very pockety, reaching 5 ft. in places, but liable to be of very limited extent. It may be that drilling will show some of these pockets to be well worth developing. Meager reports indicate little of value in Liberty township. Many workable pockets and probably some extensive basins will no doubt be found here. A small basin of excellent semi-block coal is being worked on Sand creek, in the southern part of Washington township. The rest of the township has not yet shown much coal. Penn and Reserve townships probably contain some basins of workable coal, though as yet not well located or defined. Adams township has some workable coal basins on Williams creek, and south (Coal V), and pockets of coal up to 5 ft. in thickness in the south and southeast part. Wabash county has, about Mecca, and possibly over a large area, Coals IV and III workable. These are 50 to 75 ft. below Raccoon creek. Some small pockets of Coal VI, up to 6 ft. thick, exist here, but are probably of too limited extent.

Coals III and IV, of true block character, are being worked extensively in the southwestern part of Jackson and southeastern part of Raccoon townships. Sec. 35 of T. 14 N., R. 7 W., is at present furnishing more coal than any other square mile in the State. A small basin of coal around Minshall (Coal V ?) appears to have been worked out. Some of the same coal bed is workable north of Raccoon creek. Some coal in the northeastern part of Raccoon township may be worked, but it is thin. Workable coal should be found in the southwestern part of the township. Coals III and IV are deep in Florida township. They may prove workable over part of this area, but have hardly been found so as yet. Coals VI and VII may be considered workable over most of the area shaded for their outcrop.

Only a very small amount of drilling has been done in this county, but the stream exposures and mines indicate that over the area shaded for the outcrops of Divisions V to III the coals are pockety, lying in small basins of workable thickness, and these basins separated by areas of unworkable coal, the latter areas exceeding in extent the basins of workable coal. Future drilling will probably reveal much more workable coal than is now known, perhaps many times as much. Workable areas of Coals V, IV and III occur under the area of outcrop of Coal VI. Coal VI can hardly be counted workable in Ts. 15 and 16 N. The lowest workable coals will not be over 250 ft. below the level of the Wabash, in the southwestern corner, none below the level of the Wabash, in the northwestern corner, and little, if any, below the main drainage, in the eastern part of the county.

Going south, in Vermillion county, the first workable coal known is in the neighborhood of the Big Vermillion river, northwest of Eugene (Coals VI and VIa). From there south Coal VI is pockety and not usually workable until Norton's creek is reached. Coal VII is workable around the horseshoe, on the Little Vermillion river, west of Newport. It appears to be more or less continuously workable from there south under the area of its outcrop when not removed by preglacial erosion or overlain by too thin a roof. North of Highland several factors interfere somewhat with its workability. There seems some probability of the lower coals proving workable about Highlands, Coal III (?) having a thickness of 4 ft. there. Clinton township appears to have Coals VIII, VII and VI, all workable within their limits of outcrop.

No coal should be found in this county below sea level, and in the northern part no workable coal need be looked for much below 500 ft. above sea level.

178. Sheet B.—No commercially workable coal has been found in the southern part of Putnam county nor in Owen county, except in the southwestern corner, in Marion and Jefferson townships. Here Coals III and IV are generally workable, attaining a thickness of 6 ft. in places. In the east of these townships they occur in the tops of the hills, but are at or below the general drainage before the county line is reached. The stream valleys cut out the coal over a large share of the area, yet there is left one of the largest unmined basins of block coal in the State. The coal here lies in smaller pockets or basins than about Brazil, thus yielding a larger area of unworkable coal for a given area underlain by the coal bed.

Clay county has had a fine basin of block coal northeast of Brazil, but the known bodies of this coal here are rapidly being worked out. There is probably quite a little coal in the northern part of Van Buren township unworked. West and northwest of Brazil there appears to be a good body of semi-block coal undeveloped. Coals III and IV are being extensively worked along the Big Four, in the northwestern corner of the county, and this area will probably be the most active mining region in Clay county for some time. Coal IV is 130 ft. deep at Lodi.

Cass township has no workable coal. Coal III, and to a less extent Coal IV, have been much worked in Jackson township. There appear to be still some considerable bodies of coal here, but shallow, and not always workable on that account. Posey township has contained a large body of Coal VI along the T. H. & I. Ry.; this is nearly worked out between Staunton and Turner, but is still unworked west and southwest of Staunton. Coals III and IV were workable along part of the east side of this township, but are now nearly worked out.

Washington township contains little or no workable coal. Considerable block coal is found in Sugar Ridge township (Coals III and IV), but much of it will have too poor a roof to work, as the beds are usually quite shallow. They are cut out along the bottoms of Eel river and Birch creek. Perry township doubtless contains considerable workable coal, though present data indicates a thickness inferior to that of coals north or east.

Harrison township contains a large body of unworked block coal. This is a continuation of the Owen county block coal field, though the coals here are thinner, as a rule. A belt of land from 1 to 4 mi. wide following Eel river seems to contain no coal. A small basin of Coal VI exists in the hill at Middlebury. It is thick, but of poor quality.

Coal IV seems to be workable under much of Lewis township, running up to 6 ft. in places, but generally barely workable. Toward the southwestern part of the township Coal V is of good thickness, and is extensively worked from just across the Sullivan county line.

In Vigo county Coal VI is the principal coal. It is above drainage and outcrops along the eastern edge of Nevins township, but west of that line, except where preglacial erosion has removed it or its roof, it appears to be workable under all of Nevins, Otter Creek, Lost Creek and Harrison townships, having a thickness of from 5 to 7 ft. Coal IV is workable along the eastern edge of Nevins township, but it is probable that the coals below Coal VI in the area mentioned are not workable. Coal VII is workable over a large part of Lost Creek township, with a thickness of from 3 to 5 ft. In Riley and Pierson townships Coal VII is workable in places, running up to 6 ft. Coal VIb is workable at Riley's, 3 miles south, and possibly over a considerable area over which Coal VI is little known, appearing to be thin over part of the area at least, though probably workable over part or possibly much of the area. In Honey Creek and Linton townships Coals VII and VI are workable—VII only under the upland. The data are too meager to indicate whether the coals are workable wherever they are to be found, but probably there is here a large area of workable coal.

In Fayette and Sugar Creek townships Coal VII is the principal coal yet developed. The little evidence obtained indicates that Coal VI, lying 150 ft. below the river, is workable over most, if not all, of this area. Coal VII is workable under nearly all of it, and Coal VIII is workable under a large part of the northern half of this area.

In Prairieton and Prairie Creek township all the workable coals are below drainage, and little is known concerning them. Coal VI is probably below 300 ft. above sea level in this area, and the bottom of the coal measures at or below sea level.

179. SHEET C.—In Greene county there is very little, if any, commercially workable coal east of White river. The coals there occasionally reach a workable thickness, but at such times the area is so limited that, while they will serve well for local trade or for local industries, they can not compete with outside coals. In times past some extensive mining has been done near Owensburg on 20-in. beds. Good coal is also found a few miles east of Bloomfield. All the coal in this part of the area is above drainage, to the east rising so as to be from 100 to 250 ft. above adjacent valleys.

West of White river no coal should be looked for in the extensive prairies or former marshes that are so extensively found there. Coal of a workable thickness underlies most of the upland of Jefferson, Smith, Fairplay, Grant and Washington townships, but other conditions, as poor roof, etc., will prevent the working of much of it. Coals III and IV occur here. In Wright township Coal V appears to underlie all of the western two-thirds except the stream channels, being generally above drainage. It is of excellent thickness, good roof, etc., but appears to be of such poor quality as to require special treatment before marketing. Coal IV is found workable in the eastern side of the township, and it is thought will be found to be workable under most of the township. It is an excellent coal. In Stockton township Coals VII and VI just lap the western edge. Coal V occupies a considerable area northwest of Linton, as shown on map, and a strip along the western side of the township. It is thick, but appears to be of variable quality. Coal IV underlies most of the township. It is cut out by the marsh-like prairies at the east, with much roofless coal adjacent, and west of a line passing just west of the Buckeye and Summit mines, it splits so as to lose much of its workability. Between these east and west limits it is from 5 to 6 ft. thick, of excellent quality, and altogether one of the best coals to mine in the State. That it is being extensively worked may be judged when it is stated that for several years the small area three miles long by a mile wide has been furnishing nearly 500,000 tons yearly, and in 1897 employed more men than any other whole county, except Clay. It is probable that this area shipped over one-eighth of all the coal shipped by rail from the Indiana mines. The undeveloped coal in this bed lies north and northwest of Linton. In Stafford township Coals VII, VI, V and IV are found in the southwest half, with probably considerable workable coal. It will require further prospecting here to settle which of the coals are workable and to what extent.

Sullivan county appears to contain workable coal under every foot of it, and over much of it two or three workable beds. Coal VIII reaches a workable thickness over parts of the western half of the county, especially at Merom and along Turman's creek, but in general should be counted as not workable. Coal VII is above drainage and outcrops in the eastern edge of the county, but west of that appears to be continuous from 3 to 6 ft. thick. Forty feet below it is Coal VI, from 5 to 8 ft. thick, except in the northeastern corner of the county, where it runs thin. This coal appears to be continuous within its outcrop over the eastern two-thirds of the county. Whether it continues workable over the western part of the county is not known, but it is thought that it does to a large extent. Coal V is from 6 to 9 ft. thick along much of the eastern edge of the county. It appears to thin to the west. One or two workable coals are reported at still lower levels. In vertical position Coal VI is about at drainage along the eastern edge of the county, about 250 to 275 ft. deep in the center of the county and 200 to 300 ft. below the Wabash river along the western edge of the county. The bottom of the coal measures is probably not less than 300 ft. lower still.

180. SHEET D.—In Martin county the workable coal is very limited. There is a strip along the divide between Boggs creek and Indian creek, where Coals I and III are workable in many places, but with usually a very limited extent. South of White river and west

of Shoals appears to be a body of Coal I of excellent quality, provided enough of it prove to be of workable thickness.

South of Shoals, in Sampson Hill, is a limited body of Coal III, of excellent quality. Still smaller areas of the same coal are found in the hilltops in the southeastern corner of the county. Small areas of Coal III of workable thickness occur a few miles north of Loogootee, and in the southwestern part of the county, and others may be found around Burn City.

In Daviess county there appears to be almost no workable coal in the northern tier of townships. A body of Coal III of good quality is found around Ragglesville. Enough is known to indicate at least two or three square miles of workable coal, and there may be much more. Around Epsom and to the southeast Coal IV is generally of workable thickness, and it is probable that 3 ft. of coal underlies a large percentage of Bogard township and doubtless underlies parts of Steele township.

Barr township, containing both the cannel coal (Coal III) around Cannelburg and Coal IV to the west of Montgomery, is probably more than half underlain by workable coal, and in many parts both the coals mentioned will be workable.

Much the same conditions prevail in Harrison and Reeves townships, except that Coal III contains no cannel there and both the coals are somewhat reduced in thickness.

In Washington township an excellent, though limited, body of Coal VI, lying east, south and northeast of the city of Washington, has been practically exhausted. Present workings are on a body of Coal V of good thickness, lying northwest and southwest of Washington.

In Veale township, though Coal V is over 7 ft. thick at Murry switch, the township as a whole appears to contain but little if any workable coal.

In Knox county Coal VII, though thin, might be classed as workable under the larger part of the county. It is worked at Vincennes at depths of from 350 to 400 ft. and is worked a little at numerous points along its eastern outcrop in the eastern part of the county. Coal VI is a thick workable coal around Edwardsport and Bicknell, and while it appears to thin out in the southeastern part of the county, it would seem probable that it is workable under much of the northern and western parts of the county. Coal V is workable west of Sanford, and near Edwardsport, also near Wheatland, but in general little is known of it, and it is likely it will be found to thin to the west. The known workable coal is nearly all above the level of White river along the eastern edge of the county, but is over 350 ft. deep along the western edge. From the data obtained at Vincennes, it is probable that some trouble will be met in working Coal VI on account of its roof.

181. SHEET E.—Orange and Crawford counties may each be considered as without commercially workable coal. Some workable coal may be found in the ridge about Boston, Crawford county.

In Dubois county the coals are pockety, so that no coal can be regularly relied upon as workable. On the other hand, almost all the coals are workable in places. Coal II (?) is workable over a small area in the north part of Columbia township in the northeastern corner of the county, at Huntingburg and some other points. Coal III (?) or IIIb and Coal IV have been worked at points south of White river in Boone and Harbison townships. Several of the coals are workable around Jasper. In general, while the county is well supplied with coals for local trade, no extensive bodies of workable coal have yet been found.

In Pike county the area underlain by Coal VII, as shown on the map, is underlain by at least two workable coals, while Coal V, with a thickness of from 4 to 9 ft., is workable under nearly all of the area within its outcrop as shown on the map. Coal IV will be workable in places under the whole county, and workable area of the still lower coals will probably be found.

182. SHEET F.—Coal II is the only workable coal in Perry county, and it is confined to the hills in the western part of the county. It has been long and extensively mined in the hills about Cannelton and in Troy, where the dip has carried it down to river level. Coal II continues workable in basins part way up Anderson township. Small areas of workable coal are found in the western part of Clark township.

Spencer county resembles Dubois in its coal producing capacity. Practically all of the coals found in the county are of a workable thickness at points, but as a rule the workable areas are evry limited. The knob coal occurring in the "Knobs" northwest of Rockport is nearly worked out. Coal IV there ran from 2 ft. to 5 ft. 10 in. in thickness and of excellent quality. Other areas in which workable coals are found are, south of St. Meinrad, Coal II from 3 to 5 ft. thick; near New Boston and on Crooked creek, west of Maxville, Coal IIa (?) 2 ft. 6 in. to 4 ft. thick; in the southwestern quarter of township 4 S., 4 W., Coal III, 2 ft. 6 in. thick to 3 ft. 6 in.; near Buffaloville and Lincoln City, and near Newtonville.

As far as our information goes Warrick county is limited in the main to Coal V for a supply of workable coal. This appears to be workable under practically all of the area within its outcrop, barring, as usual, areas near the outcrop where the roof is poor. Being outside the drift, there are not so many hidden areas where the coal is lacking as farther north. The coal runs from 4 to 9 ft. in thickness.

Coal VII is workable in places in the northwestern part of the county, but gets thin toward the Ohio. In some cases Coal VIa, a few feet or less below, may be worked at the same time.

Small areas of the coals below Coal V may be found of workable thickness, but on the whole the evidence did not suggest much workable coal from these lower coals.

183. SHEET G.—Recent developments in Gibson county indicate an abundance of coal. The evidence suggests that Coal V is workable under all or at least the eastern two-thirds of the county. This coal is only 4 ft. to 4 ft. 6 in. around Oakland and Francisco, but what is thought to be the same coal at Princeton averages over 6 ft. Coal VII may be workable in places, but on the whole is a little too thin. Coal V runs from a depth of 130 ft. at Oakland to from 375 to 450 ft. at Princeton. Numerous drillings around Princeton indicate up to four thick coal beds below Coal V. A gas well at Oakland also reported thick coals below Coal V. The presence of so many thick coals at Princeton is not only unexpected, but is not corroborated by the most reliable deep sections obtained to the north and south. That coal beds occur at these lower horizons cannot be questioned, but that so many of them show thicknesses of from 5 to 7 ft., while not unreasonable, is unusual, and we accept it with much question. Whether or not these lower coals prove as good as the drillings indicate, there is enough coal in Coal V to supply the demand for a long time.

Coal V underlies Vanderburg county much as it underlies Gibson, though with a reduced thickness. It is about 250 ft. deep at Evansville, where it is extensively mined. Explorations at Evansville and elsewhere have as yet failed to show any other workable coals in the county. Coal VII is probably workable locally in the northern part of the county, and future explorations are apt to find workable basins of the lower coals.

In Posey county the workable coals are deeply buried, and as yet have not been discovered. But few if any borings have gone deep enough to reach Coal V, and if that horizon has been reached no workable coal has been reported. That the county appears to be without workable coal is doubtless due to lack of sufficient exploration.

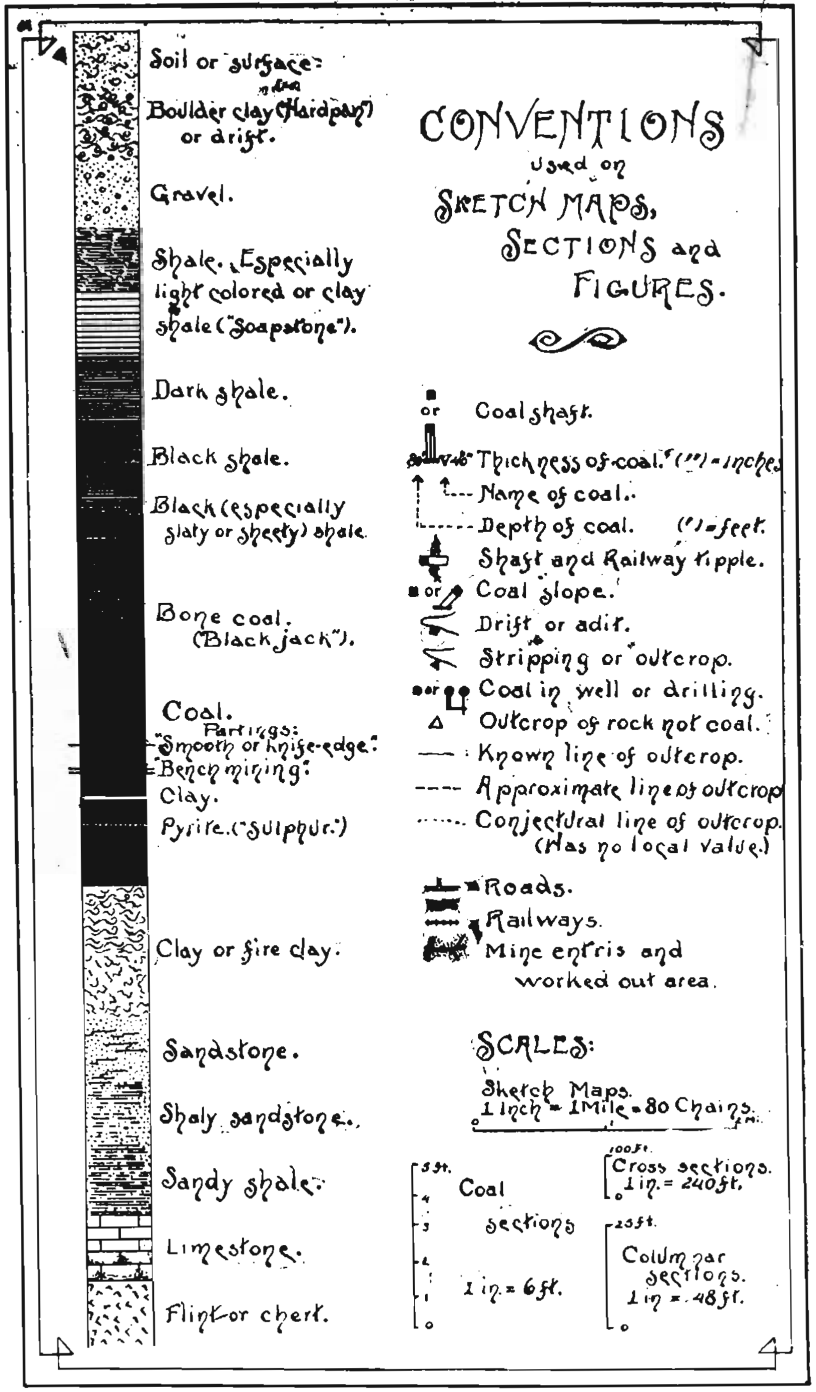


PLATE XII.

PART III. DETAILED GEOLOGY OF INDIANA COAL.

XIV. INTRODUCTORY.

184. PURPOSE AND METHOD.—This part of the report has for its purpose the furnishing of all the information obtained of any given locality. It is not written for the general reader whose interest in the coal field is purely general in its nature, but for those wishing specific information about any given locality, or about any rock or coal occurrence at any locality. It is thus written purely for reference, much as a dictionary or encyclopedia is. For that reason we have thought best to give all the data obtained, together with our interpretation of those data. If we wish to know how to spell a given word it is helpful to be given the rule for spelling that word, but most people turn not so much to the general rules as to the place where the word itself is given. So when it comes to a question concerning a particular locality or tract of land, we find there is a demand, not only for general statements of stratigraphy, distribution, roof, floor, etc., but more especially for information concerning the region immediately adjacent to, or, better still, of the very area itself in question. And as, from the conditions due to the mantle of drift and other factors, definite information is often extremely difficult to obtain, every little counts. So, too, it is often possible for us to obtain information that could not be obtained later; just as much of the data obtained by the earlier surveys was inaccessible at the time of the present survey. At the same time it should be recognized that, covering the field at the rate of 15 square miles a day, as we were compelled to do, making it necessary to accept such a large amount of data second hand, this report ought never to take the place of a personal examination by the parties interested. As we interpreted the scope of our work under the conditions imposed upon us, our report could not be a report on mines or mining properties, and to whatever extent it prove to be such, follows as an indirect result, because the data upon which our knowledge of the coals and strata must be based are largely derived from the mines.

To facilitate reference, the discussion is based on the land divisions established by congress, that is, the township and section. It should be recalled that to facilitate the location of lands the government, at an early day, divided the whole State up into a series of blocks 6 mi. square, thus containing 36 sq. mi. The blocks were designated townships—or congressional townships, to distinguish them from civic townships—and the divisions of the townships into square miles are known as sections. To designate a particular township, the tiers of townships are numbered north and south from a given line known as a base line, and tiers or ranges east and west of a chosen meridian. Thus, a township of the third tier north of the base line and fifth tier west of the principal meridian would be known as township 3 north, range 5 west, or T. 3 N., R. 5 W., or 3 N., 5 W., or even 3-5 where it is known to be in the northwest quadrant. The sections are numbered as indicated on the maps, and are divided into quarter sections of 160 acres, and these in turn into quarters of 40 acres each. In this way the location of any point in the State can be given as simply N. E. ¼ of S. E. ¼ of Sec. 20, T. 3 N., R. 5 W. (or Sec. 20-3-5), which locates it within a few rods. The discussion of townships will be taken up by counties.

In the detailed discussion under each township will be taken up:

First. Relative location of township in county, and correspondence with civil township, topography, railway facilities, etc.

Second. We attempt to answer the questions: What divisions of the coal measures underlie or outcrop in this township; how many and what coal beds occur in those divisions, how far apart are they and what rocks intervene; what are the details or characteristics of these coal beds by which they may be recognized; how are they found to vary and how do the intermediate strata vary as shown by the columnar sections; what is their quality, roof, floor, and in general their workability?

Third. We give their known and probable distribution in the township, both horizontally and vertically. While it was originally planned to put all data as to thickness of coals, quality, roof, floor, etc., under the head of stratigraphy, and this plan is rather closely adhered to in the report on Sullivan county, it was found that this took more time than the plan adopted in most of the report of giving generalizations under the head of stratigraphy, but of giving the local details and distribution together.

In this discussion the township may be considered as a whole, where the data are of small amount and scattered, or by groups of sections, taking those together in which the same division outcrops. In the latter case, if the several sections have yielded data at a number of points each, the discussion may be by sections.

It was originally planned to give under each township a summary showing total amount of coal in township, amount workable, worked out, etc. Lack of time compelled the abandoning of the plan and the substitution of a single summary by coals for the county, a method that could not have the accuracy of the former plan.

It should be added that in this part of the report, as far as possible, all data relating to the mining are omitted. Recognizing that the opportunity was a favorable one for obtaining data about the mines, output, etc., especially of the hundreds of small mines not visited by the State Mine Inspector, some mining notes were taken as our work brought us to these places. For those who wish to refer to them, these are brought together in the form of tables in Part IV.

185. Method of Correlating.—As pointed out in the preceding chapters, no one characteristic of the coals will serve for their correlation; thickness is useful to a certain extent; quality, the roof, floor, the fossil life and other factors may be used so long as we do not depend on any one factor. The earliest correlations were made by Mr. Leo Lesquereaux on the basis of the fossil life. How completely the method failed was recognized by Mr. Cox after a season or two in the field. That has been discussed in Division XI. From what has already been said in regard to the variability of the coal in regard to thickness, etc., it is evident that those factors can only be used with the greatest of care, and yet, to a certain extent, they must be used. In our work we have tried to ascertain the conditions surrounding each coal bed, and to make those, as expressed by the details of the coal and associated strata, the basis of our correlation. Thus, Coal V, over most of the State, seems to have been followed by submergence which brought in sea conditions, a sea fauna, limestone, etc. Coal VI over a large area was slightly submerged, and after the deposition of some shales, was lifted above drainage, and the overlying deposits more or less carried away. Examining the coal itself, we find it first growing in muddy waters, resulting in a shaly coal. Farther along, the coal forming process is at least twice interrupted by changes that result in the deposition of wide-spread though thin sheets of mud, the coal forming process each time being renewed at once, and so on. Thus, by careful detailed study and much comparing, it has been possible in many instances to determine the conditions surrounding each coal bed, and so its characteristics. But it is soon recognized that these conditions have varied from point to point. The earth's surface was not a rigid body which all rose or sank together, and by the same amount, but while sinking was taking place over one area, perhaps another area was rising. Then appears the value of tracing the coal from point to point systematically, for in so doing it is usually found

that some higher or lower coal, or some distinguishable stratum can be followed from the region of one set of conditions for the coal being studied, into a region with new conditions, and thus serve as a key to what would certainly mislead us if we went directly from one region to the other. In some cases where exposures are abundant it is possible by this method of continuous tracing to trace the change step by step. This leads to the

186. METHOD OF TRACING COAL OUTCROPS.—It will be only fair to give the method of tracing the lines of outcrop of the workable coals that the reader may know what dependence to put upon those lines. In areas where the coal outcrops with some frequency, a contour line, or line which follows the shape of the hill at a constant level, is drawn from each outcrop, as it is located, until the next outcrop is found. If the next outcrop is at approximately the same level, the contour line is left as the line of outcrop. If it prove to be above or below, a constant rate of dip is assumed, and a new line drawn, based on the old line. As a help in drawing this new line, the topography is often sketched roughly in the note book or on the field sheets. In an area where the topographic relief is quite marked, this adjusted line of outcrop may be almost, if not quite, as accurate as the original contour line, even where outcrops are one or two miles apart. But in a more level country, lines which are not far apart vertically may be a long distance apart horizontally, and so on the map, and to that extent become unreliable. Over the eastern edge of the coal field the Mansfield sandstone produces a somewhat rugged topography, which renders possible the fairly accurate tracing of the coals. Over most of the area, however, where the predominance of shales has allowed the glacier to plane the surface nearly to a dead level, and then the deep mantle of clays, sand and gravel left by the glacier has hidden the underlying rocks, outcrops are very scarce, often being 10 or even 15 or more miles apart. In such cases it is possible only to draw a line to include all points at which that coal has been found in mines, wells or drillings, and its accuracy depends on the amount of data obtainable. Even with such lines, an attempt is made to follow the major topographic features, though of course it would be a waste of time to attempt to make it follow the details of relief, since the constant local changes of dip which we cannot see, but are sure exist, would certainly render it inaccurate.

On the maps three kinds of lines are used—the full line, the broken line and the dotted line. The full line is used where the outcrops are within a quarter of a mile of each other, or, in cases where the relief is marked, a half mile or more apart, and may be considered closely reliable. The broken line is used where the outcrops are further apart, but the topographic relief is so marked that the line may be considered as approximating correctness.

The dotted line is used to indicate merely a line of inclusion, or where the distance of outcrops apart, or other causes, renders the factor of possible error large.

With the shortness of time at our disposal, it has not been possible to take cognizance of the difference between the present and preglacial relief, and to this factor, more than any other, we believe will be chargeable the errors in our lines, for it should be remembered that it is the preglacial surface that determines the actual outcrop. Note of such differences, however, is usually made in the text.

187. THE MAPS AND SECTIONS.—The maps accompanying this report are of two kinds:

First. A general colored geological map of the whole coal area on a scale of 2 miles to 1 inch. For convenience, this is published in seven sheets of several counties each. Each sheet, by differences of color or cross-lining, shows the area of outcrop of such of the divisions of the coal measures as can be given, the lower limiting line showing the line of outcrop of the basal coal of that division. No note is made of quaternary deposits. Where possible, each sheet gives one or more cross-sections colored to correspond with the map.

Second. Sketch coal maps of the more important mining or coal areas, on the scale of 1 mile to 1 inch. These show the location of all datum points, coal outcrops, etc. Where such maps do not of themselves make a full page or double page plate, drawings of the columnar and coal sections are placed on the same plate, and, with the cross-sections usually given, often form very comprehensive charts of coal data for their areas. In order to show better the characteristic features of the coals and columnar sections, as well as their variations, the practice is adopted all through of grouping the sections, thus making comparisons easy. To save space and time the legend and scales for the sketch maps are given at this point, and arranged so as to be readily referred to. See Plate XII, opposite page 177. Following out the idea of making the subject matter as handy as possible, numbers are prefixed to the strata of the type columnar sections and a column added showing at a glance the depth of any coal or other strata. Other features along the same lines will be noted by the reader, which need not be referred to here.

XV. NEWTON AND BENTON COUNTIES.

188. TREATMENT.—As these counties are not coal producing counties, though supposed to contain some coal, the general plan of treatment will not be followed.

189. REFERENCES AND FIELD WORK.—
Newton County—
1882. John Collett, 12th Ann. Rep., Dept. of Geol. and Nat. Hist., pp. 48-64. No mention of coal or coal measures.
1897. C. E. Siebenthal, field work for this report. (C. E. S.)
Benton County—
1885. S. S. Gorby, 15 Ann. Rep., Dept. of Geol. and Nat. Hist., pp. 198-220. On coal measures, pp. 207-212. (S. S. G.)
1897. C. E. Siebenthal, field work for this report. (C. E. S.)

190. POSITION.—These two counties lie next to the Illinois line, in the northwestern part of the State, Newton lying north of Benton, and, in turn, being separated from Lake Michigan only by Lake county. As the reported occurrences of coal in Newton county are just north of the Benton county line, a brief description of the surface of Benton county will serve all the purposes of this report.

191. TOPOGRAPHY OF BENTON COUNTY. ELEVATIONS.—The following elevations may be useful for reference:

	Authority.	*Ft.*
Ambia	L. E. & W. R. R	710
Boswell	L. E. & W. R. R	734
Chase	L. E. & W. R. R	719
Earl Park	C. C. C. & St. L. R. R	814
Fowler	C. C. C. & St. L. R. R	823
Gravel Hill	Gorby?	857
Mt. Gibbon	Owen	815
Otterbein	L. E. & W. R. R	785
Oxford	L. E. & W. R. R	703
Raub	C. C. C. & St. L. R. R	731
Talbot	L. E. & W. R. R	710
Templeton	L. E. & W. R. R	675

These show a range in elevation of nearly if not quite 200 ft. between the highest and lowest points of the county. Mr. Siebenthal describes the topography as without conspicuous elevations, but traversed by four long ridges or, rather, low swells. The first of these runs a little north of west, passing between Pine Village in Warren county and the county line, crossing the county line south of Boswell and then passing west into Illinois. The second ridge passes north of Oxford and south of Fowler, dividing in the neighborhood of Parish Grove into two forks, one of which passes southwest by Ambia into Illinois, the other pursuing a straightforward course. The third swell passes north of Andelotte and Fowler, south of Earl Park, and passes into Illinois southwest of Raub. The fourth ridge passes by Odessa, north of Wadena and into Newton county, between Kentland and Raub. These swells are hardly prominent enough to be called ridges. One can see the ascent in front of him, but the crest can hardly be recognized when standing upon it.

192. SURFACE GEOLOGY.—This county is deeply covered with drift, only a few outcrops of rock occurring. The following condensed table gives a comprehensive view of the thickness of the drift over the county, and the character of the first rock encountered; L. S., limestone; S. S., sandstone; sh., shale:

T. 26 N., R. 7 W.: Sec. 9, 78 ft. S. S.; Sec. 19, 55 ft. sh.; Sec. 25, 63 ft.; Sec. 26, 65 ft. L. S.; Sec. 28, L. S. outcrops; Sec. 34, 50 ft. L. S.; Sec. 36, 40 ft. L. S.

T. 26 N., R. 8 W.: Sec. 2, 50-80 ft. L. S. and sh.; Sec. 12, 53 ft. L. S.; Sec. 13, 60 ft.; Sec. 14, 100 ft.; Sec. 15, 79 ft., sh. or L. S.; Sec. 17, 75 ft. sh.; Sec. 24, 43 ft. L. S.; Sec. 25, 50 ft. L. S.

T. 26 N., R. 9 W.: Sec. 1, 65 ft. sh.; Sec. 3, 60-75 ft. L. S.; Sec. 10, 50 ft. L. S.; Sec. 13, 44-65 ft. L. S.; Sec. 14, L. S. outcrops (Raub's); Sec. 19, 132 ft. sh.; Sec. 20-21, 40 ft. L. S.; Sec. 22, 110 ft. L. S.; Sec. 23 (Earl Park), 15-90 ft., L. S.; Sec. 24, 65-70 ft., L. S.; Secs. 25 and 35, 65 ft.; Sec. 26, 40-50 ft. sh. and L. S.; Sec. 27, 40 ft. L. S.; Sec. 28, 76 ft. L. S.; Sec. 34, 49 ft. S. S.

T. 25 N., R. 7 W.: Sec. 11, 50 ft. L. S.; Sec. 15, 80 ft. L. S.; Sec. 23, L. S. outcrops (Stevenson's); Sec. 33, 34 ft. L. S.

T. 25 N., R. 8 W.: Sec. 12, 161 ft. L. S.; Sec. 13, 90 ft. S. S.; Secs. 15-16 (Fowler), 149 ft.; Sec. 17, 91 ft. L. S.; Sec. 18, 80 ft. L. S.; Sec. 28, 160 ft. L. S.; Sec. 30, 116 ft. L. S.; Sec. 31, 100 ft. L. S.; Sec. 34, 180 ft.

T. 25 N., R. 9 W.: Sec. 3, 75 ft. L. S.; Sec. 6 and 8, 40 ft.; Sec. 10, 50 ft.; Sec. 16, 100 ft. L. S.; Sec. 24, 80 ft. L. S.; Sec. 31, 141-206 ft. S. S. (40 ft., Dunnington); Sec. 36, 175 ft. L. S.

T. 25 N., R. 10 W.: Secs. 12, 11, 14, 23 and 24, 40-50 ft.; Sec. 25, 82 ft.; Sec. 36, 125 ft.

T. 24 N., R. 7 W.: Sec. 18 (Oxford), 385 ft.

T. 24 N., R. 8 W.: Sec. 8, 70 ft. L. S.; Sec. 18, 206 ft. L. S.; Sec. 19, 190 ft. L. S.; Sec. 31, 180 ft.; Sec. 32, 372 ft. L. S.

T. 24 N., R. 9 W.: Sec. 24 (Boswell), 161 ft. L. S.; Sec. 25, 133 ft.+; Sec. 26, 270 ft.; Sec. 31, 175 ft.+.

T. 24 N., R. 10 W.: Sec. 1, 138 ft.+; Sec. 11, 100 ft.+; Sec. 26, 187 ft.+; Sec. 35, 149 ft. L. S. (?).

These sections show a depth of the drift in and north of the southernmost swell of up to 400 ft., with an average of 200 ft. Further north the drift is thinner, ranging from 200 ft. down.

193. Bed Rock.—As noted above, nearly all the drillings that go through the drift pass directly into "limestone;" usually the drillings only go a few feet into the rock so designated. In some cases, however, after passing through a varying thickness of limestone, a considerable thickness of black shale is reported, often 50 ft. or more. The rocks noted above as outcropping are, in each case, of Keokuk (Harrodsburg) age. Coal is reported only in a small area north of Earl Park, at the county line. These facts indicate that no coal measures exist over most of the county, and if coal measure rocks be found, except in the southwestern corner of the county, they exist as patches which are not connected, from north to south across the county, with the main body of the coal measures, as has formerly been assumed.

Leaving out for the moment the southwestern corner of the county, coal measure rocks have only been reported at two places—north of Earl Park and at Mt. Nebo, a little southeast of Wadena. These will be considered first.

194. The Schluttenhofen Basin.—See Plate XIII and Plate XIV.

This is a small area lying southeast of Kentland, partly in Newton county and partly in Benton. Some years since a well drilled for water on the Schluttenhofen place, Sec. 1-26-9, was claimed to have passed through 7 ft. of coal at a depth of 104 ft. This led to the drilling of another well on the same place with the same result. The sections of these wells, as reported by Mr. Siebenthal, are as follows:

195. Section 1. Section of Well No. 1 on Schluttenhofen Place.—Sec. 1 (3)-26-9. Plate XIV, Fig. 8 (C. E. S.).

	Ft.	In.
Drift	65	0
Clay-shale ("soapstone")	39	0
Pyrite ("sulphur stone")	0	2
COAL	6	0
"Solid hard rock"	2	0

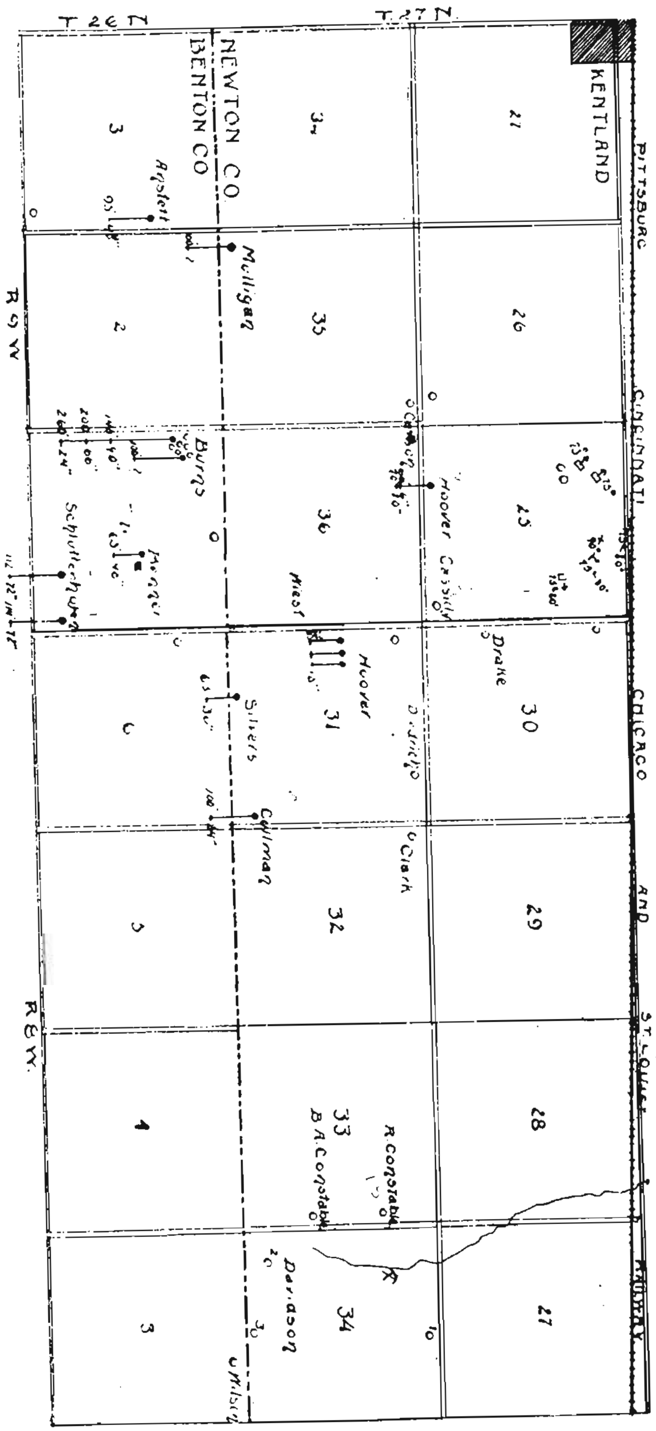


Plate XIII. Sketch map of parts of Newton and Benton counties, in Ts. 26 and 27 N., Rs. 8 and 9 W. For scale, etc., see Plate XII.

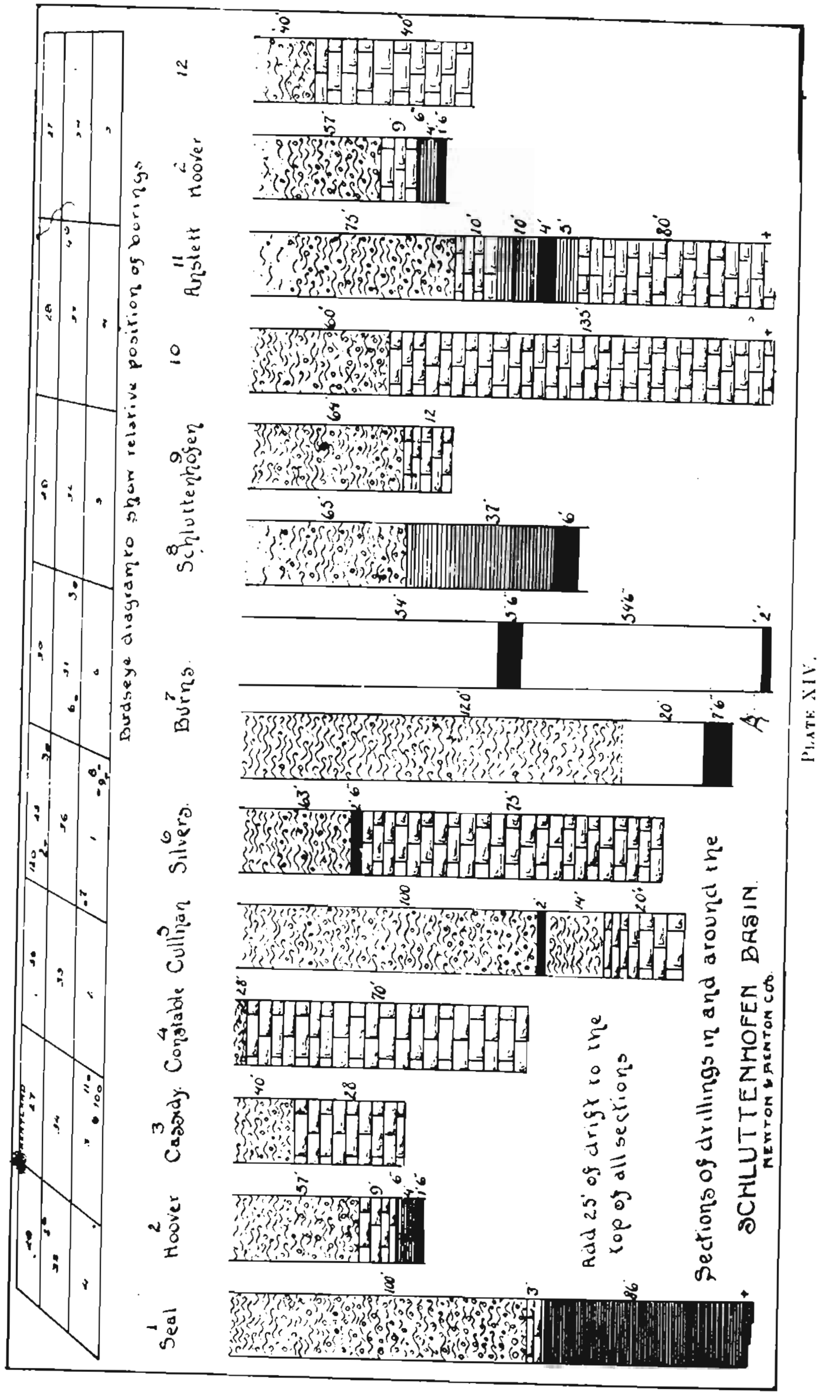


PLATE XIV.

196. SECTION 2. SECTION OF No. 2 WELL, SAME FARM.—

Drift	65 ft.
Clay shale	37 ft.
COAL	6 ft. at 102 ft.
"Hard rock," "gritty"	35 ft.
	143 ft.

The thickness of the coal is variously reported as from 4 to 7 ft. This was all that had been found when visited by Mr. Gorby in 1885, and upon such a slender basis he rejected the idea of coal existing there. Since then many more drill holes have been put down, and coal reported in a number of them. Coal has thus been reported in Secs. 25, 35 and 36 of 27-9; Sec. 31 of 27-8; Secs. 1 and 3 of 26-9. In examining the sections of the drillings it is well to study the neighboring sections at the same time.

In crossing this area on a line a mile north of the Benton county line the following sections are passed through:

197. SECTION 3. SECTION OF DRILLING ON ROBERT SEAL PLACE.—Sec. 33, 27-9 (just off of map; see bird's-eye diagram), Plate XIV, Fig. 1 (C. E. S.).

	Ft.
Clay, etc.	100
Soft white limestone	3
Black shale	86
Sandstone with pyrites	3
Hard gray sandstone	9
Soft white limestone	30
	238

The 86 ft. of black shale is very suggestive of the Devonian, and the lower 30 ft. of limestone may be Niagara. Going east, 9 ft. of limestone (?) is struck at 58 ft. in a well in Sec. 35; northeast corner. In Sec. 25, S. E. of S. W., on Henry Hoover's place, two beds of coal were reported.

198. SECTION 4. SECTION ON HOOVER PLACE.—Sec. 25, 27-9, Plate XIV, Fig. 2 (C. E. S.).

		Ft.	*In.*
Clay		57	0
Limestone, medium hard		7	0
Limestone, soft		2	0
COAL		0	6
Clay shale		4	0
COAL	18 in. to	1	8
"Hard rock"		1	0

About ½ mi. east this occurs:

199. SECTION 5. SECTION ON JOHN CASSIDY PLACE.—Sec. 25, S. E. ¼, Plate XIV, Fig. 3 (C. E. S.).

	Ft.
Clay	40
Limestone	28

Noting the figures it will be seen that the 9 ft. of limestone in the Hoover well might possibly correspond with the lower part of the 28 ft. of limestone in the Cassidy well, in which case it would appear that the coal of the Hoover well was originally overlain by 20-30 ft. of limestone. Three miles east in the S. E. of N. E. of Sec. 33, 27-8, occurs:

200. SECTION 6. SECTION ON RICHARD CONSTABLE'S PLACE.—Sec. 33, Plate XIV, Fig. 4 (C. E. S.).

	Ft.
Clay, etc.	28
Limestone	70
	98

It is presumably this same limestone which outcrops half a mile further east on the Davidson land in Sec. 34. The limestone there is known to be of Keokuk (Harrodsburg) age. As the limestone here is lying nearly horizontally, the suggestion naturally comes that the limestone at Cassidy's and Hoover's may also be of Keokuk age.

Taking a south of west course from Constable's, the first boring is met with in the S. E. corner of Sec. 31, 27-8.

201. SECTION 7. SECTION ON JAMES CULLNAN'S PLACE.—Sec. 31, Plate XIV, Fig. 5 (C. E. S.).

	Ft.
Drift	100
COAL	2
Clay	14
Limestone	20 "probably 60 feet."
	136

In the S. E. of S. W. of same section occurs:

202. SECTION 8. SECTION ON JOHN SILVER'S PLACE.—Sec. 31, Plate XIV, Fig. 6 (C. E. S.).

	Ft.	In.
Drift	63	0
COAL	2	6
White unctuous shale or limestone	75	0

In the N. W. ¼ of this section on the Hoover place, 18 in. of coal is reported to have been struck at about 65 ft. in three wells.

In the S. E. ¼ of Sec. 36, 27-9, on the Joseph Wiest place, 20 ft. of rock (limestone?) is reported at a depth of 40-45 ft. In the N. W. ¼ of Sec. 1, 26-9, on the James H. Burns place, nine wells have been sunk. Nos. 1 to 6 of these went to depths of 175 ft., 100 ft., 98 ft., 150 ft. and 100 ft., respectively, without striking rock. No. 7 went 268 ft. to hard rock, but is reported to have passed through coal at 110 ft., and from that down to 268 ft. was in "shell rock and hard-pan." Well No. 8, by another driller, went 98 ft. without striking rock. No. 9, by still a third driller, went to 280 ft. and is reported to have had blue clay with some sand to 120 ft. and gravel, the size of peas, the rest of the way. The most remarkable part of this well was, however, the reported striking of three beds of coal, the first 7 ft. 6 in. thick at 144 ft., the second 5 ft. 6 in. at 200 ft. and the third 2 ft. thick at 260 ft. This lowest coal would seem to be deep enough to lie among rocks of the Silurian age. See Plate XIV, Fig. 7.

The first bed is described as being bony, the second as a bright, good coal, a quart of drillings being obtained, some of the pieces as large as marbles. Said to burn like Pittsburg coal. The lowest bed is said to be the best coal of all.

In the S. W. of N. E. of the same section, on the Christ. Benner place, 3 ft. 6 in. to 4 ft. of coal was found at 60 ft. This led to the attempt to sink a shaft about 1880. After getting down some 40 ft. it was abandoned on account of the water, which ran in from the drift sand. Attention has already been called to the two wells on the Schluttenhofen place. A third well on the same place in the S. E. corner of Sec. 1 went through 12 ft. of limestone at 64 ft. See Plate XIV, Fig. 9. In the S. E. corner of Sec. 3, 26-9, 135 ft. of limestone is reported at a depth of 60 ft. As it is less than two miles south of this to an outcrop of Keokuk limestone on the Raub place, it would seem probable that this limestone on the Schluttenhofen place was of that age; and, again, the limestone seems to, in part at least, overlie the coal. In the S. E. of the N. E. of the same section occurs:

203. SECTION 9. SECTION ON FLORENCE ANSTETT PLACE.—Sec. 3, Plate XIV, Fig. 11 (C. E. S.).

	Ft.
Drift	75
Limestone	10
Shale	10
COAL	4
Shale	5
Limestone	80
	184

Continuing northeast, the following section occurs in the S. W. of S. W. of Sec. 35, 27-9:

204. SECTION 10. SECTION ON PATRICK MULLIGAN'S PLACE.—Sec. 35 (C. E. S.).

	Ft.
Clay, etc.	100
Coal and shale (2 beds of coal ?)	10
"Shell rock"	38
"Solid rock, flint"	2
	150

Passing by the Henry Hoover place, we find, in the N. E. ¼ of Sec. 25, 27-9, 40 ft. of limestone at a depth of 40 ft. In this section, as indicated on the sketch map, occurs one of the most disturbed areas known in the State. The rocks are exposed at a number of places, dipping in different directions from 75 deg. to 85 deg., or even up to perpendicular. The rocks are limestones of Niagara age. From the radiating direction of the dips it would almost seem as though volcanic or other agencies had produced an upheaval of a kind seldom found in nature. Fine crystals of calcite and other minerals occur at this point. The use of the Diamond drill in this region revealing, as it usually does, the dip of the rocks would prove of great help in solving the structure of the area. As to whether this disturbed structure extends into the coal basin just south cannot be stated. I am inclined to think it may to some extent, but not so as to materially effect the presence of the coal there.

205. NEXT, AS TO THE RELIABILITY OF THE DATA.—Except at the outcrops as noted, all the data were obtained by the use of the self-pumping tubular drill. The thickness of the coals is judged by the distance the drill works between the waters first becoming black and its clearing up again. In the main coal field no reliance would be put upon data obtained in this way. So that even if coal exists in this area the thicknesses given can hardly be considered more than a guess. These drillings were made by four different drillers, which would seem to discredit the suspicion of the wells having been "salted." Whether any of these drillers have had experience in the coal fields or any place where there need be no guesswork as to the character of the rock passed through I do not know. The absence of microscopic or chemical tests, or, in lieu of these, of shafts by which the driller may test and correct the record of his boring which preceded the shaft, introduces a large factor of uncertainty in these drillings. Until a test shaft has been sunk, or a core or other drilling made by parties whose knowledge and experience in the coal field make any report by them on the coal strictly reliable, we shall consider the question of workable coal in this area an open one.

206. Assuming that coal does exist there, where does it belong geologically? The rock most commonly met with in the drillings below the drift is limestone. With the exception noted, all the outcrops in this region are of limestone of Keokuk age; that is, about the middle of the Lower Carboniferous. The apparent structural relation of the coal to the limestone suggests that it is of the same age. Coal beds do occur elsewhere in the Lower Carboniferous rocks, but, as a rule, only a few inches thick and, as far as reported in the State, only in the Chester or Kaskaskia group, the highest group and one just preceding the coal measures. On the other hand, we find in the north part of the coal field of the State that the upper members of the Lower Carboniferous do not appear around the edge of the coal area, but the coal measures rest with unconformability on the middle and lower groups of the Lower Carboniferous, so that there is a possibility that coals of coal measure age have been deposited here in an old channel or depression of some kind in the older rocks. As to the presence here of coals 4, 5, 6 or 7 ft. thick, if these are coal measure coals (supposing the so-called limestone over the coal prove to be a hard shale), this might be an extra limital pocket such as are not uncommon in other States, such pockets often showing a thickness of 20 to 30 ft. But if the coals are of Lower Carboniferous age, as the reported presence of limestone over the coal and other facts seem to indicate, it is probable either that the "coal" will prove to be pockets of highly bituminous black shale, or if coal be there that it will be in thin beds, associated with beds of black bituminous shale, and that the section of coal and shale aggregating 6 ft. on the Hoover place is more typical of actual facts than the 6 and 7 ft. beds of solid coal reported in some of the other sections.

207. SANDSTONE AT MT. NEBO.—Mt. Nebo is an elevated tableland or plateau forming part of the northernmost ridge or swell. It lies about two miles south of east of Wadena. The country slopes very slightly to the east and west, a little more rapidly to the north, but to the south descends 100 to 125 ft. to Pine creek within about a mile. A well bored directly on the summit of Mt. Nebo is reported to have given the following:

208. SECTION 11. SECTION OF BORING ON SWAN PLACE (Mt. Nebo).—Sec. 20, 26-7 (S. S. G., p. 200).

	Ft.	In.
Soil	1	8
Yellow clay	9	..
Blue clay	51	10
Cavity from which flowed gas	0	10
Blue clay	11	6
Cemented gravel	1	0
Quicksand	6	0
SANDSTONE	33	6
Gravel and water	0	8
Limestone	..	..
	116	0

Other wells bored on the slope of Mt. Nebo and in adjacent territory showed no sandstone. At the Nutt quarry, 2 miles southeast, on Pine creek, Keokuk limestone is exposed. This sandstone was at the top a soft, coarse, dark-yellow sandstone, changing to dark-red with trace of iron. Toward the bottom it is fine-grained, compact and of a dull-gray color. The whole stratum was so soft that it required less than two days to drill through it. Mr. Gorby concluded that this was an outlier of Mansfield sandstone. While this theory may be correct, the softness of the stone hardly accords with the character of the Mansfield sandstone as exposed elsewhere. The presence of the iron suggests a stratum of drift sand cemented by that mineral.

209. COAL MEASURES OF SOUTHWESTERN BENTON COUNTY.—See Sheet A of large coal map. As yet no coal has been struck in this part of the county, nor is more than a few inches, if any, ever likely to be found there. The known position of the Mansfield sandstone of Division I in Warren county and in Illinois suggests that the eastern limit of this division crosses the southwestern corner of the county. At Dunnington, 40 ft. of sandstone is reported to have been reached at a depth of 141 ft. Neighboring wells report "hard rock" of undetermined character at depths of from 125 to 206 ft. The possibility of this being Mansfield sandstone has led to the drawing of the limiting line as shown on the map.

XVI. WARREN COUNTY.

Section 1. Geography.

210. REFERENCES AND FIELD WORK.—

1859-60. Richard Owen, Rep. of Geol. Reconn. of Ind., pp. 163-165. A reconnoisance. 2 coal analyses. (R. O.)

1859-60. Leo Lesquereux, same rep., p. 337. (L. L.)

1869. E. T. Cox, 1st Ann. Rep. Geol. Surv. of Ind., pp. 129-131. Preliminary report. 2 columnar sections. (E. T. C.)

1873. John Collett, 5th Ann. Rep. Geol. Surv. of Ind., pp. 190-259. Detailed report, map, 27 columnar sections, 30 coal analyses. (J. C.)

1896. T. C. Hopkins, 20th Ann. Rep. of Geol. and Nat. Resources, pp. 281-305; describes the Mansfield sandstone. (T. C. H.)

1897. E. M. Kindle, field work on part of county west and south of Pine creek. (E. M. K.)

1897. C. E. Siebenthal, field work on northeastern part of county, east of Pine creek, and T. 21 N., R. 8 W. (C. E. S.)

211. LOCATION.—Warren county is next to the Illinois line, which bounds it on the west, lying a little north of the center of the western side of the State. It lies just south of Benton county. Tippecanoe county lies east of the northeast corner of the county, while Fountain county lies east and south of Warren, from which it is separated by the Wabash river. Vermillion county lies south of the southwest corner. See Sheet A.

212. EXTENT.—The county is somewhat triangular in shape, with the northeastern and southwestern corners of the triangle truncated. It has an area of 360 square miles. It contains all of township 23 north of range 7 west, townships 22 and 23 north of range 8 west, and 21, 22 and 23 north of range 9 west; also partial townships 22 and 23 north of 6 west; 22 north of 7 west; 21 north of 8 west; 20 north of 9 west; 20-23 north of 10 west.

213. ELEVATION.—The county ranges in elevation from 491 ft. above tide at the crossing of C., C., C. & St. L. Ry. over the Wabash to probably over 730 ft. Low water in the Wabash at Attica is 516 ft. Williamsport, on the Wabash river, is 619 ft. above tide. West Lebanon and Marshfield, on the elevated prairie of the western part of

the county, are 720 and 721 ft., respectively, above tide. The C., C., C. & St. L. Ry. bridge over the Wabash is 529 ft.; Mound City is 577 ft. above tide.

214. General Topography.—The western and northern part of the county is a high, rolling prairie, deeply covered with glacial drift, much as was Benton county, just north. Approaching the Wabash river this level country is much broken up by the larger streams and their tributaries, which, as they near the Wabash, often acquire steep or precipitous banks, often walled in by perpendicular bluffs of sandstone. These bluffs, as well as those along the Wabash, are often 80 to 150 ft. high. Along the river is a flat terrace, some 80 ft. above the river. It is a terrace of planation, such as will be noted at other points down the river, the rock at many points coming very near the surface. At other points it is cut out of glacial material, which still extends as much as 60 ft. or more below its level. It varies from a half a mile to a mile wide.

215. Drainage.—As shown on the map, the Wabash river flows along the southeastern side of the county. The principal tributaries to this from the north and west are: Little Pine creek, Kickapoo creek, Pine creek, Rock creek, Redwood creek, Possum run, and the north fork of Spring creek, which flows into Vermillion county. Mud Pine creek and Fall creek are the principal tributaries of Pine creek from the west. Jordan creek rises in the northwestern portion of the county and flows southwestward into Illinois.

216. Transportation.—The Chicago & Eastern Illinois railroad crosses the county from north to south in the northeastern part. The Wabash railroad enters the county above Williamsport and runs west and southwest, leaving the county at State Line. A branch of the Illinois Central railroad enters the county from the west and meets the Wabash railroad at West Lebanon. The Big Four railway crosses the southern edge of the county from east to west.

217. Development.—This county is almost entirely an agricultural county, very little attention having as yet been given to manufactures of any kind. The quarrying of sandstone is of some importance in this county.

Section 2. Stratigraphy.

218. Surface Geology.—Away from the Wabash river or the channel of Pine creek, the glacial drift in this county is quite deep, ranging up to 250 ft. in thickness. Approaching the river or its larger tributaries the more rapid erosion has greatly reduced that thickness, so that along some of the streams the underlying strata are quite frequently exposed. Over the county as a whole the drift will probably average less than 100 ft. in thickness. Hidden preglacial channels doubtless abound, but the small amount of drilling and mining have not revealed many yet. Small ones cutting into the coal are constantly met with in mining the seams but little protected, and a few longer ones were noted at Williamsport and in township 20 north, range 9 west. The composition of the drift was well exhibited by the shaft at West Lebanon. See ¶281 and Fig. 187.

219. Coal Measures.—Divisions I, V and VI are found outcropping in or underlying this county. See Part II for a discussion of the correlation of the divisions so designated here, with those divisions at their typical localities. Divisions I and V each show one coal, Division VI showing two coals. The type section would be somewhat as follows:

Division VI—

Space, little exposed, but a few feet of black shales with sometimes blue shales over, forming the roof of Coal VIa where that coal has been left by the preglacial erosion.

Coal VIa. A thin coal, probably cut out over most of the county, usually about 1 ft. thick.

Space, ranges from 3 ft. to 30 ft., but generally under 20 ft. It is often almost or entirely made up of fire-clay with shale underlying; again in places as much as 10 ft. of shaly sandstone is noted.

Coal VI. This coal is workable in limited areas, ranging up to 4 ft. in thickness. In such places it is apt to show three benches, and to be a block or semiblock coal of fair grade. Over most of the county it probably does not attain to a workable thickness.

Division V—

Space, ranges from 15 to 40 ft., usually being at least 20 ft. Its most characteristic bed is a bed of limestone, usually black and bituminous, but a short distance above Coal V, from which it is usually separated by black bituminous shale, often sheety, indicating marine conditions following the deposition of Coal V. In some cases two beds of limestone occur. The main and upper part of this division is principally composed of shale in the northeastern part of the county, but in the southwestern is frequently composed of a massive sandstone 20 to 30 ft. thick.

Coal V. This coal is workable locally, in some areas averaging over 3 ft. thick, and up to over 4 ft. In other places its position is only indicated by the position of the overlying limestone, its horizon being occupied by black shale. It is usually a solid bed with a black shale roof and may usually be recognized by its association with the black limestone of this division. It is a block or semiblock coal of fair to medium quality.

Division IV ?—

Space. As a rule this division only appears as a more or less considerable thickness of black shale, filling up the irregularities of erosion in the top of Division I.

Division I—

Space. Principally represented by the massive Mansfield sandstone from 20 to 60 ft. thick.

Coal I. Very local in distribution, usually occurring in small pockets, hardly thick enough or extensive enough to serve even for local supply.

220. Underlying Formations.—The coal measures here lie unconformably on shales and sandstone, designated Riverside by Mr. Hopkins, in view of their questionable stratigraphic position, but claimed by Mr. Siebenthal to belong to the Knobstone group of the Lower Carboniferous. These formations outcrop around the northeast corner of the county and over a considerable area along the Wabash river. See map.

Section 3. Detailed Geology.

Township 23 North, Range 6 West. (Part in Warren County.)

221. Location, Etc.—This partial township forms the northeast corner of Warren county. Only the western half of the township is in Warren county. It corresponds with the eastern two-thirds of Medina of the civic townships.

222. Stratigraphy and Coals.—Only Division I of the coal measures occurs in this township. The following section was made by Mr. Collett in Secs. 31 and 32:

223. Section 12. Section at Green Hill Red Sandstone Quarry.—Sec. 32. (J. C., p. 229.)

	Ft.	In.
Red sandstone, heavy bedded	52	0
Covered	4	0
Soft gray sandstone, 3 ft. to 2 ft.; brown sandstone, 3 ft.; banded pebbles, 3 in.; red sandstone, 5 ft.; brown and striped sandstone, 3 ft. 6 in.; yellow ferruginous sandstone, 4 ft.	17	9
	73	9

A drilling at the forks of the road near the middle of the east side of Sec. 31 showed: Drift 10-17 ft.; red sandstone, 40-50 ft.; to gray sandstone. There is thus only the horizon of Coal I in this township, and that contained no coal at this point. It may contain a few inches at other points now hidden by the drift, but is of no economic value. For a discussion of the sandstones of Division I see report by Mr. Hopkins, as above. For extent of Division I see map. The limits as drawn by Mr. Hopkins are retained.

Township 22 North, Range 6 West. (Part in Warren County.)

224. Location, Etc.—Only the northwest corner of this township is practically included in Warren county. It comprises the eastern part of Warren township.

225. Stratigraphy and Coals.—Drillings show the drift to have a thickness of 50-60 ft. Division I only of the coal measures is developed in this township, with one coal horizon, that of Coal I. Mr. Collett gives a number of sections which show the sandstone of Division I, resting usually on shales of Lower Carboniferous age. Plate VII in Part II called attention to the nonconformity existing between the coal measures and Lower Carboniferous. Coal has been reported in a few places. The following section shows its position:

226. Section 13. Section at Munson's Mill.—Sec. 5 (northeast of southwest). (J. C., p. 226.)

	Ft.	In.
Quartzose "conglomerate" (sandstone) resting on pebbly base	4	0
Black sheety bituminous shale (horizon of Coal I)	1	0
Quartzose and green shales (Lower Carboniferous)	20	8
	25	8

227. DISTRIBUTION.—Mr. C. M. Dawson reports that a bore in Dry creek bottom, Sec. 7, S. E. ¼, showed 18 in. of coal at a depth of 18 ft. A few inches of coal is reported on the land of Robert Lank, Sec. 5, N. W. of S. W. Coal is reported to have been gotten out by old settlers for blacksmithing purposes from the north half of N. W. ¼ of Sec. 8. It is almost certain that no coal of commercial value exists in this township. The limits of the coal measures are shown on the map.

TOWNSHIP 23 NORTH, RANGE 7 WEST.

228. STATEMENT.—No information on the coal measures was obtained in this township. Based on the known position of the sandstone of Division I on either side, it is believed that the horizon of Coal I underlies the southern part of the township to the extent indicated upon the map. Considering the thickness of the drift, it may definitely be considered that this township contains no workable coal.

TOWNSHIP 22 NORTH, RANGE 7 WEST. (PART IN WARREN COUNTY.)

229. STATEMENT.—The Mansfield sandstone of Division I is well developed in the northern part of this township. At the Kickapoo Falls, Sec. 29, it shows a massive thickness of 60 ft., underlain by 20 ft. of black and drab-colored shales. No exposure of coal has yet been noted. The drift varies in depth up to 90 ft. The sandstone of Division I usually rests unconformably upon shale of Lower Carboniferous age. The distribution of the horizon of Coal I will fall within the limits given by Mr. Hopkins for the Mansfield sandstone, corrected in Secs. 13 and 14 by data obtained by Mr. Siebenthal. See map. In the N. E. corner of Sec. 14 a well on J. L. May's place found 44 ft. of rather soft shale below 60 ft. of drift. This township may be considered as containing no workable coal.

TOWNSHIP 23 NORTH, RANGE 8 WEST.

230. LOCATION, ETC.—This township occupies the center of the northern row of townships. It corresponds in area with Pine township of the civic townships. Its nearest points of shipment are at present Pine Village and Winthrop, on the C. & E. I. R. R. It is traversed by Pine creek, along which occur all the outcrops and coal exposures.

231. STRATIGRAPHY AND COALS.—As far as observed, the rocks of this township belong to: First, the drift; second, Divisions I and VI of the coal measures, and, third, Lower Carboniferous rocks. The drift acquires a great thickness in this township; a drilling in the northeast of southwest of Sec. 2 is as follows:

231. SECTION 14. SECTION OF BORING ON MRS. SARAH PEARCE'S PLACE.—Sec. 2 (C. E. S.).

	Ft.
Soil	15
Sand and clay	232
Shale (Riverside)	20

A well on the John McCandlish place, S. E. corner of Sec. 26, went 93 ft. in drift without striking rock.

232. The following section on Mud Pine creek includes the lower part of Division VI (?) and top part of Division I.

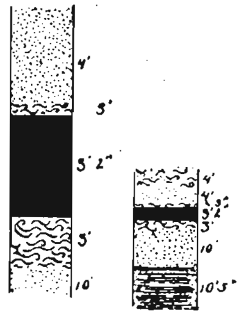


Fig. 23. Columnar section at McKey mine.
Fig. 24. Coal section at McKey mine.

SECTION 15. SECTION AT McKEY'S BANKS.—Sec. 29, S. W. of N. E., Figs. 23 and 24 (E. M. K.).

		Ft.	In.
1.	Surface clay	4	0
2.	Shelly sandstone	4	0
3.	Blue fire-clay	0	3
4.	COAL VI ?	3	2
5.	Fire clay, drab, with but little sand	3	0
6.	Shelly sandstone	10	0
7.	Blue clay shale and thin interstratified limestone	10	5
		34	5

Coal VI (?) here is reported to be a fair grade of semiblock coal, ranging from 1 ft. 6 in. to over 3 ft. in thickness, overlain by sandstone or drift and underlain by fire-clay. An analysis of the coal from this point showed (Cox):

	Top.	Middle.	Bottom.
Fixed carbon	57.50	54.70	52.25
Volatile combustible matter	32.00	33.80	28.75
Total combustible matter	89.50	88.50	81.00
Ash	7.00	8.00	16.00
Moisture	3.50	3.50	3.00
Total waste	10.50	11.50	19.00

The top part is a semicaking coal, brilliant black, with soft carbonaceous matter between the laminae, giving a puffed, brilliant liminate coke; the bottom part is sulphury and with the middle gives a coke not puffed, laminate and glossy. At one point the shales and sandstones, No. 7, show wavy and irregular bedding, as in Fig. 25.

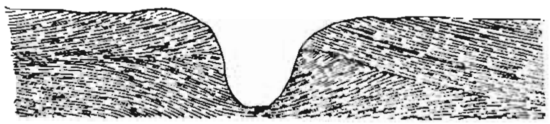


Fig. 25. Irregular bedding of shale an Mud Pine creek. From sketch by Mr. E. M. Kindle.

The Mansfield sandstone of Division I crops out along both creeks, but not so as to expose well its thickness. No coal is reported at the horizon of Coal I.

233. The Lower Carboniferous rocks show only a soft, friable sandstone in Sec. 23.

234. DISTRIBUTION.—The drift covers the whole area, and with considerable depth, as indicated above.

235. DIVISION I outcrops along Pine creek from Sec. 23 to Sec. 33, and up Mud Pine creek to the N. E. ¼ of Sec. 29. For details see Mr. Hopkins' report as above. The area of its outcrop is roughly shown on the map. As far as known it contains no coal.

236. DIVISION VI (?) outcrops along the west side of Mud Pine creek, coming nearer to drainage until in the north part of Sec. 29, at the Harvey McKey's bank it is about 18 ft. above drainage. Mr. Collett gave the section at this point as showing three coals. Mr. Kindle finds the section to contain but one coal, as indicated in the section given in ¶232. No coal has been mined here in many years. The section given by Mr. Collett is:

Laminated coal, good	4 in.
Choice blacksmith coal	1 ft. 6 in.
Laminated coal	6 in. 2 ft. 6 in.

He describes the coal at this point as a compact, clean, lustrous, semicaking coal, which burns to a white ash. See ¶232.

237. A short distance above the McKey bank the following section is exposed on the west side of Mud Pine creek. (E. M. K.)

Surface, 3 ft.; shelly sandstone, 4 ft. 6 in.; blue clay, 2 ft.; massive sandstone, 2 ft. 6 in.; soft sandstone and streaks of coal, 6 ft.; blue clay and streaks of coal, 1 ft. 3 in.; conglomerate of ironstone pebbles, 1 ft. 8 in.; black bituminous clay, 2 ft. (?); blue shale, 4 ft.

238. Up stream from this Mr. Collett describes the coal as occurring "in pockets at the crest of 'rolls' or 'waves,' from 4 to 7 ft. high, and with a space of from 70 to 150 ft. between." See Figs. 1 and 2. Going northward the spaces between the pockets diminish. It is difficult to understand how the coal could occur in pockets at the "crest" of the "waves." In a drift opened by the Lafayette Mining Company, in the N. E. corner of Sec. 19, five of these "waves" were crossed nearly at right angles. The pockets of coal are described as "flattened cylinders or elongated trapeziums, crushed when in a plastic state, from one to three feeet thick and connected by a parting or thread of carbonoceous matter." This description would indicate simply very small basins of coal such as on a larger scale are common all through the coal measures, and other descriptions by Mr. Collett referred to as similar to this confirm this view.

At a small opening on the Lamb place, Sec. 20, N. W. corner, the coal is at water level, and the coal ranges from 17 in. to 3 ft. thick. A short distance south of this, 50 ft. of drift makes the roof of the coal, which here is slightly below the level of the branch.

The limits of Division VI to the east is shown on the map. The evidence would indicate that the coal in this township occurs in small pockets, most of which are not workable, and that it would not be wise to risk much of an expenditure, even though a drilling showed 3 or 4 ft., until the ground had been very carefully proven.

Township 22 North, Range 8 West.

Section 1. Geographic.

239. Location.—This township lies about in the center of the county and corresponds with the eastern four-fifths of Liberty of the civic townships. See Sheet A and Plate XV.

240. Topography.—The topography of this township is rendered somewhat rugged by the deep cutting of Pine creek and its tributaries, which have eroded channels from 100 to 150 ft. deep, with often quite precipitous banks. The general surface slopes slightly to the south, and from either side towards Pine creek.

241. Transportation Facilities.—At present there are no railroads entering the township. The Wabash railroad just touches the southeastern corner, and the C. & E. I. railroad lies less than two miles east of the boundary.

Section 2. Stratigraphy and Coals.

242. Divisions Contained.—Divisions VI, V, I and IV (?), and also outcrops of the Knobstone (Riverside) of Lower Carboniferous age.

243. Sections of Divisions V and VI.—The following sections will show the relations of the three coals of these divisions. See Plate XV.

244. Section 16. Section on Fall Creek.—Opp. Thomas mine, Sec. 20, Fig. 2 (E. M. K.).

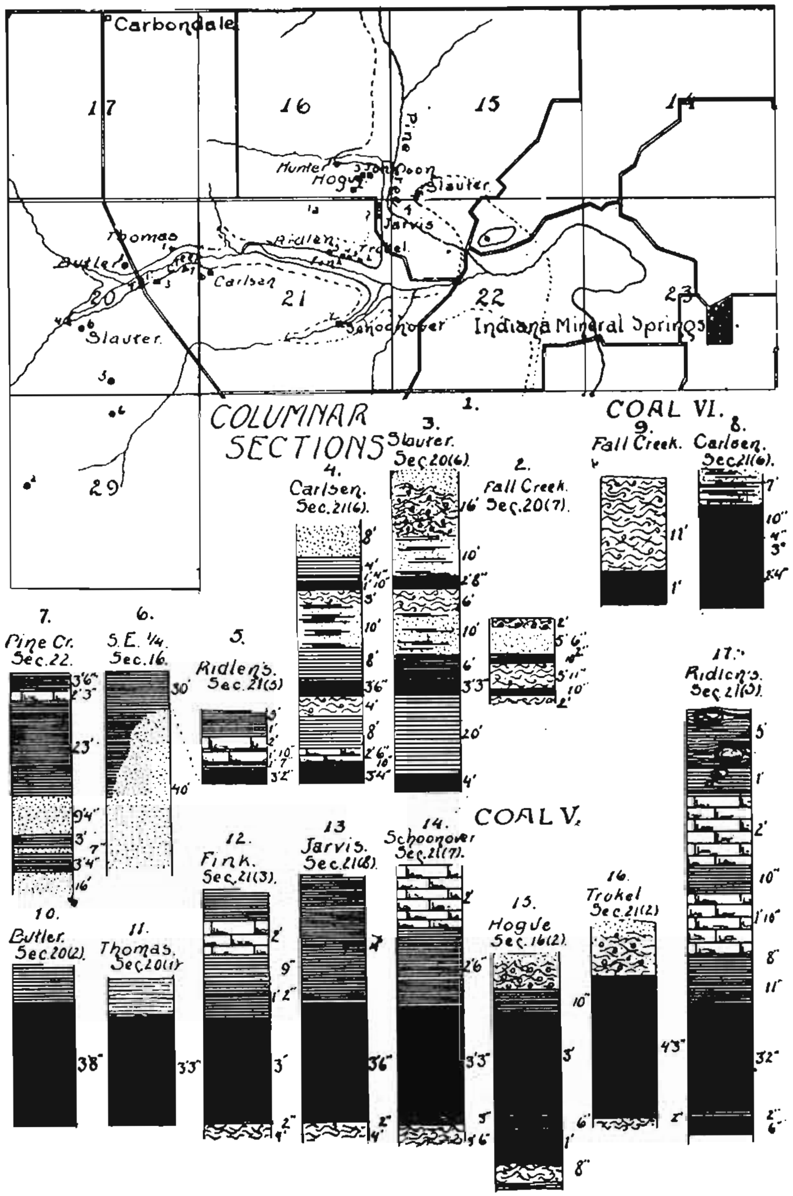


Plate XV.

Fig. 1. Sketch map of part of T. 22 N., R. 8 W.
Figs. 2-7. Typical columnar sections.
Figs. 8 and 9. Coal sections of Coal VI.
Figs. 10-17. Coal section of Coal V.

	Thickness of Strata. Ft.	In.	Coals and Spaces. Ft.	In.	Totals or Depths. Ft.	In.
1. Drift..............1 ft. to	2	0	..	..	2	0
2. Sandstone..........1 ft. to	5	6	..	..	7	6
3. Soft bluish shale.........	..	7	..	..	8	1
4. COAL VIa...............	..	10	0	10	8	11
5. Gray sandy fire-clay, hard.	5	11	5	11	14	10
6. COAL VI................	..	10	..	10	15	8
7. Light drab fire-clay, sandy, soft	2	0	..	..	17	8

245. SECTION 17. SECTION AT CARLSEN MINE.—Sec. 21 (6), Fig. 4. (J. C., p. 237.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Slope....................	..	..	..	..	..	..
2. Yellow sandstone........	8	0	..	..	8	0
3. Hard ferruginous shale and ironstone..........	4	0	.	..	12	0
4. Black sheety shale.......	1	4	..	..	13	4
5. COAL VIa..............	1	10	1	10	15	2
6. Fire-clay................	3	0	.	..	18	2
7. Shale and shaly sandstone	10	0	..	..	28	2
8. Clay shale and sand shale with ferns and coal plants.................	8	0	21	0	36	2
9. COAL VI....4 ft. 6 in. to	3	6	3	6	36	8
10. Fire-clay................	4	0	..	..	43	8
11. Blue shale........6 ft. to	8	0	..	..	51	8
12. Limestone or calcareous shale..................	2	6	..	..	54	2
13. Black shale.............	..	10	15	4	55	0
14. COAL V under water, reported	3	4	3	4	58	4
15. Fire-clay................	..	..	..	..	..	..

246. SECTION 18. SECTION OF BORING ON SLAUGHTER PLACE.—Sec. 20 (6), Fig. 3 (E. M. K.).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	16	0	..	..	16	0
2. Sandstone and shale........	10	0	..	..	26	0
3. COAL VIa..................	2	8	2	8	28	8
4. Fire clay	6	0	..	..	34	8
5. Sandstone and shale	10	0	..	..	44	8
6. Black shale	6	0	22	0	50	8
7. COAL VI	3	8	3	8	54	4
8. Clay shale	20	0	20	0	74	4
9. COAL V ("not good")	4	0	4	0	78	4
10. Fire clay	..	..	..	..	..	..

247. Where Mr. Kindle made his section, the strata from Coal VI to Coal V were not exposed. However, most of those strata are contained in another section made by him further down Fall creek, as follows:

SECTION 19. SECTION AT RIDLEN BANK.—Sec. 21 (5), Figs. 5, 17.

	Ft.	In.
1. Black calcareous shale, with molluscan fossils and large concretions	5	0
2. Dark blue shale with small lime and iron concretions	1	0
3. Limestone, fossiliferous, black....................	2	0
4. Soft black shale ....8 in. to	..	10
5. Limestone, dark blue	1	10
6. Soft black shale		8
7. Hard bluish black shale		11
8. COAL V—Coal, 3 ft. 2 in.; bone, 2 in.; coal, 6 in..	3	10
9. Fire clay		..

About the mouth of Fall creek and for a half mile down Pine creek the bluffs are composed of black shale which is supposed to lie below Coal V and unconformably above the sandstone of Division I. See Fig. 7. The relation of the shale to the sandstone is exhibited by Figs. 18-20 in Part II and Fig. 6 from sketches by Mr. Kindle.

These indicate quite a notable unconformity between the divisions of the coal measures. These shales may be considered as belonging to Division IV (?). At one point half a mile below the mouth of Fall creek, they present the following section:

248. SECTION 20. SECTION ON PINE CREEK.—Sec. 22, Fig. 7 (J. C., p. 240).

	Ft.	In.
1. Black carbonaceous shale	3	6
2. Bituminous and shaly limestone with fossils......	2	3
3. Blue and black shale, bands of concretionary limestone	23	0
4. Thinly laminated quartzose sandstone with sun cracks, reptilian tracks and plants........1 ft. to	2	4
5. Flaggy sandstone ....3 ft. to	7	0
6. Black carbonaceous shale ....2 ft. to	3	0
7. Quartzose sandstone	..	8
8. Dark shale	3	4
9. Laminated sandstone	2	0
10. Irregularly bedded sandstone	14	0
	61	1

The position of the black limestone in this section suggests that the black shales, to a certain extent, occupy the horizon of Coal V.

249. DRIFT.—The sections given only indicate a slight depth of drift. Away from the two principal stream channels, however, the drift is found to have a considerable thickness. Thus, in the N. E. corner of Sec. 15, the drift shows as follows:

250. SECTION 21. SECTION ON JOHN MEYER'S PLACE.—Sec. 15 (11), (C. E. S.).

	Ft.
Clay	22
Gravel and sand (water)	18
Blue clay	100
	140

And similar sections occur at other places showing an average depth of probably not far from 100 ft.

251. DIVISION VI.—This division carries two coals as far as observed. The upper one—VIa—is seldom, if ever, of workable thickness. In the drilling (¶246) it is reported to be 2 ft. 8 in. thick. Sometimes overlain by black shale, sometimes with sandy shale.

Coal VIa was formerly stripped on the Thomas place, from which place the coal analyzed as follows: (Cox.)

Fixed carbon	49.50
Volatile combustible matter	33.50
Total combustible matter	83.00
Moisture	4.50
Ash	12.50
Total waste	17.00

252. COAL VI locally attains a workable thickness. At the Carlsen bank it runs 3 ft. 6 in. thick, including 4 in. of somewhat bony coal, occurring 10 in. from the top. In the drilling it is reported as 3 ft. 3 in. In many cases, however, it ranges nearer a foot in thickness. In Mr. Collett's section Coals VIa and VI are separated by 21 ft. of shale and sandstone. In sections obtained by Mr. Kindle they are 6 to 11 ft. apart, separated by fire-clay only. At the Carlsen (old Keister or Luppoldt) bank this coal is described as a block coal, mining in the characteristic slabs, and having a dull lustre and heavy ring. It burns to a white ash, without clinker and with little flame. An analysis of coal from there showed:

	Top.	*Middle.*	*Bottom.*
Fixed carbon	49.00	52.50	57.00
Volatile combustible matter	37.00	33.50	35.50
Total combustible matter	86.00	86.00	92.50
Ash	9.50	9.00	4.50
Moisture	4.50	5.00	3.00
Total waste	14.00	14.00	5.50

These analyses show the lower part to be much the best coal, though the other parts are but litttle below the average.

253. DIVISION V.—This division contains the coal principally worked in this township. As shown in Figs. 10 to 17, it ranges from 3 ft. to over 4 ft. in thickness. It is characteristically overlain by black sheety bituminous shale, with *lingula*, etc., and that in turn by one or sometimes two strata of dark to black limestone. It is characteristically underlain by a little bony coal, and in a few cases that in turn is underlain by a thin bed of poor coal. The overlying strata are very similar to strata overlying Coal V (K of old survey) over most of the coal counties. See general discussion, Part II. The rest of Division V is largely shale. The composition of this coal is shown by the following analyses by Cox:

	Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Ash.	Moisture.
A. C. Jarvis, top 6 in.........Sec. 21 (7)....	88.50	38.00	50.50	5.00	6.50
A. C. Jarvis, middle 22 in.....Sec. 21 (7)....	93 50	40.00	53.50	2.75	3.00
A. C. Jarvis, bottom 14 in.....Sec. 21 (7)....	84.50	33.00	51.50	3 50	12.00
Schoonover, top 10 in.........Sec. 21 (8)....	87.00	37.60	49.40	3.50	9.50
Schoonover, bottom 32 in......Sec. 21 (8)....	89.25	34.00	55.25	4.50	6.25
Average..................................	88.55	36.52	52.03	3.85	7.45

These show the coal to average fairly. The amount of ash is high for a block coal. The coal has the characteristic soft carbonaceous partings.

254. DIVISION IV.—To this division are assigned the shales which in the main lie below the coals and seem to fill eroded depressions in the sandstone of Division I. The similarity of the coal and bone underlying Coal V to the coal and bone underlying Coal III in Clay county has suggested a possible correlation. See Part II.

255. DIVISION I.—This shows a thickness of up to 40 ft. of sandstone and layers and lenticular masses of black shale. The black shale in Fig. 7, No. 6, of Sec. 20, ¶247, appears to mark the horizon at which coal is occasionally found in the southern part of the county. No coal has been found in this division in this township. For details of the sandstone see Hopkins, pp. 297-299.

256. UNDERLYING ROCKS.—In the southeastern quarter of the township the underlying rock is sandstone, with a thickness of up to 60 ft. In the S. W. corner of Sec. 15 a drilling showed as follows:

257. SECTION 22. SECTION OF HARVEY MCALISTER'S WELL.—Sec. 15 (C. E. S.).

	Ft.
Soil and drift	112
Clay shale	8
Blue clay	12
Light gray sandstone	15
Blue clay	47
	195

The strata below the drift are believed to belong to the Knobstone group. (Riverside.)

Section 3. Distribution of Divisions.

258. DIVISION I underlies all of the township except a small area in the southeast corner, as indicated on the map. For details see Mr. Hopkins' report as above.

259. DIVISIONS VI AND V.—These divisions are confined to the west side of Pine creek, as shown on the map, except where they cross at Dixon's mill. Only a small area of Coal V exists on the east side of Pine creek at this point. At the W. L. Slaughter bank in Sec. 15, Coal V ranges from 3 ft. to 3 ft. 8 in. The roof is black shale only a few inches thick, overlain at the shaft by 16 ft. of drift. The roof is pretty fair, but the coal is cut out and replaced by the drift in many places. The McAlister well (¶257) is on the same level and about 400 yards east, and indicates that the coal is extensively cut out in that direction. The flat under which coal might occur covers about 40 acres, but in all probability the coal is cut out over much of that. Mr. Kindle has also located a coal bank above Dix's mill, just north of the center of Sec. 22, and small area of coal as mapped.

Following the outcrop of the horizons of these divisions down the western bank of Pine creek, no coal is seen in Secs. 4 and 9, though its presence is suggested at one or two points.

260. In the S. E. ¼ of Sec. 16 several mines have been opened, notably on the Hunter place, Sec. 16 (1), by a slope on Coal V; by shafts on the Johnston place, Sec. 16 (2 and 3), and by shaft on the Hogue place, Sec. 16 (4). At the Hogue mine (see Fig. 182) the coal is 50 ft. deep, and ranges from 2 ft. up to 3 ft. 4 in., averaging about 3 ft. The coal is a semi-block, the lower two-thirds resembling block coal in places. It sometimes contains a dirt band 14-16 in. from the bottom, and the upper ten inches contain thin charcoal streaks. It burns to a gray ash with a little clinker. The roof is black shale, 10 in. thick, overlain by glacial clay. The roof is not very good and tends to cave in badly if the shale is broken through. The floor is made of, first, 4 to 6 in. of bone coal, then below that is 1 ft. of poor block coal. This in turn is underlain by 6 to 8 in. of fire-clay, and that by 8 ft. of clay shale. The coal is frequently cut out and replaced by glacial clay, and faults of up to 1 ft. downthrow are common. It is said that boulders occur in the coal on the east of the shaft, the coal being harder there than on the west. On account of the thinness of the roof, it is necessary to mine without powder. Most of the product of this mine goes to the Mineral Springs.

261. Following the outcrop of Coal V up the north bank of Fall creek, the coal is first seen at the Jacob Trokel drift, Sec. 16 (2), being opened in 1897. The coal is here about 15 ft. above Fall creek. At the mouth of the entry the coal measured 4 ft. 3 in. See Fig. 16. Inside 64 ft. the coal runs between 3 and 4 ft., with one or two inches of bone at the bottom and fire-clay below that. The roof of the coal is drift clay, and as a result the coal is very pockety, being cut out frequently and replaced by drift.

262. At the Ridlen drift, Sec. 16 (5), Coal V is still 10 to 12 ft. above the creek. The coal is here 3 to 4 ft. thick. For whole section, see ¶247 and Fig. 17. The top 9 in. of the coal is soft, free of sulphur, and contains streaks of charcoal. It furnishes most of the nut coal. The bottom 15 in. contains a good many sulphur bands or patches up to 3 or 4 in. thick. The coal below the 9 in. of top coal blocks out well without the use of powder, the slips, however, not being regular in their direction, or in their distance apart, which varies from a few inches to 2 ft. The roof is very good, not having weathered any in the main entry. The underlying 4 or 5 in. of coal is

only found in places. In places it runs up to 1 ft. 6 in. thick, separated by an inch of fire-clay from the worked coal. It is bony and does not burn well.

At some old drifts between this and Trokel the limestone comes down, making the roof of the coal. The general dip here is to the west, which brings the coal down to the creek bed before the west side of Sec. 21 is reached.

263. In Sec. 18 one of the top coals was stripped many years ago on the Thomas place, Sec. 20 (1). It was there 1 ft. 8 in. thick. See analysis, ¶250. For the last 15 years or more they have mined Coal V by a slope 10 ft. deep, the coal being 5 or 6 ft. below the creek, and from 3 ft. 3 in. to 4 ft. thick. It is said not to block well, powder being used in mining, and had a very good roof. See Fig. 11.

264. A little farther up is the Butler shaft, where the coal is 45 ft. deep, and runs 3 ft. 8 in. thick on the average. The coal is semi-block, has to be shot, and has a fair, though soft, shale roof. A little bone underlies the worked coal. See Fig. 10.

265. Coal VI (?) outcrops on the Isaac Slaughter place, Sec. 20 (5), and is there about 30 ft. above the same coal at the east line of Sec. 20. Just east of the road, below Butler's, a new drift was being opened on Coal VI in 1897. The coal is here 2 ft. above the creek. It is 1 ft. 7 in. thick, is overlain by 5 ft. of shelly sandstone and underlain by 2 ft. of bluish-gray sandy fire-clay.

266. Opposite the Thomas bank occurs the section given in ¶244. A little further down the following section shows in the bank:

SECTION 23. SECTION SOUTH SIDE OF FALL CREEK.—Sec. 20 (3), Fig. 9 (E. M. K.).

	Ft.	In.
Surface, 9 ft.; shelly sandstone, 4 ft. to 6 ft.; micaceous clay shale, 6 ft.	21	0
Place of coal—		
Fire clay	11	0
COAL VI	1	0
Gray fire clay, 5 ft.; sandstone, rough bedded, 4 ft.	9	0
	42	0

267. A little further down is the Carlsen bank (formerly the Keister or Luppoldt), on Coal VI. The coal is 8 or 10 ft. above the creek, and runs from 2 ft. 4 in. to 3 ft. 8 in. The section here is given in ¶245, and the coal is discussed and its analysis given in ¶251, Fig. 8.

The roof is of shale and is poor when wet. This mine shows local dips in every direction, but has a general westerly dip. The top 2 or 4 in. of the coal is soft. It is mined partly by pick and partly with powder. Both rolls and faults occur in this mine.

268. Of the banks not now in work in this section, Mr. Collett gives sections at three as follows:

	Fink. W. ½, N. E. ¼. *Fig. 12.*		*Jarvis.* N. E. ¼, N. E. ¼. *Fig. 13.*		*Schoonover.* W. ½ S. E. ¼. *Fig. 14.*	
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Slope	..	..	..	..	30	0
Bituminous limestone	2	0	..	..	2	0
Lingula shale	..	9	..	..	..	..
Black bituminous shale	1	2	4	0	2	6
Coal V—						
Soft or rough caking	..	6	..	6	..	10
Semi-block	1	4	1	10	1	7
Block	1	2	1	2	..	10
Bone	..	2	..	2	..	3
Total of coal	3	2	3	8	3	6
Fire-clay	4	0	4	0	3	6

269. Above the bridge in the center of Sec. 22 the sandstone of Division I outcrops in the bed of Pine creek for 100 yds., and on the eastern bank shows a ledge of cross-bedded iron stained stone 15 ft. high. On the west bank opposite this the shales of Division IV (?), 55 ft. thick, extend down to the water. This shale is well exposed in the bluffs for half a mile down Pine creek from here. See section given in ¶248.

270. South of this, down Pine creek, no coal exposures were found, the hillsides usually being heavily mantled with drift.

271. A considerable amount of prospective drilling has been done in this district by different companies. The Lafayette company put down a shaft on the Schoonover place without striking coal, and the shaft was abandoned. The coal where the shaft was located was probably cut out and replaced by the drift. During the '80's the Fountain County Coal Company made a number of test drillings, but owing to lack of transportation facilities no shaft was sunk. It is claimed that these drillings showed the upper bed to thin out to the southwest, and that the two upper beds were frequently replaced by drift clay.

In ¶246 was given a boring on the Isaac Slaughter place, showing all three coals of workable thickness, if the drilling is reliable. In the S. W. of S. E. of Sec. 20, a drilling is reported to have shown the upper coal to be 6 in. thick, and Coal V 3 ft. 6 in. thick. In the N. W. of N. E. of Sec. 29, Coal V is reported to be 4 ft. 4 in. thick and 80 ft. deep. The upper coal is 2 in. thick. In the S. W. of N. W. of Sec. 29, Coal V is 90 ft. deep, 3 ft. 8 in. thick, with 20 ft. of shale for roof. Above that is 70 ft. of drift. These indicate the presence of a considerable body of workable coal.

Township 21 North, Range 8 West. (Part in Warren County.)

272. Statement.—This partial township appears to contain no workable coal. Williamsport, in the northeastern part, is the county seat of Warren county. The part of the township north and east of Rock creek corresponds with Washington of the civic townships, the area south and west of Rock creek belonging to Pike township. The Wabash railroad crosses the northern part of the township from east to west.

The country west of Williamsport is rolling, rising gradually westward, reaching its maximum height about 3 mi. west of town. To the north it rises gradually for a mile, forming a broad, nearly flat ridge, which stretches westward. This is dissected by the tributaries of the Wabash, and, as it approaches that river, breaks off into the river bluffs. The elevated points are 150 to 200 ft. above the river.

273. Stratigraphy and Coals.—The coals found belong to Divisions I, IV andV. As in the last township, a marked unconformity exists between Division I and the underlying and overlying rocks. Coal is only reported at scattering points, principally Coal I. An exposure in the bluff on Rock creek, just above the road from Lebanon, shows well the details of Divisions I and V.

274. Section 24. Section on Rock Creek.—Sec. 18 (C. E. S.).

	Ft.	In.
Division V—		
1. Drift	12 ft. to 15	0
2. Shale, yellow	1	0
3. Limestone, shaly, impure, noncrystalline	1	2
4. Limestone, blue to black, noncrystalline, cherty at south end, few fossils	4	0
5. Shale, black	3	6
6. Shale, black, sheety	..	8
7. Shale, jointed in structure	1	0
8. Shale, gray	..	4
9. Limestone, ferruginous, nodular, jointed, with fossils	..	6
10. Fire clay or clay shale	..	4
Division IV (?)—		
11. Shale, black	3	0
12. Shale, black sheety	1	0
13. Shale, black	26	0
Division I—		
14. Sandstone (Mansfield)	10 ft. to 15	0
15. COAL I	0 ft. to 1	0
16. Sandstone, white	1	0
17. Shale, soft white, micaceous	10	0

At this point the sandstone of Division I may have been eroded, and replaced by the shales of Division IV. See Fig. 5, in Mr. Hopkins' report. (T. C. H., p. 294) and ¶276.

275. Division I shows its massive sandstone over most of the townships to range between 20 and 30 ft. Around Williamsport it is found thicker, ranging up to 50 ft. of clean, massive stone. Coal I varies from nothing up to 2 ft. and usually occurs in basins of very limited extent, often being only a few yards in diameter.

276. The Lower Carboniferous rocks underlying Division I consist sometimes of shale, sometimes of sandstone. Thus, a bore hole from a test shaft on the Leclaire place, in Sec. 19, N. W. of N. E., gave, below the horizon of Coal I: Fire-clay, 25 ft.; sandstone, 55 ft. In a drilling in the N. E. corner of Sec. 3, 47 ft. of shale and sandstone were passed through below the horizon of Coal I. These rocks are probably of Knobstone age (Riverside, of Hopkins).

277. Distribution of Coal.—No coal is reported about Williamsport. The Mansfield sandstone appears at the falls of Fall creek, in town. An old preglacial channel passes 100 or 200 yds. northwest of the falls, as the well at the electric light plant, 100 yds. up stream and 10 ft. above the level of the sandstone in the bed of the creek, went 56 ft. through sand and gravel before striking rock, and other wells in this vicinity go from that up to 100 ft. deep before striking rock.

In the S. E. of the S. W. of Sec. 11 is an outcrop of coal apparently at the horizon of Coal V, as it overlies the Mansfield sandstone, here 35 to 40 ft. thick, from which it is separated by from 2 to 4 ft. of fire-clay. It is overlain by a foot or so of sandy shale, and that in turn by sandstone. The overlying material casts some doubt on the correlation of this coal with Coal V. Some 12 or 15 years ago it was stripped some 50 yards south of the outcrop in the road. It was there reported to be 1 ft. thick. Only a few wagon loads were taken.

On the J. H. Herrick place, S. W. of N. W. Sec. 14, a pocket of coal 2 ft. thick in the middle and thinning out to the edges was struck under the Mansfield sandstone in a branch. It furnished a few wagon loads. Fifty feet south of this two holes were dug back under the sandstone, following a bed of bone coal, in the hope that it would give place to coal. Fig. 26 shows the relations found at this place.

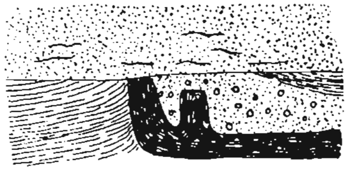


Fig. 26. Peculiar position of Coal I in mine on J. H. Herrick place, sec. 14. Sketch by Mr. C. E. Siebenthal.

The overlying sandstone contains many small veins of coals. Under it is a curious conglomerate or breccia 2 ft. thick, and that in turn is underlain or invaded by a layer of bone coal or shale as in the figure. A boring down the hollow and 10 to 12 ft. lower struck rock at a depth of 1 ft. and went 80 ft. in it without getting through. Probably Riverside.

In the S. W. of S. E. of Sec. 15 is an outcrop of Coal I. A drilling on this same 40 acres showed: Soil, 5 ft.; sandstone, 27 ft.; Coal I, 4 to 5 in.

In the S. W. ¼ of Sec. 15, one well found the drift 65 ft. thick, while another well 400 yards southeast struck sandstone at 2 ft.

In the S. E. 40 of Sec. 17 a drilling showed: Drift, 47 ft.; sandstone, 13 ft.; coal, thickness unknown. Another well a little lower struck 30 ft. of drift and 28 ft. of sandstone. A well on the Bowlus place, S. W. of N. E. of Sec. 17, went 100 ft. and showed no coal. It may have started below Coal I, as it was in a hollow. In N. E. of S. W. of Sec. 17, on the Etmyer place, a boring passed through 60 ft. of drift, 20 ft. of sandstone and into coal (Coal I).

In Sec. 18, 6 to 8 in. of coal is reported under sandstone in the N. W. corner of S. E. ¼ of S. E. ¼ (Coal I). The section on Rock creek in the S. W. of S. E. ¼ was given in ¶273. In the N. W. corner of N. E. of N. E. of Sec. 19, in the east bluff just below the road, is the coal bed given in that section. The irregularity of its occurrence is shown in Fig. 27.

In Sec. 20, S. E. of S. W., on the south side of Rock creek, the base of the Mansfield sandstone contains a layer of coarse conglomerate, and lenticular masses of coal. Mr. Collett reports Coal I as occurring on the David Biser place, N. E. ¼ of Sec. 19, where it occurs in basins or pockets a few hundred yards long, the intervening ridges being 6 to 10 ft. higher than the basins. Several years ago a test shaft was sunk in the valley of Rock creek in the N. W. of N. E. of Sec. 19 by Joseph Leclaire, which gave as follows: Soil, 9 ft.; bone coal and streaks of good coal, 5 ft. Two feet of coal was reported 40 rods down the creek from this.

Fig. 27. Occurrence of Coal on Rock creek. Sketch by C. E. Siebenthal.

Some years ago, Spears, Brown & Co., put down test borings on E. Briggs' land, S. W. ¼ of Sec. 8, E. Slusser's land, N. E. ¼ Sec. 8, and J. Etmyer's land, N. W. ¼ Sec. 5. They report finding three seams of coal, but none over 1 ft. 3 in. thick. On the south half of the N. E. ¼ of Sec. 5, Mr. O. Swank reported 3 ft. of coal at a depth of 82 ft. It may be that this well was salted, as it now turns out that the three wells drilled for Dr. Boyer, in Sec. 3 were. See J. C., p. 208. At Mr. John Ridenour's well, in the N. E. of N. E. of Sec. 3, there is reported: Drift, 65 to 70 ft.; sandstone, 25 ft.; coal and associated shale, 5 ft.; shale and sandstone (Riverside) 47 ft.

Townships 22 and 23 North of Ranges 9 and 10 West.

278. Statement.—These townships make up the northwestern part of Warren county, and correspond to the civic townships of Prairie, Jordan and western Liberty. The country is a high rolling prairie deeply covered with drift.

279. Coal has been reported in deep wells, as follows: In Sec. 15, 23-10; just across the Illinois line in the S. E. ¼ of Sec. 31, at a depth of 140 ft.; in the S. E. ¼ of Sec. 19, 22-9, at 130 ft., and on the opposite side of the road in Sec. 20. The horizons of Coals I, V, VI and VIa are all of them under this area, but the depth of the drift would indicate that they may be largely eroded. On the other hand it would not be greatly surprising if considerable basins of workable coal be discovered later.

Township 21 North, Range 9 West.

280. Statement.—This township corresponds with portions of Steuben and Pike of the civic townships. In surface conditions it resembles the township further north, but becomes more broken towards the lower part of Redwood creek.

281. Coal has been found at a few places. At West Lebanon a well bored for water was reported to have passed through 3 ft. of coal at a depth of 150 (?) ft. This led to the formation of a mining company which sunk a shaft to a depth of 121 ft. and bored some distance farther. The record of what was passed through is given as follows:

282. Section 28. Section of Shaft and Bore at West Lebanon.—S. W. ¼ Sec. 12, Fig. 28 (J. C., p. 220).

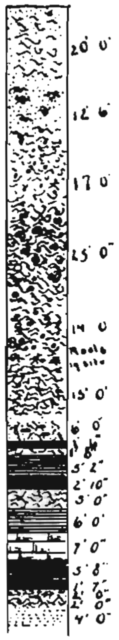


Fig. 28. Section of shaft and bore at West Lebanon.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and clay	20	0	..	..	20	0
2. White, yellow and black sand pocketed in clay, with sandstone fragments	12	6	..	..	32	6
3. Blue clay and gravel	17	0	..	..	49	6
4. Dark clay with sandstone and large granite boulders	25	0	..	..	74	6
5. Blue and green clay with pebbles	14	0	..	..	88	6
6. Black mold, roots of trees in situ	..	2	..	..	88	8
7. Dark clay and mucky soil filled with large limbs and roots of trees, apparently birch and pine	15	0	..	..	103	8
8. Disturbed sandstone with decomposed nodules of pyrites	6	0	..	..	109	8
9. COAL VIa—Coal, 8 in.; parting, 4 in.; coal, 8 in.	1	6	1	6	111	2
10. White clay and clay shale	1	8	..	..	112	10
11. Clay shale, fossiliferous	5	2	6	10	118	0
12. COAL VI—Coal, 1 ft. 0 in.; clay parting, 10 in.; coal, 1 ft. 0 in.	2	10	2	10	120	10
13. Fire-clay (in bore)	5	0	..	..	125	10
14. Blue shale	6	0	..	..	131	10
15. Dark limestone	7	0	..	..	138	10
16. Black shale	5	8	23	8	144	6
17. COAL V—Coal, 9 in.; pyrite parting, 5 in.; coal, 5 in.	1	7	1	7	146	1
18. Carbonaceous concretions	2	0	..	..	148	1
19. Fire-clay	2	0	..	..	150	1
20. Sandstone	4	0	..	..	154	1

Sinking, as it did, through over 100 ft. of surface and drift, this shaft section is of interest because showing the details of the drift much better than can be obtained in a drilling. The strata accompanying the coals show a close correspondence with the same horizons of Fall creek, in T. 22 N., R. 8 W. The coals here are none of them of workable thickness, and it suggests what may be expected all through this region. On the other hand, while a clay parting is apt to be very persistent, it would seem probable that there are large areas where it will be too thin to seriously interfere with mining. The pyrite parting is not apt to be persistent more than a few rods. Still, in any case, if the partings entirely disappeared, it would be necessary for the beds to fully double in thickness to be considered workable. Several wells at West Lebanon have pierced coal. Thus the gas well, N. W. of N. E. of Sec. 24, 1,600 ft. deep, is reported to have passed through 2 ft. 6 in. of bone coal and black shale at 65 ft., and at 110 ft. through 4 ft. of coal. A well at the corner of First and High streets is reported to have struck coal, the depth being variously reported at 100 to 140 ft. and the thickness at from 6 in. to 5 ft. It is said to have had 14 in. of shale on top and 10 in. below, and to have burned up without leaving any cinders. At Marshfield a 325-ft. well is said to have passed through 1 ft. of coal at 160 ft.

283. In Sec. 35, N. E. of N. W., limestone forms the bed of the creek at the road crossing. A short distance below the following section is seen:

SECTION 29. SECTION OF REDWOOD CREEK.—Sec. 35 (E. M. K.).

	Ft.	In.
Limestone, hard, blue, compact, 2 ft. 6 in. to........	3	0
Slaty shale	2	0
Blue shale	4	0
Black, sheety shale, with large calcareous ironstone concretions	1	0
Blue shale	5	4
Sandstone, massive, 40 ft. to........................	45	0

Going down the stream the limestone rises rapidly, exposing the massive sandstone at the bottom of the above section. In a short distance it runs out to the surface underlying the drift. The vertical cliff at this point is about 70 ft. high, the lower 40 to 45 ft. being the massive sandstone.

TOWNSHIP 20 NORTH, RANGE 9 WEST. (PART IN WARREN COUNTY.)

284. LOCATION.—This township includes the southernmost land in Warren county. It corresponds to the eastern two-thirds of Kent and Mound, and the southeastern corner of Steuben, of the civic townships.

285. TOPOGRAPHY.—The topography is considerably broken along the Wabash by the deep channels of Redwood creek and Possum run, and smaller intermediate streams. Away from the Wabash the country becomes more nearly level.

286. TRANSPORTATION.—The C., C., C. & St. L. R. R. crosses the southern part of the township. The C. & E. I. R. R. formerly had a branch to Coal Creek (Stringtown), Fountain county, which crossed this township diagonally. The Wabash R. R. almost touches the northwestern corner.

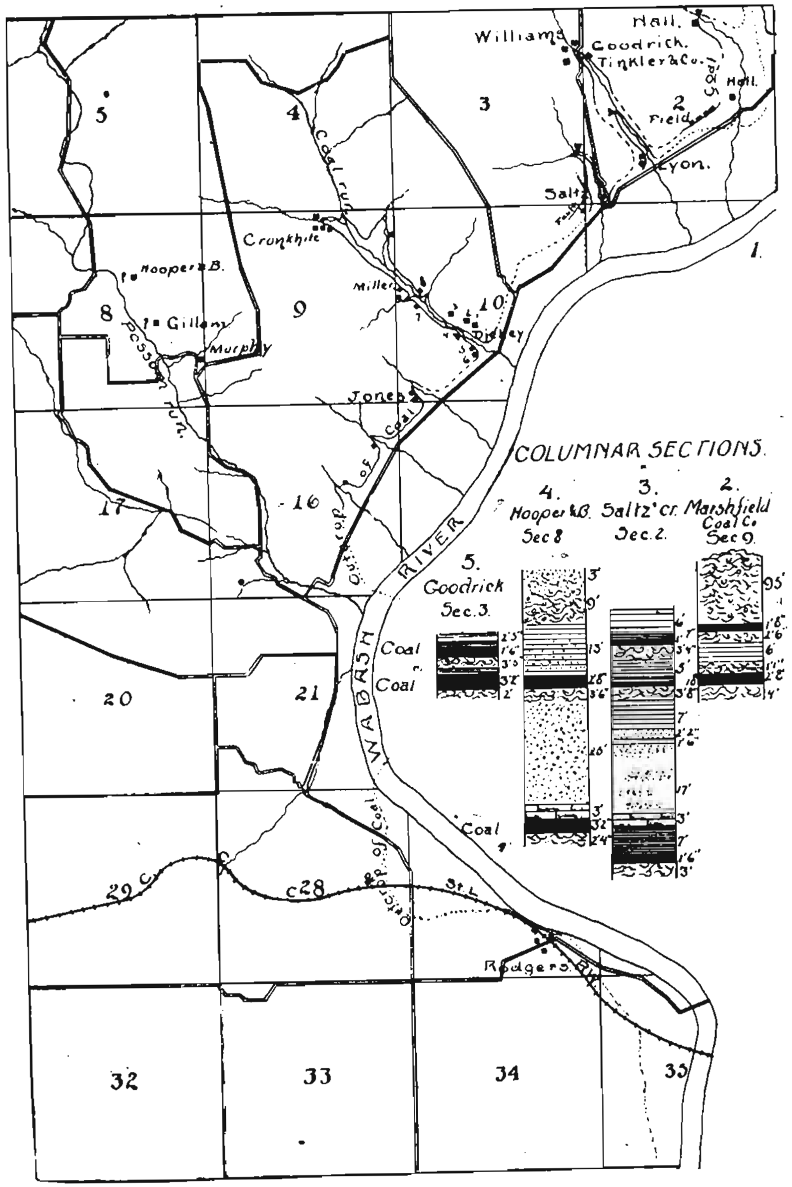


PLATE XVI.

Fig. 1. Sketch map of part of T. 20 N., R. 9 W.
Figs. 2-5. Typical columnar section.

Section 2. Stratigraphy and Coals.

287. Divisions and Coals Contained.—Divisions I, V and VI outcrop in this township. A small coal is reported near the top of Division I. Divisions V and VI are taken to include three coals and accompanying strata, which form the highest measures exposed. These three coals correspond with the three coals similarly designated in the preceding part of this county. Their correspondence with the typical section in Clay county is discussed in Part II. The underlying lower carboniferous rocks are exposed in the lower part of Redwood creek and adjacent region.

288. Stratigraphy.—The following columnar sections show the relations of the three coals mentioned:

289. Section 30. Section at Mansfield Coal Company's Mine.—N. E., N. E., Sec. 9, Fig. 2 (J. C., p. 215).

	Ft.	In.	Ft.	In.	Ft.	In.
Division VI—						
1. Slope, surface and drift....	95	0	..	..	95	0
2. COAL VIa................	1	8	1	8	96	8
3. Fire-clay	2	6	..	..	99	2
4. Clay shale	2	4	..	..	101	6
5. Clay shale with fossils.....	1	8	..	..	103	2
6. Dark clay shale	2	0	..	..	105	2
7. "Carbonaceous clod—imperfect coal"	1	1	9	7	106	3
8. COAL VI—Caking coal, 7 in.; laminated coal 9 in.; fat, resinous coal, 4 in...	2	8	2	8	112	11
9. Fire-clay	4	0	..	..	116	11

290. Section 31. Connected Section on Saltz Creek.—S. W. ¼, Sec. 2, Fig. 3 (J. C., p. 214).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Slope.						
Division VI—						
2. Gray shale	6	0	..	..	6	0
3. Black bituminous shale...	..	7	..	..	6	7
4. COAL VIa...1 ft. 6 in. to	1	0	1	0	7	7
5. Fire-clay with stigmaria rootlets	3	4	..	..	10	11
6. Sandy shale, yellow	1	4	..	..	12	3
7. Clay shale with iron nodules containing zinc blende	2	6	..	..	14	9
8. Soft bituminous shale.....	1	2	8	4	15	11
9. COAL VI.........4 in. to	..	10	..	10	16	9
10. Fire-clay	3	8	..	..	20	5

	Ft.	In.	Ft.	In.	Ft.	In.
Division V—						
11. Buff and yellow shale....	7	0	..	..	27	5
12. "Flaggy grindstone grits".	2	2	..	..	29	7
13. Buff shale	1	6	..	..	31	1
14. Gritty grindstone and covered	17	0	..	..	48	1
15. Black limestone	3	0	..	..	51	1
16. Blue and black shale.....	7	0	41	4	58	1
17. COAL V................	1	6	1	6	59	7
18. Fire-clay	3	0	..	..	62	7

291. Section 32. Section of Old Hooper & Barringer's Shaft and Bore.—N. E. ¼, Sec. 8, Fig. 4 (J. C., pp. 216-7).

	Ft.	In.	Ft.	In.	Ft.	In.
Division VI—						
1. Soil	3	0	..	..	3	0
2. Yellow clay with float coal	9	0	..	..	12	0
3. Clay shale changing to shaly sandstone	12	6	..	..	24	6
4. Clay shale with ferns, 2 in. to	..	6	..	..	25	0
5. COAL VI.........2 ft. to	2	8	2	8	27	8
6. Fire-clay	3	6	..	..	31	2
Division V—						
7. "Rock" (sandstone?) in bore	25	3	..	..	56	5
8. Hard limestone	3	0	31	9	59	5
9. COAL V................	3	2	3	2	62	7
10. Fire-clay	2	4	..	..	64	11

292. Section 33. Section at Goodrick's Mine.—N. ½, S. E. ¼, N. E. ¼, Sec. 3, Fig. 5 (J. C., p. 213).

	Ft.	In.	Ft.	In.	Ft.	In.
Division VI—						
1. Clay shale with fern leaves	1	2	..	..	1	2
2. Black sheety shale	..	5	..	..	1	7
3. Black bituminous shale...	..	10	..	..	2	5
4. COAL VIa, fat, caking, sulphurous	1	6	1	6	3	11
5. Fire-clay with stigmaria rootlets	2	2	..	..	6	1
6. "Black clay clod," with pyrite	1	3	3	5	7	4
7. COAL VI—Fair, laminated coal, 1 ft. 5 in.; good coking coal, 7 in.; pure blacksmith coal, 1 ft....	3	2	3	2	10	6
8. Fire-clay	2	0	..	..	12	6

293. Section 34. Section at Rodger's Mine.—S. E. ¼ Sec. 27 (J. C., pp. 218-9).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and gravel ...2 ft. to	10	0	..	..	10	0
Division VI—						
2. Fine laminated shaly sandstone (?)	10	0	..	..	20	0
3. Clay shale with ferns.... 6 ft. to	..	8	..	..	20	8
4. COAL	1	10	1	10	22	6
5. Fire-clay roots and stumps of stigmaria	3	6	..	..	26	0
Division V—						
6. Heavy - bedded flaggy sandstone	29	0	..	..	55	0
7. Calcareous ferruginous band ....6 in. to	1	3	33	9	56	3
8. COAL ....6 in. to	1	2	1	2	57	5
9. Fire-clay ....2 in. to	4	0	..	..	61	5
Division I—						
10. Beds of wedge-shaped (?) sandstone with carbonaceous partings	20	0	..	..	81	5
11. Massive sandstone, 5 ft. to	9	0	..	..	90	5

Some question exists as to the relative position of these coals. Mr. Kindle places Coal 8 in and near the top of the Mansfield sandstone, a very unusual position for coal. Mr. Collett correlates it with Coal V of preceding sections. Comparing it with Figs. 4 and 5, there seems to be good reason for thinking the 29 ft. of sandstone, No. 6 belongs in Division V rather than in Division I.

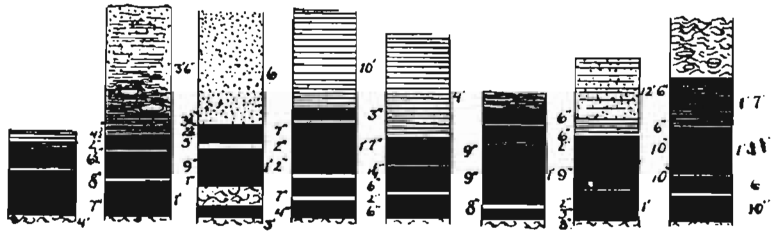
Fig. 29. Section of coal on Coal run. Sec. 10.

294. DIVISION VI contains two coals, the upper coal with one possible exception, nowhere workable in this area except by stripping, ranging everywhere less than 2 ft. thick as far as known. It is usually overlain by black shale, often sheety. On Coal run in Sec. 10,

a coal which seems to occupy the position of this one shows as a double seam with total thickness of coal of 7 ft. 9 in., the two parts being respectively 3 ft. 7 in. and 4 ft. 2 in., separated by 1 ft. 7 in. of blue to black bituminous shale. See Fig. 29. This is probably only a local pocket, as just across the ravine the coal was too thin to work. The composition of this coal is shown by the two following analyses by Mr. Cox:

	Claypool. Sec. 9.		Goodrick. Sec. 2.	
Fixed carbon	48.00		45.00	
Volatile combustible matter.........	45.00		39.50	
Total combustible matter......		93.00		84.50
Moisture	3.50		6.00	
Ash	3.50		9.50	
Total waste		7.00		15.50

There is a marked difference in these coals, the first being a good coal, the other a poor coal.



30 Jones. Sec. 10. — 31 Dickey No. 1. Sec. 10 (6). — 32 Dickey No. 2. Sec. 10 (5). — 33 Coal run Sec. 10 (4). — 34 Sigafoote Sec. 10 (3). — 35 Saltz. Sec. 2. — 36 Rodgers. Sec. 27. — 37 Williams. Sec. 3.

Figs. 30-37. Sections of Coal VI in T. 20 N., R. 9 W.

295. COAL VI is the coal principally worked. The space between Coals VIa and VI varies from 3 ft. 6 in. to above 20 ft. as far as observed. It often contains only fire-clay and shale, but where the space approaches its maximum the shale tends to be sandy or to turn into sandstone. Coal VI, Figs. 30 to 37, often approaches a workable thickness, though the presence of clay bands, which sometimes are as much as 6 or 8 in. thick, is a detriment which is apt to prevent the utilization of much of it, except to supply local demand. Where this coal can be stripped it will often be possible to mine it readily by removing one bench at a time. In some cases the clay partings

are so thin as to serve rather as a help to mining than as a detriment. The coal usually blocks well, at least as far as mined, ranging from dull black laminated splint coal, with charcoal partings, to a glossy black, brittle caking coal. The following table shows the quality of this coal, as determined by Mr. Cox:

MINE.	Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Ash.	Moisture.
R. W. Claypool, top.............Sec. 9....	87.00	38.00	48.00	3.00	10.00
R. W. Claypool, middle..........Sec. 9....	93.50	38.00	55.50	4.00	2.50
R. W. Claypool, bottom..........Sec. 9....	88.50	34.00	54.50	3.00	8.50
Goodrick, top...................Sec. 3....	88.50	42.00	46.00	3.00	8.50
Goodrick, bottom................Sec. 3....	92.50	46.50	46.00	3.00	4.50
Hopper & Barringer, top.........Sec. 8....	93.50	34.50	59.00	4.00	2.50
Hopper & Barringer, bottom......Sec. 8....	91.00	35.00	56.00	6.50	2.50
Harold & Co., top...............Sec. 9....	90.00	36.00	54.00	3.50	6.50
Harold & Co., middle............Sec. 9....	87.00	31.00	56.00	9.50	3.50
Harold & Co., bottom............Sec. 9....	87.00	31.00	56.00	9.50	3.50
Tinkler & Co., top..............Sec. 2....	93.50	43.50	50.00	3.00	3.50
Tinkler & Co., middle...........Sec. 2....	91.50	44.50	47.00	5.50	3.00
Tinkler & Co., bottom...........Sec. 2....	92.50	42.50	50.50	2.00	5.00
Average.........................	90.66	38.63	51.91	4.30	5.25

These show a coal of rather better than the average quality, being low in proportion of moisture, below the average in ash and above in quantity of fixed carbon. In most cases the ash is a red or other color, indicating the presence of iron and possibly of some objectionable elements.

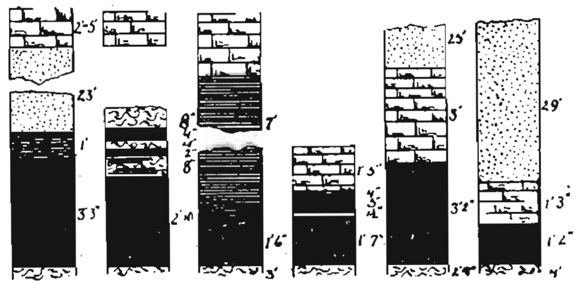
In thickness the coal runs up to a little over 3 ft. and generally shows two clay partings. Where there are more partings they are usually pyrite or shale. No marked uniformity occurs in the proportionate thickness of the different benches. The roof is in some cases bone or black shale for a slight thickness, but is usually a gray or sandy shale, with frequently a thin bed of clay shale, full of coal measure plants close above the coal. The floor usually consists of 3 to 4 ft. of fire-clay.

296. Division V.—This division carries one coal, often thin, but ranging up to over 3 ft. in thickness. This is usually overlain by its characteristic limestone and associated black shale, often sheety. The space between Coals VI and V ranges from 30 to 40 ft. Beside the limestone and black shale, this space is, in this area, often largely composed of sandstone, often massive for a depth of 20 or 30 ft. At

many points no coal at all shows at the horizon of Coal V, its place being shown by the black shale and limestone. In places two limestones show, separated principally by black shale. This bed appears to have been but little exploited, due to its occurring below the drainage of the smaller streams over much of the area. It has been reached principally by shafts. On the John Briggs place it shows as a block coal in thin laminae, with carbonaceous partings, and of the composition shown by the following analysis by Mr. Cox:

Fixed carbon	48.50	
Volatile combustible matter	44.75	
Total combustible matter		93.25
Moisture	4.75	
Ash, flesh	2.00	
Total waste		6.75

This shows a good coal, the proportion of ash being small, the proportion of gas being high.



38 Hall. Sec. 2. 39 Lyons. Sec. 2. 40 Saltz Cr. Sec. 2. 41 N. E. ¼ Sec. 16. 42 Hooper & B. Sec. 8. 43 Rodgers. Sec. 27.

Figs. 38-43. Sections of Coal V in T. 20 N., R. 9 W.

297. Division I.—No coal has been reported from this division in this area. As usual, the Mansfield sandstone comprises the principal part of this division, with a thickness of up to 45 or 50 ft. (See Hopkins' Rep.)

Section 3. Distribution and Local Conditions.

298. In Sec. I the Mansfield sandstone, both above and below the bridge over Redwood creek, forms bluffs of massive sandstone 45 to 50 ft. high. Just below the bridge, however, it occurs only as pockets

or disconnected ledges of sandstone in the midst of shale or shaly sandstone.

299. In Sec. 2, at the mouth of the first ravine west of Redwood creek, a shaft was formerly operated on the Frank Hall place, on what appears to be Coal V. The section here including section in bank above shaft is somewhat as follows:

300. SECTION 35. SECTION AT HALL'S SHAFT.—Sec. 2, N. E. of S. E., Fig. 38 (E. M. K.).

		Ft.	In.
1.	Limestone ....2 ft. to	6	0
2.	Blue shale	15	0
3.	Blue limestone ....2 ft. to	5	0
4.	Sandstone	23	0
5.	Limestone mentioned at one point (?).		
6.	Black shale or bone coal	1	0
7.	COAL V ....2 ft. 2 in. to	3	3
8.	Fire-clay	..	4
9.	Sandstone.		

This coal is said to be very good when freed from the bone, which occurs with it in considerable quantity. From its position considerable trouble was had with water. These limestones crop out first in the bank, then in the bed of the creek for half a mile. Near the head of this ravine Coal VI has been mined on the Jas. C. Hall place by stripping in the bed of the branch, and by a slope. The coal runs about 2 ft. 8 in. thick, in three benches, the lowest of which is the best. There is a little bone on top of the lowest bench, which has to be thrown out. The roof here is made by 2 ft. 6 in. of very hard gray shale. The upper of the two limestones mentioned above outcrops in the bed of the branch about 80 or 90 yards below this. Southwest of the Hall shaft, on the Ed. Field place, several old drifts occur. At one of these entries the coal dipped sharply to the east. Sixty yards to the east a bore found no coal. At two of the entries the coal got soft, and played out to the west and north. At the east side the coal ran from 2 ft. 4 in. to 3 ft. of good block coal. At the two entries just east of these the coal is not a block coal. Prospecting just west of the half-mile line indicates that the coal is cut out there and replaced by the drift. These banks formerly supplied coal to the steamers on the river.

On the Lyons place, on the next stream west, is an old entry. The main bench of coal here is 2 ft. 10 in., and is a block with distinct slips 10 to 24 in. apart, some of the slips being open as much as 2 in.

Coal appears rather soft and free of sulphur. The section above the coal is (Fig. 39, Sec. 35a):

	In.
Gray clay	8
COAL and blue bands	4
Gray fire-clay	4
COAL	2
Bituminous shale and blue clay	8
COAL ....2 ft.	10

A short distance up the branch and still on the Lyons place, this coal is 2 or 3 ft. below the branch level, and has been stripped. The coal was covered by gravel. Over it showed 3 ft. of sandy shale, then 8 in. of soft, bluish-gray shale. A short distance further up stream, and about 3 to 5 ft. above the coal, is an outcrop of light-gray potter's clay. The limestone outcrops above this.

Further up this branch, near the section line, several entries have been opened on the Williams and Lyons places. These were formerly run by W. H. Goodrick, on the Williams place. For section of these and analyses of coal see ¶¶290, 293; and by Tinckler & Co., on the Lyons place, then the J. Miller place. Coal VIa there varies from 10 to 18 in. in thickness. Coal VI runs about 3 ft. thick in benches 1 ft. 6 in., 6 in. and 8 or 10 in. thick, respectively (See Fig. 37). The top bench is a crumbly, caking coal, the other two benches are good block coal. On the east side of the creek the coal is overlain by 6 to 8 in. of bone coal.

In the S. W. ¼ of Sec. 2 coal has been mined on the Saltz place. Coal VI runs here from 2 ft. to 2 ft. 5 in., and is a good block with distinct slips, both face and butt, from 12 to 18 in. apart. The coal is pick-mined and is described as better than the average, though it has some irregular streaks of sulphur through it. The section of the coal here as given in Fig. 35 is:

	In.
Blue-gray clay shale with streaks of coal	6
COAL	3
"Blue band"	¼
COAL	5
"Blue band"	¼
Bone coal	2
COAL, good block ....1 ft.	10
Black bituminous clay	2
COAL ....1 in. to	3
Fire-clay ....8 in. to	10
Sandstone	..

Sixty or 80 yards in, a fault has been met with, which entirely cuts the coal off. The fault runs northwest and southwest, and hades toward the river, dipping 40°. At one point a lenticular pocket of charcoal 8 by 4 in. was noted at the top of the coal. The coal is here 7 or 8 ft. above the branch.

A quarter of a mile up this ravine the coal has come down to within a foot of the branch bottom, and Coal VIa appears a short distance above it. The section here is (Sec. 36, E. M. K.):

	Ft.	*In.*
1. Blue shale.		
2. COAL VIa	..	10
3. White fire-clay, plastic, with little grit	3	0
4. Gray sandy shale	3	0
5. COAL VI, top	...	3
6. Blue sandy shale, with ironstone concretion and streaks of coal	..	10
7. COAL VI, bottom	..	10
8. Fire-clay, dark blue, hard	..	6
9. Fire-clay, light gray, hard, very sandy	..	8

301. In Sec. 10 the outcrop of Coal VI keeps just west of the road, as shown, to the mouth of Coal run ravine. Here are two drifts on the Geo. P. Dickey place. At drift No. 1, Coal IV is 26 in. thick (see Fig. 31), and is in three benches, 5, 9 and 13 in. thick, respectively, with partings of charcoal. On top of the coal is $2\frac{1}{2}$ in. of bone coal, then $3\frac{1}{2}$ in. of bluish-gray shale, then 3 ft. 6 in. of sandy shale with ironstone concretions. Fire-clay underlies the coal. At the mouth of the entry a preglacial channel has been cut down just to the coal, now filled with boulder clay. At drift No. 2 the coal is about the same net thickness, the three branches being from the top 7, 14 and 4 in. thick, respectively, but the partings are sandy clay, the upper 2 in., the lower 7 in. thick (Fig. 32). The upper bench is a caking coal; the two lower benches are free burning, the slips in the middle bench being about 18 in. apart. The lower bench runs out near the back of the entry. Connected with the upper bench is a deposit of very hard light sandstone that requires to be blasted down. The roof is a stratum of shelly sandstone 6 ft. thick; 3 ft. of fire-clay underlies the coal.

This coal reaches the level of the run 300 yds. north of Dickey's No. 2 drift. Here the section is as follows (Fig. 33):

	Ft.	*In.*
Gray shale	10	0
COAL	..	3
Clay band	..	¼
COAL	1	7
Sandy clay band ....1 in. to	..	¼
COAL	..	6
Sandy and ferruginous clay band	..	2
COAL	..	6

On the east side of the run this bed was reached by 2 or 3 old slopes at a depth of 10 ft. It ran from 14 in. to 3 ft. thick, and had a roof of shaly sandstone or shale.

About 20 ft. above this is an outcrop of Coal VIa (?), which has just been opened upon, and where the coal shows the unusual thickness of 7 ft. 9 in. (Fig. 29). On the opposite side of the creek this thick seam is 2 ft. thick; below it there is exposed:

	Ft.	*In.*
COAL VIa (?)	2	0
Fire-clay	2	0
Shelly sandstone	5	0
Blue shale	4	6
Sandstone, thin-bedded	2	0
Hidden to COAL VI ....about	5	0

Seventy-five yards northwest of the new drift is an old drift, Sec. 30 (8), where the coal is 2 ft. thick in 3 benches, 7, 8 and 10 in., respectively, beginning at the top, the partings being "blue band" $\frac{1}{8}$ to $\frac{1}{4}$ in. thick. The coal is a block. For a roof there is 8 ft. of soft, sandy shale, with a 2 ft. 6 in. layer of iron ore 8 in. from the bottom. The coal is here 7 ft. above drainage.

On the Walter Miller place, J. W. Sigafoote is stripping Coal VI 2 ft. to 2 ft. 2 in. thick. The coal is in three benches (see Fig. 34), 9, 9 and 8 in. thick, respectively, with $\frac{1}{8}$ in. partings and 4 ft. of gray, sandy shale, possibly suitable for brick, make the roof; 3 to 4 ft. of gravel and sand are stripped to reach the coal. All three benches block well. The floor of light-gray fire-clay, containing numerous fern leaves, is rather irregular. A small roll runs across the stripping from north to south, 1 ft. 7 in. deep and 2 ft. 8 in. wide. The coal rises to the north.

302. In Sec. 9, toward the head of Coal run, Coal VI has been worked considerably by stripping and by slopes on Mrs. Cronkhite's place. Coal was formerly stripped here by the Marshfield Coal Company, and a section at their mine was given in ¶287. A number of slopes have been opened here and driven in as far as could be done without providing for ventilation, then abandoned. The base of the coal at one slope being operated is about 1 ft. below drainage, the dip being to the west. The coal, as usual, lies in three benches, though the partings here are very thin. The coal is mined by pick, having slips 6 to 18 in. apart. The roof of the coal is made first of from 9 in. to 2 ft. of soft, black bituminous shale, with streaks of coal, then $5\frac{1}{2}$ in. of gray clay, 4 in. of soft, black bituminous shale again, then

3 ft. 10 in. of gray shale, with occasional streaks of coal, and on top 5 ft. of yellow clay. The black shale or clay tends to come down, leaving the gray shale as a roof, which stands well. In places the coal is cut out by rolls, and some faults are met, the main entry being driven along one. The floor is made of from 3 to 5 ft. of light-gray sandy fire-clay, which was formerly shipped to Chicago. The coal, though containing considerable sulphur, is said to burn up to a white ash. For analysis of this coal at this place see ¶295, Claypool and Harold & Co., who formerly worked this coal here.

Going down stream the dip is reversed, becoming strongly east, and dips with the fall of the brook nearly to the river bluffs, when the coal rises to the east. Mr. Collett calls attention to the basin character of this coal as exhibited along this branch, the basins, "waves or rolls," being from 50 to 150 ft. in width, thickening well up in the center of the depression, but thinning to a thread over the interbasin ridge. Mr. Claypool drove entries into several of these small basins or pockets without satisfactory result. Three hundred yards below the mines above described, Mr. Kindle noted a double fault in an outcrop of sandstone.

303. At the mouth of Coal run the sandstone is exposed to the thickness of 8 ft. To the southwest the outcrop keeps west of the road. In the S. W. of S. W. of Sec. 10 it has been worked by shaft on the R. C. Jones place. The coal is here 15 ft. deep, about 2 ft. thick on the north side and 3 ft. on the south side, averaging between 2 ft. and 2 ft. 6 in. The coal works in three benches, 6½, 8 and 7 in., respectively (see Fig. 30). The slips are irregular here. On top of the coal occurs 2 in. of bone, then comes shale, with coal streaks. Under the coal is 4 ft. of fire-clay, and under that is the hard, flinty limestone. Some trouble is had with the drainage. One fault was noted running a little west of north with a displacement of 18 in.

304. In the N. E. ¼ of Sec. 16, Coal V is just at the level of a small branch, Sec. 16 (1). It has been opened upon there by a slope. The coal is at least 2 ft. thick, separated into two benches, a black clay band 1½ in. thick, 5 in. from the top, see Fig. 41. Over the coal is 4 in. of blue shale, then 1 ft. 5 in. of limestone, the lower part being shelly. The coal dips west. At a well east of this and on the same level, 18 in. of "brash coal" is reported at a depth of 55 ft.

In the southwest 40 acres of Sec. 16 a well 15 ft. deep is reported to have passed through:

	Ft.	*In.*
COAL	1	0
Fire-clay	1	6
COAL	1	0
Blue shale	9	0
COAL	..	11

No coal is at present mined up Possum run. A branch of the C. & E. I. R. R. formerly ran up this stream, at which time some mining was done in Sec. 8.

305. In Sec. 8 coal was formerly mined in the N. E. ¼ by Hooper & Barringer. A section of their shaft was given in ¶291. Some twenty-five bores put down showed Coal VI to range from 2 ft. to 3 ft. 2 in. in thickness, except in three wells on the west side of the creek. Coal VI is here 25 ft. deep. The boring in the shaft showed Coal V at about 60 ft., 3 ft. 2 in. thick, overlain by 3 ft. of hard limestone. This coal appears to have had a smooth parting 10 in. from the top and another containing most of the sulphur 1 ft. from the bottom. This is a block coal, the clay slips running 1 ft. 6 in. to 2 ft. apart, and, as shown by the analysis, ¶295, is not far behind the block coal of Clay county in purity. The abandoning of the railroad stopped further mining. Shafts were also sunk on the John Gillam farm, in the S. E. ¼ of Sec. 8, and on the Ross Murphy farm, in the same quarter, near the section line. Here the coal was 18 in. thick and a good quality of block. The fire-clay under it, as at Hooper & Barringer's, was formerly shipped to Chicago.

Fig. 41. Combined roll and fault, Rodger's mine. Sec. 27.

306. In Sec. 27, the S. E. ¼, on the Rodgers place, are several shafts, one working. The coal is here 24 ft. deep and 2 ft. thick. No partings show in the coal, which, however, shows the following divisions from the top down: Soft coal, ½ to 1½ in.; good block coal, 1 ft. 6 in.; coal not blocking freely, 8 in. There are frequently thin sheets of sulphur and some soft streaks of "mother coal." The roof is either a dark-blue fire-clay or a light, sandy shale, thinly laminated and containing pebbles of sandstone and concretions in the lower part. Above that is sandstone. The coal lies in small

basins or "waves," becoming thin over the intervening ridges. Rolls sometimes cut the coal down to 6 in. These show concretions of zinc sulphide and coal in a matrix of sandy clay. This coal mines without shooting, the slips running from 8 in. to 3 ft. apart. The bottom is fire-clay 14 to 16 in. or more thick. A combined roll and fault occurs north of the entry, as shown in Fig. 44.

The coal dips to the south and east. Just north of the road at an old shaft it is 11 ft. to bottom of coal; 100 ft. to the east it is 22 ft. to the coal, the ground being level. The air shaft 80 ft. south of shaft strikes coal at 9 ft. In the mine working, the dip in the east entry is very sharply east, but the general dip seems to be south and west. Mr. Kindle notes: "A piece of hard sandstone, buffish-gray, fine-grained, was taken out of the coal in a roll on the north side of the road. It is 5 ft. long and about 10 in. in diameter, and is now used for a hitching post." The notes are hardly definite enough to show whether this is one of the rare occurrences of a boulder entirely imbedded in the coal or not.

The coal here is on the south side of an anticline. At the center of this anticline, a short distance north of these mines, there is exposed 40 or 50 ft. of sandstone (see section ¶293). Some 5 or 10 ft. of this sandstone is exposed in the railway cut for 300 or 400 yds., at the north end of the cut the strata dipping 3° or 4° northwest. The section here shows, Sec. 37 (E. M. K.):

	Ft.	*In.*
Covered	4	0
Sandstone, thin bedded	3	6
Sandy gray shale	1	6
Bluish clay shale	1	4
Ferruginous sandstone	2	0
Fire-clay	..	8
COAL IV?	2	0
Blue clay shale with ferns	1	0
Sandstone and sandy shale	5	0

Townships 20 and 21 North of Range 10 West.

307. Statement.—These are partial townships next to the Illinois line. They are mostly slightly rolling prairie land, with the coal measures deeply hidden by glacial drift. The conditions found to the east may be supposed to continue under these townships. Coal was reported at only one place. On the Joel Briggs place, in Sec. 12, 21-10, 18 in. of coal is reported.

Section 4. Summary of Coals of Warren County.

Divisions contained: VI, V, I.
Coals contained: VIa, VI, V, I.

Round Number Estimates.

Coal VIa.

Worked area	0 acres	× av. thickness,	0 ft. ×	.... =	....	tons.
Workable area ...	1 sq. mi. ×	"	2 ft. ×	500,000 =	1,000,000	tons.
Unworkable area	150 sq. mi. ×	"	½ ft. ×	1,000,000 =	75,000,000	tons.
Total area	sq. mi	....			76,000,000	tons.

Coal VI.

Worked area	10 acres	× av. thickness,	2½ ft. ×	1,000 =	25,000	tons.
Workable area ...	10 sq. mi. ×	"	2½ ft. ×	500,000 =	12,500,000	tons.
Unworkable area	150 sq. mi. ×	"	1 ft. ×	1,000,000 =	150,000,000	tons.
Total area	160 sq. mi	....			162,525,000	tons.

Coal V.

Worked area	10 acres	× av. thickness,	3½ ft. ×	1,000 =	35,000	tons.
Workable area ...	20 sq. mi. ×	"	3 ft. ×	500,000 =	30,000,000	tons.
Unworkable area	180 sq. mi. ×	"	1 ft. ×	1,000,000	180,000,000	tons.
Total area	200 sq. mi	....			210,035,000	tons.

Coal I.

Unworkable area	300 sq. mi. ×	av. thickness,	1 in. ×	80,000 =	24,000,000	tons.

Number of coals contained: 4.
Greatest thickness recorded: Coal VI in T. 20 N., R. 9 W., 4 ft. 2 in.
Area underlain by coal or coal measure rocks: 300 sq. mi.
Area underlain by workable coal: About 30 sq. mi.
Situated in townships: Liberty, Kent and elsewhere.
Estimated total tonnage of coal: 472,000,000 tons.
Estimated total tonnage of coal removed: 60,000 tons.
Estimated total tonnage of workable coal left: 43,500,000 tons.
Number of mines working ten men or over, in operation: None.
Number of mines working less than ten men, in operation: 16.
Total number of mines in operation: 16.
Large mines not in work: 0.
Small mines not in work: 41.
Strippings and outcrops: 40.
Total number of openings to coal: 97.

See Part IV for list of mines, rank of Warren county, etc.

XVII. FOUNTAIN COUNTY.

Section 1. General Statement.

309. References and Field Work.—

1859 (1838). D. D. Owen, Continuation of Rep. of a Geol. Reconn. of Ind. made in 1838, pp. 31-33, 1 columnar section. (D. D. O.)

1859-60. Richard Owen, Rep. of Geol. Reconn. of Ind., pp. 165-6, 1 coal analysis. (R. O.)

1859-60. Leo Lesquereux, same report, pp. 334-337, 1 columnar section. (L. L.)

1869. E. T. Cox, 1st Ann. Rep. Geol. Surv. of Ind., pp. 116-129, 9 columnar and coal sections, 1 coal analysis. (E. T. C.)

1881. R. T. Brown, Dept. of Geol. and Nat. Hist., 11 Ann. Rep., pp. 89-125, map, 5 columnar sections of coal measures. (R. T. B.)

1895. W. S. Blatchley, 20th Ann. Rep. Dept. Geol. and Nat. Resources, pp. 58-64 (dealt with clays), 5 columnar sections. (W. S. B.)

1895. T. C. Hopkins, same, pp. 269-291, discusses Mansfield sandstone. (T. C. H.)

1879-1898. Reports of Mine Inspectors.

1897. G. H. Ashley and C. E. Siebenthal, field work for this report. Mr. Siebenthal worked up the eastern and northern part of the county, including all of the area of outcrop of Division I and overlapping above and below.

310. Location.—Fountain county lies south of Warren county, from which it is separated by the Wabash river. It is separated from Illinois by Warren and Vermillion counties. It lies north of Parke and west of Montgomery and Tippecanoe counties.

311. Extent.—The northern half of the county is triangular. It has a maximum length from north to south of 28½ mi. and a maximum width from east to west of 18¼ mi., covering an area of about 400 sq. mi. It includes practically the whole of townships 18-21 north of range 7 west, 18-20 north of range 8 west, and the western half of townships 18-21 north of range 6 west, and part of township 22 north of ranges 6 and 7 west, township 21 north of range 8 west, and townships 18-20 north of range 9 west.

312. Elevation.—The following elevations are known:

	Feet above tide.
Attica, C. & E. I. R. R. depot	540
Attica, Wabash Ry. depot	556
Attica, crossing of railroad	545
Coal creek, bed of, south of Veedersburg	576
Coal creek bridge, C., C., C. & St. L. Ry	610
Covington	537
Divide between Covington and Veedersburg, C., C., C. & St. L. Ry	691
Fountain and Parke county lines, C. & E. I. R. R	712
Harveysburg	699
Hillsboro	728
North fork of Coal creek bed, north crossing of C. & E. I. R. R	634
Same, south crossing, bed	608
Shawnee creek bed, at C. & E. I. R. R. crossing	590
Strader's	649
Veedersburg	622
Wabash bridge, C., C., C. & St. L. R. R	529
Wabash river, low water, at Attica	500
Wabash river, low water, at Covington	491
Yeddo	707

As far as known, the elevations show a range of from under 500 ft., where the Wabash leaves the county, to over 700 ft. in the east and south part of the county.

313. General Topography.—The general character of the county is that of a gently rolling plain with a slight inclination to the south and west. In the northeastern part of the county a high gravel ridge starts gradually and runs parallel with the river, sometimes attaining a height of 250 ft. above the river, and 100 ft. above the surrounding region. Two or three miles southeast of this is another less conspicuous parallel ridge of gravel. Along the immediate valley of the Wabash the bounding bluffs and ravines make some rather rugged country, and in the southeastern corner the tributaries of Sugar creek cut that section up considerably.

314. Drainage.—As shown on the map, the Wabash river flows along the northern and western border of the county. In the north part of the county the drainage is principally by the Big and Little Shawnee creeks. The central part of the county is drained by Coal creek, with its tributaries, Turkey run, Dry run, East Fork, Prairie creek and Graham creek. Wabash Mill creek and Sugar Mill creek drain the southern portion.

315. TRANSPORTATION.—The C. & E. I. R. R. crosses from north to south; the C., C., C. & St. L. Ry. crosses the county from east to west; the T., St. L. & K. C. Ry. crosses from east to southwest; the Wabash follows the northwestern boundary of the county down to Covington. Formerly a branch of the C. & E. I. R. R. ran from Danville, Illinois, to Coal Creek (Snoddy's Mills), but, due in part to labor troubles at the latter place, it was abandoned. So the county may be considered well supplied to ship in any direction.

316. DEVELOPMENT.—This county, formerly seven-eighths forest, is now almost entirely under cultivation. Until recently very little has been attempted except agriculture and some scattered mining. The presence of fine beds of clays is beginning to attract capital and, in view of the presence of good bodies of coal, may be counted on to lead to a greater development of manufacturing interests.

Section 2. Stratigraphy.

317. SURFACE GEOLOGY.—The drift in Fountain county will not average as thick as in Warren by at least one-half. For, while there are places where the drift is over 200 ft. deep, such places are in old channels, and away from them the drift will only average 20 to 30 ft. In some places, it is true, the drift seems to be much deeper on the level, and will range between 50 and 100 ft., but even such places seem to have been broad basins. Notwithstanding this thinning of the drift, most of the smaller streams have not cut down through it, and there are long stretches on the larger streams where none of the underlying rock is exposed. Preglacial channels have been found abundantly, but in no case has enough drilling been done to accurately determine their course or extent. These usually cut out the coal so that the coal measures have suffered much.

318. COAL MEASURES.—Over the most of the county the coal measures found belong to Divisions I, IV and V. In the southwestern corner, on Silver Island, are found in a high hill some strata supposed to belong in Division VI. These consist of two or three coals not of workable thickness, and their accompanying strata. Of most interest at that point is a channel cut down through the coal measures and filled with sandstone. See ¶383 and ¶92 of Part II.

The columnar section of the county would be as follows:

Division IX?—
1. Sandstone of channel filling at Silver Island, local.

Division VI—
2. Shales, black at bottom.
3. COAL VIb. Bony coal, Silver Island.
4. Shales, black sheety at bottom, with thin shaly limestone above.
5. COAL VIa—Good coal, Silver Island.
6. Fire-clay, running into shale at bottom.
7. COAL VI?—Rich coal, Silver Island.

Division V—
8. Fire-clay, shales and ironstone; black shale and thin limestone overlie coal.
9. COAL Va—Good coal, highest coal at Coal creek, Cates Station and south of Veedersburg.
10. Fire-clay, shale, limestone and black shale, often replaced by sandstone.
11. COAL V—Good coal. Main coal at Silver Island, Yeddo, "rider" at Veedersburg. "K" of old reports.

Division IV—
12. Fire-clay and brick shale generally, sandstone locally.
13. COAL IV—Principal coal of county. Lower coal at Silver Island, main coal at Coal creek, Veedersburg and north. Coal "I" of old reports.

Division III?—
14. Black shale, local.

Division I—
15. Massive sandstone, building stone, locally underlain by shales.
16. COAL I—Coal locally developed. Coal "A" of old reports.

319. UNDERLYING FORMATION.—Principally sandstone, with some shale and limestone. Knobstone (Riverside). No coal.

Section 3. Detailed Geology.

TOWNSHIPS 20, 21 AND 22 NORTH OF RANGE 6 WEST.

320. STATEMENT.—No coal occurs in these townships. The Mansfield sandstone of Division I outcrops over a small irregular area in T. 22 N., R. 6 W., Secs. 20, 21, 28, 29 and 30, where it lies unconformably on the Knobstone (Riverside). No exposure of Coal I is reported there. The rest of the area is thought to contain no coal measure rock or at least not of any extent or importance.

Township 19 North, Range 6 West. (C. E. S.)

321. Statement.—This township is level, with the exception of the valley of the east fork of Coal creek. The coal measures just overlap the western edge, as shown on the map. Only Division I of the coal measures, with the horizon of Coal I, occurs in this township. Division I here, as usual, consists of the massive Mansfield sandstone, which outcrops along Coal creek (see Hopkins), and some underlying black shale which locally may carry coal. No coal of economic importance exists in the township, though some pockets may be found of sufficient size to pay to work for the local trade. No coal was seen, but coal was reported to have been found in the tail race of Snider's mill, at Coal Spring, N. W. of S. W. of Sec. 16, quite a quantity of coal having been thrown out, according to reports. In the hollow a quarter of a mile south of the mill a drift was started into the black shale, but no coal was found. A boring made across the branch from the drift is reported as follows:

Drift, 30 ft.; black shale, 16 ft.; hard black micaceous "grit stone," 18 ft.; sandstone, 51 ft.

A well on Gus Parker's place, N. E. of S. E. of Sec. 17 is reported to end in coal, quite a quantity having been thrown out. Thickness and depth not known.

Among other wells in this township may be mentioned a well on Jesse Brant's place, S. E. of S. W. of Sec. 8, which had 14 ft. of soil and drift and 80 ft. of white sandstone; Alex. Bever's well, S. E. of S. E. of Sec. 7, which had 21 ft. of soil and drift and 72 ft. of limestone; Mathew Bever's well, N. W. ¼ of Sec. 17, had 70 ft. of soil and drift, 12 ft. of blue and white sandstone; Chas. Straus, S. E. of S. W. Sec. 18, showed 134 ft. of soil and drift, and into blue clay shale, much bark, roots and wood being struck between 7 and 35 ft. A well in the S. W. of N. E. of Sec. 16 showed 65 ft. of drift; one in the S. E. of N. W. of Sec. 32 showed 80 ft. of drift.

Township 18 North, Range 6 West. (C. E. S.)

322. Statement.—This half township (western) is the southeastern corner of Fountain county. It is in the main level, its principal irregularity being the valley of Mill creek, which cuts ever deeper and deeper to the southwest, and, with its tributaries, makes the topography of the southwestern corner rather rough. The remainder of the township alternates flat prairies of black soil with the hummocky topography of morainic areas of loose sandy soils. Gravel banks for gravel roads are not common.

What was said of the coal and coal measures in the last township is also true of this. The hypothetical eastward extent of the coal measures of Division I is shown on the map. Coal was reported at one point only, on the land of the Barbara Smith heirs, S. E. of S. W. of Sec. 33, as occurring 12 to 18 in. thick under clay shale or sandstone, in a tributary of Sugar creek.

Of other wells in Fountain county, Jesse Clore's well, S. E. of S. W. of Sec. 16, showed 79 ft. of soil, gravel and clay, 25 ft. of black sandstone. Shale is reported in a deep well one-half mile west of this. In Robt. Krout's well, S. E. of N. E. of Sec. 29, situated on 50 ft. hummock of drift, was found; drift gravel and clay, 105 ft.; "rock," probably sandstone, 3 ft.

Township 22 North, Range 7 West.

323. Statement.—Only a small portion of this township south of the Wabash river is in Fountain county. The Lower Carboniferous rocks predominate over this area, though Mansfield sandstone of Division I of the coal measures underlies the southern edge of the township, and has been extensively quarried. (See Hopkins.) There is probably no coal in this area, certainly none of economic importance.

Township 21 North, Range 7 West. (C. E. S.)

324. Statement.—A line from Sec. 7, N. E. of S. E., to Roberts P. O., will about define the crest of a ridge which rises 150 to 200 ft. above the alluvial plain of the Wabash river. The summit of this is as level as a floor, breaking down to the west, but stretching away to northeast as far as examined, becoming broad and rolling. From this flat there is a gentle slope to the south to Rob Roy, to the east of which the topography shows gently rolling swells. The valley of Shawnee creek is sharply trenched in this plain to a depth of 50 or 60 ft.

325. Coal.—Coal was being mined at only one point, and that on the Geo. Nave place, in the N. W. of N. W. of Sec. 19. The section here is as follows:

Section 38. Section at Nave Bank.—Sec. 19. (C. E. S.) Fig. 45.

	Ft.	In.
Drift.		
Blue shale ....2 ft. to	6	0
Black slaty shale	..	4
COAL III?—Bone, 10 in.; coal, 22 in.; bone, 12 in......	3	8
Bluish shale	5	0

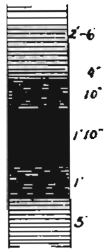


Fig. 45. Coal at Nave bank.

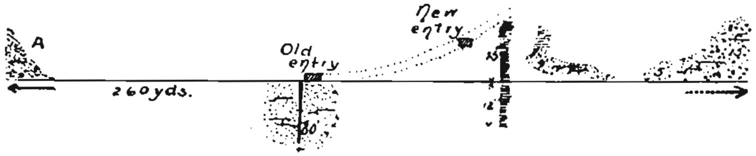


Fig. 46. Section along Nave creek. Sketch by C. E. Siebenthal.

Fig. 46 shows the general relations here along Nave creek. At "A" is an old drift just at creek level. One hundred yards east, the Mansfield sandstone shows, apparently dipping westward under the coal. A drilling at "A" went 80 ft. into sandstone. Fifty yards to the west is the new opening, the coal here being 10 ft. above the creek bed, and it appears to continue rising to the west at the same rate. Ten yards west of the new drift the section shows only shale, which extends at least 12 ft. below drainage, except a 3-in. bed of sandstone. One hundred yards farther west sandstone is exposed again, as shown in sketch. Coal has been stripped here for 50 years, but has only been worked by drifting since 1894. The coal is described as a semi-block; only entries have been dug into it. Mr. Siebenthal places this coal above the Mansfield sandstone with some question.

In the N. W. ¼ of Sec. 30 coal is reported on the land of John L. Foster, at the mouth of Little Shawnee creek, 24 in. thick. Also 400 yards above this, on Big Shawnee creek, on the west bank, under a sandstone cliff. Coal is also reported on Little Shawnee, between its mouth and the road running west from Rob Roy.

About 10 in. of coal is reported farther up the Little Shawnee, in the S. E. of N. E. of Sec. 31.

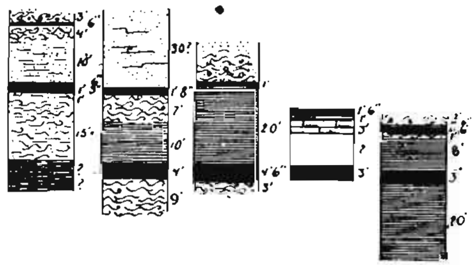
A well at the brick yard, S. E. of N. E. of Sec. 7, showed 30 ft. of drift and 32 ft. of blue sandstone, presumably Mansfield. A well on the hill south of this, in the N. E. of S. E. of Sec. 7, went 50 ft. into drift.

It would thus seem that about one-half of the township was underlain by the coal measures as shown in the map, Division I only being represented, except possibly an included pocket or two of the higher divisions. It is not probable that any pockets of sufficient extent and thickness exist here to warrant extensive operating, though pockets may be found which will serve the local demand. For shale and sandstone, see reports of W. S. B. and T. C. H., as above.

Township 20 North, Range 7 West.

326. Location, etc.—This township lies about in the center of Fountain county. It is well cut up by Coal creek, Turkey run and Dry run, away from which streams the topography tends to be level. The C. & E. I. R. R. crosses the western edge of the township, and the Clover Leaf crosses south of the center.

327. Stratigraphy and Coals.—The coal-measure rocks underlie more than half the township, Division I, with the horizon of Coal I, outcropping over most of that area (visited by Mr. Siebenthal); while a small area of the higher divisions exists in the southwestern corner (visited by the writer).



47 Clay pit S. of Veedersburg. 48 Veedersburg. 49 Culver. Sec. 31. 50 Davis. Sec. 31. 51 Lease. Sec. 30?

Figs. 47-51. Columnar sections of coal measures in T. 20 N., R. 7 W., and others.

The following sections show the coals found and their accompanying strata, the first two being extra-limital, but show certain features not shown by any of the sections found in this township:

328. SECTION 39. SECTION AT CLAY PIT, SOUTH OF VEEDERSBURG.—Fig. 47.

	Ft.	In.	Ft.	In.	Ft.	In.
Division V—						
1. Surface	3	0	..	..	3	0
2. COAL (?) streak V	..	6	0	6	3	6
3. Sandy fire-clay	4	0	..	..	7	6
4. Brown shaly sandstone	10	0	..	..	17	6
5. Dark gray calcareous shale	..	6	14	6	18	0
6. COAL V.... 0 ft. to 2 ft.	1	3	1	3	19	3
7. Dark drab sandy or calcareous shale	1	0	..	..	20	3
Division IV—						
8. Drab to gray sandy, shaly fire-clay	15	0	..	..	35	3
9. Black shale	?					
10. Bone COAL IV	?					

329. SECTION 40. SECTION OF VEEDERSBURG SHAFT.—Fig. 48.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Gravel	20	0	..	..	20	0
2. Fire-clay and shale	7	0	..	..	27	0
3. Sandstone with shale partings	30?	0	..	..	57	0
4. COAL V	1	8	1	8	58	8
5. Light drab fire-clay	7	0	..	..	65	8
6. Drab shale with plant remains	10	0	17	0	75	8
8. COAL IV?	4	2	4	2	79	10
9. Light gray sandy fire-clay	9	0	..	..	88	10

The 12 ft. of white sandstone reported by Mr. Brown (p. 104) appeared to be in error, as a careful examination failed to reveal any sandstone between the two coals.

330. SECTION 41. SECTION AT CULVER CLAY AND COAL PIT.—Sec. 31, Fig. 49.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface and drift.....6 ft. to	10	0	..	..	10	0
2. COAL outcrop V?....0 ft. to	1	0	1	0	11	0
3. Light gray clay shale, jointed, upper 6 to 10 ft. has reddish streaks	20	0	20	0	31	0
4. COAL IV?— Coal, 2 ft. to 2 ft. 9 in. Black shale, 1 in. Coal, poor, 11 in.	3	9	3	9	34	9
5. Black shale	..	3	..	..	35	0
6. Drab fire-clay	3	0	..	..	38	0

331. SECTION 42. SECTION ON DAVIS PLACE.—Sec. 31, N. W. ¼, Fig. 50. (E. T. C., p. 118.)

	Ft.	In.
1. COAL block	1	6
2. Clay shale	1	0
3. Hard impure limestone	3	0
4. Space estimated at 6 to 8 ft.	?	
5. COAL	3	0

Nos. 1 to 3 were noted on the north side of the Davis farm by Mr. Cox, and is the only place in this region where limestone is reported. No. 5 was noted near the south side of the farm, and was estimated to be 6 or 8 ft. below No. 3.

332. SECTION 43. SECTION ON GEO. LEASE PLACE.—Sec. 30 (?), Fig. 51. (E. T. C., p. 117.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Drift	2	0	..	..	2	0
2. Soft shale	..	6	..	..	2	6
3. COAL V?	1	6	1	6	4	0
4. Fire-clay	1	0	..	..	5	0
5. Buff and gray clay shale	8	0	9	0	13	0
6. COAL IV?	3	0	3	0	16	0
7. Fire-clay	?	?	..	..	16	0
8. Black bituminous shale with 1 or 2 in. of coal occasionally mixed through it	20	0	..	..	36	0

333. SECTION 44. SECTION OF DRILLING ON WM. COLVERT'S PLACE.—Sec. 20, S. E. ¼. (C. E. S.)

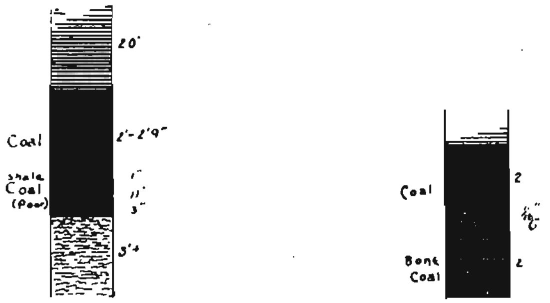
	Ft.	In.
1. Blue clay	12	0
2. Sandstone	30	0
3. Shale	20	0
4. COAL I? 3 to 4 ft.	3	6
5. Sandstone	115	0
	180	0

None of these sections show Coal I, which is reported at one or two places, except the last, so that its distance below Coal IV can not be accurately given.

334. SURFACE GEOLOGY.—The drift is not very deep in most of the sections given above, and in other sections obtained the drift is more often under 20 ft. than over. Three wells, one in the S. W. of S. E. of Sec. 22, one in the S. E. of N. E. of Sec. 28, and another in the S. E. of N. W. of Sec. 22, go through 100 ft. of drift. The first

goes into 3 ft. of sandstone, the second into 65 ft. of sandstone and the third into 100 ft. of sandstone with "coal seams," then into 8 ft. of limestone. (?)

335. Divisions II to V of the Coal Measures.—There appear to be three coals exposed in this region in these divisions, though only two coals were observed in this township, and it may be doubted if the uppermost coal is to be found here. Coal V (?) does not appear to be workable at any point yet observed in this township, though reported to be a good grade of coal. It appears to be usually covered with sandstone, and in adjacent territory was found to be in small basins and probably occurs in the same way here. Coal IV (?) is the coal being worked. See Figs. 52, 53. This coal appears to be in two



52
Shuster.
Sec. 19.

53
Culver.
Sec. 31.

Figs. 52 and 53. Sections of Coal IV in T. 20 N., R. 8 W.

benches, the upper bed containing the workable coal, and varying in thickness from 2 to 3 ft., while the lower bench varies from 6 in. to 1 ft. and is poor coal, and usually left in mining. The roof is usually a clay shale, sometimes containing ferns, and usually very suitable for the manufacture of paving brick, for which purpose it is largely used. Under the coal usually occurs a little bone or black shale. The fire-clay below that is considered suitable for pottery. Fig. 51 shows 20 ft. of black shale underlying Coal IV, and in lieu of more definite information this will be assumed to represent Division III.

336. Division I. As usual this is mainly a great thickness of massive sandstone, with a little coal reported in a few places. The 3 or 4 ft. of coal reported in the Colvert well would appear to be at the level of Coal I, and, judging from the small thickness usually attained by Coal I, we should feel very much inclined to doubt such a thickness at that point.

337. The underlying rocks appear to be principally sandstone of Knobstone age.

338. Distribution of Divisions and Coals.—Secs. 1, 2, 11, 12, 13, 14, 23, 24 and 25, and the eastern part of Secs. 3, 10, 15, 22 and 26, lie outside the coal measures, and of course contain no coal. Coal measure sandstone of Division I outcrops along Coal creek in Sec. 10, along Turkey run in Secs. 8, 9 and 16, along Dry run in Sec. 33; also in Secs. 7, 8, 18, 19 and 20. See T. C. H. as above. Coal I has been found or reported as follows: A well in S. E. of N. E. Sec. 7 shows 25 ft. of drift; 15 ft. of sandstone; bone coal, a few inches; sandstone, 10 ft. In the S. W. of S. W. of Sec. 9 at least 1 ft. of coal crops out in the water of Turkey run, beneath 10 ft. of sandstone. A well on the John Meeker place in the S. E. ¼ of Sec. 18 showed: Soil and gravel, 30 ft.; sandstone, 30 ft.; coal, "some;" sandstone, 20 ft.; "coal, some;" fire-clay, 2 ft. In the N. E. corner of the S. E. ¼ of Sec. 19 coal has been stripped a little, which probably comes beneath the bluff of Mansfield sandstone outcropping there. In the S. W. of N. W. of Sec. 20 coal was struck in ditching beside the gravel road. About the center of Sec. 20 was the well in which was reported 3 or 4 ft. of coal at a depth of 60 ft. See Sect. 44, ¶331. In Geo. W. Crane's well, S. E. of N. W. of Sec. 28, is reported as follows: Drift, 100 ft.; rock (sandstone), including seams of coal, 100 ft.; hard rock (limestone), 8 ft. Coal is also reported to have been struck in a well on Daniel Carpenter's place at the tile factory in S. E. ¼ of Sec. 27.

The sandstone is also struck in wells in Secs. 10, N. W. of S. W., 25 ft. thick at a depth of 8 ft.; in N. E. of S. W. Sec. 5, 38 ft. thick at a depth of 50 ft.; in N. E. of N. W. Sec. 17, at depth of 16 ft.; in S. W. of S. E. of Sec. 22, at a depth of 100 ft., this being an artesian well in which the water rises in pipe 7 ft. above the ground; N. W. of S. W. of Sec. 8, 38 ft. thick at 4 to 7 ft.; S. E. corner of Sec. 7, 73 ft. at depth of 5 ft., the sandstone in each case being the first rock struck below the drift.

These sections show the depth and thickness of the stone and coal and show that probably no workable coal exists in the area covered as shown on the map.

339. The higher Divisions IV and V? outcrop in three small areas in the southwestern corner of the township. The first of these lies east of Coal creek from Stone Bluff southward to Dry run, as shown on the map. Coal IV? is a little above drainage at the western side of this area, but probably rises rapidly to outcrop to the east. No coal, as far as known, has been found in this area, but it is probable that some small basins of workable coal will be found there.

The second area lies south of Dry run, as shown on the map, and probably has the same chance as the preceding area of containing some workable coal.

The third area lies west of Coal creek and has been mined on in Secs. 19 and 30. The coal is but a little above the level of Coal creek. On the J. W. Shuster place in Sec. 19 the coal (IV?) is 2 ft. 6 in. thick, with a 1-16 in. parting 6 in. from the bottom. The coal blocks on the outcrop, but farther in the slips are tight and cemented with spar. The face slips run N. 28° W. and are from 2 ft. 2 in. to 2 ft. 6 in. apart as far as measured, though reported to be up to 4 ft. apart. The butt slips run N. 62° E. and are 3 to 6 in. nearer together than the face slips. This is said to be a splint coal, the sulphur occurring in balls. The roof is a drab clay shale and good. The floor is made by 2 ft. of bone coal. The slips run through coal and bone alike. This coal is troubled by cut-outs, due to its being so near the surface. Faults are occasionally met with.

Coal has already been mentioned in the N. W. ¼ of Sec. 31 on the Davis place, ¶349. Just south of this, on the Culver place, S. W. ¼ of Sec. 31, Coal IV? is being extensively stripped in connection with the quarrying of the overlying shale. The section at this point was given in ¶348. Only the upper bench, 2 ft. to 2 ft. 9 in. thick, see Fig. 53, is worked; below that is 11 in. of poor coal left as a floor. The face slips have the direction N. 30° W. and measure from 1 ft. to 1 ft. 2 in. apart. The coal is mined with powder. The roof consists of 20 ft. of light gray clay shale, which is used in the brick factory at Veedersburg. This is one of the largest strippings seen in the State. Dips to the north.

There are probably places in this area where this coal will pay for mining in connection with the overlying shale or underlying fire-clay, where the coal would not pay to mine alone.

Township 19 North, Range 7 West. (C. E. S.)

340. Statement.—This township is practically level but for the trench where the east fork of Coal creek crosses from east to west. Black prairies alternate with rolling sandy land. The drift in the neighborhood of Hillsboro is 10 to 12 ft. thick. North of town the drift thickens rapidly, making a morainic ridge through the northern tier of sections. In the S. E. of S. W. of Sec. 27, a well on Jacob Hessler's place passed through 178 ft. of drift into sandstone.

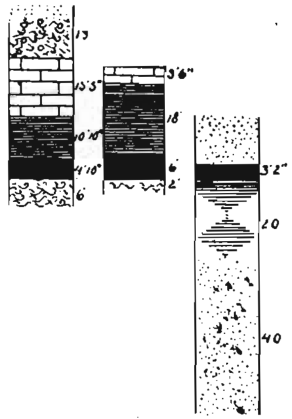
This township is entirely underlain by the coal measures, the higher divisions, in which alone workable coal may be looked for

however, being restricted to the western half of the township. The eastern half is underlain by the sandstone of Division I, which outcrops abundantly along the East fork and has been extensively quarried near Hillsboro. There is probably no workable coal in this part of the township. One ft. of coal was reported as outcropping at the water's edge on the south side of the East fork in the N. E. of S. W. of Sec. 10.

In the higher divisions underlying the western half of the township probably the coals and their accompanying strata are much as given in the columnar sections of the township just north. No coal was reported in this area, and though it is probable that some workable coal exists here, it is also probable that it lies in isolated basins, difficult to find, and probably difficult to work on account of thickness of the drift.

Township 18 North, Range 7 West. (E. ½, C. E. S.; W. ½, G. H. A.)

341. Location, etc.—This township corresponds with the western half of Jackson and southeastern part of Mill Creek of the civic townships. It is very level except in the southeastern corner, where the topography is much broken by Sugar Mill creek and its tributaries. The C. & E. I. R. R. runs along the western boundary for several miles.



54 Yeddo. Sec. 7. 55 Coats. Sec. 33. 56 Hershberger. Sec. 34.

Fig. 54-56. Typical columnar sections in T. 18 N., R. 7 W.

342. Stratigraphy and Coals.—The outcrops appear to be confined to two divisions, V and I, with one coal each. The following sections (Figs. 54-56) give the supposed correlation of the coals and rocks found:

343. SECTION 45. SECTION OF SHAFT AT YEDDO.—Sec. 7, Fig. 54 (R. T. B.).

	Ft.	In.
1. Drift	13	0
2. Sandy limestone	15	5
3. Bituminous shale	10	10
4. COAL V	4	10
5. Fire-clay	6	0
	50	1

344. SECTION 46. SECTION AT COATS' OR BYRD MINE.—Sec. 33, Fig. 55.

	Ft.	In.
1. Limestone, black to white, fossiliferous	3	6
2. Shale, gray to blue	18	0
3. COAL V—		
Coal, 2½ ft. to 3 ft. 0 in.		
Bone, 6 in. to 8 in.		
Coal, 1½ ft. to 2 ft. 0 in.		
Bone, 6 in. to 8 in.	6	4
4. Fire-clay and "rock"	2	0
5. Sandstone	..	..

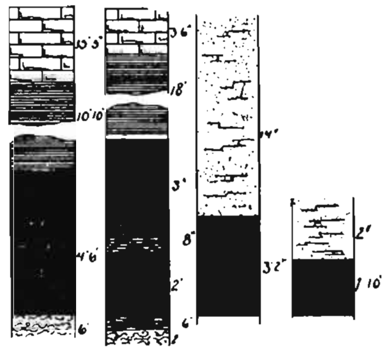
345. SECTION 47. SECTION (CONNECTED) AT HERSHBERGER'S AND BRYANT'S.—Sec. 34, Fig. 56 (C. E. S.).

	Ft.	In.
1. Sandstone	10	0
2. COAL V?	3	2
3. Shale	?	
4. Hidden	20	0
5. Sandstone	40	0

346. On stratigraphical grounds the coal at Yeddo and at Coats appears to be the same coal. On structural grounds the coal at Coats' and Hershberger's and Bryant's appears to be the same. The difference in the roof material of the coals, as well as in their thickness, introduces a factor of uncertainty in such a correlation. See, however, the description of coal on Sand creek a few miles south in Parke county, where apparently the same coal as this is overlain by limestone in places and sandstone in others, both roofs sometimes occurring in the same mine. This principal coal is correlated as Coal V. As shown in Figs. 57-60, it attains a very respectable thickness, ranging up to 6 or 7 ft. At the Coats mine there is an 8 in. parting of bone coal. However, just across the ravine to the south the coal shows a thickness of 5 ft. 8 in., with only 1 in. of clay parting. In

many cases the seam is readily recognized by the overlying roof of shale and superimposed limestone.

More thorough exploration than we were able to make might show that the coal on the Hershberger and Bryant places was below the Coats coal, being Coal IV.



57 Yeddo. Sec. 7. 58 Coats. Sec. 33. 59 Hershberger. Sec. 34. 60 Bryant. Sec. 34.

Figs. 57-60. Coal V in T. 18 N., R. 7 W.

347. Division I shows a good thickness of Mansfield sandstone, but little or no coal, none of any economic importance having yet been discovered.

348. DISTRIBUTION AND LOCAL DETAILS OF COALS.—As in the township just north, the eastern half of this township is underlain by Division I only. The sandstone of this division is exposed along Sugar Mill creek and its tributaries in Secs. 25, 26, 34 and 35. A well at the schoolhouse in Wallace showed soil and drift, 148 ft.; "honeycomb" sandstone, 30 ft. In the S. W. of the N. W. of Sec. 35 Mr. H. J. Starnes dug a test shaft, the bottom of which is about on a level with the bottom of Sugar Mill creek. The section obtained was as follows (Sec. 48, C. E. S.): Soil and drift, 10 to 11 ft.; clay shale, 6 in.; sandstone, 2 ft.; coal, 1 in.; sandstone, 6 in.; coal, 1 in.; sandstone, 3 in.; coal, 2 to 4 in.; sandstone, 8 in.; total thickness of coal, 4 to 6 in. In the S. E. 40 acres of Sec. 34, owned by Mrs. Taylor, coal is reported to have been found in two places and some taken out for blacksmith purposes many years ago.

349. DIVISION V, while supposed to cover a little more than the western half of the township, has only been exposed in two places—around Yeddo and in Secs. 32, 33 and 34.

At Yeddo a shaft was sunk in 1881 and operated until 1886. The section was given in ¶342 and Fig. 54. The coal is said to have averaged 4 ft. 6 in., though becoming 7 ft. to the northwest. The coal is reported to have been a splint coal, mining readily without powder. It has mud slips ranging from 1 ft. 8 in. to 3 ft. 6 in. apart. This coal is said to have taken a premium at the New Orleans Exposition, yet the fact that such a body of coal has lain idle for so long, directly on one of the principal coal carrying roads of the State, would seem to lend confirmation to the report that much of this coal contains too much sulphur to give satisfaction. Better methods of separating the sulphur or washing might remedy that evil, as the sulphur is said to occur in balls or masses. Mr. Thos. Wilson, who, as State Inspector of Mines, examined this coal, says: "They are working an excellent article of semi-block coal four foot ten inches in thickness The coal is a very free working seam, having open slips running through it at regular intervals, and can be mined easily without the use of powder. Four tons is an average day's work for a miner."* The roof is shale with a few inches of "draw slate," and said to be good except to the south and southwest. Six ft. of fire-clay underlies the coal. The coal is said to have been quite regular, only one roll having been met with. The dip is to the southwest. Probably 10 acres taken. It is said that drillings in every direction for a mile or two show this coal to maintain a good thickness. The coal is reported to have been worked a little by a drift on the McCreary place, S. E. of S. W. of Sec. 7, now caved in. On the John Bonebreak place, S. W. corner of Sec. 8, it is said to have shown a thickness of 4 ft. 6 in.

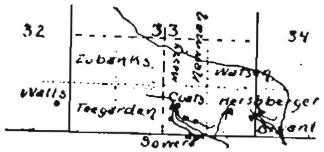


Fig. 61. Sketch map of coal field about Byrd mine.

In the S. W. of the S. E. of Sec. 33, on the W. B. Coats land, Coal V outcrops in a branch and has long been stripped and much of that along the banks rendered useless by indiscriminate and unsystematic drifting. The section here was given in ¶343 and Fig. 55. Coal is now being worked by Mr. Byrd and, across the ravine in Parke county, by Mr. Manley Sowers. At the Byrd or Coats bank the coal averages

*4th Ann. Rep. Mine Inspector, 1883, p. 36.

4 ft., though in the basin running 5 and 6 ft., and even up to 7 ft. in the center of the basin. The coal is divided by 6 or 8 in. of bone coal into two benches, the upper being 2 ft. 6 in. to 3 ft. thick, with two sulphur bands ⅛ of an inch thick, one 6 in. from the top, the other 4 in. from the bottom. The lower bench runs from 1 ft. 6 in. to 2 ft. thick, and contains considerable sulphur. This coal contains sulphur all through, but is accounted a good steam coal. Like the coal at Yeddo, it might be possible to maintain the reputation of this coal while worked on a small scale, where great care can be exercised to keep it free of sulphur, but it would be difficult to maintain its reputation when extensively worked. It is a semi-block coal, the slips being cemented with calcite. The roof is made by 18 ft. of gray to blue shale, 6 to 8 in. of which always comes down in mining. The floor is made of 6 to 8 in. of bone coal and sulphur, with fire-clay below that. The present entry is following up the center of a swamp or basin, 100 yards or less wide, the coal rising 10 to 15 ft. each side and getting thin.

In the S. E. of S. E. of Sec. 33 coal outcrops on the Chas. Hershberger place on about the same level as the coal at Coats. The coal is here 3 ft. 2 in. thick and overlain by 12 or 14 ft. of sandstone.

In the S. W. of S. W. of Sec. 34, on the Jas. P. Bryant place, coal outcrops 18 to 22 in. exposed, overlain by 18 to 24 in. of sandstone, and underlain by shale. A short distance down the branch the Mansfield sandstone outcrops with a thickness of about 40 ft. Coal is reported to outcrop on the W. P. Watson place, N. W. of S. E. of Sec. 33 and to have been struck in a well on D. Watts' place, S. E. of S. E. of Sec. 32. An 80 ft. well drilling on the north part of Sec. 33 struck no rock and showed the presence of an old channel here, which probably cut out the coal.

As to the probability of finding workable coal between this area and Yeddo, it is possible that workable coal exists all over the area between, except where cut out by preglacial channels. It is more probable, however, that the coal is distributed in irregular basins, some possibly of sufficient extent to pay handsomely for working, while over much of the distance the coal may only run a few inches or a foot or two thick.

Township 21 North, Range 8 West. (Part in Fountain County, C. E. S.)

350. Statement.—This partial township corresponds with the southwestern corner of Logan and the northwestern part of Shawnee of the civic townships. The Covington branch of the Wabash rail-

road runs along the east bank of the Wabash river. It presents the usual bluff and terrace topography common along the Wabash. In Sec. 26 three terraces were noted. The lowest one is about 60 ft. above the creek bottoms, the lower 30 ft. being a black fissle shale. The Mansfield sandstone comes to the surface in parts of this terrace, occasionally making small elevations upon it, as in the N. E. ¼ of Sec. 26. Some 30 ft. higher is a small but well defined terrace 300 yards wide. Still 35 ft. above this is the third terrace, not so well defined. Above the third terrace rises the steep face of the river bluff, whose level top bears off towards Rob Roy and the south.

351. Coal.—With the possible exception of the coal in the N. E. ¼ of Sec. 24, only Division I of the coal measures occurs in this township. The Lower Carboniferous rocks occupy some space along the river.

Coal is reported in the N. E. ¼ of Sec. 24 on the John L. Foster place, on Nave branch and west of the Nave mine, said to be 2 to 3 ft. thick. Mined by stripping and entry, now fallen in. Also in the S. W. of S. W. of same section, on Dr. Alex. Whitehall's place, 12 in. thick, overlain by 3 to 4 ft. of shale and that by the Mansfield sandstone. It is underlain by sandstone. Coal is also reported under sandstone up the same branch in the N. W. of N. W. of Sec. 25. On Mrs. Emma Peterson's land, in the N. E. of N. E. of Sec. 25, an 18 in. bed of coal was worked a little in 1896-7. In Mr. Mark Smith's well, in the N. W. of S. E. of Sec. 25, after passing through 70 ft. of drift, "black stuff" resembling coal was entered.

In the N. W. of N. W. of Sec. 26 a well on the Douglas Trot place is reported by Mr. Trot as follows: Sandstone, 45 ft.; coal, 4 ft.; shale and some very bright red sandstone, 56 ft.; chert below. The record as obtained by Mr. Hopkins two years before was: Sand, 4 ft.; sandstone, 38 ft.; coal, 1 ft. 2 in.; sandstone, 46 ft. The thickness of the coal given in the latter would better correspond with what is found elsewhere.

On the L. L. LaBow place in S. W. of N. E. of Sec. 27 a well showed: Soil and drift, 5 ft.; sandstone, 13 ft.; coal, 1 ft. 6 in.

A well on the John Hopkins place, S. E. of S. E. of Sec. 32, went 84 ft. into sandstone, but struck no coal. A well in Portland (Fountain P. O.), one square east of brick store, went 68 ft. into sandstone below 12 ft. of drift.

A well on the Edward Field place showed as follows: Drift, 34 ft.; blue clay, 16 ft.; blue shale, 25 ft.; lighter shale, 30 ft.; sandstone, a few ft.; shale, 95 ft.; white sandstone, 20 ft.

The data, while showing the presence of Coal I 12 to 18 in. thick, plainly indicate no workable coal.

Township 20 North, Range 8 West. (G. H. A., C. E. S.)

352. Statement.—This township corresponds with parts of Shawnee, Van Buren and Troy of the civic townships. The Covington branch of the Wabash railroad crosses the northeastern corner, and the Big Four the southwestern corner of the township. The absence of large streams probably accounts in large measure for the scarcity of data on the coal measures.

353. Coal.—Except a small area in the N. W. ¼ of Sec. 4, this township is entirely underlain by coal measures, the divisions above Division I outcropping over the major part of the township as shown on the map. Coal was only noted at three points.

In the S. E. of N. W. of Sec. 4 a prospecting drift was run into the bank some 30 ft. on the Philander Cox place. At the start two beds of coal were had, but the upper bed ran out in a short distance, as shown in Fig. 62.

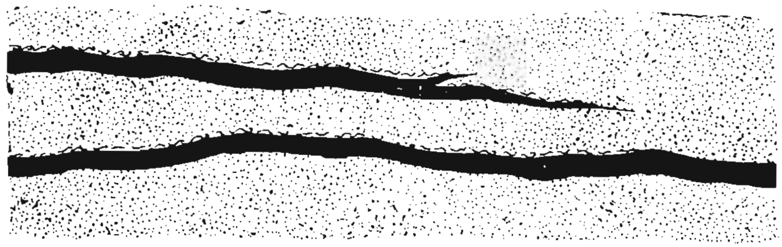


Fig. 62. Coal in entry on Cox place. (From sketch by Mr. C. E. Siebenthal.)

On the John Calhoun place, N. W. of S. E. of Sec. 5, coal has been mined by drifting. Has not been worked in 14 years, and has now caved in. The section here showed: Rotten bony coal, 4 ft.; gray clay shale, 6 ft.; sandy yellow shale, 4 ft. This coal was reported to run up to 7 ft. The same coal crops out on the E. M. Reed place in the ditch beside the road, N. E. of S. W. of Sec. 5. Should suppose the coal to correlate with the coal being mined at Veedersburg and north of there.

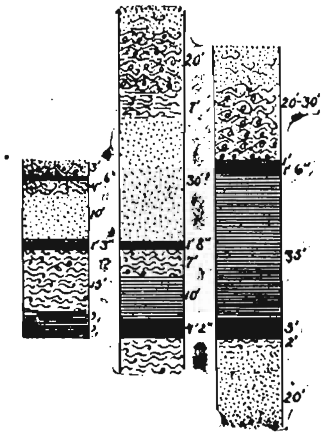
In the S. E. ¼ of Sec. 24 Coal IV? has been mined by stripping, and more recently by drifting, by Ed Eddinger. The coal in a drift just being opened measured 2 ft., appearing to be a good quality of block coal. Further in it is probable the slips will become tight. The coal has over it 2 ft. of light drab clay shale and a floor of black shale. It is just at drainage level.

Fig. 63. Coal IV at Eddinger mine.

As most of the township is underlain by the horizon of Coal IV?, it is not unreasonable to expect to find coal of workable thickness over parts of it. An examination of the sections of this coal given in the township just east of this show that in drilling great care should be taken to distinguish between the good coal and the bony and poor coal underlying it.

Township 19 North, Range 8 West.

354. Location, etc.—This township occupies parts of Van Buren, Troy, Wabash and Mill Creek of the civic townships. The topography is rather broken along Coal creek, which flows diagonally across the township from N. E. to S. W., but becomes nearly level away from that stream. The C. & E. I. railroad passes along the eastern edge of the township, the Big Four crosses the northern and the Clover Leaf the eastern parts of the township.



64 65 66
Clay pit. Veedersburg. Winters.
Sec. 12 (2). Sec. 1 (1) Sec. 31 (2).
Figs. 64-66. Typical columnar sections in T. 19 N., R. 8 W,

355. Stratigraphy and Coals.—Divisions I, IV and V outcrop in this area, including Coal I?, IV, V and Va. The following sections show the relative positions of the coals and their accompanying strata:

356. Section 49. Section at Clay Pit.—N. W. of S. E. Sec. 12. Fig. 64.

	Ft.	In.	Ft.	In.	Ft.	In.
Division V—						
1. Surface	3	0	..	..	3	0
2. COAL Va (streak)	..	6	0	6	3	6
3. Fire-clay, sandy	4	0	..	..	7	6
4. Brown shaly sandstone	10	0	..	..	17	6
5. Dark gray calcareous shale	..	6	14	6	18	0
6. COAL V, 0 ft. to 2 ft.	1	3	1	3	19	3
7. Dark sandy or limy shale	1	0	..	..	20	3
Division IV—						
8. Drab to gray sandy fire-clay	15	0+	..	..	35	3
9. Black shale	?	?				
10. BONE COAL IV	?	?				

357. Section 50. Section of Shaft at Veedersburg.—Fig. 65.

	Ft.	In.	Ft.	In.	Ft.	In.
Division V—						
1. Gravel	20	0	..	..	20	0
2. Fire-clay (?) or shale	7	0	..	..	27	0
3. Sandstone with shale partings	30	0?	..	..	57	0
4. COAL V	1	8	1	8	58	8
5. Fire-clay, light drab	7	0	..	..	65	8
6. Drab shale with plant remains	10	0	17	0	75	8
7. COAL IV	4	2	4	2	79	10
8. Fire-clay, light gray, sandy	9	0	..	..	88	10

The upper part of this section was not seen, and may prove to be in error.

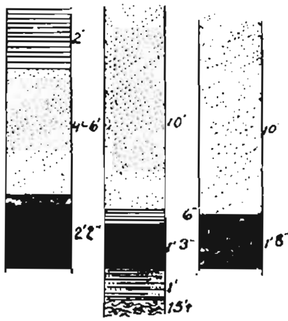
358. Section 51. Section, Center of Section 31.—Fig. 66.

	Ft.	In.	Ft.	In.	Ft.	In.
Division V—						
1. Hidden or drift...20 ft. to	30	0	..	..	30	0
2. Black shale	1	0	..	..	31	0
3. COAL Va. (Not seen; reported by Mr. Cox)	1	6	1	6	32	6
Division IV—						
4. Gray sandy shale	35	0	35	0	67	6
5. COAL IV	5	0	5	0	72	6
6. Fire-clay ....8 in. to	2	0	..	..	74	6
Division I—						
7. Sandstone, cross-bedded	20	0	..	..	94	6

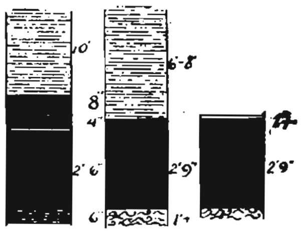
Coal V does not appear in this section.

359. Division V.—The correlations of this division are somewhat uncertain, as the limestone and shale characteristically overlying Coal V do not appear in this township. The two upper coals found in this area have been designated Coals V and Va. Coal Va is a small coal, often or usually cut out and replaced by the drift. Where better exposed in closely adjacent regions, it has a roof of black sheety shale, with often a thin layer of limestone or calcareous shale over it. It ranges about 1 ft. thick.

Coal V is the coal lying about 15 to 20 ft. above the Veedersburg coal. Around Veedersburg it is a thin, uncertain coal, ranging from



67 Hershberger. Sec. 14 (1). 68 Clay pit. Sec. 12 (2). 69 Coal Cr. Sec. 12 (1).



70 Cade. Sec. 34 (1). 71 Uplinger. Sec. 34 (3). 72 Boner. Sec. 32 (3).

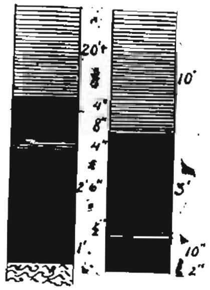
Figs. 67-69. Sections of Coal V around Veedersburg.
Figs. 70-72. Sections of Coal V east of Coal Creek P. O.

0 to 2 ft. 2 in., but reported to be, at least locally, of much better quality than the underlying Coal IV. Around Veedersburg it appears to have a sandstone roof wherever examined.

In the south part of the township the coal that has been doubtfully assigned to this horizon runs from 0 ft. to 3 ft. 6 in. in thickness, usually with a sandy shale roof. It is usually reported as a good coal there also. It appears to be without partings, though sometimes showing persistent bands of pyrite, as at the Cade bank.

360. Division IV.—This division contains the principal coal of this township, Figs. 73, 74. Around Veedersburg this coal is quite irregular, being 4 ft. thick at the shaft in town and reported to be only bone coal a mile south of the town. It has there a parting of shale or bone, and tends to be bony in the lower part. The coal as a whole is not as pure as Coal V above it. In Sec. 31 a corner of the Stringtown (Coal Creek P. O.) coal basin extends into this township.

Coal IV is there 5 ft. thick (see Fig. 73), with a 4 in. parting of shale near the top, and a 1 in. clay parting near the bottom. In Sec. 31 two smooth partings occur, one 4 in. from the top, the other 12 in. above the 1 in. clay parting. Like all the Stringtown coal, this has a high reputation for quality.



73 Winters. Sec. 31. 74 Veedersburg. Sec. 1 (1).

Figs. 73-74. Sections of Coal IV in T. 19 N., R. 8 W.

361. Distribution and Local Details of Coal.—Coal mining in this township has been confined to two districts, about Veedersburg (Fig. 75), and in the southwest corner of the township (Fig. 76). We will therefore consider, first, Secs. 1, 2, 11 and 12, then Secs. 31 to 34, then the rest of the township.

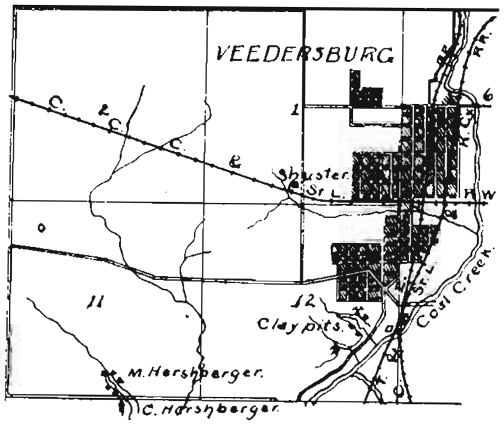


Fig. 75. Sketch map of Veedersburg district.

362. Coal in Sections 1, 2, 11 and 12.—See Fig. 75. At Veedersburg, Coal IV is a little below drainage, though it is reported to rise to outcrop in Coal creek just below the C. & E. I. railroad bridge, and half a mile further down must be several feet at least above the creek, as a small exposure of Mansfield sandstone is noted at the old mill in Sec. 13. To the north it rises again so as to be above the creek in Sec. 31 of T. 20 N., R. 7 W. At the J. W. Shuster shaft in the western part of Veedersburg, it is about 75 ft. deep and 4 ft. thick (see ¶357 and Figs. 65 and 74 for sections). The coal is mostly blocked out, though some powder is used. The face slips run N. 30° W., and tend to offset at the "dirt" band, which is here from 1 to 4 in. thick, and 10 in. from the bottom. The coal below the dirt band is not as good as that above. The roof is a drab shale, showing an abundance of plants next to the coal, 2 in. of bone, with 9 ft. of light gray fire-clay making the floor. The coal gets thinner to the east toward the outcrop. This mine was just opening up in 1897 after being closed 8 years. Just north of the C. & E. I. R. R. bridge over Coal creek, and but a few feet above the level of the creek, is an outcrop of Coal V 20 in. thick and overlain by 10 ft. of gray sandstone. Just north of this it was formerly extensively worked. Specimens of cannel coal are reported to have washed out from a place a little below the railroad bridge, and an outcrop of cannel coal has been assumed at that point. If an outcrop exists at that point we suspect it may be of Coal IV, which is usually underlain by bone coal, that may be unusually pure at this point. A little west of this Coal V is exposed in a ravine, Sec. 12 (2), and has been mined a little in connection with the underlying shaly fire-clay, which has been quite extensively worked here (see ¶356 and Fig. 64). Coal IV is reported here to be represented only by bone coal overlain by black shale. A boring near this (loc?) is reported to have shown 4 ft. 6 in. of "rotten coal." Of a boring made "near the west line of Sec. 12," Mr. Brown obtained this rather indefinite record:

Drift, 20 ft.; sandstone and clay shale, 48 ft.; black shale, 2 ft.; coal, 4 ft.=74 ft.

In Sec. 11, S. W. of S. E., little mining has been done on Coal IV on the M. Hershberger place. The coal has been mined by stripping and by drifts. At one of these 2 ft. of coal was exposed, showing well-defined slips. The roof shows 4 ft. of sandstone with shale partings, with 2 ft. of drab shale over that, and appears to be good. The coal is reported to run normally 3 ft., but is largely cut down by the sandstone roof, to half that thickness. On the C. Hershberger place, in Sec. 14 (1), two drifts were open. The coal here is about 6 ft. above

the creek, measures 2 ft. 2 in. thick, and has 6 ft. of brown shaly sandstone for a roof. As far as examined, it shows open mud slips 1 ft. to 1 ft. 6 in. apart and running N. 30° W. It is reported that three borings made in this vicinity showed a 20-in. coal bed at 25 ft. and a 4-ft. bed at depths from 86 to 95 ft. Not knowing the location of these or the elevation from which they started, only a guess can be made of the correlation of the coals reported. Assuming the bores not to have started in the creek channel, but up on the level, it would appear that the 20-in. coal was Coal V just described and the 4-ft. coal was Coal IV. In the N. W. ¼ of Sec. 11 a drilling is reported to have gone 100 ft. without striking rock, indicating the presence of a preglacial valley which must have cut out the coal. The evidence indicates that there may be quite a basin of coal here, but it also indicates the presence of numerous limiting conditions which may render much of the area unproductive.

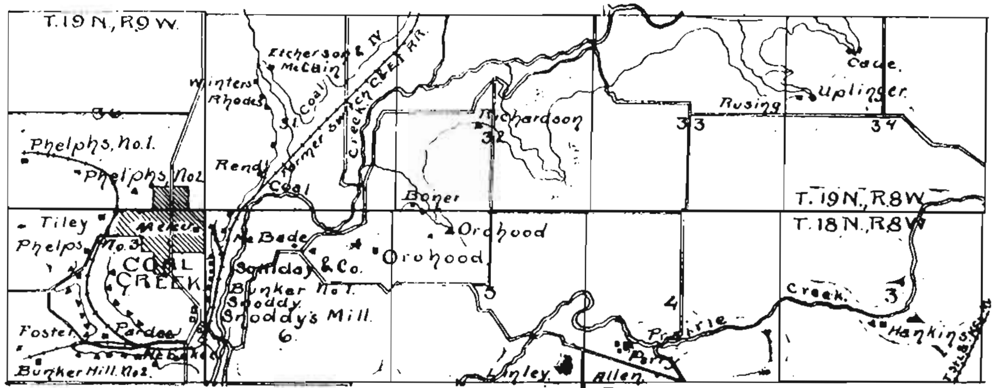


Fig. 76. Sketch map of Coal Creek (Snoddy's Mill District. ¶. 123.)

363. Coal in Secs. 31 to 34.—In Sec. 34 Coal V? is not far below the general level and probably runs out to the surface in the eastern part of the section. It has been mined some near the heads of one or two small ravines that head in that section. An 18 to 20 in. coal, supposed to be Coal IV, is reported to crop out down the ravines from the coal. At Samuel Cade's bank, N. E. of N. W. of Sec. 34, Coal V? is 3 ft. 6 in. thick. There is, first, 8 in. of coal on top, the best coal in the seam; then a sulphur band 0 to ¼ in. in thickness; then 4 in. of poor, sulphury coal; then 2 ft. 6 in. of good semi-block caking coal. It shows slips, not tight, 18 to 20 in. apart. The roof is a gray sandy shale, 4 in. of which comes down; 6 in. of bone coal makes the floor. In the S. W. of N. W. of Sec. 34, the same coal is worked a little on

the Geo. Uplinger land, also a little further down the branch on Mrs. Mary Rusing's land. The coal here measured 2 ft. 9 in., with open clay face slips running N. 20° W., and appearing to be a characteristic block coal. Either boulder clay or gray sandy shale serves as a roof, and gray fire-clay as a floor.

In the N. W. ¼ of Sec. 33, and across Sec. 32, Coals IV and V are above the bluffs of Coal creek, which here are perpendicular cliffs of sandstone (Mansfield), 20 to 25 ft. high. In Sec. 32, N. E. of S. W., Coal IV is reported to have been found on the H. C. Richardson place, 4 ft. thick. Its horizon would here be but little above the top of the sandstone bluff. Coal was reported to have been found in the S. E. 40 acres of Sec. 32. In the S. W. 40 acres Coal V? outcrops near the head of a ravine on the Melissa Boner place. It has been mined some by drifting, coal about 2 ft. 9 in. thick, and said to be a good blacksmith coal. Irregular slips, mined without powder. Roof not seen, floor hard fire-clay.

In Sec. 31 Coal IV continues well above drainage, but getting nearer to drainage in the southwest. Perpendicular bluffs of Mansfield sandstone show 20 ft. high in the ravines running into Coal creek from the northwest. Coal IV lies just above this sandstone. It is being worked in the S. E. of N. W. on Winter's and Rhodes places. The section here was given in ¶358, Fig. 66, and of coal in Fig. 73. The coal here shows 4 in. of good top coal, then a smooth parting, then 8 in. of coal to a 3 or 4 in. shale band. The 3 ft. 6 in. of coal below the principal parting shows a thin clay parting 1 ft. from the bottom and a smooth parting 1 ft. above that. Fifteen to 20 ft. of gray shale makes the roof here. Below the coal is 8 in. to 2 ft. of fire-clay, then the 20 ft. of sandstone exposed down the ravine.

Among the other mines in this neighborhood not running at present may be mentioned the Etcherson and McLain drift, Sec. 31 (1), and the W. P. Rend drift, Sec. 31 (6), the latter having been a shipping mine. The taking up of the C. & E. I. switch from Danville led to the abandoning of extensive mining here. See further discussion of this field in following paragraphs:

364. SECTIONS 3-10, 13-25, 35 AND 36.—This area would appear to be entirely underlain by Divisions IV and V, except where removed by Coal creek and its tributaries, as shown in Secs. 27, 28, 29 and 30. From Secs. 13 to 27 no data was obtained to show whether the horizon of Coal IV passes below Coal creek or not, as only drift is exposed along that part of the creek. The sandstone bluffs and two outcrops help to locate the position of Coal IV in Secs. 28 and 29.

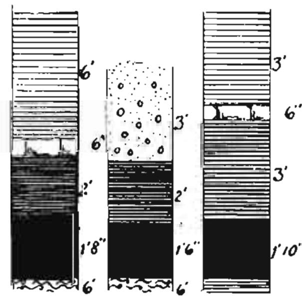
Over the rest of the area little can be said. It is probable that Coal IV exists in basins of workable thickness and extent, but it is probably also true that over no small part of the area it is either cut out by preglacial erosion or is too thin or in too small basins to work largely. Attention has already been called to the preglacial channel crossing the N. W. corner of Sec. 11; another such channel is indicated in the S. E. of S. W. of Sec. 25, where a drilling went 77 feet without striking rock.

TOWNSHIP 18 NORTH, RANGE 8 WEST.

365. LOCATION, ETC.—This township covers the western part of Mill Creek, the eastern part of Fulton and the southeastern corner of Wabash of the civic townships. Coal creek crosses the northwestern corner, Prairie creek the northern part and Wabash Mill creek the central part of the township. In the northeastern part, the valleys are but slightly below the general level; along the lower courses of the streams, however, their valleys become more marked, with slightly more rugged topography. Away from the principal streams the country is quite flat.

The Clover Leaf railroad crosses the township from northeast to southwest. The C. & E. I. follows the eastern edge for three miles, then cuts across the southeastern corner.

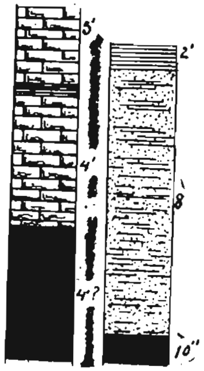
366. STRATIGRAPHY AND COALS.—While coal was found at a number of places in this township, no good connected sections were found. As nearly as could be ascertained, there are three coals in this



77 78 79
Dotson. Hardesty. Lindley.
Figs. 77-79. Coal Va in T. 18 N., R. 8 W.

township above Division I. The first of these appears to correspond to the highest coal of the preceding township, and called Coal Va. It ranges from 1 ft. to 2 ft. 6 in. in reported thickness, Figs. 77 to 79, and has over it generally a drab to black shale tending to become sheety, with usually from 0 to 6 in. of shaly limestone, running into calcareous shale, over that. Its extent is probably very limited, as wherever found it was but a few feet below the general upland surface.

Next is supposed to come the coal below the limestone, as already described from Yeddo, Figs. 80, 81. Though this limestone was re-



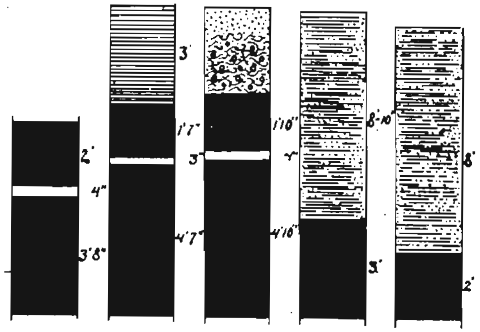
80 Towell. 81 Prairie Cr. Sec. 7.

Figs. 80 81. Coal V in T. 18 N., R. 8 W.

ported by Mr. Cox in the Prairie creek region overlying a 4 ft. bed of coal, we failed to find it. The thick bed on Prairie creek which he reports having seen as much as 10 ft. thick, he believed to be made up of this and the underlying coal bed, and claims that it is generally overlain by limestone. While we found nothing to disprove the theory that the big bed on Prairie creek, Fig. 84, is a double bed, composed of Coals V and IV, and the evidence slightly tends to confirm that theory, still not finding any trace of the limestone over the bed prevented any definite conclusions in the matter, and left it uncertain whether to call that bed Coal V or IV, or a combination of the two beds. If it is closely overlain by limestone, it would make it appear either that it corresponds with the 6 and 7 ft. coal at Yeddo, or is a double bed, as suggested by Mr. Cox. If not overlain by limestone, it would seem to be Coal IV, as is the Stringtown coal a couple of miles to the west.

Coal IV, as we shall assume the Stringtown coal on the west bank of Coal creek to be, is a coal ranging up to 6 and 7 ft. in thickness in Sec. 6, and reported in other places to attain the same thickness. We have also, with some doubt, correlated the big coal on Prairie creek

with this horizon (see just above). For the coal as developed on Coal creek, see description of same coal under last township. Its coking qualities were practically tested in this township—Sec. 6—and it is claimed to have proven very successful, as may be judged from the fact that experimental tests led to the erection here of coke ovens to the value of $150,000 by the North Chicago Iron and Steel Company. Figs. 82-86 show the development of the coal on Prairie creek. At its best



82 Lindley. Sec. 8. 83 Perry. Sec. 4. 84 Perry. Sec. 4. 85 Hankins. Sec. 3. 86 Prairie Cr. Sec. 7.

Figs. 82-86. Sections of Coal IV on Prairie creek.

development it shows a thickness of nearly 7 ft. or perhaps over, with 3 or 4 in. of shale and clay parting 1 ft. 6 in. to 2 ft. from the top. The upper bench is usually poor coal, and often all or part of it is left in mining. The lower bench is claimed to be an excellent quality of caking coal, though some sulphur was noticed.

367. Distribution and Local Details of Coal.—Secs. 1, 2, 11, 12. The coal at Yeddo is said to be known to cover much of Sec. 12, but whether extending into Secs. 1, 2 and 11 can only be surmised. For the coal as developed in Sec. 12, see description in ¶348.

368. Sections 3 to 10.—Coal IV (?) first appears near the center of Sec. 3, on the Alex. Hankins place. The coal is here at creek level and is reported to be 3 ft. thick. The drift was full of water when visited. Eight to 10 ft. of gray sandy shale overlies the coal (see Fig. 85). A well on the same place is reported to have shown 4 ft. of coal.

In Sec. 4, S. W. ¼, coal has been stripped on Prairie creek and mined by drifting, on the S. A. Perry place. Figs. 83 and 84 show two sections obtained at this place. The top bench is bony. At one place the roof is boulder clay and sand, at another soft clay shale.

The coal is here but a few feet above Prairie creek, toward which it dips. This was formerly the Thomas Orohood place, and it was here that Mr. Cox reports having seen 10 ft. of coal, the parting there being 2 ft. thick. He also reports having seen the "upper part of this great bed," "about 4 ft. thick and entirely disconnected from the lower bed," just southwest of Orohood's and on the same section. A quarter of a mile west, a well was bored to a depth of 700 ft. for salt, and is said to have passed through, at a depth of 12 ft., 5 ft. of coal, believed, by Mr. Cox, to be the lower bed here separated from the upper. In the N. W. corner of Sec. 9 the coal has risen almost to the upland surface and has been mined on the John Allen place, by a shaft, full of water when visited. In the N. E. 40 acres of Sec. 9, it is about 15 ft. below the level and 5 ft. 8 in. thick, including 18 in. of the top not mined. The section is as shown in Fig. 82. No more coal was seen down Prairie creek until it reached the point where Prairie creek enters Sec. 7. Here, a 2 ft. coal, supposed to be the same as the preceding, outcrops in the creek bed. It has a smooth parting 8 in. from the bottom and is underlain by bone coal or black shale. Whether this was the full thickness of the coal or whether this was only the top bench of the Lindley-Perry coal, could not be definitely stated. It was supposed to be the full thickness. Only a a few feet above this occurs an 8 in. to 2 ft. coal. The section a short distance down the creek in Sec. 7 was (see Fig. 81): Hillside, rock hidden, 50 ft.; yellow shaly sandstone, 4 ft.; drab clay shale, 2 ft.; gray shaly sandstone running into sandy shale, 8 ft.; Coal V (?), 8 to 10 in.; fire-clay, 4 ft.; gray to drab clay shale, 2 ft. to creek bed. The relation of this coal to the coal in the creek bed nearer the road crossing could not be ascertained.

In the N. W. corner of Sec. 5, Coal V (?) outcrops in the head of a ravine on the J. D. Orohood place. This is but a few rods above the Boner bank and is the same coal (see ¶363).

On the Orohood place near the center of Sec. 6, the Coal V (?) outcrops at the forks of the road. A well at the house is reported to have found a 4 ft. bed of coal at a depth of about 50 ft., or about 40 ft. below the outcrop of Coal V.

On the west side of Coal creek, in Sec. 6, Coal IV outcrops above drainage, and has been opened upon by numerous drifts, none of which are at present (1897) open. Among these may be mentioned the McVey mine, formerly the Ogden Bros., the Solliday & Co.'s old mine, the Bunker No. 1 mine and Snoddy's mine. The official reports of the mine inspectors show the coal in these mines to average about 5 ft. 6 in. The coke ovens, twenty-five in number, which utilized the slack from these mines, were situated in this section (see map).

How far south of Prairie creek the Perry-Lindley coal extends could not be determined. The rise from Prairie creek, south to the Lindley and Allen banks, if continued, would carry it out in a short distance. In all probability, however, it dips under again and it would not be surprising to find a fine basin of coal underlay parts of Secs. 8 and 9, and possibly extending still farther east and south, though probably with diminished thickness. This basin is but a mile or a little over from the Clover Leaf railroad.

369. Sections 13-16, 21-28, 33-36.—The northeastern part of this area, near Yeddo, is in the Yeddo basin, and contains a large area of that valuable coal, though just how far it extends to the south and west from Yeddo can not be stated. At the falls of Mill creek, in Sec. 28, it appears again, with a reported thickness of 4 ft. Only 2 ft. 6 in. were exposed. This is overlain by 9 ft. of blue limestone, containing an abundance of large crinoid stems. A 4-in. shale parting comes 4 ft. from the bottom of the limestone. It is claimed that in digging the flume for the mill a bed of cannel (?) coal was struck 5 ft. below the sub-limestone bed. It is claimed to have burned like a candle when lit with a match. Thickness unknown. A fault occurring between the upper and lower falls causes a repetition of the

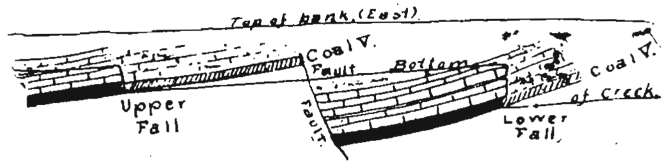


Fig. 87. Section showing structure at the falls of Mill creek.

strata, resulting in the two falls as shown in sketch, Fig. 87. A large pot-hole above the upper fall, such as are characteristically formed under the conditions obtaining there, is a subject of much curiosity locally, being supposed to have been dug out by the Indians.

At Kingman drillings only reveal the presence of a deep preglacial channel. At the water tank a drilling is said to have gone 143 ft. in drift, showing no coal. South of that 60 ft. another well went 200 ft. in the drift, but no rock or coal. One thousand feet northward another well went 200 ft. through drift into black sticky clay or "gumbo." I am inclined to think the channel found there ran southwest and down the present channel of Rush creek into Sugar creek, in Parke county. If drillings should show that the channel connects with the one found in the north part of Sec. 33 of T. 18 N., R. 7 W., it would look as though this may have been the old channel of Sugar creek, which through the northern part of Parke county has a narrow rocky channel much resembling a post-glacial cutting. All coal would probably be cut out along that course. And as, close to such principal water courses, the tributaries have usually cut considerable valleys, it is quite possible that no small portion of the southeastern part of this township may be rendered barren from that cause. Over the rest of the sections under consideration, workable coal, if present, should be found within 100 ft. of the surface.

370. SECTIONS 17-20, 29-32.—With the exception of an outcrop of limestone and coal reported in Sec. 32, S. W. ¼, in bed of Mill creek, a continuation of the coal and limestone at the falls of Mill creek, all the outcrops are of the little top coal, with the black sheety shale over (Figs. 77-79). On the Aaron Lindley place, S. W. of S. E. of Sec. 17, the coal is only 8 or 9 ft. below the general level. It is reported to have been about 30 in. thick in a well near there, with bone under. The section above it is: Soil, 2 ft.; drab shale, 3 ft.; limestone, fossiliferous, 0 to 9 in., average, 6 in.; drab shale, 3 ft.; Coal Va. The overlying shale has the appearance of being suitable for brick. On Mrs. Martha Foster's place, in the S. E. of S. W. of Sec. 17, the coal is 20 to 22 in. thick, overlain by 2 ft. 6 in. of drab to black shale, sheety in places, with 4 ft. of surface on top. The coal is here underlain by dark drab shale and dips northeast. On the John Hardesty place, S. E. of N. E. of Sec. 19, this coal is 18 in. thick, with 2 ft. of drab shale, inclined to be sheety, over. A well here starting just about on a level with this coal is reported to have found 8 in. of coal at a depth of 12 ft., 2 in. at a depth of 36 ft. and 3 ft. 6 in. of coal at 57 ft., the last having 20 ft. of sandstone over it. It is reported that five drillings on this place, made some years ago, showed 6 ft. of coal all under here. A well at Cates Station is reported to have found 14 in. (Coal V?) at 43 ft. and 3 ft. 6 in. (?) at 70 ft. The top coal is reported to outcrop on the M. D. Russel place in the N. W. 40 acres of Sec. 17. In Sec. 31, N. W. 40 acres, on the J. W. Dotson place, is an outcrop beside the road, showing the following section: Yellow micaceous sandstone in flags, 3 ft.; dark drab fissle shale, 6 ft.; fossiliferous calcareous shale into shaly limestone, 0 to 6 in.; black bituminous sheety shale, 2 ft.; Coal Va, 16 to 20 in.; light gray fire-clay, 6 ft. Here, again, whatever workable coal exists should be found within 100 ft. of the surface anywhere in these sections.

That some workable coal exists in this area at a depth of between 50 and 60 ft. seems probable.

PARTIAL TOWNSHIPS 18, 19, 20 NORTH, RANGE 9 WEST.

371. LOCATION, ETC.—It will be convenient to consider these partial townships together, as our larger knowledge of the coals and their relations came almost entirely from one of them, T. 18 N., R. 9 W., and in their general physical conditions they are very similar. They form the western edge of Troy, Wabash and Fulton of the civic townships. Topographically, they present a river bottom, river terrace, river bluff, and, along the eastern side, the flat upland. Numerous short streams serrate the bluff line and render the topography rather broken. In Fulton township there exists an old channel of the Wabash, which leaves the present channel in Sec. 10 and runs along the western side of Secs. 14, 23, 26 and 35. High water will still throw a considerable current through this old slough. Between this and the present channel is a high ridge of land known as Silver island. In Secs. 25 and 36 another old channel shows the former outlet of Coal creek to have been in Sec. 26. Whether the old channel was preglacial or not, I am not prepared to say. The Clover Leaf railroad crosses the southern edge of this area; the Big Four crosses it at Covington; the Covington branch of the Wabash runs northward from Covington.

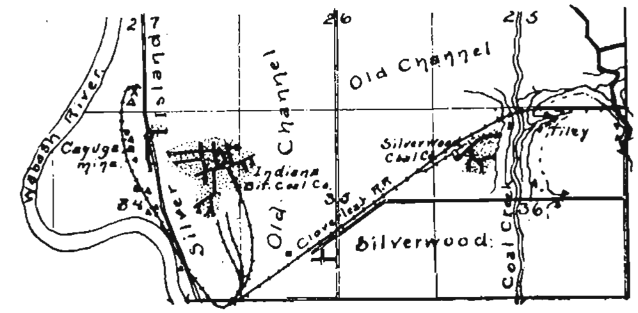
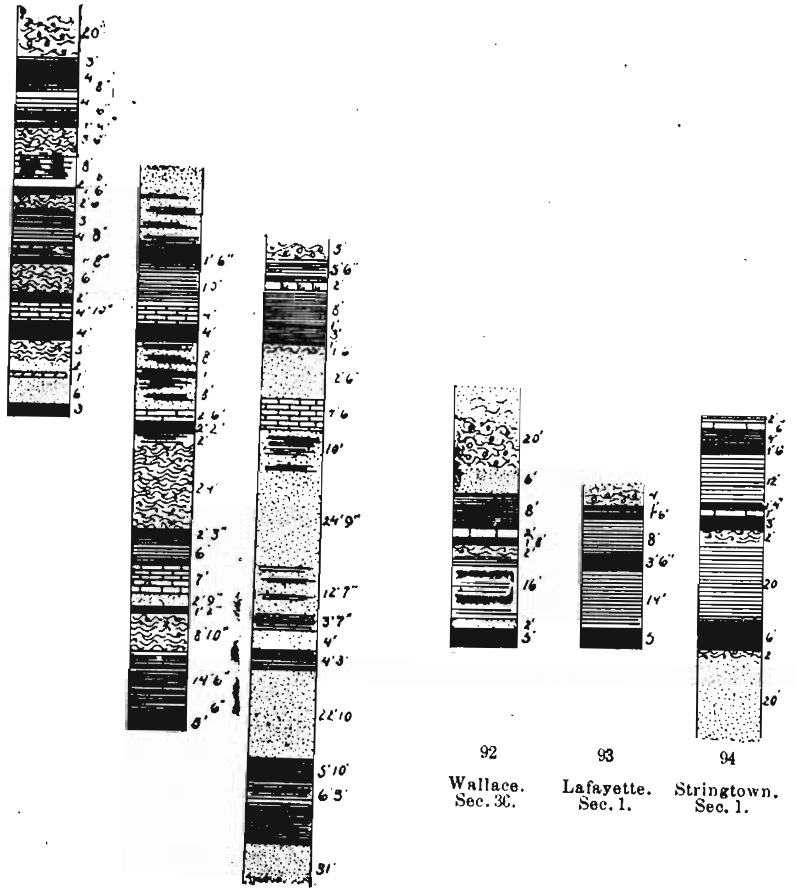


Fig. 88. Sketch map of Silverwood coalfield.

372. STRATIGRAPHY AND COALS.—Divisions I to VI appear to be included in this area. Much doubt exists as to the proper correlation of the coals in any of the sections and also between one section and another, so that the correlations indicated in the arrangement of the columnar sections, Figs. 89 to 94, should not be considered as final. One of the best sections in the northern part of the coal field formerly existed on the west side of Silver island in Sec. 34, T. 18 N., R. 9 W. The section is now much obscured by the grade of a railroad switch

laid to a large stone quarry at the north end of the bluff. Sections were made at this place and published by Mr. D. D. Owen (D. D. O., p. 32). Mr. Leo Lesquereux (L. L., p. 334) and Mr. John Collett (E. T. C., p. 120). As this section to some extent serves as a key to much of this part of the field, we have thought that it might be well to place these three records in parallel columns; only Mr. Collett's is figured. Fig. 89.



89 Silver Island. Sec. 34. 90 Silverwood. Sec. 36. 91 Artesian Well. Sec. 35. 92 Wallace. Sec. 36. 93 Lafayette. Sec. 1. 94 Stringtown. Sec. 1.

Figs. 89-91. Columnar sections of coal measures in T. 18 N., R. 9 W.

373. SECTION 52. SECTIONS AT SILVER ISLAND—Sec. 34, Fig. 89.

D. D. OWEN.	Ft.	In.	LEO LESQUEREUX.	Ft.	In.	JOHN COLLETT.	Ft.	In.
Sandstone	8	0	Drift overlying sandstone, covered	10	0	1. Drift	30	0
						2. Gray clay shale	3	0
						3. Coarse black sheety shale	5	0
Good COAL No. 1 (VIb)	1	6	Shaly COAL (VIb)	2	0	4. COAL brash (VIb)	..	8
Slaty clay and shale	10	0	Fire-clay and soft yellow shales	8	0	5. Clay shale, place of quarry rock	6	0
						6. Ferruginous fossiliferous limestone	0	6
						7. Black bituminous sheety shale	1	10
Good COAL No. 2 (VIa)	1	6	Shaly COAL (VIa)	2	0	8. COAL (VIa)	2	0
Shaly clay	10	0	Black shales and fire-clay	3	0	9. White fire-clay	3	6
Shale or variegated marl	3	0	Soft shales with plants and sandstone	8	0	10. Arenaceous shale with ironstone	8	0
						11. Band of nodular ironstone	0	6
						12. Black bituminous shale	2	0
Good COAL No. 3 (VI)	1	6	COAL, shaly No. 3 (?) (VI)	2	6	13. Fatty COAL (VI) (?)	1	6
Slaty clay and shale	8	0	Hard fire-clay with Stigmaria	6	0	14. Siliceous fire-clay	2	6
						15. Clay shale(?) with siliceous ironstone	5	0
Slaty clay interspersed with argillaceous iron ore—bands of ore 3 to 4 in. thick	5	0				16. Gray argilaceous shale, with bands of ironstone	4	8
						17. Black band ironstone	0	4
						18. Cannel coal (?) slate	0	8
						19. Black sheety shale with fish remains	1	0
Good COAL No. 4	2	0	Black shales and some COAL	6	0	20. COAL, choice caking (Vb)	1	8
Fire-clay, white above dark below	8	0	Limestone overlying fire-clay	4	0	21. Fire-clay	6	0
Hard bituminous limestone	6	0				22. Clay shale with ironstone	2	0
			Limestone	2	0	23. Bituminous fossiliferous limestone	4	10
Main COAL No. 5	4	6	COAL (main) (V)	4	0	24. COAL K (?) (V)	4	0
			Fire-clay	3	0	25. Fire-clay 4 to	5	0
Soft sandstone with specks of carbonaceous matter—passes into indurated clay slate	15	0	Yellow shaly sandstone to level of river	8	0	26. Soft sandstone	2	0
COAL No. 6. Beneath bed of Wabash; thickness unknown.						27. Siliceous ironstone	1	2
						28. Flaggy sandstone	6	0
						29. COAL I (?) (IV)	3	0
						30. Sandstone to river bed		

The comparison is given partly to show with what regard for detail Mr. Collett prepared his sections as compared with other geologists of more than national distinction, and this simply because of the large number of Mr. Collett's columnar sections, which we have used in our work. While it is true that extreme minutia of detail may be misleading occasionally, due to the variable nature of the strata, in the vast majority of cases detail is of great help.

In our own section at the same place, while we failed to find Coal V and its overlying limestone, due to the hiding grade of the switch, one or two points were noted which seem to have escaped notice or to have been misinterpreted by the workers mentioned. At the north end of the bluff is a large sandstone quarry, showing a clear thickness of massive sandstone of 35 or 40 ft. (see T. C. H., p. 276, for detailed description). Mr. Collett put this stone stratigraphically below the first coal or top coal No. 5 of this section. Mr. Owen and Mr. Lesquereux more correctly placed it above the top coal. Going south from the quarry, it is observed that the sandstone gets more shaly, but it is soon discovered that the sandstone does not run into the shales, but has been laid down in a broad channel cut out of the coal-bearing shale, etc. As we go southward, the line of contact rises and Coal VI, No. 13 of section, is noted. It has been mined a little and shows, below the sandstone of filling:

	Ft.	In.
Fire-clay	0	3
Drab shale	2	0
COAL VI?	1	6
Gray fire-clay	2	4

Everything below hidden by railroad grade. The line of contact rises rapidly here and in a few steps passes above Coal VIa, No. 8 of section. At this point the space between the two coals, 12 ft., seems to be all fire-clay except the 2 ft. of shale over the lower coal, practically as given by Mr. Owen. A little beyond this the rising line of contact reveals the roof of Coal VIa as follows:

	Ft.	In.
Sandstone corresponding to upper part of sandstone in quarry	6	8
Gray to black fissle shale with ironstone	3	0
Gray, very shaly, limestone, showing corals and cone in cone structure	..	6
Black shale, sheety in places	2	0
COAL VI	1	0
Fire-clay	10	0

The overlying sandstone is here very irregular, often cutting down almost to the coal, but finally lifting so as to expose the top coal, with this section to the next coal:

	Ft.	In.
COAL VIb bone	..	8
Gray clay shale	4	0
Black shale	2	0
COAL VIa	1	0

Going south a little past the sulphur spring is a section containing some elements not noted in the previous sections.

	Ft.	In.
Black sheety shale	1	0
COAL VIa	1	4
Brown sandstone .8 in. to	1	0
Fire-clay running into light gray clay shale, not well exposed	12	0
Concealed	5	0
Dark blue shale	3	0
Black sheety shale with septaria 1½ ft. to	2	0
COAL, rich	1	6
Gray fire-clay	4	0
COAL	1	0
Fire-clay	6	0
Drab shale	4	0
Sandy ironstone	1	0

Note in this section the sandstone under Coal VIa, as it may help in the correlation further on. Note also the two coals separated by 4 ft. of fire-clay not noted in any of the preceding sections. They would seem to correspond with Coal No. 20 of Mr. Collett's section. In that case they would be Coals Va and Vb, and Coal VI was passed in the 5 ft. of concealed space. Some uncertainty exists in regard to their correlation with the coals of Mr. Collett's section. This section should reach down quite to the limestone over Coal V, but at this point, instead of limestone, the strata appear to be sandy ferruginous shales with much ironstone for a thickness of 7 or 8 ft. The possibility suggested itself that these strata may have slid from above, though that does not make it any easier to place the strata than before, as the strata above and below the 5 ft. of concealed space are apparently intact and there is no correspondence observable unless it be assumed that the 1 ft. 6 in. of rich coal was formerly a part of the Coal VIa bed and the coal 4 ft. below it is Coal VI, which here gets close to Coal VIa, as it is found to do across the river. The absence of the sandstone in the lower section is against that theory. A short distance south of this and nearly to the wagon ford is the following section, which appears to start just below the horizon of the ferruginous shale at the bottom of the last section:

		Ft.	In.
Sandy ironstone	8 in. to	1	0
Gray shaly, flaggy sandstone	2½ ft. to	3	6
Gray to drab shale		4	0
Shaly, flaggy sandstone, with plants		1	6
COAL IV (?)		1	6
Bone coal		..	3
Dark drab fire-clay		..	6
To low water in river.			

This coal is supposed to be No. 29 of Mr. Collett's section, not noted by Mr. Lesquereux, and reported by Mr. Owen as below the river bed and as having a reported thickness of 12 ft.

At the shaft of the Silverwood Coal Company, east of Silverwood, the following section is reported in shaft and boring:

374. Section 53. Section at Silverwood Coal Co.'s Shaft.—Sec. 36, Fig. 90.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface and light shale, sometimes reddish sandstone ... 34 ft. to	28	0	..	..	28	0
2.	Black sheety shale. .0 ft. to	6	0	..	..	34	0
3.	COAL Va (?)	1	6	1	6	35	6
4.	Light gray clay shale 8 ft. to	12	0	..	..	47	6
5.	Limestone	4	0	16	0	51	6
6.	COAL V (?)	4	0	4	0	55	6
7.	Sandy shale	8	0	8	0	63	6
8.	COAL	1	0	1	0	64	6
9.	Sandy shale	8	0	..	..	77	5
10.	Limestone	2	9	10	9	75	3
11.	COAL	2	2	2	2	77	5
12.	Sandy shale	2	0	..	..	79	5
13.	Fire-clay	24	0	26	0	103	5
14.	COAL	2	3	2	3	105	8
15.	Shale	6	0	..	..	111	8
16.	Limestone	7	0	..	..	118	8
17.	Gray sandstone	2	9	15	9	121	5
18.	COAL	1	2	1	2	122	7
19.	Fire-clay	8	10	..	..	131	5
20.	Gray shale	14	6	..	..	145	11
21.	Limestone	..	6	..	..	146	5
22.	Black shale	5	6	..	..	151	11

This section I am not able to explain. No. 6 would seem to be the sub-limestone coal on Silver island, while Nos. 10 and 11 are exposed in the bank of Coal creek a short distance away. No. 8 coal was not noted elsewhere. Coals Nos. 14 and 17 may correspond to some of the lower coals to the south, but do not appear in other sections in this region, unless our correlation of the upper beds of this and the Silver island sections are very incorrect. Their presence, however, seems to be rendered possible by the record of a deep well sunk near this. Only the record of the upper part of the well need be given. The record was made by Mr. Collett, who, Mr. Cox says, "carefully examined the borings as they were brought up and noted down his observations at the time in a book which is replete with information concerning the materials passed through."

375. Section 54. Part of Section, Lodi Artesian Well.—Sec. 35, N. W. ¼, Fig. 91. (E. T. C., pp. 122, 123; R. T. B., p. 112.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Drift	5	0	..	..	5	0
2.	Clay shale with iron nodules	5	6	..	..	10	6
3.	Limestone	2	0	..	..	12	6
4.	Shale	8	0	..	..	20	6
5.	COAL	1	0	1	0	21	6
6.	White clay	3	0	3	0	24	6
7.	COAL	1	0	1	0	25	6
8.	Clay shale with iron nodules	1	0	..	..	27	0
9.	White sandstone	12	6	..	..	39	6
10.	Fossiliferous limestone with iron nodules (and "sandstone" R. T. B.)	7	6	21	0	47	0
11.	Sandstone with cannel *coal*, bituminous *coal*, charcoal and oily substance	10	0	?	?	57	0
12.	Shaly sandstone	8	0	..	..	65	0
13.	Shaly sandstone with iron nodules	16	9	..	..	81	9
14.	Sandstone and clay shale	12	7	..	..	94	4
15.	Dark clay	2	5	39	9	96	9
16.	Clay shale with *coal*	3	7	?	?	100	4
17.	Dark sandstone	4	0	..	..	104	0
18.	Shale	4	3	..	..	108	3
19.	Shaly sandstone with mica	2	10	..	..	111	1
20.	Sandstone, fine grained	..	..	..	..	..	..
21.	White sandstone	15	0	..	..	131	1
22.	Bituminous shale with "oil bloom"	5	10	36	11	136	11

		Ft.	In.	Ft.	In.	Ft.	In.
23.	Shale and *coal*	6	3	?	?	143	2
24.	Black shale	9	0	..	..	152	2
25.	White clay shale	19	6	..	..	171	8
26.	Sandstone	31	11	..	..	203	7

Mr. Brown, in reporting the sections, calls the coals of Nos. 11 and 16 thin coals and omits entirely the coal from No. 23. He does not state why he makes this change from the earlier report. The record differs in many other respects. (A recent boring is said to confirm Mr. Brown's record.) Mr. Cox says the boring was started in the bottom land 200 yards southeast of the old Thomas mine and below the outcrop of the sub-limestone layer. The resemblance of the two highest coals of the sections to the two coals noticed on Silver island, separated by 4 ft. of fire-clay, is worthy of notice and would make it look as though the reported 7 ft. of limestone, No. 10 of section, corresponded with the heavy limestone of the Silver island sections. A compromise is adopted in the grouping of the figures, and there seems some warrant for that, as in the escape shaft of the Silver Island Coal Company, which appeared to be not far from the position of the oil well, the limestone is only 1 ft. 6 in. thick, and is separated from the worked coal by 11 ft. of shale. The fact that no thickness is assigned to the lower coals, while the other strata are measured to the inch, would indicate that these coals were at the best extremely thin and of no economic importance. The question is often asked locally if workable coals will not be found below the one being worked about Silverwood. With the data at hand I should answer that no workable coal will be found below the horizon of the coal which outcrops at low water level in the Wabash and on Coal creek.

376. On the old Wallace place, in Sec. 36, on Coal creek, Mr. Cox obtained the following section:

SECTION 55. SECTION ON OLD WALLACE PLACE.—Sec. 36 (?), Fig. 92 (E. T. C., p. 119).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Drift and covered slope	20	0	..	..	20	0
2.	Flaggy sandstone	6	0	..	..	26	0
3.	Black sheety shale	8	0	..	..	34	0
4.	Limestone	2	0	..	..	36	0
5.	COAL V?	1	8	1	8	37	8
6.	Fire-clay	2	0	..	..	39	8
7.	Shale with covered space	16	0	..	..	55	8
8.	Sandstone	2	0	20	0	57	8
9.	COAL IV?	5	0	5	0	62	8

377. In Sec. 1 is the Stringtown coal. The following section was noted by Mr. Cox on the Lafayette Company's land.

SECTION 56. SECTION ON LAFAYETTE COMPANY'S LAND.—Sec. 1, Fig. 93 (E. T. C., p. 119).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Drift	4	0	..	..	4	0
2.	Shale	?	0	..	..	4	0
3.	Black shale	1	0	..	..	5	0
4.	COAL Va	1	6	1	6	6	6
5.	Shale	8	0	8	0	14	6
6.	COAL V	3	6	3	6	18	0
7.	Shale	14	0	14	0	32	0
8.	COAL IV ....4 ft. 8 in. to	5	0	5	0	37	0
9.	Covered slope to branch	10	0	..	..	47	0

378. Our section (connected) of this area is as follows:

SECTION 57. CONNECTED SECTION ABOUT COAL CREEK, STRINGTOWN.—Fig. 94.

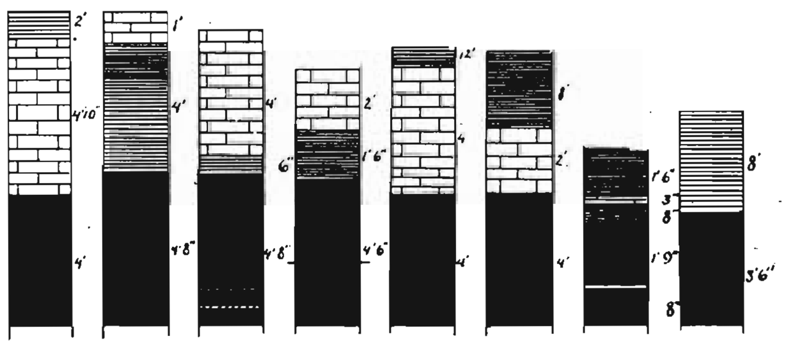
		Ft.	In.	Ft.	In.	Ft.	In.
1.	Blue shale	2	0	..	..	2	0
2.	Gray to brown limestone	..	6	..	..	2	6
3.	Black shale, mostly sheety and solid	4	0	..	..	6	6
4.	COAL Va	1	2	1	2	7	8
5.	Fire-clay and shale	8	0	..	..	15	8
6.	Brown to gray limestone containing large crinoid stems, as at falls of Mill creek, 1 ft. to (3 ft. rep.)	1	6	9	6	17	2
7.	COAL V; only locally developed ....0 ft. to	3	0	3	0	20	2
8.	Fire-clay ....0 ft. to	2	0	..	..	22	0
9.	Shales, sometimes black at bottom	+20	0	22	0	42	2
10.	COAL IV. .4 ft. 6 in. to 8 ft.	6	0	6	0	48	2
11.	Fire-clay	2	0	..	..	50	2
12.	Sandstone	20	0+	..	..	70	2

This section was made from rather disconnected sections and so may be in error, though made with considerable care. The presence of the middle seam of coal, Coal V of section, is strongly denied by those living in the neighborhood. I am quite confident, however, that it does exist there, though locally absent, or possibly it would be more correct to say only developed locally. It is certainly absent in places, but is certainly developed in other places, if the descriptions given me are accurate.

With the exception of the upper coals of Silver Island, which appear to be caught only at that point in these townships, and the two lower coals in the oil well and Moore and Hall's drilling at Silverwood, which I will leave in question, the coals of these townships are three in number, correlated as IV, V and Va.

379. COAL Va appears to be nowhere of workable thickness, ranging from 1 ft. to 1 ft. 6 in. It is characteristically overlain by black sheety shale, and that usually by a 6 in. layer of shaly limestone running into a calcareous shale. It is reported to be a desirable coal as regards quality and has been stripped some or mined along its outcrop in places.

380. COAL V.—This coal appears to be the most important coal at the southern end of this area, where it ranges from 3 ft. 6 in. to 6 ft. 6 in. It is usually a solid seam, though occasionally showing a knife edge parting 2 ft. from the bottom. Its roof is characteristically a limestone or a black shale, often with sulphur balls, overlain by limestone (see Figs. 95-102). The floor is frequently a small thickness of



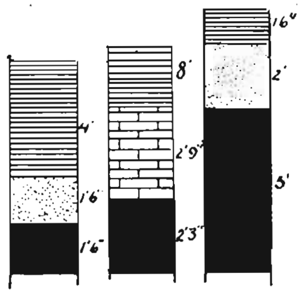
95 Silver Spring. Sec. 34. — 96 Thomas. Sec. 35. — 97 — 98 Silver Island. Sec. 34. — 99 Silverw'd. Sec 36. — 100 Wallace. Sec. 36. — 101 Cook & H. Sec. 1. — 102 Lafayette. Sec. 1.

Figs. 95-102. Sections of Coal V in T. 18 N., R. 9 W.

bone, overlying clay or shale. To the northward this coal becomes thinner and very irregular. It is supposed to be the same as the coal at Yeddo, etc.

381. COAL IV.—This is the most important coal in this area, having been extensively mined about Coal Creek P. O. (Stringtown, Snoddy's Mill), where it ranges up to 8 ft. thick. In the southern end of this area it is a variable coal, ranging from 1 ft. 6 in. to a reported thickness of 5 ft. (see Figs. 103-105). Where examined it appeared

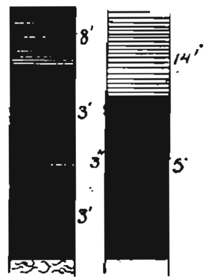
to be solid, with in one place a sandstone roof, in another a limestone roof. Near Coal Creek it averages from about 4 ft. 6 in. to 6 ft. 6 in., with usually a parting near the middle (see Figs. 106, 107). This coal was described by one of the mine inspectors as follows: "This



103 Silver Spr. Sec. 34. — 104 Coal Cr. Sec. 36. — 105 Wallace. Sec. 36.

Figs. 103-105. Sections of Coal IV around Silverwood.

is a good quality of coal and well suited for general purposes. The coal is generally free from sulphur and averages 5 ft. 6 in. in thickness. There is an excellent quality of coke made from the slack of this coal. The slack and refuse coal is washed and then goes through a patent process. The mines here are generally dry. The roof is good and is easily secured against danger of falling."



106 Coal Creek. Sec. 1. — 107 Lafayette. Sec. 1.

Figs. 106 and 107. Sections of Coal IV around Stringtown.

382. DIVISION I is not known to show any coal in this area except in the Lodi oil well. The sandstone, however, is well developed and exposed to a thickness of 50 ft. or more.

383. DISTRIBUTION AND LOCAL DETAILS.—T. 20 N., R. 9 W.—Division I is exposed by the cutting of the Wabash river along its course down to Sec. 15, where it passes under, rising again in Sec. 27, and is exposed near Covington. The most of the upland is supposed to be underlain by the horizon of at least the first coal above Division I in this region, either Coal IV or V. The depth of the drift hides nearly all the outcrops of either coal or rock. Coal is known to outcrop at only one place; that is an 18 to 20-in. coal that shows in Miller's run, in the south edge of Covington and for a distance up stream. Judging from this and what is found across the river, the best that can be said is that workable coal may be found here, but the conditions do not indicate a thickness of more than about 3 ft., and probably less.

384. T. 19 N., R. 9 W.—Division I crops out all along the river through the township, forming much of the bluffs and the bottom land, if that is not cut down into underlying formations. The horizons of the upper coals occur under the upland. Coal, reported to range from 20 in. to 3 ft. outcrops in Sec. 2 and on Neal's branch, in Sec. 11. In the days of the canal these were worked rather extensively, especially the latter, but have been abandoned many years. The coal is said to have been much like Coal IV as worked at Coal creek, but very irregular in thickness and with a poor roof. The sandstone of Division I has been quarried some in Secs. 14 and 23. (T. C. H., p. 277.) In Secs. 35 and 36 Coal IV is reported of good thickness over many hundreds of acres. The description of this area is given under the next township, where the developments have been more extensive.

385. T. 18 N., R. 9 W.—Division I outcrops boldly facing the river at the north township line, but dips rapidly to the south, and in a mile and a half passes below drainage. Division IV containing Coal IV is well developed in Secs. 1 and 2. Where Coal creek enters this township it is just about at low-water level. To the westward, where the drainage level is higher, it is, of course, found at greater and greater depths. This coal has already been described (see above). Well up in the banks of the ravine, running south through Sec. 1, is noticed the top of Coal Va, with its black sheety shale. This coal is at the branch level at the north line of Sec. 1. Going up this ravine from the southeastern corner of the section, Coal V is being worked by Cook and Herming—Sec. 1 (15). The coal is here about 15 ft. above the drainage and 3 ft. thick, running down to 18 in., with a parting 1 ft. 2 in. from the bottom. It is overlain by 8 in. of bone

coal. It has regular slips 1 ft. to 18 in. apart, but tight and full of calcite except on the crop, requiring powder to mine. The section at their drift is:

	Ft.	In.
Clay shale, —; black shale, 3 in.	..	3
COAL Va	1	0
Soft clay shale, 12 ft. 6 in.; black sheety shale, 1 ft. 6 in.; gray calcareous shale, place of limestone, 3 in.	14	3
COAL V—		
Bone, 8 in.		
Parting, knife edge.		
Coal, 1 ft. 9 in.		
Parting.		
Coal, 1 ft. 2 in.	3	7
Fire-clay	2	0

A short distance farther west are the old Webster or Nebeker drifts, upon the same seam and the same distance above the creek. A few feet farther a 15-ft. fault, with downthrow to the north, is claimed to have thrown the seam down to just below creek level, where it has been mined by a slope. A few yards northwest was the old Pardee shaft, where the coal was 40 ft. deep or about 35 ft. below the creek level. It is claimed that the coal in the shaft is the same as the coal just below the creek, a few yards away, and that that in turn is the same as the bed worked to the Nebeker's drifts, a few yards farther southeast. While the descriptions given of underground conditions seem to lend some strength to that theory, the evidence above ground is against it and it will be left as an open question. If this theory is correct, a fault with a downthrow of about 50 ft. must pass between Nebeker's and Pardee's. There seemed some ground for believing a 15-ft. fault passes just north of the Nebeker drifts. A similar fault is reported in Bunker No. 2 mine. In sinking the shaft coal was met 15 ft. higher than in the preliminary drilling made just north, no coal having been met with at this level in the drilling. The shaft was then sunk 15 ft. farther and a drift driven north which, in a short space, found the coal. The coal was 106 ft. deep and comparatively thin where first encountered. One of the strongest arguments against the 50-ft. fault is the position of the rider Coal Va, which shows in the bank just above where the coal is just below creek level, and then at about the same level on the opposite or north bank, being there fully 20 ft. above the creek, while a 50-ft. fault, or even much less, would have carried it well under the creek. At the old Phelps No. 3 shaft the limestone, with large crinoid stems, shows well 8 ft. below Coal Va; instead of overlying coal, however, it overlies 3 to 4 ft. of black fissile shale, under which is exposed 6 ft. of drab shale. A little farther up Mr. Tiley is running a small mine. The coal is here 60 ft. deep. One of the men who sank this shaft claims that about 10 ft. down is the limestone noticed at Phelps No. 3, being here 2 ft. 6 in. to 3 ft. thick, and with 6 to 8 in. of coal under. The main coal here averages about 6 ft., running up to 8 or 9 ft., it is claimed. The roof is black shale, 1 ft. of which comes down. It has from 1 to 3 in. of bone in center (see Fig. 106). The coal is said to run very regular here. A litttle farther up the rider reaches creek level.

In Sec. 36 of the township north were formerly worked the Phelps No. 1 and No. 2.

It is estimated that between 200 and 400 acres have been worked out in this locality, while drillings are said to show that the workable coal covers several thousand acres.

This coal was first opened up in 1845 by Brown, Barbee & Co., who built a tram railway over to the canal at Vicksburg. The abandonment of the canal stopped work here until 1870, when the C. & E. I. railroad constructed a branch from Danville, Ill., to this point. For a time mining was carried on here with much activity, but repeated and continued strikes, it is said, cut down the production until the railway company who were paying royalty for the use of the railway bridge at Covington abandoned this switch and removed the rails in 1887 or 1888. Since then mining has been carried on only on a small scale for local consumption.

386. Going south from Coal creek no coal or mines are reported along the creek till the Clover Leaf railroad is reached. Here the coal figured in Fig. 104 is exposed just below the bridge at level of low water. A short distance up the bank above this are some drifts on Coal V started in 1848 by Wm. Hansford, who shipped the coal by canal to Lafayette. Recently the Silverwood Coal Company sank a shaft to these workings, a short distance west and close to the railroad, which they have been supplying with coal. The section here was given above. The coal averages 4 ft. thick with 4 ft. of limestone for a roof. The lower 2 ft. of this limestone is sometimes intersected by joints so that it comes down. The coal is a caking semi-block coal, said to be very free of sulphur. On the east side of Coal creek this coal is being worked by Mr. John S. Tiley, where it has from 2 ft. to 3 ft. 6 in. of solid fossiliferous limestone over it.

387. At seven different places this coal is reported to show 4 ft. on the outcrop in the northern part of Silver Island. All of these have been worked some, though not all recently. At the Samuel's

bank, N. W. ¼ of Sec. 15, the coal was worked 50 years ago and boated across the river to Perryville. It had not been worked in many years until 1896. It is said to run 4 ft. thick and has a limestone roof. On the Collett place, S. W. ¼ of Sec. 15, the same coal was worked many years ago. The coal is here just above high water, about 8 ft. above the bottom lands. A shaft is reported to have formerly been sunk in Sec. 15, but no information concerning it could be obtained.

The coal and bluff on the west face of Silver Island in Sec. 34 have already been described. On the east side in the N. E. ¼, coal is being extensively mined by the Silver Island Coal Company. The coal is 45 ft. deep at the shaft and averages 4 ft. 6 in. in thickness, ranging from 3 ft. 6 in. to 6 ft. 6 in. (see Fig. 98). The seam is solid except for a smooth parting in places 2 ft. from the bottom. The roof is black shale, sheety in places with sulphur balls at the bottom. At the shaft it is 18 in. thick, underlying 2 ft. of limestone. At the escape shaft it is 18 ft. thick, underlying 18 in. of limestone. In places it holds well, in others it comes down for a thickness of up to 18 in. Under the coal is from 0 to 6 in. of bone, with 20 ft. of fire-clay below that, the latter, it is said, having been used for brick, etc. At a depth of 20 ft. an 18-in. seam of coal was passed through in the shaft. The coal has been worked from several openings near here in an earlier day. Thus, at the old Thomas mine the shaft passed through, Fig. 96 (E. T. C., p. 121):

	Ft.	*In.*
Soil and drift, 10 ft.; clay shale with ironstone, 1 ft.; limestone, 1 ft.; calcareous shale, 4 ft.	16	1
COAL V	4	8

A few yards further east the coal was mined from the crop and had above it, Fig. 97 (E. T. C., p. 121):

	Ft.	*In.*	*Ft.*	*In.*
Fossiliferous limestone	..	..	4	0
Bluish gray shale	..	..	..	6
COAL V—				
Cannel coal, local	..	4	..	..
"Semi-block coal"	3	6	..	..
Streak of pyrite	..	⅛	..	..
"Block coal," good	..	4	..	..
Streak of pyrite	..	⅛	..	..
Caking coal	..	6	4	8

The coal here is subject to faults and cut-outs.

388. Summary of Coals for Fountain County.—

Divisions contained: VI—, IV, I.
Coals contained: VIb, VIa (?), VI?, Va, V, IV, I.

Round Number Estimates.

Coals VIb, VIa, VI.

Unworkable area.	1 sq. mi. ×	av. thickness,	3 ft. ×	1,000,000 =	3,000,000 tons.

Coal Va.

Worked area	5 acres ×	av. thickness,	2½ ft. ×	1,000 =	12,500 tons.
Workable area ...	5 sq. mi. ×	"	2½ ft. ×	500,000 =	6,250,000 tons.
Unworkable area.	50 sq. mi. ×	"	1½ ft. ×	1,000,000 =	75,500,000 tons.
Total area	55 sq. mi.				81,262,500 tons.
					81762500

Coal V.

Worked area	320 acres ×	av. thickness,	3½ ft. ×	1,000 =	1,120,000 tons.
Workable area ...	25 sq. mi. ×	"	3 ft. ×	500,000 =	22,500,000 tons.
Unworkable area.	50 sq. mi. ×	"	1½ ft. ×	1,000,000 =	75,000,000 tons.
Total area	75 sq. mi.				98,620,000 tons.

Coal IV.

Worked area	320 acres ×	av. thickness,	5 ft. ×	1,000 =	1,600,000 tons.
Workable area ...	50 sq. mi. ×	"	4 ft. ×	500,000 =	100,000,000 tons.
Unworkable area.	130 sq. mi. ×	"	1½ ft. ×	1,000,000 =	195,000,000 tons.
Total area	180 sq. mi.				295,600,000 tons.

Coal I.

Unworkable area.	325 sq. mi. ×	av. thickness,	1 in. ×	50,000 =	16,250,000 tons.

Number of coals contained: 7.
Greatest thickness recorded: 8 ft. (10 ft.?), near Clear Creek P. O.
Area underlain by coal and coal measure rocks: 325 sq. mi.
Area underlain by workable coal: 75+ sq. mi.
Contained in Van Buren, Wabash, Mill Creek and Fulton twps.
Estimated total tonnage of coal: 494,000,000.
Estimated total tonnage of coal removed: 2,732,500.
Estimated total tonnage of workable coal left: 128,750,000.
Number of mines working ten men or over, in operation: 2.
Number of mines working less than ten men, in operation: 26.
Total number of mines in operation: 28.
Large mines abandoned: 16.
Small mines not in operation: 37.
Strippings and outcrops: 95.
Total number of openings to coal: 176.

XVIII. MONTGOMERY AND PUTNAM COUNTIES.

MONTGOMERY COUNTY.

389. Note.—As the coal measures are confined to a very small area in southwestern Montgomery county, and contain no workable coal and very little coal of any kind, it need only receive very brief treatment, much as some of the townships have been treated above. References will, in the main, refer only to the area of the coal measures.

390. References and Field Work.—Reference to Montgomery is made in the reports of Messrs. D. D. Owen and Richard Owen, but nothing given concerning the coal measures.

1875. John Collett, 7th Ann. Rep. Geol. Surv. of Ind., pp. 360-422. References to coal measures on pp. 372, 383-4, 399-401. Three columnar sections (coal measures). (J. C.)

1895. T. C. Hopkins, Dept. Geol. and Nat. Resources, 20th Ann. Rep., pp. 267-268 (describing Mansfield sandstone). (T. C. H.)

1897. C. E. Siebenthal, field work for this report.

391. Location, etc.—Montgomery county lies east of southern Fountain and northern Parke counties. Our discussion will be confined to the two half townships of 17 and 18 north of range 6 west. This area is a high level divide becoming much broken close to Sugar creek, where is to be found some of the most picturesque scenery of the State. The Vandalia railroad crosses the southern end of this area.

392. Stratigraphy.—The section at the Shades of Death, Sec. 11, T. 17 N., R. 6 W., shows the stratigraphy for this area.

Section 58. Section at Shades of Death.—(C. E. S.)

	Ft.
Glacial drift .... up to	50
Massive yellow sandstone .... 40 to	80
Place of Coal I—	
Twenty ft. above this level is a 1 to 2 ft. geode and conglomerate bed.	
Shaly Knobstone, thinning out to the west	6
Blue limestone with crinoid stems, resembling Harrodsburg (Keokuk)	2½
Shaly sandstone (Knobstone) .... 60 to	70
Total depth from hotel (bar.)	170

Only Division 1 occurs in this county.

393. DISTRIBUTION.—The distribution of the main body of the Mansfield sandstone is shown on the map. Coal is only met with in a few places. In the N. W. of N. E. of Sec. 10 several ¼ to ½ in. seams of coal occur in soft grayish black shale just below the lowest member of the Mansfield sandstone. Below the coal there shows a thickness of 8-10 ft. of shale, which gradually passes into Knobstone. Twenty feet above the coal is a conglomerate of rounded pebbles of ironstone. In the S. E. corner of Sec. 10 Mr. Moore's well went 18 ft. in soil and gravel and ended in limestone. If correct, this indicates an unconformity, the sandstone at the Shades lying in an eroded basin or channel. Patches of Mansfield sandstone are apt to be found beyond the limits laid down, such patches occupying eroded depressions in the earlier rocks, and it is principally in these old hollows that coal is found. Mr. Collett reports a number of such places, the coal at none of these places exceeding a few inches in thickness. Thus his map shows outcrops as follows: S. E. of S. E., Sec. 25-18-6; S. W. of S. W. of Sec. 25-18-6; N. W. of N. W. of Sec. 36-18-6; S. E. of S. W. of Sec. 35-18-6; S. W. of N. E. of Sec. 23-17-6 on the Hanna place; N. W. of S. E. of Sec. 23-17-6 on Burford place. Wells about Alamo go from 89 ft. to 129 ft. in drift, then into limestone. Mr. James Allen's well, S. E. of S. E. of Sec. 26-18-6 went through 216 ft. of soil and drift into 4 ft. of sandstone.

394. SUMMARY OF COAL.—While the coal measures cover about 10 square miles in this county, with one coal horizon, no workable coal exists in the county and all the coal would probably not average over 3 in. thick over half a square mile or a sum total of probably not more than 100,000 tons, none of which is available.

PUTNAM COUNTY.

NOTE.—As the coal measures of this county are confined to the western edge of the county and, except over a very limited area, contain only Division I, which is quite constant in its stratigraphic features, the discussion of the stratigraphy and coals will be taken up for the whole coal measure area in the county together, and not by townships, only the distribution and local details being discussed by townships.

395. REFERENCES AND FIELD WORK.—

1875. John Collett, 7th Ann. Rep. Geol. Surv. of Ind., pp. 463-468, describing only the coal measure rocks, 4 columnar sections. (J. C., '75.)

1880. John Collett, 2d Ann. Rep., Dept. Statistics and Geol., pp. 397-426. Map; repeats above with slight additions. (J. C., '80.)

1895. T. C. Hopkins, 20th Ann. Rep. Dept. Geol. and Nat. Resources, pp. 213-230, describes Mansfield sandstone in detail. Several sections, but none showing coal. (T. C. H.)

1897. C. E. Siebenthal, field work for this report.

Sec. 1. Geography.

396. LOCATION.—Putnam county is situated directly west of the capital of the State. It lies east of Parke and Clay counties, south of Montgomery, west of Hendricks and Morgan, north of Owen and a small part of Clay counties.

397. EXTENT.—Putnam county is a rectangle, 27 mi. long from north to south, by 18 wide, with a small additional area near the southeastern corner. It contains 500 sq. mi. It contains all of townships 13, 14, 15 and 16 north of ranges 3, 4 and 5 west, the northern half of township 12 north of ranges 3, 4 and 5 west, small portions of townships 13 and 14 north of range 2 west.

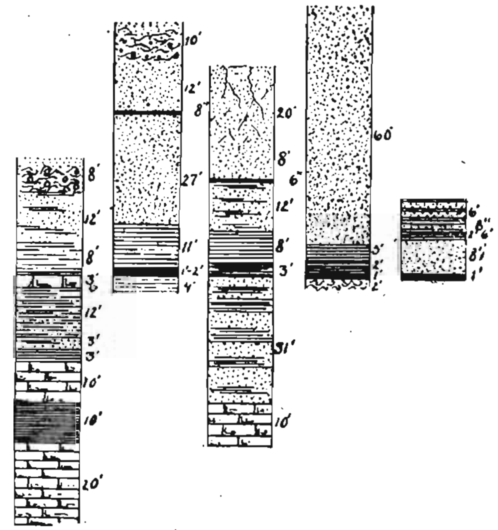
398. PHYSICAL FEATURES.—Through the southern part of the county the hills rise about 150 ft. above the level of the main watercourses. Thus, to take the valley of Deer creek as typical of this part of the county, a section in the vicinity of Manhattan would show alluvian bottoms varying from one-fourth to one-half a mile in width. Next rises a broken limestone bench some 50 ft. in height. Behind this and rising to a height of 60 to 80 ft. above the limestone bench rise the main elevations, principally of Mansfield limestone. The width of the alluvial plain, of course, varies according to the size of the stream. The tops of the areas underlain by Division III are quite level except in the neighborhood of the escarpment. The effect of the glacial action in leveling off the surface and filling up the inequalities is especially marked in the S. W. part of T. 15 N., R. 5 W., N. W., also S. W. corners of T. 14 N., R. 5 W. In the north half of T. 15 N., R. 5 W., the hummocky topography of the Shelbyville moraine becomes the prevailing type, and continues to Russellville.

The following table gives the elevation of some of the points in this area:

	Ft. A. T.
Raccoon creek valley, I., D. & W.	742
Track at Raccoon creek bridge, I., D. & W.	752
Track at Russellville, I., D. & W.	859
Track at Putnam and Parke county line, I., D. & W.	790
Track at Greencastle, T. H. & I.	841
Track at Limedale, T. H. & I.	776
Track at Hamrick's, T. H. & I.	710
Track at Reelsville, T. H. & I.	645
Eel river at Reelsville, T. H. & I.	610
Track at west line Putnam county, T. H. & I.	670

Sec. 2. Stratigraphy.

399. SURFACE GEOLOGY.—In the northern part of the area the drift acquires a thickness ranging from 30 to 60. To the south the drift becomes thinner, the topography more rugged and outcrops more abundant.



108 Reelsville. Sec. 21. 13-4. — 109 Weathers. Sec. 12. 12-5. — 110 Greec'tle. Sec. 28. 14-4. — 111 Blacks. Sec. 22. 14-5. — 112 Knauer. Sec. 5. 14-5.

Figs. 108-112. Columnar sections of coal measures in Putnam county.

400. COAL MEASURES.—The coal measures of this county are limited to Divisions I and III, the latter occupying but a very small area. The following sections will serve to show the relations of the coals to each other and the underlying rocks. See Figs. 108-112.

401. SECTION 59. SECTION AT REELSVILLE.—Sec. 21-13-4 (C. E. S. and T. C. H., p. 223), Fig. 108.

	Ft.	In.
Division I—		
1. Drift (50-60 ft. to top of ridge)	8	0
2. Flaggy, shaly, yellow sandstone........12 ft. to	14	0
3. Blue to drab sandy shale	8	0
Lower Carboniferous—		
4. Hard semi-chrystalline, reddish encrinital limestone ....2 ft. 6 in. to	3	0
5. Drab to olive green sandy, fissile shale..12 ft. to	15	0
6. Shelly limestone and sandy shale.........2 ft. to	3	0
7. Black gray or yellow sandy shale ....2 ft. to	3	0
8. Compact, blue-gray, shaly fossil limestone, 10 ft to	11	0
9. Blue to black shale	10	0
10. Compact blue limestone.................12 ft. to	20	0

402. SECTION 60. SECTION ON H. T. WEATHER'S LAND.—N. E. ¼ Sec. 12-12-5, Fig. 109. (J. C., '75, p. 466.)

	Ft.	In.	Ft.	In.	Ft.	In.
Division III—						
1. Soil and clay	10	0	..	..	10	0
2. Shaly sandstone	12	0	..	..	22	0
3. COAL III	0	8	0	8	22	8
Division I—						
4. Massive sandstone	14	0	..	..	36	8
5. Soft white sandstone	8	0	..	..	44	8
6. Gray laminated sandstone.	9	0	..	..	53	8
7. Pyritous shale, with bands and nodules of iron ore..	11	0	42	0	64	8
8. COAL I............2 ft. to	1	0	1	0	65	8
9. Gray shale	4	0	..	..	69	8

403. SECTION 61. SECTION AT CEMETERY HILL.—One mi. south of Greencastle, Sec. 28-14-4, Fig. 110. (J. C., '75, p. 468.)

	Ft.	In.
1. Disturbed sandstone with coal plants	20	0
2. Laminated sandstone	8	0
3. COAL	..	6
4. Shaly sandstone	12	0
5. Pyritous shale, with ironstones	8	0
6. Black shale and COAL I (?)	3	0
7. Shales and sandstones with coal plants	31	0
8. Limestone	10	0
	92	6

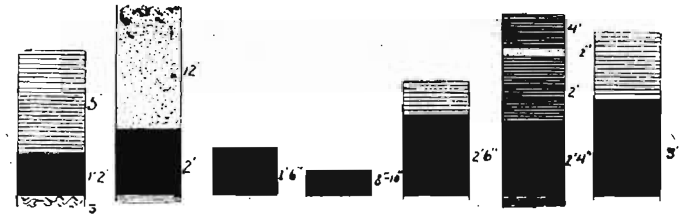
404. SECTION 62. SECTION AT ANDREW BLACK'S.—Sec. 22-14-5, Fig. 111. (J. C., '75, p. 468.)

		Ft.	In.
1.	Ferruginous sandstone	10	0
2.	Heavy sandstone, cross-bedded	15	0
3.	Massive sandstone	35	0
4.	Pyritous shale	5	0
5.	Black shale	2	0
6.	COAL I	1	0
7.	Fire-clay	2	0
8.	Lower Carboniferous to Walnut creek	95	0
		165	0

405. SECTION 63. SECTION ON C. B. KUANER PLACE.—S. E. of S. E. Sec. 5-14-5, Fig. 112. (S. E. S.)

		Ft.	In.
1.	Shale and sandstone interstratified	6	0
2.	Sandstone	..	8
3.	Black shale	2	6
4.	Sandstone	8	0
5.	COAL I ...1 ft. to	1	3
6.	Fire-clay	..	..

406. DIVISION III.—This division covers a small area under some of the higher land, usually occurring near the top of the hills. It contains one coal, seldom attaining a workable thickness.



113 Skelton. Sec. 19-14-5. 114 Hammond. Sec. 31-14-5. 115 Furney. Sec. 5-13-5. 116 Combs. Sec. 18-13-5. 117 Williams. Sec. 29-13-4. 118 Huffman. Sec. 2-12-5. 119 Balls. Sec. 34-13-4.

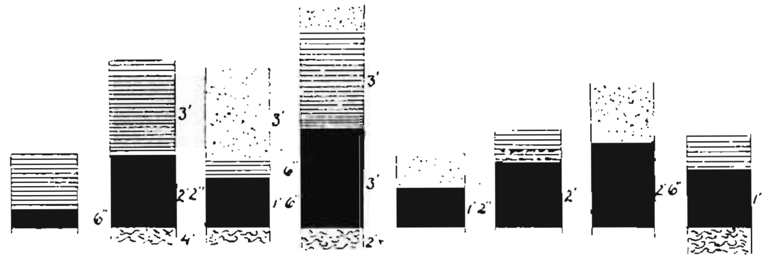
Figs. 113-119. Selected sections of Coal III (?) in Putnam county.

407. COAL III.—Figs. 113-119 show the character of this coal. In thickness it ranges up to 3 ft., generally averaging much less. At most points it was not exposed so that it could be examined; so it is not possible to tell whether it has the peculiar characteristics of that

coal as developed in Clay county. The roof in a majority of cases is shale, though sandstone in one case. The floor is usually fire-clay, though bone coal in at least one case.

408. DIVISION I.—Division I shows its characteristic massive sandstone often forming bold, precipitous bluffs, and showing a thickness of up to 60 ft. See T. C. H. for detailed description. This is usually underlain by several feet of shale, which tends to weather so as to form "rock houses." The division contains one coal, or doubtfully two.

409. COAL I.—A selection of average and the best sections from the several townships will serve to show the range of this coal in thickness. It will be noted that going southward the nonconformity below Division I becomes less marked and the coal which to the north



120 Burke. Sec. 4-15-5. 121 Wright. Sec. 11-14-5. 122 Street. Sec. 33-14-5. 123 Smith. Sec. 28-13-5. 124 Crowder. Sec. 17-13-5. 125 Williams. Sec. 29-13-5. 126 Allen. Sec. 36-13-5. 127 Brown. Sec. 4-12-5.

Figs. 120-127. Selected sections of Coal I, Putnam county.

occurred here and there in what were formerly hollows of the older surface, becomes more regular in its distribution, though still very pockety, and locally attains in these pockets to a workable thickness. The roof is usually shale, overlain by the massive Mansfield sandstone, though often the sandstone comes down, forming the roof. Fire-clay usually underlies the coal. The coal is often reported of a semi-block nature, ranging from fair to good in quality.

410. LOWER CARBONIFEROUS.—In the north the coal measures lie unconformably on the St. Louis or Mitchell limestone; going south the Chester or Kaskaskia group begins to be represented, being principally sandstone in this area. Where seen by the writer further south, these sandstones strongly resemble the Mansfield, so that they are easily mistaken for the latter, and further south they are the

source of much of the building sandstone which has usually been ascribed to the horizon of the "millstone grit." Their position there, however, is more readily defined by the presence of fossiliferous limestones which thin out before reaching Putnam county. In this county the position of Coal I, which underlies the Mansfield sandstone, has been taken as marking the lower limit of that formation, and consequently the lower limit of the coal measures, since the work to the south has shown that the upper Kaskaskia limestone or its horizon to the north lies but a few feet below Coal I. (See Greene, Martin, etc., counties.) This results in making quite a difference in the coal measure boundaries of the maps accompanying this report and those published a few years since by Mr. Hopkins, the limits given by Mr. Hopkins representing more nearly the contact between the Mitchell limestone and the overlying Kakaskia or coal measures as the case might be.

Section 3. Distribution and Local Details.

411. T. 16 N., R. 5 W.—No coal has been observed in this township. Division I covers about two-thirds of the township, as shown on the map. Along Raccoon creek are good exposures of the Mansfield sandstone, attaining a thickness of 65 ft. A good illustration of the nonconformity at the bottom of Division I shows on Ramp creek in the N. W. ¼ of Sec. 25 (see Fig. 5 of Plate VII). Mr. Hopkins also figures a possible fault of at least 20 ft. downthrow occurring on Byrd branch in Sec. 31 (Fig. 6 of Plate VII).

412. T. 15 N., R. 5 W.—The coal measures occupy the western two-thirds of the township, as shown on the map. The drift ranges in depth up to 86 ft. or more. Around Morton it is reported as 20 to 22 ft. In Sec. 2, S. E. 40, 3 or 4 in. of coal was found in a well on the Andrew Thomas place at a depth of 31 ft. It immediately overlies limestone. In the N. W. of S. E. of Sec. 4, 6 in. of coal outcrops on the Frank Burke place under a shale bluff (Fig. 120). Drillers report this coal 25 in. thick where drilled. Down the branch a quarter of a mile is an outcrop of massive sandstone, but no coal shows under it. In the S. W. ¼ of Sec. 5 or N. W. of Sec. 8 a litttle coal occurs in the shale underlying the Mansfield sandstone. It has been worked some.

In the S. E. of S. W. of Sec. 7, on J. D. Clodfelter's place, a drilling went 86 ft. in drift. In the S. E. of S. W. of Sec. 17, on John McGill's, a bore found 45 ft. of drift, then went 18 ft. in sandstone.

In the S. E. of N. E. of Sec. 19 a well on Thomas Brother's place passed: Gravel and sand, 32 ft.; gray grit, 20 ft.; "mud," 6 ft.; bright red sandstone, pretty hard, 31 ft.; rock and shale, 11 ft.; black borings (coal or black shale?), 3 ft.; shale, 1 ft.—104 ft. A well on the Israel Kuaner place, N. W. of N. W. of Sec. 32, went through 74 ft. of sandstone below 22 ft. of soil and gravel.

East of Owl creek is an area of Division I in which no coal was reported. Also part of a small area north of Falls branch, in which coal was only reported at one point, on the Lorenzo O'Neill place, S. E. of S. E. of Sec. 35.

413. T. 14 N., R. 5 W.—In the southern part of the isolated exposure of Division I, just mentioned, coal is exposed and has been mined a little on the Wm. Thomas place in Sec. 2. The coal is 8 to 10 in. thick, with 10 ft. of black shale overlying. Limestone outcrops 3 ft. below coal. Just below the bank a nonconformity shows, the black sheety shales lying directly against a 15 ft. bluff of limestone, appearing as though the shale and coal had been deposited in a channel cut in the limestone.

South of Jones branch, and east of Walnut creek, is an outlier of Division I, principally in Sec. 12. In the N. E. of S. E. of Sec. 11, coal has been worked on the Wm. Wright place by a drift. The coal ranges from 18 to 26 in. where being worked (see Fig. 121). It is said to show a thickness of from 29 to 33 in. in drillings. It is a "semi-block," rather bright coal, said to burn well, but to produce too hot a fire for general use, and carries considerable sulphur. Soft shale makes the roof, though a sandstone roof is met in places. The fireclay below is said to be 18 ft. thick.

South of this area is another small area in Secs. 13 and 24. In the S. W. of N. W. of Sec. 24, 10 in. of coal is found on the D. P. Farrow place. It is overlain by shale and underlain by bone coal. The coal is bright and appears to be of good quality. There is a nonconformity here, limestone lying to the east, and at the same level coal-measure sandstone and shale to the west.

We may next follow the outcrops of the coal measures from north to south along the west side of Little Walnut creek. As will be seen by an examination of the map, the horizon of Coal I is well up the hillside, so that the outcrops are principally near the head of the ravines. Coal outcrops on the C. B. Kuaner place, on a small branch in the S. E. of S. E. of Sec. 5. The section is as in Fig. 112 (see ¶405. The coal is from 12 to 15 in. thick, overlain by 8 ft. of fine sandstone. One hundred yards down the branch this sandstone thickens up to 20 ft., and 400 yards south up to 50 ft. The sandstone lies unevenly on the coal, and "feelers" of washed coal occur up in the sandstone for a distance of 12 in.

Following south, the next outcrop is on the David Boswell place, in S. W. of S. W. of Sec. 10. The coal is here 22 in. thick, with a foot or so of shale over and 6 in. of fire-clay below. Following up Long Branch, coal is found in the S. W. of N. W. of Sec. 17, on the Mr. Carl Eads place. The coal is 18 in. thick and is overlain by 10 ft. of shale, and that in turn by 10 ft. (as far as exposed) of sandstone. Going up the branch into Sec. 18 the sandstone is passed and an outcrop of Coal III found on the James Phillips place, N. W. of S. W. of Sec. 18. The coal is 2 ft. (?) thick, overlain by shale. Up the south fork of this branch coal outcrops on the Geo. Hall place, N. E. ¼ of Sec. 19. The coal is 21 in. thick, overlain by shale down the branch and by sandstone up the branch, and underlain by fire-clay. East of this, coal, supposed to be Coal III, is found on the David D. Skelton place (Fig. 113). The coal is 12 to 14 in. thick, thickening to the south of the dip. The coal is dull colored, free from sulphur, and is said to burn well. The roof is a black sheety shale, 5 or 6 ft. thick. Below the coal is sandstone showing 5 ft. thick down the branch, though to the east fire-clay underlies the coal. Near this and on about the same level, on Mrs. Louise A. John's place, in N. E. of S. W. of Sec. 20, and also in S. W. of Sec. 20, is a coal crop "2 or 3 in." overlain by 15 to 20 ft. of sandstone. Just south of this, on the Levi Hasty place, N. W. of N. W. of Sec. 29, 2 to 3 in. of coal was found in a well at a depth of 27 ft. It had 3 to 6 in. of shale cover, with drift over that.

Going up Snake creek from Fern, coal is met with in the south bank in Sec. 33, in N. E. of S. E., and on the Nathaniel Street place, in S. E. of S. W. of same section. The coal there is 18 in. thick (see Fig. 122), overlain by 6 in. of shale, with 3 ft. of sandstone still above, and 6 ft. of fire-clay below coal. The coal looks like a good coal. Further up in the S. E. ¼ of Sec. 32 is a ledge of ironstone, from which are weathering out chert-coated boulders of limestone. About 7 ft. above this limestone is an 8 or 10-ft. ledge of massive sandstone, and some coal has been mined from just under the sandstone. One-half mile to the west limestone boulders occur, though no outcrop can be seen. The sandstone forms heavy bluffs a few feet above. Drilling showed 6 to 7 ft. of shale, but no coal below the sandstone. Glacial striæ on the Mansfield sandstone here have the direction S. 37° W., while half a mile west of north from this others bear S. 34° W. In the N. E. of S. W. of Sec. 32 coal was reported in Snake creek, on the Conrad Lehmann place. In the N. E. corner of S. W. of S. E. of Sec. 31, 16 in. of Coal III outcrops, on Mrs. Wm. E. Fritz's farm. The coal is said to be block coal. It is overlain by 6 to 8 ft. of soft buff sandstone. Four inches of "cannel" coal was reported in the main branch, 250 yards north and 40 to 50 ft. lower. Much sandstone shows between the two outcrops. In the N. W. ¼ of Sec. 31, Coal III is worked at the Hammond bank. The coal is reported as rather poor semi-block, 18 to 32 in. thick (Fig. 114). It has 10 to 12 ft. of sandstone over it and shale below. In the S. W. of S. W. of Sec. 31, 8 to 10 in. of coal is said to have been struck, on Mr. Joel Thomas's place.

414. T. 14 N., R. 4 W.—As shown on the map, a small area of Division I occurs on the hill south of Forest Hill cemetery, south of Greencastle. The section was given in ¶403. No coal of any value occurs there. In the N. E. of S. W. of Sec. 31, 4 in. of coal is reported on the O. W. Ellis farm, overlying shale; also the same thickness on the Simpson Stoner place, S. W. of S. E. of same section. These are on a small coal measure outlier.

415. T. 13 N., R. 4 W.—Signs of coal have been noted on the Frank Hayes farm, S. E. of N. W. of Sec. 6, under sandstone and over shale. This is on the outlier just mentioned.

Southwest of Putnamville and principally in Sec. 18 is a small outlier of Division I. Coal outcrops on the Geo. Davis place, N. W. ¼ of Sec. 18, 20 in. thick, and said to be good. Also on the J. W. Smith place, 300 yds. east of the last. A like thickness, 20 in., is found on the Geo. W. Layman farm in the S. E. ¼ of the same section.

Between Deer creek, Mill creek and Doe creek is a considerable area of coal measure rocks, the northern part of which around Jenkinsville is in this township.

In Sec. 28, S. E. of S. E., Coal III is reported to have been struck on the Geo. Ford farm. On the S. E. of N. E. of Sec. 29 is the Simon Williams shaft and drift mines. The coal is 60 ft. deep in the shaft, being 24 in. thick, with a shale roof. In the S. E. of S. E. of Sec. 30 Coal I is 20 to 22 in. thick and has been mined to some extent at the Jameston mine. One-fourth mile west of Jenkinsville, 3 or 4 in. of bone coal with shale above and soft light shale below shows the position of Coal I. In the S. W. of N. W. of Sec. 33, 11 to 13 in. of coal outcrops on the Geo. Jones place. In Sec. 34 Coals I and III both outcrop on the Mrs. Mary A. Bales place. The lower bed is reported to have been only a pocket a few feet across. Coal III is variously reported from 2 ft. 8 in. up to 3 ft. 8 in. and to be a semi-block, not suitable for blacksmithing purposes. The roof is gray shale and said not to be very good. The floor is fire-clay; sandstone shows about 10 ft. below the coal. (Fig. 119.) About a quarter of a mile east there is reported to be a heavy bluff of sandstone on the same level as this upper bed, a pocket of coal, "umbrella shaped," is found in a ravine there.

416. T. 13 N., R. 5 W.—On the Daniel Zaring place, N. E. of N. E. of Sec. 1, 18 in. of coal has been found.

South of the head of Snake creek 4 to 5 in. of coal outcrop on the John Bromlee farm in N. E. of N. E. of Sec. 6. The coal is overlain and underlain by shale, with sandstone further up the ravine. In the N. W. of N. W. of Sec. 5, 16 to 18 in. of coal has been mined some on the Peter Furney place. This is above the sandstone, Coal III, Fig. 115. Coal is also reported in a well on Harvey Mosstiller's place in the S. E. ¼ of Sec. 6.

Near the head of the small creek north of Reelsville, in the N. E. ¼ of Sec. 17, coal occurs at several places on the Wm. Crowder farm. The coal is from 14 to 18 in. thick and has sandstone over. This is 20-25 ft. above the limestone outcropping down the branch.

Coal outcrops on the land of the H. B. Pickett heirs, N. E. of N. E. Sec. 20, near Reelsville. Following up Johnson creek, coal was noted on the Geo. Summers place, S. E. of N. E. of Sec. 19; Rhody Hopkins, N. W. of S. W., Sec. 19, 12 to 14 in. thick; Edward Green's, S. W. of N. W. of Sec. 19, 30 in. thick; and on Geo. Girton's, N. W. of N. W. of Sec 19, 30 in., the last two being reported as block. Also near the head of the creek in N. W. of S. E. Sec. 7, on Frank Turney's land, 16 in. thick on the outcrop.

In R. S. Coomb's well, S. E. of N. E. of Sec. 18, 8 to 10 in. of coal was struck at 40 ft. This would seem to be above Coal I and is with doubt considered as Coal III (Fig. 116).

Going south on the west side of Walnut creek, coal is found on the Calvin Plummer farm, N. W. of N. E. of Sec. 32, supposed to be from 18 to 24 in. thick. Just east of this is the coal mine of John P. Baumunk. The coal here is from 24 to 30 in. thick, a good semi-block coal. The roof is sandstone, 40 to 50 ft. thick; floor, fire-clay, 3 ft. thick. Northeast from this mine across Walnut creek in the N. E. of Sec. 28 is the L. Beecher Smith mine. The coal here ranges from 2 ft. 4 in. to 3 ft. thick (see Fig. 123). It has some resemblance to a semi-block. It has 3 ft. of shale for a roof with sandstone above that. Below is 2 ft. of fire-clay with shale still below. The position of the sandstone occurring near here would seem to be below the

coal, indicating that it is of Kaskaskia age. The dip here appears to be to the east. In Sec. 36 coal has been stripped on the Wm. R. Allen land, the coal being 24 to 30 in., with sandstone over (Fig. 126).

417. T. 12 N., R. 4 W. (Northern Half).—In the N. W. ¼ of Sec. 2, 24 in. of coal outcrop on the east side of the road. A drilling just west of this struck a little coal at 22 in. and limestone at 60 ft. A bore in the head of Fall creek hollow, on Alcanah Farmer's place, struck limestone at 30 ft. Coal is reported as having been dug for blacksmithing purposes on the Evan Cline's place, S. W. of N. E. of Sec. 9; also from the Lewis Herbert place, N. E. of N. E. of Sec. 17, said to be 6 in. thick. In the N. W. of N. W. of same section on the E. V. McVey farm coal has been stripped, claimed to be 2 ft. thick; also on the north side of Fall creek in the S. W. of S. W. of Sec. 5 on the Wm. Halfhill farm. Coal I outcrops on the Wesley Allen place in S. W. of N. W. of Sec. 6, also across the road to the south on the James Rightsell farm. Coal was also noted in the S. W. of N. W. of Sec. 7 in the spring at Amos Kunkle's.

418. T. 12 N., R. 5 W. (Northern Half).—In Sec. 1 two drifts have been opened on the Wm. R. Allen place, N. W. ¼, the coal being 30 in. thick and reported to have been fine coal for blacksmithing. Coal is also reported in Sec. 1, on Mr. John Knight's place, and in several places on the John J. Carriger farm, where it is 18 in. thick. Coal has been mined by drifting by Mr. Robert Williams in the N. E. of N. E. of Sec. 12. The coal is about 30 in. thick, and said to be a semi-block. The roof is shale. In the S. W. quarter of this section, 12 to 14 in. of coal outcrops under a bluff and is said to burn well.

Between Walnut creek and Deer creek, in Secs. 2 and 3, both Coals I and III outcrop, the latter having been worked at the Jackson Huffman mine. It is here 28 to 24 in. thick, with black shale roof (see Fig. 118). The roof appears to be fair. The coal is a semi-block, containing some sulphur. The floor is bone coal. Ten ft. below the coal is a 15 to 20 ft. bluff of sandstone. About 300 yds. east Geo. Skelton has drifted upon this same coal. It is here near the top of the ridge and Coal I outcrops a quarter of a mile south in the hollow.

West of Walnut creek and north of Croy's creek Coal I has been stripped a little on the Wm. Hapenny farm, S. E. of N. W. of Sec. 4, also on the farm of Geo. Long, in S. E. of S. W. of same section.

Coal has long been stripped and recently opened by drift in the S. E. of S. W. of Sec. 4 at the P. T. Brown bank. The coal is 20 or 21 in. thick, a semi-block, with a good shale roof, and what is claimed to be a fine grade of fire-clay under (Fig. 127). Going southward, some coal has been taken out on the Wm. McCullough place in the N. E. of N. W. of Sec. 9, reported to be 15 to 20 in. thick. Coal is also reported on the Mary Knight farm, N. W. of S. W. of Sec. 9. On the Silas S. Treston place, N. W. of S. E. of Sec. 8, 14 to 20 in. of coal occurs under sandstone. In the S. W. of N. W. of this section coal was struck in the well of James Yocum, but not gone through. At an outcrop near this the coal is 14 in. thick, with clay above. Just south of this 4 ft. of coal is reported as struck in John Ropp's well. In Sec. 6 coal outcrops on Dr. G. W. Finley's land, in the S. E. of S. W. A neighboring well showed a thickness of 10 in.

South of Croy's creek some coal has been dug in the S. W. of N. E. of Sec. 18 on the John T. Russler place, also on the Rachel J. McCollach place, in N. E. of S. W. of Sec. 17, it being used for blacksmithing.

East of Eel river and south of Mill creek coal has been taken out on the Hermann Bullerdick farm, S. E. of S. E. of Sec. 15, the coal being 18 in. thick and having a sandstone roof. In Sec. 14 coal outcrops on Mrs. Crouse's place, N. W. of N. W., 8 to 10 in. thick; on the John Bannock place, S. E. of S. W., and the Eli Crouse place, N. E. of S. E., where the coal was 28 in. In Sec. 13 Coal I is worked at the Neese bank, where it is 18 to 20 in. thick, and a semi-block. The roof is shale, not very good, about 5 in. of it coming down. Below the coal is 2 in. of bone, then 2 ft. or more of fire-clay. Coal is also found on the J. B. Harris place, S. W. of S. W. of Sec. 13, and John Evans' place, in the N. E. of S. W., the coal at the latter place being 2 ft. thick, with sandstone over.

419. SUMMARY OF COAL OF PUTNAM COUNTY.—

Divisions contained: III and I.

Coals contained: III and I.

ROUND NUMBER ESTIMATES.

Coal III.

Worked area	5? acres	×	av. thickness, 2½ ft.	×	1,000	=	12,500 tons.
Workable area ...	320 acres	×	" 2½ ft.	×	1,000	=	800,000 tons.
Unworkable area.	5 sq. mi.	×	" 1 ft.	×	1,000,000	=	5,000,000 tons.
Total area	5¼ sq. mi						5,312,500 tons.

Coal I.

Worked area	5 acres	×	av. thickness, 2½ ft.	×	1,000	=	12,500 tons.
Workable area ..	400 acres	×	" 2½ ft.	×	1,000	=	1,000,000 tons.
Unworkable area.	100 sq. mi.	×	" ½ ft.	×	1,000,000	=	50,000,000 tons.
Total area	100 sq. mi						51,012,500 tons.

Number of coals contained: 2.
Greatest thickness recorded: 3 ft.
Average thickness: About 6 in.
Area underlain by coal: 100 sq. mi.
Area underlain by workable coal: 400-500 acres.
Contained in townships: Scattered in small pockets.
Estimated total tonnage of coal: 56,825,000.
Estimated total tonnage of coal removed: 25,000.
Estimated total tonnage of workable coal left: 1,800,000.
Number of mines working ten men or over, in operation: 0.
Number of mines working less than ten men, in operation: 9.
Total number of mines in operation: 9.
Large mines abandoned: 0.
Strippings, outcrops, etc.: 103.
Total number of openings to coal: 112.

XIX. PARKE COUNTY.

420. REFERENCES AND FIELD WORK.—

1838-1853-1857. D. D. Owen, Continuation of Rep. of a Geol. Reconn. of Ind., pp. 33-35. (D. D. O.)

1862 (1859). Richard Owen, Rep. of a Geol. Reconn. of Ind., pp. 166-7. Two coal analyses. (R. O.)

1862 (1859). Leo Lesquereux, same Report, pp. 331-334. Two columnar sections. (L. L.)

1869. E. T. Cox, 1st Ann. Rep., Geol. Surv. of Ind., pp. 110-116. Two columnar sections. Two coal analyses. (E. T. C.)

1870. E. T. Cox, 2d Ann. Rep., Geol. Surv. of Ind., p. 185. Two coal analyses. (E. T. C., '70.)

1872. E. T. Cox, 3d and 4th Ann. Reps., Geol. Surv. of Ind., pp. 16-21. One columnar section. Three analyses. (E. T. C., '72.)

1872. Barnabas C. Hobbs, same Report, pp. 341-384. Map. Six columnar sections. Two coal analyses. Two figures. (B. C. H.) (Report extremely unreliable.)

1875. E. T. Cox, 7th Ann. Rep. Geol. Surv. of Ind., p. 68. One coal analysis. (E. T. C., '75.)

1888. Maurice Thompson, 16th Ann. Rep. Dept. of Geol. and Nat. History, p. 257. One columnar section. (M. T.)

1895. W. S. Blatchley, 20th Ann. Rep. Dept. of Geol. and Nat. Resources, pp. 47-58. Five columnar sections; describes clays and shales. (W. S. B.)

1895. T. C. Hopkins, same Report, pp. 230-268. Two columnar sections containing coal; describes sandstone. (T. C. H.)

1896. J. T. Scovell, 21st Ann. Rep. Report on Vigo County, pp. 507-576. Contains several references to Parke county, and gives one columnar section from that county. (J. T. S.)

1897. G. H. Ashley, field work for this report. (G. H. A.)

Section 1. Geography.

421. Location.—Parke county lies west of the center of the State and is separated from Illinois only by Vermillion county. It lies south of Fountain and part of Montgomery county, west of Putnam and Montgomery, north of Clay and part of Vigo.

422. Extent.—Parke county is nearly rectangular in shape, having a length of 24 miles from north to south and a width from east to west of about 20 mi. It occupies all of townships 14 to 16 north of ranges 6 to 8 west, 17 north of ranges 7 and 8 west, the western half of township 17 north of range 6 west, and the eastern part of townships 14 to 17 north of range 9 west, having an area of about 480 sq. mi.

423. Elevation.—The following table shows the elevation of a number of points in the county:

	Ft.
Track at Putnam and Parke county line, I., D. & W. R. R.	790
Track at South Waveland, I., D. & W. R. R.	801
Track at Guion, I., D. & W. R. R.	641
Little Raccoon valley at Guion, I., D. & W. R. R.	634
Track at Bethany, I., D. & W. R. R.	760
Track at Marshall, I., D. & W. R. R.	612
Track at Bloomingdale, I., D. & W. R. R.	656
Track at Montezuma, I., D. & W. R. R.	507
Wabash river at Montezuma, I., D. & W. R. R.	474
Rockville, J. T. Campbell	688
Atherton, J. T. Scovell	523
Hill one-half mile east of Atherton, J. T. Scovell	625
Rosedale, J. T. Scovell	537
Sylvania, C. & E. I. R. R.	694
Sugar creek, bed of, at Rockport	499

The elevations thus range from about 468 ft. to over 800 ft.

424. Drainage and Topography.—Parke county abounds in large streams. The Wabash river, flowing along the western border, receives in this county the waters of Coal creek, Sugar creek and

Raccoon creek. The latter two streams rise well to the east of this area and carry an abundance of water. All along the eastern side of the Wabash the bottom lands tend to have a width of 1 or 2 mi., back of which rise the bluffs from 100 to 250 ft. high. Sugar creek appears to be flowing through a post-glacial channel, as far as the mouth of Rush creek, its immediate valley being usually narrow and often hemmed in by cliffs of sandstone, yielding many excellent exposures of the coal measure rocks, and affording some of the most picturesque scenery of the State. Its principal tributaries from the north are Rush creek and Sugar Mill creek. The latter valley is somewhat of the type of Sugar creek; the former is thought to have been possibly the preglacial channel of Sugar creek, and its banks show little but glacial deposits of sand, clay and gravel. From the south side the principal tributary is Roaring creek, which, in the lower part of its course, winds through a narrow rocky ravine. Many of the smaller tributaries of Sugar creek are, over the lower part of their courses, enclosed in rocky gorges, with perpendicular or overhanging walls, these gorges being often from 50 to 100 ft. deep and sometimes of a less width at the top than their depth, as at Turkey run.

Raccoon creek and its principal tributary, Little Raccoon creek, occupy their preglacial channels as far as Rosedale, above which point they have broad bottoms and yield but few exposures. These broad bottoms from Rosedale pass southwest into Vigo county, showing the former course of the stream. At present it turns northward at Rosedale and flows nearly parallel, though in an opposite direction, from the Wabash river, emptying into that river at the old mouth of Leatherwood creek. This part of the channel is comparatively narrow and the side ravines yield numerous exposures, but it appears to have been a channel of some kind in preglacial times, judging from the fine deposits of gravel exposed along its banks. The principal tributaries are Leatherwood, Rocky run, Iron creek, Little Raccoon with its tributaries, Wiesner's branch, Williams' creek and Sand creek—Stronger's branch, Rocky fork, Troutman's branch and many smaller tributaries.

As may be judged from the roads shown on the map, the surface of Parke county is much broken, especially in the eastern part, where the divides tend to become sharp-crested ridges. There are, however, all over the county, small, scattered patches of the level land so characteristic of the visit of the glacier.

425. Transportation Facilities.—This county is fairly well supplied with railway facilities. The C. & E. I. R. R. runs through the western part; the I., D. & W. R. R. crosses from east to west north

of the center; the T. H. & L. R. R. crosses from northeast to southwest, the C. & S. E. Ry., leaving the latter at Sand Creek Station, runs east of south to Brazil.

426. Development.—Aside from the banks of the stream where too steep for cultivation, Parke county is for the most part well under cultivation, with an abundance of good gravel roads. Mining is a prominent industry here, Parke county standing second in production, etc., in 1895. Abundant and excellent deposits of clay and shale are leading to the establishment of clay-working plants. Glass sand and building stone may be mentioned as among the industrial products of the county. The manufacture of finished products aside from the clay plants has so far been carried on only to a very limited extent.

Section 2. Stratigraphy.

427. Surface Geology.—Parke county is entirely within the drift covered area, though as a rule not as deeply buried as the counties to the north. The drift may be said to range between 25 and 75 ft., averaging nearer the former and occasionally running over the latter up to probably 150 ft. Probably the principal reason for the comparative thinness of the drift in this county is the presence of many large streams. These large streams, by cutting deeply, greatly lower the main drainage level below what it would be with only small streams present. This gives a greater fall to the tributary streams and results in a much more rapid erosion. Away from the influence of these larger streams the conditions are much as in the flat areas of the surrounding counties, and the drift is still often over 100 ft. or over deep. A terminal moraine crosses the county from east to west across the southern end, producing hummocky topography and unusual depth of drift wherever the erosion has left it undisturbed. Some preglacial channels are found, but not many. Mention of these is made in the detailed description.

Linton Fm 428. Coxville Sandstone (Merom?).—In the earlier reports much was made of a number of "conglomerate" (Mansfield sandstone) ridges, supposed to cross the county from east to west, dividing it into a number of bays or basins in which the upper coals were laid down. It was found that what were taken to be ridges of Mansfield sandstone are the sandstone fillings of a deep and broad erosion channel or system of channels carved out of the upper measures. Not only are channels cut down through the measures, but there appears to have

been extensive though shallow erosion for some distance either side of the immediate channel, also filled with sandstone. This erosion has profoundly influenced the amount of workable coal in the county. The filling is best exposed in section on the northeastern side of Raccoon creek, at Coxville. As yet, it has not been possible to accurately set the time at which this erosion took place and to which the sandstone now filling these ancient valleys was laid down. The evidence points to either a short time after the laying down of Coal VI or to a time entirely subsequent to the deposition of the coal measures proper, or at a time corresponding with the laying down of the Merom sandstone of Sullivan county. The latter theory is considered as best sustained. Coal!

429. Coal Measures of Parke County.—The following section will give a comprehensive view of the coal measures of the county:

Division VII—
1. Black sheety shale, etc., above Coal VII. V
2. COAL VII, extensively worked at Lyford. V

Division VI—
3. Space. Shales principally.
4. COAL VIc, seen only south of Mecca. VIa
5. Fire-clay and shale.
6. COAL VIb, only worked south of Mecca and near Lyford. IV ?
7. Principally shales, suitable for brick.
8. COAL VIa. A double bed worked a little at numerous places in Wabash and Florida townships.
9. Clay and shale in Florida township, becoming only clay in Wabash township. IIIc
10. COAL VI. Double bed, thick and extensively worked in Florida township, thinning out or pockety in Wabash. III

Division V—
11-16. Three COALS and spaces; very irregular. One or more coals liable to be found just below Coal VI. Staunton coals
17. Shale worked for brick.
18. COAL Vb, mined a little in places in Wabash township.
19. Space. Shales principally.
20. COAL Va; thin; black shale over. II
21. Space. Shales and limestone underlain by black shale.
22. COAL V, extensively worked at Sand creek, Williams' creek, Minshall, Caseyville, and on a smaller scale elsewhere; not workable to the west. Minshal.

Division IV—
23. Space. Shales and sandstone.
24. COAL IV, extensively worked at Mecca, Caseyville, and in Jackson township; workable in Sugar Creek and Penn townships and on Sand creek. Upper Block ?

Division III—
25. Space, varying from 2 ft., at Mecca, to 50 ft., near Caseyville.
26. COAL III, extensively worked at Mecca, Caseyville, and in Jackson township; workable in a few other places.

Division I—
27. Mansfield sandstone, principally, building stone underlain with shale.
28. COAL I. Along eastern edge of county; not workable.

It is seen that at least six coal horizons contain at some points commercially workable coal. The aggregate thickness of the measures in this county is probably not less than 450 ft., found in the highland of western Florida township. Having determined the stratigraphic position of any coal, the approximate depth to the bottom of the coal measures can be told from the sections.

430. Lower Carboniferous.—The Lower Carboniferous underlies the coal measures of the whole county and outcrops in the northeastern part and in the stream valleys over a still larger area. The rocks appear to be the Mitchell to Harrodsburg limestone and the Knobstone, the latter predominating to the north.

Section 3. Detailed Geology.

431. Townships 15, 16 and 17 North, Range 6 West—Statement.—These townships are quite similar geologically, Division I predominating in extent of outcrop, but each township also has small areas of the divisions above the Mansfield sandstone and of Lower Carboniferous rocks. They coincide with eastern Howard, Greene and Union of the civic townships. They are alike in being much broken along the streams, but in locally having level divides away from the streams. Probably no workable coal exists in any of them, the coals found all belong below the Mansfield sandstone. A generalized section of Division I would be:

Sandstone	25 ft. to 100 ft.
Shale of varying quality	0 ft. to 25 ft.
COAL I	3 ft. to 0 ft.

Below this would come the Lower Carboniferous limestone of Keokuk and older ages. The drift acquires some thickness away from the main streams, but near those streams has been much reduced by erosion.

432. Distribution in T. 17 N., R. 6 W. (Western Half.)—The coal measure divisions above Division I occupy about 4 sq. mi. in the southwestern corner of the township. No coal or coal measure rocks were noted in this area, so that the boundary is largely conjectural, based upon the occurrence of coal just west and south of here. It will be safe to say some coal exists in this area, but it may be doubted if any of it is workable for more than local trade.

Division I occupies the rest of the area, except in the immediate valley of Sugar creek, where the Lower Carboniferous limestone is exposed in massive bluffs along Sugar creek almost continuously, at one point making such a narrow channel that a bridge is thrown across. In Sec. 18 the sandstone attains a thickness of 100 ft. (bar.) as far as exposed, and was originally more. See T. C. H. for details of sandstone. The nonconformity between the coal measures and Lower Carboniferous has been referred to and figured by Mr. Hopkins (T. C. H., p. 266), the sandstone at the bridge extending down to the creek, while 600 ft. away it caps an old hill of limestone, of which 50 ft. at least is exposed above the creek.

In the S. W. of S. W. of Sec. 4, 6 in. of coal is reported on the land of Mr. Clore. It is overlain by 2 or 3 ft. of clay shale and lies about 50 ft. above the level of the creek. In the N. W. of Sec. 17, 9 in. of coal is reported as underlying limestone on the Urial Clore place. There is reported to have been shale above and below the coal. This coal was not seen, but as nearly as we could locate it, it is above the outcrop of limestone in the stream bed. Coal is also reported to have been found on Col. Casper Budd's place, in the south half of Sec. 17. Coal is reported as 12 or 13 in. thick on the west side of Sugar creek in Sec. 18 (C. E. S.). In the S. E. ¼ of Sec. 21, on the C. C. Demaree place, 3 in. of cannel coal is reported as found in a spring. A half bushel of coal is said to have been taken out, and the whole thickness of the coal not exposed.

At the tile mill in the S. W. of S. W. of Sec. 6, the drift is 60 ft. deep.

433. Distribution in T. 16 N., R. 6 W. (Greene Township).—The drift about Parkersville is at least 20 to 40 ft. deep, wells to that depth being in gravel. In the N. W. corner of Sec. 27 a well went 35 ft. in drift. The sandstone of Division I crops out along Little Raccoon creek and its branches, but this is an old valley with broad bottoms and the sandstone does not make conspicuous cliffs as on Sugar creek. Coal is reported on the Hayley place in Sec. 7; in the N. W. of N. W. of Sec. 18 on the G. Grimes place, where it is overlain by

sandstone and reported to be of good quality. On the old J. Strong place, in Sec. 19, 20 in. of coal is reported. Mr. Hobbs reports 3 ft. of good block coal on the J. Carver place, in Sec. 34; also 5 ft. of block coal in Sec. 31, on J. Marks's land. Inquiry failed to elicit any knowledge of the Carver coal. The coal on Sec. 31, though not in work and not seen, is reported to run about 2 ft. 6 in. on the Miller and Maclain places, with a sandstone parting in places and a sandstone roof (see next paragraph). As far as could be learned, this township is practically without workable coal, though at at least two places showing coal that may be worked for local trade.

434. Distribution in T. 15 N., R. 6 W. (Union Township).—The coal measures above Division I are judged to overlie a limited area along the western edge of this township, but so near the surface that their development is apt to be irregular, and the probability of their containing workable coal is not great. Mr. Hobbs reports a fine outcrop of a 3-ft. bed of good block coal on Limestone branch in Sec. 3, about 15 to 20 ft. above the limestone. Some black shales in the northeastern 40 acres were the nearest approach to coal found. In Sec. 6 he reports two seams, the upper 3 ft. thick, the lower 2 ft. This is doubtless the 2 ft. 6 in. coal on the Mendenhall and Collins places, which in places has a sandstone parting. The coal is just at drainage and is reported as not very good, the bottom being the best. Sandstone overlies the coal. Division I in this township is quite irregular, the sandstone being well developed at places, while at other places apparently the same horizon shows only shale. On account of the lack of coal not enough study was given to these to determine their actual relation. This shale is well developed in Sec. 16. In the S. E. of N. W. this shale shows a thickness of 35 ft. In the N. E. of N. E. of this section is the following section:

Section 63. Section in Sec. 16. (T. C. H., p. 241).—

	Ft.	*In.*
Yellowish brown shale (weathered)	10 to 12	0
Drab shale	12 to 15	0
Shaly sandstone	..	4
Fissle black shale	4	0
COAL I	..	4
Lumpy drab-colored shale	8	0
Limestone	..	12

In the N. W. of N. W. of Sec. 26 is a little coal on the Spencer place; it overlies sandstone which, in turn, overlies unconformably the Lower Carboniferous limestone. The same coal has been stripped a little on the Martin place, in the N. E. of Sec. 27. It appeared to be only a few inches thick. A few rods further south the section is:

Section 64. Section on Limestone Branch in Sec. 27.—

	Ft.	*In.*
Shaly sandstone	10	0
Blue shale	3	0
Black shale with streaks of coal	..	10
Dark blue shale to creek	2	0

In the S. W. corner of this section, at Ferndale, 6 in. of "bright" coal is reported at creek level.

In Sec. 33, west of the center, coal is reported on the James Martin place, said to be good coal, but too thin to work.

Township 14 North, Range 6 West.

435. Location, Etc.—This is the southeastern township of Parke county, and corresponds with Jackson of the civic townships. The area of Division I is much broken, the stream valleys usually being narrow and often bounded by perpendicular cliffs of sandstone. The area underlain by Divisions II to V in the southern and southeastern part of the township is very level except in the immediate neighborhood of the streams. The Big Four railroad just touches the southeastern corner.

436. Stratigraphy.—The divisions and coals included in this township are I to V, Coals III and IV being workable. The following diagram will show the position of the coals:

Division V—
1. 2 in. to 1 ft. of limestone overlying 2 in. to 7 ft. of black shale.
2. COAL V, in tops of hills in southwestern sections.

Division IV—
3. 4 to 5 ft. fire-clay, 10 to 15 ft. drab clay shale.
4. COAL IV, worked in southwestern sections.

Divisions III-II—
5. Fire-clay, blue clay, gray shale, "fake."
6. Coal III, worked in southwestern sections.
7. Fire-clay or shale.
8. COAL II.

Division I—
9. Massive sandstone underlain with shale.
10. COAL I. not workable.

For more detailed columnar sections see the township next west, or the township next south under Clay county.

437. Coal V.—As far as noted, this is an 18-in. coal, characteristically overlain by black bituminous shale with limestone above.

438. Coal IV.—See Fig. 129. This is the top block coal of the Brazil field. It ranges up to 5 ft. thick, though usually coming between 3 and 4 ft.; it has a bench mining of soft, bony coal from 8 to 14 in. from the bottom. This is a typical block coal, having both slips well developed, and a good quality of coal. The roof is very poor, being a fine-looking drab clay shale that turns into clay on being wet. In places boulder clay immediately overlies the coal as in the photograph, in Part IV. This seam is quite subject to shale rolls from the roof or clay veins from the floor. The floor is fire-clay 2 to 5 ft. thick.

439. Coals III and II.—See Fig. 130. These coals all through the Brazil district lie close together, here being from 3 to 8 in. apart. Coal III lies in comparatively small basins, running down to 8 in. between the basins and up to 5 ft. 6 in. in the center of the basins. This seam has here, as all through this district, a smooth parting 6 to 10 in. from the top, the coal above being softer than the rest and more of a caking coal. The rest of the seam is solid, a true block coal, of fine quality. The roof is "fake" or shale, and fair. Under the coal is Coal II, 8 to 15 in. thick, a good quality of coal, but too soft to ship, with a few inches of fire-clay and shale above, and 4 ft. of fire-clay below. These, however, are found only in the swamps, and run out to the rise so that between the basins Coal III rests on the sandstone of Division I.

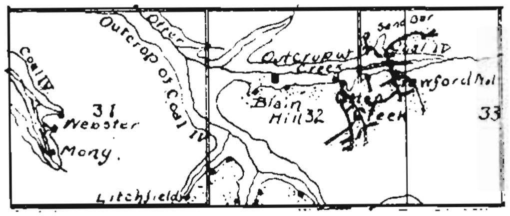
440. Division I.—As usual, this division presents a considerable thickness of massive sandstone (see Mr. Hopkins's report for details), underlain by shale, which locally contains coal, usually less than 1 ft. thick, but running up to a reported thickness of 2 ft.

441. Distribution of Coal in Area of Division I.—Secs. 1-12, 14-17, 21-23, 26. These sections contain only Coal I, which is just about drainage level or a little below. The westward dip across this area is hardly discernible, the sandstone of this division outcropping along nearly all the streams in bluffs that show that the bottom of the coal measures is but little if any below drainage. At the few points where the bottom of this sandstone can be observed coal is usually absent. The few points at which it is reported are as follows:

Sec. 1, on the G. Kuaner place, in the N. W. ¼; Sec. 22, N. E. of S. E., 2 ft. of coal reported in a drilling, a few feet below drainage; Sec. 29, 10 in. of coal reported in the N. W. ¼.

442. Distribution of Coal in Sections 13, 19, 20, 24, 25, 27-30, 34-36.—The coal in these sections, as far as tested, appears to be thin. The drift is deeper than in the preceding sections, thus the preglacial irregularities are hidden, but judging from what exploration has been done much of the coal has been cut out by these ancient channels. It is quite possible that future exploration may find some basins of sufficient extent and with coal of sufficient thickness to pay handsomely for working. It is quite possible that small basins of thick coal will be found. In Sec. 13, S. E. of S. E., coal is found in a well at 27 ft., the thickness unknown. In the N. W. of S. E. of Sec 24, on Mr. Benjamin Singleton's place, 2 ft. of coal is reported. In the N. E. of Sec. 36, on Mr. A. C. Hays's place, is reported 2 ft. or more of coal. In the S. W. of Sec. 34 coal of good thickness is reported to have formerly been worked.

443. Distribution of Coal in Sections 31 to 33.—Figs. 128-130. In these sections Coals III and IV attain a good thickness and



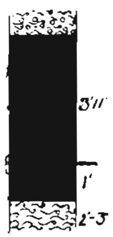


Fig. 128. Sketch map, part of Otter creek coal field, T. 14 N., R. 6 W., Secs. 31-33.
Fig. 129. Coal IV at Crawford No. 1 mine.
Fig. 130. Coal III at Crawford No. 1 mine.

have been quite extensively worked. Coal III is from 0 to 20 ft. below the level of North Otter creek. Coal IV is from 0 to 10 or 15 ft. above the level of the creek and its principal branch here. Coal V, where found, lies 15 to 20 ft. above Coal IV. Coal III lies in small basins which are 10 to 12 ft. lower in the center than on the edge. In the Crawford No. 1 mine there are four such basins, each having to be drained separately. In Fig. 2 of Part I is given a group of sections obtained in crossing from one of these basins to another in the

Crawford mine. Several preglacial channels have been noted in this area. One runs east and west along the north side of Secs. 32 and 33, another east of south across the center of Sec. 33, another southwest across the southeast corner of Sec. 32. There are probably others not learned of or not yet found. A switch from the Big Four has been run down into this territory. The coal is worked at Crawford No. 1 mine of the Crawford Coal Company, S. E. of N. E. of Sec. 32, Coal IV by a drift and Coal III by a shaft 33 ft. deep. The coal runs as described above in thickness, etc. Further down it has been worked at the Otter creek mine, S. W. of N. E. of Sec. 32, Blaine Hill mine, of Brazil Block Coal Company, S. E. of N. W. of Sec. 32, two slopes on Coal IV, shaft to Coal III; Black Diamond mine, of the Stevens Coal Company, S. E. of S. W. of Sec. 32; Litchfield, S. E. of S. E. of Sec. 31; and at some small drifts in the S. W. of S. W. of Sec. 32. All of these mines except the first are now (1897) worked out.

In the S. W. quarter of Sec. 31 coal is being mined on the N. Mong place and the Webster place. At the former Coal III shows a thickness of 3 ft. to 3 ft. 6 in., with the usual smooth parting 4 in. from the top. It has a roof of boulder clay. Below it is Coal II, consisting of 2 in. of bone and 4 in. of coal, separated from Coal III by 1 in. of fire-clay. This coal is asserted to be the upper block coal, but a comparison of the figures with the figures of the upper and lower block coal in Clay county is sufficient to show that it certainly corresponds with Coal III of Clay county. The coal is handled by tramway to a tipple on the C. & S. E. R. R. On the Webster place the coal showed a thickness of 4 ft. There is a smooth parting 10 in. from the top and a 1 to 2-in. bench mining 7 in. from the bottom. It has 1 ft. 6 in. of blue shale over and fire-clay under.

Township 17 North, Range 7 West.

444. Location, Etc.—This township lies north of the center of the county and corresponds principally with Sugar creek of the civic townships, but including the southwestern corner of Howard and northeastern corner of Penn. Remnants of flat country occur between the streams, but near the streams the country is very broken, with many bold sandstone bluffs and much picturesque scenery. There are no railroads in the township.

445. Stratigraphy and Coals.—Notwithstanding the numerous exposures of rock in this township, great difficulty was experienced in obtaining a satisfactory stratigraphic column and in correlat-

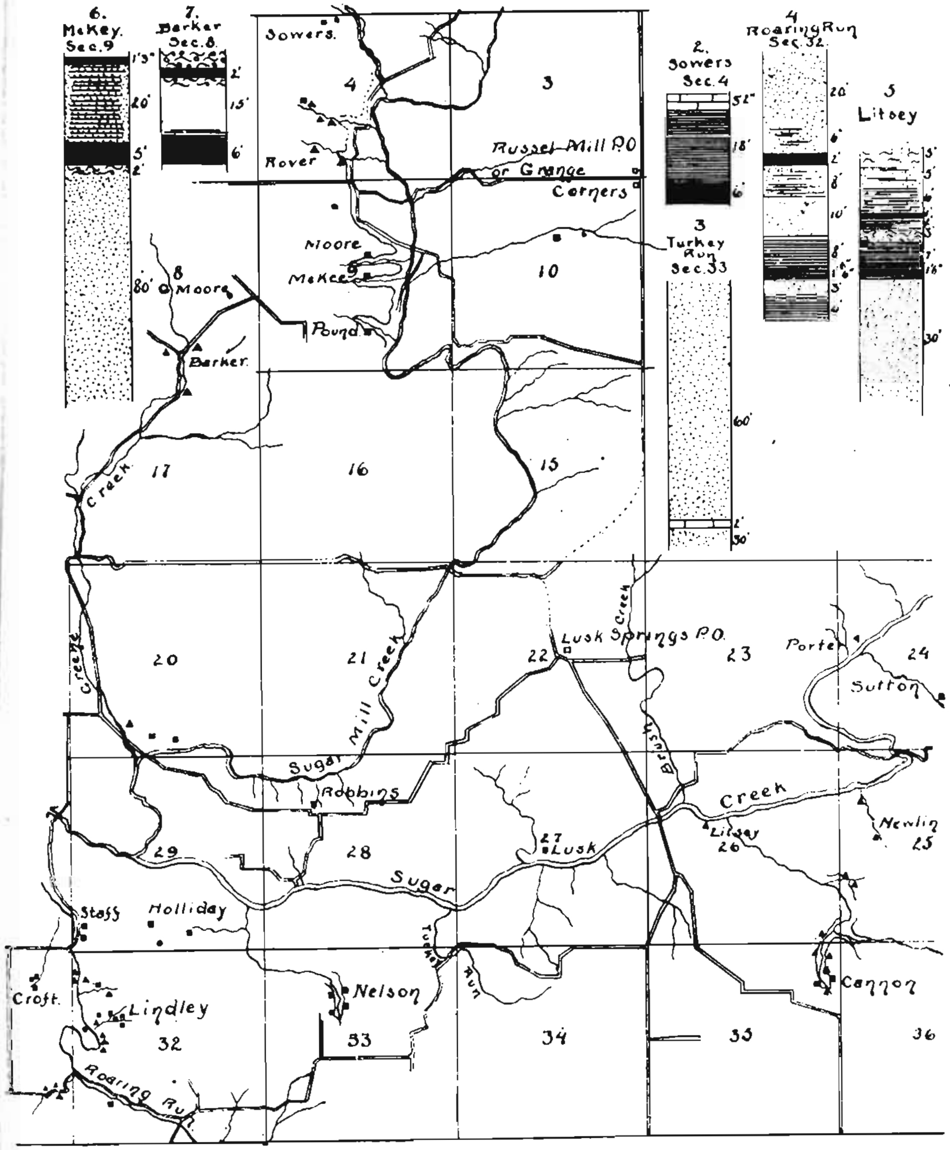


PLATE XVII. Sketch map and columnar sections in T. 17 N., R. 7 W.

ing the coals when such a column had doubtfully been obtained. The coals from one point to another vary greatly, hardly any two sections agreeing, and often where there was the greatest apparent similarity other factors seemed to indicate it was between coals at different horizons. Again, the measures appear to have been subject to a very irregular erosion followed by the laying down of sandstone. Other features assist in rendering the stratigraphy obscure. Doubtless this obscurity could easily be cleared up if sufficient time be taken, the pockety nature of the coals not seeming to warrant our giving the time necessary. As nearly as could be made out, coal occurs at three horizons, corresponding with horizons V, IV and I, with some coal doubtfully placed above Coal V. Thus, at the north boundary occurs the coal already described at the Coats or Byrd bank, in Fountain county, where the section is as given in Fig. 2 of Plate XVII, the coal being 5 to 7 ft. thick, separated by 18 ft. of shale from 3 ft. 4 in. of limestone. Half a mile south of that the thick coal appears to be above the limestone.

446. SECTION 65. SECTION IN SEC. 4, N. E. OF S. W.—

	Ft.	In.
1. Drift	15	0
2. COAL (rep.)	4	0
3. Hidden—not more than a few feet, if any	?	?
4. Shaly sandstone	4	0
5. Brown sandy shale	3	0
6. Blue shale	2	0
7. COAL	..	6
8. Shaly sandstone	4	0
9. Blue shale	6	0
10. Hidden	?	?
11. Sandstone	3	0
12. Fake	..	10
13. COAL	1	8
14. Drab shale, into fake	10	0
15. Gray shaly sandstone	4	0
16. Dark blue shale	?	?
17. Crinoidal limestone	2	0
18. Massive sandstone	?	?

The section is a very unsatisfactory one, as the exposures are disconnected and the strata Nos. 11-15 dip at an angle varying from 25° to 45°, indicating probably a fault, with a possible repetition of strata and coals.

447. A mile south, what is supposed to be the second coal below the limestone appears with this section.

SECTION 66. SECTION AT MCKEY MINE.—Sec. 9, N. W. of S. E., Fig. 6.

	Ft.	In.	Ft.	In.	Ft.	In.
Division V—						
1. COAL V?	1	3	1	3	1	3
Division IV—						
2. Fake	20	0	..	..	21	3
3. Conglomerate .....4 in. to	..	8	..	..	21	11
4. Shale, etc.	1	6	22	2	23	5
5. COAL IV?	5	0	5	0	28	5
6. Fire-clay	2	0	..	..	30	5
Division I—						
7. Sandstone (rep.)	80	0	82	0	110	5
8. COAL? (rep.)	4?	6?	4	6	114	11

448. A mile southwest of this, apparently the same coals occur, the upper showing 2 ft. of coal 12-15 ft. above the lower. Mr. Hobbs reports limestone over both coals. All that could be seen was boulder clay above the upper and shale above the lower (see Fig. 7).

The following three sections were noted south of Sugar creek:

449. SECTION 67. SECTION AT TURKEY RUN.—N. E. of N. E., Sec. 33, Fig. 3 (T. C. H., p. 262).

	Ft.
1. Sandstone of Division I	60
2. Limestone (Lower Carboniferous)	2
3. Sandstone, white, fine-grained (Knobstone)	30
Total	92

450. SECTION 68. SECTION ON ROARING CREEK.—N. W. of S. W. of Sec. 32, Fig. 4.

	Ft.	In.	Ft.	In.
Division V—				
1. Massive sandstone	25	0	..	..
2. Hidden (shaly sandstone?)	6	0	..	..
3. COAL V	+2	0	2	0
4. Fire-clay and shale	8	0	..	..
Division IV—				
5. Massive sandstone	10	0	..	..
6. Drab shale	8	0	26	0
7. COAL IV .....3 in. to	..	6	..	6
8. Black shale .....1 ft. to	1	6	..	..
Division I—				
9. Shaly sandstone	3	0	..	..
10. Drab shale to creek	6	0	..	..
Total	70	0		

451. SECTION 69. SECTION ON LITSEY PLACE.—S. E. of N. W., Sec. 26, Fig. 5.

	Ft.	In.	Ft.	In.
Division V?—				
1. Surface	5	0	..	..
2. Shaly sandstone	5	0	..	..
3. Brown sandy shale with ironstones	6	0	..	..
4. COAL V?	1	0	1	0
5. Blue shale	2	0	..	..
6. Coal traces	..	..	..	..
7. Gray fire-clay	3	0	..	..
Division IV?—				
8. Band of ironstone	..	2	..	..
9. Black shale	7	..	12	2
10. COAL IV?	..	6	..	6
11. Black shale	1	0	..	..
Division I—				
12. Flaggy sandstone	30	0	..	..
Total	60	8		

This section is only an approximation, as the upper part is much disturbed by faults or nonconformities. Up the creek from this the lower sandstone is replaced by black shale from 50 to 80 ft. thick, probably representing Divisions III and II.

452. SECTION 70. SECTION IN S. W. ¼ OF SEC. 26.—

	Ft.	In.	Ft.	In.
1. COAL, bony, usually replaced by shale.	1	6	1	6
2. Fire-clay	2	0	..	..
3. Hidden	2	0	..	..
4. Shaly to massive sandstone.....3 ft. to	8	0	..	..
5 Blue to gray shale	14	0	..	..
6. Hidden	6	0	..	..
7. Blue shale	6	0	..	..
8. Black shale, bottom bituminous and locally replaced by No. 9	2	0	40	0
9. COAL ....0 to	1	0	1	0
10. Gray to brown fire-clay	1	6	..	..
11. Gray shaly sandstone	3	0	..	..
12. Gray sandy shale running into blue shale	20	0	24	6
13. COAL (locally), usually bone....6 in. to	1	6	1	6
14. Drab shale	1	6	..	..
15. Flaggy sandstone	10	0	..	..
Total	78	6		

453. South of this, in the N. E. of N. E. of Sec. 35, on the Cannon place, the following section was noted:

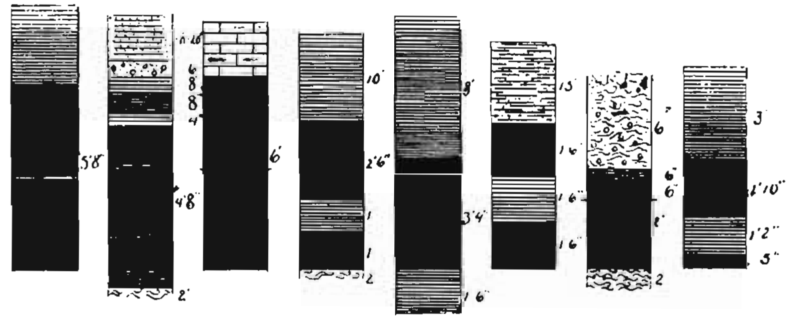
SECTION 71. SECTION ON CANNON FARM.—Sec. 35.—

	Ft.	In.	Ft.	In.
1. Boulder clay	6	0	..	..
2. Black shale (bone)	..	6	..	..
3. COAL (top 6 in. cannel)	2	6	2	6
4. Drab fire-clay	2	0	..	..
5. Massive sandstone ....0 to	4	0	6	0
6. COAL ....2 ft. to	0	0	0	0
7. Drab shale with ironstone	10	0	..	..
8. Black bituminous shale ....3 in. to	2	0	..	..
9. Drab shale	6	0	18	0
10. COAL	..	6	..	6
11. Gray fire-clay	5	0	..	..
12. Sandstone	4	0	..	..

454. A half-mile below the mouth of Sugar Mill creek occurs the following section:

SECTION 72. SECTION NEAR MOUTH OF SUGAR MILL CREEK.—(T. C. H., p. 257.)

	Ft.
1. Yellow sandstone	5
2. Black shale	3
3. Gray and yellow striped sandstone	12 to 15
4. Shale, brown to black, containing pockets of coal	12
5. Cross-bedded sandstone, shale and coal	12 to 15



131 Sowers. Sec. 4. 132 McKey. Sec. 9. 133 Barker. Sec. 8. 134 Robbins. Sec. 21. 135 Holliday. Sec. 29. 136 Lindley. Sec. 32. 137 Cannon. Sec. 35. 138 Sutton. Sec. 24.

Figs. 131-138. Coals in T. 17 N., R. 7 W.

These sections show what is still more apparent in the field, the unreliability of the coals and the variations in the stratigraphic column. Here and there the coals attain a good working thickness, and in one or two cases this thickness holds over an area sufficiently large to invite capital for their extensive development. But outside of these areas the coals are generally represented only by a few inches or even only by a little bone or black shale or sometimes not even that, but here and there suddenly thickening up into a little pocket of workable coal. The following sections show a group of coal sections taken from these pockets, and may be said to represent the pick of the section, rather than the average (Figs. 131-138).

455. Distribution and Local Details of Coal.—As the coal exposures and developments are almost entirely along the streams, it will be convenient to follow down Sugar Mill creek, then up Sugar creek.

456. Coals near Sugar Mill Creek, Secs. 3, 4, 8, 10.—Almost on the north line of Sec. 4, Coal V outcrops and is mined by Mr. Manly Sowers. The coal near the crop shows a thickness of 5 ft. 8 in. (see Fig. 131), with 1 in. of clay in the center. The clay runs out to the south, but across the ravine to the north in the Coats bank is 6 in. thick. The lower half of the bed is a good blacksmith coal. The roof is shale, 2 to 14 ft. thick, the floor fire-clay 6 ft. thick. The limestone, so prominent on the north bank over the Coats mine, appears to have run out here, though probably represented by the limestone roof, which is occasionally met with in this mine. This is evidently the same as the Coats coal, which, being overlain by limestone, has been assumed to be Coal V. No coal has been noted between this coal and the sandstone of Division I, exposed down the creek. The parting in the coal again brings up the question asked with reference to the coal on Prairie creek, in Fountain county, whether this does not represent both Coals IV and V. Conclusive evidence was not obtained either for or against such a theory. The extent of this basin to the south is not known, but it appears to have thinned out one-half mile to the south.

In the S. W. ¼ of Sec. 4 coal is exposed in two ravines. In the northern ravine the coal appeared to be above the limestone, as given in ¶446. As stated, it is quite probable that the strata here, which in places are horizontal, while for 100-200 yd. they have a dip of 25° to 45°, have been faulted and misplaced. The coal at the head of this ravine, almost at the upland level, is reported to have been 4 ft. thick. It has been worked a little, but I should imagine much difficulty would be had with the roof on account of its nearness to the surface. In the ravine to the south the lower coal would appear to be at the level of the Moore coal, just south, or the Sowers coal, to the north, and as it is a thin coal it suggests that neither of those coals are workable at this point. Near the head of this ravine some mining has been done, indicating the presence of the 4 ft. coal of the ravine just north.

In Secs. 8 and 9 is the most promising basin in this township or in northern Parke county. At the McKey bank, operated by Mr. John Morgan, the coal showed a thickness of 4 ft. 8 in., with from 1 to 3 in. of bone 14 in. from the top, and 2 in. of bone 12 to 15 in. from the bottom. The coal is semi-block, the slips offsetting 4 in. at the lower bone band, and shows no sulphur, appearing like a better coal than the average. Above the coal is 4 in. of shale, which comes down, and where the roof had fallen at one place there showed above that 8 in. of bone coal, then 8 in. of clay overlain by 4 to 8 in. of conglomerate shale. Above that is typical fake 10 to 20 ft. thick. Then comes the "rider," 14 to 15 in. thick. The roof appeared to be fair. Below the coal is 4 to 6 in. of bone, then 2 ft. of fire-clay, which runs into sandstone, reported to be 80 ft. thick, under which it is claimed drilling shows 4 ft. to 4 ft. 6 in. of coal. Judging from what is found elsewhere, I should expect a core drilling to show fully half of the bottom coal to be bone. It may be said here, however, that drillings at various points in northern Parke county report Coal I with a thickness of up to 9 ft. In favor of the view that a core drilling would show this to be principally or entirely bone coal or black bituminous shale is the fact that the horizon of Coal I is abundantly exposed east, north and southeast of this region, and nowhere shows a thickness of over 2 or very rarely 3 ft. of good coal, and the few core drillings that have been put down west of the outcrop of Coal I show only a few inches if anything at that horizon. Further, bone coal or black bituminous shale, sometimes running into bone coal at the bottom, is not uncommon at that horizon, in the latter case the thickness being sometimes as much at 11 ft., and so bituminous as to have led to attempts to burn it. The McKey coal is also being worked for local trade on the Perry Moore place, by Messrs. Newlin and Crabb, and on the James Pound place. The coal at these places, which are all drifts, runs about the same, the two bone bands at the Moore bank being 18 in. from the top and 14 to 18 in. from the bottom, with 2 to 4 in. of bone under. Drillings on this place showed the coal to run up to 5 ft. 8 in. A drilling on the Geo. Moore place, N. E. of S. E. of Sec. 8, is reported to have shown 5 ft. 6 in. of coal. On the old Barker place, S. W. of S. W. of Sec. 8, the coal occurs just below creek level, and has been stripped some, though water interfered with work. It is reported to have ranged there from 0 to 6 ft., with an average of 4 ft. Only the roof showed, being a gray shale with here and there lenticular masses of sandstone between the shale and the coal. (Compare lower bed at Sand creek.) The upper bed here appears to be about 2 ft. thick and is about 12 ft. above the creek. It has boulder clay over and fire-clay under, with 6 to 8 ft. of gray shaly sandstone or sandy fire-clay below that. Mr. Hobbs reported limestone over both beds here, but no trace of limestone could be found. It is claimed, and the evidence seems to substantiate it, that this basin covers several hundred acres. If so, it would seem an inviting field. A switch from the C. & E. I. R. R. at Kingman, four or five miles long, would reach any part of this field.

In Sec. 10, S. W. of N. E., a little coal and black shale show, and considerable money has been expended in trying to develop it.

On John Goodman's farm, in the N. W. of N. W. of Sec. 2, a shallow well is reported to have passed through 18 in. of coal. This is 70-80 ft. above Wolf creek.

457. Sugar Mill Creek in Secs. 28 and 29.—In the S. E. of N. W. of Sec. 28, coal outcrops and has been mined at Geo. Robbins's. The section here of coal and roof and floor is (see Fig. 134; Sect. 73):

	Ft.	In.
1. Gray fissle shale	10	0
2. COAL	2	6
3. Soft fissle shale	1	0
4. COAL	1	0
5. Fire-clay	2	0
6. Gray to yellow sandstone	6	0
7. Dark drab shale		

The top bench is a dull-black semi-block coal, appearing well in the mine. The lower bench is softer and richer than the upper. The roof appears to be good. It has 40 ft. of hill over it. From its position it would seem to be the upper bed, but that is uncertain.

At the old Wilkins mill it is claimed by Mr. Hobbs that there is a 5-ft. bed of coal in the creek bed, between the mill and the dam. Across the creek north from the mill a coal outcrop 1 ft. to 1 ft. 4 in. thick (2 ft., according to Mr. Hobbs), overlain by 10 ft. of massive sandstone and underlain by 2 ft. of light-gray fire-clay. The coal is about 10 ft. above the bottom and is a rich-looking coal. Further up on the north side, nearly to the mill dam, is a partial exposure of coal, 8 in. being seen, overlain by about 20 ft. of very sandy, fissile shale, the surfaces of the flakes showing much carbonaceous matter. About half-way between is an exposure of massive sandstone, dipping sharply to the east. If this is the same sandstone as that overlying the coal a short distance west it would look as though the coal in the creek

bottom here was the same as the 1 ft. to 1 ft. 4 in. coal exposed on the bank. Between this area and the coal in Secs. 8 and 9 no coal was seen. On Greene creek little but drift shows; on Sugar Mill creek are principally bluffs of Mansfield sandstone.

458. Roaring Creek.—Though presenting but little workable coal, the area bordering this stream is one of the most interesting geologically in the coal area. It furnished the material for the two only figures illustrating the structure of the coal measures published by the earlier survey. Unfortunately these figures have no counterpart in nature. At one point where the two beds were exposed in a bluff "40" ft. apart, the crop of the upper bed at the end of the bluff had furnished enough weathered matter to make a black streak in the surface material, which was constantly forming and slowly moving down the incline. A small bed still above does the same thing. This is described as follows (B. C. H., p. 361): "Here two coal seams, about 40 ft. apart, as far up the stream as they can be discovered, approach each other, the lower with a gentle rise, the upper by a descent at an angle with the horizon of about 45°. They pass down the stream separated by a few inches of clay and shale." The figure tells the same story. He then traces them down the stream, each 30 in. to 3 ft. thick, and separated by 8 in. of shale. As a matter of fact, the two beds maintain about the same distance apart all along the stream, the upper bed averaging and being generally about 2 ft. or less thick, the lower bed averaging about 6 in. thick. In the other figure the united coal beds, here reduced to 2 ft., are "closely and tortuously embedded between two sandstones, the lower of which is much the more friable." The figure represents the coal bed in waves, the deflection from the horizontal being 3 ft. 6 in. in a distance of 11 ft. Measurement shows the bed at this point, which is easily recognizable, to be nowhere over 6 in. thick and to show a slight anticlinal structure with a deflection from the horizontal of 1 ft. to 1 ft. 6 in. in a distance of 100 ft. and to be overlain by shale except at the highest point of the arch, which is slightly irregular, and to be underlain by 5 ft. of fire-clay. The upper coal is here less than 20 ft. above this bed, the section being (Sect. 74):

	Ft.	In.	Ft.	In.
1. COAL	2	0	2	0
2. Hidden	10	0	..	..
3. Dark blue shale and ironstone	5	0	..	..
4. Massive sandstone ......1 ft. 6 in. to	2	0	..	..
5. Gray shale ......0 to	2	0	19	0
6. COAL	..	6	..	6
7. Fire-clay	5	0	..	..
8. Yellow sandstone	2	0	..	..

This explanation is given in answer to questions by those who were familiar with the cuts mentioned, but who had not been able to explain them.

Passing up the ravine from Sugar creek, in the S. E. ¼ of Sec. 30, are bluffs of Mansfield sandstone. On the Samuel Durman place a nonconformity shows nicely. Below is from 0 to 2 ft. of sandy shale, then 6 ft. of massive sandstone, to water. Above is 6 to 10 ft. of sandstone, shale and ironstone, looking as though all dumped together, above which is 12 to 15 ft. of shale. Coal is first met on the C. Staff or old Hinds place, in the S. W. of S. W. of Sec. 39. The coal here measures 2 ft. 6 in., with 10 ft. of shaly sandstone for a roof, and a considerable thickness of fire-clay below. The hill is well worked out. On the old Croft place, N. E. of N. E. of Sec. 31, the same coal, probably V (?), outcrops and is worked a little from several openings in a small branch. It is there 1 ft. 6 in. to 2 ft. thick, a semi-block, with 6 ft. of shaly sandstone over and 6 ft. of massive sandstone still above. At the Rubottom mill both coals outcrop as noted above. On the Chas. W. Lindley place (old Reynolds) the upper bed is double, but instead of 30 in. each, the upper bench measured 1 ft. 2 in., and the lower 1 ft. 3 in. with one foot of soft drab shale between. At this point the roof consists of 12 ft. of drab sandy shale overlain by 3 ft. of yellow flaggy sandstone. To the southeast (?) it is reported that the parting runs down to 6 in., while in the opposite direction it is reported to increase to 6 ft., but the short space in which it is said to do so throws doubt on the information. Up another fork of the same little hollow the coal measured 3 ft. 4 in., but said to be partly bone, with 3 ft. of light gray shale for a roof, and above that 25 ft. of massive sandstone. I was not wholly convinced that this was the same bed as the double bed above mentioned, though on about the same level and only a short distance away. At the end of the point between the two forks of the ravine this coal has been burnt out before the coming of white men, its horizon now being occupied by two or three inches of ash, without clinker, overlying sandstone. In another ravine north of this, but on the same farm, it is said both beds were workable, the coal from the lower bed being a better coal than at the banks now open there. They were 25 to 30 ft. apart. A short distance above this an "S" curve of the creek cuts across one of the best faults we have seen exposed in the State. Downthrow to the south.

Up a small tributary in the S. E. ¼ of Sec. 31, the sandstone occurs in regularly stratified layers with a thickness of from 20 to 40 ft. Beneath this are pockets of coal. At one point the coal has shale over it, and probably shows its normal thickness. The section here showed:

	Ft.	In.
Massive cross-bedded sandstone	15	0
Soft drab clay shale	1	0
COAL	2	0
Bone coal	..	6

Just above this the coal shows in the creek bed for 100 ft. with a maximum thickness of 1 ft., the sandstone cutting the coal out at either end. Down the creek from where the thickest coal is exposed the bed divides up as follows:

	Ft.	In.
Brown sandy shale	6	0
COAL	..	6
Brown shale	..	6
COAL	..	1
Shale	..	1
COAL	..	½
Shale	..	2
COAL	..	¾
Shale	..	6
COAL	1	3
Bone coal	..	6
Drab shale	1	0

Up the main stream again coal has been worked a little on the west bank in the S. E. of S. W. of Sec. 32. Above this the coals and sandstone pass under the creek and little or no rock is exposed beyond.

459. SUGAR CREEK ABOVE ROARING CREEK.—On a small branch heading in the S. W. of S. E. of Sec. 29, coal is being mined on the Holliday place. The coal ranges from 2 to 4 ft., averaging 3 ft. 4 in. (Fig. 135). It is a semi-block, blocking well near the outcrop, but further in the slip tending to become tight with spar, requiring the use of powder. It is a splint coal. The roof is gray shale, fairly good away from the crop. Below is 18 in. of bone coal, said to serve fairly well the purposes of coal. Below that the following section is reported from a drilling:

	Ft.	In.
COAL being worked	3	4
Bone	1	6
Fire-clay	14	0
Sandstone	15 to 20	0
Blue shale	?	?
COAL	3	8
Fire-clay	?	?
White sandstone	25 to 30	0

		Ft.	In.
COAL	2 to	2	6
Space		?	?
COAL about 70 ft. below worked coal		6	0
Has 8 to 10 in. bone on top.			

External evidence of exposures shows little or no confirmation of this section, but rather the opposite. The worked coal is about 40 ft. below the top of the hill.

Near the head of a branch on the Geo. Nelson place, in the S. E. of N. W. of Sec. 33, coal has been mined a little. At the only point exposed it measured 2 ft. 10 in., overlain by 3 ft. of sandy shale or sandstone and with 1 ft. of dark blue shale below.

In Sec. 27, N. E. of S. W., 4 ft. of coal is reported on John Lusk's place, north side of Sugar creek, not seen. The sections on the Henry Litsey place, N. E. of S. W. of Sec. 26, and in a ravine east of there and on the Cannon place have already been given (¶¶451-453). On the Cannon place Mr. Hobbs reported 4 ft. of semi-block coal with 10 to 12 in. of cannel on top. The coal has been extensively stripped and is exposed at a number of points along the bank. The thickest coal measured, and claimed by those mining there to be the thickest known there, was 6 in. of poor cannel coal, overlying 2 ft. of bituminous coal; above these 6 in. of black shale, bony, shows. The coal has irregular calcite filled slips. Underneath is 2 ft. of drab fire-clay. In the S. W. of N. W. of Sec. 25, on the old Newlin place, there is said to have been found two large detached blocks of cannel coal, containing about 8 cubic feet each. At this point, close to the house, there is said to be 2 ft. of caking coal, which a short distance below is reduced to 1 ft. In the N. E. of S. E. of Sec. 24 Mr. Sutton is mining coal on the W. M. Shoal land. The coal is about 20 ft. above Sugar creek on Kellar branch and averages 1 ft. 10 in., with 1 ft. 2 in. of drab shale below and 5 in. of coal below that (Fig. 138). The coal is a clean, rich looking coal. The roof is drab, sandy shale, good inside. The fire-clay is sandy. This coal will hardly pay for working except in connection with the clay or shale. Two beds of coal are reported on the Susan Porter place about 20 ft. apart, the lower bed being at the water's edge. The upper bed is said to be 10 to 15 in. thick.

Township 16 North, Range 7 West.

460. Location, etc.—This corresponds with Washington of the civic townships. It is for the most part flat or rolling, the streams not cutting deeply and rock exposures very rare. The exception to

this is in the southeastern part. The T. H. & L. R. R. crosses the southwestern corner, the I. D. & W. the northern part of the township.

461. Stratigraphy and Coals.—Exposures and information concerning the coal measures is practically confined to Secs. 23 to 28, 33 to 36. Secs. 33 and 34, however, contain the well known Sand creek coal, which has a high reputation. Mr. Warner of the Hillsdale Clay and Coal Company reports having drilled 180 ft. a mile east of Marshall, also between a half and a mile south of there with-

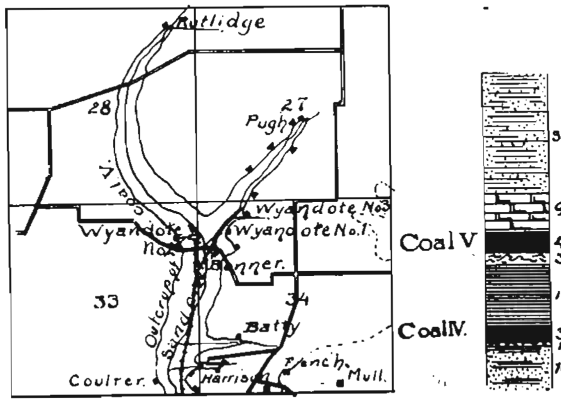


Fig. 139. Sketch map of Sand creek coal field.
Fig. 140. Columnar section of Sand creek coal field.

out finding any coal. The indications along Sugar creek to the north and Sand creek to the south suggest that the sections not included in the above number are probably underlain by two horizons at least, at which workable coal may be found, but that in this area the conditions were not favorable to the laying down of extensive basins of workable coal or to their preservation if laid down. The evidence indicates the presence of basins of workable coal in the sections not given above, at depths of less than 150 ft., but it also indicates that such basins will probably be small and detached, with considerable areas between of thin coals or no coal. We may then confine ourselves to the sections mentioned: Secs. 23-28, 33-36. The coals of these sections occur at three horizons corresponding to the Horizons V, IV and I of the preceding part of the report. The section along Sand creek varies considerably. The following section by Mr. Cox is probably as nearly normal as can be given:

462. SECTION 75. SECTION ON SAND CREEK.—Fig. 140 (E. T. C., '72, p. 17).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and clay............	8	0	..	..	8	0
2.	Drift	26	0	..	..	34	0
3.	Sandy shale with some flag	30	0	..	..	64	0
4.	Limestone	9	0	..	..	73	0
5.	Bituminous shale	..	6	..	..	73	6
6.	COAL V	4	6	4	6	78	0
7.	Fire-clay	3	0	..	..	81	0
8.	Bluish argillaceous shale...	15	0	18	0	96	0
9.	COAL IV	3	9	3	9	99	9
10.	Fire-clay	9	0	..	..	100	9
11.	Shale and sandstone......	10	0	..	..	110	9

The space between the two coals varies from 9 to 28 ft. The sandy shale No. 3 appears to be largely replaced by a massive sandstone which lies unconformably on the limestone and coal. In places the limestone has been removed and only shale separates the sandstone from the coal. Again the shale is gone and the sandstone lies directly on the coal, while in the S. W. ¼ of Sec. 27 only scattered fragments in the sandstone tell of the former existence of the coal.

As showing the variations here may be given the following borings, of which records were kindly furnished by Mr. Duncan McCullum:

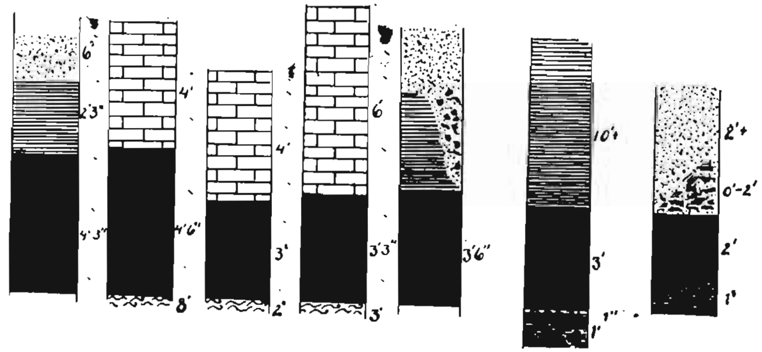
463. SECTION 76. SECTION ON SAND CREEK.—

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface and clay...........	8	0	..	..	8	0
2.	Clay and sand.............	9	0	..	..	17	0
3.	Boulder clay	4	0	..	..	21	0
4.	Soft clay and sand.........	9	3	..	..	30	3
5.	Sandstone	..	..	..	..	..	..
6.	Dark blue shale with streaks of iron ore..............	13	6	..	..	43	9
7.	Iron ore	..	4	..	..	44	1
8.	COAL	1	8	1	8	45	9
9.	Blue shale	6	2	6	2	51	11
10.	COAL	1	0	1	0	52	11
11.	Fire-clay	6	0	..	..	58	11

464. SECTION 77. SECTION ON SAND CREEK.—

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	6	0	..	..	6	0
2.	Clay and sand............	11	0	..	..	17	0
3.	Boulder clay	10	0	..	..	27	0
4.	Sandstone	23	0	..	..	50	0
5.	COAL	2	0	2	0	52	0
6.	Fire-clay	5	0	..	..	57	0
7.	White clayey sandstone....	3	9	..	..	60	9
8.	Blue shale	10	0	..	..	70	9
9.	Dark blue shale............	11	0	..	..	81	9
10.	Dark gray shale...........	8	0	37	9	89	9
11.	COAL	1	4	1	4	91	1
12.	Fire-clay	..	..	..	..	..	..

Along Little Raccoon and its branches the outcrops belong to Division I. The sandstone is here 40 to 50 ft. thick, underlain by black shale and coal.



141 Harrison. Sec. 33(?). 142 Harrison, No. 2. Sec. 34. 143 Batty. Sec. 34. 144 Wyandotte, No. 2. Sec. 33. 145 Wyandotte, No. 3. Sec. 34. 146 Bonner. Sec. 34. 147 Earls. Sec. 35.

Figs. 141-145. Coal V in Sand creek district.
Fig. 146. Coal IV in Sand creek district.
Fig. 147. Coal I east of Nyesville.

465. COAL V.—This is the principal coal of the area (see Figs. 141-145). It ranges in working places from 2 ft. 6 in. to 5 ft. in thickness, without partings. In quality, it appears to be a semi-caking coal and while coal was being shipped is claimed to have commanded as high a price in Chicago as the block coal. The coal shows both face and butt slips well developed but cemented with calcite. The upper part of the coal is said to be the purest. Also the thinner coal, as usual, is purer than the thicker. The following analyses of this coal by Mr. Cox show its composition:

	Sand Creek Coal Co.		*Batty.*	
Fixed carbon	45.50		56.00	
Volatile combustible matter	45.50		38.50	
Total combustible matter		91.00		94.50
Ash	4.50		2.50	
Water	4.50		3.00	
Total waste		9.00		5.50

Two ultimate analyses of coal from the two mines of the Sand Creek Coal Company gave as follows:

Carbon	76.38	77.03
Ash	4.71	3.19
Hydrogen	4.71	5.60
Oxygen	12.32	12.64
Nitrogen	1.88	1.54
	100.00	100.00

This coal has a roof of limestone, shale or sandstone, as shown in the figures. The roof is usually good. Below the coal is from 3 to 8 ft. of sandy fire-clay.

466. Coal IV.—This is the lower coal at Sand creek. This coal approaches more nearly a block coal, being a dull black, showing the characteristic charcoal faces when split parallel to the bedding. It may be blocked near the outcrop, but requires the use of powder farther in. The coal shows no partings or free coal, though the top 6 in. is softer than the rest (see Fig. 146). The roof at the only opening at work is a gray shale changing to blue at the bottom, with lenticular masses of sandstone at the top of the coal which tend to come down. Below the coal is 1 in. of fire-clay, then 1 ft. of bone coal. Drilling on the Harrison place is said to have shown this bed to run between 3 and 4 ft., but to have a 2 in. band of very hard gray shale in the center. This did not show where the coal was examined.

467. Coal along Little Raccoon Creek.—This coal underlies massive sandstone, but whether it is the sandstone of Division I or the sandstone which overlies unconformably Coal V on Sand creek and which was noted there attaining a thickness of 30 ft. or more was not determined. The question not having arisen when this coal was examined, it was assumed that it belonged to Division I and that view will be taken here tentatively. This coal was reported in thickness

up to 4 ft. Examination failed to reveal more than 2 ft. of good coal overlying from 1 to 2 ft. of bone (Fig. 147). An analysis of what is supposed to be this coal is as follows:

Fixed carbon	62.50	
Volatile combustible matter	31.00	
Total combustible matter		93.50
Ash	2.00	
Moisture	4.50	
Total waste		6.50

This coal was described by Mr. Cox (E. T. C., '69, p. 111) as from the Buchanan mine on Sand creek. In copying the analysis Mr. Hobbs assigns it to Sec. 23. As Mr. Buchanan has a mine in Sec. 23, while no such mine is reported on Sand creek, Mr. Hobbs's location is assumed as correct. The roof of this seam varies, in places being a conglomerate which tends to come down, while in places it is probably shale or sandstone, and better. The above analysis shows this coal to contain a very high percentage of fixed carbon. It is a semi-block, showing both slips fairly regular, and semi-caking, swelling a little in burning, but not enough to make good coke.

468. Distribution of Coals in Secs. 23-28, 33-36.—Along Little Raccoon creek are numerous exposures of the Mansfield sandstone (see Hopkins), but coal was only noted at two places. On a branch southwest of Judson, where it has been worked on the Buchanan place at the section line between Secs. 23 and 26, and north of there up the same ravine. At Buchanan's the coal is worked by a drift, is 2 ft. thick on an average, with 5 to 6 ft. of sandstone and clay over, making a bad roof. Under it is 2 ft. of bone, then 2 ft. of clay shale, then fire-clay. The coal in quality is as described above. The coal up the creek is reported 4 ft. thick, but that includes the bone as well as the good coal. Down the branch and about 15 ft. below the Buchanan coal is reported a 6 in. bed of coal under shale. This suggests that the Buchanan coal is Coal V.

On the Adam Earl place in N. W. of N. W. of Sec. 35 the same coal has been worked a little. The coal is 2 ft. thick, overlain with sandstone or locally with a conglomeritic mass of shale and coal in a matrix of sandstone. Beneath the coal is one foot of bone (Fig. 147).

Coal has been mined in the S. E. ¼ of Sec. 34, on the Mull place; also in the S. E. of S. W. of Sec. 34 by the French Mining Company. In the S. W. of S. W. of Sec. 34 some coal is mined at the old Harrison mine, Coal V. The coal is here from 3 ft. 8 in. to 5 ft. thick to the south, but to the north will run about 2 ft. 7 in. Limestone overlies coal, but in drift No. 2 is replaced by sandstone a short distance in. This coal has the slips 2 ft. 6 in. to 3 ft. apart, both sets developed, but cemented with calcite. The top 15 in. to 2 ft. is the brightest and best coal, the sulphur occurring in the lower part, in chunks. Coal IV is here 24 ft. below this bed. This bed overlies 7 or 8 ft. of sandy fire-clay.

Just north of these openings a short distance is the Batty mine. Here the coal averages 3 ft., but running up to 4 ft. The coal here is generally reported as the best in this region. (See analysis and Fig. 143.) This is one of the oldest, if not the oldest mine, on Sand creek, having been opened in 1855. The roof is limestone 4 ft. thick, the floor dark drab fire-clay 2 ft. thick. At the old tipple the lower seam is 28 ft. below this one, while at the lowest part of the mine they are only 9 ft. apart.

In the S. E. ¼ of Sec. 33, west of Sand creek, is the old Coulter slope. In the S. W. of N. W. of Sec. 34 Mr. Bonner is mining Coal IV, which is there just at the level of the creek bottom. This was in 1897 the only mine here working Coal IV. The coal was described above in ¶476, Fig. 146.

In the N. E. of N. E. of Sec. 33 is the Wyandotte No. 2 mine, one of the old Sand Creek Coal Company's openings. This is the only shipping mine here at present (1897). At the entrance the coal measures 3 ft. 3 in., overlain by 6 ft. of fossiliferous limestone and underlain by 3 ft. of drab fire-clay. Face slips have direction N. 20° W. The slips are tight with calcite, but by the aid of powder the coal may be blocked out along slips. At places the limestone is underlain by black shale. A short distance in the mine the limestone is replaced by sandstone, which is said to make as good a roof as the limestone, but the coal under it carries more sulphur.

In the N. W. of N. W. of Sec. 34 are Wyandotte Nos. 1 and 3. At the latter the coal is 3 ft. 6 in. thick, with a drab shale roof, above which is yellow coarse-grained sandstone. At the entrance to this mine a channel has been cut out of the shale and filled with the sandstone, which acts as a matrix for a conglomeritric mass of coal and shale (Fig. 145). Up this same fork a short distance in the S. W. of S. W. of Sec. 27, the section shows (Sect. 78):

		Ft.
1.	Massive yellow sandstone	10
2.	Hidden	3
3.	Gray shale	6
4.	COAL V	2
5.	Gray shale and hidden	12

A quarter of a mile further up the massive sandstone shows a thickness of about 30 ft., the lower 8 ft. being shelly with patches of shale and irregular masses of coal (see Fig. 14 of Part I).

In about the center of Sec. 27, 3 ft. of coal shows on John Pugh's place just at drainage level. Sandstone overlies the coal, which would seem to be Coal V. Coal is also worked a little in the N. E. of N. E. of Sec. 28 by Peter Rutledge.

Township 15 North, Range 7 West.

469. Location, etc.—This township includes the eastern two-thirds of Adams of the civic townships. The township is considerably

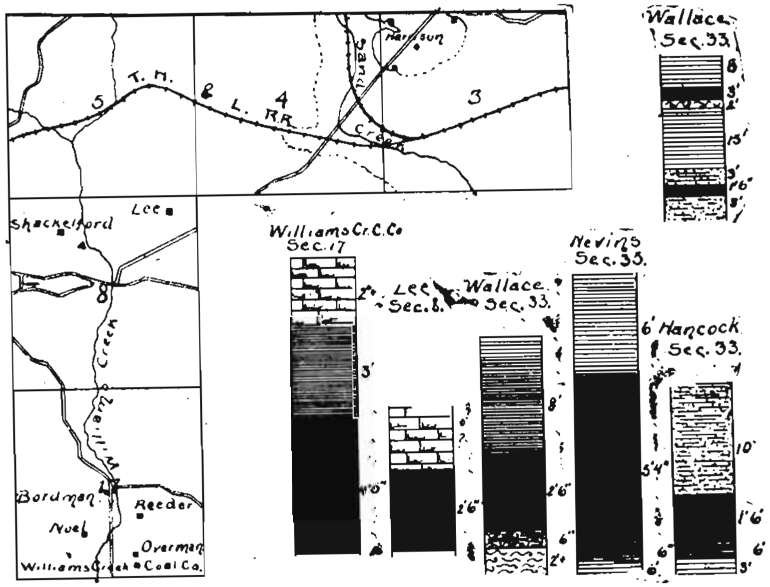


Fig. 148. Sketch map of part of northern sections of T. 15 N., R. 7 W.
Fig. 149. Section at Wallace bank, Sec. 33.
Figs. 150-154. Coal sections, T. 15 N., R. 7 W.

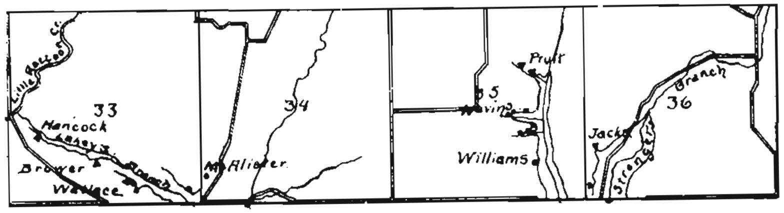


Fig. 155. Sketch map of part of southern sections of T. 15 N., R. 7 W.

cut up by Little Raccoon creek and its tributaries. Only a limited number of exposures were observed. The C. & S. E. R. R. crosses this township from north to south, the T. H. & L. R. R. crosses the north and west sides of the area.

470. STRATIGRAPHY AND COALS.—This township appears to be much like the preceding in its stratigraphy and coals. In the northern part the sections are essentially similar to those about Sand creek. The following section was obtained in Sec. 33 along Lakey's branch.

471. SEC. 79. SECTION ON LAKEY'S BRANCH.—Sec. 33, Fig. 149.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Limestone, not seen in place	..	..	..	..	..	..
2.	Light drab clay shale	8	0+	..	..	8	0
3.	COAL V ....2 to	2	6	2	6	10	6
4.	Coal shale, and pyrite	..	6	..	..	11	0
5.	Light drab fire-clay	2	0	..	..	13	0
6.	Gray shale, in places thin beds of sandstone	15	0	..	..	28	0
7.	Gray sandy shale	3	0	20	6	31	0
8.	BONE COAL	..	10	0	10	31	10
9.	Black bituminous shale with streaks of coal	9	0	..	..	40	10
10.	Drab fire-clay with streaks of coal	1	0	..	..	41	10
11.	Gray shale	3	0	..	..	44	10

Further down Nos. 7 to 11 appear to be replaced by the following:

	Ft.	In.
Light drab sandy shale	10+	0
COAL IV	1	6
Dark bituminous shale	..	6
Gray shale with sandstone bands	3	0
Shaly sandstone	2	0

472. COAL V.—This coal here is much the same as on Sand creek. A parting 2 ft. from the bottom is reported occasionally. As on Sand creek, the top is usually the best coal. It is overlain by limestone, sometimes immediately, sometimes up to 12 ft. of shale comes between the coal and the limestone. The limestone makes a good roof, the shale usually a poor roof.

473. COAL IV.—No note of this coal was made in the northwestern part of the township. Elsewhere it appeared to be thin or only represented by black shale except in Sec. 35, where the section in Fig. 153 was obtained. The details were not determined at that point, but it was reported all good coal. An analysis of this coal by Mr. Cox gave as follows:

Fixed carbon	48.50	
Volatile combustible matter	42.50	
Total combustible matter		91.00
Ash, white	1.00	
Moisture	8.00	
Total waste		9.00

This shows an excellent quality of coal.

474. DIVISION I.—Consists as usual of Mansfield sandstone with some coal below. None of this coal has been seen, though it has been worked a little at several places. It is usually reported as pockety and too thin to pay to work, except in a very small way.

475. DISTRIBUTION OF COAL IN SECS. 3, 4, 5, 8 AND 17.—In the N. E. of N. W. of Sec. 3 Coal V has been mined a little, but not of late years, probably mined out. In the S. W. of N. W. of Sec. 3 a small drift on the outcrop of Coal V was being started in 1897. In the N. W. of N. W. coal has been extensively mined on the Harrison place. See section, Fig. 141. Coal IV is 15 ft. below here, or about on a level with the bottom of Sand creek.

In the N. E. of N. E. of Sec. 8 Coal V is being worked on the Lee place by Walker & Co. The coal ranges from 2 ft. 4 in. to 3 ft. 6 in., averaging about 2 ft. 6 in. (see Fig. 151). It has limestone over, which makes a good roof. Fire-clay below. Requires powder to mine. Mined by shaft 36 ft. deep to reach coal, which is just about at level with Williams creek. At an outcrop in the creek the coal runs from 2 ft. 3 in. to 3 ft. thick. In the N. E. of N. W. of Sec. 8, Coal V was formerly reached by an 80 ft. shaft on the B. W. Shackleford place.

Going down Williams creek, the coal keeps near the creek level in Sec. 17. It is now being worked by a slope by the Williams Creek Coal Company in the S. W. of S. E. of Sec. 17. The coal there ranges from 4 ft. to 5 ft. 4 in., with an average of about 4 ft. 5 in. The roof is a gray shale 3 to 12 ft. thick, overlain by limestone, and is very poor. In places the limestone comes down on the coal. Fire-clay below coal. Top is rich, good coal, bottom contains some sulphur. In places there is a parting of sulphur and dirt 2 ft. from the bottom.

Coal is worked here winters on the John Neal and Bordman places, and was formerly mined on the Reeder place. The coal is said to run to a crop in the Williams Coal Creek Co.'s mine, except to the northwest.

476. Distribution of Coal in Secs. 33-36.—In Sec. 33, the section along Lakey's branch was given in ¶471. The lower coal outcrops near drainage level on the T. J. Hancock place, N. W. of S. W. of Sec. 33 and on the P. Brewer place, S. W. of S. E. of Sec. 33. On the John Wallace place, S. E. of S. E. of Sec. 33, the upper bed, supposed to be Coal V, has been drifted upon. It is here some 18 ft. above the creek. At one opening it measured from 2 ft. to 2 ft. 6 in., with 6 in. of coal, shale and sulphur below, in places. The roof is a light drab clay shale that does not look as though it would stand well if wet. Fragments of limestone noted near the mouth of one of the entries suggested the presence of that bed above the coal, but it was not seen in place. These drifts are in a syncline or basin, and the coal in the center may be thicker than that measured. Just west of where the railroad crosses the wagon road this coal is just on a level with the railroad, and is reported to run from 0 to 3 ft. thick. On the Mary McAlister place, S. W. of S. W. of Sec. 34, a 50 ft. drilling is reported to have gone through 4 or 5 ft. of coal at a depth of 33 ft., shale being encountered all the way to the coal.

In Sec. 35 Coal IV? is at drainage level and has been extensively stripped on the Pruitt place, S. W. of N. E. Coal was not seen, but the roof seemed to be a reddish brown fissile shale. In the N. W. of S. E. of Sec. 35, on the Jackson Nevins place, the coal is several feet above the branch and has been drifted upon at several places. The section there showed (Sect. 80, Fig. 153):

		Ft.	In.
1.	Gray shale	3	0
2.	Drab shale	6	0
3.	COAL IV?	5	4
4.	Black shale	..	6
5.	Shale into gray shaly sandstone	6	6

In the S. E. of S. E. of Sec. 35, on the Williams place, the same coal exposed a thickness of 4 ft., but of very poor quality on the crop. It was overlain by light drab shale.

In the S. W. of S. W. of Sec. 36 this coal has been stripped a little at a couple of places, but is thin.

The evidence, while showing fairly thick coal at several places, does not give much warrant for believing that large basins exist in this area.

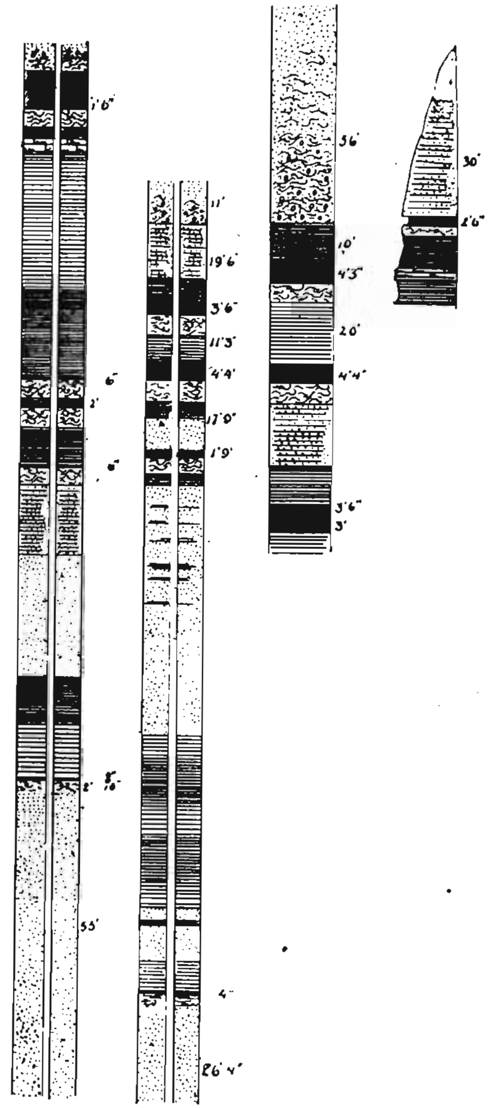
477. Distribution of Coal over Rest of the Township.—It is only fair to suppose that small basins of workable coal may yet be found in this township in addition to those already mentioned, but the evidence is not very strong in that direction. The horizon of the lowest workable coal is above drainage in the northeast corner of the township, and along Leatherwood creek in Secs. 15, 22, 14 and 23, and not far below the level of Little Raccoon creek probably in any part of the township, so that the fact that more workable coal has not been found does not augur well for much of it being found in the future. Coal IV? has been found on the Wilkinson place, S. E. of N. W. of Sec. 12. The coal is reported 2 ft. 6 in. thick, but bony. Below this is 20 to 30 ft. of sandstone of Division I, the lower two or three feet being full of sheets of coal. Below that is 10 to 12 ft. of drab shale. On Leatherwood creek is an exposure of Mansfield sandstone. Though not seen, coal is reported to have outcropped and to have been mined under this sandstone on the Nevins place in the S. W. of S. W. of Sec. 14, and Lee Overpeck place in the N. E. of N. W. of Sec. 23. Claimed to have proven to be only in small pockets. In the S. W. of S. E. of Secs. 23, on the Overpeck place, a drilling is reported as going 100 ft. through drift into 1 ft. of sandstone, then 1 ft. of coal with fire-clay below.

At Rockville a well was drilled 2,100 ft. to Trenton rock; the upper part of this well was as follows:

	In.
Drift	96
Gray sandstone	44
Brown shale, bottom of coal measures?	25
White sandstone	110
White shale	25
Black shale	105
White sandstone	50
Limestone	170

Township 14 North, Range 7 West.

478. Location, etc.—This township corresponds with Raccoon of the civic townships. The broad valley of Big Raccoon crossing the center of the township and of Little Raccoon crossing its northwestern corner with the intermediate and adjacent area flat or rolling, are its main topographic features. The C. & S. E. R. R. crosses the township from north to south in the center; the T. H. & L. R. R. touches the northwestern corner.



156 Minshall, No. 1. Sec. 17. — 157 Minshall, No. 3. Sec. 8. — 158 Superior, No. 2. Sec. 35. — 159 Outcrop at Minshall. Secs. 7 and 8.

Figs. 156-159. Columnar sections, T. 14 N., R. 7 W.

479. Stratigraphy.—The coal data here occurs in three comparatively isolated areas. In the northeastern corner of the township, in the valley of Little Raccoon creek, and in the valley of Otter

creek. In the last named area the section is similar to that in northern Clay county, the type area. A section typical of this area would be as follows:

480. Section 81. Section of Superior No. 2 Shaft.—Sec. 35, Fig. 158.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	60	0	..	..	..	..
Division V—						
2. Black shale ......5 ft. to	10	0	..	..	70	10
3. COAL V ....4 ft. to	4	6	4	6	75	4
4. Clay ....4 ft. to	5	0	..	..	80	4
Division IV—						
5. Shale	15	0	20	0	95	4
6. COAL IV	4	4	4	4	99	8
7. Fire-clay ....4 ft. to	5	0	..	..	104	8
Division III—						
8. Sandy shale	16	0	..	..	120	8
9. Brown shale ....10 ft. to	12	0	33	0	132	8
10. COAL III	3	6	3	6	136	2
11. Fire-clay ....1 in. to	..	2	..	2	136	4
Division II—						
12. COAL II bone...........	2	4	2	4	138	8
13. COAL II good...........	..	8	..	8	140	4
14. Shale	..	..	..	..	..	..

The limestone over Coal V does not appear in this section, but occurs abundantly a mile down Otter creek across the Clay county line. In the shaft of Superior No. 1 Mr. Zellar says that between Coals V and IV the section was (Sect. 82):

	In.
1. COAL V	..
2. Blue shale	18
3. Limestone	2
4. Blue shale	14
5. COAL IV	5

At Minshall, in Secs. 7 and 8, the following section shows in the bluff:

481. Section 83. Section of Bluff at Minshall.—Sec. 7, Fig. 159.

	Ft.	In.
1. Fake	30	0
2. COAL	2	6
3. Fire-clay	2	0
4. Blue shale	8	0
5. Limestone	2	6
6. Drab shale	6	0

The position of this limestone is of considerable importance, as it appears to be the limestone met all through northern Parke and southern Fountain counties. Two deep drillings have gone entirely through the coal measures.

482. SECTION 84. SECTION OF DIAMOND DRILLING NEAR SHAFT No. 7.—Sec. 17, Fig. 156.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	4	0	..	..	4	0
2. Fire-clay	3	0	..	..	7	0
3. Black shale	8	0	..	..	15	0
4. COAL	1	6	1	6	16	6
5. Fire-clay	4	6	..	..	20	0
6. Black shale	2	6	..	..	23	6
7. Blue limestone	3	0	..	..	26	6
8. Light clay shale	9	6	..	..	36	0
9. Gray shale	24	0	..	..	60	0
10. Dark blue shale	23	6	67	0	83	6
11. COAL	0	6	0	6	84	0
12. Fire-clay	3	6	..	..	87	6
13. Black shale, coal mixed	2	0	..	..	89	6
14. Fire-clay	4	6	..	..	94	0
15. Black shale	9	0	19	0	103	0
16. COAL	0	6	0	6	103	6
17. Fire-clay	4	0	..	..	107	6
18. Gray sand shale	5	0	..	..	112	6
19. Blue sand shale	12	6	..	..	125	0
20. Gray sandstone	31	0	..	..	156	0
21. Black shale	12	0	..	..	168	0
22. Dark blue shale	13	6	78	0	181	6
23. Soft coal	..	8	..	8	182	2
24. Fire-clay	2	10	..	..	185	0
25. Gray sandstone	55	0	..	..	240	0
26. White limestone	76	0	..	..	316	0
27. Gray sandstone	5	0	..	..	321	0
28. White limestone mixed with clay shale	49	0	..	..	370	0
29. White crystallized limestone	70	0	..	..	440	0
30. Dark brown sand shale	6	0	..	..	446	0
31. White limestone	10	0	..	..	456	0
32. Dark blue sand shale	10	0	..	..	466	0
33. White crystallized limestone	24	0	..	..	490	0
34. Dark gray sandstone	6	0	..	..	496	0
35. Limestone	2	0	..	..	498	0
36. Gray sandstone	113	0	..	..	611	0

This section goes well into the Lower Carboniferous, the bottom of the coal measures being just below either No. 24 or 25. I am disposed to say the former and to consider the sandstone of No. 25 as of

Kaskaskia age. That, however, would imply an unusual thickness for that formation for this region, so that such a correlation must be considered doubtful. This shows two small coals below the limestone.

483. SECTION 85. SECTION OF BORE NEAR MANWAY OF SHAFT No. 3.—Sec. 8, Fig. 157.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface, sand	11	0	..	..	11	0
2. Sandstone and fake	13	6	..	..	24	6
3. Blue shale	6	0	..	..	30	6
4. COAL V?	3	6	3	6	34	0
5. Fire-clay	5	0	..	..	39	0
6. Dark gray shale	6	3	11	3	45	3
7. COAL IV?	4	4	4	4	49	7
8. Hard fire-clay	5	3	..	..	54	10
9. Light gray shale with streaks of sandstone	4	0	..	..	58	10
10. Hard coarse sandstone	4	2	..	..	63	0
11. Light gray sandstone	4	4	17	9	67	4
12. COAL III?	1	9	1	9	69	1
13. Fire-clay	3	6	..	..	72	7
14. Light gray shale	2	8	..	..	75	3
15. Sandstone with streaks of white shale	30	0	..	..	105	3
16. Hard white sandstone	33	0	..	..	138	3
17. Light blue sandy shale	25	4	..	..	163	7
18. Gray shale changing to blue	18	6	..	..	182	1
19. Gray sandstone	5	4	..	..	187	5
20. Gray shale	1	0	..	..	188	5
21. Gray sandstone	9	2	..	..	197	7
22. Dark gray shale	7	8	136	2	205	3
23. COAL I?	0	4	0	4	205	7
24. Black shale conglomerate	3	8	..	..	209	3
25. Gray sandstone	26	4	..	..	235	7
26. Hard flinty conglomerate full of little pebbles	16	6	..	..	252	1
27. Light gray limestone	14	3	..	..	266	4

No limestone shows at the top of this section, so that there arises the question, Does Coal No. 4 of this section correlate with Coal No. 4 of the previous section, and that with the coal outcropping above the limestone in the creek bank above Minshall? (The conditions were not as carefully examined as could be desired, as the importance of the question was not appreciated at the time, but it seemed to us that Coal IV of this section came below the limestone No. 7 of Section No. 84, and either is not represented in that section, or it may be represented by Coal No. 11, if the black shale and coal mixed, No. 13, be considered the equivalent of No. 7 of this section.) In that case the limestone would be the limestone above Coal V, and the coal at Rockville, Sand creek, Yeddo, Silverwood, etc., would be Coal V as assumed in the report. This further implies the absence of Coal III over all that territory, indicating an overlap during the coal measures. It must be acknowledged, however, that the proofs of this are far from conclusive, the evidence at many points suggesting strongly that the first coal below the limestone is Coal IV. The balance of evidence seemed to favor the other theory.

On account of the differences in the coals of the three areas mentioned above, it will be convenient to divide the discussion up accordingly. The township will, then, be discussed by quarters, beginning with the N. E. ¼, Secs. 1-3, 10-15.

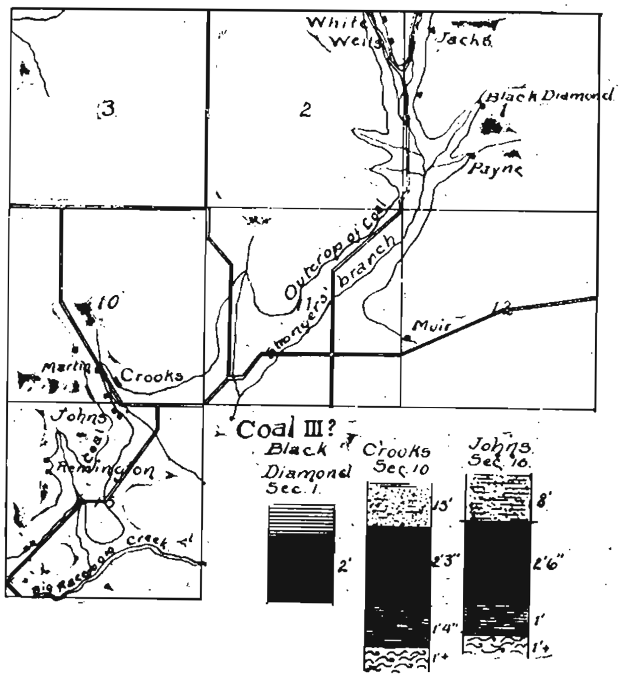


Fig. 160. Sketch map of N. E. part of T. 14 N., R. 7 W.
Figs. 161-163. Coal sections in N. E. part of T. 14 N., R. 7 W.

484. COAL IN SECS. 1-3, 10-15.—There appear to be three coals in this area, corresponding to I, III and IV, or IV and V. The lower of the two upper coals is the only one worked. In its structure it resembles Coal III of the type area. It and the coal above, however, are thought to correspond with the coals about Minshall which have

provisionally been called Coals IV and V, so that those numbers will be used to designate them here. The outcrops of Coals IV and V, as thus understood, occur along Stronger's branch or its tributaries. As shown in Figs. 161-163, Coal IV is usually represented by from 2 ft. to 2 ft. 6 in. of good coal with a foot or more of bone coal below. The roof ranges from shale to shaly sandstone. It appears to be a block or semi-block coal, and as a rule has a good reputation. It may be doubted if it can be found of sufficient thickness to work on a large scale. The upper bed has been worked in one or two places, but was not well exposed. At the Remington bank it showed a thickness of at least 2 ft., with a blue shale roof. Along Stronger's branch Coal IV seems to be above drainage along its whole course in this township, occasionally rising 10 to 20 ft. above the creek. Coming down the creek in the N. W. ¼ of Sec. 1, an outcrop is noted near the township line on the Jacks place, then below a short distance the Mansfield sandstone shows an exposure of massive stone 10 to 15 ft. thick. Further down, near the half-mile line, the sandstone just shows in the branch bottom, with this section above (Sect. 85):

		Ft.	In.
1.	Slope of hill	50	0
2.	Shaly sandstone and fake	8	0
3.	Fake	1	0
4.	Black bituminous shale, jointed	..	6
5.	COAL IV	..	10½
6.	Drab to gray sandy shale running into sandstone at the bottom	8	0

Along the branch that enters from the northwest Coal IV is exposed at two places. On the Mathew White place, the good coal is 2 ft. thick, with sandy shale above and bone below. The coal is here just above drainage. On the Wm. Wells place the coal is 15 ft. above drainage. The coal shows a thickness of 2 ft. 6 in. up to 3 ft. in the few feet the drift has yet gone. But the coal appears to be disturbed and may not retain that thickness. The roof is shale, resembling fake; below is 6 in. to 1 ft. of fire-clay, then massive sandstone as in the main fork in Sec. 1. A little coal has been dug at both these places. A quarter of a mile below the section given above the strata rise again, exposing 15 ft. or more of massive Mansfield sandstone. Up two branches from the northeast, coal has been worked a little on the Payne place and was being worked in 1897 on the Wilson place (Black Diamond mine), S. E. of N. W. of Sec. 1. At the latter place the coal is at drainage or below. It measured 2 ft. in the entry and is reported as 2 ft. 6 in. through most of the mine. It appeared to have open clay slips, and appeared to be a true block coal. Reports give it a good name; the roof is a brown clay shale.

In the N. W. of S. W. of Sec. 12, coal is reported to have been worked on the Wm. Muir place; being 2 ft. 6 in. thick, with bone below.

Openings have been made to this coal in the S. W. of S. E. of Sec. 10, on the Wm. Crooks place, where it measured 2 ft. 3 in. with 15 ft. of yellow to drab shaly sandstone above, making a good roof, and 1 ft. 4 in. of bone below, with 1 ft. of drab fire-clay still below (see Fig. 162). It has also been opened up by Mr. John Johns in the N. W. of N. E. of Sec. 15. It measured 2 ft. 3 in. in thickness, and appears more like a rich caking coal than a block (see Fig. 163). It is overlain by 8 ft.+ of drab to yellow sandy shale and underlain by 1 ft. of bone, then by a drab fire-clay. Coal is also reported to have been found on the Martin farm and other places up this hollow.

In the S. E. of N. W. of Sec. 15 Coal V was formerly mined on the Remington place. This coal appeared to be 20 or 30 ft. above Coal IV. Only 2 ft. of coal was exposed, with a little blue shale for a roof, with boulder clay above that. In the S. W. ¼ of Sec. 15 Coal IV has been dug into at a number of places, but was not exposed when visited. The coal here lies about 10 ft. above the bottom of Big Raccoon. Between two places, not far apart, where coal has been dug, a 15 ft. bluff of yellow sandstone appears to occupy the horizon at which coal is mined a few rods on either side. At the eastern of these two places the coal appears to have had over it a yellow sandstone somewhat similar to that in the bluff, otherwise the position of the coal would indicate it rose over the sandstone of the bluff. It leaves in doubt whether the sandstone of the bluff belongs to Division I, but we are inclined to think it does. An outcrop was reported on the south side of Big Raccoon creek on the Jas. Miller places in Sec. 13 or 14.

The sandstone of Division I has already been referred to as outcropping at various points along Stronger's branch and probably across Raccoon creek from Bridgeton. A boring by Mr. C. Caldwell, described as "at Bridgeton, north side, in bottom of stream; crossing of North and South Railroad (C. & S. E. R. R.)," appears to have found Coal I. It is as follows:

485. SECTION 86. SECTION IN RACCOON CREEK BOTTOM AT BRIDGETON.—(B. C. H., p. 376).

		Ft.	In.
1.	Drift	8	0
2.	Gray boulder clay	5	0
3.	"BLOCK COAL"	2	6
4.	Fire-clay	..	6
5.	"BLOCK COAL"	2	6
6.	Fire-clay	10	0
7.	Shale	1	2
8.	Fire-clay	1	0
9.	Sandstone, gray	1	0

It is hardly necessary to say that this section is not corroborated by external evidence.

Another boring by Mr. Caldwell, "one and a half miles north of Bridgeton," gave as follows:

486. SECTION 87. SECTION ONE AND ONE-HALF MILES NORTH OF BRIDGETON.—(B. C. H., p. 376).

		Ft.	In.
1.	Surface drift	2	0
2.	Boulder clay	3	0
3.	Fire-clay	10	0
4.	Clay shale, sandstone and shale	4	0
5.	Dark shale	3	0
6.	Streak of burnt coal, sandstone, dark shale and shale	20	6
7.	Yellow sandstone	5	6
8.	Blue sandstone with streaks of shale	2	0
9.	Gray sandstone	5	0
10.	White limestone	..	3

487. COAL IN SECS. 4-9, 16-18.—The information from these sections practically comes from Secs. 5, 8 and 17. At least four coals underlie or outcrop in this area, as shown in the columnar sections given above. Of these the principal coal occurs a short distance below the limestone and is apparently the same as the main coal at Sand creek. It is being mined at the McIntire bank, in the N. E. of N. W. of Sec. 5. It there ranges from 5 to 6 ft., with an average of 5 ft. 6 in. (Fig. 167). It shows a knife-edge parting 2 ft. from the bottom. This is a semi-block coal, the face slips showing the full depth of the coal, the butt slips being less regular. They are tight, cemented with calcite and require the use of powder in mining. The coal is dull black in color, with some bright streaks, and shows some sulphur. The roof is a black sheety shale 3 to 12 ft. thick, overlain by limestone. It makes only a fair roof, requiring close timbering, a few

inches always coming down. The coal here is estimated to be some 20 ft. below the bottom of Little Raccoon creek. The coal is said to be all right to the west and northeast and to improve to the northwest. Whether this is only a pocket or part of an extensive basin cannot be told as yet. It was formerly mined by Mr. Beal in the N. W. of N. E. of Sec. 5 by a shaft 30 or 40 ft. deep. Outcrops of coal were reported at a number of places in the S. ½ of Sec. 5. In the S. W. 40 of Sec. 8 the coal above the limestone outcrops and is worked by Mr. Gatt for local trade. It averages there 2 ft. 6 in.,

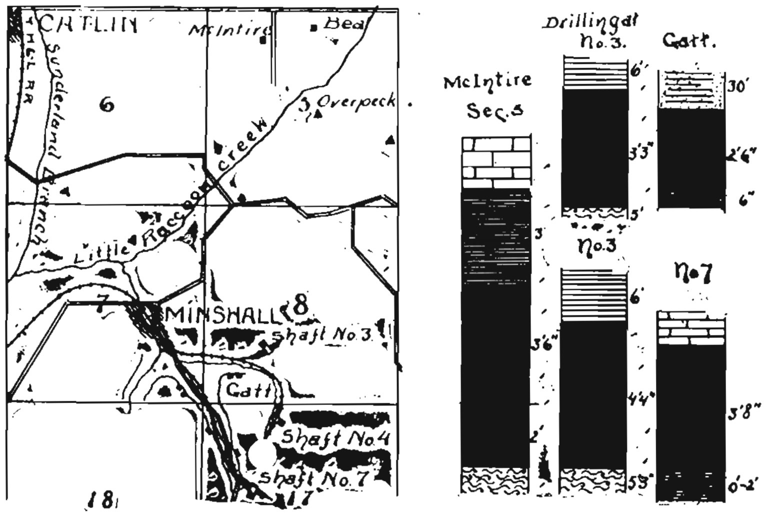


Fig. 164. Sketch map of N. W. part of T. 14 N., R. 7 W.
Figs. 165 and 166. Sections of upper coal at Minshall.
Figs. 167 and 169. Sections of Coal V at Minshall.

with 3 to 6 in. of bone below. It has a 2 in. splint in the middle and is a semi-block, with tight slips containing calcite. The roof is fake, said to be 25 to 30 ft. thick; below is fire-clay and the section given above, Fig. 166. This is said to be a non-caking coal, though a little richer than the coal about Brazil. Where exposed in the creek here the limestone is very fossiliferous and is broken by joints into blocks from 2x2½x10 ft. up to 4x2½x15 ft. This top coal has been worked on a small scale at a number of places in the banks of the ravines above Minshall. The main coal here lies at a depth of from 40 to 90 ft. below the bottoms of the drains. The known body of coal here has been worked out by the Parke County Coal Company through their shafts, Nos. 3, 4 and 7. It is described as an excellent article

of semi-block coal, ranging from 3 ft. to 5 ft. 10 in. in thickness, giving good satisfaction wherever used. It is said that in mine No. 7 the limestone came down on the coal, making the roof all over the west side of the mine; also that in places the coal is underlain by bone coal with a thickness of up to 2 ft. In No. 4 the limestone is said to have been only 10 ft. above the coal. Some drilling has been done in the neighborhood of these mines in hopes of finding other basins, but as yet without result. We are not, however, convinced that other basins will not be found adjacent to the area worked out, and should not be surprised if further exploration showed considerable workable coal in this quarter township.

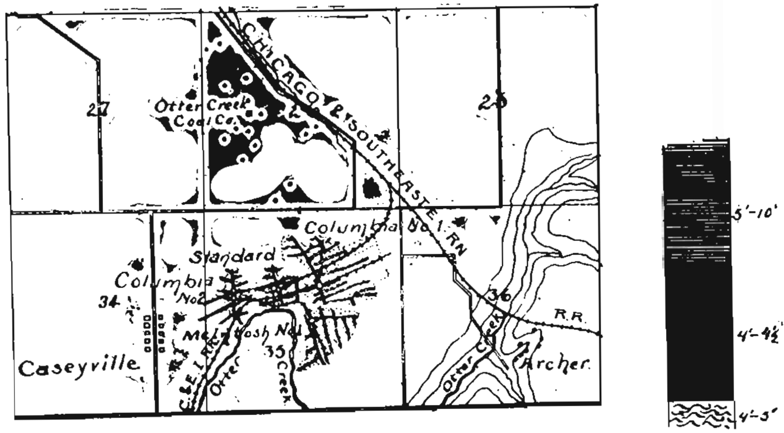
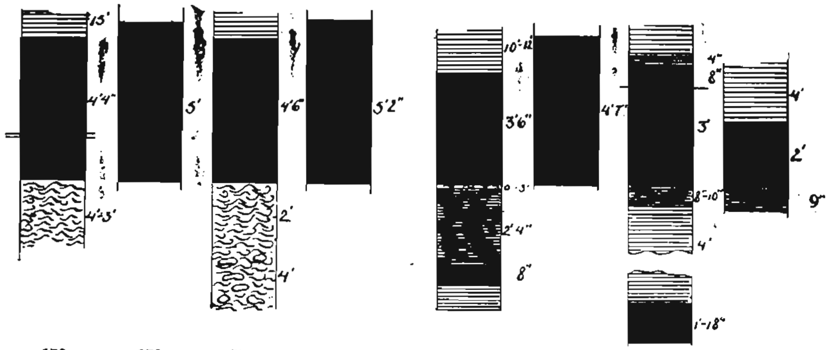


Fig. 170. Sketch map of S. E. corner of T. 14 N., R. 7 W.
Fig. 171. Section of Coal V at Columbia No. 2 mine.

488. Coal in Secs. 22-27, 34-36.—This is at present one of the most important, if not the most important, mining centers in Parke county, and it is likely to continue a large producer for many years. The three beds of block Coal V, IV and III are developed here, Coal V, however, being very limited in area. This is part of the well known Brazil block coal (major) basin. A section at Superior (or Columbia) No. 2 shaft (¶480) shows the stratigraphic relations of the beds. As noted in that section, the drift was 60 ft. deep. Coal V, though ranging from 4 ft. to 4 ft. 6 in. at Superior No. 2 shaft, was only found there on about 15 acres.

489. Coal IV.—(Figs. 172-175). This coal averages 4 ft. 6 in. in thickness, running up to over 5 ft., with a bench mining 1 ft. to 1 ft. 6 in. from the bottom. Two analyses of coal from these mines were

recently made by Mr. Noyes, though whether from this bed or the lower bed is not stated. The samples were from the (A) Columbia or Superior No. 2 mine of Teller, McCleland & Co. and the (B) McIntosh No. 1 mine of I. McIntosh & Co.



172	173	174	175	176	177	178	179
Columbia, No. 2. Sec. 35.	Columbia, No. 1. Sec. 35.	Standard. Sec. 35.	Drilling. Otter Cr. C. Co. Sec. 26.	Columbia, No. 2. Sec. 35.	Drilling. Otter Cr. C. Co. Sec. 26.	Standard. Sec. 35.	Archer. Sec. 36.

Figs. 172–175. Sections of Coal IV in S. E. part of T. 14 N., R. 7 W.
Figs. 176–179. Sections of Coal III in S. E. part of T. 14 N., R. 7 W.

	A	*B*		
Fixed carbon	52.77	51.01		
Volatile combustible matter	36.75	36.69		
Total combustible matter			89.52	87.70
Ash	3.01	4.09		
Moisture	7.47	8.21		
Sulphur	0.57	.95		
Total waste			11.05	13.25

Pounds of water evaporated per pound of coal: A, 13.4; B, 13.1.

The (A) analysis shows a higher percentage of fixed carbon than any of the other analyses made by Mr. Noyes of Indiana coal. It also leads in evaporative power, (B) not being surpassed in that respect by any of the other analyses. These analyses indicate one of the best power coals in the State. It should also serve well the other purposes of coal use. This coal does not block out as it does nearer Brazil, as in some places the slips do not show at all, and usually the slips contain calcite, being in some cases mined by shooting on the solid. This coal usually has a shale roof ranging from fair to good, though much subject to being cut out. In some cases the roof all holds up; in others as much as 6 or 8 in. comes down. The fire-clay below is 4 to 6 ft. thick, the upper 2 ft. being good, the lower part tending to be full of boulders.

490. Coal III.—(Figs. 176-179). Coals III and IV range from 30 to 50 ft. apart, the latter figure representing probably the greatest separation in the Brazil field, and occurs about a quarter of a mile north of Columbia No. 1. Where so much separated, a little bone was noted 17 or 18 ft. below Coal IV, this at first being taken to be Coal III. Coal III ranges about a foot less than Coal IV in thickness, but, as about Brazil, is of a better quality. As there, it shows a smooth parting 6 to 10 in. from the top, the coal above being softer and richer and inclined to cake in burning. The roof is generally shale and usually good. Below the coal is Coal II, usually separated from Coal III by one or two inches of clay or white shale—ranging from 0 to several feet—and consisting of bone coal underlain by good coal. At the Standard mine 4 ft. of shale is said to come between the bone and good coal. In places this bone is pure enough to be used as fuel where a large quantity of ash is no detriment. This bed is apt to be hilly, but without the coal becoming much reduced on the hills. Faults of from a few inches to 2 ft. are not uncommon in this district.

The depth of the coal at the different mines is as follows: Columbia (Superior) No. 1—Coal IV, 92 ft., coal 5 ft. thick; Coal III, 3 ft. 10 in. at 129 ft. Columbia (Superior) No. 2—Coal IV, 4 ft. 4 in. at 90 ft.; Coal III, 3 ft. 6 in. at 128 ft. Standard Mine—Coal IV, 4 ft. 6 in. at 78 ft.; Coal III, 3 ft. 8 in. at 124 ft. 6 in. McIntosh No. 1—Coal III, 125 ft. deep.

In Sec. 26 considerable drilling has been done and a shaft was started by the Watson Coal Company, but encountered a bed of quicksand which delayed the work, and the property has now passed into the hands of the Otter Creek Coal Company. These drillings show Coal IV to vary from 3 ft. 2 in. to 5 ft. 2 in. in thickness at depths ranging from 95 to about 125 ft.; Coal III varies from 0 to 4 ft. 7 in., averaging about 3 ft. 8 in. and occurring at depths of from 123 ft. to 152 ft. Toward the northwest both beds are cut out and replaced with drift, and three holes south of the center of the section show Coal IV cut out. One hole shows a combined thickness of 9 ft. 9 in. of coal.

In the S. E. ¼ of Sec. 36 both Coals IV and III are exposed on the old Archer place. Coal IV, however, was found just under the drift, and had been eroded so as not to be workable where tested. Coal III at several openings showed a thickness of only 2 ft., underlain by 1 ft. of bone and 2 in. of coal. It blocked well and appeared of good quality. Over it is 4 ft. of blue shale, then 5 ft. of fake, with a 25 to 30 ft. hill still above.

In the S. W. ¼ township no coal was reported. It is probably underlain by Coals III?, IV and V, and it is quite probable that over much of the area at least one of them reaches a workable thickness. The dip is probably quite strong, carrying them to a considerable depth, so that Coal VI is caught in the southwestern section.

Township 17 North, Range 8 West.

491. Location, etc.—This township covers most of Liberty of the civic townships, the southeastern corner being in Penn. Sugar creek crosses the southeastern corner, Rush creek runs from north to

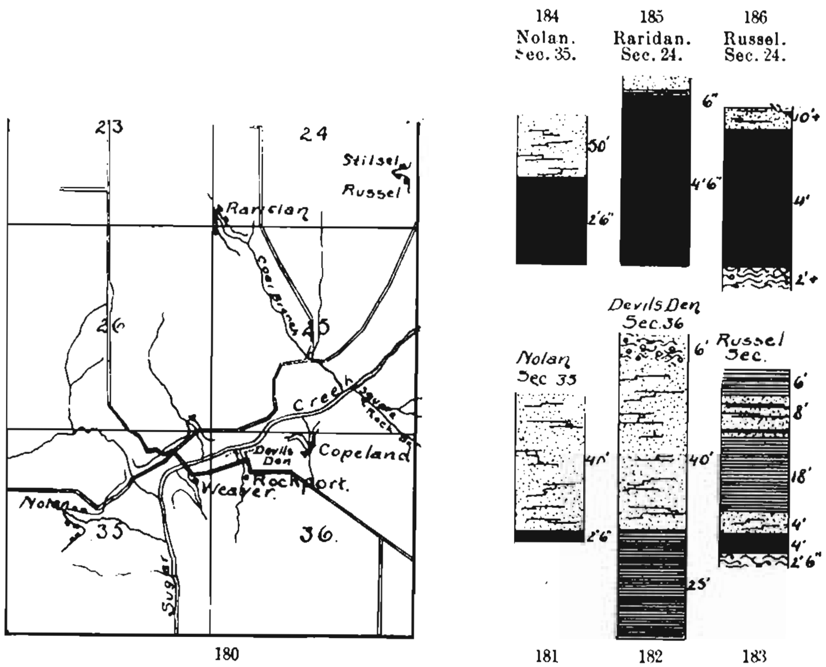


Fig. 180. Sketch map of S. E. corner of T. 17 N., R. 8 W.
Figs. 181-183. Columnar sections in S. E. corner of T. 17 N. R. 8 W.
Figs. 184-186. Coal sections in S. E. corner of T. 17 N., R. 8 W.

south through the center and Wabash Mill creek through the western part of the township. The topography is broken along the streams and rolling along the divides. As coal outcrops are very few and

scattered, so that in many cases it is difficult to correlate the coals of one area with those of another, it will be convenient to consider them by districts, based on drainage of the main streams as given above.

492. Coal Measures on Sugar Creek.—The coals in this district are comprised in Secs. 23-26, 35, 36 (see Figs. 180-186).

The coal of this district is very irregular, due apparently to this being in the path of the old Coxville carboniferous river, met with at Silverwood. Not enough detailed work was done to settle this question definitely, but from what was noted we were led to surmise that the old river channel crossed Sugar creek at Rockport. The resemblance of the sandstone filling to the Mansfield sandstone exposed both up and down the creek and the failure to find just the data needed renders this opinion somewhat doubtful. There is, however, some outside data that tend to confirm that theory; principally, that this old filled channel is plainly exposed at Silverwood, and the appearance of certain sandstones in Sec. 5 of this township indicate that the channel was not very far away. Evidences of it are next met to the southeast along the middle course of Roaring creek and in the region of Sand creek. Rockport is in the line between these places and is moreover the only place along Sugar creek where such a crossing appears to have taken place. The section at the quarry at Rockport shows:

Section 88. Section at the Quarry at Rockport.—Fig. 182 (T. C. H., p. 256).

	Ft.
Soil	2 to 6
Micaceous sandstone	40
Blue gray sandy shale	25

This sandstone interferes seriously with the development of workable beds of coal in this area, and if our surmise as to its position is correct, it may be expected to render more or less barren a broad strip of territory stretching from northwest to southeast across the township and on toward Sand creek.

Going down Sugar creek on the north side, coal is first noted on the Russel place. There the coal is 10 or 15 ft. above the bottoms and runs about 4 ft. thick. It is said to be here a good semi-block, splint coal, very hard and burning to a white ash without clinker. It has a shaly sandstone roof, serving well, and 2 ft. 6 in. fire-clay for a floor (Fig. 186). A little to the north of where it is worked by Mr. Stilsel the following section is exposed:

493. SECTION 89. SECTION ON RUSSEL PLACE.—Sec. 24-17-8, Fig. 183.

		Ft.	*In.*
1.	Hill, covered	50	0+
2.	Gray shale	6	0
3.	Sandstone and shale	8	0
4.	Dark drab shale	18	0
5.	COAL (from bed below)	..	10
6.	Yellow sandstone (roll)	4	..
7.	COAL IV (average of mine)	4	0
8.	Fire-clay	2	6
		93	4+

The sandstone lying on the coal at this point shows itself as a kind of roll, thinning out to the west, when the 10 in. feeler comes down to the main bed. The coal here appears to be above the Mansfield sandstone and rather outside the limits of the Coxville river erosion. At the immediate point of working the coal is nearly worked out, but this basin is supposed to extend northward, though how far and with what thickness is not known.

Going southwest from Russels, the foot of the bluff exposes 15 to 25 ft. of massive sandstone. Going up Coal Hollow, which flows southeast across the center of Sec. 25, is a sandstone bluff some 50 ft. high, but though in places appearing to be a solid bed, at others showing a few pieces of coal, and here and there at the same horizon enough shale to produce "rock houses" by weathering. Going up stream, the lower sandstone, apparently the Mansfield, passes below drainage, until at the section line between Secs. 25 and 24 the horizon of the few coal pieces shows a 4 ft. 6 in. coal bed. This is on Mrs. Raridon's place. Fig. 187 gives a sketch made at the mouth of the entry showing the relation of the coal and sandstone at that point. The sandstone above has a thickness of 20 or 30 ft. This sandstone is at this point very variable, at places appearing to be massive for 20 to 30 ft., in others as thin layers of sandstone and shale, and in still others as fake. The coal is a rich-looking coal, and was well spoken of by users. It has been worked by drifting and stripping many years. It would appear to be at the same horizon as the Russel coal.

Further down and about opposite the old mill at Rockport the conditions appear similar to those in Coal hollow. Strings and masses of coal occur at a horizon half way up the bluff. This is in the S. E. corner of Sec. 26. From here the horizon of the coal appears to descend until, on the W. H. Nolan place, S. E. of N. W. of Sec. 35, it is nearly down to the level of the bottom land. The coal is here from 2

ft. to 2 ft. 6 in., a dull black and full of thin scales of pyrite. The roof is sandstone, having a thickness in places of 40 to 50 ft. Figs. 181, 184. The sandstone lies irregularly on the coal, making it probable that the coal may prove much thicker in places and be cut out in others as mining progresses.

Returning up the creek on the south side, coal is met on the Weaver place, old Starkey place, in the N. E. of N. E. of Sec. 35. The coal here is about 20 ft. above the bottom, is 2 ft. 6 in. thick and has an

Fig. 187. Sketch of coal at entrance of Raridon drift. Sec. 24-17-8.

irregular roof of sandstone. It is only a few hundred yards above this to the old site of Rockport and the Devil's Den, a deep precipitous gorge cut in the sandstone. This coal has some resemblance to the coal at Nolan's, though its position would indicate it came above. Its relation to the massive bluff at the Devil's Den was not determined. Whether it dips below the sandstone or has been cut out and replaced was not worked out, but it appeared to be the latter.

In the N. W. of N. E. of Sec. 36, on the Oliver Copeland place, two beds appear, 15 to 20 ft. apart. The lower of these is about on a level with the coal at Weaver's. The upper bed measured 10 in., with drab shale and drab shaly fire-clay under. Nothing could be seen of the lower bed, which had been mined a little. It is reported 4 ft., but of little value, and, judging from the fragments of bone found around the place where worked, it would appear that the coal might have been simply bone coal. It would appear to have had a sandstone roof, with a little fissile shale between the sandstone and coal.

In the S. E. of S. E. of Sec. 25 are traces of coal in places. At one point is a thin layer of black limestone or marble, breaking into rectangular blocks. This resembles the black limestone of Warren county, which there overlies the lowest coal.

494. UP RUSH CREEK.—No coal was seen along Rush creek, whose bluffs generally show only drift, suggesting, as said above, that Sugar

creek may have formerly followed this channel from Kingman. Coal is reported as having been found on the Huxford place, in the N. E. of Sec. 33, and on the C. Farner place, in Sec. 22. Coal is also said to have formerly been gotten out 100 or 200 yds. north of the station at Tangiers, S. W. of N. W. of Sec. 15. None of these seem to have been thick enough to serve even for local supply.

495. WABASH MILL CREEK AND SOUTH.—Coal crops out on a tributary of Sugar Mill creek in Sec. 5, at what is known as the Devil's Den. Coal was reported of workable thickness here, but was not seen. Where seen the coal ranged from 6 in. to 1 ft. thick, overlain by 1 or 2 ft. of sandstone full of lenticular sheets of coal up to 3 in. thick, above which at least 2 ft. of massive cross-bedded yellow and brown sandstone is exposed. A little further down the branch the sandstone rises so as to expose the following section (see Fig. 188):

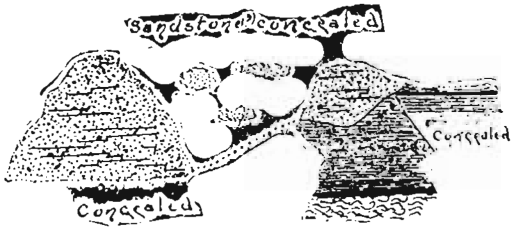


Fig. 188. Nonconformity on branch of Wabash mill creek. Sec. 5.

496. SECTION 90. SECTION NEAR DEVIL'S DEN.—Sec. 5-17-8, Fig. 188.

		Ft.	In.	Ft.	In.
1.	COAL	1?	0	1	0
2.	Blue shale	?	0	..	..
3.	Sandstone with eroded coal	3	0	..	..
4.	Gray shale	6	0	..	..
5.	Drab shale	2	6	11	6+
6.	COAL	1	0	1	0
7.	Fire-clay	6	0	..	..

Over this lies unconformably the massive sandstone as shown in figure. Coal has been stripped also further on this branch on the Milton White place in Sec. 5.

In Sec. 32, S. E. of N. W., on the Bowser place, the following section was obtained:

497. SECTION 91. SECTION ON BOWSER PLACE.—Sec. 32.

		Ft.	In.	Ft.	In.
1.	Gray to drab shale lower part shaly sandstone in places	12	0	12	0
2.	COAL Vb	1	6	13	6
3.	Gray fire-clay, gets sandy toward bottom	2	6	16	0
4.	Gray sandstone	1	0	17	0
5.	Dark blue shale with ironstone nodules	3	0	20	0
6.	Dark drab shaly limestone.....6 in. to	1	0	21	0
7.	Black sheety shale, line of ironstone nodules 8 in. from top	2	0	23	0
8.	Black fissile shale, place of Coal Va	1	0	24	0
9.	Gray to drab fire-clay	2	6	26	6
10.	Gray sandstone	2	0	28	6
11.	Drab fire-clay or shale	5	0	33	6
12.	Drab limestone or ironstone	0	6	34	0
13.	Dark blue shale black at bottom	2	6	36	6
	Place of Coal V?				
14.	Gray fire-clay to river bottom	6	0	42	6

This section agrees quite closely with the sections at Mecca and the correlations would seem to be correct. There is reported to be 4 ft. of coal under sandstone in the bottom of the old canal just west of this and at a slightly lower level.

This coal shows again in the road as it descends the bluff in Sec. 29, where it has over it 25 ft. of gray shale. It has been worked a little. A short distance below is seen the black sheety shale overlying the horizon of Coal Va.

On Jim's river in Sec. 20 the following connected section was noted (Sect. 92):

		Ft.	In.
1.	Blue to drab shale	6	0
2.	Drab, fossiliferous ferruginous limestone...4 in. to	..	6
3.	Black bituminous fissile or sheety shale...2 ft. to	2	0
4.	Bone, COAL V or Va	..	8
	Gray fire-clay	4	0

Coal Vb? is reported to have been found and worked some further up, 18 to 20 in. thick, and of good quality.

From what has been given it will be seen that the horizon of Coal VI does not occur in this township, so that workable coal must be looked for at the horizons of Coals V and IV. Both of these coals are of workable thickness at points just outside of this township, both are also of not even local importance just outside of the township; so that it would be reasonable to expect to find those coals of workable thickness over parts of the townships and of unworkable thickness over fully as much or probably more of the township. Note has already been made of the possibility of an irregular area across the township from northwest to southeast having been rendered barren by the erosion of the Coxville carboniferous river. Coal Vb may locally be workable in connection with the shale overlying it, though too thin to work alone.

Township 17 North, Range 9 West. (In Parke County.)

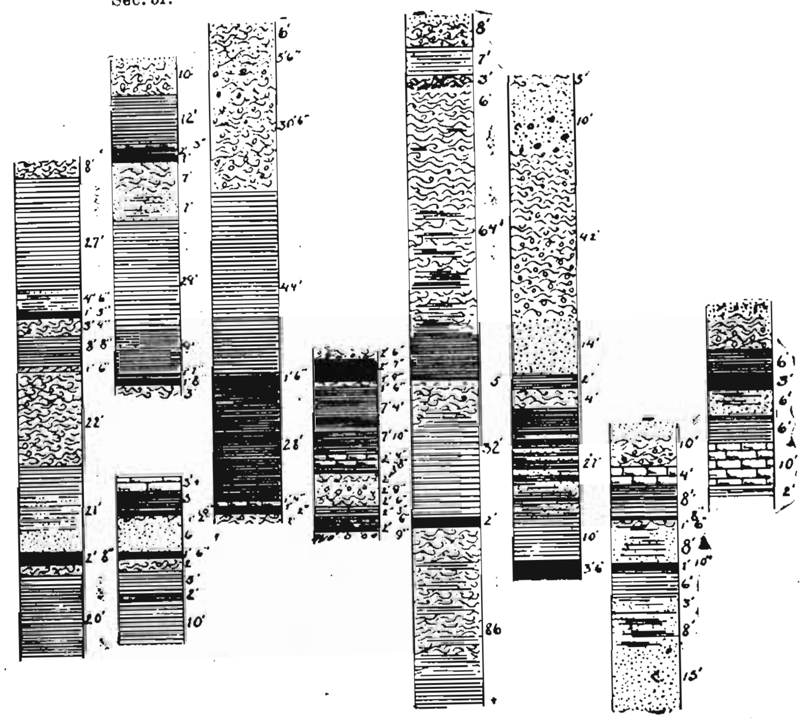
498. Statement.—Only the northeastern corner of this township is in Parke county, and as most of that is bottom land, but little coal could be found here. It is quite probable that workable coal occurs in the high land of Sec. 1 and possibly extending down into Sec. 12. Coal is reported to have formerly been stripped a little just northwest of Lodi about on the county line, and it is probable that the horizons of both Coals V and IV pass under the town of Lodi.

Township 16 North, Range 8 West.

499. Location, etc.—This township occupies most of the areas of Penn and Reserve of the civic townships, its southeastern corner being in Adams. Away from Sugar and Leatherwood creeks the surface is flat or rolling. Sugar creek, above the mouth of Rush creek, has many bluffs with good exposures. Leatherwood, for the most part, has gently sloping banks with few rock exposures. The C. & E. I. R. R. crosses the western part, the I., D. & W. R. R. the south central part of the township.

500. Stratigraphy and Coals.—As far as found, this township contains very little workable coal. Divisions VI, V, IV, III (?) and I are exposed. Much uncertainty exists in the correlations as given in Figs. 189-197. At the southern end of the township the section on the Morgan land is thought to be correctly correlated with the Mecca section, the heavy beds of shale being taken as the same as that worked at the Dee clay pit at Mecca and known to come just below the horizon of Coal VI. By the same means the section on the Cox place is tied to this, etc. None of the sections show more than one limestone. This has led to the very questionable assumption that this limestone occurs at the same horizon in all the sections, and just above Coal V. With the small amount of data now at hand, proof one way or the other is out of the question.

The following sections show the stratigraphy as far as obtained (Figs. 189-197):



Figs. 189-197. Columnar sections in T. 16 N., R. 8 W.

501. Section 93. Section near Marion Brick Company's Plant.—Sec. 31, Fig. 190.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Hill, concealed	20	0	..	..	20	0
Division VI—						
2. Drab shale	12	0	..	..	32	0
3. Ironstone or ferruginous limestone	..	3	..	..	32	3
4. Black bituminous sheety shale	1	0	..	..	33	3
5. Drab fissile shale	1	0	..	..	34	3
6. COAL VIa	1	0	1	0	35	3
7. Gray sandy fire-clay used for fire-brick	7	0	..	..	42	3
Place of Coal VI.						

Division V—	Ft.	In.	Ft.	In.	Ft.	In.
8. Gray to brown shaly sandstone	7	0	..	..	49	3
9. Gray shale	27	0	..	..	76	3
10. Blue shale	9	0	..	..	85	3
11. Dark bituminous shale	1	4	51	4	86	7
12. COAL Va?	1	8	1	8	88	3
13. Fire-clay	3	0	..	..	91	3

Mr. Blatchley has discussed the clays of this section (W. S. B., p. 51).

Just east of the clay plant and only a few feet above the level of Leatherwood is exposed 8 ft. of massive gray sandstone. Its position relative to the above section is uncertain, as no sign of such a sandstone is found in exposures farther down the creek and along Rocky fork of Leatherwood. A similar sandstone was noted on the John W. Mathas place, where the I., D. & W. R. R. crosses Leatherwood; it is there 10 ft. thick and shaly, with 6 ft. of drab shale below it to the creek bed. A short distance southwest of this on the S. & W. Hill place, S. E. of S. E. of Sec. 30, is exposed a coal (1 ft. exposed), overlain by black bituminous sheety shale. This is only 10 or 15 ft. above Leatherwood, with nothing to show the dip, and so to indicate whether it belongs above the sandstone or below. This would indicate that it may belong either to the horizon of a lenticular sandstone near Mecca, coming between Coals Va and Vb, or of a thin sandstone just below Coal Va, in either case the Hill coal being Va.

The next three sections are from drillings near Leatherwood Station on the I., D. & W. R. R.

502. SECTION 94. SECTION OF DRILLING ON BRANSON PLACE.—West of Leatherwood Station, Fig. 193.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	2	6	..	..	2	6
2. Blue shale	2	7	..	..	5	1
3. COAL	1	9	1	9	6	10
4. Fire-clay	1	6	..	..	8	4
5. Dark blue shale	7	4	..	..	15	8
6. Blue shale	7	10	..	..	23	6
7. Limestone	2	4	..	..	25	10
8. Blue shale	..	8	19	8	26	6
9. COAL	..	3	0	3	26	9
10. Fire-clay	2	0	..	..	28	9
11. Hard gray conglomerate	2	9	..	..	31	6
12. Fire-clay	2	6	..	..	34	0
13. Soapstone	2	3	..	..	36	3
14. Hard gray conglomerate	..	6	..	..	36	9
15. Black shale	2	0	..	..	38	9
16. Hard gray conglomerate	..	9	..	..	39	6

503. SECTION 95. SECTION OF DRILLING ON NATHAN COX PLACE.—N. W. of N. W. of Sec. 27, Fig. 192.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface clay	6	0	..	..	..	..
2. Clay and sand	5	6	..	..	11	6
3. Boulder clay	30	6	..	..	42	0
4. Bluish gray shale	44	0	..	..	86	0
5. Blue shale	1	4	..	..	87	4
6. COAL	1	6	1	6	88	10
7. Blue clay	28	8	..	..	117	6
8. Limestone	1	4	..	..	118	10
9. Blue shale	1	0	31	0	119	10
10. COAL	..	2	0	2	120	0
11. Fire-clay	2	0	..	..	122	0

504. SECTION 96. SECTION OF BORE ON MYERS PLACE.—W. ½ of N. W. ¼, Sec. 22, Fig. 194.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface reddish clay	8	0	..	..	..	..
2. Dark sand shale	7	0	..	..	15	0
3. Black "gumbo," possibly place of coal	3	0	..	..	18	0
4. Fine fire and potter's clay	6	0	..	..	24	0
5. Potter's clay and shales in layers	64	0	..	..	88	0
6. COAL	..	5	0	5	88	5
7. Fire-clay, potter's clay and shales of various colors	32	0	32	0	120	5
8. COAL	2	0	2	0	122	5
9. Fire-clay, potter's clay and shales	86	0	..	..	208	5

This section of a boring made for Dr. Myers in August, 1897, is peculiar in the amount of clay and shale encountered. It would be our judgment that it passed or at least reached the bottom of the coal measures. Dr. Myers writes: "On this farm, on slightly higher ground, lies a vein of peacock coal varying from 20 to 32 in. in thickness. It is overlaid by from 1 to 12 ft. of reddish clay and lies over fire-clay and potter's clay of fine quality. It is an excellent smithing and steam coal, and practically free from sulphur." (Letter of December 6, 1897.) This coal would seem to belong in Division VI, while the two coals in the section belong in Divisions V and IV respectively, the 86 ft. of clay and shale replacing Division I. As the top coal is also described as having a half-inch sulphur band and a black bituminous, sheety shale roof, it would thus seem to be Coal

VIa, which has those characteristics, and serves as a key to a large area south of this township. The 64 ft. of clay and shale, No. 5 of section, is probably the same as the clay extensively worked along Leatherwood creek a mile or so east. But that appears to correlate with a 22 ft. bed in Coke Oven hollow, thus making possible the first supposition that the overlying coal is Coal VIa. A section of this clay on the Pierson land, N. W. ½ of Sec. 23, as given by Mr. Blatchley, is as follows (W. S. B., p. 47):

	Ft.	In.
Soil and drift clay	3	..
Gravel	3	4
Coarse, sandy fire-clay	3	3
"Iron sandstone" hard and dark colored	1	10
Fine grained potter's clay (exposed)	8	..

505. SECTION 97. SECTION AT BLOOMINGDALE.—Fig. 195 (B. C. H., p. 375).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil	5	0	..	..	5	0
2.	Quicksand and gravel	10	0	..	..	15	0
3.	Blue clay, drift	42	0	..	..	57	0
4.	Sandstone, "bastard"?	14	0	..	..	71	0
5.	Shale	2	0	..	..	73	0
6.	COAL, indicated	0	0	0	0	73	0
7.	Fire-clay	4	0	..	..	77	0
8.	Black clay shale with sandstone	27	0	..	..	104	0
9.	Gray shale	10	0	41	0	114	0
10.	BLOCK COAL	3	6	3	6	117	6
11.	Potter's clay	0	0	..	..	117	6

It is judged that Coal No. 10 is Coal IV, the coal indicated, No. 6, is at the horizon of Coal V or Va. A drilling made near the depot in 1897 is reported to have struck coal at 60 ft., the thickness being variously reported at from 4 to 5 ft. This would appear to be at the horizon of Coal No. 6 of above section.

Of three drillings on the Joseph Mathas place in the S. W. ¼ of Sec. 20, one is reported to have in a depth of 180 ft. passed through several beds of coal, the thickest, however, being only 3 ft.

An exposure in the upper river bluff in the S. E. of N. W. of Sec. 19 showed:

	Ft.	In.
Limestone	1	8
Gray to blue sandy shale, with shaly sandstone in places	15	0

A short distance east of and above this, coal has been stripped on the P. Harper place, N. W. of N. E. of Sec. 19.

On the J. Warner land about West Union Station a number of drillings are said to have passed through coal. Of these, one in the N. W. of N. E. of Sec. 18 struck 4 ft. at 76 ft. In the S. E. of N. E. of Sec. 18 a drilling went 190 ft. without striking coal. The report of 9 ft. of coal at that point at once suggests black bituminous shale.

In the S. W. of S. W. of Sec. 9 a little coal has been stripped on the Andrew Linebarger place. This is not over 30 ft. below the level of the upland. One foot of coal was exposed, overlain by a few inches of drab shale.

Approaching Sugar creek by way of Coke Oven hollow, the following section appears in descending the hollow:

506. SECTION 98. SECTION IN COKE OVEN HOLLOW.—N. E. of Sec. 9, Fig. 189 (W. S. B., p. 49).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and yellow drift clay	8	0	..	..	8	0
2.	Buff clay shale	27	0	..	..	35	0
3.	Hard gray sandy shale	4	6	..	..	39	6
4.	COAL	1	3	1	3	40	9
5.	Fire-clay	3	4	..	..	44	1
6.	Blue clay shale	8	8	..	..	52	9
7.	"Iron sandstone" as near Bloomingdale	1	6	..	..	54	3
8.	Plastic potter's clay	22	0	..	..	76	3
9.	Dark hard sandy shale overlying sandstone	21	0	58	6	97	3
10.	COAL	2	8	2	8	99	11
	Below which is						
12.	Drab to gray shale with some layers of sandstone	20	0	..	..	19	11

Coke Oven hollow has long been a point of interest. Mr. Owen, in 1838, found coke being made here, "the best coal and coke I have yet seen in the State; as good, indeed, as I have seen in the western country." He says of the coal: "Its structure in the bank is columnar and the fracture conchoidal, like that of cannel coal; its luster glistening, resinous, it receives a polish; it takes fire and burns with a clear yellow flame, melting slightly and caking together. It is so clean that it will not soil a pocket handkerchief." It has "a solid sandstone roof." (D. D. O., p. 34.) He gives the following analysis of the coal:

Volatile matter	52.1
Carbon in coke	43.9
Ashes (white) from 2 ft. to	4.0
	100.0

At that time Hon. W. G. Coffin had a foundry at this point, hauling his pig iron from Cincinnati by way of wagon. This coal, No. 9 of section, has been worked at a number of places. Several of these were open, at which the coal measured from 1 to 2 ft. Mr. Blatchley, in 1895, measured 2 ft. 8 in. at one of the more southern openings, since filled up with water. The coal appears of excellent quality, what is known as "peacock coal." Below is fire-clay, then 20 ft. of drab to gray shale, with some layers of sandstone. Over the coal is 10 to 12 ft. of sandstone, shaly in places, in others massive, with shale over that. A few feet higher are traces of the next bed, overlooked in Mr. Blatchley's section. This has been worked at at least two places, though it was not seen. It is described by Mr. Hobbs as a 2 ft. bed with a sandstone roof, and said to be good for blacksmithing. The potter's clay of this section was stated by Mr. Hobbs to be the filling of a channel 200 yards broad and 40 ft. deep. At the mouth of the ravine the following section is finely exposed:

507. SECTION 99. SECTION ON SUGAR CREEK NEAR MOUTH OF COKE OVEN HOLLOW.—Fig. 191.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Limestone, fossiliferous	3	0+	..	..	3	0
2. Dark blue to black shale	5	0	..	..	8	0
3. COAL V	..	10	0	10	8	10
4. Fire-clay	1	2	..	..	10	0
5. Gray sandstone, full of roots and fossiliferous	6	0	7	2	16	0
6. COAL IV (bone)	1	8	1	8	17	8
7. Fire-clay	2	0	..	..	19	8
8. Drab shale	5	0	..	..	24	8
9. Black bituminous sheety shale ....1 ft. 6 in. to	2	0	..	..	26	8
10. Blue to gray shale	10	0	..	..	36	8
11. Concealed to creek	15	0	..	..	51	8

A quarter of a mile above the feeder dam there appears the following approximate section:

508. SECTION 100. SECTION ON SUGAR CREEK.—Fig. 196.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	10	4	..	..	10	4
2. Limestone	4	0	..	..	14	4
3. Shale	8	0	..	..	22	4
4. COAL V	..	8	0	8	23	0
5. Fire-clay	1	6	..	..	24	6
6. Shaly sandstone and fake	8	0	9	6	32	6
7. Bone COAL IV	1	10	1	10	34	4
8. Blue shale	6	0	..	..	40	4
9. Shaly sandstone	3	0	..	..	43	4
10. Sandy shale and sandstone	8	0	..	..	51	4
11. Massive sandstone, Mansfield	15	0	..	..	66	4

Coal is reported at several places up Sugar creek in Sec. 3, there being said to be two beds on Wm. Swain's place in the S. W. of S. W. of Sec. 3, the upper bed being 3 ft. thick, while 20 ft. below is an 18 in. bed. Coal was reported by Mr. Hobbs on the S. S. Jordan place, N. W. of S. E. of Sec. 3, and on J. M. Ephlin's place, S. W. of N. E. of Sec. 3, the coal on the latter farm being reported to be 4 ft. thick. Coal was seen at a number of these places, though at only one was the thickness exposed, the coal there being 1 ft. thick about 25 ft. above Sugar creek, and overlain by 6 or 8 ft. of sandstone.

Going down stream from Coke Oven hollow at one point, only 20 ft. of drab shale separates the limestone from an exposure of sandstone, supposed to be Mansfield sandstone.

On the Linebarger place, N. E. of N. E. of Sec. 7, three coals are reported, the upper bed being about 1 ft. thick; 12 to 15 ft. below is the second bed, 2 or 3 ft. thick, formerly worked rather extensively. Then, 15 to 18 ft. lower, is the third bed, said to range up to 3 ft. thick. The limestone of the last two sections is supposed to come between the two lower coals. Across the creek a somewhat better section was obtained, as follows:

509. SECTION 101. SECTION ON MANWARRING PLACE.—S. W. of S. W. of Sec. 5, Fig. 197.

	Ft.
1. Hill, concealed	50
2. Drab shale	6
3. COAL Va? .....3 ft. to	2
4. Hidden; some sandstone shows	10
5. Drab shale	4
6. Gray fossiliferous limestone.....8 ft. to	10
7. Drab shale	2

At the railroad bridge over Rush creek at the water tank is better exposed part of the section which above is hidden. There it shows:

	Ft.
1. Shaly sandstone	6
2. Drab shale	6
3. Gray limestone	6

This section was used for that part of Fig. 197.

The worked bed at these places is a semi-block, with a bluish shale roof of poor quality. In places the roof is said to be sandstone and good.

On the north side of Sugar creek, across from the mouth of Coke Oven hollow, two beds are reported on the J. Campbell place, said by Mr. Hobbs to be 2 and 3 ft. thick respectively, and one of them roofed with limestone. They were not seen.

Mr. Hobbs also reports a 2 ft. bed roofed with limestone on the D. Wright place in Sec. 6, N. W. ¼.

From these sections it is evident that the prospect of workable coal in this township is not flattering. Still, the fact that coals of workable thickness are found or reported at a few places leads to the hope that workable basins will yet be found. Coal attains a workable thickness at three horizons, which, if we take the Sugar creek limestone to be over Coal V, would correspond to horizons Va, V and IV.

Township 16 North, Range 9 West. (In Parke County.)

510. Statement.—This includes only the eastern edge of the township, an irregular strip averaging a little over a mile in width, and containing only bottom land or first terrace. No coal has been reported in this strip. The finding of workable coal across the river suggests its possible presence here, provided it has not been cut out by preglacial erosion of the river. At Hillsdale it occurs about 150 ft. below the railroad, but should be looked for at less depths here.

Township 15 North, Range 8 West.

Mecca Quad

511. Location, etc.—The eastern half of this township is in Adams and the western half in Wabash of the civic townships. The surface is much cut up by the deep valleys of Rocky run, Raccoon creek, Iron creek, Wiesner's branch and Sunderland creek; Raccoon creek lying 150 ft. or more below the remnants of flat land on the divides. As before stated, the channel of this creek formerly ran southwest from Rosedale. The valley through this township is narrow and yields many excellent exposures of the bedded rocks.

The C. & E. I. R. R. runs down the valley of Raccoon creek, the T. H. & L. R. R. skirts the southeastern corner and the I., D. & W. just misses the northwest corner of the township.

512. Stratigraphy and Coals.—This is the first township yet described in which the stratigraphic relation of all the coals seen or reported, to the coals of the type area in Clay and Vigo counties,

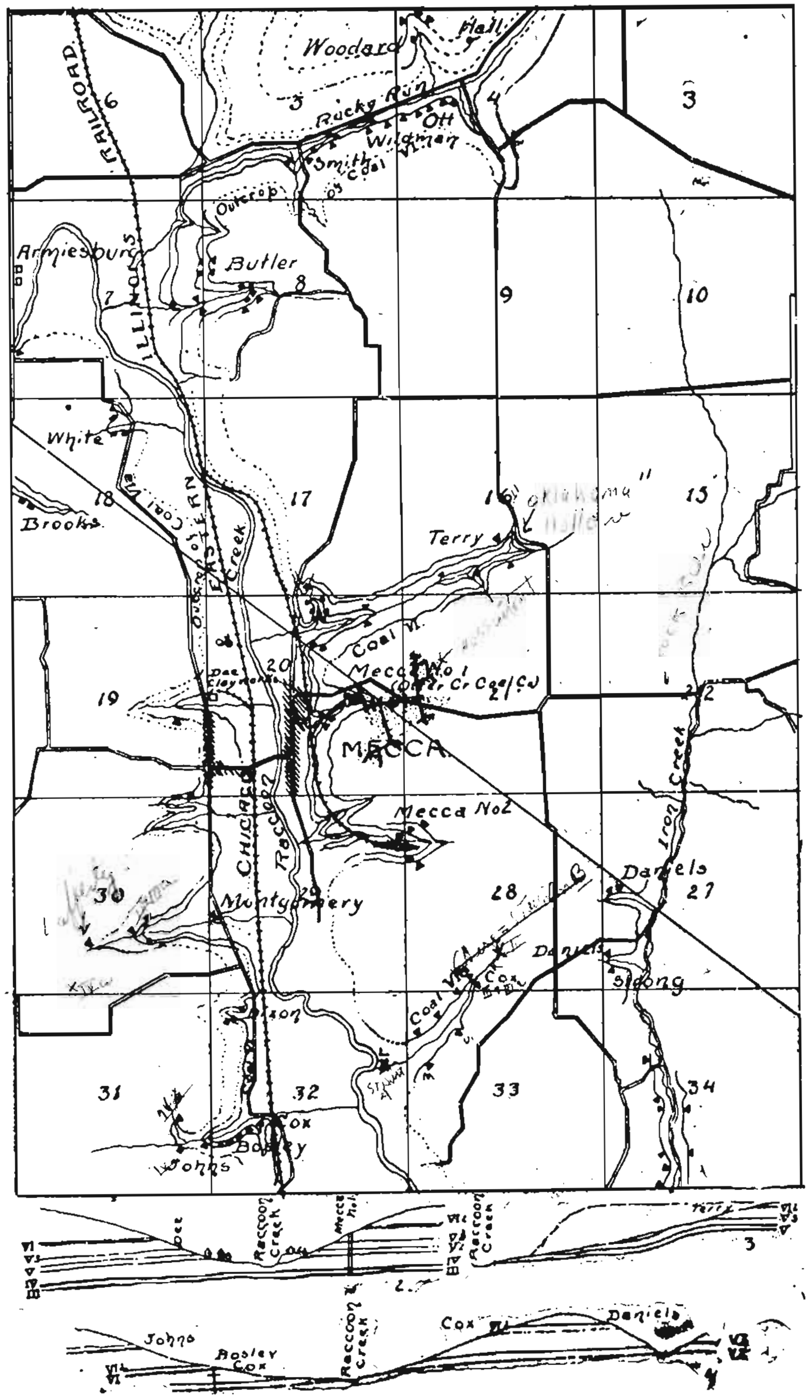


PLATE XVIII. Sketch map and cross sections in T. 15 N., R. 8 W.

appears to have been certainly determined. The coals occurring between Coals V and VI which were not recognized by the old survey can best be studied in this area, and therefore the stratigraphy is quite fully set forth. The coals observed in this township range from Division III to Division VI or VII, inclusive, with coals as follows: III, IV, V, Va, Vb, VI, VIa, VIb or VII?, VIc or VIIa?, or a total of

202 South of Armiesburg. Sec. 7. | 198 Mecca. Sec. 20. | 198a Duee Hollow. Secs. 31, 32. | 199 Drilling. Duee Hollow. Sec. 32. | 200 Butler. Sec. 7. | 201 Rocky Run. Secs. 4, 5.

Figs. 198-202. Columnar sections in T. 15 N., R. 8 W.

nine coal horizons, or ten, including a coal reported in a drilling, but not seen in adjacent exposures or elsewhere in the township. The following sections, principally connected, show the main stratigraphic features:

513. SECTION 102. CONNECTED SECTION AT MECCA.—Fig. 198.

Division VI—	Ft.	In.	Ft.	In.	Ft.	In.
1. Sandy shale ....20 ft. to	30	6	..	..	30	0
2. Black bituminous shale...	2	0	..	..	32	0

	Ft.	In.	Ft.	In.	Ft.	In.
3. COAL VIa	1	0	..	..	33	0
4. Band of fire-clay, sulphur, etc.	..	1	..	..	33	1
5. COAL VIa	..	8	1	9	33	9
6. Fire-clay	5	0	..	..	38	9
7. Blue shale	..	3	5	3	39	0
8. COAL VI 0 to 2 ft. 6 in.	..	9	..	9	39	9
9. Yellow sandstone..4 ft. to	1	6	..	..	41	3
Division V—						
10. Shaly dark shale 20 ft. to	35	0	..	..	76	3
11. Dark shale ....0 to	1	0	37	6	77	3
12. COAL Vb	1	0	1	0	78	3
13. Fire-clay	5	6	..	..	83	9
14. Shale	4	0	..	..	87	9
15. Massive brown sandstone ....1 ft. to	2	0	..	..	89	9
16. Blue shale with concretions .....2 ft. 6 in. to	6	0	..	..	95	9
17. Fossiliferous limestone ....1 in. to 1 ft. 10	..	6	..	..	96	3
18. Black fissile shale	1	0	..	..	97	3
19. Black sheety shale, very solid	1	0	20	0	98	3
20. COAL Va ....10 in. to	1	2	1	2	99	5
21. Dark fire-clay shaly......	1	6	..	..	100	11
22. Sandstone, ferruginous ....1 in. to 2½ ft.	..	6	..	..	100	5
23. Blue shale with septaria ....6 ft. to	8	0	..	..	109	5
24. Fossiliferous limestone ....0 ft. to 1 ft.	..	8	..	..	110	1
25. Black sheety shale.......	2	0	12	8	112	1
26. Black fissile shale (place of coal V)	2	0	2	0	114	1
27. Dark gray shale (with line of sulphur balls at top).	1	6	..	..	115	7
28. Fire-clay	1	0	..	..	116	7

This section is continued in the shaft of Mecca No. 1 mine, and as given by Mr. Morgan Roberts, the lower part of the section is as follows:

Division IV—	Ft.	In.	Ft.	In.	Ft.	In.
29. Sand shale or fake in layers 2 to 4 in. thick, 16 ft. to	18	0	..	..	134	7
30. Dark shale	3	0	26	3	137	7
31. COAL IV, 3 ft. 6 in. to...	4	0	4	0	141	7
32. Fire-clay.....1 ft. 6 in. to	4	0	..	..	145	7

	Ft.	In.	Ft.	In.	Ft.	In.
Division III—						
33. Black shale ....0 to	12	0	..	..	157	7
34. Limestone	1?	?	17	0	158	7
35. COAL III ...3 ft. 8 in. to	6	1	6	1	164	8
Division I—						
36. Sandstone with soft layers .... 5 ft. to	13	0	..	..	177	8

This section was made with some care from exposures in Oklahoma hollow and the ravines in which are Mecca No. 1 and No. 2 mines and the Dee clay plant. The ground was in parts gone over twice, as it became evident that the previously published sections contained errors both of omission and addition or repetition. Mr. Hobbs made this section (B. C. H., p. 345) the key section to his report on this county. The 4 ft. Coal No. 2 of his section could not be found; the 40 ft. sandstone, No. 3 of his section, was doubtless the sandstone filling of a channel which cut out all the coal in a northwest-southeast direction near Mecca No. 1 shaft. His next coal, No. 5 of section, is Coal VIa of above section. Coal VI escaped his notice. His next coal, 3 ft. thick, is Coal Vb and is nowhere seen over 1 ft. 6 in. thick. His next two coals, 2 to 4 ft. and 4 to 6 ft., respectively, were correlated by him as follows: The upper with VIa, and the lower with Vb, VI and VII as now recognized elsewhere. They should be Va and V, the former being found 1 ft. 2 in. as the thickest, the latter showing only a very bituminous shale as far as found.

The section made by Mr. Blatchley, when examining the clays in 1895 (W. S. B., p. 53), overlooked Coal VI, and the lowest coal is a repetition of the next above, otherwise it agrees closely with the section as given above, except in some minor details.

As given by Mr. Roberts, the lower part of Division V, which immediately overlies No. 29, etc., of the above section, is developed in the shaft as follows:

	Ft.	In.
1. Black shale	5	0
2. Fake ....12 ft. to	14	0
3. Shale ....12 ft. to	14	0
4. Limestone	2	0
5. Terra-cotta clay (probably decomposed limestone)	3	0
6. Tough black sheety shale......................	1	8
7. COAL V— Good, 1 ft. 4 in. Bone, 8 in..................................	2	0
8. Fire-clay	..	10
29. Sandy shale, etc., as above.		

514. SECTION 103. CONNECTED SECTION IN DUEE HOLLOW.—Secs. 32 and 31, Fig. 198a.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Black shale	10	0	..	..	10	0
2. COAL VIc?	..	8	0	8	10	8
3. Clay (exposed)	..	6	..	..	11	2
4. Shale	4	0+	4	6	15	0
5. COAL VIb (?)............	3	2	3	2	18	4
6. Hidden: The above section is exposed up the creek above the following: Hidden: Space not over 10 ft.	10?	0	..	..	28	4
7. Gray fissile shale	10	0	..	..	38	4
8. Shaly ferruginous limestone	..	4	..	..	38	8
9. Gray fissile shale with iron concretions	6	0	..	..	44	8
10. Drab hard calcareous shale, showing cone in cone structure—place of limestone ....3 in. to	1	0	..	..	45	8
11. Soft, blue shale	1	0	..	..	46	8
12. Black sheety shale	2	0	30	4	48	8
13. COAL VIa	1	0	..	..	49	8
14. Clay band ....¼ in. to	..	1	..	..	49	9
15. COAL VIa	..	6	1	7	50	3
16. Fire-clay ....5 ft. to	6	0	..	..	56	3
17. Sandstone ....0 to	1	0	7	0	57	3
18. COAL VI—coal, 2 ft. 3 in.; band, 1 in.; coal, 1 ft. 0 in.	3	4	3	4	60	7
19. Fire-clay	2+	0	..	..	62	7
20. Gray sandy or clay shale, with line of iron concretions	18	0	20	0	80	7
COAL Vb (?) is reported just below that.........	?	?	?	?	..	..

515. A drilling by Mr. McCullum, made near the Cox bank in S. W. of Sec. 32, begins just above Coal VI and carries the section down to Coal III probably.

SECTION 104. SECTION OF DRILLING IN DUEE HOLLOW.—Fig. 199.

	Ft.	In.	Ft.	In.	Ft.	In.
Division VI—						
1. Gravel and sandstone ...	1	0	..	..	1	0
2. Shale	6	0	..	..	7	0
3. COAL VI	3	2	3	2	10	2
4. Fire-clay	2	0	..	..	12	2

	Ft.	In.	Ft.	In.	Ft.	In.
Division V—						
5. Sandy shale	6	0	8	0	18	2
6. COAL (Vc)	..	2	0	2	18	4
7. Fire-clay	2	2	..	..	20	6
8. Shale	3	0	..	..	23	6
9. Gray shaly sandstone	4	6	..	..	28	0
10. Gray sandstone	11	0	..	..	39	0
11. Black shale	1	0	21	8	40	0
12. COAL Vb	1	10	1	10	41	10
13. Fire-clay	6	0	..	..	47	10
14. Sandstone	1	5	..	..	49	3
15. Black shale	2	1	9	6	51	4
16. COAL Va	1	9	1	9	53	1
17. Fire-clay	1	1	..	..	54	2
18. White sandstone	10	6	..	..	64	8
19. Brown sandstone	1	9	..	..	66	5
20. Fire-clay	1	0	..	..	67	5
21. Limestone	1	2	..	..	68	7
22. Black shale	8	6	..	..	77	1
Division IV—						
23. Gray shale	15	6	..	..	92	7
24. Black shale	1	3	..	..	93	10
25. Light gray shale	8	4	..	..	102	2
26. Sandstone	2	6	..	..	104	8
27. Light gray shale	5	0	..	..	109	8
28. Black shale	1	10	58	5	111	6
29. COAL IV?	..	4	0	4	111	10
30. Fire-clay	2	4	2	4	114	2
Division III—						
31. COAL and shale mixed (III)	1	6	1	6	115	8
Division I—						
32. Hard sandstone	3	0	..	..	118	8

The 2 in. coal 8 ft. below Coal VI does not appear in a well exposed bluff near by, nor was it seen elsewhere in the township, but thin coal not infrequently appears a few feet below Coal VI.

The position of Coal V would seem to be between Nos. 22 and 23, or 23 and 24, probably the former.

The two lowest coals may be Coal III, underlain by Coal II, as in the Brazil field, Coal IV then being wanting, or they may represent Coals IV and III, both thin and close together.

516. The measures are well exposed on the J. Butler and B. Hayworth places in Secs. 7 and 8. As the coals are not in work now, the section as made by Mr. Cox is more complete than is now exposed and will be given in preference to our own.

517. Section 105. Section on Butler Place.—Sec. 7, Fig. 200 (E. T. C., '69, p. 113).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and drift	30	0	..	..	30	0
2. Concretionary limestone	..	6	..	..	30	6
3. Black sheety shale, splits in thin laminae	1	6	..	..	32	0
4. COAL VIa	1	0	1	0	33	0
5. Fire-clay	3	0	..	..	36	0
6. Greenish clay shale	4	0	..	..	40	0
7. Black pyritiferous sheety shale with fish teeth	1	0	8	0	41	0
8. COAL VI— Coal containing irregular bands of sulphur, 2 ft. 5 in.; pyritiferous clay parting, 1 in.; coal, caking, 1 ft.; coal, block, 1 ft. 5 in.	5	0	5	0	46	0
9. Fire-clay	5	0	..	..	51	0
10. Clay shales	4	0	..	..	55	0
11. Soft schistose sandstone	10	0	..	..	65	0
12. Shales, covered	21	0	..	..	86	0
13. Black sheety shale	..	6	40	6	86	6
14. COAL Vb	1	6	1	6	88	0
15. Gray shale	8	0	..	..	96	0
16. Black sheety shale with fossil shells	3	0	11	0	99	0
17. COAL Va	..	6	0	6	99	6
18. Gray shale	6	0	..	..	105	6
19. Black pyritiferous shale, passing into hard gray fossiliferous limestone	1	6	..	..	107	0

518. A connected section in the bed of, and south bank of Rocky run, together with an exposure of Division VI, as reported by Mr. Hobbs on the Woodward place, gave as follows:

519. Section 106. Connected Section on Rocky Run.—Secs. 4 and 5, Fig. 201.

	Ft.	In.	Ft.	In.	Ft.	In.
Division VI—						
1. Black shale	?	?				
2. COAL VIa	1	8	1	8	1	8
3. Fire-clay	8	0	8	0	9	8
4. COAL VI, 4 ft. to 6 ft.	4	6	4	6	14	2
Division V—						
5. Hidden	?	?				
6. Drab shale	20	0	20	0	34	2
7. COAL Vb	1	2	1	2	35	4

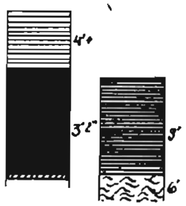
	Ft.	In.	Ft.	In.	Ft.	In.
8. Shale	10	0	..	..	45	4
9. Black shaly shale	3	0	13	0	48	4
10. Bone COAL Va	..	8	0	8	49	0
11. Drab shale ....2 ft. to	3	0	..	..	2	0
12. Limestone .... 0 to	..	6	..	..	52	6
13. Drab shale	6	0	..	..	58	6

520. At the bridge over Raccoon creek, south of Armiesburg, the following section was noted:

SECTION 107. SECTION AT ARMIESBURG BRIDGE.—Sec. 7, Fig. 202 (in part).

	Ft.	In.
1. Surface	10	0
Division VI—		
2. Brown to coarse-grained sandstone	2	0
3. Blue shale	9	0
4. Blue to black bituminous sheety shale	1	6
5. COAL VIa	1	4
6. Fire-clay, soft	2	6
Place of Coal VI.		
Division V—		
7. Massive coarse-grained yellow and brown sandstone .....8 ft. to	10	0
8. Clay shale to water .....15 ft. to	20	0

Mr. Cox reports a coal bed overlain by limestone near low water at this point. It was not exposed when the locality was visited. The absence of Coal VI and of a parting in Coal VIa made the correlation



203 Johns. Sec. 31. 204 Laferty. Sec. 30.

Figs. 203 and 204. Coal VIb in T. 15 N., R. 8 W.

here somewhat doubtful, but characteristic exposures of Coals VI and VIa a short distance south and southeast at the corresponding level seemed to show the correctness of the correlation.

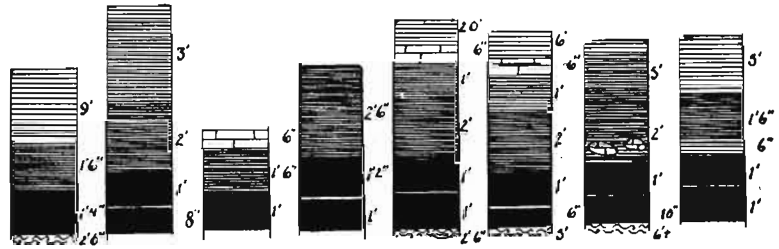
Next to consider the coals individually.

84.

521. COAL VIc.—This coal was only seen at this point, in Dues hollow in Sec. 31. It was there 8 in. thick, overlain by black shale. IVa or 6, B of IV

522. COAL VIb.—This coal is exposed only in the heads of ravines in Secs. 30 and 31. In Sec. 30 it was represented only by black shale, in places approaching a bone coal. It is worked in Sec. 31 on the Johns place. It there ranges from 3 ft. to a reported thickness of 4 ft. 6 in. The coal is a semi-block, caking coal, apparently free from sulphur and of good quality. The slips run about 2 ft. apart, but not as regular as in the main block coal field; they are filled with calcite, requiring the use of powder in mining. The exact correlation of this and the overlying bed is in doubt.

This is upper L. B. of IV. The underlying bed is IV.



205 Armiesburg. Sec. 7. 206 Brooks. Sec. 18. 207 Butler. Sec. 8. 208 Wanamaugher. Sec. 13-15-9. 209 Montgomery. Sec. 30. 210 Johns. Sec. 31. 211 Cox. Sec. 28. 212 Daniels. Sec. 27.

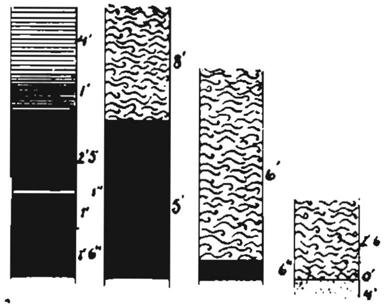
Figs. 205-212. Selected sections of Coal VIa in T. 15 N., R. 8 W.

523. COAL VIa.—See Plate XI and Figs. 205-212. This bed is the most easily recognized of any of the coals of this area, principally on account of its parting of clay. In only a few places was this parting lacking. It is further characterized by a roof of black bituminous sheety shale, with very frequently a thin bed of shaly limestone, showing often cone in cone structure, over that. In view of these features and its uniformity and persistence, it has served as a key coal over a considerable area in southwestern Parke, northeastern Vigo and northwestern Clay counties.

The coal is usually reported to be of excellent quality, and as Coal VI (the "big vein") is here very thin and irregular, this coal becomes of some importance for local trade. Above the immediate roof of the coal is usually found 20 ft. or more of sandy shale.

524. COAL VI.—See Plate XI and Figs. 213-216. This coal, which to the south and west of this area is of great importance, is in this area very irregular, and often very thin or entirely wanting. Here

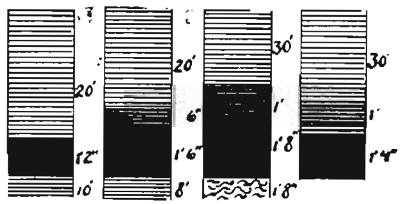
it ranges from 0 to 5 ft., with an average of probably less than 1 ft. It is of workable thickness and quite regular, where it enters the township in the southwestern part, but in a mile and a half becomes reduced to a few inches or nothing, and north and east of that occurs



213 Butler. Sec. 8. 214 Woodward. Sec. 4. 215 Brooks. Sec. 18. 216 Armiesburg. Sec. 7.

Figs. 213-216. Sections of Coal VI in T. 15 N., R. 8 W., north of Mecca. See Plate XI for figures of this coal south of Mecca.

of workable thickness in only a few places. In proportion as it gets thinner the distance to Coal VIa usually becomes less, and the space between, which to the south contains from the top fire-clay, a thin sandstone and shale, over most of the area contains only fire-clay. While the decreased thickness might appear to be due to erosion pre-



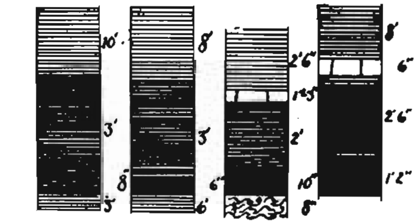
upper Raccoon

217 Patterson. 218 Butler. Sec. 8. 219 Mecca No. 1. Sec. 20. 220 Dee clay pit. Sec. 19.

Figs. 217-220. Sections of Coal Vb in T. 15 N., R. 8 W.

ceding the laying down of the fire-clay, I am inclined to think it rather due to conditions unfavorable for coal deposition. See Part II. The coal, where mined, is said to slack or weather badly, but not to clinker. It appears to have much the quality of this coal elsewhere.

525. Coal Vb.—Between this coal and Coal VI is here usually a 25 to 35 ft. bed of shale suitable for brick. This coal, ranging from 1 ft. to 1 ft. 8 in., while too thin to work by itself, will be worked to some extent in connection with the overlying shale. In many



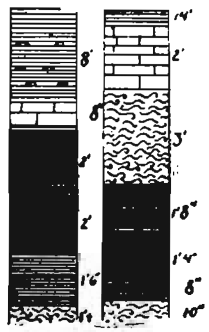
middle Raccoon

221 Rocky Run. Sec. 5. 222 Butler. Sec. 8. 223 Oklahoma Hollow. Sec. 20. 224 Mecca, No. 2. Sec. 21.

Figs. 221-224. Sections of Coal Va in T. 15 N., R. 8 W.

cases this shale comes down onto the coal. In others from a few inches to a foot of black shale directly overlies the coal. It is locally worked at a number of places.

526. Coal Va.—This coal lies but a short distance below the other, 10 to 15 ft. on the average. Usually both are so exposed that there is little or no danger of confusing them. Coal Va is usually



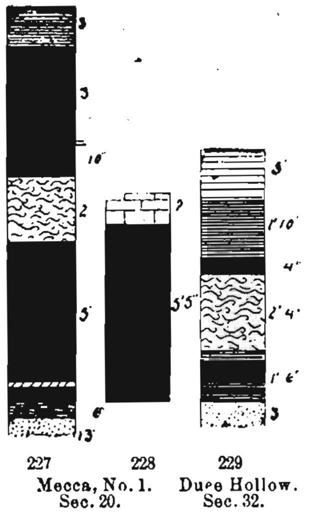
Lower Raccoon coal

225 Oklahoma Hollow. Sec. 20. 226 Mecca, No. 1. Sec. 20.

Figs. 225, 226. Sections of Coal V in T. 15 N., R. 8 W.

thinner than Coal Vb and overlain by a much greater thickness of black shale, and frequently also by a thin bed of limestone. This bed of limestone, while not very persistent, was seen ranging up to nearly 2 ft. in thickness. In only a few places is this coal even stripped.

527. Coal V.—This coal is mostly below drainage and so could not be as well studied as the preceding. It resembles the last described coal in being overlain by black shale and limestone, but the limestone seems to be much more persistent than in the former case and the coal, though often represented only by bone, is thicker.



upper block? on II

Figs. 227-229. Sections of Coals IV and III in T. 15 N., R. 8 W.

528. Coal IV.—This coal was seen only in the Mecca shaft. There it ranges from 3 ft. 8 in. to 4 ft. 2 in. It shows a bench mining of soft coal 10 in. from the bottom, and in swamps has a few inches of bone coal under. It is a non-caking (?) semi-block coal, having regular face slips running west of north and about 2 ft. 6 in. apart. The butt slips are irregular, from 1 to 3 ft. apart. The coal blocked when first mined, but the slips soon became filled with calcite and tight. They do not appear to enter the lower bench. The roof is a dark shale, and at one point, where that had come down, fake was revealed above, with its characteristic method of cutting. This coal makes some gas.

Lower bench mining hall

529. Coal III.—This coal was also seen only at the Mecca shaft. It ranges from 3 ft. 8 in. to 4 ft. south of the shaft and from 6 to 6 ft. 6 in. to the east. It shows no parting except a 2 in. band of sulphur 4 in. from the bottom. It also shows 6 in. of bone beneath in the swamps. This coal is more of a caking coal and less of a block than the upper coal. This coal has a limestone roof over part of the mine, with black shale above. In other places Coal IV comes down to within 18 in. of Coal III and whenever it gets to within 4 ft. of Coal III the two beds are only separated by "white top," here a hard, white sandy clay. At other places the two beds are as much as 16 ft. or more apart.

530. Distribution and Local Details of Coals.—West of Raccoon creek. Going north on the west side of Raccoon creek, coal is first noted in Duee hollow, in Secs. 31 and 32. Near the mouth of the hollow the Cox bank is opened on Coal VI. The coal is here about 20 ft. above the branch. It is in two benches, the upper or worked bench being 3 ft. 6 in. thick; the lower bench, not worked, is 2 in. thick and carries most of the sulphur. The parting or "dirt band" runs from 0 to 3 in. in thickness. The coal is claimed to be cleaner and harder than at Coxville, the nearest point where this coal is worked extensively. The roof is gray shale 4 ft. thick, and while it sometimes does not come down, it is usually cut up by joints that give it a tendency to come down for at least 5 or 6 in. The bottom bench makes a good bottom to timber on. Below that is 3 ft. of hard fire-clay. Coal VIa is here 18 in. thick and 12 to 13 ft. above Coal VI. Where the railroad crosses the branch it is said the trestle timbers set on coal, variously stated at from 18 in. to 3 ft. thick, more probably the former; 12 ft. below that is said to be another bed. These are probably Coals Nos. 12 and 16 of Section No. 104, which was drilled near here. Between this and the next, or Bosley mine, two exposures show the following section:

531. Section 108. Section in Duee Hollow near Mouth.—

	Ft.	In.
1. Black bituminous shale, jointed	3	0
2. COAL VIa—Coal, 11 in.; parting, 1 in.; coal, 10 in.	1	10
3. Fire-clay	6	0
4. Sandstone	..	6
5. Gray shale	2	0
6. COAL VI—Coal, 3 ft. 6 in.; parting, 3 in.; coal, 2 in.	3	11
7. Gray sandy and clay shale with line of iron nodules	18	0

At the David Bosley mine the coal is much the same, the worked bench measuring 3 ft., the lower bench 1 or 2 in., with a parting of 0 to 3 in. The roof is a soft gray clay. The coal is here about 10 ft. above the branch. An eighth of a mile above, Coal VI is only about 2 ft. above the creek and soon passes under; the upper bench is only 2 ft. 6 in. thick here. Coal VIa is here 8 ft. above, the section being as given in Nos. 7 to 18 in Sect. 103, ¶514.

A short distance above this, in the S. E. of S. E. of Sec. 31, is the Johns bank on Coal VIc. The coal was described in ¶524. It is thought the 8 in. rider here may join this coal a short distance west. This coal has been stripped in a hollow just north of this and claimed to be 4 ft. thick.

Going north, the outcrop of Coal VI keeps west of and a little above the road. In the N. W. of N. W. of Sec. 32, coal is exposed on the Dixon place. The section at the bank shows:

532. SECTION 109. SECTION AT DIXON BANK.—Plate XI.

	Ft.	In.
1. Surface	3	0
2. Black sheety shale	..	3
3. Brown soft shale	..	6
4. COAL VIa, with 1 to 2 in. parting	1	1
5. Fire-clay into shale	5	6
6. COAL VI	3	3

The bottom bench of Coal VI has run out here; 20 ft. below a 2 ft. bed is reported, Coal Vb. Where formerly stripped in a drain just north, the coal is reported to have been 3 ft. 6 in. thick. The shales overlying Coal Va or Vb are exposed just above the creek bridge and at creek level in the N. W. of S. W. of Sec. 29. Going up the branch, Coals VI and VIa are seen close together on the A. Montgomery place, N. E. of S. E. of Sec. 30, Coal VI being about 20 ft. above the creek. The section here is:

533. SECTION 110. SECTION ON MONTGOMERY PLACE.—Sec. 30, Plate XI.

Division VI—	Ft.	In.	Ft.	In.	Ft.	In.
1. Shale, changing from gray to blue	20	0	..	..	20	0
2. Hard drab calcareous shale or shaly limestone showing cone and cone structure........2 in. to	..	6	..	..	20	6
3. Dark blue shale with iron nodules	1	0	..	..	21	6
4. Black sheety jointed shale	2	0	..	..	23	6
5. COAL VIa	1	0	..	..	24	6
6. Shale band	..	1	..	..	24	7
7. COAL VIa	1	0	2	1	25	7
8. Fire-clay	2	6	2	6	28	1
9. COAL VI	1	3	1	3	29	4
10. Shaly sandstone running into sandy shale or clay shale in places to creek	20	0	..	..	49	4

A little further up and on the north side the section is again exposed in a perpendicular bluff. As the section differs slightly from the preceding, it is given, as follows:

534. SECTION 111. SECTION ON LAFERTY PLACE.—Sec. 30, Plate XI.

Division VI—	Ft.	In.	Ft.	In.	Ft.	In.
1. Gray sandy shale	20	0	..	..	..	..
2. Shaly limestone with crinoid stems	..	6	..	..	20	6
3. Gray sandy shale	6	0	..	..	26	6
4. Line of limestone nodules or septaria measuring up to 3 to 4 ft. in diameter by 2 ft. thick, still showing cone in cone structure though very indistinctly .... 0 to	2	0	..	..	28	6
5. Black bituminous shale, sheety, fish scales	2	0	..	..	30	6
6. Blue shale	1	0	..	..	31	6
7. COAL VIa, largely hidden by talus	2?	0	2	0	33	6
8. Fire-clay, partly hidden	3	0	..	..	36	6
9. Bone coal to coal, in places only brown bituminous shale	..	3	..	..	36	9
10. Fire-clay, gray	..	6	3	9	37	3
11. COAL VI	..	10	0	10	38	1
12. Hard gray sandy fire-clay to creek bed	2	0	..	..	40	1

A little beyond Coal VI is exposed in the creek bank only 3 in. thick, overlain by 4 ft. of sandy shale. And a short distance still beyond that it has entirely run out, the section being:

535. SECTION 112. SECTION ON LAFERTY PLACE.—Plate XI.

	Ft.	In.
1. Black sheety shale	1	0
2. COAL VIa	1	3
3. Parting	..	½
4. COAL VIa	..	3
5. Fire-clay, sandy	3	0
Place of coal VI.		
6. White and pink sandstone	2	0
7. Clay	1	0

Continuing up stream, the upper part of Sect. 111 is exposed in the creek bed, in places showing shaly sandstone rather than shale, until the position of the Johns coal in Duee hollow is reached, but here it proves to be only a 3 ft. bed of black shale with the fracture of coal. It is of interest that near the head of this ravine occur a number of masses of limestone from the region east or north of the coal field. Their abundance and size at this point is out of the ordinary.

Approaching Mecca, the strata rise so that partial exposures of Coal VI and Coal VIa in the N. E. corner of Sec. 30 are at least 25 ft. above the creek, and at the clay pit of the Dee Sewer Pipe Company, Coal VI is at least 40 ft. above the creek. The section there is:

536. SECTION 113. SECTION AT DEE CLAY PIT.—N. E. of S. E. of Sec. 19, Fig. —.

	Ft.	In.	Ft.	In.	Ft.	In.
Division VI—						
1. Black bituminous sheety shale	2	0	..	..	2	0
2. COAL VIa with parting	1	10	1	10	5	10
3. Fire-clay	6	0	6	0	9	10
4. COAL VI	..	6	0	6	10	4
5. Fire-clay	3	0	..	..	13	4
Division V—						
6. Shelly sandstone	..	..	..	..	..	..
7. Sandy shale, fine and uniform, used at clay plant	30	0	..	..	43	4
8. Black bituminous sheety shale	1	0	34	0	44	4
9. COAL Vb	1	4	1	4	45	8
10. Fire-clay	7	0	..	..	52	8

In the N. W. of N. E. of Sec. 18, on the John White place, the exposures of gray shale suggest that the traces of coal near the road are from Coal VIa or Coal Vb, Coals No. 2 and 4 or No. 9 of the above section.

In Sec. 7 Coal Va or Vb was reported by Mr. Cox to have been seen at low water in Raccoon creek near the Armiesburg bridge. Coal VIa there crops out at the roadside south of and above the bridge. The section here was given in ¶522.

Going south along the east bluff of the Wabash, coal is first noted on the Brooks place in the N. W. of S. W. of Sec. 18. The section here is typical and is of value for its bearing on the correlation of the coals across the river in Vermillion county.

537. SECTION 114. SECTION ON BROOKS PLACE.—Sec. 18, Fig. 202, in part.

	Ft.	In.
1. Surface	6	0
2. Blue shale	3	0
3. Dark sheety shale	2	0

	Ft.	In.
4. COAL VIa—Coal, 1 ft. 0 in.; parting, 1 in.; coal, 6 to 8 in.	1	9
5. Fire-clay	6	0
6. COAL VI	..	6
7. Fire-clay, becoming gradually shaly sandstone toward the bottom	9	0
8. Gray shale as at tile works	3	0

Coal has been worked a little here at a number of places.

A little further south, on Mrs. Lavina Wanamaugher's place, N. E. of S. E. of Sec. 13-15-9, Coal VIa has been worked recently, the coal measuring 2 ft. 3 in. with the parting 1 ft. from the bottom. The roof is a dark sheety shale. A short distance below the sandstone, underlying Coal VI, which is not exposed here, forms massive bluffs 5 or 6 ft. high, much as at the Armiesburg bridge. Coal VIa has also recently been worked on the Puntney and Usselman places, in the S. E. of Sec. 13-15-9.

Near the center of the east side of Sec. 24-15-9 a deep ravine has cut down through the measures, exposing poorly the following section:

538. SECTION 115. SECTION IN BLUFF.—Sec. 24-15-9.

	Ft.	In.	Ft.	In.
1. Drift	30	0	30	0
2. Blue shale	1	0	31	0
3. Dark blue limestone or calcareous sandstone	1	0	32	0
4. Black mark of coal outcrop	..	..	..	..
5. Fire-clay	1	0	33	0 place of IV a
6. COAL	1	0	34	0
7. Sandstone with large plant stems in abundance	1	0	35	0
8. Shaly sandstone in flakes	12	0	47	0
9. Hidden	10	0	57	0
10. Black mark indicating outcrop of coal	..	..	..	..
11. White fire-clay	4	8	61	0 IV a
12. Shaly sandstone	12	0	73	0+

It seems possible that Coal VIa is the coal indicated in No. 10 of section.

Still further south, in Sec. 25-15-9, there was noted:

	Ft.
Line of limestone concretions 0 ft. to	1
Black sheety shale	2
Coal indicated by black streak	.. IVa
Sandy fire-clay or sandstone	4
Sandstone and shaly sandstone, to level of bottom land	15

This appears to correspond with the bottom of the preceding section and with the measures accompanying Coals VIa and VI. The black streak indicating the outcrop of Coal VIa can be traced a short distance further south, but quickly dips below the level of the bottom lands, and no more coal was seen in this township.

Except about a quarter of a mile or less in width along the eastern edge, this township (15 N., 9 W.) is all bottom land. North of Armiesburg this area of bottom land extends eastward so as to include nearly all of Sec. 6 of T. 15 N., R. 8 W.

539. Down Rocky Run.—The section on this ravine was given in ¶521. Coals VI and VIa were only noted on the Hall and Woodford place, in the N. W. of Sec. 4. They were formerly worked, but the workings are now fallen in and the coal hidden. Coal VIa was reported by Mr. Hobbs as 2 ft. thick, separated from Coal VI by 8 ft. of fire-clay. Coal VI is said to have measured from 4 to 6 ft. (see Fig. 214). It is said to have been a good caking coal. Nothing could be learned as to why it was not worked more, but from its position it would seem probable that the roof would interfere seriously with mining operations.

Coals Vb and Va are exposed a very little ways down the creek, Coal Va seldom showing any coal, while Coal Vb shows about 1 ft. It has been mined a little. These exposures are on the John H. Ott, John Wildman, Simeon Smith, B. Phillips and T. J. Mater places.

Further down, on the Jose Butler place, Coal VI, 5 ft. thick (see Fig. 213), and Coal VIa, 1 ft. thick (see Fig. 207), are exposed and have been worked. See Sect. 105, ¶520. Better exposures are now found in a ravine on the B. Hayworth place. The section is much the same as on the Butler place, except that 20 to 25 ft. of gray shale under Coal VI are well exposed and 10 ft. of brown sandy shale containing ironstones are exposed above No. 2 of the section. In a partly filled drift on Coal VI, 3 ft. 7 in. of coal were measured. Coal VIa was not exposed. Mr. Cox gave its thickness as 1 ft., and notes no parting. Coal Vb, the first bed below Coal VI, Mr. Hobbs calls a 4 ft. 6 in. bed. It will hardly measure over 1 ft. 6 in. In 1871 this locality furnished some 1,600 tons of coal. All four beds have been worked a little. The extra 4 ft. 6 in. bed of Mr. Hobbs is evidently in error.*

540. Oklahoma Hollow and Mecca.—The section in the hollow and about Mecca has already been mentioned. The best exposures of Division VI are near Mecca No. 2 shaft. At different exposures

* Since the report went to press we learn that Coals III or IV have been found workable near the mouth of Rocky run, and a shaft known as the Lucia opened up on them close to the railroad, as shown on sheet A of colored map.

there Coal VI varies from 0 to 2 ft. 8 in. in thickness, this variation taking place in a few rods. Coal VIa is quite regular all through here, running from 1 ft. to 1 ft. 6 in. in thickness, with its clay parting at or a little below the center. Division V is best displayed near the switch to Mecca No. 1 shaft, and in Oklahoma hollow. In a small fork of the latter Coal Vb, overlain by 15 ft. of light drab shale, is exposed near the head of the hollow. Coming down, while the strata for short distances keep pace in dip with the stream, on the whole they do not, and the stream gradually cuts down to Coal V with practically an unbroken section. At the mouth of the hollow Coal V, represented by black bituminous shale, is at creek level. Going up the hollow, its position is readily traced by the overlying limestone which in places paves the creek bottom. For some distance it rises about with the stream. Then an easterly dip carries all the coals up to Coal Vb under, but farther up, Coal Vb rises above the creek for some distance; toward the head of the ravine it passes under and Coal VIa appears about 25 ft. above, being the highest rock exposed in the hollow and but a few feet below the general upland level. Coal VI appears to be absent here.

The main interest here is in the workable development of Coals IV and III. These coals, ranging up to 6 ft. 6 in., have already been described. The area underlaid by them appears to be considerable. The south entry of No. 1 is said to be driven 3,700 ft. and the east entry 3,500. The bottom bed has so far been the one principally developed. The beds lie unevenly, so that in 1897, in preparing to install a plant for electric haulage, it was necessary to raise the floor as much as 10 ft. in places and take down as much as 6 ft. of roof in other places. And even then the grades were found too heavy for a 20-horsepower motor to take more than a few cars. At one point the two beds nearly come together, and an incline has been driven to the upper bed at that point. Two channels have cut out the coal and measures. One runs northeast and southwest a short distance north of No. 2 shaft and is evidently a preglacial channel. The filling being soft and full of boulders, coal, pieces of shale, etc. The other is of Carboniferous age and runs just north and east of No. 1 shaft, nearly following the old Indian boundary line. This is filled with sandstone. A drilling up the ravine a little above this shaft is said to have gone 140 ft. into the sandstone, while the banks of the ravine at this point show 40 or 50 ft. more rising to the top, indicating a channel filling 180 to 190 ft. deep. It appears to have crossed just south of the mouth of Oklahoma hollow, and in the west bank just about at the section line between Secs. 18 and 19. It would appear to be part of, or one of the branches of, the Coxville Carboniferous river. Some faults and irregularities occur in the coal, but not so as to interfere with mining. One, in which the fault plane is filled with sandstone, is shown in Fig. 8 of Plate III.

541. SECTIONS 27 AND 28, 33 AND 34.—The only coals seen in these sections were Coals VIa and Vb. Coal VIa outcrops in a ravine on the John Cox and G. H. Bascom places, S. W. ¼ of Sec. 28 and N. W. of Sec. 33. The section here is as follows:

542. SECTION 116. SECTION ON COX AND BASCOM PLACES.—Secs. 28, 33.

		Ft.	*In.*
1.	Hillside, hidden	25	0
2.	Gray shale	10	0
3.	Band of ironstone (place of limestone)	..	2
4.	Dark blue shale	5	0
5.	Black bituminous sheety shale, containing line of limestone nodules near bottom	2	0
6.	COAL VIa—Coal, 1 ft. 0 in.; parting,, 1 in.; coal, 8 in. to 10 in.	1	11
7.	Gray sandy fire-clay	6	0
8.	Hidden, probably same as 7. Place of Coal VI.	6	0
9.	Gray sandy shale	3	0
10.	Gray to drab shale	8	0+

Descending Iron creek, in Sec. 22 is an exposure of 20 ft. of the shale, with iron nodules, which lies between Coals VI and Vb. In the N. W. of S. W. of Sec. 27 Coal VIa was being stripped on the John Daniels place (see Fig. 212). The coal is 2 ft. thick, with 1 in. clay band in center. Above it there is gray shale, 5 ft.; dark sheety shale, 1 ft. 6 in.; gray shale, 6 in., to Coal VIa. It is underlain by fire-clay. It is reported to be fine coal. The same coal is also worked on the J. Daniels and J. S. Strong places in the S. W. of S. W. of Sec. 27. In Sec. 34 traces of a 1 ft. coal appear at places. It appears to be Coal Vb. At one point this showed above it 10 ft. of gray shale with iron nodules and below it 4 ft. of fire-clay to the creek level. Coal VI, though workable just south of this, was not found in this area, and appears to be lacking.

In general, it may be said that four workable coals exist in township 15 north, ranges 8 and 9 west. Coals VIb, VI, IV and III. Coal VIb is workable probably only in the southwestern corner, and doubtfully there. Coal VI is also workable only in the southwestern corner and in a few local pockets elsewhere. The clay roof which it is inclined to have, except in the southwestern corner, will prevent

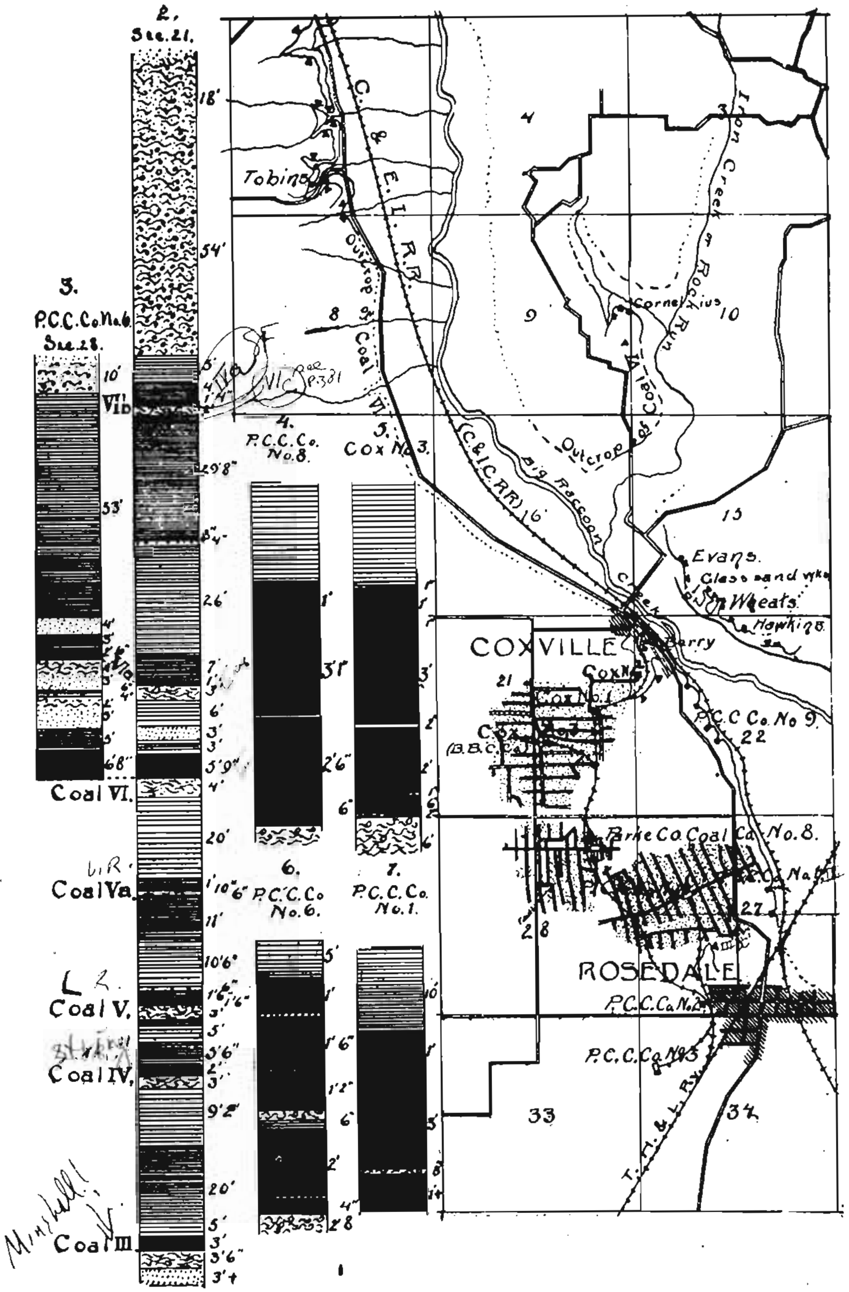


PLATE XIX. Sketch map, columnar and coal sections T. 14 N., R. 8 W.

its being worked in many places where a sufficient thickness is obtained. The outcrop of its horizon is probably not found east of Iron creek. Coals III and IV offer better inducements. They are known to cover a considerable area east of Mecca, with the possibility of basins extending out to Williams creek and toward Minshall. A drill hole in Sec. 31 found them unworkable. One of them has recently been found 4 ft. thick just across the Wabash in Vermillion county. Indications are, therefore, favorable for the finding of more coal at one or the other of those horizons than has yet been found.

(Township 14 North, Range 8 West.)

543. Location, etc.—This township is nearly in the southwestern corner of the county and corresponds to the eastern two-thirds of Florida of the civic townships. The southeastern and eastern part of the township is characterized by the broad level bottoms of Raccoon and Little Raccoon creeks; this is continued northward as a somewhat narrower valley down Raccoon creek across the center of the township. The V-shaped area north of the junction of the two creeks is cut up by Iron and Wiesner creeks into three broad rolling divides and two narrow valleys. West of Raccoon creek is a high flat tableland, from which rise the hummocks of the terminal moraine that crosses here.

The C. & E. I. R. R. crosses the township from northwest to southwest; the T. H. & L. Ry. crosses from northeast to southwest.

544. Stratigraphy and Coals.—The same divisions of the coal measures are found in this township as in the last; that is, III to VI, inclusive, with the probable addition of Division VII in the western part. With the exception of Coal VI, the other coals are much as described and figured under the last township and therefore will not require much attention here. In this township Coal VI first reaches its normal thickness. A couple of drillings obtained through the kindness of the Brazil Block Coal Company shows practically the whole stratigraphic column to Division I.

545. Section 117. Section of Drilling in Coxville—Rosedale Region.—Fig. 2 of Plate XIX.

	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1. Surface	18	0	..	..	..	..
Division VI—						
2. Boulder clay	54	0	..	..	72	0
3. Blue shale	5	0	..	..	77	0
4. Black shale	4	0	..	..	81	0

	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
5. COAL VIc	1	4	1	4	82	4
6. Clay	2	0	..	..	84	4
7. Blue shale	29	8	..	..	114	4
8. Blue shale and sulphur, place of coal?	..	4	..	..	114	0
9. Clay	..	4	..	..	115	0
10. Blue shale	26	0	..	..	141	0
11. Black shale	7	0	65	4	148	0
12. COAL and shale VIa	1	0	1	0	149	0
13. Clay	3	0	..	..	152	0
14. Blue shale	6	0	..	..	158	0
15. Sandstone, very hard	3	0	..	..	161	0
16. Gray shale	3	0	15	0	164	0
17. COAL VI	5	9	5	9	169	9
18. Clay	..	6	..	..	170	3

Another drilling, which includes the bottom of this, shows:

546. Section 118. Section of Divisions III to V.—In Coxville-Rosedale area. Fig. 2 of Plate XIX.

	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1. Surface	1	0	..	..	..	..
Division VI—						
2. Fire-clay	7	0	..	..	8	0
3. Sandstone	5	6	..	..	13	6
4. Drab shale	..	6	..	..	14	0
5. COAL VI	5	0	5	0	19	0
6. Clay	4	0	..	..	23	0
Division V—						
7. Light shale	20	0	..	..	43	0
8. Drab shale	1	0	25	0	44	..
9. COAL Vb	..	10	..	10	44	10
10. Clay	..	6	..	..	45	4
11. Black shale	11	0	..	..	56	4
12. Dark shale	10	6	..	..	66	10
13. "Hard rock" (limestone?)	..	6	..	..	67	4
14. Black shale	1	6	24	0	68	10
15. COAL V	1	6	1	6	70	4
16. Clay	3	0	..	..	73	4
Division IV—						
17. Light shale	5	0	..	..	78	4
18. Dark shale	5	6	13	6	83	10
19. COAL IV	2	0	2	0	85	10
20. Clay	3	0	..	..	88	10

	Ft.	In.	Ft.	In.	Ft.	In.
Division III—						
21. Light shale	9	2	..	..	98	0
22. Dark shale	20	0	..	..	118	0
23. Dark blue shale	5	0	37	2	123	0
24. COAL III, 4 in. of bottom, soft	3	0	3	0	126	0
25. Hard clay	3	6	..	..	129	6
Division I—						
26. Sandstone	3	0	..	..	132	6

The section at the Parke County Coal Company's shaft No. 6 is given to be as follows:

547. SECTION 119. SECTION AT PARKE COUNTY COAL COMPANY'S SHAFT No. 6.—Fig. 3.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Clay	8	0	..	..	8	0
2. Gravel	..	..	..	..	..	..
3. Blue clay	2	0	..	..	10	0
Division VI—						
4. Shale	53	0	..	..	63	0
5. Sandstone	4	0	..	..	67	0
6. Black shale	3	0	..	..	70	0
7. COAL VIa?, "rider"	2	6	2	6	72	6
8. Fire-clay	4	0	..	..	76	6
9. Sandstone	3	0	..	..	79	6
10. Soft fire-clay	..	6	..	..	80	0
11. Limestone	..	4	..	..	80	4
12. Fire-clay	2	0	..	..	82	4
13. Sandstone	5	0	..	..	87	4
14. Shale	5	0	19	10	92	4
15. COAL VI (Fig. 6)—						
Coal, 1 ft. 0 in.						
Sulphur band, 1 in.						
Coal, 1 ft. 6 in.						
Sulphur band, ½ in.						
Coal, 1 ft. 2 in.						
Clay and shale, 4 in. to 6 in.						
Coal, 2 ft. 0 in.						
Sulphur band.						
Coal, 4 in.						
Sulphur band, 0 to ½ in.	6	8	6	8	99	0
16. Fire-clay	2	8	..	..	101	8

An exposed section, showing the strata accompanying Coal VI, is found opposite Cox No. 2 shaft. Coal VI occurs just below this.

548. SECTION 120. SECTION IN RAVINE NEAR COX NO. 2 MINE.—

	Ft.	In.
1. Surface	10	0
Division VI—		
2. Light brown shale	6	0
3. Blue shale with two bands of ironstone	6	0
4. Blue-gray to black sheety shale	1	6
5. COAL VIa	..	8
6. Shale	..	2
7. COAL VIa	..	2½
8. Fire-clay ... 5 ft. to	6	0
9. Sandstone	1	0
10. Sandy shale	18	0

A rough section, somewhat more comprehensive than the last, was obtained at the old shaft of Cox No. 1.

549. SECTION 121. SECTION AT COX'S NO. 1 SHAFT.—

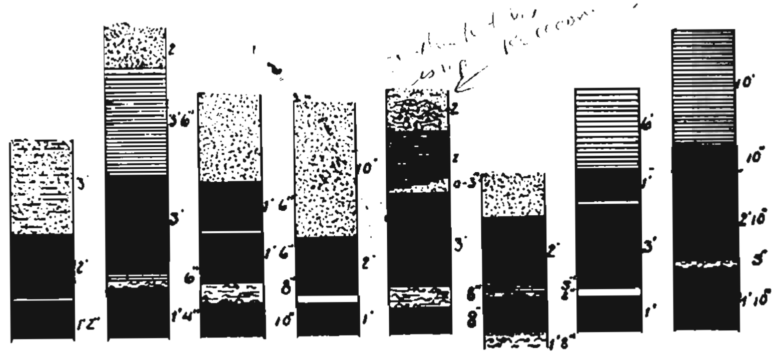
	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface and drift, curbed	18	0	..	..	18	0
2. Shaly sandstone	14	0	..	..	32	0
3. Blue shale, becoming black toward bottom	24	0	..	..	56	0
4. COAL VIa	1	0	1	0	57	0
5. Curbing (fire-clay, etc.)	12	0	..	..	69	0
6. Shaly sandstone	11	0	..	..	80	0
7. COAL VI	6	6	6	6	86	6

550. THE COALS of this township are very similar to their continuation in the last township, except Coal VI. It is the only workable coal in the area as far as developed. Coal VIa and some of the others are stripped a little for neighborhood use. It would not be surprising if Coals V and III were found of workable thickness, particularly in the eastern part of the township, and that Coal VII of workable thickness be found in the western part.

Coal VI ranges around 6 ft. in thickness. Its most distinguishing feature is a dirt band or parting from 0 to 8 in. thick, the lower part of which is fire-clay, the upper shale. A foot or 18 in. from the top is a very persistent band of sulphur or pyrite, and 6 or 8 in. from the bottom is often found another sulphur band. The variation in thickness is largely confined to the lower bench, except in the vicinity of the Coxville Carboniferous river. This coal is a strong, caking coal, inclined to be sulphury, but where washed, as at Cox No. 3, making an excellent fuel. About 75 per cent. will be lump. Its composition is shown in the following analysis by Mr. Noyes of coal from Cox No. 3 mine:

Fixed carbon	46.45	
Volatile combustible matter	41.88	
Total combustible matter		88.33
Ash	5.10	
Moisture	6.49	
Sulphur	2.98	
Total waste		14.52
Pounds of water evaporated per pounds of coal		13.1

The roof is usually a blue shale and very poor. In places the sandstone comes down onto the coal, making a good roof. The under clay, while not very deep, tends to creep to such an extent that special measures have to be adopted to counteract this tendency. As far as examined, this coal runs here quite regular in thickness, with few rolls, faults or other disturbances.



230 Cornelius. Sec. 9. 231 Berry. Sec. 22. 232 Evans. Sec. 15. 233 Rock House. Sec 15. 234 Wheats. Sec. 15. 235 236 Hawkins. Sec. 22. 237

Figs. 230-237. Sections of Coal VI in T. 14 N., R. 8 W., principally east of Raccoon creek, showing effect of Coxville river erosion.

551. Distribution and Details East of Raccoon Creek.—Descending Iron creek, Coals VI and VIa are reported on the Geo. Bailey and Presley Daniels places in Sec. 3. They were not seen, but are said to be 8 ft. apart, separated by fire-clay, the lower being 4 ft. (?) thick and the upper 2 ft. On the J. P. Conelius place, east side of Sec. 9, Coal VI is about 15 ft. above the bottom of a small branch. Where it has been drifted upon, it is in two benches, the upper measuring from 1 ft. 3 in. to 2 ft., the lower bench 1 ft. 2 in., the parting ½ to 1 in. (Fig. 230). The roof is shaly sandstone, 3 ft.+ thick, which, 10 ft. above the coal, shows as a massive outcrop 6 or 8

ft. thick. Coal VIa is reported to be 18 ft. above and to be 18 in. thick, with its usual parting, and underlain by 6 ft. of fine fire-clay.

The lower part of Iron creek or Rock run is shut in by overhanging bluffs of sandstone.

In the east bank of Raccoon creek, opposite Coxville, is the exposure of a sandstone filled erosion channel, which has been given the name of Coxville Carboniferous river. As this sandstone was, by the old survey, considered to be a ridge of Mansfield sandstone, the following sketch is given, showing the true relations:

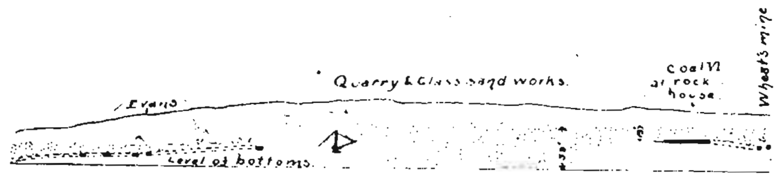


Fig. 238. Rock exposures across Racoon creek from Coxville, to show relation of Coal VI to the sandstone at crossing of "Coxville Carboniferous river."

The channel proper is some 600 ft. broad and exposed to a depth of at least 40 ft. and how much deeper is not known. The sandstone of this filling is massive, hardly showing a suggestion of bedding. Toward the west side is a little of the appearance of crossbedding, or perhaps more closely resembling sand dune structure. Above this 40 ft. of exposed channel the sandstone rises without perceptible break or change, another 15 ft., but now spreads out on either side. On the east side this can be traced some 100 ft. or so, by a clean exposure, to a rock house, where Coal VI is seen immediately underlying the sandstone. On the west the extension of this upper sandstone can be traced some distance, though poorly exposed for the first 150 yds., and there, too, it immediately overlies Coal VI. The age of the sandstone is thus put as late as the age of the horizon of Coal VI. Further south, there is commonly met with a nonconformability a little above Coal VI, and accompanying measures are often cut out and replaced by sandstone. The erosion is both of the channel and broad wash order, the channels having been noted as much as 16 ft. deep. It, however, seldom does more than remove the top of the coal, and not a single instance is recalled of its having cut through and below the coal. There is, thus, some evidence suggesting that the sandstone at Coxville belongs to the period of Division VI, but there is also some evidence that it belongs to a much later period. If, as has been suggested, this is part of the same channel or system of channels as at Silver Island, Rockport, Mecca and other places to be mentioned, it has cut channels 150 ft. or more deep, extending almost, if not quite, through the measures. Such channels require some time for their cutting, and it would seem as though, if this took place during the time period of Division VI, there should be more general evidence of a marked nonconformity than there is. The assumption of an unusually large uplift in the northeastern part of the coal field during that period might in part explain its absence elsewhere. For the present the question must remain an open one. The course of this channel was not discovered, but it appeared to cross the creek near Coxville, and go west or south of west, coming from the north.

On the west of the channel, Coal VI is worked on the Melville Evans place, the coal there ranging from 3 ft. 6 in. to 4 ft. 6 in., with an average of about 4 ft. (Fig. 232). The dirt band is 8 in. thick; the upper bench 3 ft., with a sulphur band in the middle; the lower bench is 8 or 10 in. thick. The roof is sandstone, 15 ft. being exposed. It makes a solid, but uneven roof, and the coal is subject to "rock spars" or sandstone veins. Several openings have been made along here, showing a marked rise to the southeast.

At the channel, the sandstone is quarried, and the top, which is very white and pure and a freestone, is extensively prepared and shipped to be used as a glass sand. Southeast of this a short distance is the rock house just mentioned, at the back of which the coal is 3 ft. thick with the "dirt band" 2 ft. from the top (Fig. 233). The coal at this point indicated a continuation of the southeast rise noted at Evans. In a ravine just beyond this, at the Wheat mine, the coal appears to have dropped 15 or 20 ft. as though faulted with downthrow to the east. There are several openings here. At the western one the section is (Fig. 234):

probably a lower coal ft.

	Ft.	In.
1. Surface	2	0
2. Bone coal to black shale	2	0
3. Coarse-grained carbonaceous sandstone, lenticular, 0 in. to	0	3
4. COAL VI—		
Coal, 3 ft. 0 in.		
Shale and clay, 8 in.		
Coal, 8 in.	4	4

In another entry just north the lenticular sandstone becomes 2 ft. thick and cuts the coal down to 2 ft. At still another entry the coal is again 3 ft. 6 in., with a 5 in. parting (Fig. 235). It is said in places the roof gets regular and the coal becomes 5 ft. thick.

A short distance east, in Sec. 22, Coal VI reaches its normal development on the Hawkins place. The coal is here 25 to 30 ft. above

the bottom of Raccoon creek. The sections at two openings were as follows (Figs. 419-420):

		Ft.	In.
Gray shale with thin layers of sandstone		10	0
COAL	1 ft. 0 in.	..	10
Parting, knife edge to		..	¼
COAL	3 ft. 0 in.	2	10
Parting, clay, etc.	1 in.	..	3
COAL	1 ft. 0 in.	1	10
Fire-clay		..	..

Coal VI rises to the top of the bluff and was not seen farther east. In the N. E. ¼ of Sec. 22, where the bluff and creek come close together, Coal Vb or Coal Va is exposed. The section there is (Sect. 121):

	Ft.
1. Massive yellow sandstone	12
2. Blue to gray or uneven black shale with 8-in. layer of fossiliferous limestone in places, 7 ft. from top	10
3. Dark gray fissile jointed shale	1
4. COAL (exposed)	1

Upper Raccoon Coal 1 ft.

One or two other coal outcrops were reported north or east of this that were not visited.

552. Distribution and Details of Coals of West of Raccoon Creek.—Coal VI outcrops just above the level of the bottom and at the foot of the bluff, so that its line of outcrop nearly follows the gravel road north from Coxville, and the C. & E. I. R. R. south from Coxville to Rosedale, where it continues southeast across the flat land. It is probably cut out across the old valley of Raccoon creek south of Rosedale.

Both Coals VI and VIa outcrop at a number of places in Sec. 5, notably on the A. Lewis place, S. E. of N. W. of Sec. 5, and J. Tobin place, S. E. of S. W. of Sec. 5. On the latter place the section is typical, as follows:

553. Section 122. Section on J. Tobin's Place.—Sec. 5.

	Ft.	In.	Ft.	In.	Ft.	In.
Slope	50+	0	..	..	50	0
Gray sandy shale	20	0	..	..	70	0
Black bituminous sheety shale	2	0	..	..	72	0
COAL VIa—						
Coal, 10 in.						
Parting, 1 in.						
Coal, 6 in.	1	5	1	5	73	5

	Ft.	In.	Ft.	In.	Ft.	In.
Fire-clay	6	0	..	..	79	5
Sandstone	..	10	..	..	80	3
Soft gray shale	3	0	9	10	83	3
COAL VI (poorly exposed)	3	0	3	0	86	3

Coal VI is said to run about 3 ft. 6 in. thick with a band about 2 ft. from the top, the lower bench being very hard and pure and coming out in large blocks.

As far as could be learned, no coal has been exposed in Secs. 8, 17 and 16, the coal probably dipping too low to be cut by the drains.

In a ravine at Coxville the measures are well exposed. Coal VI shows at one point 3 ft. 3 in. thick without parting. Over it is 3 ft. 6 in. of light drab clay shale, then 2 ft. of sandstone; above that is the section obtained across the ravine, ¶548. Coal VI was formerly extensively worked at shafts Cox No. 2 and No. 1 in this ravine. Mr. Barry is working a small area east of this ravine that had been left on account of irregularities of the sandstone roof. His coal runs about 4 ft. 10 in., with a 6 in. dirt band, the upper bench being 3 ft. At the end of this point the coal rises to the east very sharply and has been opened upon at the end of the point at a considerable elevation above its position at Cox No. 2 shaft. Going south from Coxville along the C. & E. I. R. R., coal has been opened upon at a number of places before reaching Parke County Coal Company's No. 9 mine, a slope. Near Coxville the exposures show a sandstone roof, but near No. 9 mine 20 ft. of sandy blue shale shows over the coal. Where noted at one point near No. 9, being worked for wagon trade, the coal measured 4 ft. 6 in., with the parting 3 ft. from the top.

At old Parke County Coal Company's No. 1 mine, being worked for wagon trade, the coal measured about 5 ft. 6 in., the same 3 in. dirt band coming 1 ft. from the bottom as far as exposed, and a sulphur band 1 ft. from the top. The roof is brown to gray shale (see Fig. 7).

To the west of the line of outcrop Coal VI has been found by shafts at Cox No. 3 mine, and at Parke County Coal Company's mines Nos. 6, 8, 2 and 5. The last two are worked out. At No. 2 mine it is said to have been 35 ft. to the coal, and 90 ft. at No. 5 mine.

At the Parke County Coal Company's No. 6 mine it is 81 ft. to the coal, the section having been given in ¶547 (see Figs. 3 and 6 of Plate XIX). The roof seems to stand in the rooms if they are systematically worked out, but tends to come down badly in the entries, there being in the shale and on top of the coal soft calcareous layers. The coal dips strongly to the southwest and is quite subject to faults

in which the downthrow is as much as 6 or 7 ft. Slight faults, accompanied by clay veins, were sketched, and two of them are shown in Figs. 3 and 4 of Plate III, in Part I.

At Parke County Coal Company's No. 8 mine the coal is 125 ft. deep at the shaft and 150 ft. at the double parting, 430 yards to the west. A number of measurements made showed a range from 6 ft. 1 in. to 7 ft. 1 in., the average being between 6 ft. 6 in. and 6 ft. 9 in., the parting being from 1 in. to 1 ft. thick, and coming 2 ft. 6 in. to 3 ft. from the bottom (Fig. 4). The roof is made by 6 ft. of gray sandy shale, which, in the new entries, shows but a few inches of "draw slate," but in the old entries comes down to a depth of 6 or 10 ft., or even more in long arches. At such places there appeared above the gray shale 3 ft. of a fake-like mixture of shale and gravel, and above that a mixture of fire-clay, shale and sandstone gravel. Below the coal is 4 ft. of fire-clay running into sandstone. It tends to creep. Clay veins from 1 in. to 1 ft. thick are also found at this mine and have been traced a half mile in some cases. Their direction is not regular. This is a machine mine, having also tail rope haulage.

At Cox No. 3 mine, of the Brazil Block Coal Company, Coal VI is ~~180~~ ft. deep. It ranges from 5 ft. 2 in. to 7 ft. 6 in., with an average of about 6 ft. 6 in. (see Fig. 5). The parting 4 ft. from the top averages about 2 in., ranging from ½ in. to 6 or 7 in. There are two quite persistent sulphur bands 1 ft. from the top and 6 in. from the bottom. The latter does not appear on the north side of the mine. On the north side of the shaft the coal is thinner, cleaner, and has a better roof than on the south side. The roof on the south side is a blue shale, of which from 18 in. to 4 ft. come down when it is left standing. The fire-clay is 6 ft. thick, running into sandstone. It tends to creep and this tendency is met by the method of laying out the mine described and figured in Part IV. This is a machine mine and has one of the best surface plants in the State, being equipped with washing and crushing machinery, revolving screens, etc., and having a storage capacity of 350 tons of the small sizes of washed coal. All the coal that goes through a 2-in. screen is washed and sized.

As far as could be learned, we would expect Coal VI to be found to be a practically continuous bed under all the western part of the township. There is, however, a rapid dip to the west and toward the western edge of the township it is probable that the coal lies at a depth of at least 300 ft. below the table-land.

The bottom of the coal measures lies about 200 to 250 ft. below Coal VI.

TOWNSHIP 14 NORTH, RANGE 9 WEST. (PART IN PARKE COUNTY.)

554. LOCATION, ETC.—This partial township (the eastern part) forms the western quarter of Florida of the civic townships. It is about two-thirds river bottom and the rest bluff and table-land, modified by the glacial moraine. The C. & E. I. R. R. crosses the southern part from northwest to south.

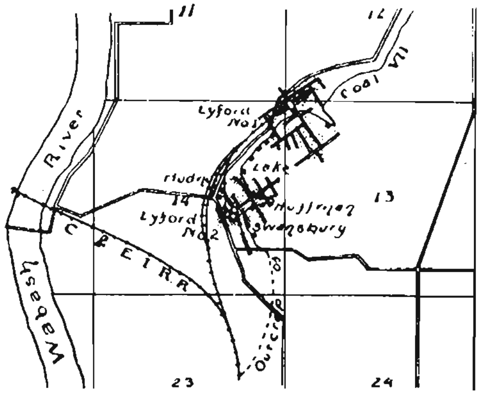


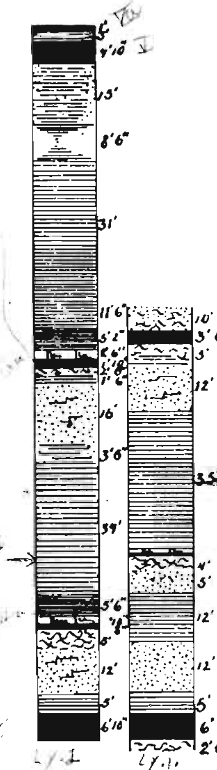
Fig. 239. Sketch map of part of T. 14 N., R. 9 W. The worked out portion of Coal VI only is indicated.

555. STRATIGRAPHY AND COALS.—The stratigraphy of this township is much the same as the last, except that the full thickness of Division VI is found, and Coal VII is well exposed.

A section of Lyford No. 2 shaft, 143 ft. to coal, 147 was given by Mr. McCullum, who sunk the shaft, and in addition is given the bluff section up to and including Coal VII. It is as follows:

556. SECTION 123. SECTION OF LYFORD NO. 2 SHAFT AND STRATA ABOVE.—Fig. 240.

Division VII—	Ft.	In.	Ft.	In.	Ft.	In.
1. Bone coal, COAL in places	1	0	1	0	1	0
2. Black fissile shale	1	0	..	..	2	0
3. Black bituminous sheety shale, with pyrite concretions	2	0	..	..	4	0
4. Soft black shale......0 to	..	2	3	2	4	2
5. COAL VII	4	10	4	10	9	0



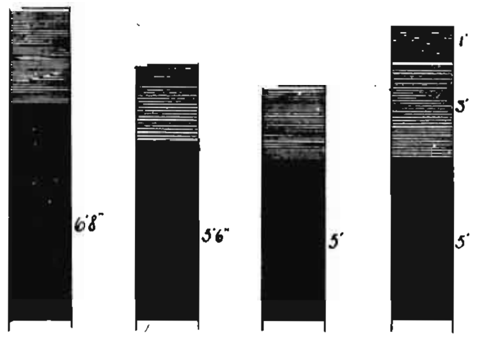
Figs. 240, 241. Columnar sections at Lyford, T. 14 N., R. 9 W.

Division VI—	Ft.	In.	Ft.	In.	Ft.	In.
6. To top of shaft, mostly sandy shale	15	0	..	..	24	0
7. Surface (in shaft)	8	6	..	..	32	6
8. Blue shale	31	0	..	..	63	6
9. Gray shale	11	6	..	..	75	0
10. Black shale	5	2	..	..	80	2
11. Black limestone	2	6	73	8	82	8
12. COAL VIb	1	10	1	10	84	6
13. Fire-clay	2	6	..	..	87	0
14. Light sand shale	1	6	..	..	88	6
15. Gray sandstone	16	0	..	..	104	6
16. Gray sandy shale	3	6	..	..	108	0
17. Dark gray shale	34?	0	..	..	142	0
18. Black shale	5	6	..	..	147	6
19. Limestone	..	10	63	10	148	4
20. COAL VIa	..	8	0	8	149	0
21. Fire-clay	5	0	..	..	154	0
22. Sandstone	12	0	..	..	166	0
23. Gray shale	5	0	22	0	171	0
24. COAL VI	6	10	6	10	177	10

The following section is given by Mr. Scovell in his report on Vigo county in the 1896 report:

557. SECTION 124. SECTION AT LYFORD (J. T. S., p. 541).—Fig. 241.

Division VI—	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil, surface sand and clay	10	0	..	..	10	0
2. COAL VIb	3	0	3	0	13	0
3. Fire-clay and shale	5	0	..	..	18	0
4. Sandstone	12	0	..	..	30	0
5. Gray shale, some dark	35	0	..	..	65	0
6. Limestone	..	8	52	8	65	8
7. COAL	..	4	0	4	66	0
8. Fire-clay and shale	4	0	..	..	70	0
9. Sand rock	5	0	..	..	75	0
10. Shale, dark and light	12	0	..	..	87	0
11. Sandstone	12	0	..	..	99	0
12. Shale	5	0	38	0	104	0
13. COAL "L," with dirt band (VI)	6	6	6	6	110	6
14. Fire-clay	2+	..	..	..	112	6



242 Ravine back of Lyford No. 1. Sec. 13. 243 Lake. Sec. 14. 244 Huffman. Sec. 14. 245 Swansburg. Sec. 14.

Figs. 242-245. Coal VII at Lyford.

558. COAL VII.—In the earlier reports this was thought to be the same as the coal at Rosedale and Coxville (formerly Roseville). It appears to be a solid bed from 4 ft. to nearly 7 ft. thick, and appears to run from fair to excellent in quality, in places showing considerable sulphur and at others appearing quite free. This coal was extensively worked when the Wabash & Erie canal was in operation. The roof is a black sheety shale, which generally makes a fine roof,

it being said that this roof will often hold up until the pillars have all been drawn over a large area. Drifts opened in the '50's are still open, which indicates a good roof.

559. DIVISION VI AND COAL VI.—As indicated by these sections, Division VI is here from 150 to 175 ft. thick, and contains at least three coals. A section across the river at Clinton showed five coals, not including the coals immediately underlying Coal VI, of which at Lyford No. 2 shaft there were said to be three. This would indicate a maximum of eight coals in this division if the three last mentioned coals be included in this division. While some of these smaller coals

Fig. 246. Coal VI at Lyford No. 1 mine.

reach a thickness of 3 ft. and are claimed to be of excellent quality, they will hardly be sought while any of Coals VI or VII are available. Considering only the coals in the sections given above, Coal VIb, or the "little vein," as it is locally called, would appear to be the same as the coal worked at the Johns bank south of Mecca. It is said to be of excellent quality. Coal VIa appears to occupy the same relative position as near Coxville, but is reported to be thin and sulphury. It is overlain by limestone. It lies from 20 to 25 ft. above Coal VI. The column shows at least two considerable thicknesses of shale.

Coal VI is reached in the two Lyford shafts. It is similar to the same coal at Coxville, averaging about 6 ft. 6 in., though running up to 7 ft. 6 in. and having a 4 or 5 in. parting below the middle. It also shows the two sulphur bands as at Coxville and elsewhere. A section of the coal as given at Lyford No. 1 is as follows (Fig. 246):

	Ft.	In.	Ft.	In.
Coal	1	1	..	..
Sulphur band ... 1 in. to	..	1½	..	..
Coal	3	0	..	..
Clay, shale and sulphur	..	6	..	..

	Ft.	In.	Ft.	In.
Coal	1	0	..	..
"Blue band" (bony coal and sulphur)	..	3	..	..
Coal	..	3	..	..
Sulphur band	..	1½	6	4
Fire-clay	..	..	7	0+

The roof of this coal is shale, and, as elsewhere, very poor. The underclay is 7 or more ft. thick and of fine quality, very plastic and inclined to creep. At Lyford No. 2 three beds, 8, 10 and 16 in. thick respectively, are said to have been dug through in digging the sump 14 ft. deep.

560. Distribution of Coals.—Coal VII outcrops in the bluff back of Lyford, and probably 25 or 30 ft. above the bottom land. The dip south, as nearly as could be learned, is rapid, carrying it down to river level probably before reaching the south line of the township. To the north it probably rises rapidly and we should expect it to outcrop at the top of the bluff, beneath the drift near the north line of the township. It probably underlies all of the east township line. It is reported to have been worked out from under the N. W. ¼ of Sec. 13 and parts of the N. E. and S. E. quarters of Sec. 14; S. W. ¼ of Sec. 13. It does not appear to have been worked to any extent north or south of Sec. 13. It is being worked on a small scale at the J. L. Swansburg and Anderson mine, N. E. of S. E. of Sec. 14. The thickness here is from 5 ft. to 5 ft. 6 in., the upper 3 ft 6 in. being the hardest coal. The dip here is slightly west and north. At the Lake bank, S. E. of N. E. of Sec. 14, the coal was set on fire about 1880 and the pillars are still burning, the water coming from the mine being quite warm. Other banks are still open, though not working, all the way from Lyford No. 1 shaft to No. 2 shaft. Mining is said to have been carried east 1,300 ft. to where the coal was cut off by a "clay slip." The nature of this could not be learned, but it is probably a fault or a preglacial cut-out, and in either case should not interfere with the proper development of this coal a short distance farther east.

Coal VI, lying 160 ft. below Coal VII, has been reached by Lyford No. 1 and No. 2 shafts of the Wabash Coal Company. At No. 1 shaft the coal is reported to be 139 ft. deep, at No. 2 shaft 143 ft. deep. The coal was described above. To the north it must rise rapidly and probably gets much thinner toward the north township line. To the south it probably dips much as does Coal VII, so that at the southwest corner of the county it is probably about 150 ft. below low water in the Wabash river and maintaining the same thickness as at Lyford.

561. Summary of Coals of Parke County.—

Divisions contained: VII-I.

Coals contained: VII, VIc, VIb, VIa, VI, Vb, Va, V, IV, III, I.

Round Number Estimates.

Coal VII.

Worked area	¼ sq. mi.	× av. thickness,	5 ft. × 500,000 =	625,000 tons.
Workable area	5 sq. mi.	× "	5 ft. × 500,000 =	12,500,000 tons.
Unworkable area	5 sq. mi.	× "	1 ft. × 1,000,000 =	5,000,000 tons.
Total area	10 sq. mi.			18,125,000 tons.

Coal VIb.

Worked area	1 acre	× av. thickness,	3 ft. × 1,000 =	3,000 tons.
Workable area	1 sq. mi.	× "	3 ft. × 500,000 =	1,500,000 tons.
Unworkable area	10 sq. mi.	× "	1 ft. × 1,000,000 =	10,000,000 tons.
Total area	11 sq. mi.			11,503,000 tons.

Coal VIa.

Unworkable area. 50 sq. mi. × av. thickness, 1½ ft. × 1,000,000 = 75,000,000 tons.

Coal VI.

Worked area	2 sq. mi.	× av. thickness,	6 ft. × 500,000 =	6,000,000 tons.
Workable area	30 sq. mi.	× "	6 ft. × 500,000 =	90,000,000 tons.
Unworkable area	20 sq. mi.	× "	1 ft. × 1,000,000 =	20,000,000 tons.
Total area	52 sq. mi.			116,000,000 tons.

Coals Vb and Va.

Unworkable area. 100 sq. mi. × av. thickness, 1 ft. × 1,000,000 = 100,000,000 tons.

Coal V.

Worked area	1 sq. mi.	× av. thickness,	4 ft. × 500,000 =	2,000,000 tons.
Workable area	10 sq. mi.	× "	4 ft. × 500,000 =	20,000,000 tons.
Unworkable area	100 sq. mi.	× "	1 ft. × 1,000,000 =	100,000,000 tons.
Total area	sq. mi			122,000,000 tons.

Coal IV.

Worked area	1 sq. mi.	× av. thickness,	4 ft. × 500,000 =	2,000,000 tons.
Workable area	50 sq. mi.	× "	3 ft. × 500,000 =	150,000,000 tons.
Unworkable area	150 sq. mi.	× "	1 ft. × 1,000,000 =	150,000,000 tons.
Total area	200 sq. mi.			302,000,000 tons.

Coal III.

Worked area	1 sq. mi.	× av. thickness,	4 ft. × 500,000 =	2,000,000 tons.
Workable area	50 sq. mi.	× "	3 ft. × 500,000 =	150,000,000 tons.
Unworkable area	100 sq. mi.	× "	1 ft. × 1,000,000 =	100,000,000 tons
Total area	150 sq. mi			252,000,000 tons.

Coal I.

Unworkable area. 200 sq. mi. × av. thickness, ½ ft. × 1,000,000 = 100,000,000 tons.

Number of coals contained: 11.
Greatest thickness recorded: 7 ft. 6 in., around Rosedale.
Average thickness, 1 ft. 4 in.
Area underlain by coal and coal measure rocks: 470 sq. mi.
Area underlain by workable coal: 100 sq. mi.
Contained in western and southern portion of county: ——.
Estimated total tonnage of coal: 996,628,000 tons.
Estimated total tonnage of coal removed: 12,628,000 tons.
Estimated total tonnage of workable coal left: 424,000,000 tons.
Number of mines working ten men or over in operation: 13.
Number of mines working less than ten men in operation: 53.
Total number of mines in operation: 66.
Large mines abandoned: 22.
Strippings and outcrops: 210+.
Total number of openings to coal: 231+.

XX. VERMILLION COUNTY.

562. References and Field Work.—

1838-1853-1859. D. D. Owen, Cont. of a Rep. of a Geol. Reconn. of Ind., made in 1838, pp. 35-37. Coal section. (D. D. O.)

1862 (1859). Richard Owen, Rep. of a Geol. Reconn. of Ind. made in 1859-60, pp. 167-169. One columnar section and coal analysis. (R. O.)

1862 (1859). Leo Lesquereux, same, p. 338.

1869. E. T. Cox, 1st Ann. Rep. State Geologist of Ind., pp. 132-135. One coal analysis. (E. T. C., '69.)

1869. Frank H. Bradley, same, pp. 138-174. Fifteen columnar sections. (F. H. B.)

1875. E. T. Cox, 7th Ann. Rep. State Geologist of Ind., pp. 67-68. One coal analysis. (E. T. C., '75.)

1895. W. S. Blatchley, 20th Ann. Rep. Dept. of Geol. & Nat. Resources, pp. 65-71. Three columnar sections, only one with coal. (W. S. B.)

1895. T. C. Hopkins, same. Description of building stone at Worthy, pp. 306-309; two plates. (T. C. H.)

1897. E. M. Kindle. Field work for this report.

Section 1. Geographical.

563. Location.—Vermillion county lies next to the Illinois State line, and due west of the center of Indiana. It lies south of Warren county, west of Fountain and Parke, from which it is separated by the Wabash river, and north of Vigo county.

564. Extent.—Extreme length from north to south of 37.5 mi.; width from east to west of from 4.9 to 9.5 mi., with an average of less than 7 mi. It has an area of about 250 sq. mi. It includes all of range 9 west, that lies west of the river in townships 14-19 north, and all of range 10 west in Indiana in the same townships.

565. Elevation.—The known elevations in this county range from 662 near Dana on the table-land to about 460 where the Wabash river leaves the county, a range of fully 200 ft. The elevation of a number of points above tide is given below:

	Ft.
State line, C., C., C. & St. L. Ry.	607
Hood's crossing, 1 mi. east of Dana, I., D. & W. R. R.	662
Dana, I., D. & W. R. R.	656
Track, Illinois and Indiana State line, I., D. & W. R. R.	641
Gessie, C. & E. I. R. R.	616
Perrysville, depot, C. & E. I. R. R.	682
Perrysville, C. & E. I. R. R.	592
Summit Grove, C. & E. I. R. R.	520
Eugene, C. & E. I. R. R.	507
Newport, C. & E. I. R. R.	506
Hillsdale railroad crossing, I., D. & W. R. R.	500
Clinton, C. & E. I. R. R.	494
Newport, C. & E. I. R. R.	494
Low water in Wabash, Perrysville, C. & E. I. R. R.	489
Low water in Wabash, I., D. & W. R. R.	474
Low water in Wabash, Clinton, C. & E. I. R. R.	464
High water in Wabash, Clinton, C. & E. I. R. R.	479

566. Drainage and Topography.—The Wabash river on the east forms the drainage level for the county. Its bottom lands on the west occupy nearly a third of the county. North of Perrysville the bluffs are not conspicuous. The river flows through a narrow valley cut in the sandstone, which outcrops at frequent intervals in a ledge rising 30 to 50 ft. above the river from Spring creek to Fort Defiance. South of Jordan creek the sandstone ceases and the clay and gravel terrace, flanked by low bluffs on the west, continues to the Big Vermillion valley. Between the Big and Little Vermillion

rivers the Wabash bottom land reaches its extreme breadth of 2.5 to 3.5 mi. In addition to the terraces at the mouth of the Big Vermillion, extensive deposits of sand and gravel occur at a much higher level at several localities, suggesting a former delta made by that stream. For 4 mi. north and 2.5 mi. below the mouth of Raccoon creek the bluffs are high and close to the river, so that the small tributaries serrating the front of the bluff yield numerous good exposures of the coal measures. Below the point mentioned, the bluffs swing off to the southwest, leaving a wide terrace of sand, gravel and clay, principally comprised in Helt's prairie, which rises about 40 ft. above the river. In the southern part of the county the bluffs are one or two miles from the river, and rise 100-135 ft.

The rest of the county may be described as a high, flat prairie-like country, cut through by the Big and Little Vermillion rivers and Brouillet's creek and cut into by the small streams. The Big and Little Vermillion have cut down to the base level of the Wabash. Of the smaller streams the most important are Spring creek, Raccoon creek, and Norton's creek. The most broken part of the county is probably along the Big Vermillion, the banks of which rise 100 to 140 ft.

567. Transportation Facilities.—The Chicago and Eastern Illinois railroad runs nearly the whole length of the county, principally along its eastern edge. The Toledo, St. Louis & Kansas City railroad (Clover Leaf route) crosses the county from east to west at the latitude of Cayuga. The Indianapolis, Decatur and Western railroad crosses at the latitude of Hillsdale.

568. Development.—The county is practically all under cultivation, except the bluffs of the Wabash and the banks of the streams which are too steep, these being generally still covered with timber. The manufacture of clay products is carried on to quite an extent near Hillsdale and Clinton, and a very small amount of manufacturing is conducted at Clinton and elsewhere.

Section 2. Stratigraphy.

569. Surface Deposits.—The drift deposits are quite heavy in the prairies of Helt township, ranging over 100 ft. deep in places, but along the Wabash valley and in the region of the Big and Little Vermillion rivers have been extensively removed. Along the Wabash bottoms and terraces are heavy post-glacial deposits, as described under Vigo county.

570. Coal Measures.—The various coals and spaces are indicated in the following stratigraphic table:

Division VIII—
1. Space over COAL VIIIa. Shale.
2. COAL VIIIa. Only noted in southwestern corner of county, 6 in. thick.
3. Space. 54 ft. of shale at the only point giving complete section.
4. COAL VIII runs from 3 to 5 ft. Worked along Brouillet's creek.

Division VII—
5. Space, ranging 80 ft. in south to 12 ft. in north. Fire-clay. Limestone, shaly sandstone and shale.
6. COAL VIIa; 0 to 2 ft. thick; only (?) noted around Clinton.
7. Space, about 20 ft. Fire-clay, limestone, shale, black shale or bone, sometimes becoming good coal.
8. COAL VII. Runs 3 to 5 or 6 ft. Worked at Clinton, north of Highland, at Dana, and at Horseshoe of Little Vermillion. Principal outcropping coal of county.

Division VI—
9. Space, 10 ft. Fire-clay, limestone, sandstone and shale.
10. COAL VIc. Local, only found at one or two points; 10 in. thick.
11. Space, 10 to 50 ft. Shale, limestone, black shale.
12. COAL VIb. Runs from 0 to 3 ft.; usually less than a foot.
13. Space, 30 to 60 ft. Shale (worked for brick), or sandstone (quarried), thin lines of ironstone, black shale.
14. COAL VIa, 0 to 2 ft. 6 in. Worked near Eugene.
15. Space. To north, fire-clay, 1 in. to 4 ft.; to south, fire-clay, sandstone and shale, 15 to 20 ft.
16. COAL VI. At south, 5 to 7 ft. thick. Lower bed at Clinton. Runs thin through Helt and Vermillion townships. Workable above Eugene on Big Vermillion river.

Division V—
17. Space of 6 to 10 ft.
18. COAL Vb (?), 1 ft. to 1 ft. 8 in. in Eugene township.
19. Space, 17 ft. in drilling near Hanging Rock.
20. COAL Va (?), 1 ft. 2 in. in same drilling.
21. Space.
22. COAL V, 0 to 4 ft. (reported) along Wabash river.

Division IV or III—
23. Space lacking to north, 40 or 50 ft. to south.
24. COAL IV or III in drillings at Hillsdale.

Division I—
25. Space. Sandstone of Division I along Wabash to north.
26. COAL I (?), not seen or reported.

Section 3. Detailed Geology.

TOWNSHIP 19 NORTH, RANGE 9 WEST. (IN VERMILLION COUNTY.)

571. LOCATION, ETC.—This township lies in the northeastern corner of Vermillion county and makes the northeastern part of Highland of the civic townships. Spring creek in the northern part and Jordan creek in the southern are the principal streams. The C. & E. I. R. R. crosses the southwestern quarter of it. Perrysville is the principal town.

571a. STRATIGRAPHY.—The drift attains a considerable depth over most of this area, so that exposures of the underlying rocks are confined to the bluffs of the Wabash. Mr. Bradley gives the following section of the rocks at Perrysville.

572. SECTION 125. SECTION AT PERRYSVILLE.—(F. H. B., p. 158.)

	Ft.	In.	Ft.	In.
1. COAL VI (?) (reported as found in wells)........................8 in. to	1	6	1	6
2. Fire-clay	2	0	3	6
3. Soft blue clay shale...........12 ft. to	15	0	18	6
4. Bluish drab shaly limestone....2 ft. to	3	0	21	6
5. Blue limestone, bottom rich in fossils..	3	0	24	6
6. Light blue and drab shaly clay..1 in. to	..	2	24	8
7. Soft black shaly calcareous clay.4 ft. to	6	0	30	8
8. Black sheety shale.............3 ft. to	4	0	34	8
9. Soft black shaly calcareous clay.3 ft. to	4	0	38	8
10. Light drab calcareous shale, rich in fossils ....1 ft. to	4	0	42	8
11. Soft black calcareous clay	1	0	45	8
12. Black sheety shale ....5 ft. to	..	6	44	2
13. Soft black shale...............12 ft. to	15	0	69	2
14. Dark drab shale with ironstone at top.	27	0	86	2

This section shows a marked similarity to the sections in Warren county, see especially the section on Rock creek (¶274). The coal in this section, occurring as it does above the limestone, would appear to occupy the position of what was called Coal VI in Warren county. Drilling to a depth of over 100 ft. below the limestone failed to reveal any coal.

573. DISTRIBUTION AND LOCAL DETAILS OF COAL.—Starting from the north, coal is first met in the valley of Spring creek. In the S. W. of S. E. of Sec. 10, 1 ft. of coal was passed through in a well at a depth of 6 or 8 ft. below the top of the hill.

In the S. E. of S. W. of Sec. 10, 16 in. of coal outcrop about 2 ft. above the creek and were formerly worked by two drifts, now caved in. A few rods below, the coal appears to have passed below the level of the creek and there is exposed above it 18 ft. of blue clay shale. A quarter of a mile further down 13 ft. of this bedded sandstone and shale are exposed, dipping 50° S. E. In the N. W. of S. W. of Sec. 10, a drilling to the depth of 65 ft. is said to have struck several little beds of coal of which the thickest was 6 in. In the S. E. of N. E. of Sec. 9, 6 ft. of blue clay shale is exposed on the north side of the creek. It contains some thin beds of iron ore and great numbers of coal plants.

In the S. W. of N. E. of Sec. 22, 2 ft. of coal, with an 18-in. clay parting, is reported to have been struck on the old Joseph Miller place. The coal is reported to have been a caking coal and to have run out to the west. The description agrees with that of the coal near Kitchen creek in Warren county, Sec. 16-20-9.

In the N. E. of S. W. of Sec. 27, a little north of Perrysville, coal was formerly worked by a drift, now caved in. It lay about 12 ft. above the bottom land, and had above it in the bluff: Surface, 8 ft. (?); sandstone, 4 ft. (?); light bluish-gray fire-clay, 4 ft. (?).

At Perrysville there appears to be a marked nonconformity between the sandstone of Division I and the overlying measures. In front of Perrysville for 300 yds. south of the ferry is an outcrop of the limestone and accompanying strata as given in the above section, the outcrop being along the top of the bluff about 35 ft. above low water. At the southern end there is a covered space of some 75 yds., when a 12-ft. ledge of sandstone sets in and continues for 2 mi. with no further trace of limestone. On the north the limestone runs nearly to the north edge of town, where the whole section is replaced with sandstone, the hidden interval being 50 or 60 yds. at the top of the bluff, but only about 15 ft. from the sandstone to the old lime kiln, which is said to have been dug in the soft clay shale at the base of the above section. The sandstone only runs two or three rods, when the limestone ledge sets in again along the top of the bluff, being at this point 6 ft. thick. It is only exposed for a few rods to the north, and is not seen further north in this county.

In the cellar and well of a store built in Perrysville in 1897 the following section was taken:

	Ft.	In.
Clay and gravel..............................6 ft. to	8	0
COAL ....18 in. to	1	8
Blue clay	10	0+

In a well at the restaurant just north of the postoffice the section is:

	Ft.	In.
Surface	12	0
COAL	1	4
Clay shale	12	0
Limestone	..	..

South of Perrysville the sandstone makes a nearly continuous ledge from the level of the bottoms to 20 to 35 ft. above the river, but no coal is seen.

At the schoolhouse in the N. E. corner of Sec. 31 a well is reported to have gone 135 ft. without striking coal.

574. SUMMARY OF COAL.—It does not appear certain that the coals mentioned above are all at one horizon, but as not more than one coal is reported at any point, in summing up it may be safe to assume only one coal in this area, and that nowhere reported of a workable thickness.

575. TOWNSHIP 19 NORTH, RANGE 10 WEST.—The drift is here quite deep, as may be judged from a well at Rileysburg which went 105 ft. in drift all of the way, and another well one and a half miles east which went 129 ft. and found a few feet of black clay toward the bottom. No exposures of rock are reported and it is not known whether workable coal is developed here similar to that at Hanging Rock in the township just south.

PARTIAL TOWNSHIPS 18 NORTH, RANGES 9 AND 10 WEST.

576. LOCATION, ETC.—These two partial townships, which together make about the equivalent of one normal township, may be considered together. They make up the southern part of Highland and northern part of Eugene of the civic townships. The southern part of the township is cut by the Big Vermillion river, along which are practically all the rock exposures.

577. STRATIGRAPHY AND COALS.—Division VI and top of V, outcrop in the southern part of area; Division I is exposed north of Jordan creek. The intermediate divisions presumably underlie a large part of the area. In Division VI are three coals, the uppermost one, however, not being persistent. Only one coal has yet been noted in the outcrop that is placed in Division V. The following sections will show the relations of these coals.

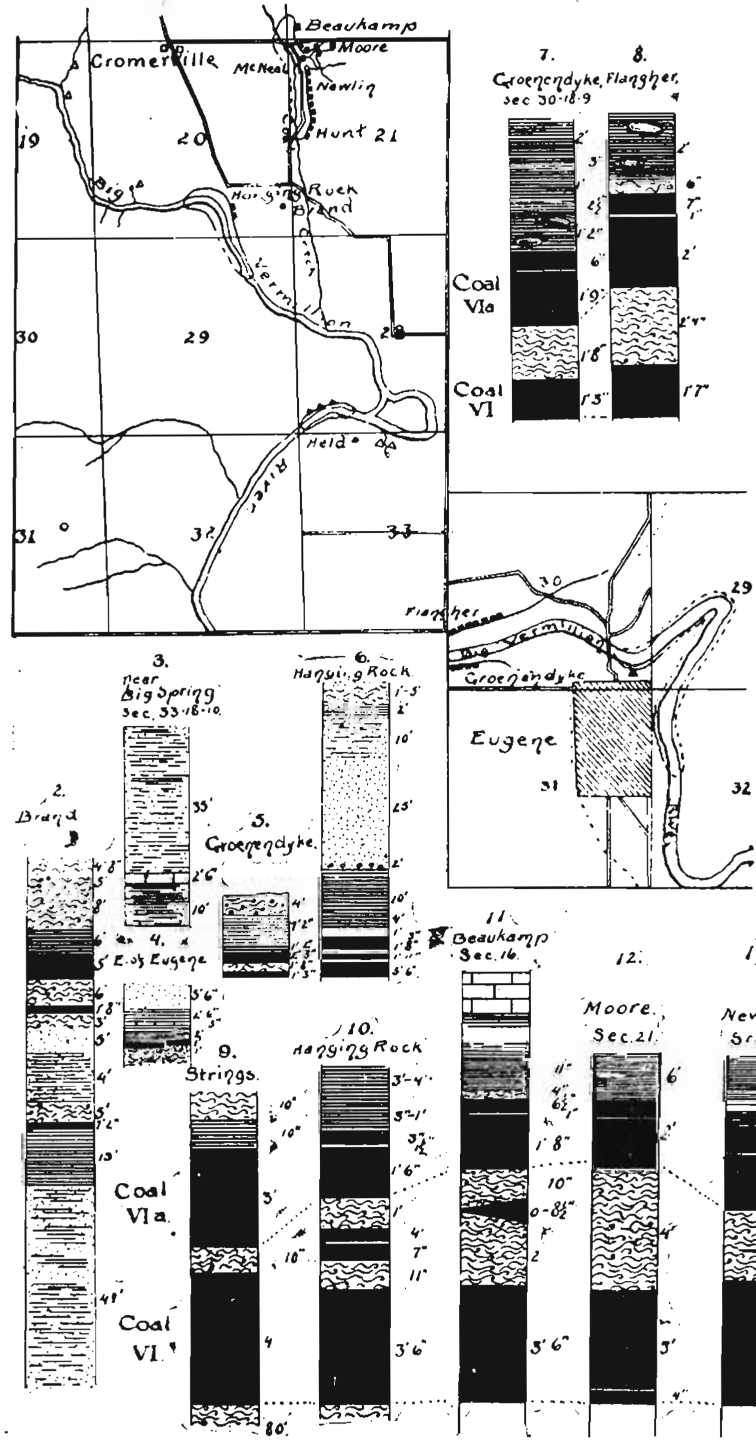


PLATE XX. Sketch map, columnar and coal sections in T. 18 N., Rs. 9 and 10 W.

578. SECTION 126. SECTION AT HANGING ROCK.—Sec. 28-18-9. (E. M. K.) Figs. 6 and 10.

		Ft.	In.
1.	Surface clay ....1 ft. to	5	0
2.	Soft bluish shale....................1 ft. to	2	0
3.	Sandstone, thin bedded	10	0
4.	Sandstone, massive, light brown to buff.........	25	0
5.	Concretionary band resembling conglomerate.....	2	0
6.	Bluish-black shale....................3 ft. to	12	0
7.	Black sheety shale..................3 ft. 8 in. to	4	2
8.	Soft rotten black shale....................3 in. to	..	12
9.	COAL, hard and brilliant, breaking with concoidal fracture....................2 in. to	..	3
10.	Blue clay....................5 in. to	..	1½
11.	COAL ....1 ft. 5 in. to	1	8
12.	Drab colored clay....................10 in. to	..	12
13.	COAL, soft, with 1-in. clay band 4 in. from the top	..	11
14.	Clay, light gray to light blue....................	..	11
15.	COAL IV ....3 ft. 2 in. to	3	6
16.	Fire-clay	..	..
		69	6½

579. SECTION 127. SECTION AT GROENENDYKE'S MINE.—Sec. 30-18-9, Figs. 5, 7. (E. M. K.)

		Ft.	In.
1.	Surface sand, gravel and clay....................	4	0
2.	Dark blue shale	4	0
3.	Soft black shale	2	0
4.	Soft dark blue shale	..	3
5.	Black sheety shale	1	0
6.	Soft dark blue shale	..	2½
7.	Tough black sheety shale, big pyritous boulders in roof	1	2
8.	COAL VIa	2	3
9.	Blue fire-clay	1	8
10.	COAL VI	1	3
		17	9½

580. SECTION 128. SECTION AT EUGENE.—Sec. 30-18-9, Fig. 4. (E. M. K.)

		Ft.	In.
1.	Sandstone, shaly, light gray	5	6
2.	Shale, dark blue, thickly laminated, soft..........	2	6
3.	Calcareous iron ore	..	3
4.	Sheety shale	2	0
5.	COAL Va ? or Vb....................	1	0
6.	Blue fire-clay, irregular, in composition soft and hard and siliceous with concretions	4	0

In giving this section Mr. Bradley notes 1 ft. of compact sandstone below the coal with 7 ft. 6 in. of fire-clay exposed below that changing to sandy shale at the bottom. The relation of this coal to the preceding is not clearly shown, its position, however, indicating that it lies just below the preceding section.

581. SECTION 129. SECTION OF DRILLING ON BRAND PLACE.—Sec. 20-18-10, Fig. 2. (E. M. K.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Loam	4	8	..	..	4	8
2.	Clay	5	0	..	..	9	8
3.	Fire-clay	8	0	..	..	17	8
4.	Black shale	6	0	..	..	23	8
5.	COAL VI	5	0	5	0	28	8
6.	Fire-clay	6	0	6	0	34	8
7.	COAL	1	8	1	8	36	4
8.	Clay	3	0	..	..	39	4
9.	Sandstone	5	0	..	..	44	4
10.	Metalliferous sand shale...	11	0	..	..	55	4
11.	Fire-clay	5	0	24	0	60	4
12.	COAL	1	2	1	2	61	6
13.	Soapstone	13	0	..	..	74	6
14.	Shaly sandstone and sandy shale	49	0	..	..	123	6

Coal No. (5) we have assumed to be Coal VI on account of the thickness, which is greater than is anywhere reported for Coal VIa; Coal No. (7) would appear to be a small bed sometimes found just below Coal VI, as at Lyford, Parke county.

582. COALS VI AND VIa.—These coals are here very close together, in one case being only 10 in. apart, and ranging from that up to 4 ft. Coal VIa ranges from 2 to 3 ft. thick, usually having its characteristic clay parting, though here it is quite near the top, and its characteristic black bituminous, sheety shale roof, with sulphur balls. In the clay separating the two beds there frequently appears a thin bed, ranging in thickness from 0 in. to 11 in. and not at all persistent. Coal is not common at this horizon, but is met with in western Clay and eastern Vigo counties. Coal VI ranges from 1 to 4 ft. in thickness. As usual Coal VIa is reported an excellent blacksmith coal. These coals have generally been considered as parts of one bed and in places they are said to come together so as to practically form one bed, yet a study of sections of Coals VI and VIa from Vigo county northward indicates quite conclusively that these are the beds which, to the south, become regularly 20 ft. or more apart.

583. Distribution and Details of Coal.—Mention has already been made of the outcrop of sandstone of Division I in the bluff of the Wabash from Jordan creek northward.

South of that, exposures of rock and coal are practically confined to the valley of Big Vermillion river. It will therefore be convenient to give first the data obtainable along that stream. Ascending from the mouth there is the gravel and sand terrace on the north side, with bottom land on the south side. A large mound near the center of Sec. 14 rises some 15 or 20 ft. above the bottoms, and appears to be a remnant of a post-glacial filling of the valley.

About a mile below Eugene, in the south bank, is met the sandstone filled channel described as occurring at Silver Island on the east side of the Wabash river. It shows here from 25 to 30 ft. of irregularly bedded highly ferruginous, coarse-grained sandstone, the southern edge being seen to cut off one coal and many feet of shale just below town.

East and north of Eugene the coal of Sect. 128, ¶580, is exposed or has been stripped, the section being as given. At the old mill north of town there is a local dip of 4° or 5° S. W. and south which carries the coal under the creek.

A little further up Coals VI and VIa are met with and have been mined by drifting at numerous places on both sides of the river. On the south side at the Groenendyke bank, the coal is about 20 ft. above low water in the river. The section varies considerably. At one bank it appears as given in Sect. 127, Figs. 5 and 7. Both coals have been worked, though in 1897 only Coal VIa was being worked. This coal varies from 2 ft. 2 in. up to 2 ft. 6 in. or more, becoming thicker to the west. It regularly shows a 1-in. sulphur band 6 in. from the top, otherwise clean. The roof of black sheety shale carries numerous large, pyritic concretions, one measuring 4 ft. by 2 ft. 10 in. Clay veins from 3 to 18 in. thick are occasionally met with. The lower 15 in. bed is a hard coal. The dip is southeast and southwest.

On the north side of the river numerous openings have heen made to the coal on Dr. Flangher's land, N. W. of S. W. of Sec. 30. In 1897 only one drift and a stripping were in work. The coals are much as across the river, Coal VIa ranging from 2 ft. to 2 ft. 8 in. with a clay band about 7 in. from the top, the clay between ranging from 2 ft. to 2 ft. 4 in. and Coal VI being about 1 ft. 7 in. Between Coal VIa and its black sheety shale roof is found 6 or 7 in. of black tough clay and shale with an abundance of molluscan fossils. In the middle of the clay separating the two beds is a black-colored streak in places, to represent the coal found there at the Hanging Rock. Coal VIa here

is at the level of the bottom land and only 6 or 8 ft. above low water in the river. The coal here is decidedly blocky in character.

Next, for a little over a mile the Big Vermillion river runs through T. 17 N., R. 10 W., the coal being carried below drainage in that space. See description of that township.

Going up the river in Sec. 32, T. 18 N., R. 10 W., the coals are below drainage. In Sec. 28 the black shale and top of coal just come to the surface at low water on the west side. About 30 ft. of shale lies above the coal here. The coal does not outcrop on the east side but was struck by a drilling on the Held place at 18 ft.

Below the big spring entering the old bayou in the N. W. ¼ of Sec. 33 is this section.

Section 131. Section near Big Spring.—Sec. 33, Fig. 3. (E. M. K.)

		Ft.	In.
1.	Shelly sandstone and shale	35	6
2.	Hard gray limestone	2	6
3.	Shale with iron and sand concretions and shelly sandstone	10	0

Near the Hanging Rock the coal rises above drainage again, a section at the old drift showing Nos. 7-16 of Sect. 126, Figs. 6 and 10. A little ways further east an old drift has been burned out leaving exposed a bed of coke, some of which is of good quality. The section in the Hanging Rock quarry is as given in the upper part of Sect. 126. The massive, moss-covered sandstone appears to be good quarry rock for 300 yards. The sandstone dips to the west and going east on the

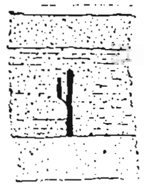


Fig. 247. Coal vein in sandstone near Hanging Rock.
Figs. 248 and 249. Faults near Hanging Rock. From sketches by Mr. E. M. Kindle.

C. & E. I. R. R. switch bed graded to this place, is seen to rise on the underlying shale, the contact being an uneven, wavy line. At the test drift at which the above section was obtained (Nos. 7-16 of Sect. 126) a few rods east of the quarry, Coal VIa is at the level of the railroad grade. This grade, being fresh when visited, has exposed a fine section of the rocks for a half mile along the north side of the river.

Among the interesting things observable are a number of coal veins in sandstone, as in Fig. 247. Two small faults are also noticed, the first hading to west with a north and south strike, the other hading to the east. The last is of interest on account of the difference in the downthrow in the coal and in the overlying shale, the latter seeming to be much more affected than the former. Sixty yards further east is the double fault, figured in Fig. 11 of Plate II, the hade in this case being to the east. The coal is 2 ft. thick, distance between faults 10 ft. Beyond the double fault the massive sandstone cuts out Nos. 5 and 6 of Sect. 126 and rests directly over the black shale, No. (7). Coal VIa runs along on a level with the railroad grade for an eighth of a mile, then suddenly passes below grade. The conditions, as nearly as can be made out at this place are shown in the accompanying sketch, Fig.

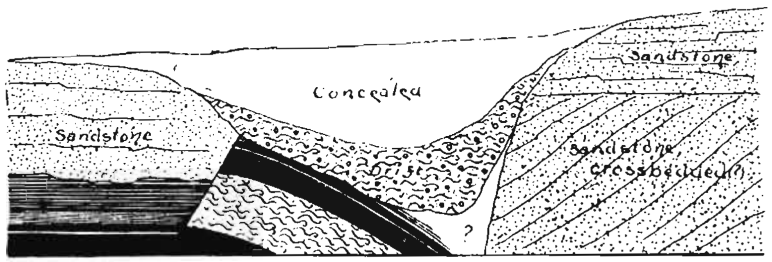


Fig. 250. Faulting observed beside Hanging Rock switch. From sketch by Mr. E. M. Kindle.

250. The sandstone at the right lies in strata 8 in. to 4 ft. in thickness. It is not quite certain whether the apparent southwesterly dip is due to cross-bedding or not, but it is thought to be. At this place it will be noted that the thin bed occurring between Coals VI and VIa has run out.

About a quarter of a mile above the Hanging Rock near the head of a ravine on the north side of the creek is exposed the black sheety shale accompanying Coal VIb, though Coal VIb itself is wanting here. Concretions of black bituminous limestone occur in the shale. Below the black shale is 15 in. of sandy shale with shelly sandstone below that. This black shale appears again on the east side of the river near the Illinois line about 20 ft. above the river. It is there capped with 2 ft. 6 in. of black sandy limestone. The black limestone also outcrops in the bed of the ravine entering the river just east of the State line. This black limestone and black sheety shale serve well the purpose of locating the position of Coal VIb.

The coals rise above drainage again in Secs. 21 and 16 on Coal branch. The coal has been worked on the Frank Beaukamp place in the S. W. corner of Sec. 16. Some 6 or 8 ft. above the coal is seen 1 ft. 3 in. of dark siliceous limestone, the same that was noted in Sec. 33. The base of the coal at an old entry here is about 5 ft. above drainage. At an open bank at Beaukamp's in Sec. 21, the coals and roof make the following section (Sect. 131, Fig. 11):

		Ft.	In.
1.	Bluish gray shale	..	..
2.	Black sheety shale	..	11
3.	Gray shale	..	4
4.	COAL VIa, top	..	6½
5.	Clay band, light gray ¾ in. to	..	1
6.	COAL VIa, bottom	1	8
7.	Clay	..	10
8.	COAL 0 to	..	8½
9.	Clay	2	0
10.	COAL VI	3	6

Inside the mine Coal No. (8) runs down to 8 in. The coal lies about 10 ft. above the creek and is said to be an excellent fuel, appearing to carry no sulphur. At the mouth of the drift on the south side a fault is exposed with a downthrow to the northeast of 22 in. Its strike is S. 70° E. See Fig. 251.

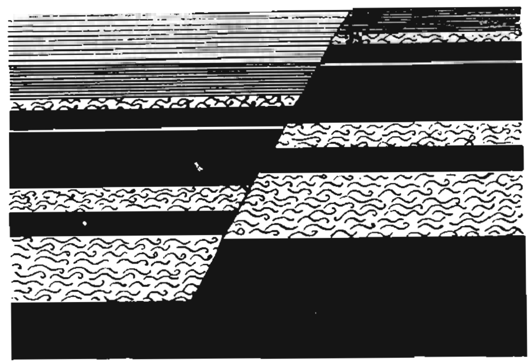


Fig. 251. Fault at Beaukamp mine. Sketch by Mr. Kindle. Strike S. 70° E. hade to N. E. Displacement 1 ft. 10 in.

Two hundred yards south of this mine a drilling by Mr. Duncan McCullum is said to have struck 6 ft. of coal, at a depth of 60 ft., supposed to be Coal V, worked now at Silverwood, Fountain county.

At the Moore shaft on the Andrew Newell place the coal is 38 ft. deep. Coal VIa is 2 ft. thick, Coal VI 2 ft. 6 in. with 4 ft. of clay between. Coal VIa has its usual clay band near the top, sometimes only showing sulphur, the coal above the parting being left to form the roof. Coal VI has a very persistent sulphur band 4 in. from the bottom (Fig. 12). The coal clinkers a little, but appears very free from sulphur. The coal is overlain by 6 ft. of soft shale and black sheety shale and that in turn by 32 ft. of shaly sandstone to top of shaft. Below the coal is 3 ft. 6 in. of fire-clay as far as determined. Some faults, running northeast and southwest, occur in the coal similar to the one figured above.

Toward the lower end of the ravine and 500 yards below the shaft, Coal VIa is being stripped on the R. McNeal place, the sheety character of the shale showing nicely as it comes up in great sheets many feet across. The stripping amounts to 3 to 5 ft. of shale and gravel. The clay band is 5 in. from the top. This coal is said to be used by blacksmiths at Perrysville. A 5-in. fault running northwest and southeast was noted here, while in one of the old entries near here a 5-in. fault runs east and west, with downthrow to the north. The middle coal is often found here running up to 7 in. thick, but always tending to run out in a short distance to sulphur and shale.

Below these the Andrew Newlin mine had just been opened in 1897. The section showing here is as follows:

SECTION 132. SECTION AT NEWLIN MINE.—Sec. 21, Fig. 13. (E. M. K.)

		Ft.	In.
1.	Bluish shale and clay ....2 ft. to	5	0
2.	Dark bluish shale	1	9
3.	Black bituminous sheety shale	1	9
4.	Soft black shale	..	4
5.	Bluish-gray shale	..	5
6.	Bone coal	..	6
7.	Coal VIa, top	..	8
8.	Clay band	..	1
9.	COAL VIa, bottom	1	8
10.	Blue-gray clay, with trace of coal at center, and concretions in lower part	2	4
11.	Bone coal	..	3½
12.	COAL VI	3	0

The upper coal here is a characteristic block coal near the outcrop, the slips ranging from 6 in. to 1 ft. 8 in. apart. Further in it will probably become a semi-block with tight slips. The coal is here about 4 ft. above drainage.

Numerous other openings have been made along here, the coal finally passing below drainage just south of the two Hunt drifts.

The drilling of the Brand place given in Sect. 129 is in the S. E. of S. E. of Sec. 20.

In the S. E. of N. E. of Sec. 31 a well was dug 30 ft. in boulder clay and drilled 24 ft. further still in the same material.

In the S. W. of the S. E. of Sec. 5 a well on the John Strings place starting 5 ft. above the creek, reached the coals at 70 ft. Coal VIa is 3 ft. thick and Coal VI 4 ft. thick, with 10 in. of light blue clay between them (Fig. 9). Coal VIa is said to be a good block coal; above it there is 10 in. of black shale, then 10 in. of white clay. Boulder clay hides everything along this part of Coal creek.

From the above data it will be evident that probably all of T. 18 N., R. 10 W. is underlain by Coal VI and Coal VIa which, over much of that area, may be presumed to be workable, since they appear to be workable wherever exposed or pierced with the drill. To work both of them the intervening clay should be marketed, tests having shown it to be very suitable for brick. This coal occurs just about at drainage level in the southern part of the township, but becoming 60 or 70 ft. below the shallow cutting streams in the northern part.

In T. 18 N., R. 9 W. these coals are assumed by both Mr. Kindle and Mr. Bradley to cover only a very limited area in the western or southwestern part of the township. The lines of outcrop as drawn by Mr. Kindle, inclose only about two square miles and bearing northwest from Eugene. In fact, his line cuts off all of the N. E. part of T. 18 N., R. 10 W. However, both the later reports of the earlier survey and Mr. Kindle in his work in Warren, assign the two upper coals there to the horizons of Coals VI and VIa (L. and M. of old system). But as we appear to have found the coal at Perrysville to be the middle of the three coals in Warren county, it evidently becomes Coal VI. If that correlation be correct, and we are far from certain that it is, then the outcrop of Coal VI may be assumed to follow the bluff line in such a way as to connect with the coal at Perrysville. In that case Coal VI and VIa would seem to retain there their thin and unworkable condition as exhibited for many miles to the south of the Big Vermillion area; and so the workable coal northwest of Eugene may be assumed to grow thin toward Perrysville. A systematic group of drillings in this area would prove a great help in settling the question of the stratigraphy of Warren county.

Below Coal VI some 60 or 70 ft. Coal V should be looked for and may prove to be workable over a large area. It is the coal worked at Silverwood and shows a workable thickness at a number of points on

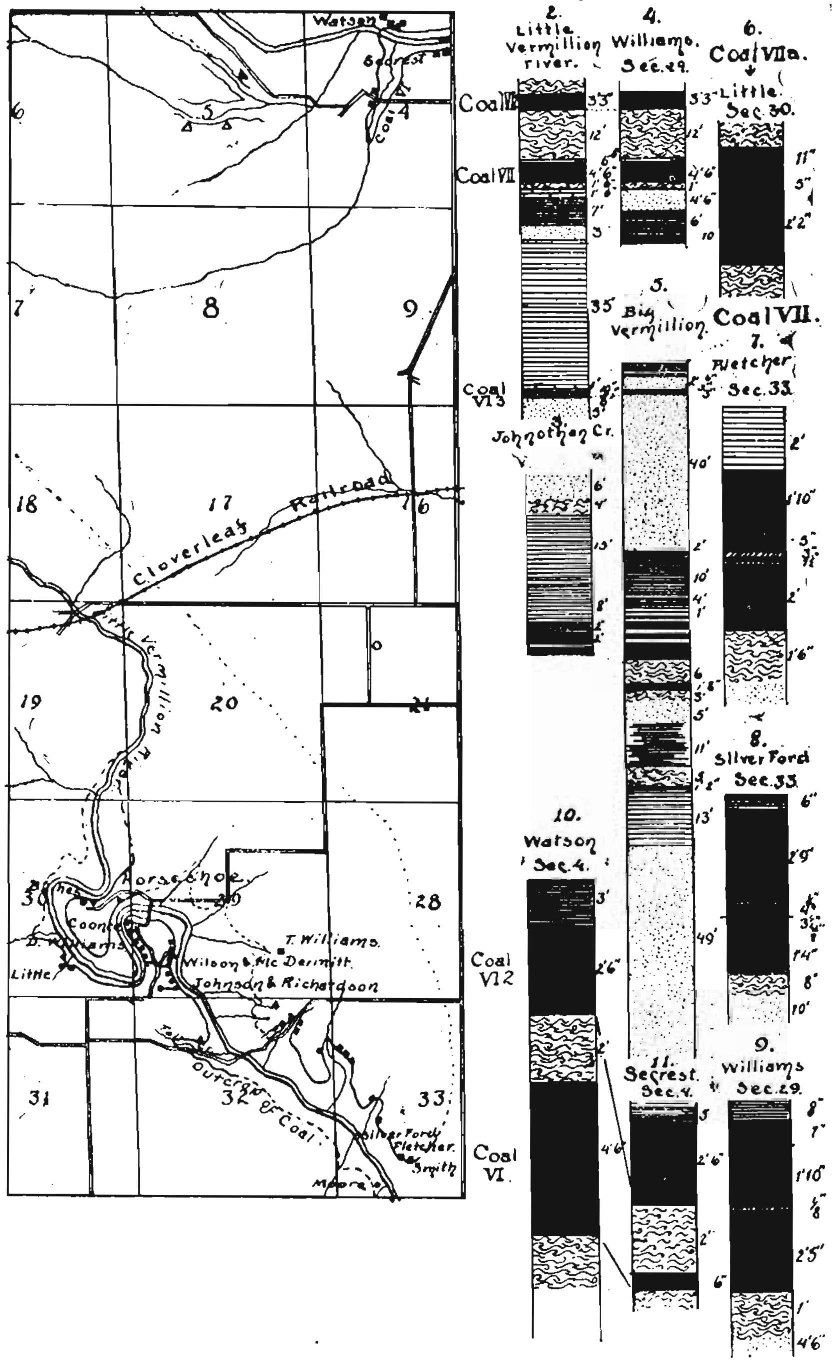


PLATE XXI. Sketch map, sections and coals, T. 17 N., R. 10 W.

the west side of Silver Island. It occurs there at about the level of high water, and a fair dip, such as is common here, would carry it well under all but the northeast corner of this area. The reported 6 ft. of coal on the McNeal place in Sec. 21-18-10 would seem to be of this coal. It is quite commonly, though not always, overlain by limestone, which sometimes becomes several feet thick, with usually black shale between the limestone and coal.

The bottom of the coal measures will probably come about 200 ft. or less below Coal VI.

TOWNSHIP 17 NORTH, RANGES 9 AND 10 WEST. (IN VERMILLION COUNTY.)

584. LOCATION, ETC.—These townships agree with the southern part of Eugene and the northern part of Vermillion of the civic townships. The Big Vermillion river just crosses the northeastern corner of T. 17 N., R. 10 W. The Little Vermillion river crosses the southern half of this area and has cut deeply, yielding many exposures of the coal measures and coals.

585. STRATIGRAPHY AND COALS.—In the northern part the stratigraphy and coals are much as in the townships just described. In the southern part a south dip carries these coals under, and the exposed coals are principally at the horizon of Coal VII. In Fig. 5 of Plate XXI is shown a connected columnar section made from those given under the preceding townships, which need not be repeated here, the only difference being in the occurrence of Coal VIb at the top of the section.

586. A connected section on the Little Vermillion from the Horseshoe to the old White's mill ford, is as follows:

SECTION 134. SECTION ON LITTLE VERMILLION RIVER.—Fig. 2. (E. M. K.)

	Ft.	In.	Ft.	In.	Ft.	In.
Division VII—						
1. Fire-clay.						
2. COAL VIIa	3	3	3	3	3	3
3. Fire-clay	12	0	..	..	15	3
4. Black bituminous clay	..	6	..	..	15	9
5. Soft black shale	..	6	13	0	16	3
6. COAL VII	4	6	4	6	20	9
7. Fire-clay	1	6	..	..	22	3
8. Limestone, hard, blue fossiliferous	1	6	..	..	23	9
9. Shale, bluish-gray, with fossils	7	0	..	..	30	9

	Ft.	In.	Ft.	In.	Ft.	In.
10. Shelly sandstone	3	0	..	..	33	9
11. Bluish-gray clay shale ...	35	0	..	..	68	9
12. Limestone, hard ferruginous and black	1	0	..	..	66	9
13. Tough black sheety shale.	..	10	..	..	67	7
14. Soft black shale	..	6	51	4	68	1
15. COAL VIb ....6 in. to	..	8	0	8	68	9
16. Shelly sandstone	5	0	..	..	73	9

Below the mouth of Jonathan creek occur the following additional strata as given by Mr. Bradley and Mr. Blatchley:

	Ft.	In.	Ft.	In.
16a. COAL VIb ....4 in. to	..	6	68	7
16b. Dark drab soft clay shale, with ferns.	2	0	70	7
17. Harder shales, with sandy layers..... 1 ft. to	10	0	80	7
18. Quarry sandstone, coarse ferruginous, with plant remains.........4 ft. to	9	0	89	7
19. Shaly sandstone and sandy shales, some layers carbonaceous with ferns, some ripple-marked flags.... 15 ft. to	20	0	109	7
20. Dark drab clay shales.......15 ft. to	20	0	129	7
21. Clay shales, with thin bands of clay ironstone, full of fossils....3 ft. to	5	0	134	7

Still further down the river Mr. Bradley reports the following additional strata:

	Ft.	In.	Ft.	In.
22. Clay shales ....6 ft. to	8	0	142	7
23. Black sheety shales, rich in fossils.... 2 ft. to	3	0	145	7
24. COAL VIa ("No. 4").........18 in. to	1	8	147	3
25. Fire-clay, dark shaly, with stigmaria, 4 ft. to	6	6	153	9
Place of Coal VI (?) (G. H. A.)........	..	..	...	..
26. Shales ....30 ft. to	50	0	203	9
27. Ironstone bands and nodules in shale.. 2 ft. to	5	0	208	9

These last strata were not seen by Mr. Kindle and he is confident that they do not outcrop on the south side of the river, though they may have been seen on the north side.

Mr. Kindle gives the following section as occurring at the mouth of Jonathan creek in connection with a shallow drilling which occupies about the same stratigraphical position:

587. SECTION 135. SECTION AT MOUTH OF JONATHAN CREEK. —Fig. 3. (E. M. K.)

	Ft.	In.
1. Sandstone	6	0
2. Fire-clay	4	0
3. Light gray shale	15	0
4. Gray to brown calcareous iron ore................	..	4
5. Shale	..	10
6. Dark calcareous iron ore.................6 in. to	..	8
7. Shale	..	6

In drilling below bed of creek,

	Ft.	In.
8. Shale	8	0
9. Black shale	2	0
10. COAL VIa	2	6
11. Fire-clay	..	4
12. COAL VI. (Broke drill in this.)		

The local details vary considerably. Thus, at the Daniel Williams mine, the section here from Coal VII down is as follows:

588. SECTION 136. SECTION AT WILLIAMS MINE.—Sec. 29, Fig. 4.

	Ft.	In.
1. COAL VII	5	0
2. Fire-clay ....10 in. to	1	2
3. Shelly sandstone	4	6
4. Dark blue shale	6	0
5. COAL VIc	..	10
6. Black shale ....1 ft. to	1	4

Still below Coal VI drillings at Newport indicate Coal V as having a thickness of over 6 ft.

589. COAL VIIa.—This coal averages about 3 ft. as far as known. It is only worked at one point, where it is a clean coal with two clay bands near the top. Over most of the area this seems to have only a roof of boulder clay, and probably suffers much in quality from the pre-glacial exposure.

590. COAL VII.—This is the coal worked at the Horseshoe. It ranges from 3 to 6 ft. in thickness, with an average of the workings seen of probably 5 ft. It has no clay bands, but usually shows a sulphur band at the center, sometimes replaced by a streak of bone coal or soft coal. The upper part of this coal is apt to carry irregular bands of sulphur and sulphur balls, which require some care in sepa-

rating. It tends to clinker in burning and much of it is said to yield a red ash. It has a very poor roof, it usually being necessary to leave some of the top coal to make a stable roof.

591. COALS VI AND VIa.—These coals, which are close together and are often mined together, will show a combined thickness of from 1 to 7 ft. Coal VIa is the more persistent of the two, seldom attaining a thickness of more than 2 ft. 6 in. and seldom running under 1 ft. It usually shows one clay parting near the top, and is generally a rich caking coal much liked for blacksmithing. Its roof is almost invariably a black bituminous sheety shale, often overlain by a few inches of shaly ferruginous limestone or calcareous ironstone. It is separated from Coal VI by from 0 to 4 ft. of fire-clay, suitable for brick or tile. Coal VI varies from 0 to 4 ft. 6 in. It is a good coal, not as rich as Coal VIa. It is without partings, and on account of its fire-clay roof can hardly be worked alone.

592. COAL V.—This coal is reported only at two points, as it lies deep in this area. At these places it has a thickness of 5 ft. and 5 ft. 6 in. respectively. At the Nixon drilling near Newport the coal brought up was analysed by Mr. Noyes with the following result:

Fixed carbon	41.49	
Volatile combustible matter	43.37	
Total combustible matter		84.86
Ash	13.49	
Moisture	1.63	
Total waste		15.12

One pound of coal will evaporate 12.2 pounds of water.

This shows a coal high in gaseous constituents and ash, low in fixed carbon. The specimens being air-dried probably gave a much lower percentage of moisture than would have fresh specimens. The evaporating effect is low, though not lower than some coals in the State that meet a ready sale. It is possible, however, that a little of the overlying black shale was mixed with the coal. This would tend to increase greatly the proportion of ash and slightly the proportion of gas over the fixed carbon.

593. DISTRIBUTION AND DETAILS OF COAL.—Coal data is obtained principally in three localities: on the Big Vermillion in N. E. corner of T. 17 N., R. 10 W.; southwest of Cayuga, and along the Little Vermillion valley.

594.—BIG VERMILLION RIVER REGION.—It will be recalled that Coals VI and VIa are here close to drainage. Coal VIa is worked at the Jacob Secrest mine, S. E. of N. E. of Sec. 4. It runs with much regularity about 27 in. thick (Fig. 11). The roof is generally a soft bluish-black shale 5 ft. thick, overlain by 3 ft. of blackish sheety shale. Sometimes clay to the thickness of 20 in. comes between the coal and shale roof. Coal VI is here only 6 in. thick, separated from Coal VIa by 2 ft. of fire-clay.

On the north side of the river the coals have been worked by shaft and slope on the Watson place. At the shaft it is 50 ft. to the bottom of Coal VI. Coal VIa is 2 ft. 6 in. thick, without parting. Coal VI runs from 4 to 5 ft. thick (Fig. 10). It has three partings of sulphur, and sometimes a few inches of bone in the top, and in mining separates into benches 1 ft. thick. In borings to the west the coal shows a still better thickness. One boring on the west side of the river is reported to have shown 6 ft. 9 in., 6 or 7 in. of bony or "mother" coal replacing the clay separating the two beds elsewhere.

The clay between the two beds runs from 15 to 30 in. and is said to make good tile. A boring in mine to the depth of 100 ft. is said to have passed through three beds of coals, the boring stopped in black shale. No faults or rolls have been passed in mining nor have boulders been encountered in the roof. The black shale over the coal outcrops about 3 ft. 6 in. above low water some 200 yards below the shaft. Above it is 35 ft. of gray sandy micaceous shale and shelly sandstone. The horizon of Coal VIb is found here about 50 ft. above the worked coal.

The coals keep above or at drainage for some distance up a branch which enters the river from the south opposite the Watson mine. Coal VIa has been stripped both north and south of the road in S. E of N. W. of Sec. 4 and in stream on N. E. of S. W. of Sec. 4. At the latter place the exposure shows (Sect. 137, E. M. K.):

	Ft.	In.
Black, sheety, shale	2	4
Blue-gray clay	1	8
Black bituminous clay, with molluscan fossils	..	5
COAL VIa—coal, 3 in.; clay band, 1 in.; coal, 1 ft. 6 in.	1	10
Clay	2	0

Coal VI is not worked here and thickness unknown.

In Sec. 5 are found outcrops of the black shale over coal VIb and in the S. W. of N. E. of Sec. 5, 2 or 3 in. of coal shows. The section there is (Sect. 138a, E. M. K.):

	Ft.	In.
Black, sheety shale	2	6
Soft bluish shale	..	6
Shelly sandstone	2	6
Dark gray sandy shale	..	3
COAL VIb ....2 in. to	..	3
Sandstone, shelly	5	4

The other exposures noted are in the N. W. of S. E. and N. E. of S. W. of Sect. 5. At the first of these the section is (Sect. 139, E. M. K.):

	Ft.	In.
Sandstone, rather shelly	4	0
Gray sandy shale	17	0
Limestone, flinty and sandy	1	6
Blue shale, with concretions	2	0
Place of Coal VIb.		

At the other exposure is seen (Sect. 140, E. M. K.):

	Ft.	In.
Surface	5	0
Black shale, very tough and sheety	2	6
Place of Coal VIb.		
Fire-clay	4	0
Sandstone, shelly and irregularly bedded	5	0
Blue shale	11	0

Just below the narrow place in the ridge road, in the north side of Sec. 5, the black shale outcrops on the south side of the creek about 2 ft. thick, with 15 ft. of fissile, gray shale above it.

595. Coal Near Cayuga.—At the Cayuga Brick and Coal Company's pit is noted the following section (Sect. 141, E. M. K.):

	Ft.	In.
1. Surface ....2 ft. to	6	0
2. Shelly brown sandstone ....6 ft. to	9	0
3. Blue and buff sandy shale	15	0

At the south end of pit appears in addition:

	Ft.	In.
4. Traces of coal (Coal VIb) ....0 to	..	¼
5. Blue fire-clay	5	0
6. Hard sandy blue clay.		

Coal 4 ft. thick is reported to have been struck at a depth of 75 ft. It would evidently be Coal VI or VIa, or both.

Following up the bed of the branch in the S. E. ¼ of Sec. 7, the shelly sandstone of preceding section outcrops along bed of branch, showing very irregular bedding for several hundred yards. Then a small bed of coal appears, of which no trace was seen below. The section becomes (Sect. 142, E. M. K.):

	In.
1. Black sheety shale	10
2. Soft black thinly laminated shale	6
3. Black sheety shale	6
4. Soft black shale	10
5. Bone coal	6
6. COAL VIb	7
7. Blue sandy shale.	

This is evidently the same as the coal trace at the brick factory. In ascending the bed of the branch the coal and shale rise with it for a little ways at creek level, then the coal runs out against a bank of sandstone, while the overlying shale mounts this sandstone bank at an angle of 34° to a height of 9 ft., when it again runs level. The relation of things here is shown in Fig. 252. The coal at this point has all become bony. A short distance above the black limestone,

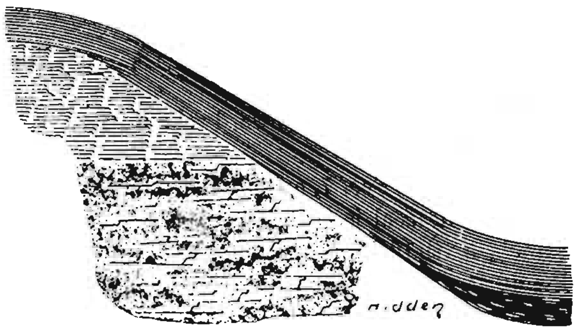


Fig. 252. Relations of strata observed in ravine in S. E. ¼ of Sec. 7-17-9. From sketch by Mr. Kindle.

which below had only been represented by concretions, becomes a regular bed 8 in. thick, overlying the black, sheety shale which has thinned from 20 in. below the rise to 14 in. above.

At the brick factory in the S. W. of N. E. of Sec. 7 there is the following section in the rear of the kiln:

Section 143. (E. M. K.)

	Ft.	In.
1. Yellow boulder clay ....5 ft. to	6	6
2. Sandy shale, almost shelly sandstone	4	0
3. Shelly to massive, pinkish-brown in places	9	0

Just below that the section is as follows (Sect. 144, E. M. K.):

		Ft.	In.
1.	Yellow surface clay	2	0
2.	Shaly sandstone	1	6
3.	Gray sandy shale, with 3 in. blue streak at top, thickly laminated	1	6
4.	Sandstone	2	0
5.	Sandy shale	1	4
6.	Sandstone	2	0
7.	Gray to buff shale, some sandy layers 1 to 2 in. thick	6	0

These sections indicate a horizon above that at the Cayuga brick and coal plant, and therefore above Coal VIb. At one point where there is a joint, No. (3) has been squeezed upward, as in Fig. 253,

Figs. 253 and 254. From sketches at the Cayuga Brick and Coal Co.'s pit (E. M. K.).

and No. (5) has been squeezed downward where there is no joint, as in Fig. 254.

In the S. E. of N. E. of Sec. 7, a shaft known as the Citizen's shaft has been started. The coal is reported to be 110 ft. deep and to be 4 ft. 10 in. thick, 5 ft. 10 in. including what is either coal or black shale. In the 40 ft. the shaft had been sunk only sandstone showed on the dump, being either a bluish-gray shaly sandstone, speckled with carbonaceous matter, and much mica, or a pinkish-brown micaceous sandstone. Over the coal is said to be 16 to 24 ft. of black shale, "hard as coal." A drilling which went 45 ft. below the coal went through clay shale and fire-clay into black shale. This would seem to be Coal VI.*

South of this area Mr. Bradley reports that coal reported to be 5 ft. thick has been seen at extremely low water in the bank of the Wabash in the north part of Sec. 15.

596. Valley of the Little Vermillion.—In the first ravine west of the road from the creek, in the center of Sec. 36-17-9, the following section is exposed (Sect. 145, E. M. K.):

*This mine has since been opened up, and is known as the Catinga mine.

		Ft.	In.
1.	Gray shale	1	6
2.	COAL Vb (?) (roof not seen)	2	0
3.	Concealed	3	0
4.	Black shale	2	0
5.	Limestone, soft, dark, shaly ....6 in. to	..	8
6.	Sheety black shale. Place of Coal Va.		
7.	Gray sandy fire-clay	3	0
8.	Bluish-gray shale.		

If this section is compared with No. (1) to (9) of Sect. 91, ¶508, the resemblance is seen to be very close. Further, if the position of the two sections be compared, it will be seen that they are less than two miles apart, and as the strata in Sec. 91 occur well up in the river bluff, the average dip of this region would just about bring them down to the level of the strata of Sect. 145, on the west side of the river. This would indicate that the coal of the above section is Coal Vb, or the first coal below Coal VI, as developed about Mecca, in Parke county.

At the mouth of the Little Vermillion river Mr. Bradley reports finding a few inches of highly fossiliferous, calcareous ironstone, especially full of serpulae, as well as other fossils. This would appear to mark the horizon of one of the coals of Division V, if, indeed, it did not belong just above Coal V. Mr. Kindle found only sand and loam visible here when he visited the locality.

In the S. W. of Sec. 28, at the mouth of a ravine from the south, a 1-ft. bed of coal lies about 6 or 8 ft. above the bed of the creek, on the Morehouse place. It has a roof of black sheety shale containing fish scales and has been stripped a little. This is judged to be coal VIa, Coal VI being wanting or not tested for.

In the S. E. ¼ of Sec. 28, on the H. V. Nixon place, half a mile from the river, a drilling is said to have found 6 ft. 6 in. of coal at a depth of 112 ft. It is said to have a rock roof 7 ft. 8 in. thick. This probably started above the level of Coal VI and reached one of the lower coals, probably Coal V or Coal IV, or the coal worked about Silverwood. For the analysis of this coal, see above.

Near the mouth of the small creek entering the Little Vermillion, in the S. E. ¼ of Sec. 29, is an exposure of 8 ft. of thin-bedded sandstone.

At the mouth of Jonathan creek, in Sec. 30, Coal VIa is 12 ft. below the creek level. The section was given above—Sect. 135. A short distance up the creek, in Sec. 31, the section is (Sect. 146, E. M. K.):

		Ft.	In.
1.	Massive hard gray sandstone	6	0
2.	Gray shale	5	0
3.	Interbedded shale and shaly sandstone	3	0
4.	Gray clay shale, with iron concretions in lower part	3	0

At the end of the bridge, in the S. W. of N. E. of Sec. 30 is the following section (Sect. 147, E. M. K.):

		Ft.	In.
1.	Drift	3	6
2.	Massive sandstone	8	0
3.	Fire-clay, bluish-gray, not very sandy	5	4
4.	Sandstone	2	0
5.	Shale	6	0
6.	Drab-colored shale	3	0

A quarter of a mile farther up, at the McCammens quarry, the section has become (Sect. 148, E. M. K.):

		Ft.	In.
1.	Drift ....2 ft. to	5	0
2.	Massive sandstone bluff, with brown specks	15	0
3.	Gray shaly fire-clay	5	0
4.	Shaly sandstone ....8 in. to	1	4
5.	Bluish-gray fire-clay	5	6
6.	Bluish-gray shelly to massive sandstone	4	0

Near the middle of the quarry No. (4) disappears, leaving 10 ft. of silicious drab colored shale, approaching fire-clay. The dip is southwest, and at the old White mill ford, in the S. E. of S. W. of Sec. 30, the upper sandstone of above section, which at the quarry has its base 25 ft. above the bed of creek, at the ford forms the base of the old dam, a dip of about 80 ft. to the mile. Above White's mill the section is (Sect. 149, E. M. K.):

		Ft.	In.
1.	Bluish-gray shale	35	0
2.	Limestone, black, bituminous, hard, with joints 18 in. to 2 ft. apart, running a little S. of E.	1	0
3.	Tough black shale, with east and west and diagonal joints	..	10
4.	Soft black shale	..	6
5.	COAL VIb ....6 in. to	..	8
6.	Sandstone, shelly, gray	5	0

In Sec. 33-17-10, the S. E. of S. W., Coal VII appears about 20 to 25 ft. above the creek and is worked in the Jos. Fletcher and the Smith mines, these openings being close together. The coal is from 4

ft. to 5 ft. 6 in., averaging about 4 ft. 8 or 10 in. thick without clay bands but with some sulphur bands, none of which are quite constant. A section shows (Fig. 7):

	Ft.	In.
Coal	1	10
Sulphur band	..	⅛
Coal	..	5
Sulphur band	..	3
Coal	..	1½
Sulphur band	..	⅛
Coal	2	0

The roof is 2 ft. of shale and there is 1 ft. 8 in. of fire-clay below resting on sandstone. The coal below the thickest sulphur band is the heaviest and best. Streaks of bone sometimes appear near the top. One clay vein is reported in the Smith mine, and slight swells or horsebacks are sometimes met with. The coal burns to a white ash and it is thought from some tests will make good coke. Below the coal at the Smith mine is seen (Sect. 150, E. M. K.):

	Ft.	In.
Fire-clay	..	8
Shelly gray to brown sandstone	10	0
Shale, hidden	4	0
Brown ferruginous limestone	..	10
Shale and iron ore.		

At the Moore place, across the river from the Smith mine, it is reported that a drilling at the house starting about 25 ft. above the river (or at about the level of Coal VII) struck 7 ft. of coal at a depth of 70 ft. (Coal VI).

Northwest of the Fletcher mine, in the ravine below the Silver ford, coal was formerly mined. Above the coal is exposed (Sect. 151, E. M. K.):

	Ft.	In.
Sand, stratified	10	0
Dark gray shale	5	0
Calcareous ironstone band, with zinc sulphide, and coal ....2 in. to	..	3½
Dark blue soft shale	..	7
COAL VII.		

In the ravine just above Silver ford, in the S. W. of N. W. of Sec. 33, are a number of openings, the coal running from 4 ft. 5 in. to 4 ft. 9 in., with from one to three sulphur bands. At one point there was only one band 2 ft. 10 in. from the top, coal 3 ft. 5 in.; at another point there was a ½-in. band 2 ft. 9 in. from the top, a knife-edge band 4 in. lower, and ⅛-in. band 3½ in. lower (see Fig. 8). The coal is from 8 to 16 ft. above drainage. The roof is poor, being made by a light blue clay shale; below is 6 to 8 in. of fire-clay, with 10 ft. of sandstone showing below. Coal shows irregular slips.

At the Silver ford the coal appears to lie much higher on the south side than on the north side, the position of the coal being marked by a terrace a few feet wide. Mr. Bradley gives the following section below the coal at that point.

597. SECTION 152. SECTION AT "SILVER MINE."—(F. B., p. 145.)

		Ft.	In.
1.	COAL VII ....4 ft. to	5	0
2.	Fire-clay, top dark, bottom light drab, including a band of calcareous ironstone or limestone ("silver ore") ....0 to	3	5
3.	Light bluish-gray shale ....8 ft. to	10	0
4.	Nearly black clay shale	1	8
5.	Light gray, slightly sandy shale, with fossiliferous bands of calcareous iron ore and shaly limestone.	11	0
6.	Dark drab concretionary shale, top fossiliferous....	16	0

In the N. E. ¼ of Sec. 32 coal has been mined and stripped at several points beside the road. There is over the coal here 3 in. of bone coal and 6 ft.+ of fire-clay, the upper 2 ft. 6 in. containing bands of iron ore.

In Fall creek, beside the road in the S. E. of N. W. of Sec. 32, occurs the following section:

598. SECTION 152A. SECTION ON FALL CREEK.—(E. M. K.)

		Ft.	In.
1.	Fire-clay	3	0
2.	COAL ....3 in. to	1	2
3.	Fire-clay, bluish-gray ....8 ft. to	12	0
4.	Limestone, gray, flinty, with fossils.... 0 to	..	8
5.	Gray sandy shale	8	0
6.	Band of calcareous iron nodules....	..	4
7.	Shale	4	0

Fifty yards above this section No. (6) has expanded to a bed of gray, very sandy limestone, 4 ft. thick and full of fossils. It forms the bed of the branch there. The limestone No. (4) outcrops an eighth of a mile above the Fall creek ford in the bed of a creek.

In the S. E. ¼ of Sec. 29 is the Thomas Williams mine. The section in the air shaft shows:

599. SECTION 153. SECTION AT T. WILLIAMS MINE.—(E. M. K.)

		Ft.	In.
1.	Yellow boulder clay	10	0
2.	Blue fire-clay	2	0
3.	Soft pyrite clay (pyrite in minute crystals, coloring band golden)	..	½
4.	Soft black clay	..	2
5.	Soft black shale	..	6
6.	Bone coal, with some thin pyrite sheets	..	3
7.	COAL VII—Coal, 2 ft. 8 in.; sulphur band, 0 to 3 in.; coal, 1 ft. 8 in....	4	7
8.	Fire-clay.		

As a rule, the coal is thicker, measuring 5 ft. 1 in. at the mouth of the drift, and 5 ft. 11 in. inside. The coal is solid, with the exception of a sulphur band near the middle, which is not quite persistent, though thickening up to 3 in. in places. As indicated in the above section, the regular roof of the coal is not strong enough and it is customary to leave 14 to 16 in. of coal for a roof. The regular roof carries some sulphur balls, etc.

A drilling starting west of the mine and 30 ft. below the worked bed is said to have passed through 6 ft. 2 in. of coal in going 102 ft. This would appear to be Coal VI, though the distance below Coal VII is at least 10 or 15 ft. more than the distance between the two as exposed in the outcrops.

The upper bed outcrops at the spring west of Mr. Williams's house, at which point its thickness is 3 ft. 1 or 2 in.

On the west side of the river, in the S. W. ¼, the coal is or has been mined from a number of openings. At the Johnson and Richardson bank Coal VII is 30 or 35 ft. above drainage. The coal is from 3 ft. to 3 ft. 8 in. in thickness, with a sulphur band ⅛ to ¼ in. thick near the middle, not regular, but sometimes replaced by a ½-in. band of bone coal or soft coal. Otherwise the coal seems to be quite clean and free from sulphur. It has distinct but irregular joints, giving it a semi-block appearance. The roof is bad, consisting of 6 in. of dark blue shale, with bluish shale above that. The entries have to be timbered closely. A few inches of coal are left in the rooms. The coal is said to grow thinner to the south. The coal from these mines is raised to the top of the bluff 55 or 60 ft. above by horse power over an inclined tramway 100 yds. or so long.

Going north, the coal thickens, so that at the Wilson and McDermitt mine, in the same quarter section, it runs from 4 ft. to 4 ft. 6 in. thick. This coal shows no regular sulphur band, but the upper part is full of sulphur bands from 0 to 4 in. thick, and sometimes sulphur balls weighing 400 or 500 pounds are found which occasionally extend entirely through the coal. From 2 to 8 in. of bone coal overlies the good coal, and where these sulphur balls exist, the contact is marked by slickened sides, indicating the compressive movement that has taken place in the coal since the formation of these boulders. The bone coal tends to come down around the boulders. The coal is said to be a good coal after the extraction of the sulphur. Coal VIIa is here about 3 ft. thick, soft and not desirable, and about 15 ft. above Coal VII.

On the east side of the west side of the horse-shoe, in the N. E. of N. E. of Sec. 30, the first mine from the north is the Coonce mine. The coal here averages about 5 ft. thick, ranging from 4 ft. 6 in. to 6 ft. The sulphur band in the middle is quite regular. The coal here seems to be comparatively free of sulphur balls, though small ones often make a downward swell in the roof. About 6 in. of coal is left to sustain the roof, which then seems to stand well. The section above the coal is:

600. Section 154. Section at Coonce Bank.—(E. M. K.)

		Ft.	In.
1.	Surface soil and outcrop of COAL VIIa or VIII	3	0
2.	Blue and yellowish clay	3	0
3.	Limestone	..	3
4.	Blue clay (potters' clay)	3	6
5.	Pyrites, clay and shale	..	2½
6.	Dark blue clay shale	..	4
7.	Hard black shale	..	8
8.	Sulphur band ¼ in. to	..	1
9.	Bone coal	..	4
10.	COAL VII	5	0

A north and south fault in the coal shows a displacement at the bottom of 7½ in., with slicken sides, but at the top appears hardly disturbed at all. This fault was traced across at least two rooms. Coal here almost exhausted.

At Daniel Williams mine, a little south of the last, the section shows as follows:

601. Section 155. Section at D. Williams Mine.—Figs. 4, 9 (E. M. K.).

		Ft.	In.
1.	Roof shale	..	8
2.	COAL VII—coal, 7 in.; knife-edge parting of sulphur; coal, 1 ft. 10 in.; sulphur band, 6 in. to ⅛ in.; coal, 2 ft. 5 in.	4	10
3.	Fire-clay 10 in. to	1	2
4.	Shelly sandstone	4	6
5.	Dark blue shale	6	0
6.	COAL VIc	..	10
7.	Black shale 1 ft. to	1	4

The coal here runs from 4 ft. 8 in. to 4 ft. 10 in., with the sulphur band at the center quite regular. Eight or ten inches of the top are left for the roof, which will then hold up well for about a year. There are a good many sulphur balls in the upper part of the coal, but they are rare in the roof. Free from faults, rolls, clay veins or other irregularities.

In the S. W. of S. E. of Sec. 30 is the Robert Little bank, working Coal VIIa. The coal measured about 3 ft. 7 in., with two clay bands 11 in. and 1 ft. 4 in. from the top. These run from ¼ to 1 in. in thickness. The coal shows no sulphur bands and very few nodules. It burns to a white ash, with a little clinker. The roof here is boulder clay, but it shows very little cutting in the entries. The bottom is a hard fire-clay. The coal here is about 50+ ft. below the level of the hill and about 25 ft. above drainage. The bed thins to the north. It lies quite regularly, dipping to the east. What seems to be Coal VII outcrops a short distance below the new entry. The coal has been mined by drifting and by stripping.

On the west side of the Horse-shoe, in Sec. 30, are some good exposures of the coals and accompanying rocks. The average section here is as given in Sect. 134, ¶586, Nos. (1) to (10). At one point the shales and sandstone under Coal VII are very irregularly bedded, suggesting nonconformity.

In the N. E. corner of N. E. of S. E. of Sec. 30, west of the ford on the north side of the river, the beds underlying Coal VII rise suddenly 8 or 9 ft. in 30 yds. Coal VII shows below the point of rise, but can not be seen above it.

In the S. E. of N. E. of Sec. 30 coal has been stripped on the Bushes place; said to be 2 ft. 6 in. to 3 ft. thick.

602. Distribution in Area in General.—Of the five beds that attain a workable thickness in this area, Coals VII and VIIa (or Coal VIII) are confined to the southern or southwestern part of T. 17 N., R. 10 W. In this area Coal VIIa being so near the surface will prevent more than a very small portion being worked. Coal VII probably underlies all of the area shown on the map and probably holds a workable thickness over most of it, provided none of it is left for roof, and probably much of it will be thick enough to allow the leaving of

a few inches of the top and still be workable. These coals are above drainage almost to the State line. Coals VI and VIa occupy nearly the territory west of the C. & E. I. R. R. Coal VIa is thick enough to be worked alone only in spots. These coals, either separately or together, seem to be workable over all the western part of the area, and the northern, but become too thin to work or run out, to the southeast. They are probably not workable over much of the southern half of T. 17 N., R. 9 W. These coals occur about 100 ft., or a little over, below Coal VII, and are below drainage except over the lower courses of the Big and Little Vermillion rivers, and the bottom land and terrace of the Wabash river. Still below these, 75 ft. or so, appears to be another bed, probably Coal V, which, at least in places, attains a good workable thickness. This underlies the whole area, but is probably not as persistent as the higher beds. In a general way the bottom of the coal measures may be looked for 250 ft. below Coal VI and 350 below Coal VII. Not more than one, if any, workable beds need be looked for below Coal V.

Township 16 North, Ranges 9 and 10 West. (In Vermillion County.)

603. Location, etc.—These townships occupy the southern part of Vermillion and northern part of Helt of the civic townships. The western part of the area is largely included in the extremely level and fertile Grand Prairie. Except as broken by Little Raccoon creek, this level country extends almost to the Wabash river, the bluffs for a distance being close to the river. The C. & E. I. R. R. runs along the foot of the river bluff and the I., D. & W. Ry. crosses the southern part of the area.

604. Stratigraphy and Coals.—The coals of this area, as far as noted, are Coals VIIa, VII, VIb, VIa, VI and IV or III. Probably others might be found between VI and III.

The following sections will serve to show the relation of these coals to each other. We may first consider a group of sections along the I., D. & W. Ry. (Plate XXII). Fig. 1 shows their position along the railway, two of the borings being in Illinois, while the Illiana shaft is just at or over the State line. The section also shows the absolute and relative elevation of each section and the configuration of the surface, from a plot kindly furnished by the railway company. Beginning at the west, where the highest strata are found, the sections in order are as follows:

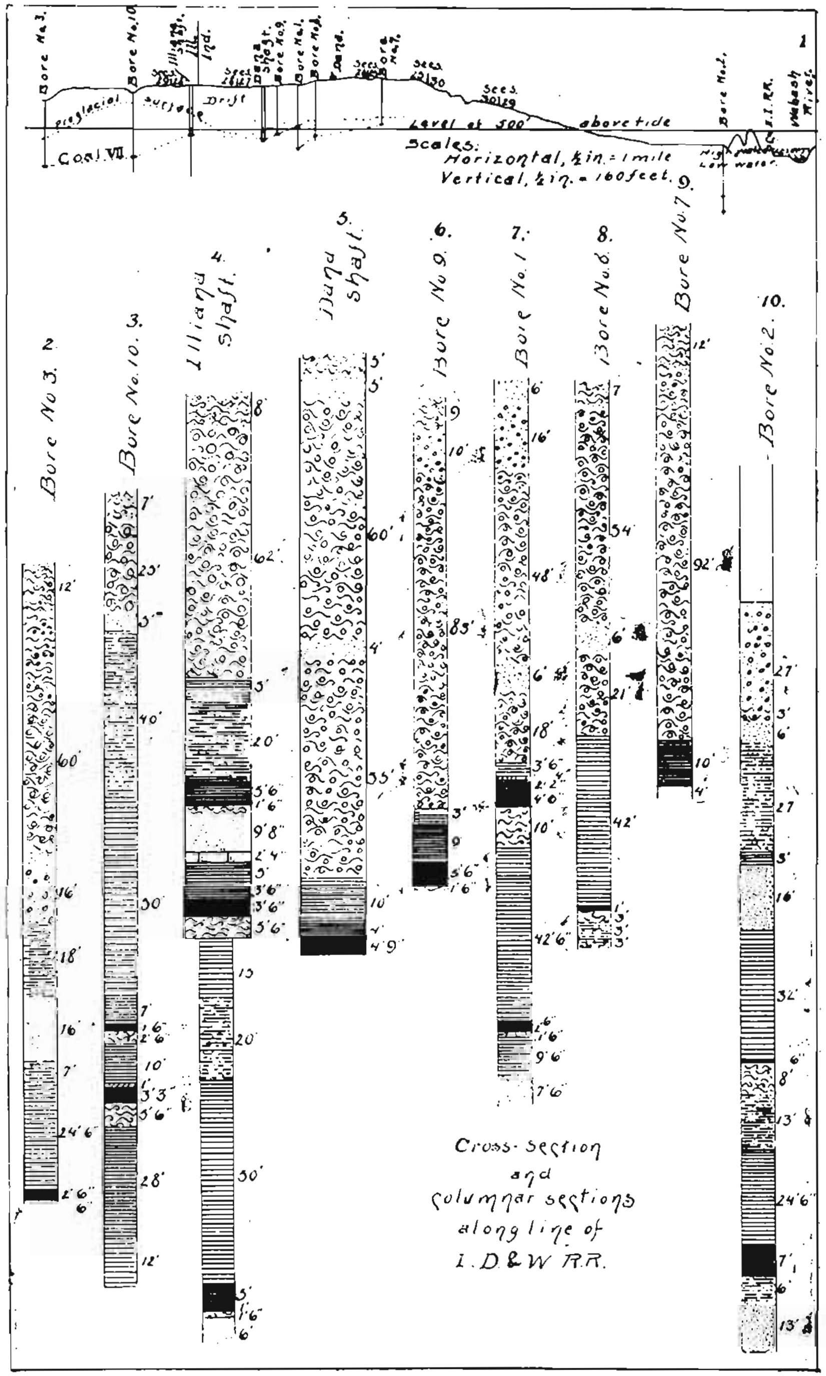


PLATE XXII.

605. SECTION 156. SECTION OF BORE NO. 3.—Beside I., D. & W. R. R., Sec. 30-16-10, in Illinois (Fig. 2).

	Ft.	In.	Ft.	In.
Division VII—				
1. Surface	12	0	12	0
2. Boulder clay ("Hard pan")	60	0	72	0
3. Gravel and sand	16	0	88	0
4. Sandy shale ("Sandstone shale")	18	0	106	0
5. Hard sandstone	16	0	122	0
6. Sandy shale	7	0	129	0
7. Clay shale ("Soapstone")	24	6	156 3	6 0
8. COAL VII	2	6	156	0
9. Fire-clay	..	6	156	6

606. SECTION 157. SECTION OF BORE NO. 10.—Beside the I., D. & W. R. R., Sec. 29-16-10, in Illinois (Fig. 3).

	Ft.	In.	Ft.	In.
1. Surface	7	0	7	0
2. Boulder clay	23	0	30	0
Division VII—				
3. Sandstone	5	0	35	0
4. Sandy shale	40	0	75	0
5. Shale	54	0	129	0
6. Clay shale.			135	
7. "Soot vein and coal" (COAL VIIa)	1	6	137	6
8. Fire-clay	2	6	140	0
9. Shale and hard rock ledges	10	0	150	0
10. "Sulphur"	1	0	151	0
11. COAL VII	3	3	154	3
12. Fire-clay	5	9	160	0
Division VI—				
13. Shale	28	0	188	0
14. Gray shale	12	0	200	0

607. SECTION 158. SECTION OF ILLIANA SHAFT AND BORE.—Sec. 28-16-10, Fig. 4.

	Ft.	In.	Ft.	In.
1. Surface	8	0	8	0
2. Boulder clay	62	0	70	0
Division VII—				
3. Green clay shale	5	0	75	0
4. Sandy shale, with hard seams	20	0	95	0
5. Black shale, "coal parting"	5	6	100	6
6. Fire-clay	1	6	102	0
7. Sandstone	9	8	111	8
8. Limestone	2	4	114	0
9. Dark shale	5	0	119	0
10. Black shale	3	6	122	6
11. COAL VII	3	6	126	0
12. Fire-clay	5	6	131	6

	Ft.	In.	Ft.	In.
Division VI—				
13. Shale	15	0	146	6
14. Sandy shale	20	0	166	6
15. Blue shale	50	0	216	6
16. Black shale	5	0	221	6
17. COAL VIb	1	0	222	6
18. Fire-clay	1	6	224	0
19. Gray sandstone	6	0	230	0

608. SECTION 159. SECTION OF DANA SHAFT.—Sec. 27-16-10, Fig. 5.

	Ft.	In.	Ft.	In.
1. Surface	5	0	5	0
2. Quicksand	5	0	10	0
3. Boulder clay	60	0	70	0
4. Sand	4	0	74	0
5. Boulder clay	55	0	129	0
Division VII—				
6. Shale	10	0	139	0
7. Hard black and gray shale	4	0	143	0
8. COAL VII	4	9	147	9

609. SECTION 160. SECTION OF BORE NO. 9.—Beside I., D. & W. R. R., Sec. 27-16-10, Fig. 6.

	Ft.	In.	Ft.	In.
1. Surface	9	0	9	0
2. Gravel	10	0	19	0
3. Boulder clay	83	0	102	0
Division VII—				
4. Green clay shale	3	0	105	0
5. Black bituminous shale	9	0	114	0
6. COAL VII	5	6	119	6
7. Fire-clay	1	6	121	0

610. SECTION 161. SECTION OF BORE NO. 1.—Beside I., D. & W. R. R., Sec. 27-16-10, Fig. 7.

	Ft.	In.	Ft.	In.
1. Surface	6	0	6	0
2. Sand and gravel	16	0	22	0
3. Boulder clay	48	0	70	0
4. Sand	6	0	76	0
5. Boulder clay	18	0	94	0
Division VII—				
6. Clay shale	3	6	97	6
7. Hard sandstone	..	4	97	10
8. Black shale	2	2	100	0
9. COAL VII	4	6	104	6
10. Fire-clay	10	0	114	6

	Ft.	In.	Ft.	In.
Division VI—				
11. Clay shale	42	6	157	0
12. Black shale	..	6	157	6
13. COAL VIb	2	0	159	6
14. Fire-clay	1	6	161	0
15. Hard clay shale	9	6	170	6
16. Hard sandstone	7	6	178	0

611. SECTION 162. SECTION OF BORE NO. 8.—Beside I., D. & W. R. R., Sec. 26-16-10, Fig. 8.

	Ft.	In.	Ft.	In.
1. Surface	7	0	7	0
2. Boulder clay	54	0	61	0
3. Sand	6	0	67	0
4. Boulder clay	21	0	88	0
Division VI—				
5. Clay shale	42	0	130	0
6. COAL (VIb) and black shale	1	0	131	0
7. Dark fire-clay	3	0	134	0
8. Sandy shale	3	0	137	0
9. Sandstone	3	0	140	0

612. SECTION 163. SECTION OF BORE NO. 7.—Beside I., D. & W. R. R., Sec. 25-16-10, Fig. 9.

	Ft.	In.	Ft.	In.
1. Surface	12	0	12	0
2. Boulder clay	92	0	104	0
Division VI—				
3. Black shale	10	0	114	0
4. Fire-clay and COAL (VIb)	4	0	118	0

613. SECTION 164. SECTION OF BORE NO 2.—Near I., D. & W. R. R., Sec. 34 or 35-16-9, Fig. 10.

	Ft.	In.	Ft.	In.
1. Sand and gravel	27	0	27	0
2. Boulder clay	3	0	30	0
Division V-III—				
3. Sandstone	6	0	36	0
4. Sandy shale	27	0	63	0
5. Gray shale	3	0	66	0
6. Hard sandstone	15	0	81	0
7. Gray shale	32	0	113	0
8. COAL (IV?)	..	6	113	6
9. Fire-clay	8	0	121	6
10. Soft sandy shale	13	0	134	6
11. Clay shale	24	6	159	0
12. "Soot vein and COAL" (Coal III?)	7	0	166	0
Division I (?)—				
13. Soft sandy shale	6	0	172	0
14. Hard sandstone	13	0	185	0

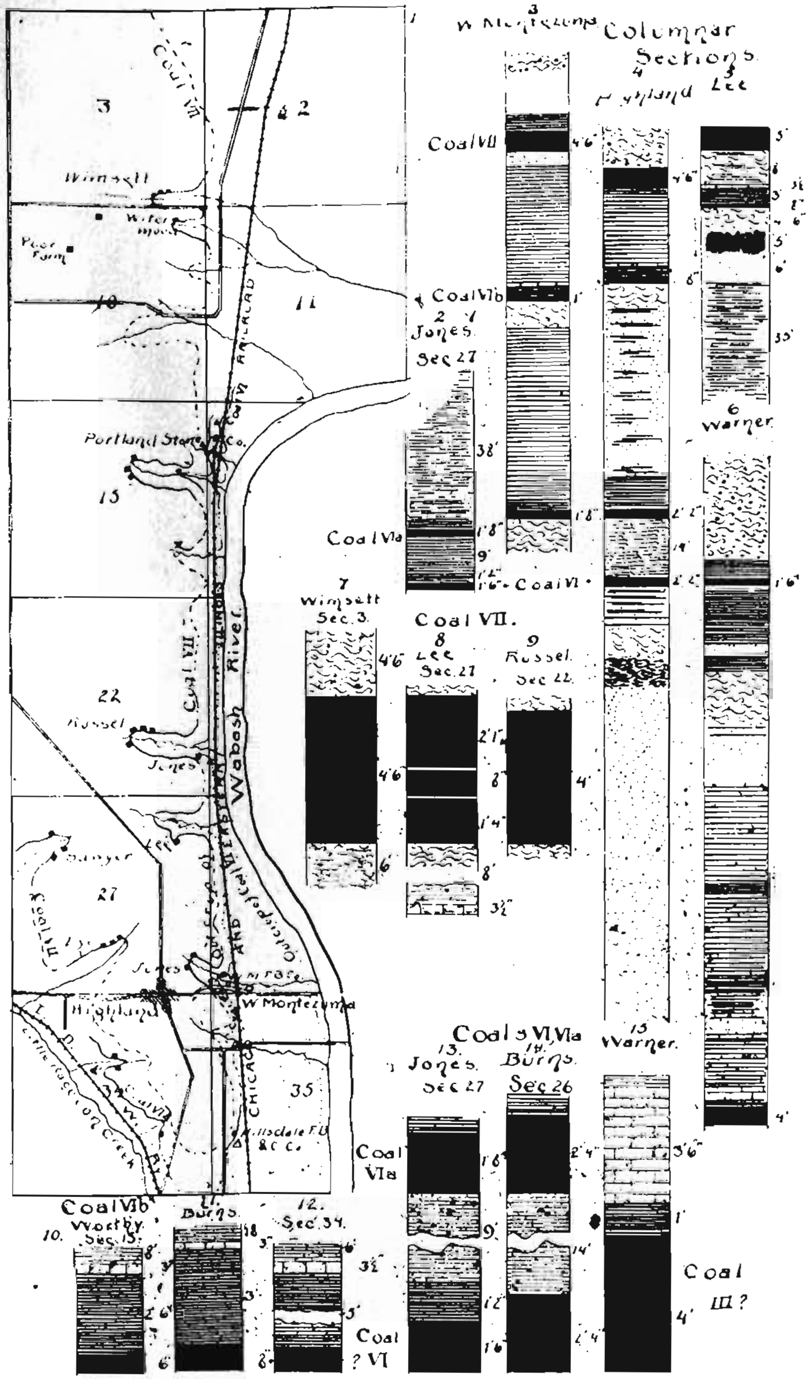


PLATE XXIII. Sketch map, columnar sections, coal sections, T. 16 N., R. 9 W.

614. The following section was obtained by Mr. Blatchley on the land of Mr. Jos. Burns, S. W. ¼, Sec. 26-16-9, a short distance west of West Montezuma station.

SECTION 165. SECTION AT WEST MONTEZUMA.—Fig. 3 (W. S. B., p. 67).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and drift .... 5 to 7	0	..	..	7	0
2.	Sandstone .... 2 to 10	0	..	..	17	0
3.	Light gray sandy shale, 1 to 6	0	..	..	23	0
4.	COAL VII .... 3 to 5	6	5	4	28	6
5.	Fire-clay .... 3 to 4	0	..	..	32	6
6.	Blue to drab argillaceous shale ....25 to 30	0	..	..	62	6
7.	Concretionary iron carbonate (two bands)	6	..	..	63	0
8.	Black fissile shale......2 to 3	0	37	6	66	0
9.	COAL VIb 1	0	1	0	67	0
10.	Fire-clay (white silicious).. 5 to 7	0	..	..	74	0
11.	Blue and drab argillaceous shale 42	0	..	..	116	0
12.	Black fissile shale 2	0	51	0	118	0
13.	COAL VIa 1	8	1	8	119	8
14.	Fire-clay 8	0	..	..	127	8

615. Mr. Kindle gives the following generalized section of the area about Highland:

SECTION 166. SECTION ABOUT HIGHLAND.—Fig. 4 (E. M. K.).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Drift ....8 to 10	0	..	..	10	0
2.	COAL VII 4	6	4	6	14	6
3.	Shale 18	0	..	..	32	6
4.	Limestone, bluish-gray, fossiliferous	3	..	..	32	9
5.	Black sheety shale 3	0	21	3	35	9
6.	COAL VIb	8	0	8	36	5
7.	Sandy clay, hard (fire-clay) 5 to 7	0	..	..	42	5
8.	Sandstone, shelly 40	0	..	..	82	5
9.	Shale (in well at brick yard) 8	0	55	0	90	5
10.	COAL VIa ....2 to 2	4	2	4	92	9
11.	Shale 14	0	14	0	106	9
12.	COAL VI ....2 to 2	4	2	4	109	1
13.	Shale and sandstone 7	0	..	..	116	1
14.	Sandstone, hard 1	0	..	..	117	1
15.	Fire-clay 8	0	..	..	125	1
16.	Black bituminous clay—"plumbago" 7	0	..	..	132	1
17.	Hard sandstone 81	0	..	..	213	1

616. SECTION 167. SECTION AT LEE MINE.—Sec. 27-16-9, Fig. 5 (E. M. K.).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	COAL VII ....4 to 6 ft.	5	0	5	0	5	0
2.	Gray shale and fire-clay	8	0	..	..	13	0
3.	Limestone, gray, dark, fossiliferous	..	3	..	..	13	3
4.	Dark blue shale	3	..	11	3	16	3
5.	COAL VIb	..	8	0	8	16	11
6.	White sandy fire-clay	4	6	..	..	21	5
7.	Concealed	5	0	..	..	26	5
8.	Massive rough-bedded sandstone	6	0	..	..	32	5
9.	Gray shale to bluish, with much sand and mica......	35	0	..	..	67	5

617. SECTION 168. SECTION OF DRILLING NORTH OF HILLSDALE.—Fig. 6 (G. H. A.).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	25	0	..	..	25	0
2.	Shale	3	6	..	..	28	6
3.	COAL VI?	1	6	1	6	30	0
4.	Clay	1	0	..	..	31	0
5.	Dark shale	13	0	..	..	44	0
6.	Hard sandstone	2	0	..	..	46	0
7.	Black shale	4	0	..	..	50	0
8.	"Clay rock"	13	0	..	..	63	0
9.	Shaly sandstone	1	6	..	..	64	6
10.	Sandstone	12	6	..	..	77	0
11.	Light shale	23	0	..	..	100	0
12.	Black shale	2	0	..	..	102	0
13.	Light shale	20	0	..	..	122	0
14.	Brown shale	3	0	..	..	125	0
15.	Brown fake	6	0	..	..	131	0
16.	Light shale	4	0	..	..	135	0
17.	Limestone	1	0	..	..	136	0
18.	Brown shale	11	6	..	..	147	6
19.	Limestone	3	6	..	..	151	0
20.	Brown shale	1	0	126	0	152	0
21.	COAL III or IV?.........	4	0	4	0	156	0
22.	"Rock"	..	6	..	..	156	6

If the coals hold here anything like the distance apart they are found to have to the north or east, the 4 ft. coal in this section would occupy about the position of the lower coal at Mecca (Coal III) and Coal V should come about at the horizon of the black shale No. (12) of the section.

618. COAL VII.—This coal seems to be of workable thickness over most of the area, ranging from 3 ft. 6 in. to a reported thickness of 8 ft., but averaging about 4 ft. It shows no persistent clay or sulphur

bands, though clay bands are sometimes found. It appears to be a good coal, but pockety. The roof is usually very poor, generally being fire-clay or boulder clay and requiring that some of the top coal be left to hold it. Around Highland this bed is greatly disturbed, showing high and varying dips and being much cut up with clay veins.

619. COAL VIb.—This is a good coal, too thin to mine by itself, but underlain by the most highly refractory clay yet found in the State. It is characteristically overlain by black shale and a thin bed of fossiliferous limestone.

620. COALS VI AND VIa.—These coals are, as far as found, too thin to work except by stripping, and too far apart to work together. We are inclined to think, however, that Coal VI may thicken up to the west, becoming then, as at Clinton, a good workable coal.

621. COAL III (?).—This coal has been found of workable thickness north of Hillsdale, and may be found workable at other points. It is probably a fine coal, with a good roof.

622. DISTRIBUTION AND LOCAL DETAILS OF COAL.—In giving the data obtained it will be convenient to proceed south along the bluff of the Wabash, then up the Little Raccoon valley and on over to Dana.

In the S. E. 40 of Sec. 3 is the Jacob Wimsett mine, in a deep hollow. Coal has been mined from both banks. A section here shows (Sect. 169, E. M. K.), Fig. 7:

	Ft.	In.	Ft.	In.	Ft.	In.
1. Boulder clay ....0 to	60	0	..	..	60	0
2. Sandstone.						
3. Fire-clay ....4 to	6	0	..	..	66	0
4. COAL VI. 3 ft. 6 in. to 5 ft. 6 in.	4	6	4	6	70	6
5. Fire-clay, hard, nearly shale	6	0	..	..	76	6
6. Sandy shale	10	0	..	..	86	6
7. Tough black sheety shale...	2?	0	18	0	88	6
8. COAL VIb	1	0	1	0	89	0
9. Fire-clay	?	0	..	..	..	..
10. Shaly sandstone	10	0	..	..	99	6+
11. Shale (in well), hard, gray, sandy	3	0	..	..	102	6+

Coal has been mined here for many years. It ranges from 3 ft. 6 in. to 5 ft. 6 in. in thickness, with an average of about 4 ft. 6 in. The coal appears to be without partings, though a dull black slaty band occurs within 8 or 10 in. of the roof in several places. No sulphur

balls or bands were noticed in the coal. The roof is fire-clay, good in places, in others poor. The floor is a dark blue fire-clay, inclined to be shale. Clay veins from 1 in. to 1 ft. 6 in. seem to be abundant in this mine. In some cases the vein is simply a more or less vertical band of clay, in others it simply occurs in masses in the middle of the crushed coal found at a fault line. See Fig. 5 of Plate III.

In the N. E. of N. E. of Sec. 10, Coal VII has been worked on the Joseph Witermood place. The coal is from 4 to 5 ft. 6 in. thick, and much the same as in the Wimsett bank.

In the N. E. of N. W. Sec. 10 coal has been mined by a shaft 75 ft. deep. At the Poor farm, in the same quarter section, 5 ft. of coal is said to have been struck at 75 ft. As that is about the depth of Coal VII below the upland surface in this region, the coal found is doubtless Coal VII.

In the N. W. of N. W. of Sec. 14 Coal VIa appears at the side of the railroad and only about 12 ft. above low water in the Wabash. It is 8 in. thick, overlain by black shale and underlain by fire-clay. A short distance south of this is the quarry from which is obtained the so-called Portland stone, which is well and favorably known on the market. A section in the quarry shows:

623. SECTION 170. SECTION IN PORTLAND STONE QUARRY.—Sec. 14 (E. M. K.).

	Ft.	In.
1. Boulder clay	6	0
2. Gray shale	8	0
3. Limestone, blue-gray, full of fossils...............	..	3
4. Black shale	2	6
5. COAL VIb	..	6
6. Sandy clay ....5 to	7	0
7. Light gray-blue to buff sandstone	40	0

This stone has been quite fully described by Mr. Hopkins (T. C. H., pp. 306-9, 317), and a photographic view of the quarry is given in Plate X. Drilling is reported to show a depth of the sandstone of at least 69 ft. On the east side of the quarry the massive sandstone appears to run into a shaly sandstone, or almost a sandy shale, and so sharply are the two marked off as to suggest a nonconformity. Closer examination indicates that that is not the case, and that the difference may be due to a difference in cementing material. The base of the quarry is only about 20 ft. above low water in the Wabash.

Coal VIb shows 10 in. thick in a ravine a quarter of a mile south of the quarry. This ravine exposes well the strata from Coal VII, which was formerly worked from three or four old drifts near its head down.

There are only 16 to 18 ft. of blue shale between Coal VII and the limestone over Coal VIb here. The limestone in this ravine is shelly and thin-bedded throughout.

In a ravine in the S. E. ¼ of Sec. 22 Coal VII is being mined on the John Russel place by Bert Jones. The coal here is from 3 to 4 ft. thick, and without partings (Fig 9), and said to be of very good quality. It lies level, has a few inches of fire-clay over it in places, but generally boulder clay, which is very liable to cave in. In places the coal is cut out by the irregularities of the old surface. A few clay veins are met with. Under the coal is hard fire-clay. Just above, where the drain passes under the railroad, Coals VI and VIa crop out; the section shows:

624. SECTION 171. SECTION AT JONES'S BANK.—Fig 471 (E. M. K.).

	Ft.	In.
1. Blue to gray shale	38	0
2. COAL VIa	1	8
3. Gray shale	9	0
4. Black sheety shale	1	2
5. COAL VI	1	6

Coal VIa has been stripped at the Jos. Jones bank here, having a thickness of 20 in. of clean coal. The lower bed is not worked.

In the N. E. ¼ of Sec. 27 Coal VII is worked at Russell Lee's bank. The section here was given in Sect. 167, ¶616, Fig. 5. The base of this section is in the bed of the branch under the railroad bridge. The coal runs from 4 ft. 6 in. to 5 ft. thick. There are two clay bands in the coal here. The following sections show variations in their position (Fig. 8):

	Ft.	In.	Ft.	In.
Coal	2	1	1	0
Clay parting	..	¼	..	⅛
Coal	..	8	..	8
Clay and bone	..	⅛	..	1
Coal	1	4	2	4
	4	1+	4	1+

Of these bands, the upper one runs quite regularly. No sulphur bands, and coal seems to be free of sulphur. The cleat is marked in places, suggesting block coal. The roof is fire-clay, about 4 ft. thick, overlain by soft, brownish-gray, micaceous sandstone. It is quite irregular in composition, usually containing pebbles, many of which are quite large, 6 in. to 2 ft., making it look like boulder clay. The sandstone lies unconformably upon the clay, as shown in the following sketch (Fig. 255). The top of the coal has to be left for a roof. While the main dip of the coal is to the east, it shows very marked and irregular local dips in all directions. These dips vary from 5° to 25° in a few feet. In one room the dip is 15° to 25° east, while in another room, 60 ft. away, it is 15° north. In Figs. 11 and 12, Plate

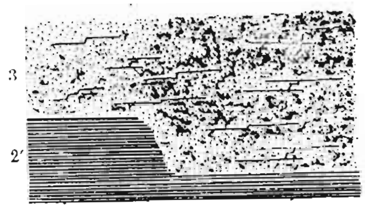


Fig. 255. Sketch showing relation of sandstone and shale or clay. By E. M. K.

III, are shown two irregularities. The coal at the right in Fig. 11 dips 40° toward the north. The clay vein, in this case 1 to 8 in. thick, crosses the entry at N. 70° W. In Fig. 12 the bending down of the clay in the vein shows that it came from the clay of the roof.

At the West Montezuma Fire Brick works, Coal VIa is 2 ft. to 2 ft. 4 in. thick and about 8 ft. below the surface; Coal VI is of the same thickness and about 22 ft. below. The section is as given in Sect. 166, ¶615, Nos. (9-17). In the first hollow north of West Montezuma 4 ft. of coal is said to have been struck at a depth of 18 ft. It suggests a local thickening up of Coal VI, such as occurs in places near Mecca.

Coal VII is found near the head of the hollow just west. The coal runs about 4 ft. 6 in.; but in some test entries driven by the railroad company it ran down to 8 in. in a distance of 70 yards, indicating the pockety nature of that coal through this area. The section here is given in Sects. 165 and 166. At the A. W. Jones bank, in the S. E. of S. E. of Sec. 27, Coal VII measures 3 ft. 8 in. The coal is here 25 or 30 ft. below the top of the hill and 75 or 80 ft. above the Wabash. Two thin clay partings were seen in the lower 18 in., but they did not seem to be persistent; 10 in. of coal and bone is left to hold the roof. Above the coal there is exposed 9 ft. of sandy shale. The strata between Coals VIb and VIa, while in places shaly and suitable for brick, in other places are massive sandstones. Thus, in the N. W. of N. W. of Sec. 35, just west of the wagon and railway crossing, 18 ft. of sandstone shows, the top 8 ft. being shaly and thin-bedded, the rest massive. At one place in a ravine just north of Highland the soft shaly sandstone containing much clay and lying in strata ½ to 2 in. thick, changes in the space of 3 ft. to a massive, very hard, fine-grained, gray sandstone, with vertical joints.

At the Hillsdale Fire Brick and Coal Company's plant, the sandy fire-clay just under Coal VIb is mined, this clay being exceedingly refractory. Coal VIb is here a good coal, 1 ft. thick, and is here left for a roof in the clay mine. Coal VII is about 20 ft. above, but is not worked. The section is much the same as at West Montezuma, except that a 4 in. band of limonite is noted 2 ft. 6 in. above the limestone over Coal VIb. A drilling here shows Coal III (?) to underlie this point at 152 ft. and with a thickness of 4 ft. See Sect. 168 and Fig. 15.

In Sec. 34 Coal VIb has been stripped in the S. E. quarter. Just north of the center of the section at other strippings are exposures of the accompanying strata. At one of these the following section was obtained (Sect. 172, E. M. K.):

	Ft.	*In.*
1. Boulder clay.		
2. Light blue-gray shale	6	0
3. Limestone, gray fossiliferous	..	3½
4. Blue shale, blocky and tough, slightly laminated, fossiliferous	5	0
5. COAL VIb	?	?
6. Gray sandy fire-clay	5	0
7. Massive sandstone	11	0

In the S. W. of S. E. of Sec. 27 is the Vine Eye bank, run by G. W. Craig. The coal is Coal VII, running 4 ft. thick, with very little sulphur. The coal here lies within 25 ft. of the top of the hill and about 4 ft. above the bed of the adjacent ravine. A clay band ⅙ in. thick shows near the mouth of the entry, but is not persistent. It has a roof of boulder clay, with sometimes 8 or 10 in. of fire-clay between it and the coal. As would be expected, preglacial channels or erosion irregularities are met with, and would doubtless interfere seriously with an attempt to work the bed extensively. A little further up the ravine, at a stripping and old entry, the roof is better, showing 7 ft. of bluish-gray, rather sandy shale, with sandstone above.

In the N. W. ¼ of Sec. 27, at the J. C. Sawyer mine, Coal VII has been worked from several openings. These are now caved in. At the only point the coal was exposed, it measures 4 ft. thick, overlain by a few inches of fire-clay, and that in turn by boulder clay. Seventy feet away, and on the same level, is an exposure of 20 ft. of gray shale, indicating probably a very rapid rise in that direction. Dip is strongly southwest. It is claimed that on the south side of

this mine the coal thickens up to 7 or 8 ft. A clay vein (?) or roll 14 ft. thick was struck in several of the entries in these mines. It runs a little east of north. At a new entry being started here (1897) the coal shows a clay band 10 in. from the top. The top 6 or 8 in. of coal is left up for roof. At the mouth of this entry the coal dips 20° S. W. A few feet below the coal an exposure of 4 ft. of soft sandy shale is seen to be cut by a clay vein, as shown in Fig. 256.

Fig. 256. Clay vein in shale, near Sawyer mine. Sketch by E. M. K.

This doubtless runs up through the coal, the clay probably being derived from above the coal.

On the west side of Little Raccoon creek, N. W. of N. E. of Sec. 28, Coal VIb 16 or 18 in. thick lies 2 or 3 ft. above the creek, and has been stripped there. Above it is first a tough black shale, then a dark gray shale, then 3 in. of gray shaly limestone full of minute gasteropods. The fire-clay below is very sandy and appears like that under this coal at Hillsdale.

In the N. W. of N. W. of Sec. 34 a coal reported to be 2 ft. thick has been dug some. It lies 15 to 18 ft. above bed of creek, and is overlain by 8 ft. of dark blue shale, with bands of iron ore.

In T. 16 N., R. 10 W., coal is said to have been struck on the Wade place, one mile S. E. of Quaker Point in the S. W. of Sec. 8, at a depth of 137 ft.

One mile west of Dana is the Dana shaft, reaching Coal VII (?) at 143 ft. The coal is said to range from 4 to 5 ft., with an average of about 4 ft. 6 in. The section of the strata above and below coal was given above in Sect. 159, ¶608. The coal is said to have from 8 to 18 in. of black shale for a roof, which is said to be poor on the south side, but tough and good on the north side. The soft fire-clay under the coal was mined and shipped to Chicago. The coal is said to have been good after the sulphur was picked out. Mine has not been worked since 1875 or '76.

Still a mile west on the State line was the Illiana shaft, where the coal is reported to be 122 ft. 6 in. deep, but to have a bad roof; otherwise probably much as at Dana. See ¶607, Fig. 4 of Plate XXII.

625. In general, it is seen that Coal VII underlies all of this area except the valleys of the Wabash river and Little Raccoon creek. It has, however, such a poor roof and lies nearly everywhere so close to the boulder clay that much difficulty will be experienced in working most of it. Coal VI has not been seen of workable thickness, but we should not be surprised if it attained to a workable thickness under much of the western part of the area. Coal III (?) is found workable under Hillsdale, and 150 ft. nearly below Coal VI. It may be doubted if it attains a workable thickness over much of the area.

Township 15 North, Ranges 9 and 10 West. (In Vermillion County.)

626. Location, etc.—These partial townships make up the southern two-thirds of Helt of the civic townships. The most of these townships are taken up with Grand and Helt prairies. Exposures of the coal measures are rare, and, as far as seen, were confined to Secs. 3, 11, 15, 32 and 33, of T. 16 N., R. 9 W. The C. & E. I. R. R. crosses the eastern edge of the area.

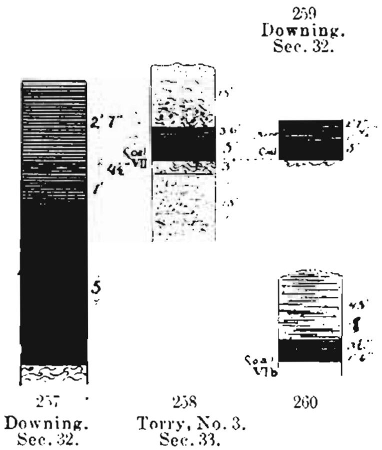


Fig. 257. Coal VII in southern part of T. 15 N., R. 9 W.
Figs. 258 and 259. Stratigraphy of Coal VII, same area.
Fig. 260. Stratigraphy of Coal VIb. Southern, Sec. 33.

627. Stratigraphy and Coals.—The stratigraphy of this area is much like that last discussed, the difference being principally that the space between Coals VIb and VII, which in Township 16 North had been reduced to 18 to 25 ft. increases to 45 ft. or more. Coal VIb increases in thickness as we go southward. Coals VI and VIa tend to be near together, separated by clay in the northern part, as on the Big Vermillion river, but to the south probably drift apart and at the same time Coal VI assumes a good workable thickness. On the western edge of this area Coal VIII is found of workable thickness along the lower part of Brouillet's creek. Its stratigraphic position will be more thoroughly discussed in connection with the two townships just south. The following sections illustrate these features:

628. Section 173. Section at Torry No. 3 Drift.—Fig. 258 (E. M. K.).

	Ft.	In.
1. Surface	15	0
2. Black sheety shale	3	6
3. COAL VII	5	0
4. Fire-clay	3	6
5. Shaly sandstone	15	0

629. Section 174. Section at Downing Mine.—Sec. 32, Figs. 257, 259 (E. M. K.).

	Ft.	In.
1. Black sheety shale ("slate")	2	7
2. Bone coal	..	4½
3. Black sheety shale	1	0
4. COAL VII	5	0

630. Section 175. Section on Souther's and Overpeck's Land.—Sec. 33, Fig. 260 (E. M. K.).

	Ft.	In.
1. Gray sandy shale	45	0
2. Black jointed shale	3	6
3. COAL VIb	1	6

631. Section 176. Section at Parrott's Mine.—Sec. 3, Figs. 262, 265 (E. M. K.).

	Ft.	In.
1. Yellow shale	20	0
2. Black shale	2	0
3. COAL VIa	1	8
4. Fire-clay	11	0
5. COAL VI	3	4
6. Shelly to massive sandstone	10	0

632. Section 177. Section Near Road and Railroad Crossing.—Sec. 11, Figs. 263, 266 (E. M. K.).

	Ft.	In.
1. Bluish-gray shale	5	0
2. Fossiliferous limestone and iron ore	..	4
3. Dark blue shale	2	0

		Ft.	In.
4.	Black sheety shale	1	8
5.	COAL VIa	1	4
6.	Light sandy fire-clay	3	0
7.	Bone Coal VI	..	3
8.	Soft sandy shale, with much iron ore	10	0

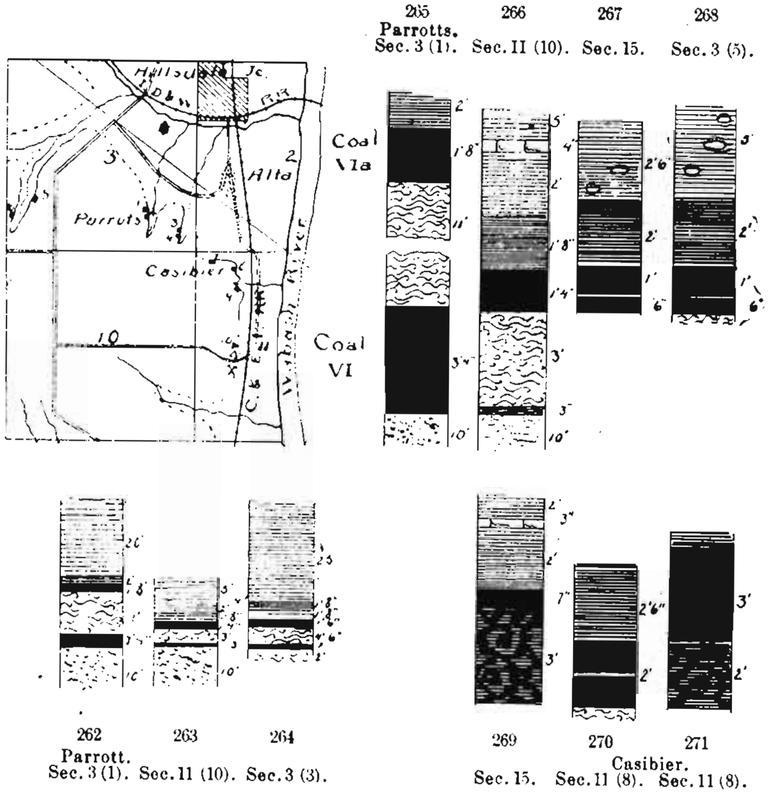


Fig. 261. Sketch map of N. E. corner of T. 15 N., R. 9 W.
Figs. 262-264. Columnar sections in same area.
Figs. 265-271. Coal sections, same area.

633. SECTION 178. SECTION EAST OF PARROTT CLAY WORKS.—S. E. of Sec. 3, Fig. 264 (E. M. K.).

		Ft.	In.
1.	Gray sandy shale	25	0
2.	Tough black sheety shale	1	8
3.	Soft blackish-blue clay shale, with fossils	1	8
4.	COAL VIa	1	4
5.	Fire-clay	4	6
6.	COAL VI	?	?

634. DIVISION VII.—This division, as usual, shows one workable coal of good thickness and with probably a better roof than further north. The coal, where exposed, is 5 ft. thick, with a black sheety shale roof. As it is similar to its development in 14 N., 9 W., where it has been more extensively mined, a more extended description will be given there, which see.

Coal VIII probably underlies the western part of this area, but was not exposed here; see 14 N., 10 W.

635. DIVISION VI.—This shows three coals as usual, but the coals appear to be variable, and not being correlated by Mr. Kindle, there is considerable doubt as to their proper assignment to the different horizons. None of them, however, appear to be workable except locally.

636. DISTRIBUTION AND DETAILS OF COAL.—Around Highland, Coal VI appears to be nearly down to low water in the Wabash, but south of Hillsdale rises until above the level of the railroad. It is exposed at a number of places in Secs. 3, 11 and 15. In one ravine in the N. W. of S. W. of Sec. 3, Coal VIa is exposed. It is 18 in. thick, with a clay band parting 6 in. from the base. It has over it 1 ft. 8 in. of black sheety shale, while above that shows 5 ft. of bluish shale, with many ironstone concretions (Fig. 268). Below it is soft blue fire-clay, not sandy. At one exposure it is 18 ft. above the branch, while a quarter of a mile farther up it is in the bed of the branch. At the Parrott clay and coal mine, the clay is a rather sandy, gray, hard, fire-clay. Coal VIa is used for blacksmithing. Coal VI can not be worked without taking out some of the clay. Where worked the coal is about 1 ft. above the branch and 6 or 8 ft. above the creek. To the north it rises to 12 ft. above the branch. In a ravine a quarter of a mile east of the clay works, both Coals VI and VIa are exposed, the section being as in Sect. 176, ¶631.

In the N. W. corner of Sec. 11, Wesley Casibier is working a coal of which the upper 2 ft. 6 in. or 3 ft. is good coal, while the lower 18 in. or 2 ft. is bone, a shale parting ½ in. or so thick separating the two parts. At an exposure near the mouth of the entry, the coal is only about 2 ft. thick, with a clay parting, and with tough, black sheety shale over (Figs. 270, 271). The coal here lies just at the base of the hill or top of the terrace and dips west. In a ravine just south the coal is 1 ft. 8 in. thick and good, with no parting. Just west of the center of Sec. 11 is the section given in ¶632, Sect. 177. About 300 yards south of this is a sandstone quarry. Fifty yards farther south is a 12 to 15 in. bed of coal which is clearly cut out by the sandstone-filled channel at the quarry.

In the S. E. of N. E. of Sec. 15 are two beds of coal about 15 ft. apart. In the bed of the branch one has been stripped, being 18 in. thick and very good. The roof is a tough blue shale, crowded with fossils, with tough black sheety shale above that. There is a white sandy fire-clay under the coal which has been used for whitewash. A sulphur band shows 6 in. from the bottom of the coal. In other places there is immediately over the coal 2 ft. of black sheety shale and from 1 ft. to 2 ft. 6 in. of dark blue shale, with 10 ft. of gray shale above that. The upper coal shows 7 in. of hard coal and 3 ft. of rotten coal; over it is 2 ft. of dark blue shale, then 3 in. of dark fossiliferous limestone, with 2 ft. of light blue shale still above (Fig. 269). With the data at hand the coals are not easily correlated, but it would seem that they might be Coals VI and VIa, but considering only the coals, they appear more like the Coals VIa and VIb, though that would make these coals very much nearer together than usual. Mr. Bradley assumes that Coal V or the Thomas coal at Silverwood comes up through here.

Below this no coal is seen until Norton's creek is reached. In Sec. 33 Coal VIb is just about at creek level. It runs about 18 in. thick and has been stripped on the Grant Overpeck place, in the S. E. of S. W. of Sec. 33, S. E. of N. W. of Sec. 33, and on Mr. Southern's place, in N. E. of N. W. of Sec. 33. It is overlain by 3 ft. 6 in. of black shale, which is cut by regular joints 18 to 24 in. apart, running N. 75° E. This shale contains many boulders; over it is 45 ft. of gray sandy shale; see Fig. 260. A 250-ft. well sunk on Mr. Grant Overpeck's place is said not to have encountered any coal; salt water was reached at that depth, which is not far from the bottom of the coal measures.

Coal VII is or has been worked at Torrey No. 3 drift and at the Joseph Downing mine. At the former it is about 20 ft. above drainage. The coal runs 5 ft. thick, with black sheety shale over, full of boulders, as at Clinton. The sections at these places were given in ¶¶628, 629, Sects. 173, 174, Figs. 257-259. At the Downing mine an anticline shows just above the drift. The arch has a rise of 3 ft. in a span of 30 ft. It has the direction N. 60° E.

The outcrop of Coal VII would appear to pass north to the west of Norton's creek, so that that bed underlies all of 15 N., 10 W., but only the western mile or mile and one-half of 15 N., 9 W. It would seem probable that it maintains a working thickness under most of that area, though it is possible that lack of roof will prevent the mining of much of it.

Coal VI and VIa, after the exposures south of Hillsdale, would seem to dip to the south and, passing under the river, should be looked for 150 ft. or more below Coal VII. As far as exposed, they show but little workable coal; but we are inclined to think will prove better to the south and west, tending to become regular, and Coal VI to be of good workable thickness.

Coal VIII probably underlies much of 15 N., 10 W.; it outcrops along Brouillet's creek, in Sec. 28, and is or has been worked at two places. At Sylvester Miller's bank, in the S. E. of N. W. of Sec. 28, the coal is 4 ft. thick, overlain by 2 ft. of bone coal or black shale, and that in turn by 4 ft. of clay shale. Below the coal is 4 ft. of clay, and a well section is reported to show 86 ft. of shales under the fire-clay. The coal contains some sulphur streaks, but has a pure band at the bottom suitable for blacksmithing. The bone coal makes a good roof, except where cut by clay slips. The fire-clay, as usual with this bed, tends to creep. Shale veins are common here. The usual limestone below this coal is lacking here. The coal is just at drainage. The dip is to south or southwest.

Half a mile farther south a shaft has been opened to the same bed.

Township 14 North, Range 9 West. (In Vermillion County.)

637. Location, etc.—This township forms the southeast corner of Vermillion county, and corresponds with the eastern part of Clinton of the civic townships. This township presents the usual bottom land, terrace, bluff and upland topography of eastern Vermillion county. Norton's, Feather and Brouillet's creeks cross the township from northwest to southeast. The C. & E. I. R. R. crosses the northeast corner of the area.

638. Stratigraphy and Coals.—The outcrops of this area belong to Divisions VI-VIII, with outcrops of Coals VIb?, VII, VIIa and VIII. Below outcrop are known to be Coals VIa and VI, the latter workable. Other coals probably still underlie. With the data at hand, many questions concerning the stratigraphy of the coals here are still open. We might take as a starting point the coal outcropping 5 ft. thick in the bluff west of Clinton. This is Coal VII. From 160 to 170 ft. below it is found Coal VI, a 6-ft. coal. As we have dealt with these coals either to the east or north we have found uniformly two small coals between them, Coal VIa lying not far above Coal VI, and Coal VIb lying about half way between Coals VIa and VII. In

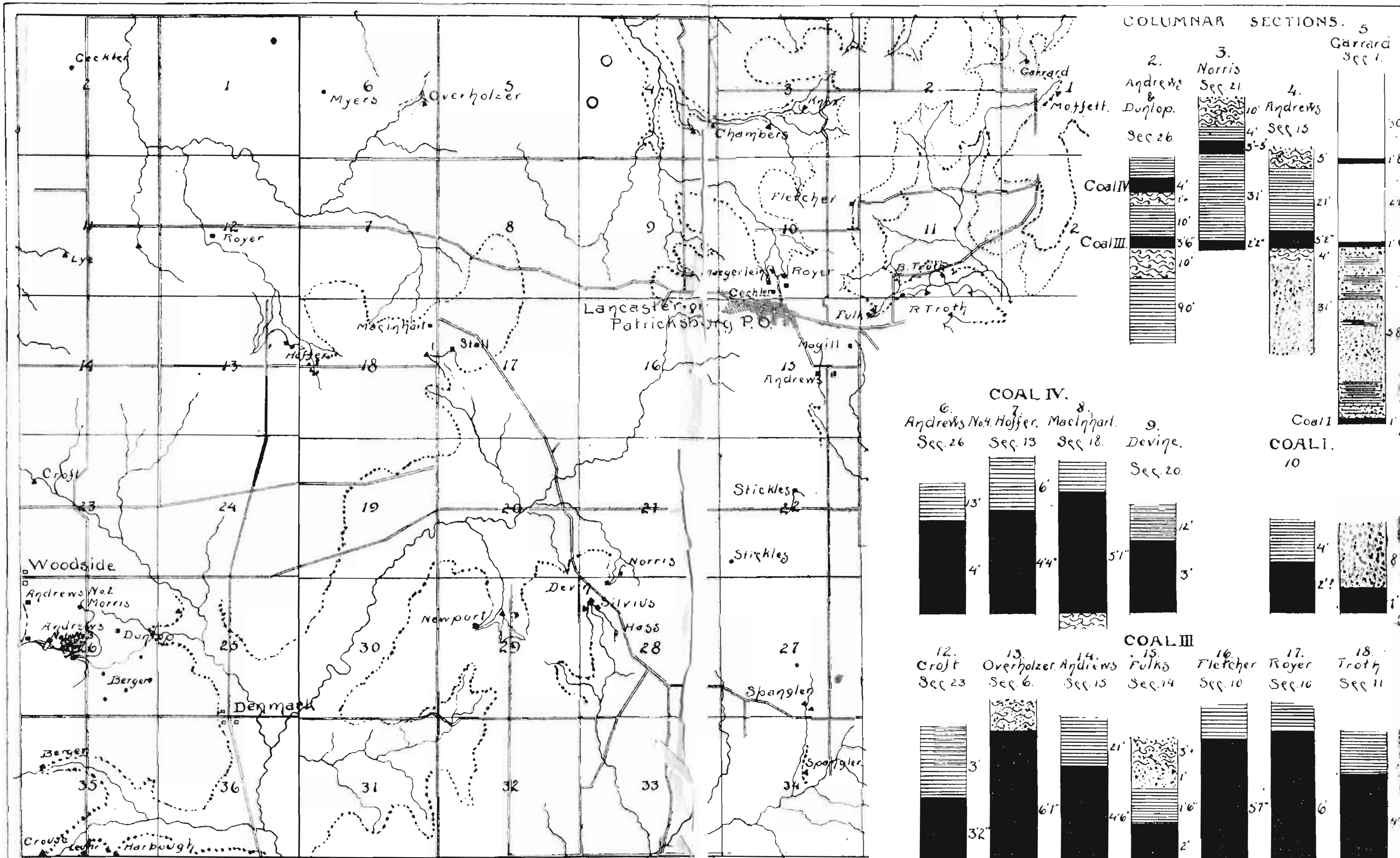
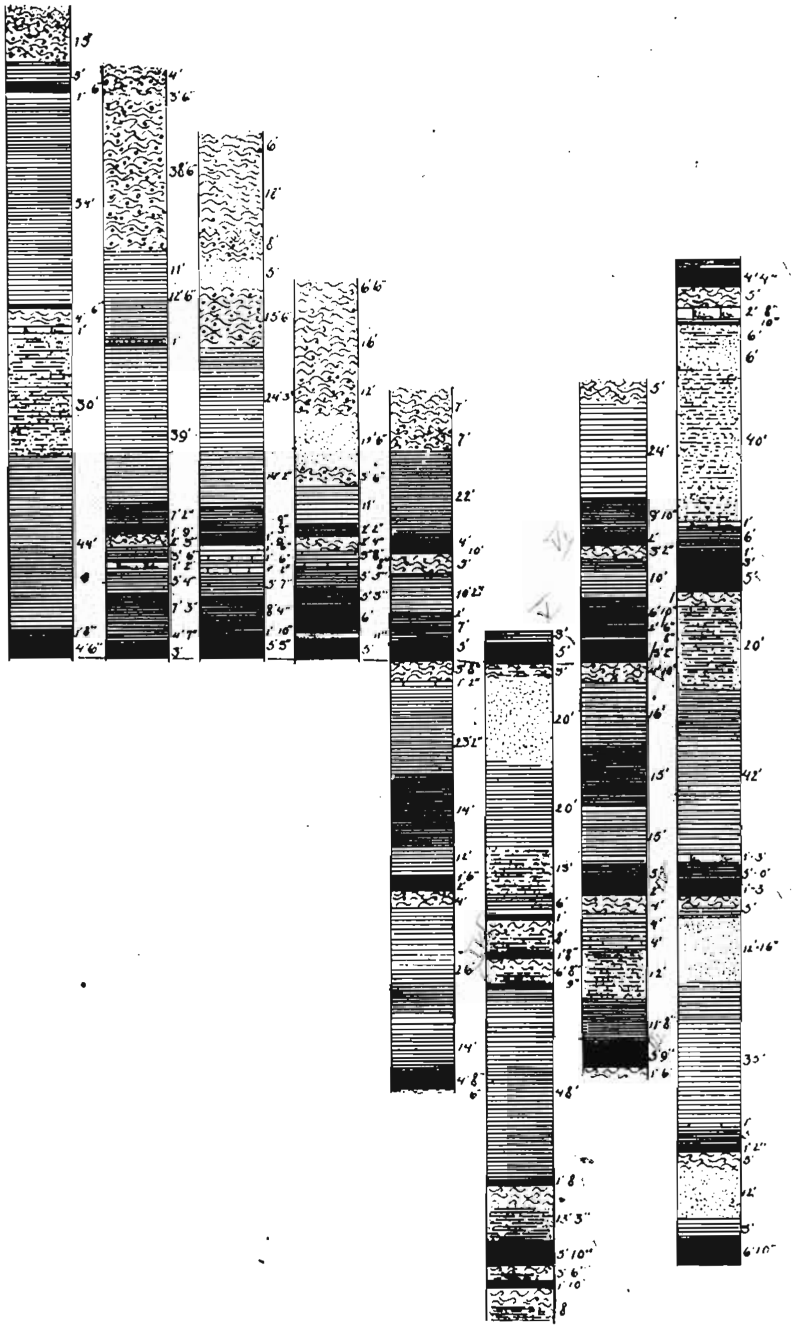


CHART OF LANCASTER BLOCK COAL FIELD.

PLATE XXVI.



272 Gavin. 14-14-10.
273 Bore No. 2. S. W. ¼, Sec. 8.
274 Bore No. 3. S. W. ¼, Sec. 8.
275 Bore No. 4. S. W. ¼, Sec. 8.
276 Bore B. B. C. Co. Sec. 33.
277 Buckeye. Sec. 16.
278 Bore B. B. C. Co. Sec. 33.
279 Connected sections.

Figs. 272-279. Columnar sections in T. 14 N., Rs. 9 and 10 W.

Fig. 279 is shown a generalized section, showing what is observed in outcrop (spaces probably exaggerated). This does not include some of the coals reported in drillings but not seen. The lower part is based on outcrops north of this township. In Fig. 277 is shown the section obtained in sinking the Buckeye shaft near Clinton. This shows Coal VIa as we would expect it, but Coal VIb is replaced by three coals, 8 ft. and 6 ft. 8 in. apart, and each as thick as Coal VIb is normally. These would become Coals VIb, VIc and VId.

In Figs. 276 and 278 are given sections of drillings almost at the southeastern corner of the county, showing Coals VII and VIb somewhat closer together than they are farther north. One coal shows between. A 10-in. to 2-ft. coal is met in these drillings about 20 ft. above Coal VII, in addition to a coal in the black shale over VII. This feature is noted at many of the outcrops around Clinton and Lyford, as indicated in Fig. 279.

Above Coal VII occurs another coal, which outcrops along Brouillet's creek and has been opened upon at many places. So similar is this coal to Coal VII at Clinton that in the absence of reliable sections connecting them, and the fact that the upper coal is only exposed workable along a stretch of country through which Coal VII does not show, that at first the writer was strongly inclined to the view that the bed at Clinton (Coal VII) rose so as to outcrop along Brouillet's creek and Coal creek, in Vigo county, descending again to where Coal VII is extensively worked west of Terre Haute. The evidence, however, more strongly sustains the view that Coal VII dips south from Clinton, passing below the river, and not reappearing until nearly the latitude of Terre Haute, and that the lowering of the strata across this syncline in part accounts for the appearance of the Brouillet creek coal in this area. This will be known as Coal VIII. Sections 273-275 are drillings to Coal VII, while in 272 is shown the section of a shaft supposed to be sunk to Coal VII. In none of these sections is the position of Coal VIII clearly indicated. It is thought, however, that its position is indicated by the 6-in. coal in the Garvin shaft (Fig. 272). If so, it lies about 70 ft. above Coal VII, and between there is the irregular coal noted in the boring near the county line (Fig. 278). In the drillings figured in Figs. 273-275 this coal is underlain a few feet by a limestone, sometimes double. In the Garvin shaft a 1-ft. coal occurs above Coal VIII and will therefore be Coal VIIIa. The details of the sections figured, and some others, are given below:

639. SECTION 179. SECTION OF SHAFT ON JAS. GARVIN'S PLACE.—Fig. 272. Shaft sunk by Redmond Kemans (from notes of J. T. S.).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and clay	15	0	..	..	15	0
2. Shale	5	0	..	..	20	0
3. Slaty shale	..	6	..	..	20	6
4. COAL VIIIa (?)	1	0	1	0	21	6
5. Clay shale	54	0	54	0	75	6
6. COAL VIII (?)	..	6	..	6	76	0
7. Fire-clay	4	0	..	..	80	0
8. Limestone	1	0	..	..	81	0
9. Sandy shale	30	0	..	..	111	0
10. Soft clay shale	44	0	..	..	155	0
11. Black shale	1	8	80	8	156	8
12. COAL VII (?)	4	6	4	6	161	2

Lacking information as to elevation at which this shaft started relative to Coal VIII there must remain some doubt as to the correctness of the correlation above indicated. The section is accompanied by this note: "Lower coal perhaps same as upper vein at Clinton."

The following four sections are from drilling on the north ½ of the S. W. ¼ of Sec. 8:

640. SECTION 180. SECTION OF BORE NO. 1.—N. E. of S. W., Sec. 8-14-9.

	Ft.	In.
1. Surface	69	6
2. Shale	1	0
3. "Rock" shale	15	11
4. Shale	15	7
5. COAL VII	5	4
	107	4

641. SECTION 181. SECTION OF BORE NO. 2.—N. E. of S. W., Sec. 8-14-9, Fig. 273.

	Ft.	In.	Ft.	In.
1. Surface	4	0	4	0
2. Clay and sand	3	6	7	6
3. Boulder clay	38	6	46	0
4. Soft gray shale	11	0	57	0
5. Hard gray shale	12	6	69	6
6. "Rock"	1	0	70	6
7. Gray shale	39	4	109	10
8. Black shale	7	2	117	0
9. Bituminous shale	1	9	118	9
10. Dark fire-clay	2	3	121	0
11. Gray shale	3	6	124	6

	Ft.	In.	Ft.	In.
12. Limestone	1	2	125	8
13. Blue shale	5	7	131	3
14. Black shale	7	3	138	6
15. Bituminous shale	4	7	143	1
Struck a hard boulder at base of shale.				
16. COAL VII	3	0	146	1

642. SECTION 182. SECTION OF BORE NO. 3.—N. W. of S. W., Sec. 8-14-9, Fig. 273.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface and clay	6	0	..	..	6	0
2. Clay and sand	18	0	..	..	24	0
3. Boulder clay	8	0	..	..	32	0
4. Sand (water)	5	0	..	..	37	0
5. Boulder clay	15	6	..	..	52	6
6. Gray shale	24	3	..	..	76	9
7. "Rock"	..	4	..	..	77	1
8. Gray shale	14	2	..	..	91	3
9. Black shale	8	9	..	..	100	0
10. COAL VIIb	..	9	0	9	100	9
11. Fire-clay	1	3	..	..	102	0
12. Gray shale	1	9	..	..	103	9
13. Limestone	..	6	..	..	104	3
14. Gray shale	1	6	..	..	105	9
15. Limestone	1	2	..	..	106	11
16. Bluish-gray shale	5	7	..	..	112	6
17. Black shale	8	4	..	..	120	6
18. Bituminous shale	8	4	28	1	128	10
19. COAL VII	5	3	5	3	133	1

643. SECTION 183. SECTION OF BORE NO. 4.—N. W. of S. W. of Sec. 8-14-9, Fig. 275.

	Ft.	In.
1. Surface and clay	6	6
2. Clay and sand	16	0
3. Boulder clay	12	0
4. Layers of sand	12	6
5. Boulder clay	3	6
6. Gray shale	5	6
7. Dark shale	5	6
8. Black shale	2	2
9. Fire-clay	2	4
10. Hard shale	3	8
11. Limestone	..	8
12. Bluish-gray shale	5	5
13. Black shale	5	3
14. Bituminous shale	6	0
15. "Rock"	..	11
16. COAL VII	5	0
	92	11

The following group of sections was made on the B. A. Smith farm, in Secs. 5 and 6-14-9, by the Torry Mining Company:

644. SECTION 184. SECTION OF BORE NO. 1, SMITH FARM.—

		Ft.	*In.*
1.	Surface and clay	6	0
2.	Boulder clay	5	0
3.	Sand	1	6
4.	Boulder clay	37	6
5.	Dark blue clay	3	0
6.	Black shale	3	10
7.	COAL VII	5	0
8.	Fire-clay	0	0
		61	10

645. SECTION 185. SECTION OF BORE NO. 2, ON SMITH FARM.—

		Ft.	*In.*
1.	Surface and clay	10	0
2.	Boulder clay	38	0
3.	Clay and sand	14	0
4.	Soft blue clay	4	0
5.	Black shale	6	6
6.	COAL VII	4	0
		76	6

646. SECTION 186. SECTION OF BORE NO. 6, ON SMITH FARM.—

		Ft.	*In.*
1.	Surface and clay	10	0
2.	Clay and sand	12	0
3.	Boulder clay	20	0
4.	Soft blue clay	6	0
5.	Hard blue clay	5	0
6.	"Conglomerate rock"	6	4
7.	Black shale	18	0
8.	COAL VII	4	5
		81	9

647. SECTION 187. SECTION OF BORE NO. 7, ON SMITH FARM.—

		Ft.	*In.*
1.	Surface	8	0
2.	Coarse gravel	3	0
3.	Boulder clay	28	0
4.	Soft clay	19	0
5.	"Conglomerate rock"	13	9
6.	Gray shale	43	3
		115	0

Coal VII appears to be lacking in this boring, and in bore No. 8 was not found in going 82 ft.

648. SECTION 188. SECTION OF BORE NO. 10, ON SMITH FARM.—

		Ft.	*In.*
1.	Surface	12	0
2.	Boulder clay	11	0
3.	Sand	3	6
4.	Boulder clay	26	6
5.	Black shale	1	0
6.	Fire-clay	3	10
7.	"Hard conglomerated rock"	3	8
8.	Black shale	16	8
9.	COAL VII	4	4

649. SECTION 189. SECTION OF BUCKEYE SHAFT.—Sec. 16-14-9, Fig. 277 (J .T. S., p. 542).

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1.	Shale, black, bituminous, sheety	3	0	..	..	3	0
2.	COAL VII	5	0	5	0	8	0
3.	Fire-clay and shale	3	0	..	..	11	0
4.	Sandstone	20	0	..	..	31	0
5.	Shale, light colored	20	0	..	..	51	0
6.	Shale, sandy	13	0	..	..	64	0
7.	Shale, slaty and brown, with ironstones	6	0	62	0	70	0
8.	COAL	1	0	1	0	71	0
9.	Fire-clay and sandy shale	8	0	8	0	79	0
10.	COAL	1	8	1	8	80	8
11.	Fire-clay and shale	6	8	6	8	87	4
12.	COAL	0	9	0	9	88	1
13.	Shale, somewhat sandy, varying in color	48	6	48	6	136	7
14.	COAL	1	8	1	8	138	3
15.	Fire-clay and sandy shale	13	3	13	3	151	6
16.	COAL VI	5	10	5	10	157	4
17.	Fire-clay and sandy shale	3	6	3	6	160	10
18.	COAL	1	10	1	10	162	8
19.	Fire-clay and sandy shale	8	0	..	..	170	8

As noted above this record shows an unusual number of coals between Coals VI and VII. Of interest in this connection is the record of the boring on the Wm. Morey place, just across the county line, as given by Mr. Scovell in the report for 1896. As the record is considered by many as reliable, it is given here for comparison.

650. SECTION 190. SECTION OF BORING ON MOREY PLACE.—Sec. 4-13-9 (J. T. S., p. 542).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface sand and gravel	4	0	..	..	4	0
2. Shale	50	0	..	..	54	0
3. Sand rock	1	8	..	..	55	8
4. COAL	3	6	3	6	59	2
5. Fire-clay and sandy shale	12	0	..	..	71	2
6. Black rock and gray slate	5	0	17	0	77	2
7. COAL	4	9	4	9	80	11
•8. Iron bands and black slate	2	2	2	2	83	1
9. COAL	3	11	3	11	87	0
10. Fire-clay	3	0	..	..	90	0
11. Limestone	9	6	..	..	99	6
12. Slate, gray	10	6	..	..	110	0
13. Sandy shale and sandstone	34	0	..	..	144	0
14. Iron band and gray slate	5	4	62	4	149	4
15. COAL	1	6	1	6	150	10
16. Shale and iron band	10	0	..	..	160	10
17. Sandy shale and iron band	12	4	..	..	173	2
18. Sandstone	14	0	..	..	187	2
19. Gray slate	2	0	38	4	189	2
20. COAL	6	6	6	6	195	8

The presence of the thick coals in this section is so at variance with what is found elsewhere that we are strongly inclined to the belief that the record is in error, and the more so that other drillings in the same neighborhood that we have reason to have confidence in do not show any such coals, only one coal appearing between Coals VI and VII.

A couple of drillings in the S. E. of S. W. of Sec. 33-14-9 by the Brazil Block Coal Company gave as follows:

651. SECTION 191. SECTION OF BORING.—Sec. 33-14-9, Fig. 276.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	7	0	..	..	7	0
2. Boulder clay	7	0	..	..	14	0
Division VII—						
3. Dark brown shale	22	0	..	..	36	0
4. Black shale	4	0	..	..	40	0
5. COAL VIIa	..	10	..	10	40	10
6. Fire-clay	5	0	..	..	45	10
7. Gray shale	10	2	..	..	56	0
8. Black shale	7	0	..	..	63	0
9. COAL VII	5	0	5	0	68	0
Division VI—						
10. Fire-clay	3	8	..	..	71	8
11. Limestone	1	2	..	..	72	10
12. Gray shale	23	2	..	..	96	0
13. Black shale	14	0	..	..	110	0
14. Light shale	12	0	..	..	122	0
15. Black shale	1	6	55	6	123	6
16. COAL VIb?	2	0	2	0	125	6
17. Dark fire-clay	4	0	..	..	129	6
18. Light shale	26	6	..	..	156	0
19. Gray shale	14	0	44	6	170	0
20. COAL VI	4	8	4	8	174	8
21. Fire-clay	..	6	..	..	175	2

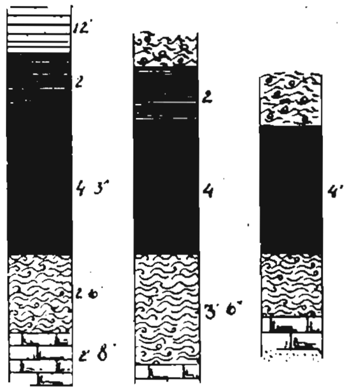
652. SECTION 192. SECTION IN BORING NEAR LAST.—Fig. 278.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface and gravel	5	0	..	..	5	0
2. Blue shale	24	0	..	..	29	0
3. Dark shale	9	10	..	..	38	10
4. COAL VIIa	2	0	2	0	40	10
5. Fire-clay	3	2	..	..	44	0
6. White shale	10	0	..	..	54	0
7. Black shale	6	10	20	0	60	10
8. COAL and shale	2	6	2	6	63	4
9. Sulphur and shale	..	8	..	8	64	0
10. COAL VII	5	2	5	2	69	2
11. Fire-clay	4	10	..	..	74	0
12. Light shale	16	0	..	..	90	0
13. Dark shale	15	0	..	..	105	0
14. Light shale	15	0	..	..	120	0
15. Dark shale	5	0	45	10	125	0
16. COAL VIa	2	0	2	0	127	0
17. Fire-clay	4	0	..	..	131	0
18. Light shale	4	0	..	..	135	0
19. Lime shale	4	0	..	..	139	0
20. Light sandy shale	12	0	..	..	151	0
21. Brown shale	11	8	35	8	162	8
22. COAL VI	5	9	5	9	168	5
23. Fire-clay, soft	..	6	..	..	168	11
24. Fire-clay, hard	1	0	..	..	169	11

653. SECTION 193. CONNECTED SECTION FROM OUTCROPS.—Fig. 279. (Upper part by E. M. K.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Black bituminous shale	2	0	..	..	2	0
2. COAL VIII	4	4	4	4	6	4
3. Fire-clay	5	0	..	..	11	4
4. Limestone, flinty, fossiliferous	2	8	..	..	14	0
5. Sandy blue shale	1	0	..	..	15	0
6. Shaly sandstone	6	0	..	..	21	0

		Ft.	In.	Ft.	In.	Ft.	In.
7.	Sandstone, massive to shelly	6	0	..	..	27	0
8.	Shaly blue to gray sandstone	40	0	..	..	67	0
9.	Limestone, hard, flinty, few fossils	1	0	..	..	68	0
10.	Dark blue shale	6	0	..	..	74	0
11.	Bone coal	1	0	..	..	75	0
12.	Black, bituminous, sheety shale	3	0	71	0	78	0
13.	COAL VII	5	0	5	0	83	0
14.	Fire-clay	3	0	..	..	86	0
15.	Sandy shale	20	0	..	..	106	0
16.	Shale	40	0	..	..	146	0
17.	Limestone ....1 ft. to	3	0	..	..	149	0
18.	Black shale ....3 ft. to	5	0	71	0	154	0
19.	COAL VIb ....1 ft. to	3	0	3	0	157	0
20.	Fire-clay and shale	5	0	..	..	162	0
21.	Sandstone ....12 ft. to	16	0	..	..	178	0
22.	Shale	30	0	..	..	208	0
23.	Limestone	1	0	..	..	209	0
24.	Black shale	5	0	57	0	214	0
25.	COAL VIa ....1 ft. to	2	0	2	0	216	0
26.	Fire-clay	5	0	..	..	221	0
27.	Sandstone	12	0	..	..	233	0
28.	Shale	5	0	22	0	238	8
29.	COAL VI	6	10	6	10	244	10

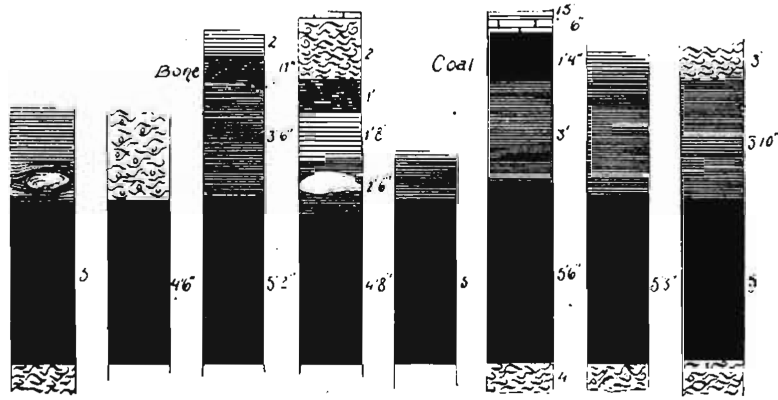


280 Hedges. Sec. 30. — 281 Wright. Sec. 31. — 282 Wright. Sec. 32.

Figs. 280-282. Coal VIII in T. 14 N., R. 9 W.

654. Coal VIII.—See Figs. 280-282. This coal is a solid bed, ranging in this township from 4 ft. to 4 ft. 6 in. in thickness. It is characterized by having a bed of bone coal ("slate") as a roof and by

having a bed of flinty, fossiliferous limestone immediately underlying its fire-clay. This limestone is often of service in locating the coal. In quality this coal appears to be very good. It seems to contain everywhere clay or shale veins running from the roof to the floor. These are numerous enough at times to seriously interfere with mining. The coal is reported as a rather hard shooting coal. The fire-clay floor is not good, in most of the mines giving some trouble with its tendency to creep.



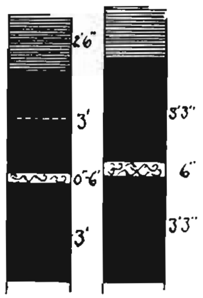
283 Torry. Sec. 4. — 284 Malone. Sec. 9. — 285 Buckeye. Sec. 16. — 286 House. Sec. 16. — 287 Hazel Cr. No. 2. Sec. 16. — 288 Ind. Bit. Co. Sec. 21. — 239 Boring. Sec. 8. — 290 Boring. Sec. 6.

Figs. 283-290. Coal VII in T. 14 N., R. 9 W.

655. Coal VII.—As shown in Figs. 283 to 290, this coal, where exposed near Clinton, runs about a foot thicker than Coal VIII. It is a solid bed with a black bituminous, sheety shale roof, much resembling the bone coal roof over Coal VIII. In many places near the top of this black shale is a foot or so of bone coal which is said to become good coal in places; above this is generally found a bed of limestone, often double. The black shale over this bed appears to make an excellent roof, except where the pyrite boulders become too numerous. These are often very large and often project down into the coal and have to be removed in mining. The coal contains a good many "sulphur balls," but none of the clay slips so common in Coal VIII. The underclay is about 3 ft. thick and gives some trouble with creeping, often giving trouble when dry as well as when wet.

656. Coal VI.—See Figs. 291, 292. This coal occurs about 170 ft. below Coal VII. It runs from 5 to 7 ft. thick and is characterized by a clay parting in the middle which may vary from 0 to 6 in. in

thickness. It frequently carries a sulphur band 1 ft. or 18 in. from the top. The roof is shale, which tends to slack readily in warm weather. The fire-clay runs to 6 ft. in thickness, with sometimes a thin bed of coal just below. The coal carries a good many sulphur balls, but is generally accounted a rich steam coal.



291 Buckeye. Sec. 16. 292 Torrey. Sec. 5.

Figs. 291 and 292. Coal VI near Clinton.

657. Distribution and Local Details.—Coal VI doubtless underlies the whole of this area, and possibly with a workable thickness under most of the area. Its depth below the level of the Wabash river increases rapidly from north to south. At the north it is perhaps 50 ft. below low water, nearly 100 ft. at Clinton and between 150 and 200 ft. at the county line. To the southward it will be found at still greater depths. It has only been mined in the Buckeye and Torrey shafts.

At the Torrey shaft, in the N. E. ¼ of Sec. 5, coal is reached at a depth of 156 ft. or 176 ft. below Coal VII. When visited, work had just begun on Coal VI, which is found here to be 7 ft. thick with its 6 in. clay band. The roof contains no boulders, though many are found in the coal.

At the Buckeye shaft Coal VI is found at a depth of 165 ft., the shaft starting a few feet below the worked outcrop of Coal VII. The coal ranges from 6 to 7 ft. with an average of 6 ft. 6 in. The usual clay band ranging up to 6 in. thick is found near the middle of the coal and a sulphur band 18 in. from the top. The coal carries sulphur bands in places. The roof is black shale 2 ft. 6 in. thick, overlain by sandstone. It is said to slack in warm weather. Some rolls are met with and one 6-ft. fault has been encountered. The floor is fire-clay 5 to 6 ft. thick.

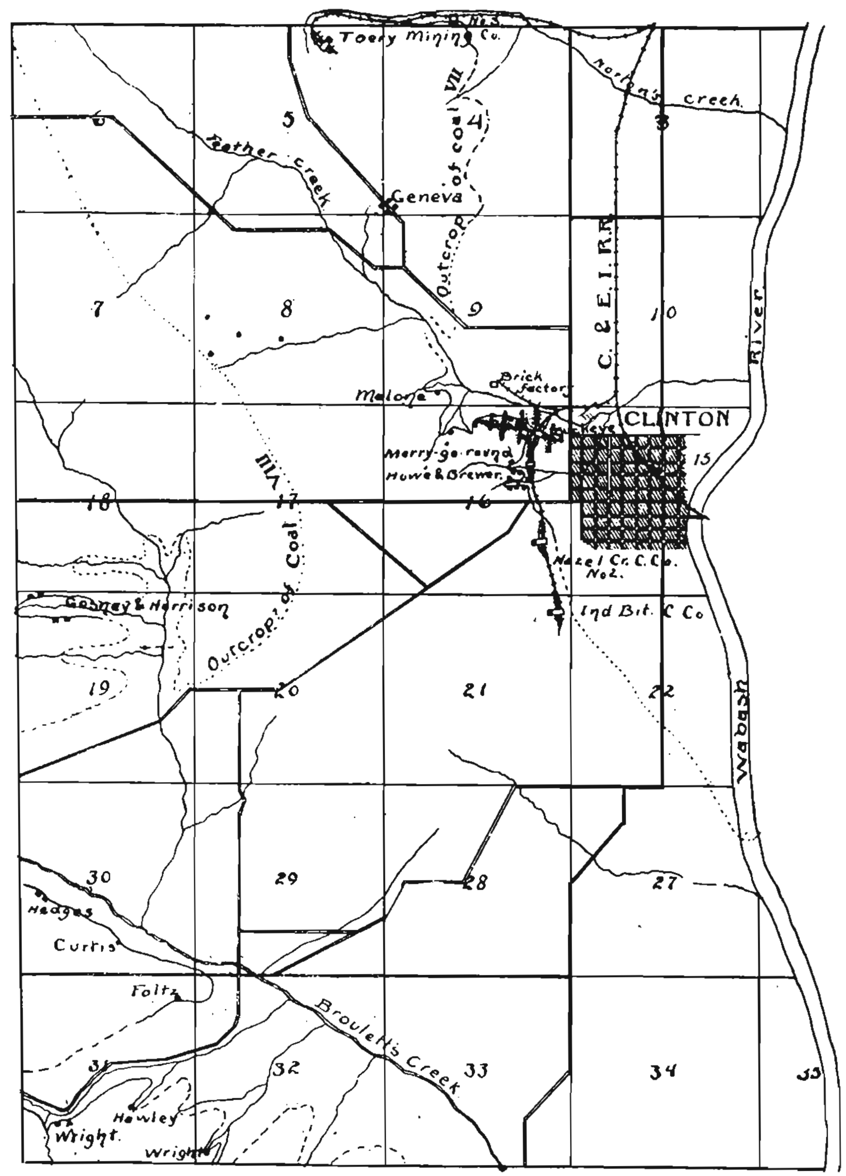


Plate XXIV. Sketch map of T. 14 N., R. 9 W.

Coal VI has as yet hardly been touched in this district, on account of the presence of Coal VII workable. Only a few entries had in 1898 been driven in the Torrey mine, and only 20 or 30 acres had been worked out at the Buckeye shaft. At the drillings in Sec. 33 this coal is 5 ft. 9 in. and 4 ft. 8 in. thick, at depths respectively of 162 ft. 8 in. and 170 ft.; see ¶¶651, 652. It thus seems quite possible that it underlies the whole township except in the north part of the area of Wabash bottoms, where it may have been removed by the preglacial erosion.

658. COAL VII is supposed to underlie all of the area west and south of the line of outcrop as shown on the map. As a matter of fact, it is doubtless cut out from under the bottom land of the Wabash to the county line. It shows well the southward dip of the rocks, as in Sec. 33-15-9 it is perhaps 100 ft. above the Wabash. In the N. E. ¼ of Sec. 16 it is some 50 ft. lower; in the N. E. of Sec. 21, 40 ft. lower still, and soon passes below the level of the river. There is also a dip to the west, so that it is found at greater depths to the west than at the outcrop along the river.

Beginning at the north, this bed has been worked in the N. E. ¼ of Sec. 5 by the Torrey Mining Company, where it is 80 ft. deep and averages 5 ft. thick (see Fig. 283). It is without partings, though some sulphur balls are found. The roof is black sheety shale, 3 ft. thick and good. It carries many large boulders which often extend down into the coal so as to interfere slightly with the mining. The fire-clay is 3 ft. thick and gives some trouble by creeping. To the east it runs into drift, covering the preglacial outcrop. Coal has been worked from this shaft some four years (in 1897) and from drifts about nine years, so that the present works are nearly exhausted. Drillings in Secs. 5, 6 and 8 show this bed to maintain its thickness over nearly all this part of the township, appearing to be absent in a few places and cut out by the preglacial erosion in others (see ¶¶640, 648).

In the S. E. of S. W. of Sec. 9 this bed has recently been opened upon on Mrs. Sallie Malone's place. It is just above the branch at this place. The coal is 4 ft. 6 in. thick and at the start has a roof of dark gray boulder clay, full of pebbles (Fig. 284).

In the N. W. of N. E. of Sec. 16, at the shale pit of the Clinton Brick Company, the section shows (Sect. 194, E. M. K.):

	Ft.	In.
Soil and surface clay	3	0
Shale, sandy grayish	4	0
Shale, dark blue	25	0
COAL VIb	1	6

This shale is fossiliferous in places, some layers containing an abundance of brachiopods, etc.

At the old drift on Coal VII back of the Buckeye shaft, N. W. of N. E. of Sec. 16, the section shows (Sect. 195, E. M. K., Fig. 285):

	Ft.	In.
Light blue shale	2	6
Bone coal	..	11
Black sheety shale	3	6
COAL VII	5	2

Coal VII has been worked from a number of entries close to this, but is now about worked out, and the pillars are being drawn.

A little southwest of these drifts is the Merry-go-round mine, operated by Cohous & Co. Coal VII is here 35 ft. deep and coal about 5 ft. thick. The coal leased is nearly worked out.

At a drift just south of the Buckeye the coal is 4 ft. 8 in. thick. Above it shows (Sect. 196, E. M. K., Fig. 286):

	Ft.	In.
Limestone, fragments	..	..
Bluish gray clay shale	2	0
Bone coal	1	0
Blue shale	1	8
Black sheety shale	2	6
COAL VII	4	8

Southeast of the Merry-go-round is the drift mine of John Howe and Millie Brewer. Coal VII is here 5 ft. thick but nearly worked out, as they are (1897) drawing pillars. No sulphur bands show but some sulphur concretions.

Near Hazel Creek Coal Co. No. 1 shaft, three drifts are being worked for local trade and two or three others have been abandoned and have caved in. The boulders in the roof here are very abundant, and extend down into the coal. Up this ravine a short distance, the limestone above Coal VII is exposed 1 ft. thick, gray, hard and flinty, and without fossils. It is said that the coal of this bed is nearly worked out from under this quarter section.

Near the center of the S. E. ¼ of Sec. 16, the Hazel Creek Coal Co. has a shaft, No. 2, which reaches Coal VII at 60 ft. The coal runs from 4 ft. 8 in. to 5 ft. in thickness (see Fig. 287); the roof contains many boulders, some as "large as a barrel", otherwise roof good. The body of coal leased here is nearly worked out.

A half mile farther south, in the N. E. ¼ of Sec. 21, Coal VII 5 ft. 6 in. thick, is being worked by a shaft 45 ft. deep by the Indiana Bituminous Coal Co. The section of this shaft shows (Sect. 197, E. M. K., Fig. 288):

		Ft.	In.
1.	Drift and surface	17	0
2.	Blue shale	15	0
3.	Limestone	..	6
4.	COAL	1	6
5.	Black, bituminous, sheety shale	5	0
6.	COAL VII	5	6
7.	Fire-clay	4	0
8.	Sandstone	..	..

The bed shows no parting but considerable sulphur, confined principally to the lower part of the coal. The roof is excellent except for the presence of the sulphur or pyrite concretions in it, which often weigh from 100 pounds to a ton. The under clay gives much trouble by creeping, even when dry. The dip is a little west of south. The coal only runs a short distance east of the shaft before encountering the drift covering the old outcrop. The coal does not appear to be as free from sulphur as that further north toward Norton's creek and all that this company has leased is nearly worked out.

Since the completion of the field work two new mines have been opened on this coal. The Indiana Bituminous Coal Company has opened their No. 4 mine a quarter of a mile south of the No. 3 mine; and the Prince mine has been opened a mile and a quarter west of and a quarter of a mile south of the tile plant.

At this point Coal VI is reported to be from 150 to 156 ft. below this bed.

From here Coal VII is carried by the dip below the level of the river, though, as stated above, probably cut out under the river valley. At the drillings in Sec. 33 it shows a thickness of 5 ft. 2 in. at depths of 63 ft. and 64 ft. respectively (see ¶¶651, 652).

659. COAL VIII covers only a small area in the southwestern corner and central western part of this township, as indicated on the map.

This coal was formerly worked in the N. W. ¼ of Sec. 19 by Frank Gosney and Milo Harrison, through four drifts, now all caved in and covered up. The coal is here about 3 ft. above the drain and is overlain by 25 to 30 ft. of drift. Near the south line of the same section some of the strata below the coal are exposed as follows (Sect. 198, E. M. K.):

	Ft.
Limestone, hard, gray and flinty	2
Massive sandstone	4 to 5
Shaly blue sandstone	20

To the east of this, this bed evidently rises to the top of the hills near the center of Sec. 20, and passing north of ex-Governor Matthew's house, is not found east or southeast of there.

On the south side of Brouilett's creek in the S. W. of Sec. 30, Coal VIII has been mined by stripping and drifting by Columbus Hedges at the tile kiln. The section here shows (Sect. 199, E. M. K., Fig. 280):

		Ft.	In.
1.	Surface clay	2	0
2.	Bluish gray shale	12	0
3.	Bituminous shale or bone coal	1	8
4.	COAL VIII	6 ft. to 4	3
5.	Fire-clay	3	0
6.	Limestone, hard, light gray	2	8
7.	Shelly gray sandstone	14	0

Following down the outcrop, the coal was mined a little on Mr. Philip Foltz's place some 35 years ago and on one or two other places along here.

At Mr. Wright's place in the S. W. ¼ of Sec. 31, on the south side of Gin creek, a small amount of coal is mined by drifting and stripping. The coal is said to be 4 ft. thick (Fig. 281), with a roof of 2 ft. of bone and 10 to 12 ft. of drift above that. There are occasionally clay bands in this coal but not regularly, and clay rolls are rather common, sometimes cutting the coal entirely out. An 18-in. fault has been noted in this bank. The coal is about 3 ft. 6 in. above the creek, in the bottom of which is found the limestone usually underlying this bed.

In the S. W. ¼ of Sec. 30 this coal has been mined for home use at Mr. Hawley's.

This coal has further been mined in the S. W. corner of Sec. 32 on Mrs. Wright's place. The coal is reported to run from 4 to 5 ft. in thickness, without partings. It is overlain by drift, while the limestone shows in the ravine a few feet below.

No local value should be put on the line of outcrop of this coal to the north of Sec. 20.

Township 14 North, Range 10 West. (In Indiana.)

660. Geographic. This partial township forms the southwestern corner of Vermillion county and corresponds with the western part of Clinton of the civic townships. The main topographic feature of this area is the valley of Brouillet's creek which, with rather broad bottoms, ½ to 1 mi. wide, is cut down sharply from the general level of the upland from 60 to 100 ft. Mr. Kindle notes a rather remarkable interruption of this level bottom land in the shape of a knoll nearly a

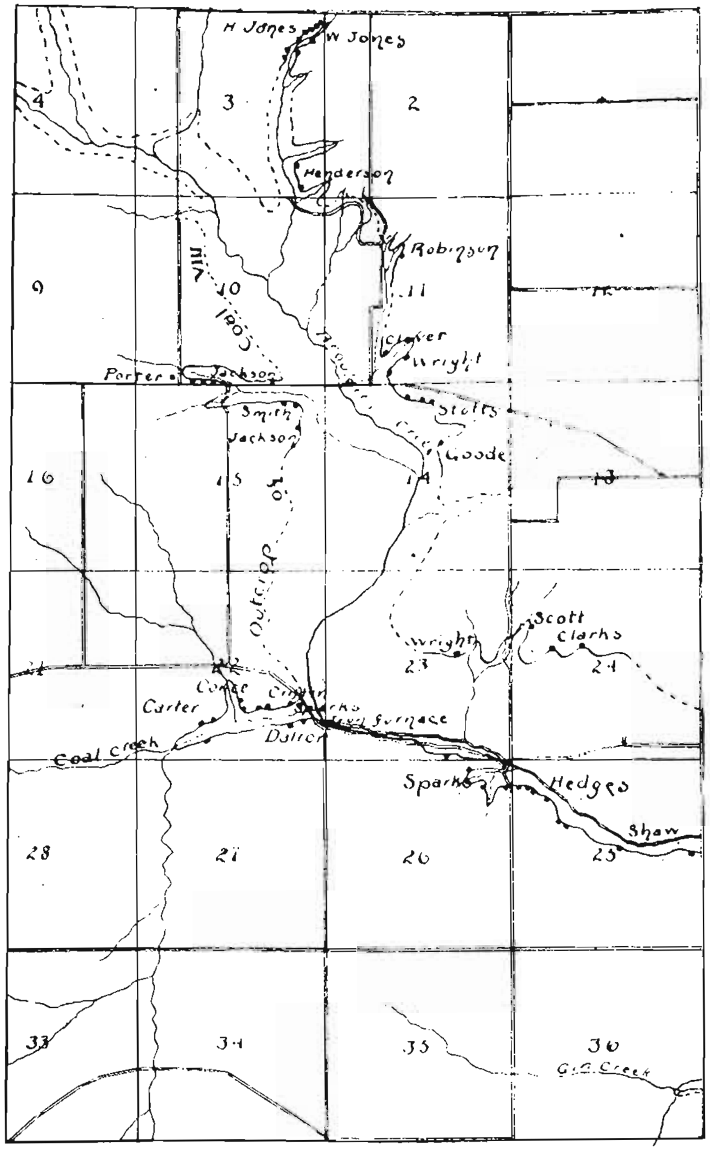


PLATE XXV. Sketch map of part of T. 14 N., R. 10 W.

quarter of a mile long by 300-400 yards wide and with a height of about 40 ft. Indian mounds occur at each end. Coal creek and Gin creek are the principal tributaries, and as they and the other tributaries cut down nearly to the level of the main creek it gives the upland near Brouillet's creek a somewhat broken appearance.

No railroads cross this area, the nearest being the C. & E. I. at Clinton.

661. STRATIGRAPHY AND COALS.—In a general way, the paragraph on stratigraphy under the description of the last township will serve for this township. Only Coal VIII outcrops in this township. It is thought that Coal VII of workable thickness may be expected some 70 ft. below VIII and Coal VI about 150 to 170 ft. below Coal VII, with thin coals between and below. See ¶638 and following paragraphs. The record of the Garvin shaft (?) or drilling, though more properly belonging with this township, is given and figured with the last for the sake of comparison.

Of the exposed rocks, Mr. Kindle found quite a typical section as follows:

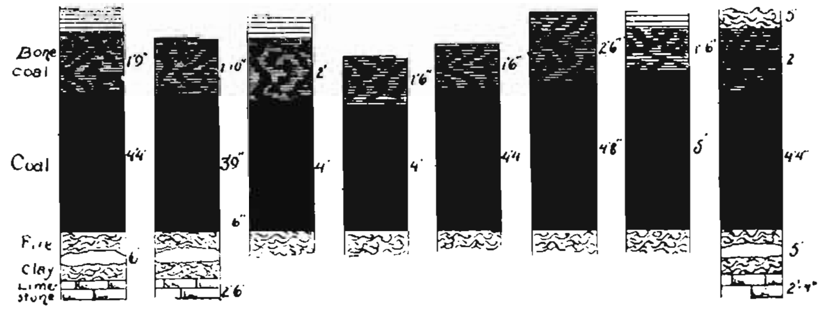
662. SECTION 200. SECTION ON EAST OF OLD INDIANA FURNACE.—Sec. 33 (E. M. K.).

	Ft.	*In.*
1. Drift clay	20	0
2. Fire-clay	5	0
3. Black shale or bone coal	2	0
4. COAL VIII	4	4
5. Blue fire-clay	5	0
6. Limestone, gray flinty	2	8
7. Sandy blue shale	..	10
8. Shelly sandstone	6	0
9. Sandstone, shelly to massive	6	0

663. COAL VIII, see Figs. 293-300, is here much as described under the last township. It is a solid bed averaging about 4 ft. 4 in., with a roof of bone coal or black bituminous shale, and a bed of limestone underlying its fire-clay. It appears to contain less sulphur than the coals about Clinton. The roof is good, the floor inclined to "creep." It is characterized also by clay veins. This coal tends to have a parting 6 or 8 in. from the bottom, running from ¼ in. to a line of considerable boulders.

664. DISTRIBUTION AND LOCAL DETAILS.—All the mines and outcrops and all the obtainable data in this township are found along the banks of Brouillet's creek, so that it will be convenient in the discussion to describe what is found consecutively along first one bank and

then the other. Following the outcrop from township 14-9, as shown on the map, coal is first met with in this township in Sec. 24, the S. E. of the N. W. Coal VIII here lies in the bed of the branch and has been stripped, though not recently. A little farther west, on Mrs. Clark's place, a drift and stripping was worked in 1895. Still farther west, but in the same section, is the old bank of Scott and Pinson's, not worked recently.



293	294	295	296	297	298	299	300
H. Jones. Sec. 3.	Henderson. Sec. 3.	Clover. Sec. 11.	Jackson. Sec. 10.	T. Jackson. Sec. 15.	Wright. Sec. 23.	Carters. Sec. 22.	Dayton. Sec. 22.

Figs. 293-300. Coal VIII in T. 14 N., R. 10 W.

In the N. E. ¼ of Sec. 23 the coal is exposed in a drift on Mrs. Maggie Wright's place. The coal is here 4 ft. 8 in. thick (see Fig. 298) and has 2 ft. 2 in. of bone coal and shale for a roof. The coal here is about 25-30 ft. above the creek. Clay seams appear to be common in this bank. An illustration of one is given in Fig. 301. This is about 1 ft. wide and runs from the fire-clay below into the shale above. In Sec. 14 a bank was opened in 1896 on the Goode place, and a bank is also run by Mr. Clover on Mrs. Lucie Stott's place. The limestone outcrops at intervals below the coal.

In Sec. 11 the coal is exposed in Mr. John O. Wright's bank. It has been worked here by stripping and drifting. The coal is 4 ft. thick and seems to carry much sulphur. At the old stripping there is exposed above it 15 ft. of shale and from 3 to 6 ft. of drift. Across the drain is the Clover bank. The coal is here also 4 ft. thick (see Fig. 295) and has a bone and shale roof 2 ft. thick. The coal here lies 35 ft. above the branch. The coal carries a good many pyrite nodules near the center, and clay veins 8 to 10 in. thick are common, 12 having been gone through in one year. The fire-clay has not given trouble creeping, possibly because too dry. Farther north, in the N. W. ¼ of

Sec. 11, Coal VIII has been mined both by stripping and drifting, on the Jas. Robinson place. The coal here is only about 10 ft. below the level topped ridge.

In the S. E. of the S. E. of Sec. 3 the coal is exposed in the Abe Henderson mine. It is here 4 ft. 3 in. thick, with a small parting of sulphur, and sometimes clay, 6 in. from the bottom. The roof is bone coal 22 in. thick, and is said to heat well. Below is fire-clay, then 2 ft. 6 in. of limestone, with soft shaly blue sandstone below that (Fig. 294).

Fig. 301. Clay vein in Wright mine. (Sketch by E. M. K.)

North of the ford, in the S. W. ¼ of Sec. 3, stratified beds of sand and gravel occupy the top of the hill, which is here about 60 ft. above the bed of the creek. In the east half of this section a small branch flows south, along which several drifts have been opened. In the N. E. ¼ of the section, near the head of the ravine, the coal lies 1 to 2 ft. above its bed. It has been worked here from four or five drifts, which have been abandoned. One is still operated on Wiley Jones's land. A short distance below the coal is stripped, on Hiram Jones's land. It is here 4 ft. 4 in. thick, with 21 to 22 in. of black shale or bone and 16 ft. of blue shale and drift over it (see Fig. 293). The shale above the coal here contains an abundance of iron concretions. The coal is a hard, shooting coal, containing some clay veins. About 200 yds. below H. Jones's bank the gray flinty limestone outcrops in the bed of the branch about 6 ft. below the coal.

In the S. E. of S. W. of Sec. 10 coal is mined on the Thomas Jackson place by stripping and by a gin shaft, the latter being 21 ft. deep. The coal is 4 ft. 4 in. thick (see Fig. 297), with 18 in. of bone or black shale over it. The coal is said to have been worked here for 50 years. It carries a good deal of sulphur, and many clay veins. Just west it was formerly worked on the Wm. Porter place and by a gin shaft in the S. W. of S. W. of Sec. 10.

In the N. E. ¼ of Sec. 15 coal has been stripped on the J. L. Smith and Gideon Jackson places. The coal measures 4 ft., and from 10 to 18 ft. of drift is removed to get the coal.

Along the banks of Coal creek, in Sec. 22, outcrops of Coal VIII are frequent, and a large amount of coal has been taken here from drifts and by stripping. The coal is above drainage nearly to the junction of the north and south forks of the creek. Starting up the creek, on the north side, the coal is about 15 ft. above the creek at the old Geo. Sparks stripping, not worked recently. Farther up it is worked winters by drifting and stripping at the Griffin bank. Still above the coal was exposed where being stripped on the Conce land. The coal here lies in the bed of a branch and requires about 3 ft. of stripping. It is 4 ft. 6 in. thick, overlain by 22 in. of black shale or bone, and 3 ft. of clay shale. While containing some poor streaks, the coal generally burns well. The bed shows some clay veins, horse-backs and small faults. The dip is to the southwest. Still above, in the S. W. ¼ of Sec. 22, coal has been extensively stripped at the Carter bank, the stripping consisting of 5 to 6 ft. of drift and 3 ft. of fire-clay. The coal runs about 5 ft. thick (see Fig. 299). Some faults and horse-backs occur here. Some 11 acres can readily be stripped here. This coal largely goes to Paris, Ill.

At an outcrop in the creek bank just below Carter's bank a number of clay veins show in the coal; a couple of these are figured in Figs. 302, 302a.

Figs. 302 and 302a. Clay veins showing in coal outcrop near Carter's mine. (Sketch by E. M. K.)

This same coal is reported as occurring in the Garvin shaft, one mile west of the Indiana line, at 127 ft., the coal being from 4 ft. 4 in. to 5 ft. thick. At 47 ft. an 18-in. bed of coal was passed through, which was underlain by 4 ft. of fire-clay.

On the south side of the creek coal is mined by Mr. Dalton. A section of the coal and accompanying strata as exposed near here was given in ¶661, Fig. 300.

In the S. E. ¼ of Sec. 23 the coal outcrops at the side of the road, for about 80 yds., overlain by 2 to 3 ft. of gravel. It would appear that a considerable amount of coal might be stripped here at small expense.

In the N. E. corner of Sec. 26 the coal is exposed in outcrop at the end of the bridge and has been stripped in a small branch near by Geo. Sparks. The coal is rather soft, about 4 ft. 6 in. thick, with 2 ft. of bone over. From 10 to 25 ft. of clay and drift overlies the part not stripped. The limestone outcrops below.

In the N. W. corner of Sec. 25 coal has been stripped and drifted upon on Noah Hedges's land. The coal is about 4 ft. 6 in. thick, with 2 ft. 6 in. of bone for a roof. Above that 10 ft. of sandy blue shale is exposed. The coal here is about 15 ft. above drainage. At a stripping east of this some 50 yards the underlying limestone is 2 ft. 6 in. thick. Nearly a quarter of a mile below the bridge, on the Hedges place, the coal is being stripped, about 10 ft. of material being removed. The coal is 4 ft. 2 in. thick and seems quite free of sulphur. It is here 10 ft. above the creek. A section here shows (Sect. 201, E. M. K.):

	Ft.	In.
Gray and yellow clay	6	5
Gravel	1	3
Sand	3	0
Bone coal	2	3
COAL VIII	4	2
Fire-clay	..	..

In the S. W. of N. E. of Sec. 28, at the Shaw bank, the coal is 4 ft. to 4 ft. 8 in. thick, apparently quite free of sulphur; and has over it the usual bone coal roof, then 14 to 15 ft. of sandy shale, with 10 ft. of sand still above. Coal was formerly stripped in the S. E. of this section.

665. SUMMARY OF COAL OF VERMILLION COUNTY.—

Divisions contained: VIII to I.
Coals contained: VIII, VIIa, VII, VIb, VIa, VI, Vb, Va, V, IV, III.

ROUND NUMBER ESTIMATES.

Coal VIII.

Worked area	¼ sq. mi. × av. thickness,	4 ft. ×	500,000 =	500,000 tons.
Workable area	30 sq. mi. × "	4 ft. ×	500,000 =	60,000,000 tons.
Unworkable area	6 sq. mi. × "	2 ft. ×	1,000,000 =	12,000,000 tons.
Total area	36 sq. mi			72,500,000 tons.

Coal VII.

Worked area	1 sq. mi. × av. thickness,	5 ft. ×	500,000 =	2,500,000 tons.
Workable area	74 sq. mi. × "	5 ft. ×	500,000 =	185,000,000 tons.
Unworkable area	25 sq. mi. × "	2 ft. ×	1,000,000 =	50,500,000 tons.
Total area	100 sq. mi			237,500,000 tons.

Coal VIa.

Worked area	¼ sq. mi. ×	av. thickness,	2½ ft. ×	500,000 =	1,600,000 tons.
Workable area ...	5 sq. mi. ×	"	2½ ft. ×	500,000 =	6,250,000 tons.
Unworkable area.	150 sq. mi. ×	"	1½ ft. ×	1,000,000 =	225,000,000 tons.
Total area	155 sq. mi	....			232,850,000 tons.

Coal VI.

Worked area	¼ sq. mi. ×	av. thickness,	6 ft. ×	500,000 =	750,000 tons.
Workable area ...	50 sq. mi. ×	"	6 ft. ×	500,000 =	150,000,000 tons.
Unworkable area.	110 sq. mi. ×	"	2 ft. ×	1,000,000 =	220,000,000 tons.
Total area	160 sq. mi	....			370,750,000 tons.

Coal V.

Worked area	0 sq. mi. ×	av. thickness,	... ft. ×	.... =	.... tons.
Workable area ...	10 sq. mi. ×	"	4 ft. ×	500,000 =	20,000,000 tons.
Unworkable area.	100 sq. mi. ×	"	1 ft. ×	1,000,000 =	100,000,000 tons.
Total area	110 sq. mi	....			120,000,000 tons.

Coal III.

Workable area ...	10 sq. mi. ×	av. thickness,	4 ft. ×	500,000 =	20,000,000 tons.
Unworkable area.	100 sq. mi. ×	"	1 ft. ×	1,000,000 =	100,000,000 tons.
Total area	110 sq. mi	....			120,000,000 tons.

Coal VIIa.

Unworkable area.	10 sq. mi. ×	av. thickness,	½ ft. ×	1,000,000 =	5,000,000 tons.

Coal VIb.

Unworkable area.	100 sq. mi. ×	av. thickness,	1 ft. ×	1,000,000 =	100,000,000 tons.

Coals Vb, Va, IV, etc.

Unworkable area.	100 sq. mi. ×	av. thickness.	2 ft. ×	1,000,000 =	200,000,000 tons.

Number of coals contained: 11+.
Greatest thickness recorded: 7 ft. Coals VI and VIa together. Sec. 4-17-10.
Area underlain by coal: 250 sq. mi.
Area underlain by workable coal: 100 sq. mi.
Situated in twps. All but Highland.
Estimated total tonnage of coal: 1,457,600,000.
Estimated total tonnage of coal removed or lost: 5,350,000.
Estimated total tonnage of workable coal left: 441,000,000.
Number of mines working ten men or over, in operation: 5.
Number of mines working less than ten men, in operation: 47.
Total number of mines in operation: 52.
Large mines not in work: 3+.
Small mines not in work: 140.
Strippings and outcrops: 65+.
Total number of openings to coal: 260+.

XXI. OWEN COUNTY.

666. References and Field Work.—

1838, 1853, 1859. D. D. Owen, Cont. of a Rep. of a Geol. Reconn. of Indiana, p. 43. Only mentioned as in coal area. (D. D. O.)

1862 (1859). Richard Owen, Rep. of a Geol. Reconn. of Indiana, p. 171. (R. O.)

1862 (1859). Leo. Lesquereux, same, pp. 324, 325. (L. L.)

1869. E. T. Cox, First Ann. Rep. of Geol. Surv. of Ind., p. 132. (E. T. C., '69.)

1876 (1875). John Collett, 7th Ann. Rep. of Geol. Surv. of Ind., pp. 301-360. Detailed description of county, map, 28 sections containing coal-measure rocks, accompanied by 38 coal analyses.

1896 (1895). W. S. Blatchley, Ind., Dept. of Geol. and Nat. Resources, pp. 83-86. Two columnar sections containing coal. (W. S. B.)

1896 (1895). T. C. Hopkins, same, pp. 213, 214.

1897, June, July. G. H. Ashley, field work for this report in southwestern portion of county (Marion and half of Jefferson townships).

C. E. Siebenthal, field work for this report over rest of county.

Section 1. Geography.

667. Location.—Owen county is an irregularly shaped county, lying west of Clay, south of Putnam and part of Clay. On the east it is bordered by Morgan and Monroe counties, and on the south by Greene county.

668. Extent.—The county has an area of 398 sq. mi., having a length from north to south of 21 mi., and from east to west of 25 mi. It includes all of townships 11 north of ranges 3 and 4 west, 9 and 10 north of 3, 4 and 5 west; the southern half of 12 north, 3 and 4 west; southwestern corner of 12 north, 2 west; the southeastern corner of 12 north, 5 west; the western half of 11 north, 2 west; the eastern two rows of sections of 9 and 10 north of 6 west.

669. ELEVATION.—This county ranges in elevation from about 500 to between 800 and 900 ft. above tide. Where White river leaves the county it is probably about or a little below 500 ft., and 50 ft. higher where it enters. Some of the elevations along the I. & V. Ry. are as follows:

	Ft.
Gosport	595
Spencer	557
Freedom	538
Farmers	528

Coal City, with an elevation of 651 ft., is on one of the highest points along the western border. Going eastward, the land becomes more hilly and higher, so that at Quincy the elevation is 749 ft., and it may be safe to say that the highest hills are fully 100 ft. higher.

670. GENERAL TOPOGRAPHY.—In the northeastern part of the county, near Quincy, the surface is rolling, the valley of Eel river broad, level and shallow. From the northwestern to the southeastern corner of the county stretches a belt of high hills or ridges and deep, narrow valleys, the ridges rising 150 to 250 ft. above the valleys and up to 300 ft. above White river. To the southwest the hills become lower and broader, with broader valleys between.

671. DRAINAGE.—The principal stream is White river, which crosses the county from northeast to southwest. Its principal tributaries are Mill, Rattlesnake and Fish creeks from the north, and McCormack's and Raccoon creeks from the south and east. Eel river, rising near the northeastern corner of the county, flows west or northwest, but swings around, and, after receiving Jordan, Six Mile and Lick creeks, crosses the southwestern corner of the county, flowing a little south of east.

672. TRANSPORTATION FACILITIES.—The Chicago, Indianapolis & Louisville railway crosses the northeastern corner. The Indianapolis & Vincennes railway crosses the county, following the valley of White river. The E. & I. division of the Evansville & Terre Haute railroad just enters the southwestern corner of the county, while their Lancaster branch just crosses the county line northwest of Denmark. This branch, when extended, will tap the richest part of the county.

Section 2. Stratigraphy.

673. SURFACE GEOLOGY.—All but the southeastern corner of this county lies in the drift area. Over the hillier part of the county the drift is shallow or wanting, so that it interferes but little with observing the rocks. Towards the northern and southwestern parts of the county the drift increases in depth, but still probably averaging less than 20 ft. and not often running over 30 ft. in thickness.

674. COAL MEASURES.—The accompanying section will show the divisions and coals occurring in this county, with their measurements:

Division V—
1. Space above Coal V.
2. Coal V, rider around Coal City; not workable.

Division IV—
3. Sandstone, shale, fire-clay.
4. Coal IV, upper bed, Woodside, Coal City, Hausertown, up to 5 ft. thick; block coal.

Division III—
5. Shale to sandstone, fire-clay; 11 ft. to 35 ft.
6. Coal III. Main coal at Coal City and Patricksburg, up to 6 ft. thick; block coal.

Division I—
7. Sandstone, often replaced by shale, 50 to 75 ft.
8. Coal I. Not workable; only coal of eastern half of county, 0 to 3 ft.

Lower Carboniferous—
9. Lower Carboniferous sandstone, shale, limestone.

The aggregate thickness of the coal measures in the county is probably not over 150 ft., comprised in Divisions I-V. In drillings at Coal City an additional coal is found, but as its position relative to Coal V has not been determined it is not included in the above table. Coals III and IV are locally workable in the southwestern part of the county, but the most of the county is not underlain by workable coal. Knowing the horizon of any coal at any point, the approximate distance to the bottom of the coal measures can be readily estimated.

675. LOWER CARBONIFEROUS.—The Lower Carboniferous rocks which form the outcropping strata over much of the eastern part of the county are most readily recognized from the presence of heavily bedded limestone. This limestone at places immediately underlies the coal measures; at other places there is a considerable thickness of shale or sandstone between. The limestone usually shows the characteristic Kaskaskia fossils, *Archimedes*, *Pentremites*, etc.

Section 3. Distribution and Local Details.

As the higher coals of workable thickness are practically confined to Marion and Jefferson townships in the southwestern part of the county, it will be convenient to consider those townships (9 and 10 N. of 5 and 6 W.) by themselves.

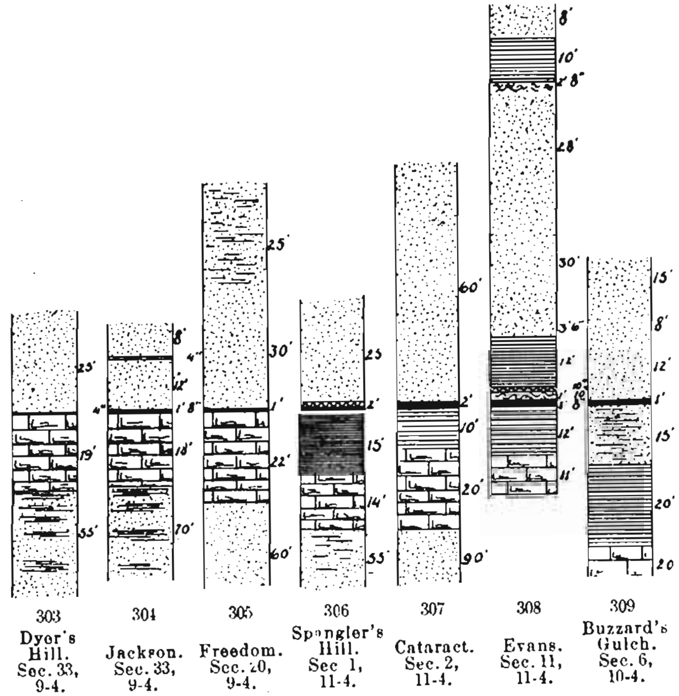
Townships 9, 10, 11, N. of R. 3 and 4 W., and Parts of 11, 12, N. of 2 and 3 W.

676. Geographic.—As just stated, these townships and partial townships occupy all of the northern and eastern part of the county, and are considered together because of their similarity in stratigraphy and in nonworkability of coals. The most of this area is an intricate mass of high and narrow hills and valleys, running off to the north-east into a rolling country. In 12 N., 4 W., it would appear that Eel river is flowing in a post-glacial channel, its former course having been probably down Jordan creek, which has the same general direction and an unusually broad valley. After a careful examination of the head waters of these streams, Mr. Siebenthal says it is certain that it did not flow down Rattlesnake creek as asserted by Mr. Collett. By this change in direction it is forced to cut its channel down through the Lower Carboniferous rocks, which it is doing by the recession of two small falls or cataracts just north of Cataract P. O. On the south side of Eel river the tributary streams are very short. In 11 N., 4 W., the topography is quite rugged and the drift thin and in places not apparent. Township 11 N., 5 W., is similar on the east, but the drift is thicker and in places quite marked, and as a whole the township shows to a certain extent the smooth appearance of a glaciated area. Township 10 N., 4 W., is quite rough, the hills ranging from 150 to 250 ft. above the creek bottoms, and but few of the effects of glaciation show themselves. In 9 N., 3 W., the topography is quite rugged and in places picturesque. The hills range from 250 to 300 ft. above the river. The drift limit is indicated on the map. For a description of the Flat woods, which touch this township, but are outside the coal area, see the 21st Ann. Rep., p. 301. The valley of White river in 9 N., 4 W., above Freedom, will average about a half a mile broad. The lower foot-hills near White river are usually heavily covered with sand. Drift is noted in places, but not in thickness to modify the topography.

The drainage is as already described and as indicated on the map.

The Monon and I. & V. railroads cross this part of the county.

677. Stratigraphy and Coals.—As shown by an examination of the map, the predominating formations of this area belong to the Lower Carboniferous. Of the coal measures, Division I predominates, though Division III caps the ridges in Lafayette township.



Figs. 303-309. Stratigraphy in Ts. 9, 10 and 11 N., Rs. 3 and 4 W.

In Figs. 303 to 309 are shown a group of columnar sections which give the stratigraphy of the upper part of the Lower Carboniferous and lower part of the coal measures.

678. Section 202. Section at Dyer's Hill.—S. E. ¼ Sec. 33-9-4, Fig. 303 (J. C., p. 336-9).

	Ft.	In.
Division I—		
1. Sandstone	25	0
2. COAL I and shale	..	4
Lower Carboniferous—		
3. Kaskaskia limestone	19	0
4. Shale and limestone	55	0
	99	4

679. SECTION 203. SECTION AT JACKSON'S BLUFF.—S. W. ¼ Sec. 33-9-4, Fig. 304 (J. C., p. 336).

	Ft.	In.
Division I—		
1. Slope ....40 ft. to	20	0
2. Shelly sandstone	8	0
3. COAL Ia (?)	..	4
4. Massive sandstone	12	0
5. Shale and cannel COAL I	1	8
Lower Carboniferous—		
6. Kaskaskia limestone	18	0
7. Shale and sandstone	70	0
	130	0

680. SECTION 204. SECTION AT RITTER'S HILL, FREEDOM.—S. E. ¼ Sec. 20-9-4, Fig. 305 (J. C., p. 337).

	Ft.	In.
Division I—		
1. Surface, soil, etc....10 ft. to	30	0
2. Soft sandstone	25	0
3. Massive sandstone	30	0
4. Place of Coal I	1	0
Lower Carboniferous—		
5. Kaskaskia limestone	22	0
6. Ferruginous limestone	60	0
7. Sandstone, massive in river	19	0
	187	0

681. SECTION 205. SECTION AT SPANGLER'S HILL.—Sec. 1-11-4, Fig. 306 (J. C., p. 339).

	Ft.	In.
Division I—		
1. Soil and drift	20	0
2. Sandstone	25	0
3. COAL I and iron ore	2	0
4. Bituminous shale	15	0
Lower Carboniferous—		
5. Kaskaskia limestone, fossiliferous	14	0
6. Sandstone, shaly	55	0
7. Gray shale	15	0
8. Shaly limestone	20	0
	166	0

682. SECTION 206. CONNECTED SECTION NEAR CATARACT.—Sec. 2-11-4, Fig. 307 (J. C., p. 341).

	Ft.	In.
Division I—		
1. Sandstone ....20 ft. to	60	0
2. COAL I ....0 ft. to	2	0
Lower Carboniferous—		
3. Clay shale ....20 ft. to	10	0
4. Kaskaskia limestone ....10 ft. to	20	0
5. Sandstone ....60 ft. to	90	0
6. Limestone	85	0
7. "Keokuk group"	11	0
	278	0

683. SECTION 207. SECTION AT EVANS.—N. E. ¼ Sec. 11-11-4, Fig. 308 (J. C., p. 342).

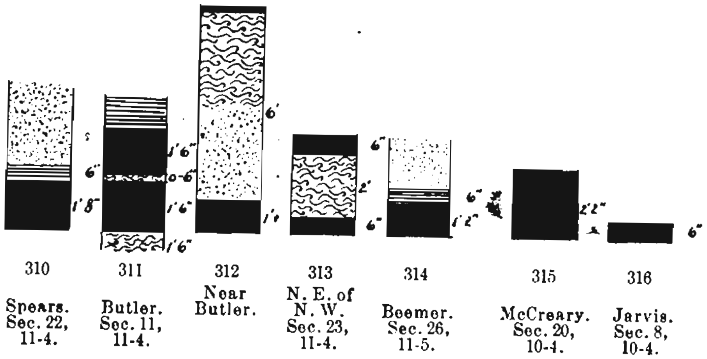
	Ft.	In.
Division III—		
1. Soil and surface	16	0
2. Yellow sandstone	8	0
3. Blue shale with ironstone	10	0
4. Black shale, position of Coal III (?)	..	8
5. Fire-clay	2	0
Division I—		
6. Coarse sandstone	28	0
7. Massive gritty sandstone, white and yellow	30	0
8. Soft white sandstone	3	6
9. Blue clay shale	12	0
10. "Carbonate of iron, band and kidneys"	..	.8
11. Black "clod" or clay	1	10
12. COAL I "bright"	1	8
Lower Carboniferous—		
13. Blue shale with iron ore	12	0
14. Kaskaskia limestone in creek	11	0
	137	4

684. SECTION 208. SECTION AT "BUZZARD'S GULCH."—S. E. ¼ Sec. 6-10-4, Fig. 309 (J. C., p. 343).

	Ft.	In.
1. Soil	20	0
Division I—		
2. White gritty sandstone	15	0
3. Massive white gritty sandstone	8	0
4. Heavy bedded sandstone	12	0
5. COAL I	1	0
Lower Carboniferous—		
6. Fissile sandstone	15	0
7. Blue pyritous shale, with excellent iron ore	20	0
8. Kaskaskia limestone	20	0
	111	0

These show the limestone in some instances immediately underlying the coal, while at other times a bed of blue clay comes between.

685. Coal I.—Coal I in this area is practically not workable, except in a small way. See Figs. 310-316. It ranges in thickness from 3 ft. down, but as a rule will be found less than 1 ft. thick. Over large parts of the area 4 to 6 in. is the greatest thickness reported, and it is quite possible that over much of such areas the coal is altogether wanting. Attention is called to the splitting of Coal I in this area as illustrated in Figs. 311-313.



Figs. 310-314. Sections of Coal I in Ts. 9 to 11 N., Rs. 3 and 4 W.
Figs. 315-316. Sections of Coal III? in same area.

The following analyses of this coal by Mr. Cox will show the composition from picked and dried specimens.

	Beamen's, Sec. 3-11-4.	*Cress, Sec. ? 2-10-4.*	*James, Sec. ? 2-9-4.*
Fixed carbon	52.50	55.00	32.50
Volatile combustible matter.	41.00	39.50	54.00
Total combustible matter	93.50	94.50	86.50
Water	3.50	3.00	4.00
Ash	3.00	2.50	9.00
Total waste matter.....	6.50	5.50	13.50

The last of these is a cannel coal; the others give much better analyses than the coal as a whole would probably give.

686. Coal III?.—Above the Mansfield sandstone coal is found at a number of points, especially in township 9 N., 4 W., a coal bed which is called Coal III, as it occurs at the same horizon as the lower block coal in Clay county, as nearly as could be determined. It is a thin bed, 2 ft. 2 in. being the thickest reported, and as it occurs in this area

only in the narrow summits of a few of the ridges it may be considered as not workable. It is possible from the basin nature of this coal that basins of thicker coal may be discovered, but present knowledge does not give much hope that way.

687. Township 12 North, Range 4 West. (Part in Owen County.)—Division I caps the tops of the hills in the western part of this area. The falls and gorge of Eel river are cut in Mitchell limestone. Coal was only noted at three points. On the line between Secs. 28 and 29, the coal outcrops 18 in. thick. In Sec. 29 there are two slopes in the N. W. of the S. W. on Mrs. Dennis Cochrane's place, from which coal has been taken out; the coal is 2 ft. 4 in. thick.

688. Township 12 North, Range 5 West. (Southeastern Corner in Owen County.)—The horizon of Coal I underlies most of this area, being cut out in the valleys of Jordan creek headwaters. Coal was only reported at one place, on the Wievener farm in Sec. 36. The horizon of Coal III may be caught in the top of the hill in parts of Secs. 23 and 24.

689. Township 11 North, Range 3 West.—The outcrops of Division I are confined to a small area near Cuba P. O., in Sec. 19, coal being reported in places there beneath the sandstone, and possibly in a high hill in Sec. 7. A large quantity of sandstone fragments indicates the presence of the Mansfield sandstone, though no coal was reported from here.

690. Township 11 North, Range 4 West.—Division I caps the higher portions of the ridge extending south from Cuba, and Coal I shows at places at the bottom of the division. Rattlesnake creek cuts down through the Kaskaskia into the Mitchell limestone, which forms the bed of the creek, and crops out some distance up the bank. Division I forms the summits of the ridges west of Rattlesnake creek, while the valleys cut down into the shale and sandstone of the Kaskaskia.

Mr. Collett calls attention to Coal I. 2 ft. thick, on Jas. Beamen's place, in Sec. 3, which Mr. Cox describes as a "dull black, dry block coal, in very thin laminae; no signs of pyrite in laminae."

An outcrop of Coal I was noted near the center of the S. E. ¼ of Sec. 24, and 6 in. of coal is reported as found in black shale on Hugh Mand's place, at the center of Sec. 25. Near the center of Sec. 2 coal is reported on the W. E. Meek place. Near the center of the west side of Sec. 2 is found an outcrop of 6 in. of rash coal, with sandstone above and fire-clay below. In the S. E. ¼ of Sec. 3 two coals 40 ft.

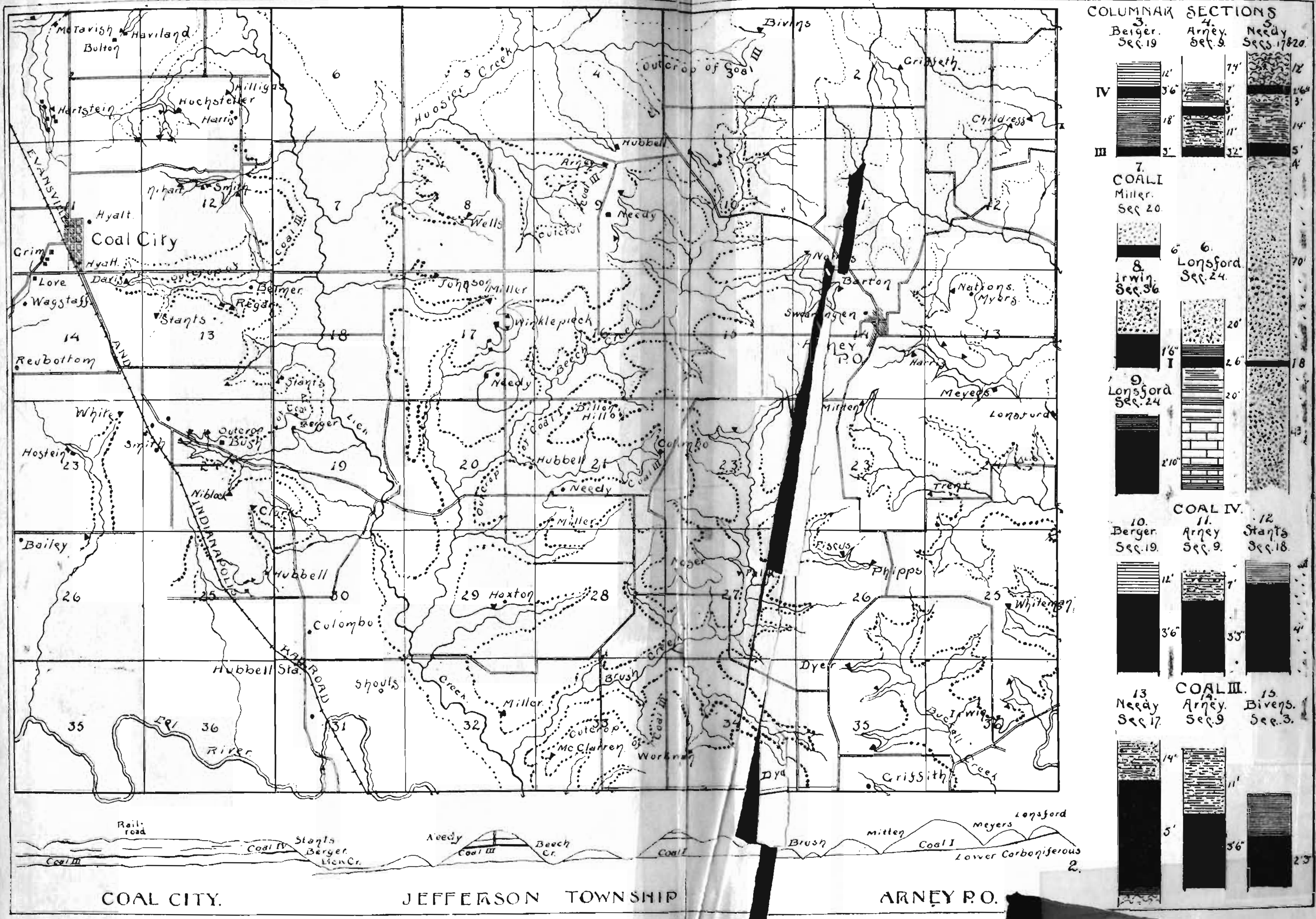
apart are reported. The upper bed is 14 in. thick and lies about 80 ft. above the branch; it has been stripped and drifted upon. The lower bed is said to be a cannel coal 1 ft. thick. The upper bed has sandstone roof. A crop was noted in the S. E. of N. W. of Sec. 10. A little southeast of the center of Sec. 11 is the Owen coal bank, owned by Angeline Butler. The coal is here 3 ft. thick, in two benches of 18 in. each, with from 0 to 6 in. of clay between. See Fig. 311. The bank had fallen in when examined. Above the coal is soft shale, with sandstone above, not a good roof. Below is 18 in. of fire-clay. Just across the road to the north where some coal was formerly mined the parting has increased to 6 ft.; the upper bed has thinned out to a mere seam, and the lower seam, somewhat over a foot in thickness, lies on fire-clay and has "hard rock" above, so that it is not an easy seam to mine. See Fig. 312. In the N. E. of N. W. of Sec. 23 the coal occurs in two benches, each 6 in. thick, and 2 ft. apart, separated by clay. See Fig. 313. On the Isaac Hall place, in the S. W. of N. W. of Sec. 23, the coal is said to be from 12 to 16 in. thick. Near the S. E. corner of Sec. 22 is the Addison Spear bank. The coal is here 18 to 20 in. thick (see Fig. 310), a semi-block, and said to be a good coal. The roof is sandstone, separated from the coal by 6 in. of draw slate. The coal has been mined by drifting. On the opposite side of the ridge the same coal has been mined on the S. P. Evans place, S. E. of S. E. of Sec. 21. The coal is said to outcrop on the Welty place, in the N. E. ¼ of Sec. 21. In Sec. 20 Coal I is noted on the J. B. Randall place, south of Atkinsonville, and on the C. E. Temple place, northwest of that town. At the latter place the coal is 14-18 in. thick. On Isaac Lucus's place, S. E. of S. W. of Sec. 17, the coal is 18 in. thick. Outcrops of the coal are also noted in the N. W. of N. W. of Sec. 19; S. W. of S. W. of Sec. 19; N. W. of N. W. of Sec. 27; S. E. of N. W. of Sec. 27; N. E. of S. W. of Sec. 27; the coal here lying under a 10-ft. bluff of sandstone; S. W. of S. E. of Sec. 34; N. E. of N. W. of Sec. 31; on Smith's place and on the Lizzie Williams place, in S. E. of S. W. of Sec. 31. The line of outcrop of this coal is shown on the map. At several places just below the horizon of the coal a thin bed of limestone is seen, which is taken to be the equivalent of a bed of Kaskaskia limestone found in Greene county just below Coal I.

691. TOWNSHIP 11 NORTH, RANGE 5 WEST (EASTERN TWO TIERS OF SECTIONS).—As far as known, the coal measure rocks of this area all belong to Division I. They are confined to the ridges, the valleys of Jordan and Six Mile creeks being cut out in Kaskaskia rocks. The line of contact and outcrop of the horizon of Coal I is shown on the map. In the S. E. of N. W. of Sec. 26 Coal I was formerly worked by a drift on the W. B. Beemer place. The coal is reported 14 in. thick, overlain by 6 in. of shale and 18 in. of sandstone. See Fig. 314. Some coal has been obtained for thrashing on the Thomas Brown place, S. E. of S. E. of Sec. 24. Coal outcrops were also noted on the Henry Jordan place, S. E. of S. E. of Sec. 13; W. H. Kerschner farm, S. E. of N. W. of Sec. 24, said to be 1 ft. thick, and on D. Worley place, in S. E. of S. E. of Sec. 25.

692. TOWNSHIP 10 NORTH, RANGE 4 WEST.—Rattlesnake creek flows through this township from north to south near the east side of the township. The Mitchell limestone forms the bed of the creek and crops out half way up the bluff. Above this comes the Kaskaskia sandstone and shale with the included patches of limestone. The higher portions of the ridge between Rattlesnake and Fish creeks are occupied by the coal measures of Division I. No coal was noted in this ridge except in Sec. 27. Here a small mine was opened some 15 years ago on the Wm. Galimore place in the S. E. of S. E. of the section. The coal is reported to have been 1 ft. 10 in. thick with 18 in. of cannel coal 4 ft. below. On the south line of the S. W. of S. E. of same section 18 in. of coal is reported on the E. T. Galimore place. In the N. W. of S. E. of this section is 1 ft. of coal on Wm. Medearis's farm. A crop was also noted in N. W. of S. W. of this section. In the S. W. ¼ of Sec. 14, N. E. ¼ of Sec. 15, and N. W. ¼ of Sec. 23, the limestone noted above was found just below the horizon of Coal I, the limestone running from 4 to 12 ft. thick.

West of Fish creek the rocks of Division I occur lower down on the ridges, and Coal III, from 6 in. to 2 ft. thick, is caught in the tops of some of the ridges. The map shows the area underlain by each of these divisions.

In the N. W. ¼ township, Coal III is struck in wells in the S. W. ¼ of Sec. 5. The coal is reported to be 2 ft. thick. It comes to a crop in the head of a drain in the N. E. of S. W. of Sec. 5, and in the S. E. of S. W. of the same section has been stripped where 2 ft. thick on the Jno. Freeman farm. In Sec. 9 Coal I crops out a quarter of a mile east of Vandalia, and a less distance northwest, in the N. E. of S. E. of Sec. 8, Coal III crops out 6 in. thick on the John Jarvis place (Fig. 316). In the S. W. ¼ of Sec. 8 Coal III crops out with some sandstone above it. Down the bank near the creek, in the N. E. of S. E. of Sec. 7, Coal I crops out on the Jas. Biddle place. Another outcrop of Coal I was noted in the S. E. of S. W. of Sec. 7, and in the center of the N. W. ¼ of that section an outcrop of Coal III. The


COLUMNAR SECTIONS
3. Berger. Sec. 19
4. Arney. Sec. 9.
5. Needy Secs. 17 & 20.
COAL I
7. Miller. Sec. 20.
8. Irwin. Sec. 36
6. Lonsford Sec. 24.
9. Lonsford Sec. 24
COAL IV.
10. Berger. Sec. 19.
11. Arney Sec. 9.
12. Stants Sec. 18.
COAL III.
13. Needy Sec. 17.
14. Arney. Sec. 9
15. Bivens. Sec. 3.
Coal City
Evansville and Indianapolis Railroad
Hubbell Sta.
Hoosier Creek
Outcrop of Coal III
Beech Cr.
Lick Cr.
Brush Creek
Buck Creek
Eel River
Arney P.O.
Lower Carboniferous
COAL CITY.
JEFFERSON TOWNSHIP
ARNEY P.O.

PLATE

same coal outcrops on the J. B. Long place in the center of the N. E. ¼ of Sec. 18. Both coals crop out in the N. W. ¼ of Sec. 16. On the Wm. Wisely place, near the N. W. corner, Coal I is 18 in. thick and it has the same thickness on the John Fender place a little south. On both sides of the line between Secs. 16 and 21 are outcrops on the J. Ault farm.

In Sec. 20, the N. W. of S. W., Mr. Robt. Biddle is reopening a bank on the McCreary place. The coal is 2 ft. 2 in. thick, Coal III (Fig. 315). On the Geo. Biddle farm in Sec. 19, S. E. of N. W., Coal I is 21 in. thick. An outcrop of Coal I was noted in the N. W. of N. W. of Sec. 29, on the Michael Needy place, formerly Cress. Mr. Collett mentions Coal I as occurring on the D. C. Cress place, near Vandalia, 2 ft. 3 in. thick. Mr. Cox describes this coal as "a dull black, slaty, caking coal, with pyrites in the partings."

693. Township 9 North, Range 3 West.—The Mitchell limestone forms the valleys and main part of the hills in the eastern part of the township. The Chester sandstone and shale cap the ridges in the eastern part of this region, dipping westward, and being superimposed in turn by the Mansfield sandstone about midway of the township. In the southeastern part of the township the parting between the Chester and Mitchell is about 200 ft. above the river, the hills averaging 250 ft. Going westward, the upper limit of the Mitchell gradually becomes lower and lower until it disappears beneath White river, having dipped 200 ft. in 8 miles, making 25 ft. to the mile. Through the eastern part of the township where the Mitchell limestone is the surface formation, its presence is shown by the characteristic "sink holes."

The Mansfield sandstone of Division I forms the cap rock of the ridges in the western half of the township. But a few outcrops of coal are reported and none more than a few inches thick. In several places coal fragments are reported in hollows which head up against the sandstone of Division I. Thus, coal fragments were noted in a branch in the S. W. ¼ of Sec. 8 and in branch in N. W. ¼ of Sec. 17. Also on the Katherine Wilson place near the center of Sec. 9. A coal outcrop was reported near the center of the line between Secs. 17 and 18.

In the southern half of the township coal fragments were noted in ravines in the N. E. ¼ of Sec. 20, and W. ½ of Sec. 30. Outcrops were noted in the S. E. of N. E. of Sec. 33 on the Mallicote place, a few inches thick; in a spring on the Jas. Renard place near center of Sec. 35, and on the H. A. Niells place in the S. W. of S. W. of Sec. 36, where the coal was 3 to 4 in. thick.

694. Township 9 North, Range 4 West.—In this township the Mitchell limestone crops out along the river in the northeastern corner. Over the rest of the township rocks of Chester or Kaskaskia age predominate, the coal measures being confined to the top of the hills. South of White river, Division I crowns the tops of the higher hills as mapped. Coal I occurs at but few places and then but a few inches in thickness. Thus, coal fragments were noted in the branch in the center of Sec. 24, also a 6 in. crop on the D. W. Burton place in Sec. 22. The Mansfield sandstone of Division I caps the hill west and south of Freedom, Coal I outcropping 1 ft. thick on the A. J. McBride place in the S. E. of S. E. of Sec. 17, and on the Thos. Minnich place in the E. ½ of the S. W. ¼ of the same section. Another body of the sandstone occurs north of Freedom a couple of miles. At Geo. W. Condor's 4 in. of coal was struck in a well, N. W. of S. W. of Sec. 9. West of Fish creek the Mansfield sets in, to persist until it disappears beneath the overlying formations near Eel river. Coal has been found on Mr. Alex. Childer's, S. W. of S. W. of Sec. 6, and on David Lonford's on the township line at N. W. corner of Sec. 19. Here the coal is said to be 2 ft. 10 in. thick, a drift having been run in some 25 ft. See description of 9 N., 5 W.

Mr. Cox describes coal from an 8-in. bed on Mr. Jackson Janes's place near Arcola as "a compact, lustreless, deep black cannel coal."

At Nelson's cut, a mile and one half east of Farmer's, there occurs the nonconformity shown in Plate VIII. As shown in the figure, the Mansfield sandstone caps the neighboring ridge nearly half a mile from the cut at the railroad, and about 60 ft. above the railway level. In digging the cut for the railroad, coal was struck beneath sandstone. This coal has been dug into 18-20 in. without going through, and dips to the northwest, apparently thickening in that direction. This was in the north ditch. A hole bored into the south ditch struck limestone and found no coal. Limestone crops out abundantly to the southwest, especially near the big spring which flows south. Enough coal was taken out at this cut to serve the section hands one winter and for the company's stores in Farmer's and Freedom.

Township 10 North, Ranges 5 and 6 (in Part) West.

695. Geography.—This area includes all of Marion, the western third of Lafayette, and the southwestern corner of Morgan of the civic townships. It is hilly in the east, but tends to become less broken to the west, where it is rolling. The drainage is principally to

the south to Lick creek, though the northern part drains to Six Mile creek and Eel river. The Lancaster branch of the E. & I. R. R. just enters the area near the southwestern corner.

696. STRATIGRAPHY AND COALS.—The stratigraphy of this area is not as clear as might be wished. This much seems evident, that there are two workable beds from 20 to 30 ft. apart, overlying the sandstone of Division I. They are supposed to correspond in position with the two block coals of Clay county, Coals III and IV.

The following sections will show their relations to each other and to Division I:

697. SECTION 208. SECTION ON ANDREWS AND DUNLOP PLACES.—Sec. 26-10-6, Fig. 2 of Plate XXVI (p. 481).

	Ft.	In.	Ft.	In.	Ft.	In.
Division IV—						
1. Blue shale	..	..	..	..	..	..
2. COAL IV	4	0	4	0	4	0
3. Fire-clay into sandstone	4	0	..	..	8	0
Division III—						
4. Brown to black shale	10	0	14	0	18	0
5. COAL III	3	6	3	6	21	6
6. Fire-clay	10	0	..	..	31	6
Division I—						
7. Dark shale with iron bands (in drillings)	90	0	..	..	121	6
Lower Carboniferous?—						
8. Sandstone	24	0	..	..	145	6
9. Hard sandstone	2	0	..	..	147	6

Apparently the Mansfield sandstone has been carried away and replaced by shale, or shale was deposited here while sandstone was being deposited to the east.

698. SECTION 209. SECTION ON WM. S. NORRIS'S LAND.—"S. E. ¼ Sec. 21-10-5," Fig. 3 (J. C., p. 353).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil ....4 ft. to	10	0	..	..	10	0
Division IV—						
2. Gray shale	4	0	..	..	14	0
3. COAL IV ....3 ft. to	5	0	5	0	19	0
Division III—						
4. Shale and iron ore	30	0	30	0	49	0
5. COAL III	2	2	2	2	51	2

699. SECTION 210. SECTION AT ANDREW'S MINE.—N. W. of S. E., Sec. 15-10-9, Fig. 4 (W. S. B., p. 83).

	Ft.	In.
1. Surface and yellow drift clay	5	0
Division III—		
2. Blue-gray argillaceous shale	21	0
3. COAL III	5	2
Division I—		
4. Fire-clay	4	3
5. Sandstone	31	0

700. SECTION 211. SECTION AT BRAMMER'S (GARRARD).—S. E. of N. W. of Sec. 1-10-5, Fig. 5 (J. C., p. 355).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Slope	30	0	..	..	30	0
Division IV—						
2. COAL IV	1	8	1	8	31	8
Division III—						
3. Gray shale and covered	27	0	27	0	58	8
4. COAL III	1	6	1	6	60	2
Division I—						
5. Shale and sandstone	58	0	58	0	118	2
6. COAL I	1	0	1	0	119	2

701. COAL IV.—See Figs. 6 to 9 of Plate XXVI. With the opportunities at hand, we were not able to work out a set of characteristics by which these two beds could be readily distinguished. While these beds are supposed to lie at about the same horizons as Coals IV and III of the type locality, yet they have lost the peculiar characters of those beds as seen around Brazil. It is sometimes stated that the lower bed always shows a clay or shale parting near the middle. Investigation shows that to be only true locally, and therefore not a reliable character. It is possible that with more detailed information than we were able to obtain at the time of year in which this region was visited, it might be found that this parting is a regular characteristic, though often showing only as a smooth parting. As far as could be learned, Coal IV in this area is a solid coal, ranging up to over 5 ft. in thickness. It appears to be a good coal, approaching the block coal of Brazil in having open and regular slips, allowing the coal to be readily mined without powder. Where best seen, at the Hoffer bank, the slips are open a quarter of an inch or more. The face slips are here about 2 ft. apart, and seldom continue for any distance. Their direction varies from N. 12° W. to N. 18° W. The butt slips, at right angles, average about 18 in. apart.

702. COAL III.—See Figs. 12 to 18 of Plate XXVI. As stated above, it is thought by some that a parting in the center characterizes

this bed. The data obtained did not sustain this view, though it is thought possible that more detailed information might show it to be more constant than at first supposed. Such a parting was reported in the coal at several places, though not at mines from which the above figures are taken. Aside from that, the characteristics most commonly noted were that the top of the coal is often a semi-block coal, while the center of the main body of the coal is a block, and the bottom a bony coal. These characters were noted in three of the banks visited by Mr. Collett, none of which are open now. I should not be surprised if more detailed information showed this bed to tend to have those differences regularly, on account of the resemblance to the top semi-block coal and bottom bone coal of Coal III around Brazil. This bed seems to resemble the upper bed in its block properties. Where best observed, at the H. Fulk's bank, the face slips run about N. 22° W. in direction, and from 1 ft. 6 in. to 2 ft. 6 in. apart, while the butt slips showed a direction of N. 70° E. and were about 1 ft. 6 in. apart. The following analyses by Prof. Cox give an idea as to the composition and quality of picked and dried specimens:

	Section.	Township.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Water.	Ash.	Total Waste.
Brammer's (Cannel), top	1	10-5	46.00	48.50	94.50	4.00	1.50	5.50
Brammer's, middle	1	10-5	53.50	41.00	94.50	2.00	3.50	5.50
Brammer's, bottom	1	10-5	46.00	47.00	93.00	2.50	4.50	7.00
Burger's, middle	26	10-6	54.00	42.50	96.50	2.00	1.50	3.50
Burger's, bottom	26	10-6	58.00	35.00	93.00	3.50	3.50	7.00
Croft, middle	23	10-6	57.30	38.50	96.00	2.00	2.00	4.00
Croft, bottom	23	10-6	57 00	36.00	93.00	2.50	4.50	7.00
Fletcher, top	10	10-5	60.00	35.00	95.00	2.00	3.00	5.00
Fletcher, middle	10	10-5	58.00	37.50	95.50	2.00	2.50	4.50
Fletcher, bottom	10	10-5	44.00	45.50	89.50	2.00	8.50	10.50
Norris	21 (?)	10-5	45.00	48.00	93.00	2.00	5.00	7.00
Overholtzer, middle	6	10-5	57.00	35.00	92.00	3.50	4.50	8.00
Overholtzer, bottom	6	10-5	53.00	34.50	87.50	3.00	2.50	12.50
Rowe, middle	11	10-6	56.00	36.00	92.00	3.00	5.00	8.00
Rowe, bottom	11	10-6	53.50	39.00	92.50	3.00	4.50	7.50
Royer, top	11	10-5	55.50	38.00	93.50	2.50	4.00	6.50
Royer, middle	11	10-5	55.00	39.00	94.00	3.00	3.00	6.00
Royer, bottom	11	10-5	51.50	41.50	93.00	3.00	4.00	7.00
Stahl's	19	10-5	58.00	36.00	94.00	3.00	3.00	6.00

An analysis of this coal, properly sampled, by Messrs. McTaggart and Carver, gave as follows:

Fixed carbon	47.22	
Volatile combustible matter	37.44	
Total combustible matter		84.66
Ash	2.68	
Moisture	12.66	
Sulphur	.62	
Total waste		15.96

These analyses show a high grade of coal, almost if not quite equal to the average of the basins about Brazil. Whether this coal would prove of as good quality as the Brazil block when mined commercially, remains to be seen. It has a slight advantage in being thicker, thus not being as liable to have pieces of the roof and bottom mixed with it. Drilling is said to show the coal here to lie in smaller basins than about Brazil, so that we would expect that extensive mining would reveal an average thickness here little if any greater than the upper block bed there. As far as explored, the average would seem to be at least a foot greater than at Brazil. Again, it is more than probable that these beds will be found to lack in quality when mined on a large scale what they gain in thickness; that is, that some of the increase in thickness will be found to be due to the addition of impurities.

While these coals have not quite the regularity of joint structure of the Brazil block coal, they come as near it as any of the coals outside of what is generally recognized as the original block field, and in not having these joint or slip faces cemented by calcite or other material, thus rendering it possible to mine the coal readily without shooting, they probably come nearer the typical block coal than the coal of any other part of the field. While these slips are often open or filled with mud, they are commonly stained with iron to a greater or less extent.

On the whole, the major basin or field of these coals, which is principally contained in the area under discussion, and which is often known as the Lancaster block coal field, probably contains the best and largest amount of undeveloped block coal in the State.

In regard to the roof, which forms such an important item in the practical operation of mining, the lack of extensive mining here prevents forming an accurate estimate. Where mined near the western edge of this basin, over the line in Clay county, the roof has proven far from satisfactory in most cases. In contrast with that area, however, where the land is flat and the coal below drainage, with often only a thin covering of indurated rock, over most of the area the coal is above drainage and under hills of some height. As far as observed over this area in the small mines the roof held well.

In the table of analyses, as well as in the figures, much doubt exists in several cases as to whether the coal belonged to the horizon of Coal III or Coal IV.

703. DIVISION I.—As usual, this division consists largely of sandstone underlain by one coal. At a few places this division appears to have been eroded extensively before the laying down of the higher divisions. Mr. Jno. Andrews, of Lancaster, described a nonconformability near a mine in this region. A short distance on one side of the mine the sandstone was exposed at the same level as the bank, and so much above as to lead to the question if this coal did not pass under the sandstone. A drilling, however, passed through the sandstone only to find the shale and bands of iron ore which accompany Coal I. A drilling a short distance on the opposite side of the mine shows the sandstone replaced with shale. In Fig. 2 it will be noticed that the place of Division I is occupied by 90 ft. of shale instead of the usual sandstone, and the same was found in other places.

Again, in several places, most noticeably in Secs. 1 and 2 of township 10-6, outcrops of the Mansfield sandstone of Division I occur at so much higher levels than neighboring exposures of Coals III and IV as to suggest that the upper coals were laid down in basins eroded out of the strata of Division I. It is quite possible that marked structural folding is responsible for the apparent nonconformity, or it is barely possible that an instrumental survey would show that we were deceived in the apparent differences of level.

In any case, the result has been to render the lines of contact of Divisions III and I very unreliable over several parts of this area, but especially in the northwest.

Coal I (see Figs. 10, 11, of Plate XXVI) runs about the same as in the area to the east, probably being nowhere workable and generally running about 1 ft. or less.

704. DISTRIBUTION AND LOCAL DETAILS OF COAL.—In this discussion it will be convenient to take up the area in three parts: (1) the two eastern tiers of sections of 10-5, which were worked up by Mr. Siebenthal, and found to contain practically no workable coal; (2) the western two-thirds of 10-5; (3) the two eastern tiers of sections in 10-6, the areas 2 and 3 having been worked up by the writer.

705. DISTRIBUTION IN TWO EASTERN TIERS OF SECTIONS OF 10-5.—As indicated on the map, the horizon of Coal I occurs low down in the valleys, while the horizon of Coal III is found well up toward the top of the ridges in this area.

In Sec. 1 the columnar section at Brammer's or Garrard's was given in ¶700, Sect. 211. At another outcrop in the N. W. of N. W. of this section, Mr. Collett gives the following section:

706. SECTION 212. SECTION AT BRAMMER'S CANNEL COAL BANK.—(J. C., p. 355.)

		Ft.	In.
1.	Slope	40	0
2.	Blue and gray shale	4	0
3.	Quartzose sandstone	1	2
4.	Choice cannel COAL	..	8
5.	Resinous COAL 1 to	2	0
6.	Blue and gray bituminous shale	8	0
7.	Massive sandstone	12	0
		67	10

Mr. Collett calls the lower sandstone, No. 7, "conglomerate," meaning, as we have seen, not a conglomerate, but the horizon at which conglomerate, or rather grit, occurs, implying that the coal is above or at the horizon of Coal III. Mr. Cox describes this coal as 32 in. thick, and as "a dull, black semi-cannel coal, with a slightly conchoidal fracture, the bottom of the seam running into slaty block coal, with pyrites in the partings, the whole showing iron stains." Mr. Siebenthal has placed this coal at the horizon of Coal I. In the N. E. of S. W. of Sec. 1, 15 in. of coal is found on the Moffett farm. This is a black, bright coal.

In the S. E. of N. E. of Sec. 12, 4 in. of coal outcrop at the horizon of Coal III.

In the S. W. of S. E. of Sec. 11, also S. E. of S. W. of same section, Coal III is found on the Britain Troth place, and has been worked by a drift. The coal is 4 ft. 3 in. thick (see Fig. 18) and a semi-block. The roof is shale and sandstone, some of which tends to come down. Below is at least two or three feet of fire-clay. A short distance east the sandstone of Division I outcrops with a thickness of 20 ft.

In Sec. 14 this coal has been dug at two places on the R. Troth place in the N. W. of N. E. of the section.

In the N. W. of N. W. of this section the H. Fulk bank was visited by the writer. Coal III is mined here by stripping and by a drift. It is 2 ft. thick, without visible parting. The block slips, which generally run clear through the coal, are quite marked here. See ¶702. The joint faces are not always as smooth as about Brazil. Over the coal at this point is from 8 to 18 in. of blue shale, then 1 ft. of brown sandstone, with 3 to 8 ft. of surface on top. The coal is from 20 to 25 ft. below the level above. See Fig. 15.

In the N. E. ¼ of Sec. 13 is a case of the Mansfield sandstone being replaced by shale. In the N. W. of N. E. is an exposure of massive sandstone 12 to 15 ft. thick. Toward the east the sandstone thins out. On the west side of the drain, near the township line, a drift was driven a short distance under the sandstone, but no coal was struck. A well in the bottom of the branch just above this went through 50 ft. of black shale. The road from the branch to the top of the hill 50 to 60 ft. above shows gray shale all the way, making a thickness of 100 to 110 of shale, in the midst of which is the horizon of the massive Mansfield sandstone of Division I. In the center of Sec. 23, on the other hand, is found an example of the nonconformity existing between Division I of the coal measures and the Lower Carboniferous. On the land of Mr. Robert Chambers, near the center of the section, the Kaskaskia limestone has been quarried to a thickness of 17 or 18 ft. A couple of hundred yards up or down the creek only sandstone shows, and in such a position as to indicate that it has been deposited against a hump or ridge of the limestone. At the exposure down the creek, Coal I, 1 ft. thick, is said to underlie the sandstone. This is on Mr. Geo. Chambers's land.

In Sec. 24, Coal III, 2 ft. thick, outcrops on the Elias Dayhoff place, in the N. W. of the N. W. Coal I outcrops on the Henry Long place, in the S. E. of S. W.

In the S. E. of S. W. of Sec. 25, 2 ft. of coal is reported at 18 ft. on the T. B. Blanton place. Coal I is found on the Jas. McKelvy place, formerly the Granville Grady farm. The limestone is reported as found 20 to 30 ft. below the coal.

In Sec. 36, Coal I, 20 in. thick, has been stripped a little on the Tillman Rawley place, in the N. E. of S. W. of section. The coal has a shale roof, and a floor of blue sticky fire-clay.

707. Distribution in Western Two-Thirds 10-5.—On account of what appeared to be a nonconformity between Division I and the overlying divisions, much uncertainty exists as to the exact position of the line of contact at the top of the division, and not too great reliance should be put on the line as mapped. Division III appears to be cut out all along Lick creek and the low divide west of Patricksburg. Again, the distribution in Sec. 27 and adjacent regions is rendered uncertain by a question as to the stratigraphic position of the coals at the Spangler place. The line of outcrop as mapped from the old diggings on the Moss place, in Sec. 28, and Stickles place, in Sec. 22, would barely cross the N. W. corner of Sec. 27. On the other hand, the coal at those places might prove to be Coal IV rather than Coal III.

In Sec. 3, Division III appears to just cross the S. E. corner of the section. The Mansfield sandstone outcrops in the sides of the ravine in the south half of the section, and Coal I (?) has been stripped at a number of places. On the Chambers farm, in the N. W. of S. W. of the section, the coal has been stripped at different places many years. The coal here is reported 2 ft. thick, though only 1 ft. was seen. The coal is described by Mr. Cox as "a jet black, brittle, caking coal in the top and middle portions of the seam, while the bottom part is slaty, with considerable pyrites. The whole more or less stained with iron in the vertical seams." Above the coal is 4 ft.+ of blue, joined shale, with many sandstone fragments above, indicating the presence of the Mansfield. Farther up the branch, coal has been stripped on the Knox place. This point was examined by Mr. Siebenthal, who reported 3 ft. of block coal.

In the S. E. of the N. E. of Sec. 10 is the Toliver or old Calvin Fletcher mine, not open now. Mr. Collett gives the following section of this mine (Sect. 213, J. C., p. 354, Fig. 16 of Plate XXVI):

	Ft.	*In.*
Soil, clay	5	0
Gray shale .5 ft. to	8	0
COAL III—Semi-block coal, 1 ft. 8 in., choice block coal, 3 ft. 4 in.	5	0
Shaly clay	5	0
	23	7

Analyses of this coal were given above. Mr. Cox describes the coal as "a dull black, laminate, block coal, with charcoal partings, no visible pyrites, though stained with iron in the vertical seams."

North of Patricksburg or Lancaster are or have been a number of slopes or drifts. At the Wm. Geckler slope, just north a few rods, the coal is about 20 ft. down and about 30 to 35 ft. below the level of the town. The coal exposed measured 4 ft., without visible partings. Over the coal is 16 ft. of shale. Just northwest are the remains of the old Maegerlein slope.

Just east of the last are the remains of an old shaft, supposed to be the Wm. Royer mine visited by Mr. Collett. His section at this point was as follows (Sect. 214, J. C., p. 554), Fig. 17:

	Ft.
Soil, clay ....30 ft. to	5
Gray shale ....4 ft. to	10
COAL III—Semi-block coal, 1 ft. 8 in.; choice block, 3 ft. 6 in.; splinty cannel, 10 in................................	6
Shaly clay	4
	25

Mr. Cox describes the coal here as a "deep black, laminate block coal, with charcoal in the partings. Some pyrites in lower part of seam."

A little north a drift was opened in 1896 or '97. The coal here being removed, measures from 4 ft. 5 in. to 4 ft. 7 in. The joints or slips do not appear to run entirely through the coal. A direction of about N. 10° W. seems to predominate with them, though slips were noted swinging around as far as N. 10° E. The blocks will range from 1 ft. by 1 ft. 6 in. up to 1 ft. 6 in. by 2 ft. 6 in. At one point a half-inch clay band was noticed 1 in. from the top of the coal exposed.

Mr. Jno. Andrews reports 5 ft. 10 in. of coal at a depth of 137 ft. at Patricksburg, or 113 ft. below the bed they are working. Half a mile south of Patricksburg Mr. Andrews is working this coal in connection with his tile plant. The coal here ranges from 3 to 5 ft. thick, with an average of about 4 ft. 6 in. It shows no shale or clay bands, though often a streak of splint coal about 3 ft. from the bottom, and at times a little free coal about 14 in. from the bottom, which is sometimes mined in (Fig. 14). The slips tend to offset at the splint band and do not appear to extend entirely through the coal. The blocks vary much in their dimensions, ranging from 18 in. to 3 ft. on a side. This coal is mined by shooting. Over the coal is a fine brown shale 20 ft. or more thick and appearing to be very suitable for the manufacture of clay products. Below is about 4 ft. of shaly fire-clay. The section here was given in ¶699, Sect. 210. Coal has been worked in this vicinity for many years and at many places. Just east of the tile factory is the slope of Mr. Frank Halstead. Northwest of this a slope was being opened in 1897 on the Magill place by Geo. Laswell and others.

In Sec. 26 this coal has been worked just north of the center of the section on Michael Stickles's place. This mine had fallen in, but the coal was reported to be 6 ft. thick. The roof, however, was poor. In the S. W. of the S. W. of Sec. 22, on Mr. Stickles Jr.'s land, 4 ft. of coal is reported as found in a well at 26 ft.

In Sec. 27 coal has been stripped on the John Spangler place in the S. W. of S. E. of the section. Starting at the wagon bridge with a few inches of coal, as they stripped northward, the bed was more intact and the thickness increased until it is said to have been 2 ft. 10 inches. A quarter of a mile north a drilling was made, which, it is said, was reported in the Brazil papers as having gone through 5 ft. 6 in. of coal. If that be true it would suggest that this coal is Coal III, though its position would more strongly suggest Coal I. At the wagon bridge there is exposed 10 ft. of shaly sandstone with some shale, overlying 8 ft. of sandy shale with some sandstone. This must be just above the coal. Twenty-seven ft. above the coal stripped is said to be the crop of a good bed of blacksmith coal. The sandy strata near the bridge suggests the sandstone of Division I, but the space of 27 ft. between the two coals, while about the average of the space between Coals III and IV here, is only one-half to one-third the usual space between Coals I and III here, and so argues for the coal stripped being Coal III.

In Sec. 21, two coals are reported on the Wm. Norris place and the section as determined by Mr. Collett was given in ¶698, Sec. 209, Fig. 3. Mr. Collett assumed, and the section seems to sustain that view, that the two coals of that section are both above the Mansfield sandstone. While we have concurred, it is as much because of lack of positive proof to the contrary as because of being convinced of the correctness of such an assumption. At several points in this neighborhood coals whose position made them seem to correspond to the upper coal at Norris's appeared to be just above the Mansfield sandstone.

Just across the line in the N. W. of N. W. of Sec. 28 the coal has been mined on the Devin place, formerly the Sinks place. At an open drift the coal measured 2 ft. 10 in. in thickness. It is a semi-block to block, showing the slips and splitting readily along the dull bands. It appears like a good coal. Above it is 12 ft. of brown to blue shale. (Fig. 9.)

Across the road southwest coal has been dug on the Silvius place, where the coal is reported to have been 5 ft. thick. This is apparently on a level with the coal at Devin's. Southeast of this a quarter coal has been mined some on the Hass place, reported to be 4 ft. thick.

In Sec. 29 coal was formerly mined by a drift on the Newport place. The coal is reported as 3 ft. 6 in. to 4 ft. thick, but containing a good deal of bone. Down the hollow from this mine is an exposure of sandstone supposed to belong to Division I; under it is shale, and it is reported that coal has been found under the shale. This sandstone would seem to occupy a position between the two coals on the Norris place. Going south from the Newport farm down the branch, in the S. W. ¼ of Sec. 29, sandstone is abundantly exposed, and near the

S. W. corner of the section makes bluffs 15 ft. high. Below the sandstone is a bed of blue to black shale which, a short distance south, shows a thickness of 10-12 ft. No coal was found in or under this, though coal is reported to outcrop in Secs. 32 and 31 at a number of places.

In the valley of Lick creek, west of the area we have been considering, are a number of outcrops of the blue to brown shale underlying the Mansfield sandstone, with some outcrops of coal reported, though not seen. Above this the sandstone is seen, as at Marion Mills or Hausertown P. O., where the massive sandstone is exposed to a thickness of 15 to 20 ft. in the village, and about 25 ft. above the bottoms of Lick creek. In Sec. 4 two drillings, starting near the bottom of Division I, are reported to have been sunk entirely in shale, one to a depth of 60 ft. and the other to a depth of 70 ft.

In Secs. 5 and 6 is a small area of the upper coals, or at least of Coal III. In the N. E. of S. E. of Sec. 6 coal has been stripped on the Overholtzer place. The coal is reported to vary from 4 ft. to 6 ft. 1 in. It was described by Mr. Cox as "a dry, laminate, dull black, block coal, with charcoal partings, vertical seams stained with iron." Analyses were given above. The coal has not been worked here in some time, as the amount of stripping became too great, yet not thick or strong enough to mine under. See Fig. 13. At Mrs. Eliza Myers's a well at the house is said to have struck coal at a depth of 28 ft. This is on high ground. In the N. E. of N. E. of Sec. 18 Coal IV? is worked at the McInhart bank. The shaft is about 20 ft. deep and the coal measures 5 ft. 1 in. No bands or partings could be seen. The floor is fire-clay, the roof shale. The top of this shaft is 75 to 100 ft. above the valley to the north, and appears to be above the horizon of Coal III. See Fig. 8. Just south the coal has been worked by stripping and by slope on the Jno. C. Stall place. The coal here was reported by Mr. Collett as 4 ft. 6 in. thick. It is described by Mr. Cox as "a deep black, laminate, block coal, breaking in regular cubic forms, has charcoal partings, and the vertical seams are stained with iron."

708. Township 10-6 (Part in Owen County).—In the N. E. of N. E. of Sec. 1, 1 ft. of soft coal was met at a depth of 20 ft., 16 ft. of the distance being through sandstone. This sandstone of Division I is exposed in the road in the N. W. corner of Sec. 1. In the N. W. ¼ coal was reported as found at 18 ft. in a well on the Geckler place. Mr. Collett reports that in digging a well 4 ft. square on the J. Frantz place, in the S. W. corner of Sec. 1, a "ton of superior iron ore was obtained in passing the shale bed, 5 ft. thick, which overlies Coal B."

Though "B" was used in this county to designate the first coal above the Mansfield sandstone, we would assign the coal to a position below the Mansfield, and are inclined to think that this heavy bed of iron ore will nearly, if not quite, always be found to accompany Coal I, and not coals above the Mansfield. Going south from Secs. 1 and 2, either as a result of a strong southwest dip, or due to the apparent nonconformity between Divisions I and III, mentioned above, coal supposed to be Coal III is met with at levels but little if any above the levels of Coal I to the north and east.

In Sec. 11 coal has been worked at a number of places. On the Fred Lye place coal has been stripped and is reported to be 4 ft. thick. At the old Jesse Rowe place the coal was reported by Mr. Collett as 3 ft. 2 in. thick. Mr. Cox describes the coal here as "a dull, slaty, laminate, semi-block coal, with pyrites in the partings." Analyses were given above.

In the N. W. ¼ of Sec. 12, 5 ft. 3 in. (?) of coal are reported to have been dug through at a depth of 22 ft. on the Rensler farm. In the S. W. ¼ coal has been worked by a slope on the J. J. Royer farm. The coal is reported to be 3 ft. or 3 ft. 6 in. thick, with a 2-in. shale band in the middle.

In the S. E. of the N. E. of Sec. 13 is the Hoffer mine. This appeared to be about on a level with the McInhart coal but several score of feet above the coal at the Royer bank just mentioned. The mine is a slope. The coal is 4 ft. 4 in. thick, a block coal, with open or mud slips. See ¶701, Fig. 7. The coal is mined without shooting. The roof is made of 6 ft. of shale, which seems to serve well. This is not far from the top of the high ground extending east and west here. To the west this high ground ends quite abruptly near the line between Secs. 13 and 14. To bring this coal down to a level of what is taken to be the same coal at Cole's and Salisbury's, across the Clay county line, in Sec. 10, will require an unusually high dip.

In the N. W. ¼ of Sec. 23 coal was long worked on the G. Croft place. Mr. Collett gave the following section at this point (Sect. 215, Fig. 12, J. C., p. 352):

	Ft.	In.
Clay and drift	5	0
Gray clay shale	3	0
COAL III?—Semi-caking coal, 6 in.; choice block, 2 ft.; Pasty cannel "Albertite," 8 in.	3	2
Clay	2	0
	13	2

This is said to be an excellent coal. It is on land now owned by the Harrison Coal Company. Analyses were given above. Mr. Cox says "it is a dry, laminate, black coal, with charcoal partings, no pyrites visible." About an acre has been taken.

In the N. W. ¼ of Sec. 26 Mr. Jno. Andrews has had four shafts to Coal IV. Previous to that coal was worked here by a slope by Mr. Ed. Morris. At Andrews No. 4 shaft, the only one open, the coal is from 20 to 25 ft. deep and measured 3 ft. 6 in.+ in the main entry, but is said to average 4 ft. (See Fig. 6.) The 6-in. at the bottom is said to be caking, the rest a semi-block. The slips are not very marked. The roof is a blue shale, 13 ft. thick. This coal runs to a crop just east of this, but Coal III underlies nearly all of the eastern half of the section at a slight depth. The average of a number of bores on the Burger place, in the S. W. ¼, is said to have been 3 ft. 6 in. It has been worked on the Dunlop place, in the N. E. ¼, by drifting, being 3 ft. 6 in. thick, with a band of black shale in the middle 1-2 in. thick. The roof was brown to black shale, 10 ft., and below was 10 ft. of fire-clay. For a connected section here and on the Andrews place, combined with a well northwest of Andrews No. 4, see ¶697, Sect. 208.

In the N. W. ¼ of Sec. 35 is the Berger slope, where the coal is reported to average 4 ft., ranging from 3 ft. 6 in. to 4 ft. 6 in., without parting. Near the south line of this section are the Crouse, Leohr and Harbough drifts, on Coals IV and III, the two coals here being about 12 ft. apart. The upper coal is said to range from 3 ft. 6 in. to 4 ft., with a blue shale roof, and fire-clay under. The lower bed is said to run from 2 ft. to 3 ft., being a fine quality of block coal. Between the two beds is shale.

Township 9 North, Range 5 West.

709. Geography.—This township, lying on the southern edge of the county, corresponds with the eastern three-fourths of Jefferson of the civic townships.

Lick creek at the west has comparatively broad bottoms, with not very steep banks. Going eastward, the country becomes more rugged, the hills higher and steeper, the valleys narrower and deeper. The drift, while noticeable in protected patches, has no topographic importance.

The E. & I. R. R. just crosses the southwestern corner, and the I. & V. just misses the southeastern corner.

710. Stratigraphy and Coals.—The stratigraphy of this township seems quite clear, though the nearness and similarity of the two upper coals render them difficult to distinguish when only one is found.

Without stating exact equivalency for the two upper coals to the type section, the coals may be called I, III and IV. A few sections will suffice to show their relations.

711. Section 216. Section (General) at Burger Mine.—Sec. 19, Fig. 3.

		Ft.	In.
Division IV—			
1. Sandstone		..	..
2. Shale	10 ft. to	12	0
3. COAL IV	3 ft. to 4 ft.	3	6
Division III—			
4. Shale, etc.		18	0
5. COAL III	1 ft. 8 in. to	3	0
		36	6

712. Section 217. Section at Arney Mine.—N. E. Sec. 9, Fig. 4 (J. C., p. 344).

	Ft.	In.
1. Slope	74	0
Division IV—		
2. Gray clay shale	7	0
3. "Pyritous band"	2	0
4. COAL IV	3	0
Division III—		
5. Indurated clay	1	0
6. Gray shale with kidney iron ore	11	0
7. COAL III—Laminated, rough, 6 in.; laminated, good, 6 in.; splinty cannel, 4 in.; choice caking, 1 ft. 6 in.; rough coal, 2 in.	3	2
	101	2

713. Section 218. Section of Needy Well.—S. E. of S. E. of Sec. 17, top of Fig. 5 (J. C., p. 346).

	Ft.	In.
1. Clay and soil	12	0
Division IV—		
2. COAL IV	2	0
3. Stony fire-clay	3	0
Division III—		
4. Sandy shale	14	0
5. COAL III	4	9
6. Plastic fire-clay	4	0

The lower coal, when mined, showed a thickness averaging 5 ft. or over, and Coal IV, where dug into just north, showed a thickness of 3 ft., so the thickness of the coals is increased a little over this section, as Fig. 5 is intended as a generalized section for this neighborhood. Below Coal III Mr. Collett notes (J. C., p. 346):

	Ft.	In.
Division I—		
Sandstone	70	0
COAL I	1	8
Lower Carboniferous—		
Sandstone	43	0
Kaskaskia limestone	17	0

714. SECTION 219. SECTION OF HAXTON BORE.—S. E. Sec. 29 (J. C., p. 345).

	Ft.	In.
1. Clay soil	9	0
Division I—		
2. COAL I, 18 in. to 2 ft. where mined	..	4
Lower Carboniferous—		
3. Sandstone	32	0
4. Kaskaskia limestone	18	0
5. Sandstone	3	0
	62	4

715. SECTION 220. SECTION AT LONSFORD'S MINE.—Sec. 24 (C. E. S.), Fig. 6.

	Ft.	In.
Division I—		
1. Sandstone and black shale	20	0
2. COAL I	2	10
Lower Carboniferous—		
3. Concealed clay, shale and sandstone	20	0
4. Heavy flaggy limestone	15	0
5. Shale and limestone	25	0
	82	10

716. DIVISIONS III AND IV.—Each of these divisions contains one coal in this area, the coals ranging from 2 to 5 ft. 3 in. in thickness (see Fig. 5), and from caking to a non-caking coal. In quality they have a good reputation, especially the lower coal. A detailed section of the lower coal at Arney's was given in ¶712, Sect. 217. Analyses of this coal by Mr. Cox gave:

	Top.	Middle.	Bottom.
Fixed carbon	49.50	49.50	51.00
Volatile combustible matter	45.00	45.00	40.50
Total combustible matter	94.50	94.50	92.00
Water	3.00	3.50	3.00
Ash	2.50	2.00	5.00
Total waste	5.50	5.50	8.00

Mr. Cox describes this coal as "a dull black, caking coal, breaking into irregular blocks, except a few inches of the middle of the seam, which has a conchoidal fracture, slightly irridescent and indistinctly laminate. In the upper and lower parts of the seam the laminae are well marked and calcite appears in the vertical seams." Mr. Collett says of Coal III, in this section: "It is of excellent quality, compares favorably with the best coking coal in the country and burns with a brilliant sheet of white flame to a white ash without clinker. Coke from this bank was formerly used at Seward's foundry, at Bloomington, and was found equal, if not superior, to that of Pittsburg; softening instead of hardening the metal. It is superior for blacksmith's use, and sought for burning in grates on account of the brilliant illumination of the flame. Where known, it is reported as selling for 4 cents a bushel more than block or other western coals for household purposes."

The space between the two coals varies from 7 ft. up, and is occupied by shale or shaly sandstone.

717. DIVISION I.—This division in this area contains one coal barely workable, though it has been worked in a small way at a number of places. It ranges up to 3 ft. in thickness, though it will average nearer 1 ft. 6 in. The following analyses will show the composition at a number of points:

	Barton. Sec. 26.	Fiscus. Sec. 26.	Hester. Sec. 26.
Thickness	1 ft. 5 in.	1 ft. 2 in.	1 ft. 2 in.
Fixed carbon	44.00	45.00	47.00
Volatile combustible matter	49.00	33.00	36.00
Total combustible matter	93.00	78.00	83.00
Water	2.50	2.50	4.50
Ash	4.50	19.50	12.50
Total waste	7.00	22.00	17.00

Of the Barton coal Mr. Cox says, "a glossy, black, caking coal, with pyrite in the parting; breaks into irregular cubes." Of the Fiscus coal: "This is a compact, slaty, dull black cannel coal, with pyrites and plant impressions in the partings." Of the Hester coal: "A compact, slaty, dull black cannel coal, with pyrites in the partings." From these it may easily be judged that Coal I offers little hope of showing desirable or workable coal.

On the whole the sandstone of this division seems more persistent than in the township next north.

In the relation of Division I to the Lower Carboniferous there is another apparent nonconformity in this township. At the Lonsford drift, in the N. E. corner of Sec. 24, Coal I is about 55 to 60 ft. above Fish creek. Less than three-fourths of a mile away the same coal has been worked at the Mayer mine in the bottom of a branch emptying into Fish creek and a score or two of feet below the coal at Lonsford. While this may be due to a rapid dip in that direction, the observed structure suggests a nonconformity.

718. DISTRIBUTION OF COALS.—As shown on the map, Coal I is cut out in all the valleys in the eastern part, the Mansfield sandstone in that region capping the ridges and being underlain by Coal I. In the western part Coal I is cut out across the bottom of Beech and Brush creeks, and part of Lick creek. The banks of these streams show principally the sandstone of Division I, with Coal I at about the level of the creek bottoms, while on the divides between Hoosier and Beech creek, also between Beech and Brush creeks, are narrow areas of Coals III and IV.

For convenience of discussion, we may take up, first, the eastern tiers of sections, where only Coal I was found—worked up by Mr. Siebenthal; second, the divide between Hoosier and Beech creeks, containing principally Coals III and IV—worked northeastern part by Mr. Siebenthal, southwestern part by writer; third, divide between Beech and Brush creeks—worked same as last; and, fourth, the area west of Lick creek.

719. DISTRIBUTION IN EASTERN SECTIONS.—A small area of Coal III extends into Secs. 1 and 2, but no coal was seen at that horizon in these sections. Coal I crops out on the Elisha Childress farm, in the S. E. ¼ of Sec. 1; on the Thos. Griffith place, in the S. W. of N. E. of Sec. 2; and on the Norris place, in the S. W. of S. W. of Sec. 11. In Sec. 13, 2 ft. of coal is reported in the well on Alvin Myers's place, in the N. E. of N. W. of section. Coal has been dug some on the John Nations place, formerly the Israel Spears place, in the N. W. of N. W. of Sec. 13. It is reported from 2 to 3 ft. thick. In the N. W. of S. W. of this section coal outcrops at two places on the King Dyer place. Southeast of the last is the Chas. Myers bank, where coal has been mined both by stripping and drifting. The coal here is reported 2 ft. thick and semi-block. It is said to "pop" badly in the fire and to contain much sulphur.

In Sec. 14, in the N. E. of N. W., is the Reuben Barton coal described above, 18 in. thick. At Arny P. O., a well at Mr. Wm. Swearingen's reached the coal at 40 ft. In the N. E. of the S. E. of this section is the Mahlan Harris bank, where coal has been worked for 40 years. It is on Mrs. Mary Harris's farm. The coal was formerly hauled to Worthington, a fact that speaks for the good quality of the coal. The coal was 2 ft. thick and was stripped. Not worked recently.

In Sec. 23 coal was stripped in the '60's on the John Mitten place, in the N. W. of N. E. The coal is said to have been from 1 ft. 6 in. to 2 ft. thick.

In Sec. 24 a little coal has been dug on the Josiah Trent farm, in the N. W. of S. W. of section. Also on the David Lonsford place, on the township line. The coal here is 2 ft. 10 in. thick (see Figs. 6 and 9).

In Sec. 25, the N. W. of S. E., coal has been worked by a drift on the J. Whiteman place, formerly the Jas. Smith farm. The coal is said to be good and to dip north.

In Sec. 26 coal has been mined in both the N. E. and N. W. ¼s, on the Aaron Fiscus, Wash. Phipps and Mrs. Louisa Heaton farms. As described above, the coal here is a little over a foot thick and a rather poor cannel coal.

In Sec. 35 coal outcrops in the N. E. of N. W., on Frank Dyer's place. It has been stripped on the Frank Fulk place, in the S. W. of N. E. of this section, being 14-15 in. thick. In the N. E. of S. E. of this section it outcrops 20 in. thick, and in a well on the Harrison Griffith place, in the S. W. of S. E., is reported as 3 ft. thick.

In the N. E. ¼ of Sec. 36 coal 18 in. thick outcrops on the A. B. Irwin place. A drilling 50 ft. back is said to have shown 3 ft. 4 in. of coal. The coal here underlies a ledge of sandstone. Two other outcrops of coal under ledges of sandstone were noted in the hollow just east and on the same 80 acres.

720. DISTRIBUTION AND DETAILS BETWEEN HOOSIER AND BEECH CREEKS.—In the N. W. of N. E. of Sec. 3 Mr. Eli Bivens has dug down through black shale into 2 ft. 3 in. of block coal, with fire-clay below. Coal III.

The same coal, 18-20 in. thick, has been stripped in the N. W. of N. W. of Sec. 10.

In Sec. 11 Coals III and IV are both well developed. A section here, at the L. C. Arney mine, was given in ¶712, Sect. 217, Fig. 4, and the coal described. Coal IV at the Arney mine is from 3 ft. to 3 ft. 6 in. thick and a good block coal; Coal III here ranges from 2 ft. to 4 ft. 10 in. and is a caking coal, as described above. Both beds have an excellent sandy shale roof. On the Jacob Hubbell place, in the N. W. corner of the section, the upper bed is 16 to 18 in. thick, and has been worked a little. The lower bed is said to be here, but has not been worked. Coal III has been worked on Armour Needy's place by shaft and drifts for some forty years. The coal runs from 3 ft. to 3 ft. 9 in. in thickness, without partings, and has a shale roof. A great many rolls are met with here, some of which pinch the coal out.

In the S. W. of S. E. of Sec. 17 Coal III reaches a thickness of over 5 ft. in the Joe Needy place. This is in the base of a knob 40 ft. high. A well in the top of this knob shows Coal IV, 2 ft. thick, to lie 17 ft. deep. The section of this well was given in ¶713, Sect. 218. Coal III is said to range from 5 ft. to 5 ft. 3 in. in thickness, with a shaly sandstone or sandy shale roof over, and below is, first, a few inches of shale, then fire-clay (Fig. 13). The roof is good. The coal is slightly irridescent and is said to be hard to dig, being shot. It is reported to be a non-caking (?) coal, making no soot or clinker, and being rich and oily. The upper bed is said to be a block coal, very pure, but not lasting as the lower bed. To the north, on the opposite side of a hollow, both beds have been worked, being there only 7 ft. apart, and Coal IV there being 3 ft. or more thick.

These coals have also been worked a little on the Wells place, in Sec. 8, and Winklepleck, Mitchell, Johnson and Miller farms, in Sec. 17, the coal at the last named places being reported 2 ft. 3 in. thick.

721. Distribution South of Beech Creek.—The area underlain by Coal III is shown on the map. An 80-ft. well sunk in the top of Dillon hill, in the N. W. of N. E. of Sec. 21, is said to have struck no coal. An outcrop of Coal III was reported on the Geo. Colombo farm, in the S. E. of N. E. of this section. In the N. W. of S. W. of Sec. 21, 2 ft. of block coal was struck in a well on the Joe Needy place at a depth of 12 to 15 ft. It had hard shale over. At a depth of 32 ft., 2 in. of coal was struck, the strata between being all shale. In the S. W. corner of this section 6 in. of coal was found on the Miller place, under sandstone.

In Sec. 20 a similar thickness of coal is reported on the Hubbell place.

An outcrop of Coal I occurs in the S. W. of N. E. of Sec. 22, also in a similar position in Sec. 27, on the Wesley Falk farm. An outcrop of Coal III occurs on the H. S. Moser place, in the S. W. of N. W. of Sec. 27.

In the S. E. ¼ of Sec. 34 a well is said to have struck Coal III, 3 ft. thick, on the Geo. Dyer place. A half mile west an entry on Miles Workman's shows 30 in.

A mile farther west Coal IV is found, 2 ft. thick, on the Wm. McClarren place.

In Sec. 32 Coal I is reported to outcrop in the edge of Lick creek bottoms, on the Dan. Miller place, formerly the Rube Hummel farm. In the N. E. of S. W. of Sec. 28 a drilling on the Ben White farm is said to have gone through 80 ft. of sandstone. Coal I outcrops and has been stripped some on the Haxton place, in the S. E. of Sec. 29. A drilling made in the edge of the bottom here was given in ¶714, Sect. 219.

722. Distribution West of Lick Creek.—As shown on the map, Coals III and IV project into this region in small tongues from the west.

In the S. W. of S. W. of Sec. 18 coal has been stripped and drifted upon on John Stant's land. The coal is reported 4 ft. thick, without partings. It has blue shale over and is about 25 ft. above Lick creek, from which it was judged to be Coal IV.

In the N. W. ¼ of Sec. 19 both coals have been worked on the Berger place, the coals being 18 ft. apart. See Fig. 3. Coal IV is said to be 3 ft. to 4 ft. thick, with 2 to 4 in. of black soft coal in the center. The coal is not as good as Coal III. It has a shale roof. Coal III is said to range from 20 in. to 3 ft. It has a shale roof. Both beds block out, though the lower bed does not mine easily. Coal III is here but very little above the level of Lick creek.

Coal I is reported at a depth of 16 ft. in a well on the Colombo place, in the S. E. of S. W. of Sec. 30; and in a drilling in the S. E. of N. W. of Sec. 31, 6 in. thick. A well on the Wm. Shouls place, in the S. E. of N. E. of Sec. 31, starting about 60 ft. above Eel river, is reported to have passed through sandstone from a depth of 5 ft. to 49 ft.

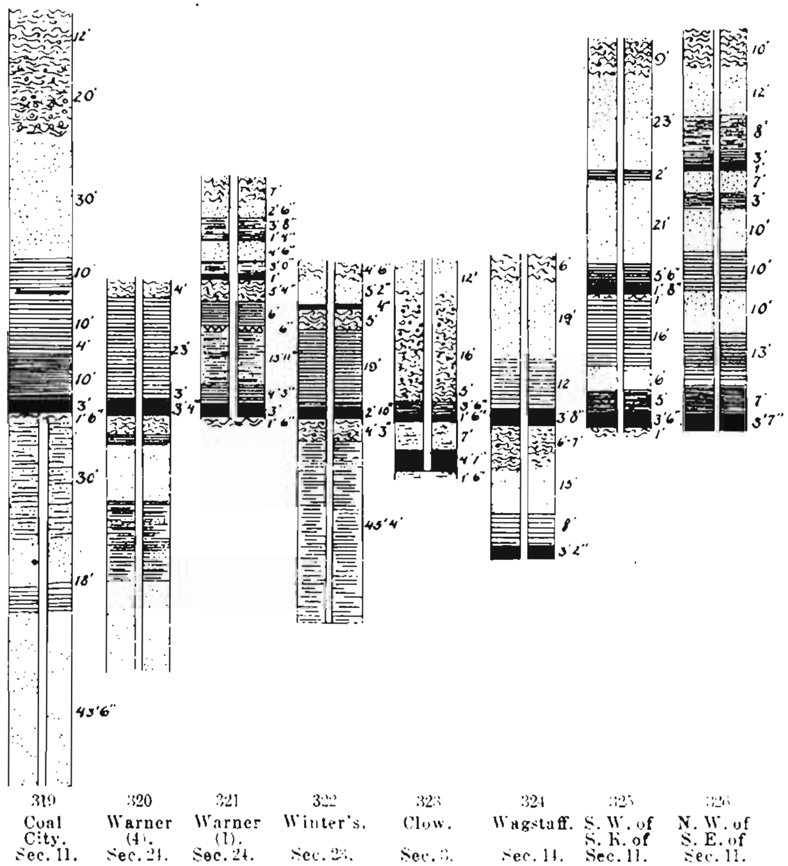
Coal is reported to outcrop in the bottom of Eel river at the old mill at Johnstown, S. W. ¼ of Sec. 31.

TOWNSHIP 9 NORTH, RANGE 6 WEST. (PART IN OWEN COUNTY.)

723. GEOGRAPHY.—The part of the township in Owen county includes only the two eastern tiers of sections. It forms the western end of Jefferson of the civic townships.

Coal City is on the crest of high ground from which the drainage flows in all directions.

The E. & I. R. R. crosses the area diagonally from northwest to southeast, being within easy reach of all the coal in the area.



Figs. 319-326. Columnar sections in T. 9 N., R. 6 W.

724. STRATIGRAPHY AND COALS.—The divisions outcropping in this area run from I to V. Coals III and IV are often workable, though with hardly a large enough margin to hold capital as yet. The

stratigraphy here is not quite as clear as might be wished, not so much from lack of information as from the variableness of the coals, the coals being very pockety, and while of a workable thickness in one boring, may be lacking in adjacent drillings. The following sections have been obtained in this area.

725. SECTION 221. SECTION IN COAL CITY SHAFT.—S. E. ¼, S. W. ¼, Sec. 11. Fig. 319 (J. C., p. 444).

	Ft.	In.	Ft.	In.
1. Surface clay	12	0	12	0
2. Boulder clay	20	0	32	0
Division IV—				
3. Soft yellow sandstone	30	0	62	0
4. Gray shale and thin COAL	10	0	72	0
Division III—				
5. Gray pyritous shale	10	0	82	0
6. Gray pyritous shale, with plant remains	4	0	86	0
7. Blue and dark shale	10	0	96	0
8. COAL III ....2 ft. 11 in. to Bore in the same.	3	0	99	0
Division I—				
9. Fire-clay	1	6	101	6
10. Gray sandy shale	30	9	132	3
11. White sandstone and shale	18	0	150	3
12. Massive sandstone	43	6	193	9

726. SECTION 222. SECTION OF BORING ON WARNER FARM.—S. E. ¼ Sec. 24, Fig. 321 (J. C., p. 346).

	Ft.	In.
1. Surface clay	7	0
Division IV—		
2. Gray sandstone	2	6
3. Blue sandy shale	3	8
4. Black shale	1	4
5. Blue sandstone	4	6
6. Sandy shale	3	0
7. COAL IV	1	0
Division III—		
8. Clay	5	4
9. Blue shale	6	0
10. Iron ore	..	6
11. Sandy shale	13	11
12. Blue shale	4	3
13. COAL and shale (III)	3	0
14. Fire-clay	1	6
	57	6

727. Section 223. Second Bore, Same Farm.—(J. C., p. 347.)

	Ft.	In.
1. Surface clay	4	0
2. Shaly fire-clay	4	8
3. Gray sandy shale	26	4
4. White sandstone	4	6
5. Gray sandy shale	21	2

728. Section 224. Third Bore, Same Farm.—(J. C., p. 347.)

	Ft.	In.
1. Surface clay	5	6
2. Yellow sandstone	14	0
3. Blue sandstone	1	0
4. Gray shale	2	4
5. Gray sandstone	40	2
6. White sandstone	1	0

729. Section 225. Fourth Bore, Same Farm.—Fig. 320 (J. C., p. 347).

	Ft.	In.
1. Surface clay	4	0
2. Gray sandy shale	23	6
3. Blue shale	3	0
4. COAL III?	3	4
5. Fire-clay	3	2
6. Iron ore	..	7
7. White shale—ironstone	1	0
8. White sandstone, with iron balls	8	11
9. Gray sandstone	14	6
10. Blue sandy shale	20	3

730. Section 226. Section of Boring on Winter's Farm.—N. E. ¼ Sec. 23, Fig. 322 (J. C., p. 348).

	Ft.	In.
1. Surface clay	4	6
2. Sandstone	5	2
3. COAL IV?	..	4
4. Fire-clay	5	0
5. Blue sandy shale	19	5
6. COAL III?	2	10
7. Fire-clay	4	3
8. Sandy shale	45	4

731. Section 227. Second Bore, Same Farm.—(J. C., p. 348.)

	Ft.	In.
1. Surface clay	17	6
2. Boulder clay	10	6
3. Sandstone	1	0
4. "Rotten COAL" (IV?)	..	8
5. Fire-clay	7	6
6. Blue sandy shale	8	8
7. Blue shale	3	0
Place of Coal III?		
8. Fire-clay	2	0

732. Section 228. Third Bore, Same Farm.—(J. C., p. 348.)

	Ft.	In.
1. Surface clay	3	6
2. Blue shale	21	1
3. COAL III?	3	6
4. Fire-clay	..	6

733. Section 229. Section of Boring on Love's Farm.—S. E. ¼ Sec. 23-9-6 (J. C., p. 348).

	Ft.	In.
1. Surface clay	30	6
2. Boulder clay	12	0
3. White sandstone	4	8
4. Fire-clay	2	0

Just west of this area some boring was done on the Clow farm, and the record of one of the bores is added here for comparison. It is from the center of the S. E. of the N. E. of Sec. 3.

734. Section 230. Section on Clow Farm.—Sec. 3, Fig. 323 (J. C., p. 445).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface, soil, etc.	12	0	..	..	12	0
2. Boulder clay	16	0	..	..	28	0
3. Red clay	5	0	..	..	33	0
Division IV—						
4. Dark slaty shale	3	6	..	..	36	6
5. COAL IV	1	6	1	6	38	0
Division III—						
6. Shaly sandstone	7	0	7	0	45	0
7. COAL III	4	2	4	2	49	0
8. Shaly sandstone	1	6	..	..	50	8

Coals III and IV are nearer together in this boring than in any other section in the area. The case may be similar to that on the Needy farm, in Sec. 17 of the last described township, where the coals were 7 ft. apart, separated by shaly sandstone.

The following section is from a boring on the farm of Mr. Wagstaff, Jr., in the N. W. ¼ of Sec. 14, starting about on a level with the creek bottom. It was given from memory and may not be accurate in detail, though the coals and the spaces between them are probably correct.

735. SECTION 231. SECTION ON WAGSTAFF'S PLACE.—Sec. 14, Fig. 324.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	6	0	..	..	6	0
Division IV—						
2. Sandstone	19	0	..	..	25	0
3. Shale	12	0	..	..	37	0
4. COAL IV	3	8	3	8	40	8
Division III—						
5. Fire-clay	7	0	..	..	47	8
6. Sandstone	15	0	..	..	62	8
7. Shale, black	8	0	30	0	70	8
8. COAL III	3	2	3	2	73	10

736. The following three sections were kindly furnished by Mr. Jas. Hyatt, S. W. of S. E. Sec. 11, Fig. 325.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Clay	9	0	..	..	9	0
Division IV—						
2. Sandstone	23	0	..	..	32	0
3. Shale	2	0	..	..	34	0
4. Sandstone	21	0	..	..	55	0
5. Shale	5	6	..	..	60	6
6. COAL IV	1	8	1	8	62	2
Division III—						
7. Fire-clay	1	0	..	..	63	2
8. Shale	16	0	..	..	79	2
9. Sandstone	6	0	..	..	85	2
10. Black shale	5	0	28	0	90	2
11. COAL III	3	6	3	6	93	8
12. Fire-clay	1	0	..	..	94	8

737. SECTION 233. SECTION OF BORING BY J. F. HYATT.—N. W. of S. E. of Sec. 11, Fig. 326.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Yellow clay	10	0	..	..	10	0
Division IV?—						
2. Sandstone	12	0	..	..	22	0
3. Sandy shale	8	0	..	..	30	0

	Ft.	In.	Ft.	In.	Ft.	In.
4. Shale	3	0	..	..	33	0
5. COAL IVa (?)	1	0	1	0	34	0
6. Sandstone	7	0	..	..	41	0
7. Shale	3	0	..	..	44	0
8. Sandstone	10	0	..	..	54	0
9. Shale	10	0	..	..	64	0
Division III—						
10. Sandstone	10	0	..	..	74	0
11. Shale	13	0	..	..	87	0
12. Black shale	7	0	60	0	94	0
13. COAL III	3	7	3	7	97	7

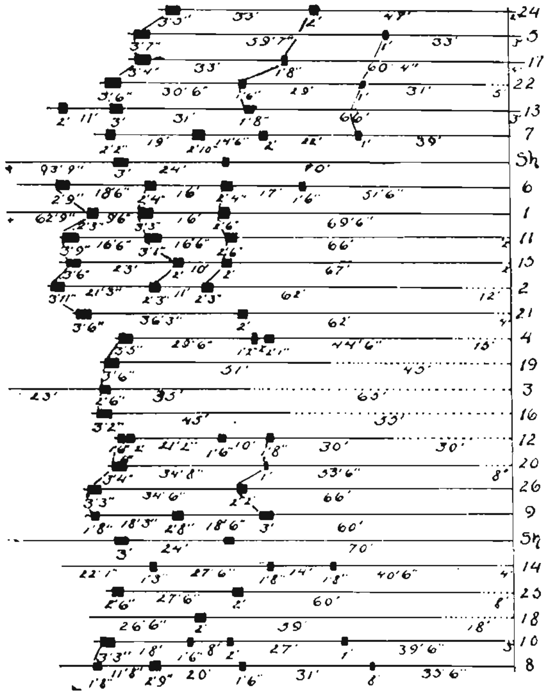


Fig. 327. Tabulation of twenty-six drillings in the south half of Sec. 11 and north half of Sec. 14.

738. SECTION 234. SECTION OF BORING BY J. F. HYATT.—N. E. of S. W. of Sec. 11.

	Ft.	In.
1. Surface and yellow clay	7	0
2. Blue clay shale	28	0
3. COAL	4	0
4. Fire-clay	3	0

739. In Fig. 327 is given in graphic form the results of some 26 bores made in the S. ½ of Sec. 11 and N. ½ of Sec. 14. The depths and thicknesses of coals were given by Mr. Collett, pp. 350, 351, in a table from which the above figure was prepared. As, assuming the correctness of the data, the figure illustrates well the irregularity of the coal in thickness, in vertical distance apart and in position in the ground, the following plate (Plate XXVIII) is given, showing the position of each hole. The horizontal line at the top of Fig. 327 represents datum level. Where a drilling started below the datum level, the fact is indicated by the dotted line, and the distance in feet is given on the figure and need not be given in the text. The courses and distance of each hole from the shaft are added, as they will hardly go on the map.

		Ft.
1.	S. 11° E.	321
2.	S. 5½° E.	1.531
3.	N. 87½° E.	2.020
4.	S. 45° E.	2.400
5.	N. 2° E.	1.996
6.	S. 65° W.	152
7.	N. 20° W.	153
8.	N. 59° E.	164
9.	N. 59° E.	314
10.	S. 59° E.	310
11.	S. 15° E.	618
12.	N. 80° E.	930
13.	N.	382
14.	N. 53° W.	432
15.	S. 10° E.	1.000
16.	S. 79° E.	1.607
17.	N.	1.250
18.	W.	1.650
19.	S. 62° E.	1,676
20.	S. 54° E.	1.200
21.	S. 35° E.	1.650
23.	N. 35° W.	1.150
24.	N. 25° W.	2.400
25.	N. 80° W.	1.250
26.	S. 60° E.	650

The drillings shown in Fig. 327 differ from the complete sections previously given in finding as high as four coals. Of these the uppermost is wanting in most of the bores and thin in the others; the second coal is wanting in a few of the holes, and in the others ranges from 1-3 ft., with an average of 2 ft. or a little over; the third coal is absent in many of the holes, but where present averages between 2 ft. 6 in. and 3 ft.; the fourth coal is the most persistent and thickest coal,

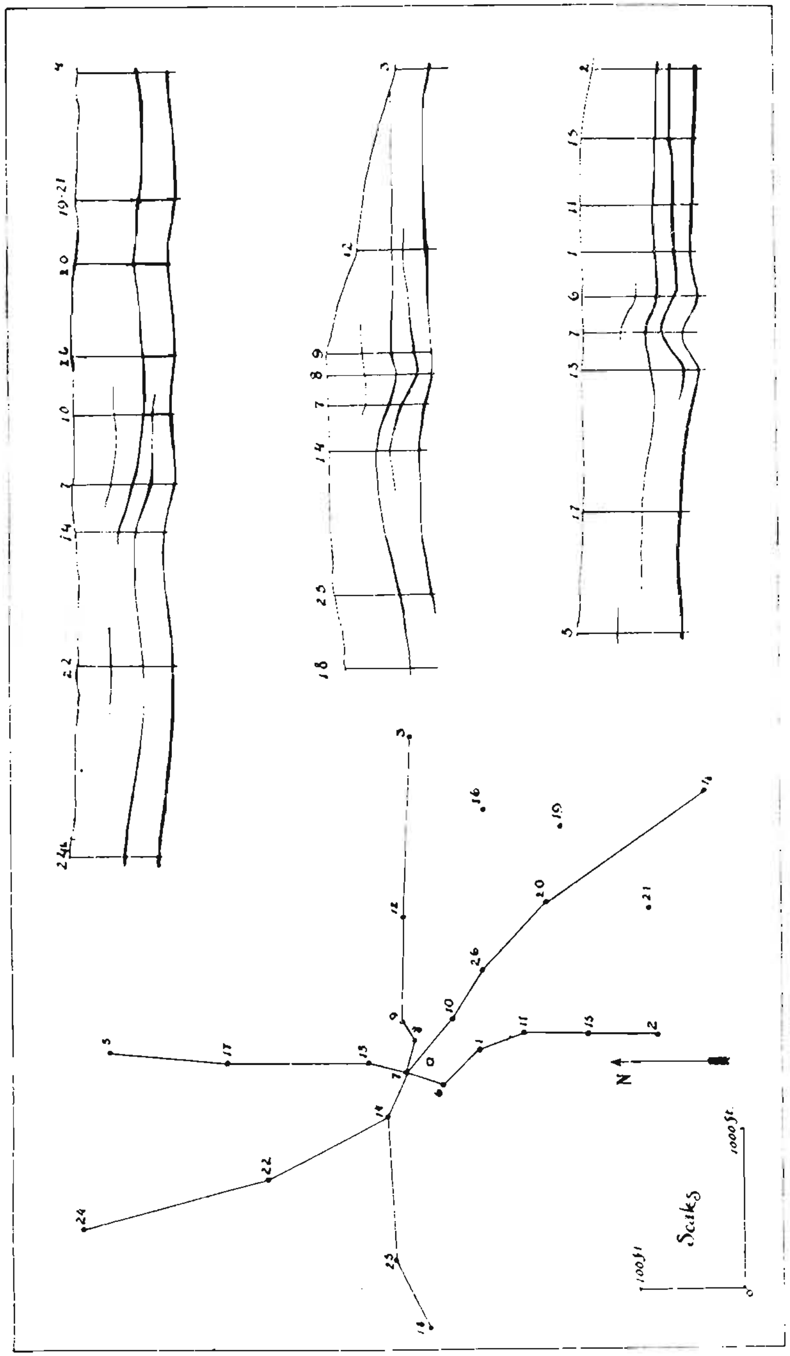
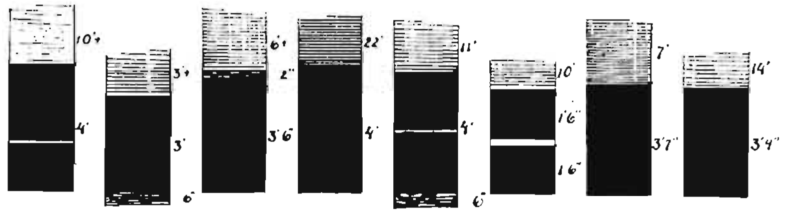


PLATE XXVIII. An interpretation of a group of borings in the south half of Sec. 11 and north half of Sec. 14, to show variable nature of lower coal beds.

averaging over 3 ft. and ranging up to nearly 4 ft. In many cases it is difficult or impossible, lacking a record of the intermediate strata, to tell which coals of one drilling correspond with those of the next drilling, as shown in Plate XXVIII. The two lower coals correspond with the coals designated III and IV in adjacent territory, and probably one of the upper coals corresponds with Coal V, but which one can not be determined with the data at hand. The fossiliferous limestone and black shale overlying Coal V were found north of Coal City, indicating its presence in this area. It thus is impossible to decide whether the extra coal is Coal Va or IVa.

740. Coals III and IV.—These coals in this area were not readily distinguished. It was thought that the lower bed would be found to have a smooth parting near the top, with the coal above of a semi-caking and laminated nature. As stated above, Coal III appears to be



328	329	330	331	332	333	334	335
Harstein. Sec. 2.	Hochstetler. Sec. 1.	Reagan. Sec. 13.	Bush. Sec. 24.	Hubbell. Sec. 25.	Grim. Sec. 11.	Hyatt. Sec. 11.	Berger. Sec. 13.

Figs. 328-335. Sections of Coals III and IV in T. 9 N., R. 6 W. (Owen County).

the more persistent and the thicker coal of the two. It is judged to be the coal principally worked in this area, though Coal IV has been dug into in a number of places. The coals are of a semi-block nature, the upper bed running under 3 ft. on an average, and probably not workable on a large scale, Coal III averaging over 3 ft. and workable. Both coals occur in small basins, and this is doubtless one of the largest limiting factors. The following analyses will give some idea of the composition of these coals; they are by Mr. Cox:

Jessie Reagan's coal, N. E. ¼ Sec. 13, 3 ft. 6 in. thick. He describes it as a "dull black, dry, shaly, laminate block coal, running into caking coal at bottom of seam; charcoal partings between the laminae; vertical seams stained with iron."

	Top.	Middle.	Bottom.
Fixed carbon	52.50	52.00	52.50
Volatile combustible matter	37.00	40.50	39.50
Total combustible matter	89.50	92.50	92.00
Water	3.00	2.50	2.00
Ash	7.50	5.00	5.50
Total waste	10.50	7.50	8.00

Mrs. R. White's coal, "one mile south of Coal City," 2 ft. 6 in. thick, "a bright black, laminate, semi-block coal, with iron stains and pyrites in the partings."

Fixed carbon	55.50	
Volatile combustible matter	39.00	
Total combustible matter		94.50
Water	3.00	
Ash	2.50	
Total waste		5.50

741. Distribution and Local Details.—The horizon of Coal I probably underlies all of this area. Little or no coal has yet been found at that horizon by the drillings that have gone down to it. Coal III may, therefore, not only be considered the lowest workable coal, but, from the practical standpoint, the lowest coal of the area. Coal III will be found about at drainage level around the edge of the area, but about 100 to 120 ft. deep along the divide upon which Coal City is situated.

In Sec. 1 Coal III has been stripped on the Enoch Hochstetler and the Wagstaff places, in the S. W. ¼ of the section. The coal is reported 3 ft. thick, with a 1 to 2 in. clay parting in the middle (Fig. 329). The top does not come out in as large blocks as the bottom, and is said to make a sharper fire, but to burn out more quickly than the bottom. Above the coal is exposed a solid blue shale. Coal IV has been dug into up the ravines from the above strippings. About 18 in. has been exposed, but as the regular roof was not reached, its thickness is not known. In the S. E. ¼ of this section coal has been dug on the Hilligas place and struck in the wells at Mr. Harris's. At the house the well went 2 ft. into the coal at a depth of 18 ft.; at the barn the well went 3 ft. into the coal without going through. The top foot or so is said to have been block coal, while the rest was "fine" coal. Over the coal was several feet of shale.

In the N. E. of N. E. of Sec. 2 coal has been worked by slope and stripping on the Haviland place. As far as exposed this coal appeared solid and a semi-block, slightly irridescent (peacock colored), with rich bands through it. Above the coal is exposed 8 ft. of gray fissile shale. The same coal was formerly worked just southwest of this by a gin shaft on the Bolton farm. In the N. W. ¼ of this section both Coal III and Coal IV have been worked on the Wm. Kreble place. The upper bed is reported as 3 ft. 6 in. to 3 ft. 10 in. thick, with a blue shale roof. Below is fire-clay and shale for 12 ft., to Coal III, 3 ft. thick. The lower coal is said to block out well, and to be of excellent quality. The upper bed has been worked at McTavish's, in this same quarter section. In the S. W. ¼ Coal III has long been worked on the A. Harstein place. The coal runs from 2 ft. 6 in. thick to 4 ft. 10 in., with an average of 4 ft. 1 in. The upper half of the coal appeared to be more of a caking coal than the lower half, being a brighter, richer coal, mining in smaller blocks. Above the coal is a light brown, shaly sandstone to a light brown to blue fissile shale. Coal IV was noted 10 to 15 ft. above, and reported to be 18 in. thick. At one point there appeared to be the smut marks of two beds at this level 6 ft. apart. Mr. Collett reported a 3-ft. bed of limestone near the top of the bank. This was not found, but is taken as showing the horizon of Coal V. At one of the more southern openings the coal is reported as having been 3 ft. thick, with a 0 to 2 in. band of shale 1 ft. from the bottom. At the present workings (1896) the coal is about 12 ft. deep, the dip being strongly to the north at that point. Fig. 328.

Just west of Coal City is the old Henry Grim shaft. The junior Mr. Grim reported the coal to have been about 3 ft. thick, not including a clay parting of several inches in the middle, and about 100 ft. deep. The position of the coal about Coal City is well indicated in the sections given above. Fig. 333.

In the N. W. ¼ of Sec. 12 Coal III has been drifted upon on the Smith place and stripped on the Nihart place; at the former 10 ft. of shale is exposed over the coal. At an outcrop of Coal IV in the road south of Stockton the strata exposed below are principally sandstones underlain by 10 ft. of shale.

In the N. E. ¼ of Sec. 13 Coal III (?) has long been worked on the Jesse Reagan place, both by stripping and drift. The coal measured 3 ft. 8 in., with no visible parting. On top is 0-2 in. of bone, and still above is exposed 5 to 6 ft. of clay shale (Fig. 330). Mr. Collett gives the following section of the coal at this point (Sect. 235, J. C., p. 349):

	Ft.	In.
Clay and gray shale	5	0
Soft black shale	..	4
COAL III—Semi-block, 9 in.; lustrous cubic coal, 3 in.; block coal, 1 ft. 6 in.; semi-block coal, 1 ft.	3	6
Stony clay	2	0
	10	10

As a whole, the coal is said to be a semi-caking coal, yielding a high ash, otherwise good. The bottom is considered the best. Just northeast of this, coal is reported to have been struck in a well on the Belmer place. Coal is reported to have been stripped on the Noah Stants farm, in the N. W. ¼ of Sec. 13, and on the Bush farm, in the S. E. ¼ of the same section. In the S. W. ¼ a drilling by Mr. Barrick on the Berger place gave (Sect. 236, Fig. 335):

	Ft.	In.
Surface	4	0
Shale	14	0
COAL	3	4

In the N. E. corner of Sec. 14 coal has been stripped on the Davis place. This is in a ravine 50 to 75 ft. below Coal City. Above the coal is blue shale. About 20 ft. above is massive sandstone, which is quarried a little for local use. In the N. W. ¼ of Sec. 14 coal is reached by a shaft on the Jas. Love place. The coal is about 10 ft. deep, said to be 3 ft. or less thick and reported not a good selling coal. It would appear to be the upper coal. The drilling on the Wagstaff place in this quarter section was given in ¶735, Sect. 231. The drillings figured in Fig. 327 are partly in this section, and show the position and thickness of the coal here. A drilling on the Reubottom place, in the S. W. ¼ of this section, is reported to have found 3 ft. 4 in. of coal at 80 ft. Coal has been stripped in the S. E. ¼, on the White place.

In Sec. 23 coal has been worked some on the Hostein and Van Horn places. The coal is reported to run from 3 ft. to 3 ft. 9 in. in this section. At the Hostein bank the coal is just at drainage level and has been worked by drifting.

In the S. W. of N. E. of Sec. 24 Coal III is being worked at the Bush shaft. The coal here is reached at a depth of 28 ft. and runs from 3 ft. to 4 ft. 7 in., with an average of 4 ft. The coal is without partings, of a dull black, with few bright bands and only traces of sulphur. Above is black shale 22 ft. thick, of which only a half inch tends regularly to come down. About 30 ft. above is a 2-ft. bed of coal, overlain by sandstone. Below the worked coal are several feet of fire-clay, with gray shale under to a depth of at least 18 ft. (Fig. 331). Coal has been stripped on the Niblack and Clark farms, in the S. E. ¼ of Sec. 24, and on the Smith farm, in the N. W. ¼, was struck in a well, 3 ft. 9 in. thick.

The coal rises rapidly to the south, so that in the N. E. ¼ of Sec. 25 it is well up on the hill on the Hubbell place. In some test drifts here Coal III is reported to have run from 4 ft. to 4 ft. 8 in., with ½ in. to 1 in. of shale in the middle. This ran out to the north. The lowest 6 in. of the coal was bony. The coal tended to slack readily. Over the coal is 11 ft. of shale (Fig. 332). At a drilling made on the hill above this coal the 2-ft. bed, with sandstone over, was struck. The drilling was carried 28 ft. below the lower coal without striking another bed, as it found only shale, with an occasional thin layer of sandstone. A drilling by the barn, starting at a lower level, went 76 ft. without striking coal.

The borings given above from the Warner and Winter farms, in Secs. 23 and 24, indicate that the coals get very pockety and unreliable to the south, though often showing as great a thickness as elsewhere in the area. It seems probable that both coals are cut out along the bottoms of Eel river.

742. Summary of Coal of Owen County.—

Divisions contained: I, III, IV, V.
Coals contained: I, III, IV, V.

Round Number Estimates.

Coal V.

Unworkable area	1 sq. mi. ×	av. thickness, ½ ft. ×	1,000,000 =	500,000 tons.

Coal IV.

Worked area	¼ sq. mi. ×	av. thickness, 4 ft. ×	500,000 =	500,000 tons.
Workable area	5 sq. mi. ×	" 3 ft. ×	500,000 =	7,500,000 tons.
Unworkable area	20 sq. mi.	" 1 ft. ×	1,000,000 =	20,000,000 tons.
Total area	30 sq. mi			28,000,000 tons.

Coal III.

Worked area	20 acres ×	av. thickness, 5 ft. ×	1,000 =	100,000 tons.
Workable area	5 sq. mi. ×	" 3 ft. ×	500,000 =	7,500,000 tons.
Unworkable area	25 sq. mi. ×	" 1 ft. ×	1,000,000 =	25,000,000 tons.
Total area	30 sq. mi			33,600,000 tons.

Coal I.

Unworkable area	100 sq. mi. ×	av. thickness, ½ ft. ×	1,000,000 =	5,000,009 tons.

Number of coals contained: 4 or 5.
Greatest thickness recorded: 6 ft. 1 in. Coal III, Sec. 6-10-5.
Area underlain by coal: 100-125 sq. mi.
Area underlain by workable coal: 30 sq. mi.
Contained in Ts. 9 and 10 N., Rs. 5 and 6 W.
Estimated total tonnage of coal: 67,000,000.
Estimated total tonnage of coal removed or lost: 600,000.
Estimated total tonnage of workable coal left: 15,000,000.
Number of mines working ten men or over, in operation: 1.
Number of mines working less than ten men, in operation: 27.
Total number of mines in operation: 28.
Large mines abandoned: 3.
Total number of openings to coal: 200.

XXII. CLAY COUNTY.

General Statement.

742a. References and Field Work.—

1862 (1859-60). Richard Owen, Geol. Reconn. of Ind., pp. 169, 170, one columnar section, two coal analyses. (R. O.)

1862 (1859-60). Leo. Lesquereux, same, pp. 327, 329, one columnar section. (L. L.)

1869. E. T. Cox, 1st Ann. Rep. of Geol. Surv. of Ind., pp. 20-85, detailed description, map, colored cross-section, nineteen columnar sections, eight coal analyses. (E. T. C.)

1871 (1870). E. T. Cox, 2d Ann. Rep. of Geol. Surv. of Ind., pp. 8-11, one columnar section; p. 175, one coal analysis. (E. T. C., '70.)

1872. E. T. Cox, 3d and 4th Ann. Reps. of Geol. Surv. of Ind., p. 37, five coal analyses (ultimate).

1876 (1875). E. T. Cox, 7th Ann. Rep. of Geol. Surv. of Ind., pp. 48-55, forty-seven coal analyses. (E. T. C., '75.)

1876 (1875). John Collett, same, pp. 421-462, detailed description of southeastern part; fifty-six columnar sections. (J. C.)

1896 (1895). W. S. Blatchley, Dept. of Geol. and Nat. Rec., 20th Ann. Rep., pp. 77-83, one columnar section, describes clays. (W. S. B.)

1896 (1895). T. C. Hopkins, same, pp. 213-218, describes sandstones. (T. C. H.)

1897. G. H. Ashley, field work for this report. As with the other counties, for data on mines sunk since the county was surveyed, I am indebted to Mr. Fisher, Mr. Epperson, and to others.

743. LOCATION.—Clay county is a long north-and-south county, lying a little southwest of the center of the State, and separated from the Illinois line by Vigo and part of Sullivan counties. It lies south of Parke county, west of Owen and part of Putnam, and north of Owen and Greene.

744. EXTENT.—The county has an area of 360 sq. mi., having a length of 30 mi. and width varying from 10 to 16 mi. It covers congressional townships 9, 10 and 11 north of range 7 west in whole; and townships 9 and 10 north of range 6 west, 11 and 12 north of range 5 west, and 13 north of range 7 west, in part.

745. ELEVATION.—Of the points whose elevation is known the highest is Middlebury, with an elevation of 676 ft. above tide. It is probable that the high points of Washington and Van Buren townships will more than equal that, if, indeed, they do not reach 700 ft. Eel river flows out of the county at an elevation not determined, but probably at least as low as 530 above tide. Between these the elevations of some of the more important points are as follows:

	Ft.
Harmony	672
Brazil	643
Staunton	643
Perth	633
Cory	625
County line on E. & I. R. R., west of Cory	614
Clay City	584
West county line on Vandalia	583
Cloverland	577
Lodi	564
Saline City	555
Feeder dam, Eel river	550

746. GENERAL TOPOGRAPHY.—In general this county is very level, especially the western half. Some broken country occurs along the eastern margin, especially along Croy's creek and east of Eel river, in Washington township. Some rough country is found along the banks of the north and south forks of Otter creek, which cut deeply into the general level. With these exceptions, the streams have either not channeled deeply, or their banks present rather gentle slopes. Eel river and many of the streams running into it have broad bottoms, the Eel river bottom becoming as much as five miles wide before leaving the county. Near the southwestern corner, on Splunge creek, is a large basin, with very gentle slopes. A part of this basin is drainless.

747. DRAINAGE.—The north and south forks of Otter creek drain the northwestern part of the county and flow into the Wabash river. The rest of the county is drained by Eel river, which empties into White river. Croy's creek and Birch creek are the principal tributaries of Eel river. For the details of drainage, see Sheet B.

748. TRANSPORTATION FACILITIES.—The northern part of this county is well supplied with railroads. The Cleveland, Chicago, Cincinnati & St. Louis (Big Four) railway crosses the northern edge of the county. The Terre Haute and Indianapolis (Vandalia) railway, of the Pennsylvania system, crosses at the latitude of Brazil, and, with its Center Point and other coal branches forms the outlet for much of the coal going east and west. The Chicago and Southeastern (Midland) railway runs north from Brazil through Carbon. The Chicago & Eastern Illinois (C. & I. C.) railway runs northwest from Brazil and, with several branches, serves as the outlet for most of the coal for Chicago and the North. In the southern part of the county is the Evansville & Indianapolis railway, branching at Saline City to Brazil and Terre Haute, where connections are made in all directions. Its Lancaster branch has started to tap a rich field.

749. DEVELOPMENT.—Clay county is almost entirely under cultivation. It has long been the largest miner and exporter of coal in the State, and, as a sequence of this, has become one of the largest manufacturing counties in the State, the plants for the manufacture of clay products especially being noteworthy.

Brazil, the county seat, is the most important mining town in the State. Clay City, Center Point and Bowling Green are the most important of the smaller towns.

750. SURFACE GEOLOGY.—The surface of this county has been described as generally level. Drilling and mining have shown that, could the soft surface deposits of sand, clay and gravel, laid down by the glacier or since, which, of course, contain no beds of coal, be removed, the surface would be found completely cut up with valleys and narrow intervening ridges. Except where some of the larger streams have in part cut out the filling of their old channels, the present surface gives no clew to the irregularities of the old surface. As these old hidden valleys are often broad and up to 150 ft. deep, they often cut out large strips of coal and may make almost valueless a piece of coal land that, judging only from the present surface, would be supposed to be entirely underlain with coal. This makes it necessary to make a large number of drillings in order to determine the amount of coal under a given piece of land.

Some of these hidden channels have been revealed by mining operations or the drill. Thus, near Carbon, three old channels exist, running southwest, one passing a short distance east of the Litchfield shaft, the other two, some 100 or more feet broad, cross the property of Eureka No. 2 shaft, cutting out the upper coal, but not reaching the lower.

South of Carbon, drillings are reported to have revealed a broad channel, crossing Sec. 7, and running south on the top of the hill west of Otter creek, then still running south to the west of Brazil, then turning and passing south to Turner and going west into Vigo county. In like manner these old valleys have been met in all parts of the county, and may be expected.

751. Coal Measures.—The following section will give a comprehensive view of the divisions and coals found in Clay county:

Division VII—
1. Sandstone principally.
2. COAL VII, barely workable, western central edge of county, about 3 ft.

Division VI—
3. Fire-clay, or fire-clay shale, limestone and black shale.
4. COAL VIb, worked a little at Cory and just south.
5. Shale, *sandstone, limestone, black shale.*
6. COAL VIa, "rider" at Stanton and Turner.
7. *Fire-clay,* shale.
8. THIN COAL, generally absent, only a few inches thick in a few places.
9. Fire-clay and shale, 6 ft. to 20 ft.
10. COAL VI, "big vein," Turner, Stanton, 5 to 9 ft. thick.

Division V—
11. Fire-clay shale.
12. COAL Vb, not workable. Local. 0 to 2 ft. 6 in. thick.
13. Fire-clay and shale.
14. COAL Va, only near Lodi.
15. *Shale* (workable), *limestone, black shale.*
16. COAL V, "rider" or "top block," in block coal.

Division IV—
17. Sandstone and shale, 2 ft. to 50 ft.
18. COAL IV, "upper" or "middle block" coal of block coal field, generally workable, 3 ft. to 4 ft.

Division III—
19. Shale or "*fake,*" 12 ft. to 40 ft.
20. COAL III, "lower block" coal, 2 ft. 6 in. to 5 ft.

Division II (?)—
21. Fire-clay or nothing, 0 to 10 ft.
22. Bone and coal, underlying (20), 0 to 3 ft. 6 in.

Division I—
23. *Mansfield sandstone,* often replaced by shale.
24. COAL I, not workable, 0 to 4 ft.

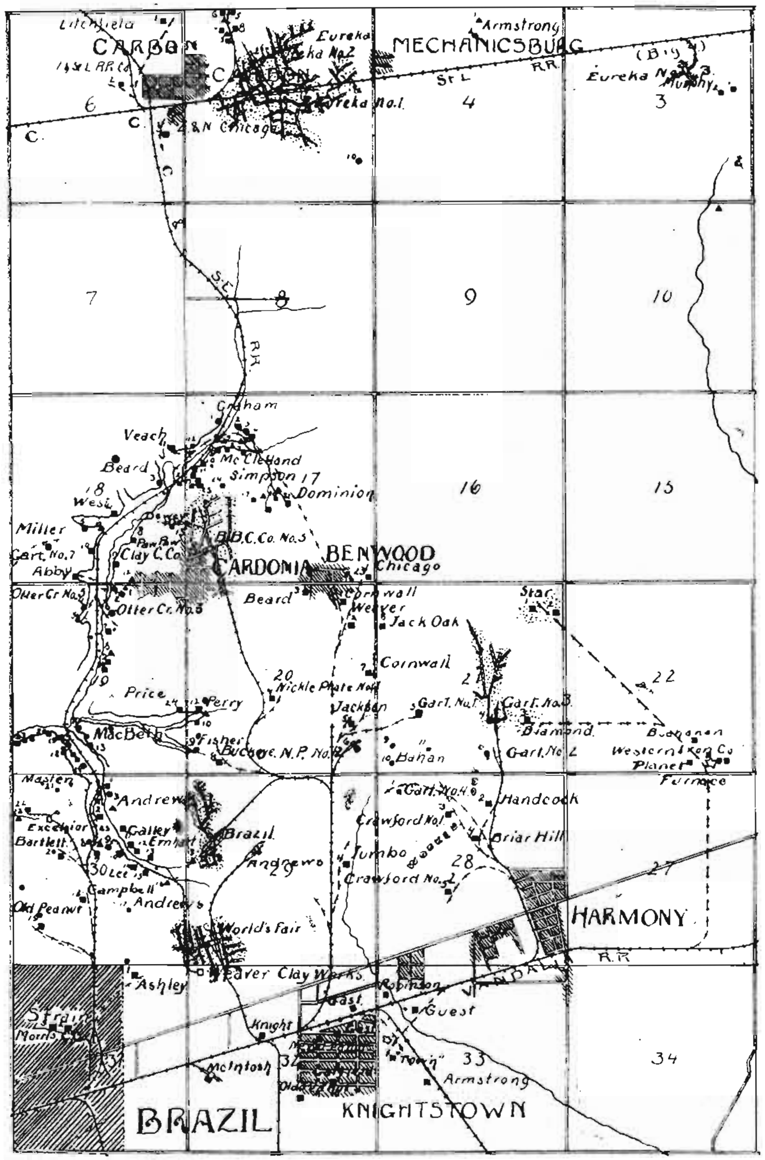


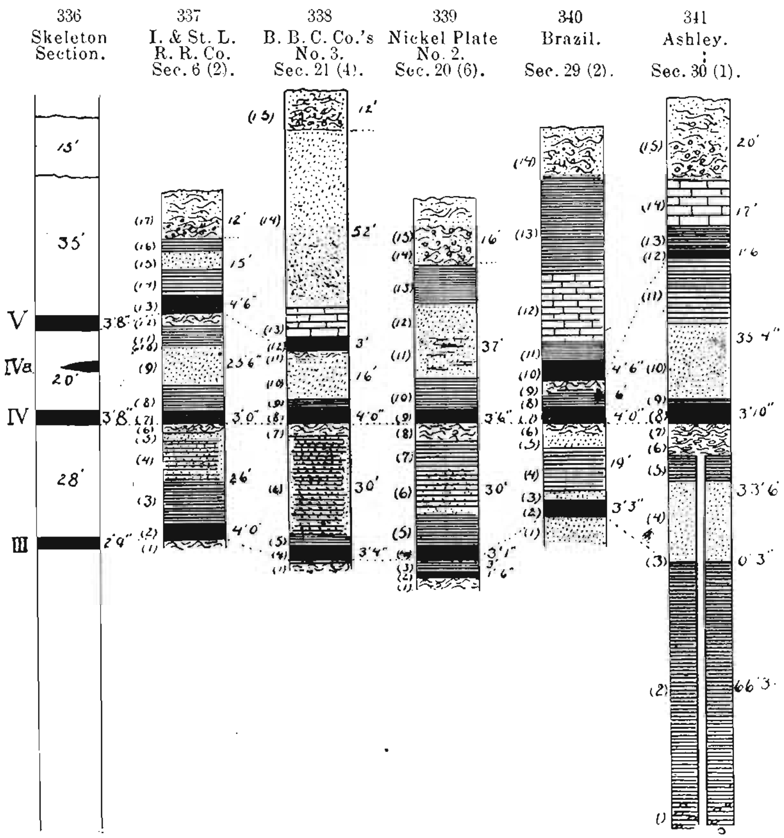
Plate XXIX. Sketch map of part of T. 13 N., R. 6 W.

The sections show the aggregate thickness of the coal measures in this county to be nearly 250 ft., including all the divisions from I to VII. There are three principal coals worked, the "big vein" or Coal VI, a caking coal at Turner, and westward, and Coals III and IV, the so-called "block coals." The "rider," Coal V, is worked at a few mines. At least four of the other beds are worked locally.

(Township 13 North, Range 6 West.)

Section 1. Geography.

752. Position.—This is the northeast township of Clay county, and corresponds with Van Buren of the civic townships, and with part of Brazil township in the southwest sections. See Sheet B.



Figs. 336-341. Typical columnar sections, T. 13 N., R. 6 W.

753. Transportation.—This township is and long has been better supplied with railroad facilities than any other township in the Indiana coal field. Containing as it does the finest basins of block coal in the State, it has offered sufficient inducements to lead to the building of numerous branches from the railways crossing it.

Section 2. Coals Contained and Their Relations.

754. Divisions Outcropping.—Divisions I to V outcrop in this area. Coals of Division II are reported as met in drillings at Harmony. Divisions I, III, IV and V, as a rule, only show one coal bed each, which will therefore be called Coals I, III, IV and V, respectively. It may be remembered that this was part of the area chosen as showing typically the relations of these divisions.

Vertical Relations of Coals.—The following selected columnar sections show clearly the relation of the main Coals III, IV and V.

755. Section 237. Section at Old Carbon Shaft.—Sec. 6 (2); see Fig. 337.

	Ft.	In.	Ft.	In.	Ft.	In.
Surface—						
17. Clay and drift	12	0	..	..	12	0
Division V—						
16. Clay shale	3	0	..	..	15	0
15. Sandstone	5	0	..	..	20	0
14. Gray clay shale	7	0	..	..	27	0
13. COAL V	4	6	4	6	31	6
12. Fire-clay	3	0	..	..	34	6
Division IV—	Ft.	In.	Ft.	In.	Ft.	In.
11. Clay shale	2	0	..	..	36	6
10. Gray shale	3	0	..	..	39	6
9. Sandstone	10	6	..	..	50	0
8. Dark gray clay shale	7	0	25	6	57	0
7. COAL IV	3	0	3	0	60	0
6. Fire-clay	2	6	..	..	62	6
Division III—						
5. Sandstone	2	0	..	..	64	6
4. Sandstone and shale	10	6	..	..	75	0
3. Bluish shale	11	0	26	0	86	0
2. COAL III	4	0	4	0	90	0
1. Fire-clay.						

Section by E. T. Cox and John Elder.*

756. Section 238. Section at B. B. C. Co.'s No. 3 Mine.—Sec. 21 (4); see Fig. 338.

*2d Rep. Geol. Surv. of Ind., 1871, p. 9.

	Ft.	In.	Ft.	In.	Ft.	In.
Surface—						
15. Surface	12	0	..	..	12	0
Division V—						
14. Sandstone	45	0	..	..	57	0
13. White limestone	7	0	..	..	64	0
12. COAL V	3	0	3	0	67	0
11. Fire-clay	2	0	..	..	69	0
Division IV—						
10. Sandstone, fine, white, with numerous carbonaceous partings, 18 ft. to	12	0	..	..	81	0
9. Shale, dark blue, 0 ft. to 6 ft.	2	0	16	0	83	0
8. COAL IV, 3 ft. 8 in. to 4 ft. 6 in. aver.	4	0	4	0	87	0
7. Fire-clay, plastic, 2 ft. to 4 ft. 6 in.	3	0	..	..	90	0
Division III—						
6. Sandstone and shale (fake)	24	0	..	..	114	0
5. Shale, gray to brown, 0 to 6 ft.	3	0	30	0	117	0
4. COAL III, 2 ft. 8 in. to 4 ft. 0 in. aver.	3	4	3	4	120	4
3. Fire-clay and shale, 4 to 6 in.	0	5	0	5	120	9
2. COAL bone, 4 to 8 in.	0	6	0	6	121	3
1. Fire-clay, gray, sandy	1	0	..	..	122	3

757. SECTION 239. SECTION AT NEW NICKEL PLATE MINE.—Sec. 20 (6); see Fig. 339.

	Ft.	In.	Ft.	In.
Surface—				
15. Clay, 4 ft.	6	0	6	0
14. Boulder clay (hard pan), 6 ft.	10	0	16	0
Division V—				
13. Blue shale	10	0	26	0
12. Sandstone, gray, 6 ft.	7	0	33	0
11. Sandstone, shelly, 10 ft.	12	0	45	0
10. Shale, 0 ft.	8	0	53	0
Division IV—				
9. COAL IV, 0 ft. to 4 ft. aver.	3	6	56	6
8. Fire-clay ....3 ft. to	4	0	60	6
Division III—				
7. Shale, bluish ....2 ft. to	10	0	70	6
6. Sandstone, flaggy	8	0	78	6
5. Shale, gray, 0 ft. to 12 ft.	8	0	86	6
4. COAL III, 2 ft. 6 in. to 4 ft. aver.	3	1	89	7
3. Shale ....2 ft. 6 in. to	3	0	92	7
2. Coal ....0 ft. to	1	6	94	1
1. Fire-clay or "black-gray rock."				

758. SECTION 240. SECTION AT BRAZIL MINE.—Sec. 29 (2); see Fig. 340.

	Ft.	In.	Ft.	In.	Ft.	In.
Surface—						
14. Surface	?	?	..	..	..	..
Division V—						
13. Shale	?	?	..	..	17	0
12. Limestone ....0 ft. to	17	0	..	..	34	0
11. Shale, black	4	0	..	..	58	0
10. COAL V, 4 ft. 3 in. to 5 ft. 2 in.	4	6	4	6	62	6
9. Fire-clay	?	?	..	..	..	..
Division IV—						
8. Shale, gray or black	?	?	?	?	68?	0
7. COAL IV ....aver.	4	0	4	0	72	0
6. Fire-clay	2	6	..	..	74	4
Division III—						
5. Sandstone	3	6	..	..	78	0
4. Shale	11	0	..	..	89	0
3. Sandstone ....1 ft. to	2	0	19	0	91	0
2. COAL III ....aver.	3	3	3	3	94	3
Division I—						
1. Sandstone, hard.						

759. SECTION 241. SECTION AT ASHLEY SHAFT.—Sec. 31 (1); see Fig. 341 (E. T. C.).

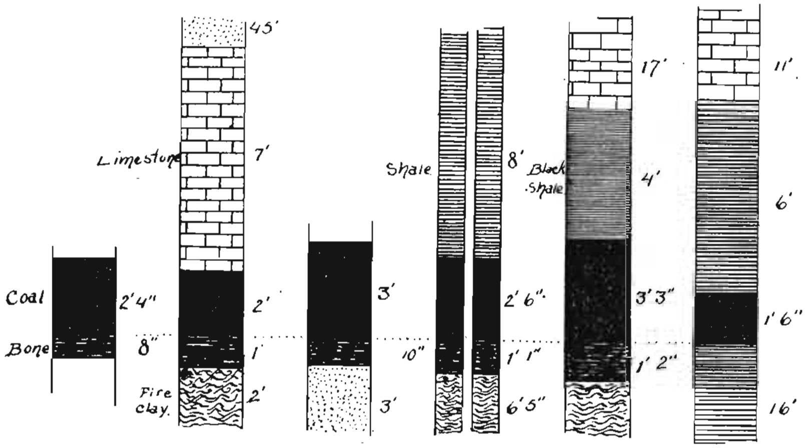
	Ft.	In.	Ft.	In.	Ft.	In.
Surface—						
15. Soil and drift	20	0	..	..	20	0
Division V—						
14. *Limestone*, fossiliferous	11	0	..	..	31	0
13. Bluish clay shale	6	0	..	..	37	0
12. COAL V	1	6	1	6	38	6
11. Gray shale	16	0	..	..	54	6
Division IV—						
10. Sandstone, thin-bedded, light-colored, with reddish band colored with iron	18	0	..	..	72	6
9. Shale, stiff bluish clay, 0 to 8 ft.	1	4	35	4	73	10
8. COAL IV	3	10	3	10	77	8
7. Clay, potters	1	6	..	..	79	2
6. Clay, sandy, hard, mixed with iron balls	6	0	..	..	85	2
Division III, in boring—						
5. Hard bluish shale	6	0	..	..	91	2
4. Sandstone, soft, with layers of yellowish clay	20	0	33	6	111	2
3. COAL III	0	3	0	3	111	5

Division II?—	Ft.	In.	Ft.	In.	Ft.	In.
2. Shale, clayey and sandy..	60	3	..	..	171	8
1. Shale, gray, with iron balls	6	0	..	..	177	8

No good section was obtained connecting these coals with Coal I. On Croy's creek Sandstone I shows with a thickness of 15 ft., and is probably thicker, though hidden. Below this an unknown number of feet the following was observed:

760. SECTION 242. SECTION AT DR. CULBERSON'S.—Sec. 23 (1).

	Ft.	In.
4. Shaly sandstone, light buff colored................	6	0
3. Sandy shale, grayish-blue	12	0
2. COAL, poorly exposed	3	0
1. Shaly sandstone, to bed of Croy's creek...........	3	0



342 Cornwall. Sec. 20 (1). 343 Gart. No. 3. Sec. 21 (4). 344 Nickel Plate No. 2. Sec. 20 (6). 345 Bahan. Sec. 21 (10). 346 Brazil. Sec. 29 (2). 347 Ashley. Sec. 31 (1).

Figs. 342-347. Type sections of Coal V, T. 13 N., R. 6 W.

761. DISCUSSION OF SECTIONS.—The sections show an average thickness of surface soil and drift of 15 ft. A number of the old preglacial channels have been reported as encountered in the mines and in drilling. The rider or Coal V has a cover of 35 ft. average thickness, according to the sections; as a matter of fact, Coal V is wanting over quite a large part of the area, so that 35 ft. is evidently too high for the township as a whole. The limestone characteristically overlying Coal V appears in a majority of the sections. This limestone appears to be unevenly developed in the area. In places it attains a thickness of almost 20 ft., while in others a coal supposed to be Coal V is overlain by 20 ft. or more of clay shale, very suitable for tile-making, with no limestone. Thus, at the Brazil mine, Sec. 29 (2), the limestone over Coal V is restricted to a small area north of the shaft, where it attains a thickness of 17 ft. Over most of the mine it is replaced by sandstone. The black shale so characteristically overlying Coal V to the south is often wanting in this township or replaced by drab shales, as stated above.

762. COAL V.—The following sections of Coal V (Figs. 342 to 347) show that while attaining a thickness of 1 ft. 6 in. to 4 ft. 6 in., with an average of nearly 4 ft., it is only from two-thirds to three-fourths of it good coal, the lower one-third to one-fourth being usually bone coal. It is generally overlain by shale, often black and bituminous, with limestone or sandstone above that.

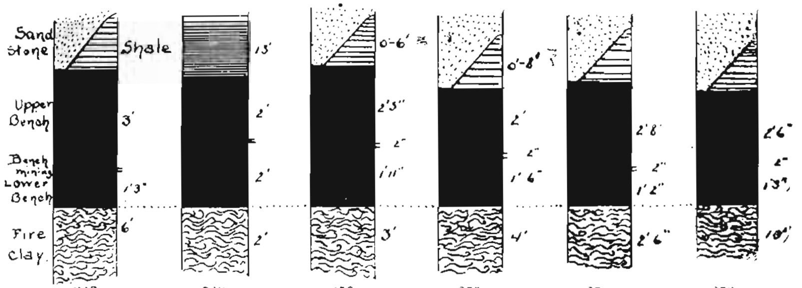
The sections may be tabulated as follows:

	Cornwall, Sec. 20 (1).		B. B. C. Co.'s No. 3, Sec. 21 (4).		New Nickel Plate, Sec. 20 (6).		Bahan, Sec. 21 (10).		Brazil, Sec. 29 (2).		Ashley, Sec. 31 (1).	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Sandstone	....	?	45	0	....	?	....	?	?	?	?	?
Limestone	....	?	7	0	....	?	....	?	17	0	11	0
Shale	....	?	0	0	....	?	8	0	4	0	6	0
COAL, good	2	4	2	0	3	0	2	6	3	4	1	6
COAL, bone	0	8	1	....	0	10	1	1	1	2	0	0
Fire-clay	....	?	2	....	0	0	6	5	?	?	0	0
Shale	....	....	....	....	0	0	....	....	....	....	16	....
Sandstone	....	....	....	....	3	0	....	....	....	....	....	....

763. In quality this coal is generally reported as ranking below the two Coals III and IV which underlie it. The bed was not being worked when this township was surveyed (1897), and no analyses are known to have been made of it. It is reported to be a soft coal, with red ash.

764. DIVISION IV.—Contains Coals IV (typical) and IVa. Coal IV is described in the next paragraph. Coal IVa was certainly re-

ported at only one point, at Gart. No. 1 shaft. At this point Mr. Duncan McCullum reports having drilled through a 3 ft. 6 in. bed of coal, lying 6 ft. above Coal IV and below Coal V. At many points in the mines of this township the roof of Coal IV has fallen, revealing a bed of coal much nearer Coal IV than Coal V was supposed to be, judging by drillings. It is possible that in some cases this is an intermediate coal between Coals V and VI.



348 Eureka No. 2. Sec. 5 (2). | 349 Jack Oak. Sec. 21 (8). | 350 B. B. C. Co.'s No. 3. Sec. 21 (4). | 351 Nickel Plate No. 2. Sec. 20 (6). | 352 Brazil. Sec. 29 (2). | 353 World's Fair. Sec. 29 (4).

Figs. 348-353. Type sections of Coal IV, T. 13 N., R. 6 W.

Nothing is known of the quality or details of this coal in this area.

The space between Coals V and IV is very variable in thickness. In the Ashley shaft it is over 35 ft. At the New Nickel Plate mine it is only about 4 ft. at one point. The space will average about 20 ft. Its most prominent member is a massive sandstone from 5 to 20 ft. thick. This sometimes lies directly on the coal; more often there are a few feet of dark blue shale between it and the coal. There seems to be unconformability between the sandstone and shale, though we are not certain of this. The sandstone often shows dark carbonaceous wavy partings of shale, especially in its lower part; these partings are often as thin as paper and from one-half to one inch apart.

765. Coal IV.—It may be safely said that this coal bed in this township has been more thoroughly exploited than any other coal bed in a similar area in the State. The reputation of Indiana block coal was made from the coal mined from this bed, principally in this township, and with the bed below, discovered later, and which proved to be, if anything, of even better quality, it for a long time furnished the principal part of Indiana block coal. The following sections (Figs. 348 to 353) show it to be a solid bed, with a 2-in. bench mining of soft coal a foot or so from the bottom. The sections may be tabulated as follows:

	Eureka No. 2.		Jack Oak.		B. B. C. Co.'s No. 3.		Nickel Plate No. 2.		Brazil.		World's Fair.	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Sandstone	....	....	....	....	....	....	....	....	....	....	....	....
Shale	0-?	....	13	....	0-6	....	0-8	....	0-?	....	0-?	....
COAL IV—												
Upper bench	3	....	2	....	2	5	2	....	2	8	2	6
Bench mining	?	....	?	....	....	2	....	2	....	2	....	2
Lower bench	1	3	2	....	1	11	1	6	1	2	1	3
Fire-clay	6	....	2	....	3	....	4	....	2	6	10	....

The average thickness of the bed in this township, where worked, may be taken as a little over 3 ft. 6 in. In some of the mines it has averaged over 4 ft. and runs to nearly 5 ft. in places. It occurs in rather large basins in this area. This bed shows in this township the most perfect development of those properties which characterize block coal of any township in the State (see Fig. 4, in Part I). Most of the coal mined in this township has been blocked out or mined without the use of powder. The system of joints or slips is remarkably regular here, they having a direction of about N. 30° W. and N. 60° E. wherever measured. In some places the face slips were found to have a direction of N. 15° W. The slips are usually more open at the top in this bed and usually offset some or are not marked after passing through the bench mining. The face slips run from 2 ft. 6 in. to 3 ft. apart, the butt slips being about 6 in. nearer together. Both open and mud slips are common. In the mines the slips are usually barely open enough to allow the easy insertion of a knife blade, but vary from this to 10 or 12 in. between the blocks in places, especially near the outcrop or near a point at which the coal outcropped in preglacial times. In places these large spaces are not between all the blocks, but between lines of blocks, often offsetting one or more lines of blocks, much like cracks in a brick wall that has settled some. The mud-filled slips or mud slips are usually met with in Coal IV only near the outcrop or where the roof is bad.

766. Roof.—This bed is usually roofed either with sandstone or shale, either roof being fair to good in places, while in others it is very poor and leaky. The sandstone usually has a little shale between

it and the coal, though not always. This shale, where less than 2 ft. thick, tends to come down. No thinning of the coal under the sandstone could usually be observed—in fact, some of the thickest coal measured had a sandstone roof. The coal is usually reported to be of a little better quality under the shale roof. In some of the mines the coal is overlain by one or two inches of bone coal.

767. QUALITY.—An analysis of coal from Eureka No. 1 mine, Sec. 5 (1), by Mr. Noyes, gave:

Fixed carbon	50.42	
Volatile combustible matter	36.32	
Total combustible matter		86.74
Moisture	9.80	
Ash	3.46	
Sulphur	.34	
Total waste		13.60

Pounds of water evaporated per pound of coal, 13.1.

The following table shows analyses made by Mr. Cox of picked and dried specimens:

MINE.	Location.	Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Moisture.	Ash.	Evaporated Effects.
Garlick & Collins	Sec. 19 (15) ?	88.50	31.00	57.50	8.50	3.00	13.96
Knightsville No. 1	Sec. 33 (3)	90.70	30.90	59.80	9.00	0.03	11.33
Knightsville No. 2	Sec. 33 (3) ?	90.00	33.00	57.00	8.00	2.00	14.23
McClelland No. 1	Sec. 17 (10) ?	93.50	38.80	54.70	5.00	1.50	14.89
McClelland No. 2	Sec. 17 (10) ?	93.00	40.00	53.00	4.50	2.50	14.81
Star	Sec. 21 (1)	93.50	32.50	61.00	3.50	2.50	14.83
Carbon	Sec. 6 (2) ?	95.10	39.85	55.25	3.40	1.50	15.17
Garlick & Collins	Sec. 19 (15) ?	93.75	35.85	57.90	2.75	3.50	14.89
Morris Coal Co	Sec. 31 (2)	95.50	43.50	52.00	3.50	1.00	15.28
Niblock & Zimmerman	Sec. 19 (6) ?	95.25	40.62	55.63	3.00	0.75	15.29
Average		91.88	36.60	56.38	5.12	1.83	14.77

These show a high percentage of fixed carbon, a very small percentage of ash, a small percentage of volatile combustible matter and an average to high percentage of water.

On the whole, it may be safely said that for purity, small waste in handling, transportation and stocking this coal will excel any other coal in the State, and will compare favorably with any bituminous coal on the market.

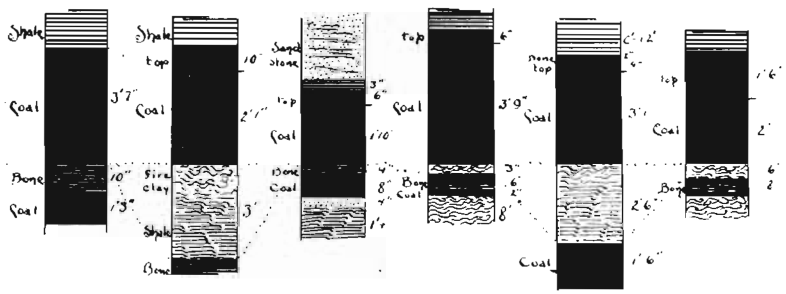
768. DIVISION III.—This division contains one coal to be described in the next paragraph. The space between Coals III and IV is generally fairly constant, though varying over the field from 20 ft. to 35 ft., with an average of about 30 ft. Its most characteristic member is the mixture of sandstone and shale known as "sand-slate" or "fake." This usually overlies shales, often reddish or brownish in color. Pure sandstone is seldom found in this space, though noted occasionally.

769. COAL III.—In the discussion of this coal in the district it will be convenient to consider at the same time the underlying coal, which probably should be placed in Division II, but which is so intimately associated with Coal III that it may well be treated in connection with that coal.

770. STRATIGRAPHICAL DETAILS.—Figs. 354 to 359 show well the details of this coal. By itself it is a solid bed, with usually a knife-edge parting from 6 to 18 in. from the top. The coal above this parting is usually softer than the rest and approaches more nearly a caking coal. The main body of the coal is a splint coal of great purity. It is quite characteristically underlain by a bed of bone coal or "black jack," and good coal (Coal II). Usually there is a little fire-clay between the main bed and the underlying bed. Locally, this may be wanting and the bottom of the main bed may adhere so closely to the bone coal that part of the bone will be raised in mining. In other cases the two coals may become 10 to 12 ft. apart. This coal will average in the working places close to 3 ft. The average over the whole area would be much lower than that, as the coal runs very thin or runs out entirely in the southwest corner of the township. The fire-clay and shale between the two coals will average close to 6 in. The lower coal is usually made up of about one-half bone coal and one-half good coal, the bone overlying. It will vary in thickness from 0 to 3 ft. or over. The presence of the underlying coal has proved of much assistance in recognizing Coal III. The lower coal is sometimes all good coal, sometimes all bone, but generally both occur.

Coal III sometimes has a little bone coal on top. The roof is usually either shale or "fake." The former makes a fair roof for a while, the latter tends to flake down badly in the entries, but holds up well in the rooms.

This bed, like Coal IV, shows a very perfect development of the joints or slips characteristic of block coal. In this bed the slips are more open and regular in the bottom of the coal, often not being marked at all in the top bench. In mining, the top bench quite commonly does not block down with the rest, but sticks to the roof until several square yards of the main bench have been removed, when, on being sheared, it either falls or is easily wedged down by the miner, breaking, however, in small blocks of some regularity in falling. Clay slips occur in this coal in such a way as to suggest that the clay is the



354	355	356	357	358	359
Murphy.	Eureka No. 2.	Graham.	Gart. No. 5.	Nickel Plate No. 2.	Gart. No. 3.
Sec. 3 (1).	Sec. 5 (2).	Sec. 17 (1).	Sec. 17 (22).	Sec. 20 (6).	Sec. 21 (4).

Figs. 354-359. Type section of Coals III and II, T. 13 N., R. 6 W.

under-clay forced by pressure up into the slips. Slips usually extend down through the bone coal and good coal below. Basin structure is usually well shown by this coal in this area, as it usually is thickest in the "swamps" or low places, and more or less nearly thins out going over the hills or divides between the basins. The under Coal II shows this still more markedly. As a rule, the under coal and the bone coal are only found in the low places and feather out on going up over a hill. The fire-clay between does the same, so that while in the low places Coal III is thick and underlain by fire-clay, bone coal and coal in succession on the hills, it is usually thin and lies immediately on the massive sandstone of Division I. The slips have the same direction as in Coal IV and are about the same distance apart, running smaller as the thickness of the coal decreases.

771. Quality.—Of the analyses by Mr. Noyes, that at mine No. 5 of the Brazil Block Coal Company is of this bed. The analysis gave:*

*21st Ann. Rep. Geol. Surv. of Ind., p. 106.

Fixed carbon	49.16	
Volatile combustible matter	36.11	
Total combustible matter		85.27
Ash	3.53	
Moisture	11.20	
Sulphur	.62	
Total waste		15.35

Pounds of water evaporated by one pound of coal, 12.8.

An analysis by Mr. Cox of this coal from Otter creek, at the Lafayette furnace, gave:*

Fixed carbon	57.95	
Volatile combustible matter	37.35	
Total combustible matter		95.20
Ash	2.60	
Moisture	2.10	
Sulphur	0.07	
Phosphorus	.22	
Total waste matter		4.99

Pounds of water evaporated by one pound of coal, 15.15.

General report would make this bed, if anything, a little better on the average than the bed above, being usually a trifle harder than Coal IV and, if possible, containing still less sulphur. It is usually reported as of a better grade and thicker when the shale makes the roof. As already stated, the top bench is softer and richer in volatile constituents, being a semi-caking coal.

The bone coal of Coal II is often a very bright, rich-looking bone, and in many places has so many bands of pure coal in it that it is used occasionally around the mines. Its very richness, however, makes it liable to be mixed with the other coal and so injure the reputation and efficiency of the good coal. The coal underlying is usually of a good grade, but too soft to stand shipping.

772. Division II.—There has already been described the coal immediately underlying Coal III. Over most of the township that would seem to represent all there is of Division II.

*2d Ann. Rep. Geol. Surv. of Ind., p. 175.

In a cut extending 26 ft. below Coal III, in Gart. No. 5 mine, the following section was exposed below Coal III. Section 243—

		Ft.	In.
1.	COAL III	3	1
2.	Fire-clay, 0 ft.	0	3
3.	Coal II, average	0	6
4.	Fire-clay, drab, 0 ft.	8	0
5.	Sandstone, 0 ft.	2	0
6.	Clay, light gray to 12 ft. below coal, 10 ft.	4	0
7.	Clay and shale conglomerate, with streaks of washed-in coal up to 1 ft. thick, 0 ft.	3	0
8.	Shaly limestone or light-colored shale, intergrading.	9	0

In this case the conglomerate No. 7 is good evidence of a time break. The divisions above made are questionable. A short distance north, on Otter creek, and in the same section, the massive sandstone of Division I is being quarried, while Coal II outcrops only a few feet above.

In the south part of the township drillings at Harmony, Knightsville and Brazil all report a great thickness of shales under Coal II, but no sandstone. Mr. Zellar reported that the drilling at Harmony showed two or three coal beds lying 20 to 30 ft. apart and with a thickness of up to 14 in. Mr. Cox, in reporting the well at Harmony in 1869, says that the drilling "was in argillaceous shales to the bottom and passed no coal."

Whether these shales represent the westward extension of Sandstone I, or were deposited in depressions eroded from that member is in doubt. I am inclined to think the latter explanation correct, and so have assigned these shales to Division II.

773. Division I.—This division shows the usual massive sandstone, a characteristic exposure being at the rock cut of the Vandalia railway where it passed under the National road, east of Harmony. No great thickness of this sandstone has yet been found, natural outcrop usually not exposing over about 15 ft. A good thickness of shale occurs in the lower part of the division overlying Coal I. This coal is only exposed at a few points along Croy's creek, with a thickness of 3 ft. or under, and reported to be of rather low grade.

Section 3. Structure and Distribution of Coals.

No accurate levels for showing the dip across the country were obtained. It probably will not average for the township over 5 or 10 ft. to the mile. This means that the coals lie nearly level, though with many local elevations and depressions, which are often quite marked. In one or two cases local dips of 50 ft. to the 100 ft. were found. Divisions II and above are cut out in the valley of Croy's creek, in the southeastern part of the township, and along the south fork of Otter creek.

For convenience we will consider first Secs. 23-26, and 35 and 36.

774. Sections 23-26, 35, 36.—By reference to the large map it is seen that these sections contain practically only Division I. Over most of the area the horizon of Coal I is a little below the level of Croy's creek. At a few points local folds bring it up.

In Sec. 23 (1 and 2), on Dr. Culberson's place, it is exposed just at creek level. A small bluff at this point exposes the section given in ¶760. At this point it dips sharply to the northwest. A slope has been opened here and some coal mined, but it had fallen in at the time of our visit. The outcropping coal, when examined, appeared shaly. The coal is reported to be 3 ft. thick and solid. It is said to clinker some, and make a hot fire that is hard on stoves.

On the Austin Frost place, Sec. 35 (1), coal was reported 3 ft. thick. Sandstone I or Mansfield sandstone outcrops were noted in the northeast corner of Sec. 35, at the railroad cut of the Vandalia, where up to 15 ft. of the sandstone is exposed. On the west bank of Croy's creek, on the National road, shelly and cross-bedded sandstone to a thickness of 20-30 ft. is exposed, and also down the ravine from the Planet furnace, in N. W. Sec. 24, on Croy's creek, and other places.*

775. Sections 1 and 2.—At Mrs. Raleigh's, Sec. 1 (2), coal has been opened up in the head of a small ravine; caved in at mouth at time of visit. Coal appeared to be at least 2 ft. 6 in. thick, but was much disturbed. It is overlain by 5 or 6 ft. of yellow sandstone. At a distance of 50 ft. the coal is reported to have been cut down by a rock roll, and the drift was abandoned.

Just northeast of this, coal has been worked a little on the Butts or Dobson place; coal reported 2 ft. thick.

This coal would appear to be at the horizon of Coal III or Coal IV. The sandstone overlying would suggest Coal IV unless it be possible that a local fold has brought Coal I up. Just south of Maysville or Lena a slight anticline brings up a small exposure of rather massive sandstone underlain by two feet of shale.

More detailed local work, aided by a boring of 100 to 150 ft., would probably be able to settle the position of this coal; and also determine

*See 20th Ann. Rep. Geol. Surv. of Ind., p. 217.

whether, if it prove to be Coal IV, Coals III and I, especially the former, are of workable thickness under this area.

776. SECTIONS 11 AND 12.—No data obtained in these sections. Supposed that horizon of Coal III underlies them at a little below drainage level. May prove to contain coals of workable thickness. Bottom of coal measures probably not over 100 ft. below drainage, more probably less.

777. SECTIONS 13 AND 14.—Outcrops of coal were reported on the Buchanan place, Sec. 13 (1); Gurton place, Sec. 13 (2), coal 2 ft. to 2 ft. 6 in., with shale roof; Butts place, Sec. 14 (3); Mercer place, Sec. 14 (4). At the road crossing of Croy's creek, in the N. W. ¼ of Sec. 13, is a typical exposure of fake some 15 ft. thick. This is a short distance above the outcrop which has been worked on the Buchanan place, and indicates that that coal is Coal III. A short distance west of the stream crossing, and not far from the level of the divide, is an outcrop of Coal IV. This was the only point at which the relative positions of the coals were clearly determined. It leads to the conclusion that Coal IV underlies the highest points in the two sections and probably not under conditions favorable to mining. That Coal III lies at about drainage level, below in the northern parts of the sections and above in the southern, and, judging from reports, is not of a thickness to invite extensive working. Exploration with the drill might reveal workable pockets.

Coal I and the bottom of the coal measures probably between 50 and 100 ft. below drainage.

778. SECTIONS 3, 4, 7, 8, 9, 10, 15, 16.—The horizon of Coal III, and to a large extent of Coal IV, is supposed to underlie all these sections, but as yet drillings seem to have largely failed in finding workable coal. More or less drilling has been done in these sections, dating from the opening up of the block coal in the '60s; but as far as could be learned the drill revealed only 2-ft. coals or under, or else found only the sand of a preglacial channel.

The N. ½ of Secs. 3 and 4 promise better. In the N. E. ¼ of Sec. 3 prospecting has recently led to the sinking of two test shafts on the Murphy place; Sec. 3 (1 and 2) by the Eureka Coal Company. At the eastern shaft Coal III was reported reached at 62 ft., with the section shown in Fig. 354. At the western shaft, on lower ground, the coal was reported, at 41 ft., as 3 ft. 11 in., underlain by 2 in. of fire-clay, 3 in. of bone coal and 6 in. of coal; shale roof. The company is reported to have located a shaft on the S. W. ¼ of the N. E. ¼ of Sec. 3, on the Joseph Smith place. (This shaft, known as Eureka No. 3 mine, was opened up in 1898.) An outcrop in the N. E. corner of Sec. 10 was judged to be of Coal IV and to show the position of that coal as too near the surface level to be workable.

On the Armstrong place, Sec. 4 (1), 8 to 30 in. of coal, with shale over, is found in the branch bottom. At Sec. 4 (2) a drilling was reported to have passed through 4 ft. 6 in. of coal, depth not known.

In the N. W. ¼ of Sec. 4 the Crawford Coal Company report some workable coal on lands held by them.

In Secs. 7 and 8 drillings are reported to have found an extensive preglacial channel filled with sand, across which the coal is cut out.

As for the future prospects of these sections, it may be said that the horizon of Coal I underlies all of them at depths varying from 20 to 100 ft. below drainage, but is not likely to show a thickness or quality that would pay for extensive mining. The horizon of Coal III probably underlies most of the sections about at or a little below drainage, according to local folds. Drillings so far do not seem to have found it of workable thickness, except as mentioned in Secs. 3 and 4. I am inclined to think that the coal in this area lies in small basins or pockets and that at some time many of these pockets of workable extent and thickness will be discovered. In this area the level of drilling should be carefully determined, and by a study of the sections it will often be possible to detect the direction of slope which will lead into a basin.

779. SECTIONS 5 AND 6.—This includes the district about Carbon. It has been worked long and extensively.

The section at the old Carbon shaft was given in ¶755; see also Fig. 337. It shows the presence of all three Coals III, IV and V, at depths of 27 ft., 57 ft. and 76 ft., and all of workable thickness.

780. At Eureka No. 2 shaft, the only one now operating extensively in the district, Coal V is wanting, having been carried away by the preglacial erosion. Coal IV is found at 60 ft. and Coal III at 96 ft. Coal IV averages here from 4 ft. to 4 ft. 3 in., having a blue shale roof and 6 ft. of fire-clay for a floor. It has a bench mining 1 ft. to 1 ft. 3 in. from the bottom. This bed is frequently found to have been cut out by preglacial streams. In this mine two such channels or "sand bars" have been met cutting out Coal IV for a width of 30 yds. or more, and running from northeast to southwest. They had not cut down to the bottom bed. Coal III averages 3 ft. 9 in. thick, with shale roof, 6 in. of which comes down in mining. The top bench is here about 10 in. thick, and sticks to the roof. The bone and coal

underlying are of equal thickness, running from 0 in. to 4 in. In parts of the mine these were about 3 ft. from the coal; see Fig. 355.

The butt slips are not marked in this coal, the face slips only being developed, and running a little west of north.

An approximate section at this mine is as follows:

SECTION 243A. SECTION AT EUREKA NO. 2 SHAFT.—Sec. 5 (2).

	Ft.	*In.*	*Ft.*	*In.*
Surface, 11 ft. 14 in.; boulder clay, "hard pan," 10 ft. 12 in.	25	0	25	0
Shaly sandstone, blue shale	35	0	60	0
COAL IV	4	0	64	0
Fire-clay, 6 ft.; shale	32	0	96	0
COAL III	3	9	99	9
Fire-clay and shale	3	0	102	9
Coal II	1	0	103	9

At the Eureka No. 1 shaft, Sec. 5 (1), it was about 80 or 90 ft. to Coal III.

781. At the Litchfield shaft, Sec. 6 (1), it was 50 ft. to Coal IV, 4 ft. to 4 ft. 6 in. thick, and between 80 and 90 ft. to Coal III, 3 ft. 6 in. to 4 ft. thick. Coals had a shale roof. A "sand bar" similar to those at Eureka No. 2 was reported to have been met just east of the shaft.

782. At the Chicago shaft, just south of Carbon, Sec. 6 (3), the coal was reported to be 4 ft. thick.

At an early day coal was worked in the hollow northeast of Eureka No. 2, by a slope known as the Eureka. Coal IV has been extensively stripped in this hollow and a little mining is carried on principally on the pillars up to the present. During the strike of 1897 some few openings were being worked in this hollow. They showed a thickness of Coal IV of 3 ft. 8 in., the bench mining coming 1 ft. to 1 ft. 6 in. from the bottom. There is here only 2 ft. of blue shale, with 15 to 20 ft. surface and drift above that; fire-clay below. The coal here has many false slips, which prevents its being mined in large blocks.

This field extends north to the mines on North branch of Otter creek, northeast to the Caseyville mine, and westward to the mines at Perth and Lodi.

In conclusion, Coal V occurs very near the surface, and is probably limited to a very small area or to a few isolated pockets. Coal IV occurs from 50 to 60 ft. below the level of the Big Four railroad at Carbon, and is largely worked out. Coal III occurs from 75 to 95 ft. below railroad level, and is also approaching exhaustion. Just how much coal was still unmined in the two sections could not be learned. Considerable coal has not been reached on account of sand bars and other interruptions, and some of these bodies may prove worth sinking for.

783. SECTIONS 17-21, 28-33.—Some idea of the extent to which mining has been and is being carried on in these sections can be gained from the map. In 1895 these sections yielded 350,000 tons of coal, or about one-twelfth the total yield of the State. When examined in 1897, six large mines were in operation, and about a dozen small mines supplying clay plants or local trade.

784. In Sec. 17 Coal III is being extensively worked, at Gart No. 5 shaft. Coal IV, 4 ft. to 4 ft. 3 in. thick, occurs some 25 ft. from the surface, but has not been worked on account of lack of roof, there being only surface and drift above it. Coal III is reached at 52 ft. in the shaft. It varies in thickness from 2 ft. 6 in. to 3 ft. 9 in., with an average of 3 ft. or 3 ft. 1 in. (see Fig. 357). The top bench will run up to 9 in. in thickness; below, the coal is locally up to 3 in. of fire-clay; more commonly the coal rests directly on bone coal, with a thickness of up to 2 ft., but averaging about 6 in. One or two inches of coal usually underlies the bone coal. Below that the rock varies, in places being fire-clay, in others being sandstone, showing the rootlets of the coal plants, and probably suitable for the uses to which gannister is usually put. The roof is usually either shale or sandstone, the best and thickest coal occurring under the shale. At one point the following section was obtained between Coals III and IV (Sect. 244):

	Ft.	*In.*
COAL IV	4	3
Fire-clay, 1 ft. 6 in.-4 ft. 0 in.; blue shale fire-clay, 7 ft. 8 in.; black shale, with thin streaks of coal, 1 ft.	13	0
COAL III	3	1

At one place a cut has been made where the coal goes over the edge of a basin for about 500 ft., and to a depth of 26 ft. (see Fig. 3 of Part I). This has already been referred to in Part I, and as the measurements of the coal are given on the figure, they need not be repeated here. The section below the coal is very irregular, and varies much even in the short space of the cut. For a compromise section, see ¶772, Part III. The interesting coal vein met with in the entry (Fig. 14 of Plate III) has already been referred to in Part I.

An analysis of this coal by Mr. Noyes was given in ¶771. Coal III outcrops on the branches of the south fork of Otter creek, in the N.

W. ¼ of Sec. 17. It was worked in the 60's by McClelland & Sons by drifting, Sec. 17 (10). At one of the drifts still open the coal measured 3 ft. 8 in. thick, with a cover of 2 ft. of gray sandy shale. Slips run N. 30 W. and N. 80 E. In 1897 two banks were operating on a small scale in the coal left from the old McClelland workings. At the Simpson slope, Sec. 17 (24), the coal is 3 ft. thick; the top bench, 6 in. thick, is soft, and slacks more readily than the rest; is a caking coal, liked by blacksmiths, and tends to stick to the roof; slips do not usually enter it. Roof is a blue shale, with lime and iron concretions in lower 6 in.; not very good. This mine is working a small area between Gart No. 5 and the old McClelland mine. At the other opening, Sec. 17 (9), they are simply drawing pillars from the McClelland mine (see plate in Part IV).

Coal has been extensively stripped in the creek bottom at the center of the N. W. ¼ of Sec. 17. From this old stripping and the McClelland drift, the coals rise rapidly to the northwest, so as to expose some 15 ft. of the Mansfield sandstone, the top 5 or 6 ft. not being as solid as the rest. The coal is seen outcropping only a few feet above.

Just south of the McClelland drift, an apparent slight unconformability is noticed, the overlying strata being about horizontal, while the underlying strata dip south a few degrees. Still farther south, at the head of the small ravine, and just north of Cardonia, is an illustration of folding, the gray shale showing several small folds with dips as high as 45°.

On the north side of the creek, coal is being gotten out at Grahams, Sec. 17 (1). The section there is (see Fig. 356):

	Ft.	*In.*
Shaly sandstone, 18 ft.; blue to black shale, 3 ft......	18	3
COAL III, soft top coal, 6 in.; main block, 23 in.......	2	4
COAL II, bone coal, 4 in.; good coal, 8 in.............	1	0
Fire-clay, 1 ft.; hard, fine-grained micaceous sandstone, 4 in.; blue shale, 1 ft........................	2	4

The coal is here above the level of the C. & S. E. R. R., and 15 ft. above the level of the creek. It dips west, and is said by the miners to get better as they go north. Only entry driven.

Up the branch to the southeast from the stripping mentioned above, coal is exposed at several places, and near the center of the section a number of openings have been made, and some stripping. The Old Dominion slope was at this point. At one slope the coal was exposed to a depth of 2 ft. 3 in., with 5 ft. of gray shale over. The slips are quite open, the face slips running N. 15° W., the butt slips N. 75° E. From face to face is very regularly 2 ft. 7 in. to 2 ft. 8 in.; from butt slip to butt slip, 1 ft. 11 in. to 2 ft. 2 in.

In the S. E. corner of the section is the old Chicago shaft of the Jackson Company; coal reported to be 37 ft. deep and to be divided into three basins by hills and local dips. The coal worked, supposed to be Coal IV, is very near the surface, and I think cropped out to the north. Nothing could be learned as to Coal III at this point.

785. In Sec. 18 Coal III outcrops above Otter creek nearly to where it leaves the section. Just west of McClelland's a bluff exposes this section:

	Ft.	*In.*
Fire-clay (under clay of Coal IV).		
Sand and shale (fake) and blue shale................	12	0
COAL III	1	8
Buff sandstone, hard, 6 in.; fire-clay, running into shaly sandstone, 12 ft.................................	12	6

At the west end of this bluff, close to where the C. & S. E. R. R. crosses the creek and enters a small cut, is a good exposure of a small fault. See Fig. 9, Plate II, drawn from a photograph.

The downthrow is about 6 ft., the hade being to the east. This is one of the most accessible faults in the coal field, and can be readily reached from Brazil by any one interested. The fault line in this case is very sharp, yet the crushing effect can be readily noticed in the coal to a distance of 6 in. or a foot from the line, and a trifle less in the sandstone. A few feet to the east is either a sharp bend or small fault in a hidden space, the downthrow in this case being to the west.

Across the creek north of this was the old Veach drift, where the coal is reported to be 3 ft. 6 in., and had to be mined by shooting. The coal along here is well above the creek, exposing a good thickness of Mansfield sandstone, which has been quarried some. The coal has been extensively mined on both sides of the creek. Among the older mines might be mentioned the Pawpaw, Sec. 18 (4), and Abby, Sec. 18 (10-11). At the latter, both beds were worked. West of the Abby the Brazil Block Company's shaft No. 7, Sec. 18 (13), has been more recently worked, though now worked out. Much of this coal was worked out in an early day by the Clay Coal Co. Some coal has been gotten out recently at the Beard bank, Sec. 18 (3); Miller bank, Sec. 18 (5), and some coal was being shipped in 1897 from an old opening of the Clay Coal Company, Sec. 18 (9). At the latter opening there shows above the coal, beginning at the top, 6 ft. of shale, 1 to 2 ft. solid sandstone, and 6 ft. of sandstone and shale in thin alternating layers to coal 3 ft. or more thick. The Dewey mine has recently been opened northeast of the Pawpaw.

786. Following down the creek through Sec. 19 are many old drifts, from which probably most of the coal on either side has been largely removed. In the '60's and '70's the Otter Creek Coal Company and Niblock Coal Company operated extensively in this section. One of these mines, later known as Coal Brook No. 3, operated both beds by a shaft. Sec. 19 (6); Coal Brook No. 5 worked Coal III by a slope, Sec. 19 (4). The coal at these points is reported to average about 3 ft. 7 in.

In the S. W. ¼ of Sec. 19 was the old Lafayette furnace, and considerable mining has been done in this locality. Near the furnace Coal IV is obtained by drifting, Coal III by sinking. At the furnace, however, the strata dip sharply to the southeast, so that a short distance west the following section is exposed above the creek (Sect. 245):

	Ft.	*In.*
Shaly sandstone.		
COAL IV	3	0
Fire-clay, 6 ft.; sandy shale, running into blue and gray mixed micaceous shaly sandstone, 12 ft.	18	0
COAL III	0	8
Fire-clay	6	0

From that point the strata dip to the west rapidly, and the 8 in. bed soon thickens up to nearly its normal thickness. The dip carries it below drainage before reaching the west side of the section.

A little coal has recently been gotten out at the Price drift, Sec. 19 (24).

At Sec. 19 (18) a little mining was being done in 1897 on Coal IV. It is here 20 to 25 ft. above Otter creek, and is 3 ft. to 3 ft. 6 in. thick, with the bench mining 1 ft. from the bottom. The roof is here "fake," the floor white sandy fire-clay, becoming hard below.

Where one of the old rooms of the Lafayette furnace mine has been worked to the crop, Coal IV is 4 ft. 4 in. thick, with a light brown to drab shaly sandstone roof. The "roll" shown in Fig. 9, in Part I, occurs in this room. In an adjacent room the roof is a characteristic "fake."

The Mansfield which is exposed along Otter creek, in Sec. 18, disappears a few rods south of the north line of the section, the dip there being quite sharp to the south or southwest.

787. In Sec. 20 Coal V has been worked a little on the Cornwall place, at Benwood, Sec. 20 (1). It was reported to be 3 ft. thick, full of sulphur, and to have 8 in. of bone coal in the bottom.

Just southwest of Benwood, Mr. John Beard is working Coal IV, winters. Coal reported to be 40 ft. deep, to average 4 ft. thick, ranging from 3 ft. 6 in. to 4 ft. 9 in. The roof is shale and reported to be poor.

A little south of Benwood was the old Weaver shaft, reported to have worked Coal V. This may be a mistake. Another bed not worked reported to underlie the worked coal.

The Cornwall mine of the Watson Company found Coal IV 3 ft. 7 in. thick at a depth of 85 ft.

At Nickel Plate No. 1 mine both Coals III and IV were worked, Coal IV being found at a depth of 90 ft. This mine is said to have been in the center of a fine basin, the coal dipping to the shaft from every direction, and for a while it was one of the most extensively worked mines in the State, some 500 men being employed, one shift working the bottom bed in the day, while another shift worked the top bed at night. Coal IV averages 4 ft. thick.

In the S. W. corner of the section coal was formerly mined extensively at the Buckeye shaft, Coal IV being 60 ft. deep, and averaging 4 ft. thick.

At the Perry and Fisher drifts, Sec. 20 (12 and 9 respectively), small remnants of this coal are being worked. At the Perry bank from 10 to 15 acres are reported as not having been touched yet. There Coal IV shows an average of 3 ft. 10 in., with the bench mining 14 to 15 in. from the bottom. The roof is shale and holds up well. The coal shows open clay slips, often open enough to admit one's finger. The dip is east. At the Fisher drift, working on pillars and will probably finish up in winter of 1897-8.

788. At the Nickel Plate No. 2 mine or New Nickel Plate, the section obtained has been given (¶757 and Fig. 339). Coal V was not met in sinking the shaft, but has been found underlying about 2 acres. At one point it is 3 ft. thick, with 10 in. of bone coal below, and is only separated from Coal IV by 3 ft. of "rock" (see Fig. 344).

Coal IV varies from 0 ft. to 4 ft. in thickness, with an average of 3 ft. 6 in. It is worked down to 2 ft. 4 in. The 2-in. soft bench mining is 18 in. from the bottom, the coal below being a little softer than that above. The roof of this coal is in places shale ranging from 0 to 8 ft. thick. In places the overlying shelly sandstone forms the roof. Sometimes up to 4 in. of bone coal comes between the shale roof and the coal. The floor is fire-clay, 3-4 ft. thick in places, soft and fine, in places full of boulders. This coal bed grows thin and is reported to outcrop to the northeast (see Fig. 351).

Coal III varies from 2 ft. 6 in. to 4 ft. in thickness, with an average of 3 ft. 1 in. It runs thicker and better to the northeast, as Coal IV grows thinner. Top coal, softer, 5-6 in. thick, and as a rule slips do not enter it, so that in breaking up it follows the false slips and breaks up into small blocks. This coal lies about 30 ft. below Coal IV. The roof is usually a gray shale, ranging in thickness from 0 to 12 ft. There are usually about 2 in. of bone coal between coal and roof. The floor is composed of 2-3 ft. of shale, underlain by 18 in. of coal. Both shale and coal thin out in every direction except to the west and northwest. Below the underlying coal is a black gray rock (not seen), with gray sandy fire-clay in places. See Fig. 358.

Two faults have been met in this mine, one having a downthrow of probably 18-20 ft., the other a small fault, with downthrow just the thickness of the beds.

In the Jackson shaft, just north, the larger fault was met with, cutting diagonally across the shaft. The double entry was driven from the level of the coal in the shaft, and at a distance of 90 ft. met the downthrown coal regaining its old level. It is of interest that when the coal in the mine was nearly worked out, a cross entry was driven a short distance from and parallel to the main entry, only following down the downthrown coal, and a room was worked out under the original main entry (see Fig. 14, Plate II).

789. In Sec. 21, at the Jack Oak mine, Coal IV is 46 ft. deep, the following section being obtained (Fig. 349):

	Ft.	In.
Surface, 12 ft.; yellow boulder clay, 8 ft.	20	0
White sandstone, 14 ft.; black shale, 13 ft.	27	0
COAL IV	4	0
Fire-clay, hard, not gritty	2	0

In Coal IV the bench mining of 2 to 4 in. is about in the middle of the bed, the coal above being bright, while that below is darker and heavier. Coal III, 3 to 3 ft. 6 in. thick, is reported to lie about 25 ft. below Coal IV, and has not been opened upon. There are about 20 acres yet unworked in this corner of the section.

At the old Star mine, in the N. E. corner of the section, Mr. Cox reported the following section at the No. 1 mine* (Sect. 246):

* 1st Ann. Rep. Geol. Surv. of Ind., p. 48.

	Ft.	In.
Red clay, 14 ft. 7 in.; boulder clay, 4 ft.	18	7
White sandstone, 23 ft. 6 in.; silver gray sandstone, 15 ft.; blue clay shale, 1 ft.; light gray sandstone, with carbonaceous markings in the seams, 2 ft. 11 in.; blue clay shale, 3 ft. 3 in.	45	8
COAL III, called "I" (IV) by Cox	4	8
Fire-clay, soft, dark, containing roots of plants, 3 ft. 6 in.; light gray sandstone in bottom of shaft, 15 ft. (probably Mansfield)	18	6
Total	87	6

Evidently Coal IV is wanting in this section. Its place would appear to be under the 2 ft. 11 in. sandstone, judging from what was afterwards found, as described by Mr. Duncan McCullom, now of Clinton. At this shaft the coal appeared to rise in all directions. A few rods east No. 2 shaft was sunk, finding the coal at practically the same level, at 34 ft., and with a thickness of 5 ft. To the north of No. 2 shaft the coal rose to a crop, as at No. 1, but to the southeast dipped and became thinner and thinner in an entry driven west from the main south entry. An entry driven from No. 1 to meet this entry rose to meet it, but the coal maintained its thickness. This puzzled those engaged in the work, as they were supposed to be working the same bed, until the entries were driven together, when it was found that shaft No. 2 had been working Coal IV, and in the entry just driven it had dipped until only 8 in. above Coal III, when it thinned out entirely. Going back to No. 2 shaft, they found that the coal worked at No. 1 shaft was 49 ft. deep at No. 2 shaft, with 10 ft. of fire-clay between the two beds. The following diagram may help to make clearer this interesting relation as described by Mr. McCullom, and is a good illustration of the irregular manner in which the coal beds are often found to lie, and how readily one may fall into error where only meagre outcrops or borings must be depended upon:

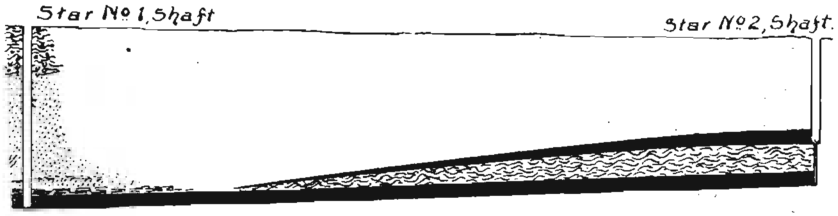


Fig. 360. Showing interesting relation of Coals III and IV at Star Nos. 1 and 2 mines.

An analysis of coal from this mine by Mr. Cox is given in ¶767. The territory south of these mines is now being worked from B. B. C. Co.'s No. 3 mine.

790. The section at the Brazil Block Coal Company's No. 3 mine is given in ¶756; see also Fig. 338. Coal V is here reported as 2 ft. thick, at a depth of 64 ft., with a foot of bone coal underlying (Fig. 343). Coal IV varies in thickness from 3 ft. 8 in. to 4 ft. 6 in. The bench mining of soft or free coal, 2 in. thick, runs 1 ft. 11 in. (where measured) from the bottom. At one place a little clay was noticed at the level of the bench mining. This was not noticed anywhere else in the district. The bottom 2 or 3 in. of the coal is a soft, free coal. The roof is either a dark blue shale, varying up to 6 ft. in thickness, or a fine white sandstone, with numerous carbonaceous partings. The sandstone does not seem to affect the thickness of the coal, as in one room with sandstone roof the coal was measured and found to be 4 ft. 6 in., equal to the thickest coal in the mine. Where the shale is only a foot or two thick, it tends to come down, leaving the overlying sandstone as the roof. The face slips run N. 30° W., butt slips N. 60° E. A number of measurements gave an average of 2 ft. 6 in. between face slips and 2 ft. between butt slips.

The floor of this bed is made up of from 2 to 4½ ft. of plastic fire-clay, with sometimes a little soft shale immediately below that. See Fig. 350.

Coal III varies from 2 ft. 8 in. to 4 ft. in thickness, with an average of 3 ft. 4 in. (Fig. 359). The soft top coal has a thickness of from 1 ft. to 18 in., is not usually entered by main slips, sticks to the roof in mining, and when wedged down later, breaks up into small blocks. All the slack comes from this top coal and the slack made in undermining. The top bench varies in thickness about in the same proportion as the coal bed, as a whole. The main body of the coal is a fine block, a little harder than Coal IV, and when thick, comes out in somewhat larger blocks, the slips averaging about 6 in. farther apart.

The roof of this coal is either a gray to brown shale, full of plant remains, or characteristic sandstone shale (fake). The relation of the shale and fake could not be clearly determined. In places the shale appears to simply underlie the fake. In other places they appear to grade into each other, the shale beginning to show thin streaks of sandstone, which increase in number until fully one-half or more of the rock consists of thin sandstone flakes. The fake tends to cut in the entries in the peculiar way described in Part I. The thicker and better coal occurs under the shale roof.

The floor of this seam is made up of from 4 to 6 in. of shale or fire-clay, underlain by from 4 to 8 in. of bone coal, as in most of this district, not being uniform throughout, but consisting of thin streaks of pure coal, separated by thin bands of black shale. In places the pure coal so predominates as to make a poor grade of burnable coal. Beneath the bone coal is a hard, sandy fire-clay. As in most of this district, these coals usually show a marked thinning on the hills.

The old Diamond mine lay just east of No. 3. Both beds were reported as having been worked here, averaging 3 ft. 8 in. thick, and found at depths of 60 to 75 ft., respectively.

Gart, No. 1 mine lay west of No. 3. Both beds are said to have averaged over 4 ft. in this mine. It was one of the earliest mines in the region, and was worked extensively for many years.

Gart, No. 2 lies just south of No. 3, and had practically the same coal to work on.

Some drillings on the S. W. corner of the section, on the old Bahan farm, are instructive in showing the variations of the rocks there. They were reported by Mr. Cox* (Sect. 247).

(No. 1 bore) Sect. 247—	*Ft.*	*In.*	*Ft.*	*In.*
Surface, soil and clay, 7 ft.; soft clay and sand, 2 ft.; boulder clay, 13 ft. 10 in.; hard clay and sand, 13 ft. 2 in.; soft brown clay, with drift wood, 2 ft.; clay shale (?), 1 ft. 8 in.; coarse gravel and sand, 0 ft. 4 in.; hard clay and sand, 8 ft. 6 in.	48	6	..	..
Sandstone, 0 ft. 2 in.; clay shale, 6 ft. 5 in.	6	7	55	1
COAL V	0	1	..	..
Fire-clay	1	1	56	3
(No. 2 bore) Sect. 248—	*Ft.*	*In.*	*Ft.*	*In.*
Surface and clay, 7 ft. 6 in.; soft clay and sand, 7 ft. 0 in.; clay, 1 ft. 0 in.	15	6	..	..
Hard brown sandstone	5	2	20	8
Place of Coal V?				
Potters' clay, 1 ft. 2 in.; blue shale, 2 ft. 2 in.; iron ore, 0 ft. 3 in.; blue shale, 2 ft. 2 in.; iron ore, 0 ft. 1 in.; blue shale, 1 ft. 5 in.; iron ore, 0 ft. 1 in.; blue shale, 0 ft. 7 in.; shale, with thin sandstone, 1 ft. 3 in.; clay shale, 5 ft. 3 in.; sandstone, 26 ft. 12 in.; shale, 0 ft. 1 in.	39	7½	60	3½
COAL IV	4	3	64	6½
Fire-clay.				

*1st Ann. Rep. Geol. Surv. of Ind., 1869, pp. 51-53.

(No. 3 bore) Sect. 249—	Ft.	In.	Ft.	In.
Surface, soil and clay, 8 ft. 6 in.; soft clay and sand, 7 ft. 0 in.; boulder clay, 2 ft. 0 in.	17	6	..	..
Hard sandstone, 6 ft. 1½ in.; soft bluish sandstone, 7 ft. 6 in.	13	7½	31	1½
COAL V (good coal, bone coal 6 in.)	2	8½	33	10
Fire-clay, good, 4 ft. 9 in.; sandstone, 0 ft. 2 in.; light blue sandstone, 9 ft. 6 ½ in.; "rotten limestone" (?), 3 ft. 8 in.; blue shaly sandstone, 9 ft. 2 in.; sandstone, 10 ft. 5 ½ in.	37	9	71	7
COAL IV	4	2	75	9

(No. 4 bore) Sect. 250—	Ft.	In.	Ft.	In.
Surface, soil and clay, 6 ft. 6 in.; soft clay and sand, 8 ft. 6 in.; boulder clay, 12 ft.	27	0	..	..
Clay shale	8	4	35	4
COAL V (good coal, 2 ft. 6 in.; "rotten" coal, 1 ft. 1 in.)	3	7	38	11
Fire-clay, 6 ft. 5 in.; sandstone, 3 ft. 3 in.; pale blue shale, 19 ft.; sandy shale, 2 ft. 2 in.; blue sand and shale, 12 ft. 8 in.	26	3	65	3

791. SECTION 22.—Coal has been mined in this section only in the S. E. ¼, near the old Planet furnace. The old shaft at the Planet furnace gave the following section (Sect. 250a, from notes of E. T. C.):

	Ft.	In.
Clay and drift, 10 ft.; boulder clay, 24 ft.; blue-gray shale, 1 ft.	35	0
COAL III	4	0
	39	0

In 1897 two small shafts were opened to Coal III, on the Buchanan place, Sec. 22 (4 and 5). Coal III occurs just below the level of drainage at that point and runs from 3 ft. 6 in. to 4 ft. 6 in., including 6 in. of soft top coal (which has to be left for roof, as there is only boulder clay above), and 1 ft. of soft coal at bottom. Coal was formerly mined close by the old furnace, both by shaft and drift, to supply the furnace. No very reliable information could be obtained as to the coal underlying the rest of the section. In the S. W. of the N. W. ¼ a drilling was reported to have found 3 ft. 8 in. of coal at between 45 ft. and 50 ft. This might, however, have included the underlying bone coal.

In the S. W. ¼ section the coal is reported to be of good thickness, the mining at the Diamond shaft just west having been carried up to

the section line. On the whole, it would seem probable that a good basin of coal may still exist in this section, though so near the surface that it may not be found profitable to mine it.

792. SECTIONS 27 and 34 are probably underlain for the most part by the horizon of Coal III, but so far as could be learned no borings have yet found workable coal in them. Future prospecting may reveal workable basins.

793. SECTION 28.—This section is dotted with mounds, now becoming overgrown with shrubs and other vegetation, that once marked the position of the different mines. As far as could be learned, all the coal of this section has been worked out.

The N. E. ¼ of this section may be an exception as regards being worked out. The following two sections were obtained here by Mr. Cox:

SECTION 250B. SECTION OF DRILLING ON JOHN TRIPLET PLACE. —E. ½ of N. E. ¼, Sec. 28. (E. T. C. notes.)

	Ft.	In.
Soil, clay and gravel, 15 ft. 6 in.; boulder clay, 1 ft.; blue clay, 3 ft. 6 in.; dark blue clay shale, 2 ft. 6 in.; dark shale, 6 in.	23	0
COAL IV	2	0
Fire-clay, 10 ft.; sandstone, 2 ft. 6 in.; blue clay shale, 1 ft.; kidney iron ore, 6 in.; sandstone, 14 ft.; sandy shale, 6 in.	28	6
COAL III	1	9
Fire-clay.		
	55	3

SECTION 250C. SECTION OF DRILLING ON JOHN TRIPLET PLACE. —E. ½ of N. E. ¼, Sec. 28. (E. T. C. notes.)

	Ft.	In.
Soil, clay and gravel, 13 ft. 6 in.; boulder clay, 10 ft. 6 in.; clay shale, 11 ft.	35	0
COAL III?	3	10
Fire-clay.		
	38	10

The location of the following mines is shown on the map:

1. Gart. No. 4.
2. Hancock.
3. Crawford No. 1.
4. Briar Hill.
5. Crawford No. 2.

794. SECTION 29.—Coal is being worked extensively at the Brazil mine, World's Fair mine, and Andrew's mine (just opened), in this section.

795. At the Brazil mine all three beds are of workable thickness. For the columnar sections, see ¶758 and Fig. 340. Coal V is here 3 ft. 3 to 4 in. thick, with from 1 ft. to 1 ft. 2 in. of bone coal under; see Fig. 346. The roof of this coal to the north of the shaft consisted of 4 ft. of black shale, overlain by 17 ft. of impure limestone. Over the most of the mine, however, sandstone replaces these, making the roof. This coal was found at a depth of 58 ft. and was at first opened upon under the impression that it was Coal IV, or the upper block coal.

Coal IV was only 1 ft. thick at the shaft, but averages 4 ft. through the mine (Fig. 352). It has the usual 2 in. of free coal 14 in. from the bottom. Gray or black shale makes the roof, the black shale proving the better roof. A carboniferous channel now filled with "white top" cuts out this coal bed over quite a width and along a course that winds irregularly through the mine. It is of interest that Coal V proved to be the thickest and best where it overlies the course of this old channel, and Coal III is reported the same under the old channel. The floor of this bed is a fire-clay, merging, in a few feet, into white sandstone.

Coal III averages here 3 ft. 3 in., with ½ in. of bone coal underlying in places. The soft top coal is 8 in. thick. The roof is a hard sandstone, 1 to 2 ft. thick, overlain by shale. The floor is a hard sandstone. As observed in this mine, the coals about follow each other in the dipping or rising, though Coal V appears to be more independent than the others.

796. At the World's Fair mine Coal IV is being worked. An imperfect section here is as follows (Sect. 251):

	Ft.	In.	Ft.	In.
Surface, 25 ft.; limestone (locally), 2-0 ft.; black shale, 6 ft.	32?	0	32?	0
COAL V ....0 to	1	0	33?	0
Fire-clay, 4 ft. 8 in.; white to gray sandstone, with black partings, 10-15 ft.; blue shale, 0-8 ft.	31?	0	64	0
COAL IV	3	6	67	6
Fire-clay, 10 ft., etc. ....15 ft. to	25	0	92	6
COAL III (including bone coal)	2	0	94	6
Fire-clay, 5 ft.; shale, ?, "hard conglomerate."				

Coal IV here averages 3 ft. 6 in., though ranging up to 4 ft. 4 in. It has the 2-in. bench mining about 15 in. from the bottom. The

slips are not quite as marked in the top 4 in. of the coal, but that coal comes with the rest of the block, not separating, as with the top coal usually forming the upper part of Coal III. The roof is usually a blue shale ranging from 0 ft. up to 8 ft., with an average thickness of 3 ft. In places the shale feathers out and the overlying sandstones come down to the coal forming the roof. As a rule, the coal is found to be better under the shale roof.

Out of five 40-acre tracts adjacent to this mine, only one has proved up well. Several channels running northwest and southeast have cut out the coal, the channel filling usually being "white top." One of the channels ran west of north only a short distance east of the shaft. Many faults have been met with running in all directions. The largest ran east and west and had a downthrow of 4 ft.

At the Gartside or Jumbo mine, recently worked out, both beds were worked, Coal IV being worked by a tunnel driven up from Coal III. This mine is a good illustration of the unsatisfactory results often obtained with the churn or jumper drill, as I understand the territory adjacent was drilled over several times and declared not to contain workable coal.

797. SECTION 30.—In this section, and running down into Sec. 31, Coal IV is reported to have occurred in a basin of fine quality, while Coal III is, over most of the area, too thin to work. In an early day coal was worked here by Andrews, Butsch and Dickson, and Jane Ernhart, in the eastern half of the section. Later the western half was nearly worked out through the Morris, Campbell and Bartlett shafts by the Brazil Block Coal Company. These mines were all worked into one another. Some coal in the northwest part of the section was also worked out from the Masten shaft.

At present Coal IV is mined at two places in connection with its under clay, the latter being used in the manufacture of clay products.

798. At the Excelsior Clay Works, Coal IV, 3 ft. 8 in. thick, is mined by a slope. The section here, as well as could be obtained, is (Sect. 252):

	Ft.	In.	Ft.	In.
Surface, 15 ft.; light gray clay shale, with a little grit, 12 ft.	27	0	27	0
COAL V ....1 ft. 7 in. to	1	10	28	10
Potters' clay, 5 ft.; sandstone, 8 ft.; shale, ?	13	0	41	10
COAL IV	3	8	45	6
Fire-clay, sandy	5	0	50	6

The upper part of the section is exposed at the shale pit a little northeast of the ovens. The coal is mined farther to the west, down a small drain. Coal V is made up of 15 to 18 in. of good coal overlain by 4 in. of bone coal. The shale overlying contains sufficient sand so that it can be used without further mixing. Coal IV has the usual bench mining about 2 ft. from the bottom. The roof is largely sandstone, with some "white top," which is reported as better for manufacture than the under clay. The floor is composed of a sandy fire-clay, which is used in the manufacture of brick. The shale is drawn up a highly inclined slope directly to the plant. The coal and under clay are drawn by mules to a point in the ravine just north of the plant, and then hauled up in the same manner as the shale.

There appears to be a fault running through the ravine throwing the strata up on the south side as to expose Division III (?). There is a creek level, on that side, and for 5 ft. above, an outcrop of massive sandstone, then black shale in place of Coal III (?); above this is shale to what was thought to be the under clay of Coal IV.

799. The Weaver Clay and Coal Company are mining Coal IV by a drift, Sect. 30 (9). The coal measured 3 ft. 2 in., with the bench mining 10 in. from the bottom. The roof is blue shale, 8 to 10 in.+ thick, becoming brown in the upper part. The under clay is mined to a depth of three ft. Coal and clay are hauled to the plant on a long tramway by horse power.

Coal has been mined at numerous places along this branch, running from the old furnace to the Brazil mine. Of these, the Galley, Ernhart and Lee slopes were partly open and were worked in 1896 or shortly before. At the Galley drift 2 ft. 10 in. of coal were exposed, with a shale roof, which, however, ran at once into a shaly sandstone. At the Lee drift the coal and roof were the same as at Galley's.

800. SECTION 31.—No mining is at present being done in this section. Of the old mines, the location of the Ashley and Strain and Morris shafts are shown on the map. The section at the Ashley shaft as reported by Mr. Cox was given in ¶759, Fig. 341. As in Sec. 30, Coal III is not of workable thickness under this section as far as explored. Coal IV was said to have been of the finest quality. This section is now principally occupied by the city of Brazil, so that it is unlikely that much, if any more, coal will be mined from under it, even if it exists there.

801. SECTION 32. The coals are, in this section, very near the surface. A section at a shaft a half mile west of Knightsville, sunk in 1862 by Mr. John Andrews, is reported by Mr. Cox to have given the following section* (253):

* 1st Ann. Rep. Geol. Surv. of Ind., p. 53.

	Ft.	In.	Ft.	In.
Drift, 18 ft.; dark gray sandstone, lower part soft and mixed with coal, 6 ft.	24	0	24	0
COAL IV	0	6	24	6
Fire-clay and clay shale, 12 ft.; sandstone, 4 ft.	16	0	40	6
COAL III	1	8	42	2
Fire-clay, hard and sandy, 4 ft.				

Shaft ends here; a boring yielded the following additional strata:

	Ft.	In.	Ft.	In.
Sandstone very white and coarse-grained, 12 ft.; bluish-gray shale, 16 ft.; clay shale, soft and easily bored, 65 ft.	93	0	135	2

The coal in this shaft dipped east at the rate of 1 ft. in 12 ft.; 30 rods east of the shaft a boring by Mr. Andrews gave, according to Mr. Cox* (254):

	Ft.
Drift	12
COAL IV	4

A shaft a few yards from this found Coal IV at the same depth as in drilling, but having only the drift for a roof, it could not be worked economically, and so was abandoned. A boring from the bottom of this shaft found Coal III 16 ft. below and passed through the same section as in the first drilling just above.

At present (1897) the only mining being done in this section is at the McIntosh shaft, Sec. 32 (7). This shaft was at first sunk in 1896 to Coal IV. By April, 1897, they had worked out all the available coal from Coal IV. In November, 1897, after the writer had visited the area, they continued the shaft down to the lower coal. At the shaft, Coal III was only 14 in., but is reported as workable to the east.

Knightsville is surrounded by the slack piles of old mines. Of these the map shows the position of the old Guest mine, the Guest and Morgan, the Old Peanut, or Eureka No. 1, the New Peanut, the Garfield and the Knight. At the old Guest and Morgan it is reported that the coal ran out to a crop to the north. The old Peanut was originally sunk to Coal III, and, after being operated by different owners, a tunnel was, in 1886, driven up to Coal IV. At the New Peanut the coal was reported to have been only 12 ft. deep, and as a result much trouble was experienced with the roof and with water. At the Garfield, Coal IV only was at first worked at an early day, the

* Loc. cit.

coal being reported to be 3 ft. 5 in. When Coal IV was worked out, the mine was abandoned. Later, the discovery of Coal III led to its being reopened, and Coal III was worked out.

This section is nearly worked out, unless it be that body of Coal III of good thickness still exists in the southern or southeastern part of the section.

802. SECTION 33.—No coal was being mined in this section in 1897. The eastern part of the section is generally considered barren of coal. The N. W. ¼ south of the railroad appears to have been all worked out through the old Town shaft and Guest shaft. North of the railroad some coal has been mined recently by a slope on the Robinson place. In the S. W. ¼ Coal IV has been extensively mined from the old Armstrong shaft. It is reported that in working Coal III at the Garfield shaft the coal extended over into Sec. 33 beyond their line, in full thickness, indicating that there is still a good body of that coal in that quarter section.

803. Section 34 is generally considered barren of coal.

TOWNSHIP 13 NORTH, RANGE 17 WEST. (PART IN CLAY COUNTY.)

Section 1. Geography.

804. POSITION.—Only the eastern two-thirds of this township, or the part in Clay county, will be considered here. It forms the northwestern part of the county, corresponding with the civic township of Dick Johnson, and in its southern corner with Brazil township. See Sheet B and Plate XXX.

805. TRANSPORTATION.—No point of this township is more than 1½ mi. from a railroad, while only seven sections are not already entered or crossed by some railroad or its switches. The C., C., C. & St. L. R. R. crosses the northern part of the township, with the Caseyville branch of the C. & E. I. Ry. still north of it. The main line of the C. & E. I. crosses the central part of the township and extends down the southeastern side to Brazil. The Otter Creek branch of the C. & E. I. crosses the southern part of the township. The Vandalia just tips the southeastern corner.

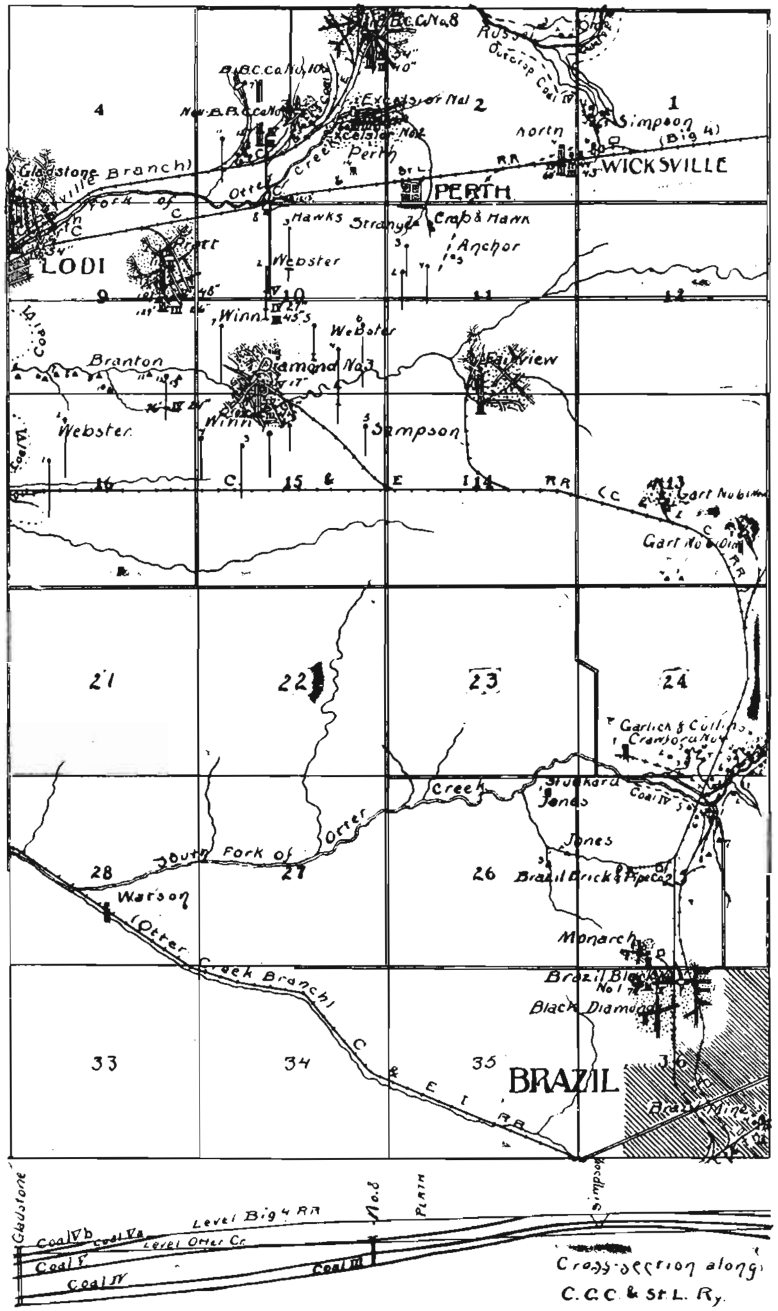
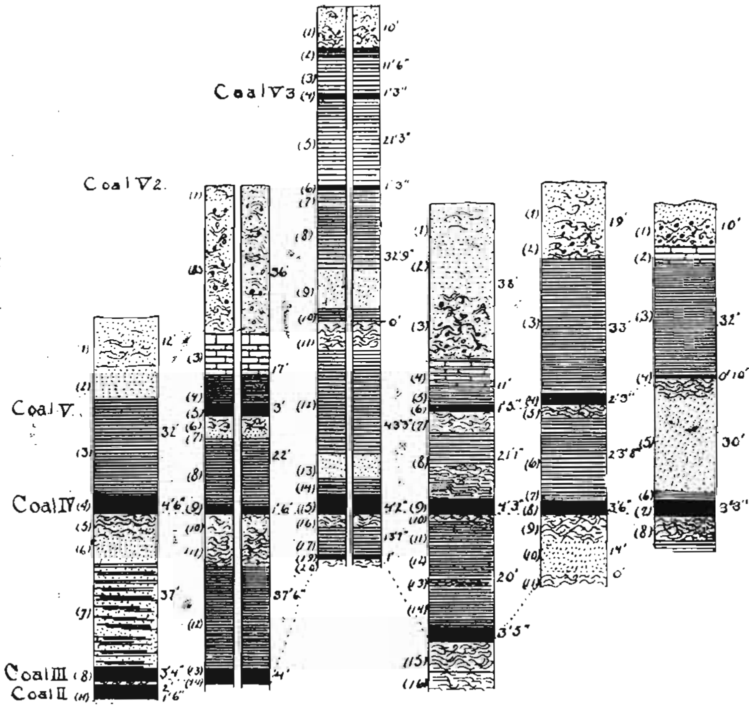


PLATE XXX. Sketch map and cross setions, T. 13 N., R. 7. W.

Sections 2. Coals Contained and their Relations.

806. Divisions Outcropping.—With the exception of very small areas of Divisions I and VI, the rocks outcropping in this township are in Divisions III to V, inclusive. The coals are therefore much as in the last township discussed, except that certain minor additional coals are found. As none of these minor coals are known to have been mined in the township, the three principal coals will be called Coals III, IV and V, respectively.

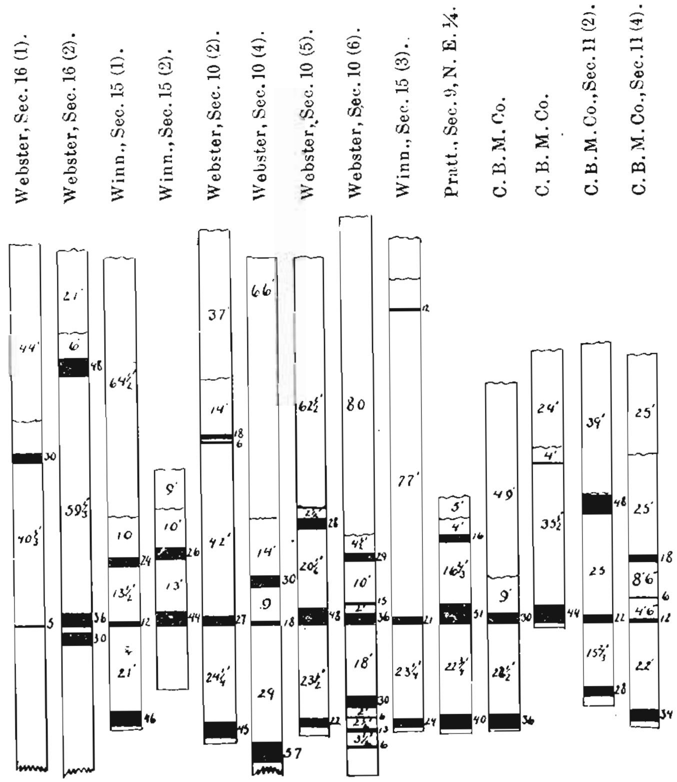


361 B. B. C. Co. No. 8. Sec. 3 (1). 362 B. B. C. Co. No. 10. Sec. 3 (11). 363 Glad-stone. Sec. 4 (1). 364 Diamond. Sec. 10 (1). 365 Monarch. Sec. 25 (10). 366 Brazil. Sec. 36 (3).

Figs. 361-366. Type columnar sections, T. 13 N., R. 7 W.

807. Vertical Relations of Coals.—The vertical relations of the coals are shown in the group of selected columnar sections, Figs. 361 to 366, and in the skeleton coal columnar sections, Figs. 367 to 380. With the latter figures some doubt exists as to the correctness of the correlations indicated with some of the figures.

In the following typical columnar sections, the section at the Gladstone mine, which is the most westerly, includes higher strata than any of the others. This is due simply to the rapid westerly dip of the rocks, the top of the drilling having been probably as low or lower than the top of the section at B. B. C. Co.'s No. 8 shaft:



367 368 369 370 371 372 373 374 375 376 377 378 379 380

Figs. 367-380. Skeleton sections of drillings, T. 13 N., R. 7 W.

808. Section 255. Section at B. B. C. Co.'s No. 8 Shaft.—Sec. 3 (1), Fig. 361.

	Thickness of Strata. Ft.	In.	Coals and Spaces. Ft.	In.	Total Depth. Ft.	In.
1. Sand	12	0	..	..	12	0
Division IV—						
2. Sandstone	8	0	..	..	20	0
3. Shale	24	0	..	..	44	0
4. COAL IV	4	6	4	6	48	6
5. Fire-clay	4	6	..	..	53	0

	Ft.	In.	Ft.	In.	Ft.	In.
Division III—						
6. Sandstone, gray	7	6	..	..	60	6
7. Sandstone and shale	25	0	..	..	65	6
8. Shale ....2 in. to	0	6	37	6	86	0
9. COAL III	3	4	3	4	89	4
10. Fire-clay ....1 in. to	0	4	..	4	89	8
Division II—						
11. COAL ....0 ft. to	3	6	3	6	93	2
12. Shale	12	0	..	..	105	2

Section starts only a few feet above Otter creek.

809. SECTION 256. SECTION NEAR B. B. C. CO.'S NO. 10 MINE. —Sec. 3 (7), Fig. 362. Drilling.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface soil	3	0	..	..	3	0
2. Boulder clay ("hard pan").	33	0	..	..	36	0
Division V—						
3. *Limestone*	10	0	..	..	46	0
4. *Black Shale*	7	0	..	..	53	0
5. COAL V	3	0	3	0	56	0
6. Fire-clay	3	0	..	..	59	0
Division IV—						
7. Sandstone	2	0	..	..	61	0
8. Shale, blue	17	0	22	0	68	0
9. COAL IV	1	6	1	6	79	6
10. Fire-clay ("rock")	5	0	..	..	84	6
11. Fire-clay	7	6	..	..	92	0
Divisions III and II—						
12. Shale, gray	25	0	37	6	117	0
13. COAL III and bone coal of Coal II	2	0	2	0	119	0
14. Coal II (in part).........	2	0	2	0	121	0

In this section Coal V is about on a level with top of preceding section.

810. SECTION 257. SECTION NEAR GLADSTONE MINE.—Sec. 4 (1), Fig. 363. Drilling.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	10	0	..	...	10	0
Division V—						
2. Black shale	2	0	..	..	12	0
3. White shale	9	6	..	..	21	6
4. COAL Vb	1	3	1	3	22	9
5. White shale	21	3	21	3	44	0
6. COAL Va	1	3	1	3	45	3
7. White shale	4	5	..	..	50	0
8. Blue shale	15	0	..	..	65	0
9. Sandstone	10	0	..	..	75	0

	Ft.	In.	Ft.	In.	Ft.	In.
10. Gray shale	3	0	..	..	78	0
Place of Coal V.						
11. Fire-clay	7	0	..	..	85	0
Division IV—						
12. Shale, blue	25	0	..	..	110	0
13. Sandstone	7	3	..	..	117	0
14. Shale, gray	4	0	75	8	121	0
15. COAL IV	4	2	4	2	125	2
16. Fire-clay	3	0	..	..	128	2
Divisions III and II—						
17. Shale, blue	10	7	13	7	138	9
18. COAL and shale	0	6	0	6	139	3
19. COAL	0	6	0	6	139	9
20. Fire-clay	1	0	..	..	140	9

The upper part of this section is exposed in outcrop just across the line in Vigo county, and should be used instead of the section in the drilling. It is as follows (Sect. 258):

	Ft.	In.
Division V—		
1. *Shale, black and sheety*.........................	1	0
2. COAL Vb	2	0
3. Fire-clay	1	0
4. Sandstone, gray	0	3
5. Shale, gray	4	0
6. Iron and lime concretions...............2 in. to	0	6
7. Shale, blue	2	0
8. *Shale, black and sheety*.........................	1	0
9. COAL Va	2	3
10. Fire-clay	3	0

The drilling above reported at the Gladstone mine was only a few yards from where the shaft was sunk later. One of the men who helped sink the shaft claimed that four small beds of coal were passed through before the 4-ft. bed was reached. Other sections obtained make it seem probable that Coal V was lacking at the point of this drilling and that its horizon is as indicated.

811. SECTION 259. SECTION IN DIAMOND NO. 3 SHAFT.—Sec. 10 (1), Fig. 364.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	10	0	..	..	10	0
2. Sand	12	0	..	..	22	0
3. Boulder clay ("hard pan")	16	0	..	..	38	0
Division V—						
4. *"Lime and shale"*........	5	0	..	..	43	0
5. *Shale, dark*	6	0	..	..	49	0
6. COAL V	1	5	1	5	50	5
7. Fire-clay	5	0	..	..	55	5

	Ft.	In.	Ft.	In.	Ft.	In.
Division IV—						
8. Shale, blue	16	1	21	1	71	6
9. COAL IV, 2 ft. 9 in. average of mine	4	3	4	3	75	9
10. Fire-clay	1	6	..	..	77	3
Division III—						
11. Clay and shale	8	0	..	..	85	3
12. Shale, gray	6	0	..	..	91	3
13. Clay, soft	1	6	..	..	92	9
14. Shale, dark	10	0	21	0	102	9
Place of Coal III average of mine	3	5	3	5	106	2
Division II—						
15. Fire-clay	7	9	..	..	113	11
16. Clay and shale, soft	16	0	..	..	129	11

812. SECTION 260. SECTION OF MONARCH SEWER PIPE CO.'S SHAFT.—Sec. 25 (10), Fig. 365.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and yellow clay	12	0	..	..	12	0
2. Boulder clay, blue	7	0	..	..	19	0
Division V—						
3. Clay shale, gray	33	0	..	..	52	0
4. COAL V	2	3	2	3	54	3
5. Fire-clay (potters' clay)	3	2	..	..	57	5
Division IV—						
6. Clay shale, blue	19	0	..	..	76	5
7. Shale, dark bituminous fossiliferous	1	6	23	8	77	11
8. COAL IV	3	6	3	6	81	5
9. Fire-clay	5	4	..	..	86	9
Division III—						
10. Sandstone, blue, hard	9	0	13	4	95	9
Place of Coal III	..	..	0	0	..	..
11. Fire-clay.						

813. SECTION 261. SECTION OF OLD SHAFT NEAR DEPOT AT BRAZIL.—Sec. 36 (4). See Fig. 366. Reported by Richard Owen.*

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and drift	10	0	..	..	10	0
Division V—						
2. *Limestone*	4	0	..	..	14	0
3. Clay shale	28	0	..	..	42	0
4. COAL V	0	10	0	10	42	10
Division IV—						
5. Sandstone	28	0	..	..	60	10
6. Shale	2	0	..	..	72	10
7. COAL IV	3	3	3	3	76	1
8. Fire-clay	6	0	..	..	82	1
Divisions III and II—						
9. "Blue shales indefinitely down."						

*1862. Rep. Geol. Reconn. of Ind., p. 169.

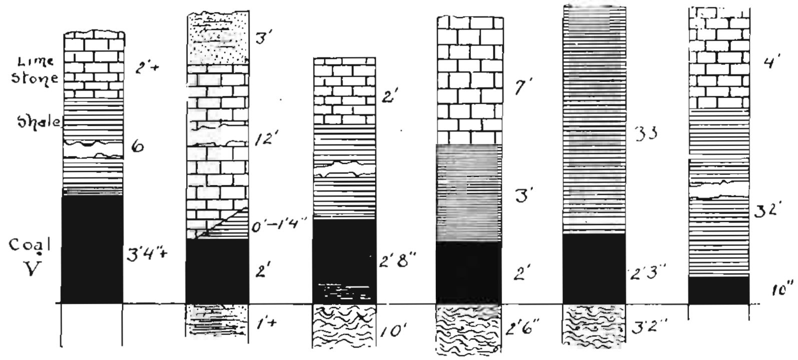
814. DISCUSSION OF SECTIONS.—The sections show a variation in the thickness of surface soil and drift of from 10 to 38 ft., or up to 80 ft., including the skeleton sections, as will be done in this discussion. As might be judged, especially from the thickness of the drift given in the skeleton sections, the preglacial erosion plays an important part in the distribution of the coals of this township. Probably the most important channel as far as discovered, is one that is reported by Mr. Zimmerman, and others, to cross into this township from Sec. 7 of the township east, to pass southwest across Secs. 12, 13, 14, 23, etc., cutting out the coals over a broad belt between B. B. C. Co.'s No. 6 mine and Fairview mine. This channel is supposed to turn south and pass a mile or two west of Brazil. Hardly enough drilling has been done to definitely fix its course. The presence of other channels is well indicated in the skeleton sections given.

The notable preglacial erosion of the surface of this township has been an important factor in making mining slow to start up, especially in the southern half of the township, and has interfered very seriously with mining operations at many points where it has been undertaken.

815. DIVISION VI.—Coal VI and its accompanying strata were not seen, nor were they reported in this township. From their position just across the county line at two points, it is reasonably certain that they lap over into Clay county in Sec. 16 and possibly in Sec. 9. It will suffice to say that Coal VI ranged from 6 to 7 ft. at the nearest exposures just across the Vigo county line, and it would doubtless maintain that average to its outcrop. The area as indicated on the map, will be so small and the coal so near its outcrop that it need not be counted on for a very large yield.

816. DIVISION V.—The rocks of this division will be the first rocks met with in drilling or shaft sinking in nearly every part of the township. The outcrops of the lower formations will be confined to the eastern part of the valleys of the north and south forks of Otter creek. This division attains considerable thickness in the western part of the township, where it contains two coals in addition to the bed commonly known in the block coal field as the "rider." These two upper coals very closely resemble each other—and were it not for the frequent finding of both in the same bluff or in other sections, they would easily be confused with each other, and with the underlying Coal V. They vary from a few inches to 2 ft. or a little over in thickness, and are usually both overlain by a black, sheety, bituminous shale. The other accompanying rocks are usually shales, a little sand-

stone, particularly in lenticular masses, lines of concretions of iron and lime and a little calcareous, fossiliferous shales, overlying the black shale, that elsewhere is frequently a hard, ringing limestone, though not observed as such in Clay county. Probably not more than a few tons have been mined from the beds altogether and that at scattered points of their outcrop.



381 Excelsior No. 2. Sec. 3 (4). 382 Outcrop. Sec. 10 (8). 383 Pratt. Sec. 9 (1). 384 Diamond. Sec. 10 (1). 385 Monarch. Sec. 25 (10). 386 Brazil. Sec. 36 (3).

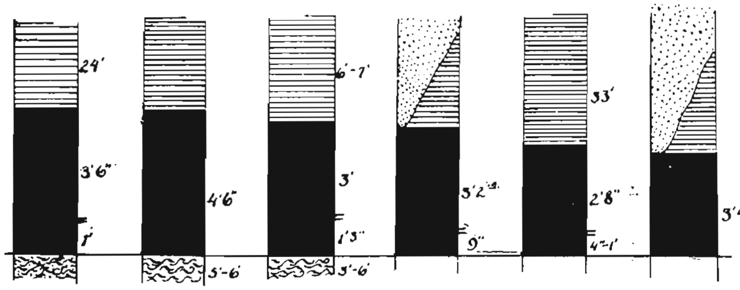
Figs. 381-386. Type sections of Coal V, T. 13 N., R. 7 W.

The characteristics of Coal V and accompanying strata are shown in Figs. 381 to 386. These show that the bed is not of workable thickness over most of the township. Around Perth and to the northwest it is frequently found ranging from 3 to 4 ft. and has been worked a little. The shale over it is in places black, bituminous and sheety; in other places it acquires a thickness of 20 to 30 ft., in which case it is usually a drab or blue color and has been found very suitable for the manufacture of clay products.

The outcrop at the shale pit of the Indiana Paving Brick Co., two miles north of Brazil, on Otter creek, well illustrates this facies of the shale. The limestone overlying Coal V acquires an unusual thickness in the northern part of the township, sometimes being found from 10 to 20 ft. thick. Notwithstanding this thickness, it is not as persistent as would be expected, as in many cases it is found strongly developed at one point, and only a few rods away a drilling shows no trace of it, its horizon coming in the center of a considerable thickness of blue shale. The floor of this coal is here usually soft clay, in several cases near Brazil having been used in the manufacture of pottery.

817. Division IV.—Over most of the township this division contains only one coal bed. In some parts, however, as shown in Figs. 374 and 380, there appears to be a thin coal between Coals IV and V. It will be designated Coal IVa, where found. It does not appear to be at all persistent and as far as found is of no economic importance.

The massive sandstone so common in Division IV in the township to the east is met with at many places, but not very persistent, and is wanting in a majority of the sections, in which cases the space from



387 B. B. C. Co. No. 8. Sec. 3. 388 Gladstone. Sec. 4. 389 Diamond No. 3. Sec. 10. 390 Fairview. Sec. 11. 391 Monarch. Sec. 25. 392 Brazil No. 1. Sec 36.

Figs. 387-392. Typical sections of Coal IV in T. 13 N., R. 7. W.

Coal V to Coal IV shows only shale, exclusive of the under clay of Coal V. At exposures on Otter creek at the crossing of the C. & E. I. railroad, there appear two sandstones, the lower massive, the upper shaly and in thin beds, and with a noticeable unconformability between the two.

818. Coal IV.—See Figs. 387 to 392. This is the most persistent and important bed in the township. It is a practically solid bed, with usually a bearing-in band of soft coal a foot or less from the bottom. The lower bench is often a trifle softer than the upper. The roof is usually a blue shale, often very poor, though in many places the massive sandstone comes down on the coal, making the roof. The latter makes the better roof, but the best coal is usually reported under the shale. The floor of this bed is generally a sandy fire-clay, grading into sandstone below in some cases. It has been found very suitable for the manufacture of clay products.

In the southeastern part of the township this coal is very similar in structure to the same coal in the township just east, but going toward the northwest the slips are in places less pronounced, and in many of the mines shooting is resorted to. Otherwise, coal blocks out as northeast of Brazil. West of Brazil only one set of slips are developed, and they run nearly east and west.

819. QUALITY.—Mr. Noyes gives an analysis of this coal from Brazil Block No. 1 shaft, Sec. 36 (1), as follows:*

Fixed carbon	49.96	
Volatile combustible matter	45.16	
Total combustible matter		85.12
Moisture	13.82	
Ash	1.06	
Sulphur	1.47	
Total waste		16.35

Pounds of water evaporated per pound of coal, 12.9.

This shows a coal very rich in volatile matter, giving a higher percentage of gas and of water than any other coal reported by Mr. Noyes. It also shows a higher percentage of sulphur than the block coal in general. As far as could be learned, the coal in the southeastern part of the township is about the same in quality as the coal just northeast of Brazil, belonging as it does to the same basin. To the north and northwest the coal appears brighter and richer, being a finer looking coal than that about Brazil, but is generally reputed as not the equal of the Brazil coal. The analysis of coal from McIntosh No. 1 mine, just across the Parke county line, will serve for the north part of the township, and is therefore repeated.

Fixed carbon	51.01	
Volatile combustible matter	36.69	
Total combustible matter		87.70
Moisture	8.21	
Ash	4.09	
Sulphur	.95	
Total waste		13.25

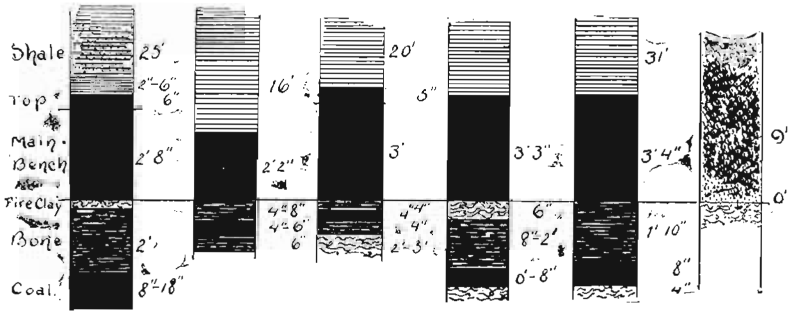
Pounds of water evaporated per pound of coal, 13.1.

An analysis of coal from the Brazil shaft, made by Mr. Richard Owen in 1859-60, gave as follows:†

*21st Ann. Rep. Dept. Geol. and Nat. Res., p. 106.
†1862. Rep. of Geol. Reconn., p. 169.

Fixed carbon	44.00	
Volatile combustible matter	48.00	
Total combustible matter		92.00
Moisture	5.00	
Ash	3.00	
Total waste		8.00

Pounds of water evaporated with one pound of coal, 14.8.



393	394	395	396	397	398
B. B. C. Co. No. 8. Sec. 3 (1).	Pratt. Sec. 9 (1).	Diamond No. 3 Sec. 10 (1).	Fairview. Sec. 11 (1).	Drilling. Sec. 11 (2).	Monarch. Sec. 25 (10).

Figs. 393-398. Type sections of Coals III and II, T. 13 N., R. 7 W.

820. DIVISION III.—This division appears to contain only one coal bed, as in the last township. As before, shales make up most of the division, "fake," shaly sandstone and massive sandstones being met with sparingly, as shown in typical sections.

821. COAL III.—See Figs. 393 to 398. This bed is usually solid, with often a smooth parting near the top, the coal above this parting, as usual, being softer and more of a caking coal. This smooth parting is not as persistent in this township as in the preceding. Coal II, underlying it, is usually characteristically developed in the center of the basins and helps in the recognition of this bed. This coal is not as persistent as Coal IV, nor as persistent as the same bed was in the last township. In the southeastern part of the township it is not of workable thickness or is usually wanting entirely, as shown in Figs. 365 and 366 It usually shows markedly the basin characters of being thickest in the swamps and thinning out on the hills. In thickness it will not average as well as Coal IV. The roof is usually shale and generally fairly good. The floor is usually the bone coal of Coal II, and where it does not stick to the bottom of the main coal, makes a

good floor. In quality this bed is generally reported as superior to Coal IV. As compared with that coal, making up in quality what it lacks in thickness.

822. DIVISION II.—The coal underlying Coal III, which in general is all that is known of this division, is generally thicker than in the township just east, ranging up to 3 ft. 6 in., including the bone coal, or up to 18 in. of good coal. This coal has not been worked here to my knowledge, and generally is too thin to pay for handling, even if its quality were first-class, unless it could be utilized in connection with the bone coal. At Brazil a drilling was made to a considerable depth below the bottom of the shaft, which passed through nothing but clay shale.

823. DIVISION I.—Just the top of this division is exposed by the erosion of the north fork of Otter creek, in Secs. 1 and 2, a little massive sandstone being all that shows. No drillings that I could hear of have pierced it except the oil well at Brazil. The record of this gave nothing of value in this connection.

Section. 3. Structure and Distribution of Coals.

824. THE SECTION accompanying Plate XXX shows the high westward dip which exists over the northern part of the township. The section does not show many faults that doubtless exist, as a rapid descent of the rocks accompanied by faulting is reported in several of the mines. Several of the largest faults met with in the coal area occur in the northern part of this area. Across the southern part of the township the dip is not quite as marked. Across the central part it is probably nearly, if not quite, as marked. Across the northern part the dip averages about 60 ft. to the mile, though at one part of the B. B. C. Co.'s No. 10 mine Coal IV descends 62 ft. in a quarter of a mile. At Simpson's mine, in Sec. 1, Coal IV is probably 20 ft. below the plateau, which at Perth is 633 ft. above tide, while at the Gladstone shaft Coal IV is about 130 ft. below Lodi, 564 ft. above tide. This gives a difference of level of close to 180 ft. in 3 mi., or 60 ft. to the mile, as above.

825. SECTION 1.—Coals III and IV appear to underlie all of this section, except where cut out by the channel of the North Fork of Otter creek, as shown. At the Simpson Clay Works they appear to be only 10 or 15 ft. apart. This point was the only one in the section where the coal was observed. The section here is (Sect. 262):

	Ft.	In.
Surface, 4 ft.; yellow shaly sandstone, 8 ft.	12	0
COAL IV	3	7
Fire-clay, 3 ft.; blue to brown shale, 8 ft.	11	0
COAL III (exposed)	2	0

Coal IV is mined in connection with its underclay. It has been opened upon in a number of places in a small ravine, and is here only about 20 ft. below the level of the Big Four railroad. Where measured it gave a thickness of 3 ft. 7 in. The slips are not pronounced. except just on the outcrop. The roof is of sandstone and appears to be good except near the outcrop. The underclay is fine and white, 3 ft. thick, of which 2 ft. are mined for use in the clay works. Farther down the drain Coal III has been opened upon at four places, though when visited all but one were washed full of dirt, and that one was partly filled, exposing, however, 2 ft. of coal. This coal was blocked out, the face slips running N. 30° W. It shows 6 in. of top coal which is not penetrated by slips. The roof is a blue to brown shale, 8 ft. and over thick. This coal appears to contain much less sulphur than the upper coal.

826. SECTION 2.—Underlain by Coals III and IV, except in northeastern corner. Coal IV close to surface over much of section. Along the North Fork of Otter creek Coal III is cut out for a short distance and has been worked a little on the outcrop on the Bart. Ord place. Thickness reported at 2 ft. 4 in. Coal IV is reported to have been opened upon a little higher up the bank, on the Russel place. In the S. E. ¼ of the section both coals were formerly mined at the North mine by Mr. Benj. Simpson. Coal IV was there reported to have been 3 ft. 8 in. thick and found at a depth of 33 ft. Coal III reported 3 ft. 7 in. and occurring at a depth of 60 ft.

827. SECTION 3.—No. 8 shaft of the Brazil Block Coal Company is located in the northeastern corner of the section. For the columnar section in this shaft, see ¶808 and Fig. 361. Coal V was not found in the shaft, but, except over the creek, occurs of workable thickness all over the territory belonging to this mine. It is there usually overlain by black shale and limestone. In places the coal is only 6 to 12 ft. above Coal IV, in which case it is only separated from that coal by "white top."

828. COAL IV here ranged from 4 ft. 3 in. to 4 ft. 9 in., with an average of 4 ft. 6 in. The bench mining occurs 1 ft. from the bottom, the lower bench not being quite as hard as the upper. Both sets of slips are open, nevertheless not more than half the coal mined is

blocked out, the rest being shot. Though showing many local dips, the general dip is to the south of west. The roof is shale and good where there is sufficient rock. In places the shale is overlain by sandstone, which affords a good protection. The roof is, of course, poor wherever the "white top" is encountered, as that tends to come down. The floor is fire-clay, 4 ft. 6 in. thick, plastic for the first 18-20 in., then becoming sandy and grading over at the bottom into the underlying sandstone. A number of normal faults have been met, with downthrow of up to 3 ft. 6 in. The drillings to the west reveal a 40-ft. fault, running northeast and southwest, with downthrow to the northwest. This fault appears to run out to the southwest before reaching the territory of No. 10 mine. Only a few of the faults of Coal IV extend down to Coal III, and those that do are reported to show a smaller downthrow than in the upper coal. In like manner a few faults are reported in Coal III that were not found in Coal IV. A number of rolls or channel fillings interfered with the working of Coal IV, often cutting the coal entirely out. The filling material resembled the roof material, except that it contained more sand. Coal IV occurs at a depth of 44 ft.

829. COAL III is found from 30-33 ft. below Coal IV and ranges in thickness from 2 ft. 6 in. to 3 ft. 6 in., with an average of 3 ft. 4 in. (Fig. 393). The soft caking top coal is 6 in. thick. The rest of the coal is solid and claimed to be cleaner and better than Coal IV. The slips are in part open, in part tight, the face slips ranging around N. 26° W. This coal is principally mined by shooting. The roof is a dark blue sandy shale, sometimes becoming like sandstone, and is usually good. From 2 to 6 in. of the roof comes down, forming that much "draw slate." This coal gets thinner on the "hills," Much trouble is experienced in mining Coal III, from the presence of numerous sandstone veins or "rock spars." In this mine they are usually perpendicular and vary in thickness from an inch or two up to a foot thick. They consist of a very hard gray sandstone, filling a crevice. They extend through the coal and often into the roof and downward through the floor, the bottom of one never having been reached. The one shown in Fig. 9, Plate III, is reported by Mr. Roberts, the mine boss, to have been traced about a quarter of a mile. They do not run straight, but bend sometimes at a large angle, or even approaching a right angle. Occasionally one is found to fork, the branches running off at an angle to one another. It hardly seems possible that these are surface cracks filled with sand, as they seem to be here more open below, No trace of slickensides was observed in either of the veins or on their surfaces. The relation of the coal and sandstone is very close and intimate, the two appearing to merge at the line of contact, as shown in Fig. 16, in Part I.

The coal is disturbed or "curly" for 3 or 4 ft. on each side of one. The underlying coal and bone (Coal II) are confined to the low places, running out to the rise. This coal appears richer, but not as pure as the coals nearer Brazil. Work in this mine is at present confined to Coal III, Coal IV being worked out over 160 acres, except some pillars. About 60 acres of Coal III have been taken.

Using electric chain machines, about 20 per cent. of this coal is slack. This is one of the best mines in the State. See Part IV for a description of the plan of this mine. It is the plan here, using the electric machines, to run 50 ft. rooms with two necks and gob the center.

830. At the Excelsior No. 1 mine of Mr. Ehrlich, Sec. 3 (2), Coal IV is cut out in the bottom of Otter creek and the tributary from the east, but is found under the hills either side. It has been worked out over the 80 acres connected with this mine. Coal from this seam was lowered to the lower seam by a drop shaft. Coal III lies about 60 ft. below creek bottom and 30 ft. below Coal IV. It ranges from 3 ft. to 3 ft. 6 in. with an average of 3 ft. 3 in. The top coal, which sticks to the roof, is thin. A good deal of sulphur is reported as running in streaks near the bottom of coal. The roof is mostly sandstone and good, though some shale roof occurs. A good deal of trouble has been had here with irregularities in the coal of one kind and another, and especially has the water interfered with the mining, having drowned out the mine several times.

831. The Excelsior No. 2 mine is a drift on Coal V, just across the valley from Excelsior No. 1 (see Fig. 381). Though not in work now, this mine is reported to have formerly shipped over 100 tons a day until the company's lines were reached. The coal measured 3 ft. 4 in. as far as exposed and appears to run 4 ft. The roof is at the entrance made of blue shale, a little inclined to be sheety at the bottom, with limestone overlying that. The coal is reported as being of good quality, some of it being said to be better than the underlying coals. The coal is here only 4 or 5 ft. above the creek, but has a 40 or 50 ft. hill above it, and as this hill runs some distance to the north, it would seem that there may be a good body of coal here, provided it maintains its thickness.

Since writing the above it is learned that the Brazil Block Coal Company have arranged to work Coal V over the territory of their No.

11 and No. 8 mines, using the old opening of Excelsior No. 2 mine, and calling it No. 11½ mine of their series.

832. Brazil Block Coal Company's No. 11 mine lies a little northwest of Excelsior No. 2. This and No. 10 mine were visited during the strike, and, as there was no one at either mine, the coal was not examined at either place.

833. No. 10 mine lies a little northwest of No. 11 mine. Mr. P. J. Mooney, mining engineer for the company, kindly furnished the writer some interesting data concerning this mine. Of perhaps the most interest was a large fault encountered to the east of the shaft. This fault had a direction of northwest and southeast, or nearly at right angles to the neighboring fault found just west of the workings of their No. 8 mine. The trace of this fault as copied from the mine map is shown in Fig. 6, Plate II, and is interesting as showing in detail the irregularity of such a fault.

At J the fault was double for a short distance, the thin block between where first struck having settled about 4 ft. less than the strata just west. From B to J the coal was all worked out up to the fault face. An entry driven from Shaft A to I, however, found that the fault had broken up into a series of step faults, six in number, and by taking down roof and filling up the floor the entry was made to follow the coal until at I the upper level was reached at a distance of ¼ mi. from the shaft and 62 ft. above the shaft. To the east the coal ran level, but to the west sloped a little toward the fault, so that while the change of level of the monocline is between 60 and 70 ft., the fault at B was found to have a downthrow of only 32 ft. The two sections, Figs. 7 and 8, drawn from A to C and from A to I, will make this clearer. The wall of the fault as encountered in mining on the downthrow side was reported to resemble closely "white top" and was probably the clay vein which had filled the open crevice left by the fault, unless faulting and filling went on simultaneously, as is probable. To the south and west mining was stopped by a channel filled with "white top." At the southeast this did not cut entirely through the coal, but left a foot or two of the bottom, which ran on under the channel. The coal near this channel was much cut up by small side channels, which would start only a short distance from the main channel and run to it, with courses at right angles to its course. Where they started they were hardly noticeable, but rapidly increased in size until they reached the main channel. So regular and so abundant were these side channels or "rolls" that they served to indicate the position and direction of the main channel and thus permitted the mining and driving of entries to be governed accordingly. Mr. Mooney reports that wherever this "white top" filling of this channel came down, the bottom of a coal bed was exposed only a few feet above. As drillings show that Coal V is usually more than 20 ft. above Coal IV in this area (see Fig. 262), it brings up the question again as to whether this coal over the "white top" is Coal V or a coal lying between Coal V and Coal IV.

This mine will illustrate to what an extent coal mining is often interrupted or stopped by irregularities imposed subsequent to the laying down of the coal bed. Thus, in this mine, mining was interrupted on the north and east by a large fault, on the south and west by a channel of Carboniferous age, made probably soon after the laying down of the coal, and on the northwest by a preglacial channel of comparatively recent date. It is of value to note further that these irregularities only temporarily interrupt the coal. The coal had not thinned out in any direction, and it would be proper to assume, until proved otherwise, that by going to the other side of the fault or of the channels, the coal would be found having its normal thickness and possibly having considerable extension in that direction before thinning out or being again interrupted. In this case this has been proven true of the fault.

At this mine it is 127 ft. to Coal IV, and 165 ft. to Coal III. Coal III here, as at No. 8 mine, is much troubled with sandstone veins or "rockspars." A drop shaft is used to lower Coal IV to the level of Coal III. As no record could be gotten of the shaft, the company kindly furnished the drilling record given in ¶809 and in Fig. 362.

Down the ravine from No. 10 mine Coal V outcrops and has been stripped and drifted upon to a small extent. Only the top of the coal was exposed. Section there (Sect. 263):

Limestone, 3 ft.; yellow clay (decomposed limestone), 1 ft.; COAL V (exposed), 1 ft.

Just south of the culvert, under the Big Four railroad, near the center of the south line of this section, Sec. 3 (12, 13), several drifts have been made on Coal V. The section here is (Sect. 264, Fig. 382):

Surface and drift, 20 ft.; shaly sandstone, 3 ft.; gray limestone with blue cherty streaks, very fossiliferous, 12 ft.; dark blue soft shale with fossils (decomposed limestone), 0 ft.—1 ft. 4 in.

COAL V (exposed), 2 ft. (a short distance south, 1 ft. 6 in.).

Gray sandy shale, 1 ft.

There is an excellent exposure of the limestone overlying Coal V at this point. Coal V is here about 10 ft. above Otter creek.

In the S. E. ¼ of the section much of the coal has been taken through the Perth slope of the Edgar Coal Co., and the Vigo mine, run by Myers and Davis. No coal is being mined here at present and the locality was not visited.

From the above it will be seen that probably all of the coal in this section is in process of being won from one or another of the mines in operation or has already been removed. It is possible some coal in the S. W. ¼ has not been looked after.

834. SECTION 4.—The Gladstone or "Big Four" mine is the only one operating in the section. This mine is situated in the extreme southwest corner of the section, close to the county line. No section of the shaft could be obtained, the rock being exposed at only two points, which showed a fine-grained blue shaly sandstone. Through the kindness of the Brazil Block Coal Company the section given in ¶810 and Fig. 363 shows the section obtained in a drilling a few feet from where the shaft was sunk. As stated above, one of the men who helped sink the shaft claimed that they passed through four small coals before reaching the coal being worked. We would certainly expect three; and, as he reported simply from memory, it may be a mistake was made. The coal being worked lies at a depth of 125 ft. at the shaft. It appears to be Coal IV that is being worked. The coal varies from 4 ft. to 4 ft. 8 in., with an average of 4 ft. 6 in. This coal is classed as a semi-block, but hardly a trace of slips occur and the coal does not block readily. It is reported to be a caking coal, much richer than the coals nearer Brazil. In mining the coal is shot on the solid, and yields in this way 75 per cent. of lump. The roof is usually a shale, which tends to come down for several feet, the space left flanging at the top. In places the roof is "fake," which flakes down with its characteristic arch in the entry, as usual not falling in the rooms. Where the fake makes the roof, there is between the fake and coal a kind of conglomerate of sandstone and shale that looks as though eroded pieces of shale had been enclosed in a sand matrix, suggesting an unconformability between the shale and fake. The floor is made of 5 to 6 ft. of fire-clay, free of sand. Some irregularities are met with in this mine. The shaft is situated in the center of a basin, so that there is easy haulage on all the entries. At an air shaft and escapement which was being sunk near Lodi, the coal has risen until it is 43 ft. above the coal at the shaft. As far as digging had gone they had only met a 3-in. coal bed at a depth of 15 ft. Much trouble has been experienced at this mine through the breaking in of Otter creek.

Of the parts of Sec. 4 north and east of the territory adjacent to the Gladstone mine, the prospect seems good for Coal IV and possibly Coal III to prove of workable thickness over a considerable area, and at from 75 to 120 ft. for Coal IV, according to surface topography.

835. SECTION 9.—The Pratt mine is located in the N. E. ¼ of this section. As well as could be obtained, the section here is (Sect. 265):

	Ft.	In.	Ft.	In.
Surface (?) blue shale, 30 ft.				
COAL V	2	8	..	..
Fire-clay 4 ft., blue shale (?) fire-clay ("white top")	..	..	105	8
COAL IV	1	6	107	2
Fire-clay 4 ft., fissile shale 16 ft.	20	0	127	2
COAL III	2	2	129	4

The record of a drilling by the company in this same quarter section showed (Sect. 266):

	Ft.	In.	Ft.	In.
Surface	5	0	5	0
Blue shale	4	0	9	0
COAL V	1	4	10	4
Clay 4 ft. 8 in., sand shale 12 ft.	16	8	27	0
COAL IV	4	3	31	3
Clay 1 ft. 9 in., gray shale 21 ft.	22	9	54	0
COAL III	3	4	57	4
Clay	0	4	57	7
Coal II (bone)	0	3	57	10

The limestone over Coal V does not show in the shaft, but in the air shaft was found 2 ft. thick and 7 or 8 ft. above the coal. In the shaft Coal V was only about 10 ft. above Coal IV, with nothing but white top between. The lower quarter of Coal V is bone. See Fig. 383.

836. COAL IV ranges from 8 to 20 in. where overlain by white top, to 4 ft. 8 in., with an average of about 4 ft. The coal shows both face and butt slips running from top to bottom, but not very markedly, nor is the bench mining very distinct, so that much of the mining is done at the bottom. The coal is won by undermining and shooting. Much trouble is had with faults, rolls, etc. Faults vary in downthrow up to 7 ft. While they sometimes run through the mine, they often run out in a short distance.

837. COAL III (see Fig. 394) runs about 2 ft. 2 in. and is reported as a better coal than Coal IV. It contains less sulphur, mines in larger blocks, and has more open slips. It would have to be mined by shooting. In places it is claimed there is nothing but white top (?) between the two coals; in other places there is a shale over the white top. Below Coal III occurs: Shale, 1-16 to 1 in.; bone coal, 4 to 8 in.; coal, 4 to 6 in. This coal is 129 ft. deep, the shaft starting about 25 ft. above Otter creek.

Coal Va, 1 ft. thick, outcrops just north of the shaft. At Lodi both Coals Va and Vb outcrop close to the county line.

It is possible a small area of Coal VI may be found in the high divide south of Otter creek. Along the stream running west through the south part of the section, these upper coals show at many places. A section close to the county line road showed: Black shale, somewhat sheety, 1 ft. 6 in.; coal, 2 ft.; fire-clay and shale, 5 ft. This would appear to be Coal Va. Just west of this, Coal Vb shows about 12 ft. above Coal Va. Going east, Coal Va dips until almost creek level, then rises again, and another coal appears below it. At one bluff, thin coals appear. The section was poor and suggestive that some of the coals might have repeated themselves by sliding, though no good evidence of a slide having taken place could be found. The section showed (Sect. 267):

	Ft.	In.
Black shale, sheety	1	0
COAL	2	0
Blue shale	6	0
Black sheety shale	2	0
COAL	1	6
Fire-clay and hidden	7	0
COAL	1	0
Shale	1	2
COAL	0	6

Toward the southeast corner of the section a ledge of limestone outcrops. A drilling by Mr. Henry Brenton on Mr. W. H. Brenton's land, at this point, Sec. 9 (12), gave (Sect. 268):

	Ft.	In.	Ft.	In.
Surface	5	0	5	0
Sandstone 17 ft., gray shale 18 ft. 6 in., sandstone 10 ft., shale 23 ft. 6 in., sandstone 2-3 ft.	71	3	76	3
COAL IV	2	0	78	3
Clay 1 ft. 6 in., gray shale 15 ft. 9 in., black shale 9 ft.	26	3	104	6
Place of Coal III.				
Fire-clay	2	0	106	6

Like Section 4, this section may be assumed to be underlain with Coals III and IV, the latter lying from 100 to 125 ft. below drainage level, and varying from 0 to 5 ft. in thickness, with probably a rather low average thickness, though possibly between 3 and 4 ft., and possibly over 4 ft. over a limited area.

838. SECTION 10.—Coal is being worked in this section by the Diamond Block Coal Company at their Diamond No. 3 mine. They hold all of the coal in the section, except in the N. E. ¼. The section at the shaft has already been given in ¶811 and Fig. 364. As showing the unreliability of the coal beds in this area and the changeableness of the other strata, the following scattered sections are selected from the many kindly furnished by the company:

839. SECTION 272. DRILLING ON R. A. WEBSTER PLACE.—Sec. 10 (2). See Fig. 371.

	Ft.	In.	Ft.	In.
Surface 15 ft., quicksand 2 ft., boulder clay 19 ft.	36	0	36	0
Limestone 14 ft., black shale 1 ft.	15	0	51	0
COAL V, top bench	1	6	52	6
Shale	0	6	53	0
Coal V?, bottom bench (?)	0	6	53	6
Clay 5 ft., sand shale 37 ft.	42	0	95	6
COAL IV	2	3	97	9
Clay 5 ft. 9 in., light shale 3 ft., gray shale 15 ft. 6 in.	24	3	122	0
COAL III	3	9	125	9
Sandstone	1	0	126	9

Some doubt exists as to the correctness of calling the second coal a part of Coal V. See two coals at bottom of the section given in Sect. 267.

840. SECTION 269. DRILLING ON HANKS PLACE.—Sec. 10 (3).

	Ft.	In.	Ft.	In.
Surface 19 ft., sand 1 ft., boulder clay 23 ft.	43	0	43	0
Sandstone	40	0	83	0
COAL IV (soft)	2	3	85	3
Clay 2 ft., gray shale 15 ft. 9 in., black shale 20 ft.	37	9	123	0

840a. SECTION 270. DRILLING ON WEBSTER PLACE.—Sec. 10 (4). See Fig. 372.

	Ft.	In.	Ft.	In.
Surface 16 ft., boulder clay 29 ft., sand 4 ft., boulder clay 17 ft.	66	0	66	0

	Ft.	In.	Ft.	In.
Blue shale	14	0	80	0
COAL V (?)	2	6	82	6
Clay 1 ft., gray shale 8 ft.	9	0	91	6
"Smut" and shale (IV?)	1	6	93	0
Clay 6 in., "rock" 5 ft. 6 in., gray shale 23 ft.	29	0	122	0
COAL III?	4	9	126	9
Shale 12 ft. 3 in., blue shale 41 ft.	53	3	180	0

In this case Coal IV appears to have been represented only by 1 ft. 6 in. of "smut" and shale.

841. SECTION 271. DRILLING ON WEBSTER PLACE.—Sec. 10 (5). See Fig. 373.

	Ft.	In.	Ft.	In.
Surface 16 ft., sand 12 ft., boulder clay 34 ft. 6 in.	62	6	62	6
Shale, soft blue	2	6	65	0
COAL V	2	4	67	4
Clay 2 ft., light shale 5 ft. 8 in., gray shale 12 ft. 6 in.	20	2	87	6
COAL IV	4	0	91	6
Clay 2 ft., clay shale 3 ft. 6 in., gray shale 18 ft.	23	6	115	0
COAL III	1	10	116	10
COAL, bone, II	1	3	118	1
Clay, hard	0	11	119	0

This record serves as a help in correlating the preceding record.

842. SECTION 273. DRILLING ON WEBSTER PLACE.—Sec. 10 (6), Fig. 374.

	Ft.	In.	Ft.	In.
Surface 15 ft., boulder clay 4 ft., sand 4 ft., boulder clay 57 ft. 6 in.	80	6	80	6
Sand shale	4	6	84	6
COAL	2	5	86	11
Clay 2 ft. 7 in., gray shale 7 ft. 6 in.	10	1	97	0
Shale and coal	1	3	98	3
Clay	1	9	100	0
COAL	3	0	103	0
Clay, soft, 1 ft., clay shale 6 in., sandstone 7 ft., gray shale 4 ft. 3 in.	18	3	121	3
COAL	2	6	123	9
Clay, dark	2	0	125	9
COAL (soft)	0	6	126	3
Black shale	2	6	128	9
COAL	1	1	129	10
Clay 1 ft., brown shale 25 ft.	2	5	133	3
COAL ("mixed")	0	6	133	9
Clay 1 ft., light shale 5 ft. 9 in.	6	9	149	6

This section is given without comment. It is supposed to be reliable. The correlation given in Figs. 367-380 is very questionable.

843. SECTION 274. DRILLING BY HENRY BRENTON, ON JAMES A. WINN PLACE.—Sec. 10 (7).

	Ft.	In.	Ft.	In.
Surface 14 ft., sand 10 ft.	24	0	24	0
Blue shale 3 ft., limestone 1 ft., sandstone 11 ft., gray shale 32 ft. 6 in., white sandstone 10 ft., sandstone 3 ft. 4 in.	60	10	84	10
Place of Coal IV?.				
Clay 2 ft. 2 in., blue shale 18 ft. 6 in.	20	8	105	6
COAL III?	2	6	108	0
Blue shale	1	10	109	10
COAL II?	1	6	111	4
Fire-clay 3 ft. 6 in., gray shale 12 ft. 10 in., blue shale 4 ft., sandstone 5 ft.	25	4	136	8

844. At the Diamond No. 3 mine, Coal IV is found at 72 ft. The limestone overlying Coal V outcrops in the bank and creek bottom, just southwest from the shaft, 8 ft. showing, fossiliferous, with bands of dark blue flint. Coal IV here averages 4 ft. 3 in. The bench mining is from 12 to 18 in. from the bottom. Both benches have the slips pronounced, but the slips offset an inch or two in going from the top bench to the bottom. The roof is made by 6 or 7 ft. of gray shale. Some "white top" roof occurs, and at one such place examined, where the roof had fallen in, the bottom of Coal V (?) was exposed only 3 ft. above the top of Coal IV. The floor is fire-clay, not very sandy, and, including some shale, 3 to 6 ft. thick. Small concretions occur at the partings between the fire-clay and shale below. Then gray shale extends to bottom coal.

Coal III averages 3 ft. 5 in. (Fig. 395). The semi-caking soft top coal is 5 in. thick. The roof is a gray shale. The floor in the center of the basin consists of: Bone coal, 4 in.; coal, 4 in.; bone coal, 4 in.; fire-clay, 2-5 ft.; sandstone, 14 ft. to 42 ft. to shale.

They are working in a basin, the coal being cut off sharply in every direction. The nature of the limiting factor was not learned. This coal blocks well and is a brighter, richer looking coal than that nearer Brazil.

845. SECTION 11.—At the Fairview mine, Coal IV is being worked to the east of the shaft, and Coal III to the west. Coal IV is 80 ft. deep, and averages 4 ft. thick. It has the 1-in. bench mining of free coal, 6 to 12 in. from the bottom. At the mine the slips are more open at the bottom, with 6 to 8 in. of top coal, which the slips do not

enter. Over much of the mine the roof is a blue shale, and poor, though the thickest coal is found under it. On this account it is difficult to keep the mine dry. In places the roof is a white sandstone, with black partings. This makes a good roof, but overlies thin coal. The sandstone overlies the shale, and when the latter is thin it tends to come down, exposing the sandstone. The floor is usually a fire-clay, 3 to 4 ft. thick, over an uneven (?) rock bottom. It is reported

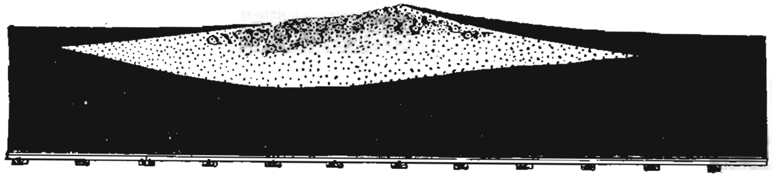


Fig. 399. Sandstone "roll" in Fairview mine.

that where the sandstone of the roof comes down on to the coal, the rock underlying the fire-clay rises so that the fire-clay is very thin at these points. I suspect that pressure was the real factor that accounts for the thinness of the fire-clay under the sandstone roof. In places this sandstone was noted coming down into the coal in the form of rolls. In working this coal they have at one point made a cut 16 ft. deep to reduce the grade over a hill, from which it may be judged how unevenly the coal lies. Fig. 399 shows a sketch of one of these rolls, having the characteristic coal feelers, indicating a channel existing in the coal previous to the laying down of the roof. Fig. 5, Plate II, shows a sketch of a typical normal fault made in this seam. The faults in this mine run northeast and southwest.

Coal III is 110 ft. deep to bottom of coal. It ranges in thickness from 2 ft. 9 in. to 3 ft. 11 in. (Fig. 396). Except for a little free coal at the bottom the coal is uniform throughout. The roof is a brown sandy shale, with 6 to 12 in. of draw slate in places, and appears to be good all through mine. In most cases, by timbering, all of the roof holds up. The floor is made of fire-clay, 6 in.; bone coal, 8 in. to 2 ft.; coal, 8 in. to nothing. This undercoal thins out as the bone becomes thinner, and in places the bone is also wanting. Beneath is fire-clay in places and sandstone in places. In Fig. 13, Plate II, is shown a sketch of a small fault which is of interest as a type of a number of faults in this coal in which the downthrow is in the opposite direction from the dip of the bed, as shown in the small supplementary sketch.

In this mine, as in many others, the coal sometimes gets thinner to the dip. I think that investigation will generally show in such cases that the dips and rises of the coal are due to the later earth movements.

A number of drillings in the N. W. $\frac{1}{4}$ of this section, kindly furnished by the Coal Bluff Mining Company, will show the thickness and position of the coals there.

846. SECTION 275. DRILLING BY C. B. M. CO.—Sec. 11 (2), Fig. 379.

	Ft.	In.	Ft.	In.
Surface 4 ft. 6 in., sand and muck 13 ft. 6, in., sand and boulder clay 14 ft., rough boulder clay 7 ft.	39	0	39	0
COAL V	4	0	43	0
Clay, 5 ft., soft sandstone 3 ft., blue shale 17 ft. 6 in.	25	6	68	6
COAL IV	1	10	70	4
Clay 13 ft. 2 in., gray shale 2 ft. 6 in.	15	8	86	0
COAL III	2	4	88	4
COAL (bone) II	1	4	89	8
Clay	0	4	90	0

847. SECTION 276. SAME.—Sec. 11 (3).

	Ft.	In.	Ft.	In.
Surface 2 ft., boulder clay 2 ft., conglomerate 18 ft.	22	0	22	0
Sand shale 12 ft., black shale 1 ft. 2 in., gray shale 31 ft.	44	2	66	2
COAL III	3	4	69	6
COAL II (bone 1 ft. 10 in., coal 8 ft.)	2	6	72	0
Clay	0	4	72	4

848. SECTION 277. SAME.—Sec. 11 (4). Fig. 380.

	Ft.	In.	Ft.	In.
Surface, 5 ft.; sand, 20 ft.	25	0	25	0
Yellow shale, 6 ft.; blue shale, 19 ft.	25	0	50	0
COAL V	1	6	51	6
Clay, 7 ft. 6 in.; shale, 1 ft.	8	6	60	0
COAL IVa?	0	6	60	6
Clay	4	6	65	0
COAL IV	1	0	66	0
Clay, 5 ft. 6 in.; shale, 16 ft. 6 in.	22	0	88	0
COAL III	2	10	90	10
COAL II (bone)	1	6	92	4
Clay	0	6	92	10

A small body of these coals has been worked out by their Anchor mine since 1891.

Just south of Perth, coal was worked a little back in the 70's at the Strange bank, and later a slope was opened to the east of that bank by Messrs. Crab and Hawk.

The location of the Star mine, just south of Perth, was not obtained. This mine was opened in 1887 by the Steward Coal Company. Both beds of coal were worked, Coal III being reported at 70 ft. deep, and the coal averaging 3 ft. 10 in.

849. SECTION 12.—Nothing was obtained as to the coal in this section, except that the broad preglacial channel seemed to have passed through it, as judged by some of the drilling done. It hardly seems right to infer that all the coal of the section has been carried away, and we are inclined to think some coal may yet be found there. The indications from neighboring points seem to show that the horizons of Coals IV and III are very near the surface, and it may be that on that account they have been eroded, or, if found, would be in small pockets, with little or no good roof.

850. SECTION 13.—Coal has been worked in this section principally from the two shafts of the Brazil Block Coal Company's mine No. 6. Coal IV was worked here only a short time, as the roof proved very dangerous and the coal was subject to a great many irregularities. There is probably a small amount of coal in this section not yet taken, and the amount may yet prove greater than is generally thought. The difficulties encountered in winning it may prevent it being mined, at least for a time. The preglacial channel is supposed to cross the N. W. corner of the section.

Sec. 14 is generally reputed to contain but little coal. It is probable, however, that the western half and possibly some of the eastern half is well underlain by Coals III and IV, though probably as to the north only workable in irregular and somewhat limited basins.

851. SECTION 15.—In the northern part of this section, including the Winn and Sampson farms, the coal is being held or mined by the Diamond Block Coal Company. A few records of drillings by the company will serve to show the way the coal lies in this section.

852. SECTION 278. DRILLING BY THE DIAMOND BLOCK COAL COMPANY.—Sec. 15 (1), Fig. 369.

	Ft.	In.	Ft.	In.
Surface, 13 ft.; sand and gravel, 45 ft.; boulder clay, 6 ft. 6 in.	64	6	64	6
Limestone, 7 ft.; black shale, 3 ft.	10	0	74	6
COAL V	2	0	76	6
Fire-clay, 2 ft. 6 in.; sandstone, 4 ft.; sand shale (fake), 7 ft.	13	6	90	0
COAL and shale, IV	1	0	91	0
Fire-clay, 3 ft.; light shale, 7 ft.; gray shale, 11 ft.	21	0	112	0
COAL III	3	10	115	10
Fire-clay	0	8	116	6

853. SECTION 279. SAME.—Sec. 15 (2), Fig. 370.

	Ft.	In.	Ft.	In.
Surface, 4 ft.; gravel, 1 ft.; boulder clay, 4 ft	9	0	9	0
Dark blue shale	10	0	19	0
COAL IV	2	2	21	2
Light shale	13	0	34	2
COAL IV	3	8	37	10
Clay, 2 ft. 4 in.; gray shale, 12 ft. 6 in.; clay, 2 ft. 6 in.	17	4	55	2

854. SECTION 280. SAME.—Sec. 15 (3), Fig. 375.

	Ft.	In.	Ft.	In.
Surface	10	0	10	0
Dark blue shale	7	0	17	0
COAL V and shale	1	0	18	0
Light shale, 2 ft.; gray shale, 75 ft.	77	0	95	0
COAL IV	1	9	96	9
Shale, 1 ft. 9 in.; shale and "rock," 15 ft.; gray shale, 6 ft. 6 in.	23	3	120	0
COAL III and shale	2	0	122	0
Clay	1	0	123	0

The great thickness of gray shale in this record overlying Coal IV would lead one to suspect that an error had crept in.

855. SECTION 281. SAME.—Sec. 15 (4).

	Ft.	In.	Ft.	In.
Surface and sand, 14 ft.; gravel, 6 ft.; boulder clay, 16 ft. 6 in.	36	6	36	6
Dark blue shale, 14 ft. 6 in.; sand shale, 20 ft.; sand and shale, 1 ft.; gray shale, 19 ft.	54	6	91	0
COAL IV	3	8	94	8
Clay	0	4	95	0

856. SECTION 282. SAME. ON SAMPSON'S PLACE.—Sec. 15 (5).

	Ft.	In.	Ft.	In.
Surface, 12 ft.; sand, 14 ft.; boulder clay, 8 ft.	34	0	34	0
Sand shale, good	5	0	39	0
COAL IV	3	7	42	7
Clay, 1 ft. 5 in.; light shale, 3 ft.; gray shale, 13 ft.; clay, 1 ft.	18	5	61	0

It would appear from sections above that Coal III was wanting in those cases.

857. SECTION 16.—In this section the horizons of Coals III and IV have dipped rapidly and Coal VI is just at drainage level at the center of the west side of the section. From which we may estimate that the horizon of Coal III lies from 120 to 150 ft. below. Two drilling records obtained from the N. W. ¼ of the section are given, with some hesitation.

858. SECTION 283. DRILLING ON WEBSTER PLACE.—Sec. 16 (1), Fig. 367.

	Ft.	In.	Ft.	In.
Surface, 13 ft.; sand, 9 ft.; boulder clay, 22 ft.	44	0	44	0
Shale, 2 ft.; clay, 4 ft.; shale, 1 ft. 6 in.	7	6	51	6
COAL	2	6	54	0
Fire-clay, 7 ft. 6 in.; blue shale, 3 ft.; clay, 6 ft. 4 in.; sandstone, 1 ft.; "flint rock" (limestone), 1 ft. 5 in.	19	3	73	3
Place of coal?				
Clay, 4 ft. 3 in.; sandstone, 3 ft.; clay, 7 ft. 6 in.; blue shale, 6 ft. 4 in.	21	1	94	4
COAL	0	5	94	9
Shale, 3 ft. 5 in.; clay, 1 ft. 9 in.; limestone, 4 ft. 2 in.; blue shale, 7 ft.	16	4	111	1
Place of coal?				
Clay, 1 ft. 2 in.; gray shale, 20 ft. 7 in.	21	9	132	10

The following interpretation of this section is suggested:

I am inclined to think the so-called shale over the first coal should be clay belonging to the drift, and the first coal represents the bottom of Coal VI. If, as would appear, the drilling was started on the plateau, this coal would lie about on a level with the outcrop of Coal VI, at the railroad. According to that, Coal Vb belongs just below the "flint rock;" the 5-in. coal is Coal Va, and Coal V is wanting, but should occur just below the limestone and blue shale. By this view the drilling must have stopped close to Coal IV.

859. SECTION 284. SECTION ON WEBSTER PLACE.—Sec. 16 (2), Fig. 368.

	Ft.	In.	Ft.	In.
Surface, 6 ft.; sand 15 ft.	21	0	21	0
Blue shale	6	0	27	0
COAL	4	0	31	0
Fire-clay, 4 ft.; shale, 3 ft.; sandstone, 1 ft.; blue shale, 2 ft. 6 in.; clay, 9 ft.; blue shale, 2 ft.; clay, 8 ft. 6 in.; sandstone, 3 ft.; gray shale, 13 ft.; blue shale, 13 ft. 8 in.	59	8	90	8
COAL	3	0	93	8
Shale	1	8	95	4
COAL	2	6	97	10
Shale, 3 in.; sandstone, 2 ft. 7 in.; gray shale, 36 ft. 4 in.	39	2	137	0

In this case the two lowest coals suggest Coals IV and III, or possibly Coals III and II, on the supposition that the lowest coal is in part bone.

860. SECTION 24.—No mining has, to our knowledge, been done in the northern part of this section. It would be reasonable to expect to find Coals IV and III underlying this area, with a workable thickness under at least part of it.

In the south part of the section, near Otter creek, Coal IV has been extensively worked.

In the southeast 40 acres, Garlick & Collins worked Coal IV in an early day, and the north bank of the creek is dotted with abandoned drifts. West of the C. & E. I. R. R. bridge the coal has been stripped and mined by drifting, the coal measuring up to 3 ft. 9 in. Still farther west, Sec. 24 (1), it has been extensively mined by the Crawford Coal Company at their No. 4 mine.

A little coal is still mined, winters, along the creek. At one point, Sec. 24 (13), an open drift showed 3 ft. 6 in. of coal. At Sec. 24 (14) the roof appears to be a blue and gray mixed, shaly, nodular sandstone.

At Sec. 24 (15), in bottom of creek, Garlick & Collins formerly worked Coal III by a shaft, one tipple serving for both this coal and Coal IV. Each bed is reported by Mr. Cox to average 4 ft. thick.

861. SECTION 25.—Just east of the C. & E. I. R. R. bridge, at a quarry, the strata between Coals V and IV show as follows (Sect. 285):

	Ft.	In.
1. Fire-clay	1	0
2. Sandstone, solid in places, shelly in places, and lying with unconformability on No. 3	6	0
3. Sandstone, solid, white, friable	10	0
4. Blue shale, local ... 0 in. to	0	6
5. COAL IV	3	0

On the south side of the creek, and opposite to the preceding, this section shows (Sect. 286):

		Ft.	In.
1.	Blue shale	2	0
2.	COAL V	0	10
3.	Shale, gray to black	2	6
4.	Shaly sandstone in thin beds, lying with unconformability over No. 5 ....3 ft. to	8	0
5.	Sandstone, solid, white ....4 ft. to	8	0

A little southeast of this, at the clay pit of the Indiana Paving Brick Company, Coal V is about 10 in. thick, and overlain by 20 to 30 ft. of blue shale, with 3 ft. of shelly sandstone overlying that.

Coal III is reported to lie 18 ft. under the creek where the wagon road from Brazil crosses, and was formerly worked by a shaft just south of the present ford.

As shown on the map, coal is exposed and has been drifted upon at a number of other places along the creek.

862. At the Brazil Brick and Pipe Company's mine, Coal IV is worked by a slope. The coal here averages 3 ft. 2 in. thick. In this mine the slips do not enter the top 6 in. of the coal. The bench mining of bone coal is 14 in. from the bottom. The roof is composed of massive white sandstone (shown at mouth of slope, in Part IV). The floor is fire-clay, 4 ft. 2 in. thick, with soft sandstone to Coal III. This mine is in a small basin, and they are at present (1897) working on pillars. This mine is in the head of a ravine running to the west. The underclay is extensively worked.

863. At the Monarch mine it is 80 ft. to Coal IV, the coal averaging 3 ft. 4 to 6 in. thick. See Fig. 365. In a few places there is an inch of bone coal over. One foot from the top is a 2-in. band of hard bone coal. The bench mining ranges from 4 in. to 1 ft. from the bottom, the slips not entering it, as a rule. The roof is blue shale and good (see section in ¶812 and Fig. 365). About 6 in. of roof comes down. The underclay is 5 ft. thick, 4 ft. being raised. When mined it is very hard and sandy, but weathers in a few weeks to a fine-grained, plastic mass. This coal is full of faults and irregularities. Fig. 400 shows a normal 5-ft. fault, which runs north of east and south of west, and parallel to the butt slips. Fig. 1, Plate III, shows a channel of contemporaneous origin, with a change of level in the coal on either side.

The faults here, as at Diamond No. 3 mine, have their downthrow in the opposite direction to their dip.

Coal III appears to be entirely absent here. The section between the two beds is given in ¶812.

864. SECTION 36.—At the Brazil Block Coal Company's No. 1 shaft it is 100 ft. to Coal IV, which there averages 3 ft. 4 in. In places this coal has sandstone partings, with a thickness of up to 18 in. These do not occur at a regular horizon and are never more than

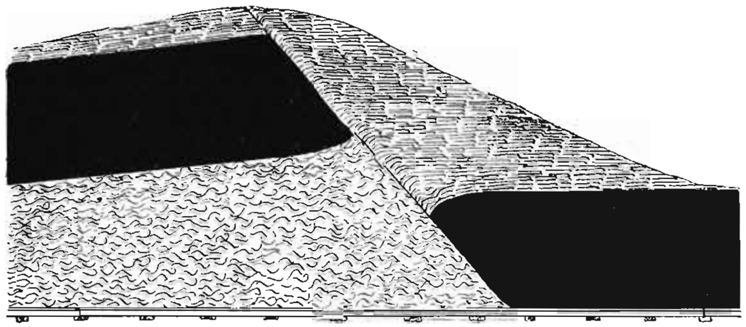


Fig. 400. Five-foot fault in Monarch mine.

90 ft. long. The roof is shale or sandstone, either making a good roof, though about 4 in. of the shale comes down. The coal at this mine is subject to many irregularities. In one fault, with a downthrow of 4 ft., the ends of the broken strata are reported to be 15 yds. apart. The faults have no regular direction; sometimes the same fault will cross the same entry twice. In other places the coal is described as nearly pinched out. From the description, I judge these to be filled channels, or rolls, the filling material being either shale or sandstone. On either side of these "squeezes" the coal is 4 to 6 in. thicker. Coal III is not workable here.

865. SECTIONS 21-23, 26-28, 33-35.—These sections are as yet entirely undeveloped. A shaft was sunk by the Watson Coal Company, but has not been worked. My understanding of it, however, is that the difficulty was not with the coal. Another test shaft was sunk by Mr. Watson just south of the township line. Drilling done in Secs. 33, 34, etc., is reported, on good authority, to have shown a basin of fine semi-block coal, 3 mi. long by 1 mi. wide. The coal in this basin is said to show one set of slips running a little north of east. In the winter of 1898-99 coal mined from Watson's test shaft is reported to be an excellent article of coal, being claimed to be better

liked in Brazil than the block coal mined near there and commanding a higher price. Farther north, in Secs. 21 and 22, another good body of coal is reported to have been proven by drilling, and royalties are being paid on some of it. Though information concerning the coal in these sections was very meager, the information obtained from different sources would indicate that there is still a considerable body of coal here as yet untouched. Prospecting in the easternmost of these sections appears to have shown much barren area there, assumed to be due to the continuance of the preglacial channel previously mentioned, and it is probably due to this that developments have been so slow in the western sections. In Sec. 26 Coal III? is 2 ft. thick, on the Jones place, being overlain with black shale and having 2 to 3 in. of bone coal under.

A drilling near the water works, in Sec. 35, is reported to have shown the following section (Sect. 287):

	Ft.	In.	Ft.	In.
Boulder clay, 23 ft.; brown clay, 8 ft. 6 in.	31	6	31	6
Shale	16	6	48	0
COAL V	0	8	48	8
Fire-clay, 2 ft. 6 in.; white sandstone, 8 ft. 6 in.	11	0	59	8
COAL IV	3	2	62	10
Fire-clay, 5 ft.; shale, 4 ft.; fire-clay, 5 ft. 6 in.; blue shale, 2 ft. 8 in.; blue sandstone, 11 ft.	28	2	91	0
COAL III	5	0?	96	0

As the evidence on all sides of this point indicates that Coal III is, all through that area, either wanting or not of workable thickness, we are inclined to think an error may have been made in reporting 5 ft. of coal at that horizon.

Township 12 North, Range 6 West. (See Plate XXXI.)

Section 1. Geography.

866. Position.—This township corresponds with Jackson of the civic townships, except a small part of Sec. 6, which is included in Brazil township. It lies southeast of the city of Brazil. See Sheet B.

867. Transportation.—As shown on the map, the Brazil branch of the E. & I. R. R. crosses the western side of the township, making connections at Brazil for the north, east and west. The Center Point branch of the Vandalia line passes almost through the center of the township from north to south, and by side switches taps the coal on either side of its position.

Section 2. Coals Contained and their Relations.

868. Divisions Outcropping.—The rocks outcropping in this township belong to Divisions I to V. Division I outcrops in the valleys of Croy's and McIntire's creeks, and over an indefinite region in Sec. 30. As far as known, these divisions show only one coal each, which will therefore be designated Coals I to V, and are supposed to correlate with coals correspondingly numbered in the preceding discussion of Clay county.

869. Vertical Relations of Coals.—The following columnar sections show clearly the relations of the coals and accompanying strata:

870. Section 288. Section at Oak Hill Slope and Adjoining Hill.—Sec. 18 (15). (J. C., p. 436.) See Plate XXXI, Fig. 4, p. 592.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil, clay	8	0	..	..	8	0
2.	COAL V	1	8	1	8	9	8
3.	Fire-clay	1	4	..	..	11	0
4.	Sandstone and shale	28	0	29	4	39	0
5.	COAL IV ....3 ft. to	4	1	4	1	43	1
6.	Gray and blue shale	28	0	28	0	71	1
7.	COAL III ....2 ft. to	3	7	3	7	74	8
8.	Blue sandy shale	70	0	..	..	144	8

The last 70 ft. show a correspondence with the results obtained at Brazil, Knightstown and Harmony.

871. Section 289. Section at Hoosierville Shaft of Woodruff and Cotton.—Sec. 18 (3). (J. C., p. 436.) See Plate XXXI, Fig. 5.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Clay and gravel	13	0	..	..	13	0
2.	Glacial drift	5	0	..	..	18	0
3.	Sandstone	3	0	..	..	21	0
4.	Gray sandstone	24	0	..	..	45	0
5.	Black shale	13	0	..	..	58	0
6.	COAL IV ....aver.	4	0	4	0	62	0
7.	Clay	4	0	..	..	66	0
8.	Gray shale and sandstone.	1	0	5	0	67	0
9.	COAL III ....aver.	2	6	2	6	69	6
10.	Clay	3	0	..	..	72	6

In this section Coals IV and III, if correctly reported, are unusually close together. The coals appear to be much closer together about Hoosierville than they are generally reported elsewhere, being reported as averaging only 10 to 12 ft. apart.

872. SECTION 290. SECTION AT THE OLD LOVE SLOPE OF THE LIMITED LIABILITY COMPANY.—Sec. 14 (2). (J. C., p. 434.) See Plate XXXI, Fig. 6.

	Ft.	In.	Ft.	In.
1. Surface soil	2	0	2	0
2. Boulder clay	9	0	11	0
3. Blue shale	9	0	20	0
4. COAL III	3	10	23	10
5. Plastic clay	1	8	25	6
6. Black shale (bone of Coal II?)	1	8	27	2
7. COAL II ....1 ft. to	0	8	27	10
8. Gray shaly sandstone	10	0	37	10

873. SECTION 291. SECTION AT BARNETT MINE.—Sec. 10 (1). (E. T. C., p. 60.) See Plate XXXI, Fig. 7.

	Ft.	In.	Ft.	In.
1. Drift, clay and gravel	19	8	19	8
2. Gray shale	5	0	24	8
3. Sandstone	1	5	26	1
4. Gray shale	0	7	26	8
5. Sandstone	0	2	26	10
6. Gray shale	1	4	28	2
7. Dark sandstone, with black seams	1	0	29	2
8. Shale	0	9	29	11
9. COAL III	3	10	33	9
10. Fire-clay	0	5	34	2
11. COAL II; bone, 1 ft. 7 in.; coal, 2 ft.	3	7	37	9
12. Fire-clay	3	0	40	9

874. SECTION 292. SECTION AT CRAWFORD NO. 3 (NEW) MINE.—Sec. 11 (3). See Plate XXXI, Fig. 8.

	Ft.	In.	Ft.	In.
1. Surface	16	0	16	0
2. Red shale	16	0	32	0
3. Blue shale, sandy	8	0	40	0
4. COAL III	3	6	43	6
5. Fire-clay, 2 ft. 2 in.	0	4	43	10
6. COAL II; bone, 1 ft. 2 in.; coal, 1 ft.	2	2	46	0
7. Fire-clay	2	0	48	0
9. Sandstone I.				

875. SECTION 293. SECTION AT DRIFT OF JOHN ENGLEHART.—Sec. 12 (1). See Plate XXXI, Fig. 9.

	Ft.	In.
1. Brown sandstone	6	0
2. Drab shale, with plants	3	0
3. COAL I, exposed	2	0

876. DISCUSSION OF SECTIONS.—As shown by these sections, the drift is not deep in these townships. Doubtless many local channels exist, though little note was made of them.

877. DIVISION V.—Division V appears in only one of the sections and, as far as could be learned, is very limited in area. Coal V was reported at only two points—at the Oak Hill slope, and at Columbia No. 3 mine. The nearness of the other divisions to the surface precludes the possibility of extensive outcrop of this division. At the Oak Hill slope Coal V was 1 ft. 8 in. thick, with only surface material over it. It is hardly probable that Coal V will be found of an extent and thickness to pay for working.

878. DIVISION IV.—Outcrops of this division probably do not cover more than one-half the township. As far as noted, the rocks of this division consist of a massive sandstone overlying with some regularity a blue or dark shale, and under these comes Coal IV.

879. COAL IV.—See Figs. 11 to 13 of Plate XXXI. This bed has the same characteristics as in the township just north. It is divided into two benches by 1 or 2 in. of soft coal or bone coal about a foot from the bottom. As a rule, the coal is a true block coal, as previously described. The roof is generally shale, and not always good. In thickness the bed averages about 4 ft. or less. The under stratum is usually fire-clay, though in some cases sandstone.

880. ANALYSES OF COAL IV.—The following analyses by Mr. Cox of this coal in this area show how it averages:

MINE.		Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Moisture.	Ash.	Total Waste.
J. McCrea, top	Sec. 18 (1)	96.00	39.50	56.50	2.00	2.00	15.1
J. McCrea, middle	Sec. 18 (1)	92.00	36.00	56.00	2.50	5.50	14.5
J. McCrea, bottom	Sec. 18 (1)	95.00	37.00	58.00	2.50	2.50	14.9
Oak Hill, top	Sec. 18 (5)	93.50	36.50	57.00	3.00	3.50	14.7
Oak Hill, middle	Sec. 18 (5)	94.50	36.50	58.50	2.00	3.00	14.8
Oak Hill, bottom	Sec. 18 (5)	92.50	34.50	58.00	2.50	5.00	14.5
Buckeye, top	Sec. 20 (1)	91.50	36.00	55.50	2.00	6.50	14.1
Buckeye, middle	Sec. 20 (1)	94.50	35.50	59.00	2.00	3.50	14.8
Buckeye, bottom	Sec. 20 (1)	96.50	38.50	58.00	2.00	1.50	15.2
Buckeye (3 years old)	Sec. 20 (1)	94.50	35.50	59.00	4.00	1.50	14.8
Average		94.05	36.55	57.55	2.50	3.45	14.7

As compared with the township just north, these analyses show this coal to contain a higher percentage of combustible matter, about the same amount of volatile combustible matter, more fixed carbon, less moisture, and more ash, with the average vaporating effect about the same. Comparing the analyses of different parts of the bed, it will be noticed that at the McCrea mine the top is the best, at the Oak Hill mine the middle, and at the Buckeye mine the bottom is the best, indicating no general superiority of one part over another.

881. DIVISION III.—This division in this area is usually composed mostly of clay shale or sandy shale, with a few narrow bands of sandstone noted. In thickness the division varies from 30 ft. down to a few feet. It underlies most of the township, forming the outcropping rock of no small part of it.

882. COAL III.—This is the most important coal in the township, due principally to its extent (Figs. 15-20). It usually shows a top, semi-caking coal of from 6 to 10 in., separated by a smooth parting from the main bench, which ranges from 2 ft. to 3 ft. 6 in. in thickness. The roof is usually shale and very fair, where there is sufficient cover over it. The floor consists of from 0 ft. to 1 ft. 6 in. of fire-clay, underlain by Coal II, the presence of Coal II proving a handy trademark for the recognition of Coal III.

883. THE QUALITY of this coal is shown by a recent analysis by Mr. Noyes, given in the 21st Ann. Rep., p. 106, of coal from Crawford No. 3 mine, Sec. 11 (3).

Fixed carbon	48.23	
Volatile combustible matter	36.34	
Total combustible matter		84.58
Moisture	11.26	
Ash	4.16	
Sulphur	.56	
Total waste		15.98

Pounds of water evaporated per pound of coal, 12.7.

Two analyses by Mr. Cox are also given; first, of the coal at the Barnett mine, Sec. 10 (1), 1st Ann. Rep., p. 61:

Fixed carbon	57.0	
Volatile combustible matter	37.5	
Total combustible matter		94.5
Moisture	4.0	
Ash	1.5	
Total waste		5.5

Pounds of water evaporated per pound of coal, 15.0.

Second, at Love's mine, Sec. 14 (2), 7th Ann. Rep., p. 50:

Fixed carbon	57.0	
Volatile combustible matter	37.0	
Total combustible matter		94.0
Moisture	3.0	
Ash	3.0	
Total waste		6.0

Pounds of water evaporated per pound of coal, 14.8.

As elsewhere, Mr. Noyes's results doubtless may be considered the more trustworthy. Where seen, this coal is a typical block coal.

884. DIVISION II.—In a drilling at Oak Hill mine, 70 ft. of sandy shale were reported, which doubtless belonged to Division II. But, as a rule, the division shows only Coal II, or is lacking entirely.

885. COAL II.—In this township Coal II appears to attain its greatest thickness, ranging up to over 3 ft. 6 in. with the bone coal, and at the Barnett mine showing 2 ft. of good coal. As far as could be learned, this coal has not been mined anywhere in this township, so that its quality here could not be determined. It is probable, though, that, like the same coal farther north, it is of good quality, but too soft to ship.

886. DIVISION I.—Drillings in Sec. 30 are reported to have passed through 80 ft. of sandstone, which would doubtless be referred to this division. Near the center of Sec. 11 is a small but characteristic exposure of the Mansfield sandstone.

887. COAL I was only seen at the Englehart mine, in Sec. 12, where 2 ft. were exposed, though 4 ft. were reported. Judging from some fragments, it would appear to be of good quality at this point. Its horizon underlies nearly the whole township, but it is doubtful if the coal has a similar extent, or is of workable thickness, if it has.

Section 3. Structure and Distribution of Coals.

888. On the coal map of this area is given a section from east to west across the center of the township, which shows that the westward dip is very slight. It also shows a syncline running between Columbia No. 3 and Columbia No. 4 mines. Two miles south of that section, a cross section would show still less westward dip, if, indeed, accurate leveling did not show that the divisions stood at a higher level at the

western township line than at the eastern. In Sec. 25 the top of Division I is at least 20 ft. below the level, while in Sec. 30 it forms the surface outcrop. Across the northern row of sections the westward dip is a little more pronounced. In its minor details the structure at many points gives evidence of being quite complicated. Of unusual interest in this township is an area of highly compressed structure, in Secs. 21, 22, 27 and 28, in which are found reversed faults, crushed and thickened coal beds, and a completely different character of slips in the coal. See description of Columbia mines Nos. 3 and 4.

889. SECTION 1.—No outcrop or coal noted in this section. Coal I is near or above the level of Croy's creek, so should not be sought in the bottoms of the creek, but may be found under the hills on either side.

890. SECTION 2.—An outcrop reported in the N. W. ¼ in the south bank of Billy's creek is probably of Coal I. A number of drillings in the S. W. ¼ are reported to have found a little coal below 30 ft. or more of sandstone, and at a depth of 60 ft. or more; doubtless Coal I.

891. SECTION 3.—The horizon of Coal III probably underlies the western half or two-thirds of this section, but quite near the surface, so that Coal III may have been largely removed.

892. SECTION 4.—Coal III near surface in eastern part, and may have been removed or have become too thin to work. To the west dip probably brings in Coal IV. Coal has formerly been worked by slope on the Berry place.

893. SECTION 5.—Coals III and IV have been extensively worked in this section through the Columbia shaft. Coal IV near surface, and had very bad roof, reached by tunnels from Coal III. Some coal has been worked in N. E. ¼ through the Barnett gin shaft. Fishharbor & Yew have a small shaft open east of the Columbia mine. Not working when visited. It is reported that the S. E. ¼ of this section contains some coal not yet touched.

894. SECTION 6.—The Nellie mine had, in 1897, just finished working out a limited area of the coals in the N. E. ¼. In the N. W. ¼ some good coal land is reported not mined on as yet, notably on the Stewart and Sourwine places.

895. SECTION 7.—The coal of this section has been extensively mined. In the N. E. ¼ mining has been carried on through the Watson shaft and the Keystone shaft. At the latter the coal is reported to have been 67 ft. deep and 3 ft. 10 in. thick. Supposed to have been Coal III. In the S. E. ¼ the Watson and Crescent shafts and John Morrison slope indicate that most of the coal there has been won. In the S. W. ¼ the coal has been worked out through the Centennial mine and Shefferman shaft. Coals IV and III were, in the former mine, reported as 50 ft. and 67 ft. deep, and 4 ft. and 3 ft. 8 in. thick, respectively. A little coal has been worked recently by a slope just southeast of the Shefferman shaft.

896. SECTION 8 is supposed to contain some small pockets of coal, and may yield some coal in the future. Some coal has been obtained through the Winn slopes.

897. SECTION 9.—In this section occurs the first mine in work in the sections so far enumerated. Here Coal III was being worked at the Denham gin shaft by Messrs. Taylor, Ally and Race. At the shaft the coal is 35 ft. deep, and shows an average of 3 ft. 6 in. as far as drilled. Where the coal is being worked it runs from 4 ft. to 4 ft. 3 in. in thickness. The top coal, which the slips do not enter, is here 8 to 12 in. thick. The roof shows first 4 in. of "draw slate," then 4 to 10 ft. of sandy shale, with only the surface and drift material above. The roof is reported as good. The floor consists of 4 to 6 in. of a very rich bone coal, underlain with a hard fire-clay; the bone coal runs out on the hills (Fig. 17). Slips reported to run N. 30° W. and N. 60° E. This coal rises to the east rapidly so that in a well at the house only a few rods from the shaft, and practically on the same level, it was struck at 12 or 15 ft. It was here 1 ft. thick, and in crossing the well, 4 ft. square, dipped 5 ft., indicating a somewhat different shaped ridge between basins from those studied north of Brazil. At another boring a few rods south the coal is found at a depth of 12 ft., with no roof. These two points are on, or nearly on, the top of an interbasin ridge, which here runs northeast and southwest. Drillings indicate another ridge bringing the coal to the surface between a quarter and a half mile to the west. These facts indicate that in Sec. 9, as in Sec. 4, the coal will be apt to be found in small basins, very near the surface. Some basins may be found large enough to pay for working extensively.

898. SECTION 10.—This section is probably well worked out. Coal III was mined in an early day at the Barnett drift, where it was 3 ft. 10 in. thick and underlain by fire-clay and Coal II, as shown on Plate XXXI, Fig. 15. The section at this mine was given in ¶873. The coal from this mine is said to have been of very good quality.

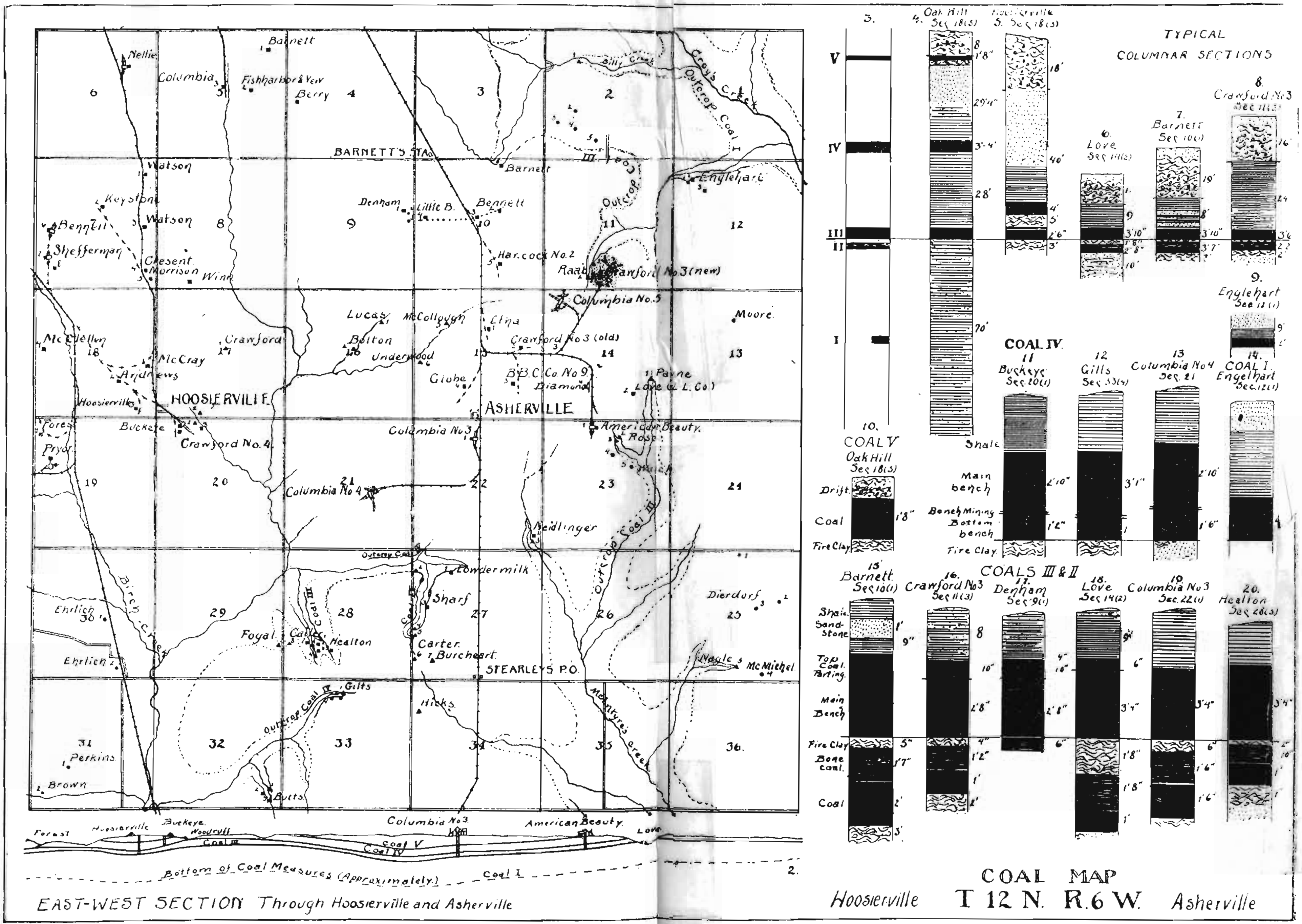
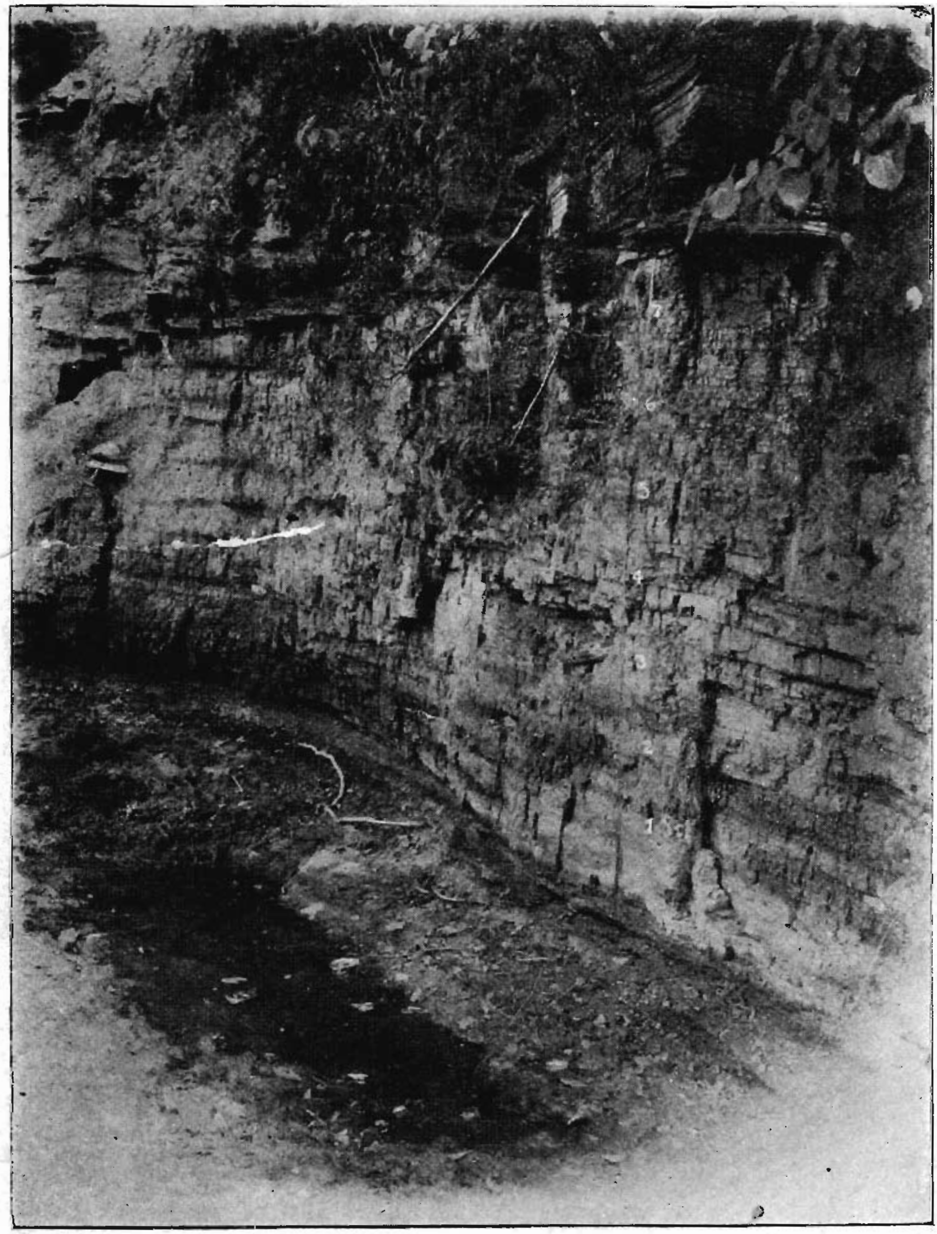

COAL MAP
Hoosierville
T 12 N. R. 6 W.
Asherville
TYPICAL COLUMNAR SECTIONS
EAST-WEST SECTION Through Hoosierville and Asherville
Bottom of Coal Measures (Approximately.)
HOOSIERVILLE
ASHERVILLE
BARNETT'S STA.
STEARLEYS P.O.
Croy's Creek
Birch Cr.
McIntyres Creek
Outcrop Coal III
Outcrop Coal IV
Outcrop Coal I
Nellie
Columbia
Fishharbor & Veiv
Berry
Barnett
Watson
Keystone
Bennett
Shefferman
Chesent
Morrison
Winn
Denham
Little B.
Bennett
Harcock No. 2
Raab
Crawford No. 3 (new)
Columbia No. 5
Englehart
Moore
McClellan
Andrews
McCray
Crawford
Lucas
McCollough
Bolton
Underwood
Etna
Crawford No. 3 (old)
Globe
B.B.C. Co. No. 9
Diamond
Payne
Love (L. L. Co.)
Hoosierville
Buckeye
Crawford No. 4
Forest
Pryor
Columbia No. 3
American Beauty
Rose
Columbia No. 4
Neidlinger
Lowdermilk
Sharf
Dierdorf
Ehrlich
Fogal
Catt
Healton
Carter
Burchheart
Nagle
McMichel
Gilts
Hicks
Perkins
Brown
Butts
Woodruff
Love
Coal III
Coal IV
Coal V
Coal I
COAL V
Oak Hill Sec 18(3)
Drift
Coal
Fire Clay
COAL IV.
Buckeye Sec 20(1)
Gills Sec 33(4)
Columbia No 4 Sec 21
COAL I
Engelhart Sec 12(1)
Main bench
Bench Mining
Bottom bench
Shale
COALS III & II
Barnett Sec 10(1)
Crawford No 3 Sec 11(3)
Denham Sec 9(1)
Love Sec 14(2)
Columbia No 3 Sec 22(1)
Healton Sec 28(3)
Sand-Stone
Top Coal Parting
Main Bench
Bone coal
Oak Hill Sec 18(3)
Love Sec 14(2)
Barnett Sec 10(1)
Crawford No 3 Sec 11(3)
Englehart Sec 12(1)

PLATE XXXI.



Coal in Indiana.
Natural outcrop at Alum Cave, Sullivan County.
NOTE.—Coal 8 ft. thick. Hat in background nearly at height of average man.
Photographed by G. H. A.

Fifty rods south of this mine the following section obtained by drilling is reported by Mr. Cox in the 1st Ann. Rep., p. 61 (Sect. 294):

	Ft.	In.
Drift, clay and gravel, 11 ft.; boulder clay, 10 ft. 6 in.	21	6
Gray shale, 4 ft.; sandy shale, with small balls of iron-stone, 3 ft.; black shale, 1 ft. 6 in.	8	6
Coal III	3	6
Fire-clay.		

Coal III was formerly extensively worked near the center of the section, at the Bennett mine, and by small shafts to the east and west, known as the Little Bennett mines, the coal from which was hauled by tramway to the tipple of the Bennett mine, where it was screened and loaded.

From the Hancock No. 2 mine probably most of the coal in the S. E. ¼ has been won. Coal in this mine is said to have run out in places, and in others the roof proved too poor to be mined under.

899. SECTION 11.—Coal III was mined by stripping in an early day on the Raab place. In 1897 the only mining being done was at Crawford No. 3 mine. Here Coal III is 40 ft. deep and averages 3 ft. 6 in. The section here was given in ¶874, and an analysis of this coal in ¶883. The top coal, 10 in. thick (see Plate XXXI, Fig. 16), generally comes with the rest, but is softer and mines out in smaller blocks. This coal blocks finely, and is mined entirely without shooting. The slips are open, but clean. The roof is blue or red shale. The blue shale is sandy, except close to the coal, and makes a good roof, but tends to run out and let the red shale come down on to the coal, the latter making a poor roof. The thickest coal is under the red shale roof. The floor is fire-clay, ranging from 2 in. to 2 ft., but for the most part being about 4 in. thick. It appears to get thick or thin, in correspondence with the thickening or thinning of the coal. This fire-clay is underlain by Coal II, consisting of 1 ft. 2 in. of bone coal and, from 1 ft. down, of good coal. Beneath this in turn is fire-clay, which in a short space downward gets sandy, and grades into the massive sandstone which outcrops along the creek. As shown on the map, this coal is cut out by the creek. The coal is reported worked out to the south. It is thought this shaft has coal enough to run it well into 1898. The company holds leases on land just west of the territory being worked from this shaft and expect to open up on that as soon as the area being worked is exhausted.

Down the ravine from Crawford No. 3 mine, the Mansfield sandstone is exposed, and near the center of the section shows a noticeable structural disturbance, dips being noted to the north, northeast, east and south, changing rapidly from one direction to another, and measuring as high as 35°. Near this point some stone has been quarried on the Englehart place.

900. SECTION 12.—The outcrops of this section belong principally to Division I. In the N. W. ¼ coal has been mined a little on the Englehart place. The section here was given in ¶875. The coal was reported to reach 2 ft. 8 in. in thickness, 1 ft. 10 in. only being exposed. A shaft was sunk southeast of the drift, but it was reported that no coal was ever taken out of it. At the drifts the coal dips strongly to the north. This coal is said to be a semi-block coal, mining in small square blocks, and has to be mined by shooting.

Semi-block coal was also reported as occurring in the south half of the section.

901. SECTION 13.—This section is supposed to be underlain by the horizon of Coal III, but very near the surface, so that much of the coal may be gone or unworkable. Coal I was reported in a well on the Moore place as 3 ft. 6 in. thick at a depth doubtfully given as 80 ft.

902. SECTION 14.—This section is pretty well worked out, Coal III alone being workable. In an early day it was worked on its outcrop at the head of McIntire's creek, on the Payne place. Later, the Limited Liability Coal Company worked out nearly the 40 acres comprising the Love place. The section at this place has been given in ¶872, Fig. 6. The section of Coal III reported by Mr. Collett in the 7th Ann. Rep., p. 434, was as follows (Fig. 18):

	Ft.	In.
Semi-block—smith's coal	0	6
Block coal—good	2	8
Bone .1 in. to	0	2
Block coal	0	2
Soft clay, "bearing in"	0	2
	3	10

He reports the top 6 in. of coal as in great demand for blacksmithing purposes. Coal from this mine was hauled over a mile by a tramway to what is now the Center Point branch of the Vandalia.

In the S. W. ¼ coal was extensively mined through the Diamond No. 2 shaft; the coal here being reported 4 ft. thick and 63 ft. deep.

Since writing the above, the Columbia No. 5 mine has been opened in the N. W. 40 acres.

903. SECTION 15.—Both Coals III and IV are workable in this section, and have been extensively worked, if not exhausted, unless it be in the N. W. ¼. Coal IV was here too near the surface to be worked profitably on account of poor roof, and in some cases of poor quality. The Globe mine appears to have been the first mine opened extensively in this section. Here Coal III was 80 ft. deep, and ranged from 3 ft. 6 in. to 3 ft. 9 in. In the E. ½ of the section was the Ætna mine, where Coal III is reported to have averaged from 3 ft. 6 in. to 4 ft., and to have been 92 ft. deep. It was underlain by 6 in. of bone, and 6 in. of coal. Coal IV is said to have been there, but is described as resembling "dried-up blacking," and of no value. In old Crawford No. 3 shaft, Coal III is reported to be 86 ft. deep. At No. 9 shaft of the Brazil Block Coal Company both coals were worked, Coal IV only a little, as it had a very dangerous roof.

Outcrops of Coals IV or V were reported on the McCullough and Underwood places, but were not visited, and their location is uncertain.

904. SECTION 16.—Outcrops of Coals IV or V reported on the Jas. Bolton and Lucas places. Not examined, and location only approximate. It would seem reasonable to expect to find a considerable quantity of workable coal in this section; it probably lies in pockets or small basins and may not be found except by considerable prospecting.

905. SECTION 17.—This section would seem to present much the same conditions as the last section. Coal 3 ft. 6 in. to 4 ft. thick is reported as having been stripped and drifted upon near the center of the section, on the Crawford place. It is reported that the Crawford Coal Company are holding some 200 acres of coal in this section until needed.

906. SECTION 18.—Coal IV is claimed to be about 60 ft. deep near Hoosierville, to have averaged about 4 ft. thick and to have been worked in all of the mines of this section. Coal III, from 5 to 30 ft. lower, is reported to range from 2 to 4 ft. This coal is said to be only partly worked out. Its presence was known at the time the mines of this section were operating, but the coal leases having at the beginning been made for 20 cents a ton, by the time Bed IV was worked out coal had decreased in price so that they could not afford to operate the lower coal bed and pay that royalty. So that it is claimed that most of Coal III remains untouched.

At Mr. John McCrea's shaft, 51 ft. deep, both coals were worked, though the lower coal was worked the more extensively. Coal IV is said to have averaged 4 ft., and Coal III 3 ft. 8 in. to 4 ft. West of the McCrea shaft was a shaft owned by Mr. John Andrews.

The Hoosierville shaft was just west of the little settlement of that name. The section at this shaft was given in ¶871, Fig. 55. Coal IV here averaged 4 ft. at a depth of 58 ft., while Coal III at a depth of 67 ft. averaged, according to borings, 2 ft. 6 in.

The Oak Hill slope of Ward & Perry worked Coal IV, the average of twenty-four bores put on their territory showing 3 ft. 4 in. as the thickness. The section at this slope and the adjacent hill was given in ¶870. This bed is described by Mr. Collett as follows:

	Ft.	In.
Upper block	3	0
Splinty cannel	0	10
Soft bearing in bed	0	3
	4	1

The location of this slope is given from Mr. Collett's map accompanying the 7th Ann. Rep. He described it as the S. W. ¼ of Sec. 19.

The McClelland shaft is located by report.

907. SECTION 19.—Coal was being mined in 1897 in this section only at the Pyrah slope. When visited the mine was not working, and, being nearly full of water, a full examination could not be made. Coal IV here lies about 20 ft. below the surface, and in the entry measured 3 ft. 11 in. thick. Both face and butt slips show well, the face slips, as elsewhere, running N. 30° W. The coal dips rapidly north. The roof could not be seen.

At the Forest mine Coal IV is reported to have been 48 ft. deep, and 3 ft. 6 in. to 3 ft. 8 in. thick, with shale roof. It is said to have blocked well.

The E. ½ of this section has not been worked, unless from the Hoosierville or Buckeye shafts. It is reported to contain a good body of coal, which, however, has in part, at least, been leased.

908. SECTION 20.—Coal IV? has been worked in the N. W. corner of this section through the Buckeye shaft. It was there 65 ft. deep, and ranged in thickness from 3 ft. 6 in. to 4 ft. 6 in., with an average of 4 ft. A section of this coal by Mr. Collett was as follows:

	Ft.	In.
Upper block	2	4
Splinty cannel	0	6
Lower block	1	2
	4	0

Coal III is reported to average 3 ft. 6 in. at this point, but to be of a poorer quality than Coal IV. In 1899 Coal III is being worked by a shaft put down close to the old Buckeye shaft (Crawford No. 4).

In a small drain a little farther east, Sec. 20 (2 and 3), a drift was started by Mr. Woodruff, but, meeting a fault with 7 ft. of downthrow, work was abandoned, though the coal was 4 ft. thick.

The coal around Hoosierville is reported as often showing the slips open enough to allow putting the arm in them, or even more. In the Hoosierville mine a "rock" parting became 2 ft. thick (reported up to 10 ft. thick), with 1 ft. 2 in. of coal below. The coal appears to lie in marked basins, whose edges rise from 15 to 20 ft. above the center of the basin, and the coal thins often to a mere parting between the basins. Mr. Collett records a reported case in one of the mines where there was met with a "cone or hill 250 yds. in diameter and 20 ft. high, surrounded by coal 4 ft. thick, which mounted on the side of the cone, but thins to 3 ft. at the top."

This section is accredited with containing considerable workable coal, the bottom bed not having been worked at all yet (1897). The Crawford Company are said to have paid royalties on some of the land for several years.

909. SECTION 21.—In this section the coals are quite deep, a marked syncline appearing to run through the section from north to south.

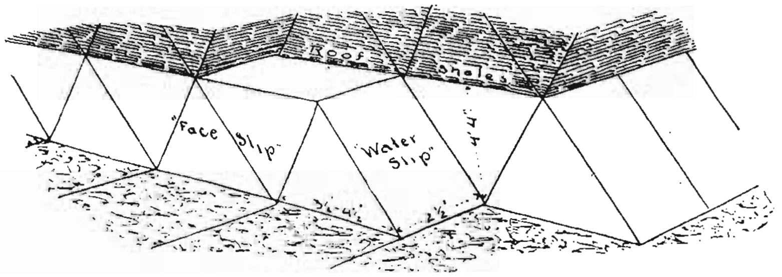


Fig. 400a. Diagram showing diagonal jointed structure of coal southwest of Ashcville Columbia No. 4 mine.

910. COLUMBIA NO. 4 is the only mine in the section. At the shaft Coal V is 85 ft. deep, Coal IV 105 ft. deep, and Coal III 20 ft. lower. Coal IV is worked here, varying in thickness from 3 ft. up, with an average of 4 ft. 4 in. It has to be mined by shooting and is reported very free from sulphur. The block structure of this coal is interesting when taken in connection with some other phenomena

exhibited here and at Columbia No. 3 mine, near Asherville. In general, it will be remembered that the slips of block coal, in their character and appearance, suggest the action of a pulling force which would seem to have pulled the coal apart, and shrinkage due to loss of moisture and gas has been suggested as a possible cause. But in this area the slips tend to be of an entirely different character. In parts of the area the face and butt slips are developed in something

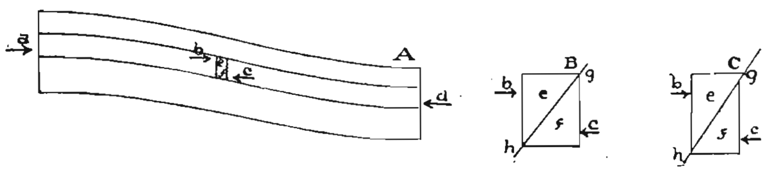


Fig. 401. Suggesting the way tangential pressure combined with slight initial dip may produce oblique jointing with tendency to slipping and faulting.

like the normal manner, though usually with this slight difference, that the butt slips are not quite perpendicular. Over most of the area, however, this lack of perpendicularity becomes very pronounced, so that the butt slips dip to the north 55° to 65°; they also become continuous, the face slips disappearing and often a second set of butt slips dipping to the south are formed, as shown in the right of Fig. 400a. Notice also that in contrast with the normal slips which are confined to the coal, these slips extend through all the strata alike, showing that they are due to some cause outside of the coal. Furthermore, when examined in the mine it is found that the sides of these slips are polished very smooth or slickened, as though they had rubbed on each other. As these slips extend through all the strata to the surface, they form convenient passages for water, and hence are known locally as "water slips." Fig. 401 suggests a possible explanation of these north dipping slips. In this case the measures which are supposed to be slightly folded are under a powerful lateral pressure. To consider the effect on the structure of the strata, a block (ef) may be taken out. Due to the slight fold of the measures, the pressure from the left will act a little more strongly on the upper part of the block, and the pressure from the right will be stronger on the bottom of the block (exaggerated in Fig. 401). As a result, the rock will tend to shear diagonally along a line (gh) and the parts (e) and (f) tend to wedge past each other, resulting in a slight slipping along (gh), as shown at (c). The slickened faces of the slips are evidence that such movement does take place, though as a rule the displacement is not noticeable. In some places, however, very marked slipping has taken place along these slips, resulting in reversed faults, with considerable upthrow. Fig. 13 of Plate III shows such a fault observed in the same entry of No. 4 mine from which Fig. 400a was taken. In this case slipping has continued until Coal III has slid up the slip, here become a fault plane, past Coal IV and an unknown distance beyond. At another place in this mine, which could not be visited, the measures are reported as disturbed so that Coal III is locally thickened up to 4 ft. 6 in., and Coal IV, thickened up locally to 6 ft. 6 in., has been forced down to within 6 or 8 in. of Coal III, making a total thickness of the coal at that point of 11 ft. In places the slips lose their regularity and the coal appears full of slickensides, sometimes the slickened surface being curved so as to resemble cone-in-cone structure on a large scale. Coal IV has the bench mining of free coal about 18 in. from the bottom. In places this free coal is replaced by shale, which becomes as much as 16 in. thick. Where water slips inclined both to the north and south are developed, the coal tends to come out in long, wedge-shaped blocks. At such places the two sets of slips entering the roof and intersecting there breaks the roof up into wedge-shaped blocks also, and as these tend to come down readily, the roof in such places is very bad. The roof of this coal is a blue shale. In the air shaft it is all blue shale from Coal V down to Coal IV. In the main shaft there is 10 ft. of "sand shale" or fake (?) overlying the blue shale. Above this Coal V is 2 ft. 8 in. thick, overlain by black shale. The floor is made of fire-clay in places, but generally consists of "solid rock," with fake extending down to Coal III, which here averages about 3 ft. thick. No. 4 mine is in a basin which extends up to the N. E. corner of Sec. 21. The coal is reported cut off on the south and west by "sandbars." It would be reasonable, then, to expect to find a good body of coal either south or west beyond these preglacial channels. The coal rises to the west in this mine.

911. SECTION 22.—Coal III has been worked at Columbia No. 3 mine for several years and the territory adjacent to the mine is nearly worked out. It is here 85 ft. to Coal III, Coal V being passed through in sinking, while Coal IV is reported as being absent. Coal III ranges from 6 in. to 4 ft., with an average of 3 ft. 4 in. It has the face slips developed only in the south entry, and there the butt slips are barely perpendicular. Otherwise the structure is as in No. 4, though perhaps not so strongly developed. As corroborating the testimony obtained in No. 4 mine that the slip structure of the coal in this limited field is due to pressure, the following sketch, Fig. 10, Plate III, was obtained, showing the details along an entry wall of crushing to which the coal had been subjected by lateral pressure, resulting in thickening up the bed normally 3 ft. 4 in. thick to 12 ft. thick. The sketch does not show the full height of the coal, as the entry has been graded up for several feet.

As might be expected, the coal thus squeezed up crumbled to slack when mined. The roof is a blue shale and good, though having 4 ft. 6 in. of draw slate. As usual, Coal II underlies Coal III. At one point the following section was measured:

	Ft.	In.
COAL III	3	8
Shale	1	0
BONE COAL	1	2
COAL	1	6
Shale (in basins, "rock" on ridges).		

The section given on Plate XXXI is said to be an average. The coal dips rapidly to the southwest, being 35 ft. lower at the water-hoist than at the shaft.

In the S. E. corner of the section a small basin of Coal III is reported as underlying the Neidlinger and two adjacent farms. It has been mined a little on the Neidlinger farm, where it is claimed to have shown 3 ft. 8 in. of good coal.

912. SECTION 23.—It is probable that Coal III only is workable in this section. A small basin of this coal was worked out through the American Beauty shaft, the coal here being 57 ft. deep and averaging 4 ft. on the east of the shaft and from 2 ft. 8 in. to 3 ft. on the west. Just south of the shaft a small pocket of Coal IV, 150 ft. long by 30 ft. broad, is reported. A short distance east, Wm. Rose was just opening a slope on Coal III, which there ran 3 ft. 6 in., with 6 to 8 in. of soft top coal. They have about 10 acres here not yet won. The coal crops out in the ravine here and has been stripped some. The coal of this section and of Sec. 24 is so near the surface that it is likely to be found only in small basins suitable for local trade mining.

913. SECTION 25. In this section Coal III appears to be very close to the surface, and probably cut out over some of the section. Coal was reported as outcropping on the Nagle place 18 in. thick, and coal found at 18 ft. in a well on the McMichel place is thought to be Coal III. Also on the Conrad Dierdorf place, in well, Sec. 25 (2), coal blossom is reported at 20 ft., and in well, Sec. 25 (3), 2 ft. of coal was found at 18 ft. These data all indicate a coal too near the surface to be worked on a large scale. A deeper drilling on the Dierdorf

place, Sec. 25 (1), appears to have passed through Division I, and at 67 ft. and 75 ft., respectively, is reported to have found thin beds of coal, doubtless the same Beds I and Ia that are found outcropping near Eel river a short distance east.

914. SECTION 26.—Division I forms outcrops in valley of McIntyre's creek. Division III outcropping in higher points of section. If workable coal exists at all in this section, it would appear to lie in small pockets close to the surface under the higher ground.

915. SECTION 27.—The dip carries Coal III well under in this section, so that Coal IV underlies at least a considerable portion of the section, and has been worked some in the western part of the section. On the Lowdermilk place it has been stripped and worked by drifting. Just west of this, at the section line, Coal IV outcrops about 15 ft. above the bottom of the ravine. It is underlain by fire-clay, shale and sandstone in succession. At a drift on the Geo. Sharf place, Coal IV is reported as 3 ft. 6 in. thick and as showing "water slips" as at the Columbia mines to the north, with no face slips. The coal here dipped east and north. It blocked well only on the crop.

Coal outcrops, and has also been stripped, on the Carter and Burcheart places, in the S. W. ¼. The data would seem to favor some workable coal in this section.

916. SECTION 28.—Coals III and IV both outcrop in this section, and both underlie most of the section, though Coal IV is quite near the surface. It is reported as 4 ft. thick on the Cailer place, where it has been stripped some.

On the Healton place, Coal III has been mined by stripping, drifting and by shaft. In the gin shaft, where the coal was 18 ft. deep, it is reported as 3 ft. 4 in. thick. It is here underlain by 2 in. of fire-clay, 10 in. of bone and 12 in. of coal. Below this in turn came 1 ft. of fire-clay and 5 ft. of hard, white sandstone. The bone and under-coal ran out going up the raise. At the shaft the coal dips westward; at the outcrop, a little to the northwest, it dips southeast; at the stripping on the west fork of the ravine it dips to the east. About two acres have been worked out here.

917. SECTION 29.—Both Coals III and IV have been reported to have been stripped on the Fogal place, in the S. E. ¼. It would appear that workable coal should be found on this section, especially away from the fork of Birch creek which crosses the section.

918. SECTION 30 would appear to be barren of coal, with Division I outcropping, judging from the borings put down by Mr. Chris. Erhlich, near Prairie City. These borings, one-fourth mile apart, each went 125 ft. deep and each passed through 85 ft. of fine-grained sandstone and into 3 ft. of black "muck."

919. SECTION 31.—It would seem probable that Divisions III and upward were cut out in the immediate valley of Birch Creek. In the S. W. ¼ of the section coal is reported to have been struck on the Brown place and on the Martin Perkins place. On the former, 3 ft. 3 in. of coal is reported at from 20 to 25 ft.

920. SECTION 32 is reported to contain some excellent coal land, it being claimed that drillings show three workable coal beds over a considerable area. Some mining has been done in the S. E. corner on the Butts place by stripping and by a gin shaft, some 2,600 tons being mined here in a single season. Coal IV is here reported to average, in 14 bores, 3 ft. 4 in., while Coal III, 18 ft. below, is claimed to show 3 ft. 5 in. A drilling 35 ft. below Coal III encountered only sandstone.

921. SECTION 33.—This section is also supposed to contain some good coal land. On the Gilts place, Coal IV is being worked a little. It here shows from 4 ft. to 4 ft. 8 in., the bench mining coming 1 ft. from the bottom, where the coal measures 4 ft. and 1 in. The slips are marked and normal. The roof is a drab shale, 8 ft. thick, as far as exposed. The coal is said to lie in a basin, here only 150 yds. wide, but growing larger to the south.

922. SECTION 34.—The following record of a drilling on the land of L. C. & R. L. Kennedy is reported by Mr. Collett as follows (Sect. 295):

	Ft.	*In.*	*Ft.*	*In.*
Soil and drift	12	0	12	0
COAL V, soft	2	0	14	0
Potter's clay, 4 ft.; white sandstone, 3 ft.; gray shale, 8 ft.; shale and sandstone, 9 ft.; blue shale, 10 ft.	34	0	48	0
COAL IV	0	7	48	7
Shale and sandstone, 9 ft.; shale and sandstone, 16 ft.; blue shale, 0 ft. 6 in.	28	6	77	1
COAL III	1	0	78	1
Shale	22	0	100	1

In general the section would seem to be similar to Sec. 27 in the position of coals and coal prospects.

923. SECTIONS 35, 36.—Practically no information was obtained about the coal in these sections. It is probable that the conditions in the two sections immediately north hold in these sections in a general way.

TOWNSHIP 12 NORTH, RANGE 5 WEST. (PART IN CLAY COUNTY.)

924. This partial township, as shown on the map, contains principally Division I, Division III appearing at the western end. Coal outcrops at the horizon of Coal I, in Secs. 20, 22, 28 and 33. In a well in the S. W. corner of Sec. 33 the coal was 2 in. thick at a depth of 42 ft. Near the center of the S. W. ¼ of Sec. 33, Coal I is 14 in. thick in outcrop. In the N. W. ¼ of Sec. 32 some coal has been dug on the Sunnyfield place. In the S. W. ¼ of Sec. 31 the following section was noted beside the road (Sect. 295a):

	Ft.	In.
Hidden and massive sandstone	50	0
COAL I, upper bench	0	6
Blue to brown shale	8	0
COAL I, lower bench	0	6
Hard gray sandstone	1	0

This shows the dividing of Coal I noted in Owen county and in the next township south. Coal III is reported to outcrop thin on Mrs. Latham's place, in the N. W. 40 of Sec. 31.

The evidence is sufficient to show the lack of workable coal in this partial township.

TOWNSHIP 11 NORTH, RANGE 5 WEST. (PART IN CLAY COUNTY.)

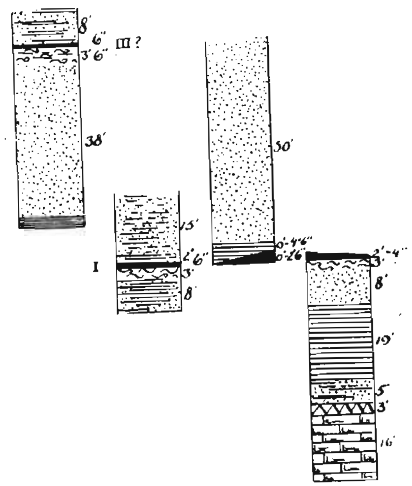
Section 1. Geography.

925. POSITION.—The part of this township in Clay county includes the four western rows of sections. With the partial township just north it forms the easternmost part of Clay county. It constitutes the eastern two-thirds of the civil township of Washington.

926. TRANSPORTATION.—This township is entirely without railway facilities, the nearest point for shipping being Center Point.

Section 2. Stratigraphy.

927. DIVISIONS OUTCROPPING.—The rocks outcropping in this township belong almost entirely to Division I. Division III may be caught by the tops of a few of the highest hills, and the underlying Lower Carboniferous rocks are exposed in one or two places by streams. Division I here contains at least two coals locally, though it is doubtful if either prove of sufficient thickness and good quality to lead to extensive working. As far as developed, the coals here have proved of comparatively little value.



Figs. 402-405. Columnar sections in T. 11 N., R. 5 W.

928. VERTICAL RELATIONS OF COALS.—The columnar section for this township is shown by the following columnar sections, the first being brought in from just across the township line to show features not shown by the sections obtained in the township.

929. SECTION 296. SECTION AT BOOTH'S.—Sec. 13-11-6 (?), Fig. 402. By Collett.*

*7th Ann. Rep. State Geol. Ind., p. 431.

		Ft.	In.
1.	Sandy clay	12	0
2.	Sandstone and gray shale	8	0
3.	COAL III (?), shaly—caking	0	6
4.	Sandy clay, with stigmaria	3	6
5.	Shaly sandstone	8	0
6.	Massive sandstone	12	0
7.	Soft, ferruginous sandstone	18	0
8.	Black shale in river	2	0
		64	0

930. SECTION 297. SECTION JUST NORTHEAST OF BOWLING GREEN.—Sec. 18 (1), Fig. 403.

		Ft.	In.
1.	Sandstone, shaly or massive	15	0
2.	Sandy shale	2	0
3.	COAL I	0	6
4.	Fire-clay, blue, shaly	3	0
5.	Shale, sandy, gray to brown	8	0
		27	6

931. SECTION 298. SECTION AT CENTER OF SEC. 20.—Fig. 404.

			Ft.	In.
1.	Massive sandstone		50	0
2.	Soft blue shale	0 ft. to	4	6
3.	COAL I	0 ft. to	2	6

932. SECTION 299. SECTION AT BUELL PLACE.—Sec. 7 (1), Fig. 405; after Collett.*

			Ft.	In.
1.	COAL I and shale	2 ft. to	0	4
2.	Fire-clay or blue shale		3	0
3.	Sandstone, cross-bedded		8	0
4.	Shale, blue, with iron ore		11	0
5.	Pyritous blue shale		8	0
6.	Sandstone and shale		5	0
7.	Ocherous iron ore		3	0
8.	Limestone		16	0
			54	4

This section shows the rocks underlying Coal I, as the preceding sections show more especially the rocks above. At what point in this section the coal measures end and the Lower Carboniferous rocks begin is in doubt, certainly the Limestone (No. 8) is of Lower Carboniferous age.

*7th Ann. Rep. State Geol. of Ind., p. 431.

933. DISCUSSION OF SECTIONS.—Division III probably forms the top of some few hills in the township, but was nowhere seen, and need not be considered.

934. DIVISION I.—The rocks of this division at nearly every point include all the rocks from the tops of the hills down to drainage, and practically all the coal of the township belongs in this division. No very good exposures of the Mansfield sandstone were seen, but on several of the hills along the roads leading out of Bowling Green, outcrops indicated a thickness of shaly sandstone with some massive layers of from 50 to 75 ft. At the base of this is usually, though not always, some dark blue shale. Coal I ranges in thickness from 0 ft. to a reported thickness of 3 ft. 8 in. or 4 ft. In the northwestern part of the township two beds of thin coal appear instead of one, at this horizon. In quality this coal does not appear to give satisfaction, as nearly all the coal used locally is hauled from Center Point or elsewhere, so that the township gives little promise of ever yielding coal on a large scale.

Section 3. Structure and Distribution of Coal.

A slight westward dip of the rocks is noticeable, so that Coal I, while well above drainage in the eastern sections, is usually close to the drainage in the western.

935. In Sec. 4 a well 84 ft. deep was sunk at Mr. Kattman's. The section given by the drillers was: Surface, 25 ft.; sandstone, 8 ft.; coal, 4 ft.; sandstone and shale the rest of the distance. Mr. Kattman himself was not inclined to think that as much coal as that existed there. Outcrops, Sec. 4 (1-3), were referred to Coals I and Ia.

936. In Sec. 5 Coals I and Ia outcrop on the Kattman place only a little above the bottoms of Eel river. They are reported as each 20 in. thick, the upper bed poor, crumbly, and sulphury, the lower fine, solid coal. They are 8 ft. apart, separated by shale, each underlain by fire-clay, with sandstone over the upper bed.

937. In Secs. 6 and 7 coal is reported as outcropping at several points along the foot of the bluff west of Eel river.

938. In Sec. 8 an 18 to 20 in. bed of coal has been stripped a little on the hill 40 or 50 ft. above the bottoms of Eel river. A well at the same place is reported to have passed through 2 ft. of coal at 25 ft.

939. In Sec. 10, Coal III?, 18 in. thick, was mined in 1885-86 on the Tapy place, Sec. 10 (1). The coal is here about 75 ft. above Jordan creek, is overlain by thick shales, with much sandstone above. The coal appears to be above the Mansfield sandstone.

940. In Secs. 15 to 18, along Jordan creek, outcrops of massive sandstone occur at several points. Whether this sandstone was above or below Coal I was not determined. The section on the Buell and Cullen farms, in Secs. 17 and 18, was given in ¶932. No trace of the limestone showing there was seen up the creek in Clay county. The section just out of Bowling Green, on the Jordan creek road, was also given in ¶930. Massive sandstone outcrops at a number of places about Bowling Green, in Sec. 19.

941. In Sec. 20 coal outcrops and has been worked a little on the John Clark place, Sec. 20 (1), and on the old John Woods place, Sec. 20 (2). The section here was given in ¶931. The coal averages less than 2 ft. thick, has sometimes a sandstone roof and sometimes shale comes between the coal and sandstone. It was reported by Mr. Collett as a brilliant caking coal, with a good reputation. The fact that it is not mined more indicates a comparatively poor quality.

942. In Sec. 21 the coal is said to average over 2 ft. on the Daniel Hoover place, Sec. 21 (1). Near the center of Sec. 28 is a good exposure of the Mansfield sandstone. In Sec. 29 a 2-ft. coal bed outcrops on the Rice place, the section being the same as for Sec. 20.

943. In Sec. 30, on the Godbury place, formerly the Jas. Black place, coal has been stripped some at several places. It is reported as very sulphury, and failed to give satisfaction. The section at the well on this farm, as given by Mr. Collett, is: Hard sandstone, 6 ft.; soft sandstone, 12 ft.; Coal I, 3 ft. 8 in.

Doubtless many other outcrops of Coal I occur, but, due to its apparent lack of commercial value, but little time was given to the coal of this township.

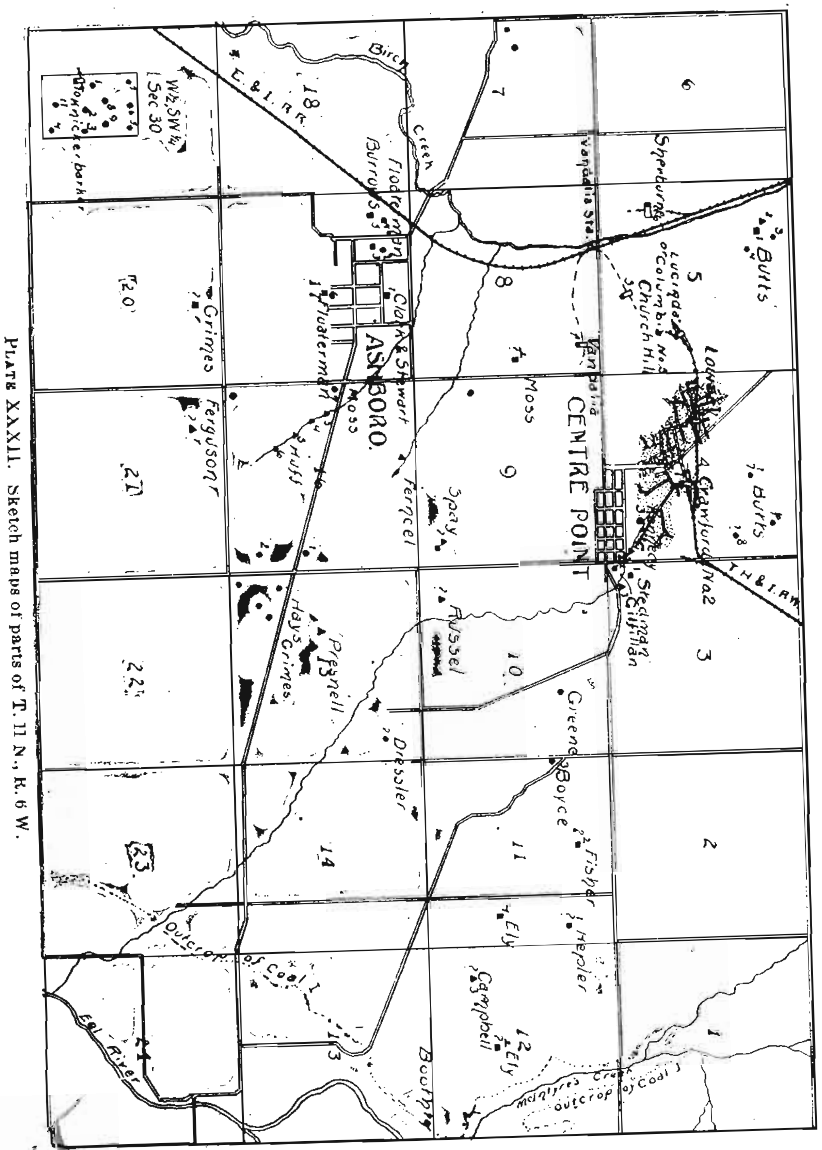


PLATE XXXII. Sketch maps of parts of T. 11 N., R. 6 W.

Township 11 North, Range 6 West.

Section 1. Geography.

944. Position.—About the geographical center of Clay county. The two eastern rows of sections are in Washington, and the rest in Sugar Ridge of the civil townships. See Sheet B.

945. Topography.—Eel river on the eastern side, and Birch creek on the western, have each broad valleys, with gentle slopes on the western side and somewhat steeper slopes on the eastern side. Between the two streams is a divide, rather high and rolling, but to the south an even prairie-like slope to Eel river.

946. Transportation.—The E. & I. railway just touches the southwestern corner of the township. The Brazil branch of the same road crosses the northwestern part of the township. The Center Point branch of the Vandalia just enters the township at its northern side. Thus most of the workable coal lies within one or two miles of existing railways.

Section 2. Stratigraphy and Coals.

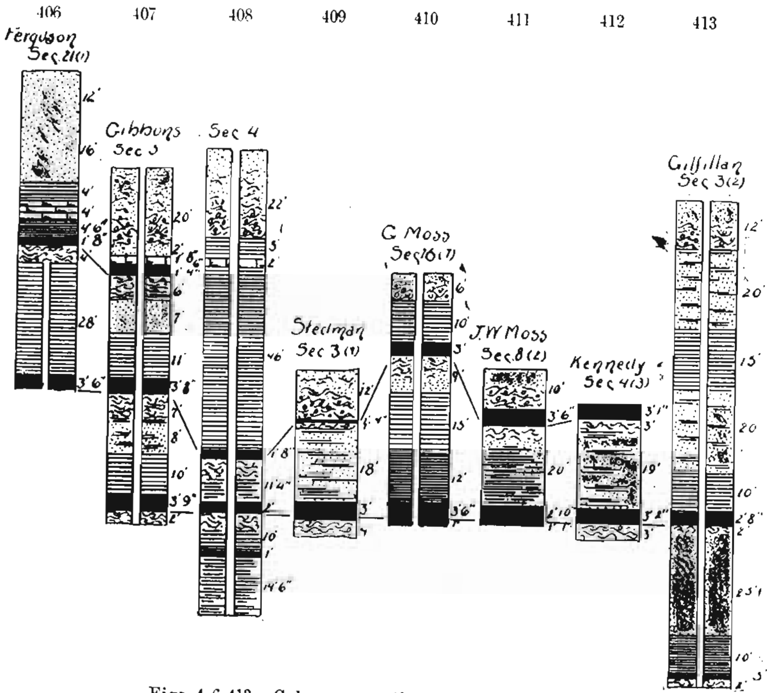
The following sections, all reported by Mr. Collett in the 7th Ann. Rep., will show the relative position of the coals of this township.

947. Section 300. Section of Outcrops on Ferguson-Grimes Farms.—Secs. 20 and 21, Fig. 406.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Clay soil	12	0	..	..	12	0
Division V—						
2. Red ferruginous sandstone.	16	0	..	..	28	0
3. Pyritous shale	4	0	..	..	32	0
4. Bituminous limestone	4	0	..	..	36	0
5. Black shale ....1 ft. to	4	6	..	..	40	6
6. COAL V	1	8	1	8	42	2
7. Fire-clay	4	0	..	..	46	2
Division IV—						
8. Gray and blue shale (in bore)	28	0	32	0	74	2
9. COAL IV ....1 ft. to	3	6	3	6	77	8

948. Section 301. Section on A. Gibbons Farm.—Sec. 5, S. E. ¼, Fig. 407.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Average of 12 bores. Site of Churchill mine.						
2. Surface clay	20	0	..	..	20	0
Division V—						
3. Sandstone	2	0	..	..	22	0
4. Bituminous limestone	1	8	..	..	23	8
5. Black shale, pyrite balls..	0	6	..	..	24	2
6. COAL V	1	4	1	4	25	6
7. Fire-clay and shale	6	0	..	..	31	6



Figs. 4 6-413. Columnar sections in T 11 N., R. 6 W.

	Ft.	In.	Ft.	In.	Ft.	In.
Division IV—						
8. Hard sandstone	8	0	..	..	39	6
9. Blue shale	11	0	25	0	50	6
10. COAL IV	3	8	3	8	54	2
11. Clay and shale	7	0	..	..	61	2
Division III—						
12. Shaly sandstone	8	0	..	..	69	2
13. Gray shale	10	0	25	0	79	2
14. COAL III	3	9	3	9	82	11
15. Fire-clay, laminated	2	0	..	..	84	11

949. SECTION 302. SECTION OF BORING IN SEC. 4.—Fig. 408.

	Ft.	In.	Ft.	In.
1. Surface	22	0	22	0
Division V—				
2. Blue shale	5	0	27	0
3. Hard blue limestone	2	0	29	0
4. Place of Coal V	..	..	29	0
Division IV—				
5. Shale and sandstone	46	0	75	0
6. COAL IV	1	8	76	8
Division III—				
7. Clay and sandy shale	11	4	88	0
8. COAL III	2	0	90	0
Division II—				
9. Clay and shale	10	0	100	0
10. COAL III	1	0	101	0
11. Gray sandy shale	14	6	115	6

950. SECTION 303. SECTION AT OLD STEDMAN SLOPE.—Sec. 3 (11), Fig. 409.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Clay soil	12	0	..	..	12	0
2. COAL IV	0	4	0	4	12	4
3. Fire-clay	1	0	..	..	13	4
4. Shaly sandstone	18	0	19	0	31	4
5. COAL III	3	0	3	0	34	4
6. COAL II, bone	0	7	0	7	34	11
7. Shaly clay	4	0	..	..	38	11

951. SECTION 304. SECTION OF BORE ON GEO. MOSS'S PLACE.—Sec. 16 (7), Fig. 410.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface soil	6	0	..	..	6	0
2. Blue shale	10	0	..	..	16	0
3. COAL IV	3	0	3	0	19	0
4. Shaly clay and sandstone	9	0	..	..	28	0
5. Shale	15	6	..	..	43	6
6. Dark shale	12	0	36	6	55	6
7. COAL III	3	6	3	6	59	0
8. Shaly clay	1	0	..	..	60	0

952. SECTION 305. SECTION IN MORRISON-MOSS SHAFT.—Sec. 8 (2), Fig. 411.

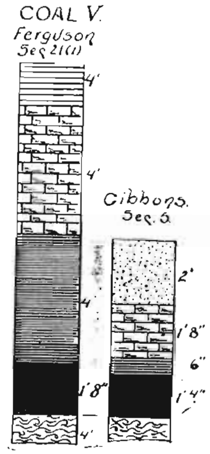
	Ft.	In.	Ft.	In.
1. Surface clay ....1 ft. to	10	0	10	0
2. COAL IV	3	6	13	6
3. Clay and sandy shale	20	0	33	6
4. COAL III	2	10	36	4
5. Coal II (bone, 2 in.; coal, 11 in.)	1	1	37	5

953. SECTION 306. SECTION AT OLD KENNEDY SHAFT.—Sec. 4 (3), Fig. 412.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Coal IV outcropping	3	1	3	1	3	1
2. Shaly clay	3	0	..	..	6	1
3. Shaly sandstone	19	0	22	0	25	1
4. COAL III	3	2	3	2	28	3
5. COAL II	0	9	0	9	29	0
6. Clay	3	0	..	..	32	0

954. SECTION 307. SECTION IN BORE AT GILFILLAN'S PLACE.—Sec. 3 (2), Fig. 413.

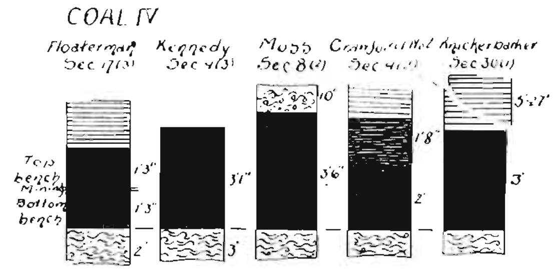
	Ft.	In.	Ft.	In.	Ft.	In.
1. Clay and soil, place of Coal V	12	0	..	..	12	0
2. Shaly sandstone	20	0	..	..	32	0
3. Blue shale, place of Coal IV	15	0	..	..	47	0
4. Shaly sandstone	20	0	..	..	67	0
5. Gray shale	10	0	..	..	77	0
6. COAL III	2	8	2	8	79	8
7. Plastic clay	2	0	..	..	81	8
8. "Hard rock" (sandstone)	25	0	..	..	106	8
9. Black-gray shale	10	0	37	0	116	8
10. COAL I	0	5	0	5	117	1
11. Plastic clay	2	0	..	..	119	1



Figs. 414, 415. Sections of Coal V in T. 11 N., R. 6 W.

955. DISCUSSION OF SECTIONS.—All the divisions from I to V, inclusive, outcrop in the township. The drift and surface soil, as a rule, have a combined thickness of less than 25 ft. In a few places preglacial channels have been found where it is nearly 50 ft. to the coal measure rocks.

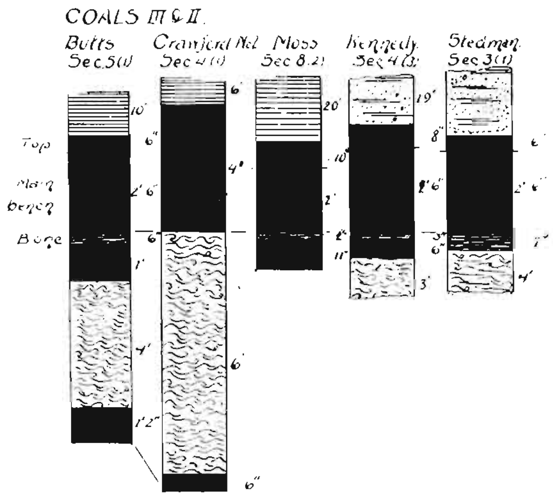
956. Division V.—This division occurs only in the higher ground of the northwestern part of the township. Coal V has not been noted of workable thickness, 2 ft., just east of Center Point, being the thickest reported. At several places it is quite characteristically overlain by the black shale and limestone. See Figs. 414 and 415.



416 417 418 419 420

Figs. 416-420. Sections of Coal IV in T. 11 N., R. 6. W.

957. Division IV.—Rocks of this division form the most of the outcrops of the western half of the township. Shales abound in this division, with some shaly sandstone. Coal IV was found in work only at Ashboro, where it is thin, but shows the characteristic bench mining. In general it ranges in thickness from 3 ft. 8 in. down to nothing. Its thickness in several shafts is shown in Figs. 416 to 420. Its roof is usually shale and reported as poor. At several points where of good thickness it is too near the surface or has only soft surface deposits over it.



421 422 423 424 425

Figs. 421-425. Sections of Coals III and II in T. 11 N., R. 6 W.

958. Division III underlies most of the township outside of the immediate valley of Eel river, and the southeastern corner of the township. In thickness this division varies from 10 to 30 ft. Shaly sandstone is perhaps more abundant than shale. Coal III is the coal that has been principally worked. In thickness it varies from 4 ft. 6 in. down. It shows the characteristic bench of top coal, semi-caking, 6 to 10 in. thick. It is usually quite characteristically underlain by Coal II, which in many cases is mined with it as part of one bed. The roof is either shale or shaly sandstone, and very good when of sufficient thickness. The coal seemed to have a good reputation as far as could be learned.

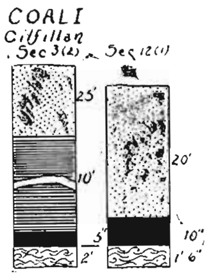
959. The following table shows analyses made by Mr. Cox, and reported in the 7th Ann. Rep.:

MINE.		Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Moisture.	Ash.	Total Waste.
Kennedy, top	Sec. 4 (3)	81.50	35.00	46.50	3.00	15.50	18.50
Kennedy, middle	Sec. 4 (3)	88.50	39.00	49.50	2.50	9.00	11.50
Kennedy, bottom	Sec. 4 (3)	92.50	40.50	52.00	3.00	4.50	7.50
Morrison, top	Sec. 8 (2)	89.50	37.00	52.50	3.50	7.00	10.50
Morrison, middle	Sec. 8 (2)	92.50	34.00	58.50	3.00	4.50	7.50
Morrison, bottom	Sec. 8 (2)	93.00	36.00	57.00	3.50	3.50	7.00
Stedman, top	Sec. 3 (1)	93.00	35.50	57.50	3.00	4.00	7.00
Stedman, middle	Sec. 3 (1)	90.00	39.50	50.50	2.00	8.00	10.00
Stedman, bottom	Sec. 3 (1)	92.00	32.00	60.00	3.00	5.00	8.00

This coal as exhibited above shows a good percentage of fixed carbon, and a somewhat small percentage of volatile combustible matter, and a comparatively large percentage of ash, and an average percentage of water.

960. Division II.—This includes Coal II, as usual part bone and part good coal. The bone is usually thin in this township, ranging from 2 to 7 in., and as the coal under runs up to a foot in thickness of good coal, with generally no clay or shale between Coals III and II, Coal II is generally mined as part of the bed, thus making, with Coal III, a total thickness of often 4 ft. 6 in.

In the northwestern part of the township another coal is met with from 4 to 10 ft. below Coal III. It was at first thought that this was only Coal II separated from Coal III by a greater average distance than usual; but at the Butts mine, in Sec. 5, what appears to be typically Coal II, consisting of 6 in. of bone, overlying 12 in. of good coal, immediately underlies the main bed, Coal III, while 4 ft. below, still, is a 14-in. bed of coal. At Crawford No. 2 shaft, this lowest coal is 6 in. thick and 6 ft. below Coal III. In a boring in Sec. 4 (see Fig. 408) it is 1 ft. thick and 10 ft. below. We do not feel perfectly sure that we are right in making it below the coal called Coal II in the preceding townships of Clay county, but the relations at the Butts mine indicate that it is.



Figs. 426-427. Sections of Coal I in T. 11 N., R. 6 W.

961. DIVISION I.—This division outcrops along the bluffs each side of Eel river. As usual, it is mainly a massive sandstone. The best exposure of this sandstone noted was along Eel river, in Secs. 35 and 34. Coal I was nowhere seen of workable thickness. It ranges quite persistently from a few inches to a foot in thickness.

Section 3. Structure and Distribution of Coals.

962. STRUCTURE.—Very little could be made out of the general structure. There is a slight westward dip, but, while locally high, its general effect is slight. It would appear as though an anticline of some size crossed the southeastern corner of the township in a direction about N. 60° E. A set of levels obtained with some care might show that this anticline was not such in point of fact. The appearance of its being an anticline is still more marked in the township to the south.

963. SECTIONS 1 AND 2.—No coal was seen in these sections. Mr. Collett maps an outcrop of Coal I, in the S. W. of the S. E. of Sec. 1. This outcrop could not be found, but would indicate that Division I is largely above drainage in Sec. 1, and no coal need be looked for in that section. In Sec. 2 it is probable that Division III outcrops over part of its area at least, but Coal III, if there, is probably too near the surface to be largely worked.

964. SECTION 3.—In the S. W. corner of this section, close to Center Point, Coal IV is just at or above drainage; Coal III is a few feet below, but within reach of slopes; Coal V has been noted just east of Center Point and at about the level of the upland. Coal V? was not seen, but was reported to have been exposed near where the Gilfillan bore is reported to have been put down by a cave-in over the Stedman mine. It is reported 2 ft. thick and 4 ft. below the general surface. Coal III has been worked for many years at the old Stedman slope. The section here was given in ¶950, and shown in Fig. 409, and the coal in Fig. 425. The coal shows 2 ft. 6 in. of good block coal, with 6 in. of top caking coal. The bottom 7 in. of bone appear to have been worked, making a total of 3 ft. 7 in. Roof is a shaly sandstone.

965. SECTION 4.—Coal was being extensively mined in this section at the Crawford No. 2 mine and the Louise mine. At the Crawford No. 2 mine, of the Crawford Coal Company, Coal IV is found at a depth of 60 ft. This bed is thin, ranging from 2 ft. 6 in. down, with from a few inches to 18 in. of bone coal. The roof is bad and it is not worked. See Fig. 419. Coal III is found at 96 ft. It ranges from 4 ft. 6 in. to 1 ft. 6 in. It is here a semi-block coal, and has to be mined with powder; the slips are not distinct, and sometimes only the face slips can be distinguished. It has a very good roof of blue shale, with a sandy shale above. In places there are a few inches of "draw slate." The mine is one of the driest in the State. Below the coal is 6 ft. of fire-clay, then 6 in. of coal. See Fig. 422. The shaft examined will probably be worked out in 1898, but the company report holding enough good coal land around this for three more mines.

966. The Louise mine, of the Weaver Coal Company, lies just west of No. 2, and, aside from the fact that the coal is found at 106 ft., has just the same conditions as at No. 2.

In the N. E. ¼ of the section, three borings on the Butts place are reported to show as follows (Sects. 308-310):

	1st Bore.		*2d Bore.*		*3d Bore.*	
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Space to Coal IV	15	10	12	0	40	0
Coal IV	2	8	3	0	1	11
Space to Coal III	14	4	22	0	13	0
Coal III	1	6	1	2	1	7

If correct, these borings indicate very little workable coal in that area.

Previous to the opening of the Crawford No. 2 mine the same coal was worked just north of town by shaft, by Kennedy, or later by Dun-ingan. The section here is given in ¶952, Figs. 412, 417 and 424. The section of the coal as given in detail by Mr. Collett was:

	Ft.	In.
Roof coal, caking	0	8
Block coal, choice	2	6
Splinty cannel	0	3
Cubic Albertite	0	3
Soft, bearing-in coal	0	3
	3	11

As given by one of the men who formerly worked in the mine, the section was:

	Ft.	In.
COAL III	3	0
COAL II (bone, 4 in.; good coal, 8 to 12 in.)	1	4

This indicates that what Mr. Collett called "cannel" or "splinty cannel" in describing several of the mines of this township is what we have been calling "bone coal" in this report above. A specimen of this bone supposed to be from that part of the coal was tested by the writer. In cross section it appeared like a rich, clean cannel coal, but when split showed its shaly structure. When placed on the fire it burned well for a time, but left a larger mass than the coal was originally, showing its bony nature. By this interpretation of Mr. Collett's term "cannel," it becomes easy to correlate the coals described by him which could not be examined.

In the Kennedy mine it is reported that the bone coal became thicker going to the rise, indicating a structural hill of later date. Where the coal was thickest there was reported to be some bone coal on top of the main bed.

967. SECTION 5.—Coal III was being worked for wagon trade in the N. W. ¼, on the Butts place, by Ekland & Johnson. At the shaft the coal was 14 ft. deep, but had formerly been stripped just a few rods west. The section here showed (Sect. 311), Fig. 421:

	Ft.	In.
Surface	4	0
Shale	10	0
COAL III	3	0
COAL II (bone, 3 to 6 in.; good coal, 9 to 12 in.)	1	6
Fire-clay	4	0
COAL ....1 ft. to	1	3

Coal III here appears to be a good grade of block coal, the slips being open from 1-16 to ¼ of an inch. This may be in part due to the coal, where being worked, being so near the outcrop. The face slips run N. 15° W. The top coal, 4 to 6 in. thick, sticks to the roof in mining, and is not usually entered by the slips. The roof is shale, and seemed good, though it had only been worked under a short time. In the shaft, about 4 ft. above the coal, was noted what appeared to be an unconformability in the shales, as shown in Fig. 427a. In the

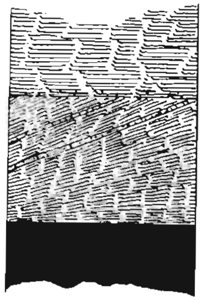


Fig. 427a An apparent nonconformity in the Ekland & Johnson shaft, Sec. 5-11-6.

mine the dip is very strong to the north, but must soon be reversed in that direction, as in the drilling a short distance to the north it was only 8 ft. to the coal. Coal IV was passed through in a drilling a little southeast and up the hill from the shaft.

In the S. E. ¼ of Sec. 5 was the Churchill mine. The section in this quarter, as obtained by averaging twelve bores made on the Gibbons place, was given in ¶948, and shown in Fig. 407. Coal V, though thin here (1 ft. 4 in.), was stripped for many years for blacksmithing, for which purpose it is reported to have been well suited, being unusually free from sulphur. Coal IV averaged 3 ft. 8 in., Coal III 9 in.

The Churchill mine is reported to have had a 4-ft. bed of coal at 54 ft. in depth, Coal III, and a 3 ft. 3 in. bed at 37 ft., Coal IV. Coal has also been worked extensively in the S. W. ¼ through the Sherburne shaft. Recently the Crawford No. 5 shaft has been opened up in the S. E. ¼ of Sec. 5.

968. SECTIONS 6 AND 7.—Drilling is reported to have shown only thin coals in this section. The drillings near the west side of Sec. 7 are reported to have shown 2 ft. 10 in. of coal at a depth of 70 ft. Leases formerly held in these sections have largely been given up.

969. SECTION 8.—The broad bottom of Birch creek occupies a large share of this section. In the N. E. ¼ both Coals III and IV have been worked at the Vandalia shaft.

The section at the old Morrison shaft (loc. ?), on the J. W. Moss land, was given in ¶952 and figured in Fig. 410, Coal III being reported 3 ft. 9 in., and Coal IV 3 ft. 6 in. It would seem that Coal IV is probably cut out across the bottoms of Birch creek.

970. SECTIONS 9 AND 10.—The Coals III and IV appear to be very near the surface of these sections. Both coals are reported to outcrop and to have been stripped at several places. At the Greene place, in Sec. 10, 3 ft. to 3 ft. 6 in. of coal is reported at 70 ft. No very definite or trustworthy information obtained on these sections or the next.

971. SECTION 11.—Coal has been mined to some extent in this section. At the Fisher slope (loc. ?) the coal is reported to have been good block coal 2 to 3 ft. thick, with splint coal 6 to 7 in. from the bottom, and bone coal roof. At the Martin Ely slope, situated some 20 ft. below the general level, the coal is reported as 2 ft. 9 in. thick, with a shale roof. It is suggested that these mines are in Coal III, though our examinations were not thorough enough to settle that question. On the Boyce place, Sec. 11 (3), 3 ft. 6 in. of coal are reported at 60 or 70 ft., Coal I, if information is correct.

972. SECTIONS 12 AND 13.—In these sections Coal I outcrops along the bluff of Eel river and McIntyre's creek, usually near level of bottom land; Coal III cropping out near the top of the bluffs or farther back, and usually being thin.

In the S. W. ¼, Sec. 12 (1), the following section was taken:

Mansfield sandstone, brown and yellow, cross-bedded, 20 ft.; Coal I, 6 to 10 in.; gray fire-clay, 1 ft. 6 in. See Fig. 427. The coal is here about 15 ft. above Eel river bottom. The sandstone at this point forms quite a prominent "rock house," and can be traced south along the bluff for some distance, in which direction, on the Booth farm (loc. ?), Mr. Collett reports the section given in ¶929 and Fig. 402, Coal III being only 6 in. thick and Coal I not seen. At the Ely drift, Sec. 12 (2) (loc. ?), the following section is reported: Surface—sandstone, 8 to 10 ft.; shale, 1 ft.; bone coal, 4 to 6 in.; Coal III (?), 2 ft. 4 in.; potters' clay, a few inches; then "hard material." The coal at this point is said to be about 30 ft. above Eel river bottom. At the Campbell place (loc. ?) the coal is reported to have been 18 in. thick where stripped.

973. SECTION 14.—Probably Coal III near the surface, and Coal I, 30 to 50 ft. below, with little, if any, workable coal.

974. SECTIONS 15 AND 16.—Some stripping has been done on Coal IV, on the Presnell place, though coal could not be seen when visited. It was reported as 3 ft. thick. Dumps show gray sandstone, with shale remains and a little shale, which presumably overlay the coal: Also on the Grimes place, Coal IV at a depth of 12 ft. was formerly mined a little and hauled to Bowling Green. Of three drillings on the Hays place, one, Sec. 15 (2), is reported to have shown 3 ft. 6 in. of coal at a depth of 22 ft., and at 50 ft. to have passed through 2 ft. of good coal overlying 2 ft. of bone coal, presumably Coal III. The other two drillings, Sec. 15 (4 and 5), showed only Coal III of the same thickness and at the same depth as in the first drilling. Another drilling in the S. E. corner of Sec. 16 showed practically the same thing.

At Sec. 16 (1) a thin bed of coal, Coal V?, is reported as about 20 ft. down, and a 2 ft. 6 in. to 3 ft. bed at 45 ft., Coal IV? In a small drain in the west part of Sec. 16 are several isolated patches of a thin coal overlain by black, bituminous, sheety shale; presumably Coal V. It has been stripped at several places. Down the drain is an outcrop of an 8 to 10 in. bed of coal, Sec. 16 (3), with white to gray shaly sandstone over it. Its relations to Coal V could not be determined with certainty, as Coal V, where seen, had just about the pitch of the stream, but is supposed to be below, and to be either Coal IV or Coal IVa. A drilling on the Geo. Moss place, Sec. 16 (7) (loc. ?), reports Coal IV as 3 ft. thick, Coal III as 3 ft. 6 in., underlain by Coal II, 1 ft. thick. See ¶951 and Fig. 410 for section. Considerable stripping has been done on Coal IV (rep.) (loc. ?), on the Ferncell place, Sec. 16 (8).

975. SECTION 17.—Coal has been mined about Ashboro for many years and in many places. At the Floaterman gin shaft, the section obtained was: Surface, 9 ft.; blue and gray shale, 19 ft.; Coal IV, 2 ft. 6 in.; fire-clay, 2 ft.; micaceous, shaly sandstone, 8 in.; gray shale, ——; Coal III, 20 ft. below Coal IV, and reported as thicker than Coal IV. Coal IV has its characteristic bench mining about 14 to 15 in. from the bottom. It is a block coal having regular slips, the face slips being 20 in. apart and extending the whole thickness of the bed, while half way between came "half" or "false" slips which offset at the bench mining. The butt slips average 10 to 12 in. apart. The top 8 or 9 in. of the coal is reported to be the best, being clean and caking coal; the rest is a non-caking coal. The roof is said to be good.

At the Clark and Stewart mine the coal is also 30 ft. deep, and is reported very similar to the Floaterman coal. Mr. Floaterman has had several openings about Ashboro. Coal is also reported to have been worked on the Burrows place, Sec. 17 (4 and 5), by slopes and by McKeen and Minshall, in the S. E. ¼ of the section (loc. ?). Coal IV about Ashboro is little, if any, below the level of Birch creek, so may practically be considered as cut out across the immediate valley of that creek. As Sec. 18 is composed largely of the bottom of that creek, it is probable that Coal IV underlies only the small portion of the section that is upland. Coal III probably underlies the whole section; but it is doubtful if more than a limited amount of it can be worked.

976. SECTIONS 19 TO 23.—These sections are probably entirely underlain by coal horizons III and IV. On the Ferguson and Grimes farms, in Secs. 20 and 21, Coal V is characteristically developed 1 ft. 8 in. thick (see Fig. 414), and in a boring Coal IV is reported as 3 ft. 6 in. thick. See section ¶947 and Fig. 406. Coals III and IV are reported at a number of places in Secs. 20 and 21, but no definite information could be obtained as to thickness or depth. It seems probable that some workable coal exists in these sections, except in Sec. 23, where Coal III must be very near the level of the upland. The horizon of Coal I comes near the level of Eel river bottoms, so that it is probably cut out over the eastern side of Sec. 23, and nearly all of Secs. 24, 25 and 26.

SECTIONS 27-29.—Through these sections the land slopes very gradually to the bottoms of Eel river. While Coal III may underlie the northern part of the sections, it hardly seems probable that any amount of workable coal will be found in them. Coal I underlies all the sections, but probably contains no workable coal.

977. SECTION 30.—The slight westward dip has carried the horizons of Coals III and IV deep enough to be workable in this section. Drilling done on the W. ½ of the S. W. ¼ show Coal IV? averaging about 3 ft. at a depth of about 50 ft. A summary of eleven borings, as reported by Mr. Collett, is given in the following table. See map of eighty acres in Sec. 19 on map of township. (Sects. 312-322.)

MATERIAL.	NUMBER OF BORE.										
	1	2	3	4	5	6	7	8	9	10	11
Surface clay	16-00	17-00	15-00	18-02	12-00	20-00	16-00	18-00	17-00	14-00	10-00
Quicksand	6-06	.....	8-00	.....	21-02	27-06	31-06	9-00	.....	2-00	.....
Sandstone, gray shale, etc.	22-06	17-00	15-06	18-10	14-04	.....	.....	.....	14-06	26-06	8·00
Dark, hard shale	5-02	8-03	9-00	27-08	9-02	.....	.....	17-09	13-00	7-00	26-06
COAL IV?	3-00	3-02	3-02	3·00	3-02	2-09	3-00	3-00	3-02	3-00	3-04
Fire-clay, shale and sandstone	44-10	07	04	04	02	03	.....	.....	.....	.....	.....
Totals	98-00	46-00	51-00	68-00	60-00	50-06	50-06	47-09	47-08	52-06	47-10

The levels showed a dip of 9 ft. from bore No. 5 to bore No. 10, and the coal is reported to rise 11 ft. between the shaft sunk at bore No. 10 and the S. W. corner of the section. The Nickerbarker Coal Co. put down a shaft at bore No. 10 and planned to work the coal extensively. Financial difficulties are said to have led to the abandonment of the mine before work had progressed far. The coal is reported a choice block coal, the bed being very persistent and uniform, and very free from interruptions. In driving the entire 1,200 yds. only two small "horsebacks" were found. The drillings show traces of an old channel in the N. W. corner of the 80 acres. The coal doubtless extends with a similar thickness beyond the limits of the 80 acres tested, but its nearness to the surface may prevent its profitable mining.

978. SECTIONS 31-33.—Probably underlain by Coals III and IV in the northern part of Sec. 31 and possibly in the N. W. part of Sec. 32, otherwise only Coal I need be looked for, and that not far below the level of Eel river, and not of workable thickness.

979. SECTIONS 34-36.—Probably no coal north of Eel river. On the side of Eel river in Secs. 34 and 35 are almost continuous and fine exposures of Mansfield sandstone, forming perpendicular or overhanging bluffs 30 or more feet high. Coal I, a few inches thick, is reported to underlie this sandstone in the river. A blossom of coal was observed above, or in the sandstone just west of the line between Secs. 34 and 35. In Sec. 36 the Mansfield sandstone is found to the top of the 75-ft. ridge between Eel river and Six Mile creek, where it has been planed and scratched by the glacier, the scratches showing nicely beside the road in the N. E. ¼. On the M. B. Trump place occurs 6 to 8 in. of coal, Sec. 36 (1).

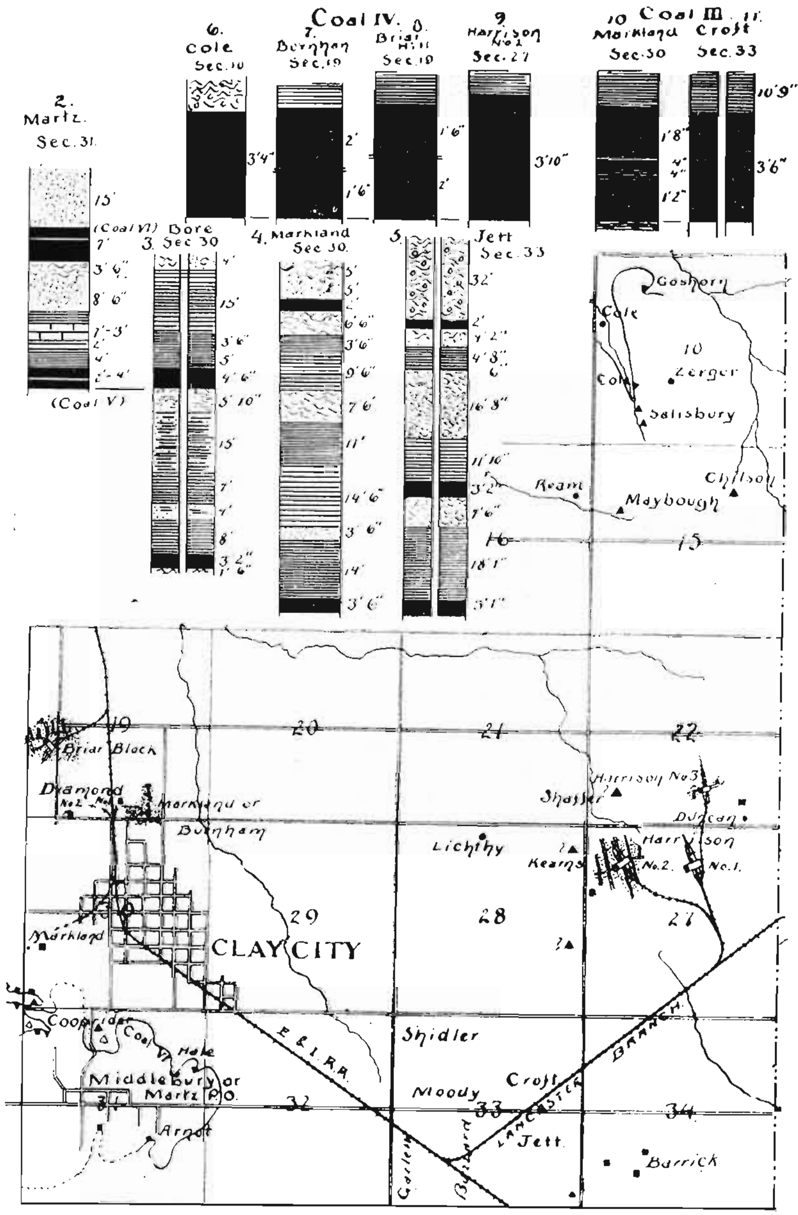


PLATE XXXIII. Sketch map, columnar and coal sections, T. 10 N., R. 6 W.

TOWNSHIP 10 NORTH, RANGE 6 WEST. (PART IN CLAY COUNTY.)

Section 1. Geography.

980. LOCATION.—This partial township includes the Secs. 3-10, 15-22, 27-34, or the four western rows. It very nearly corresponds with the eastern half of Harrison of the civil townships.

981. TOPOGRAPHY.—In the northwestern part of the township the surface is very level, sloping imperceptibly to Eel river. This level land extends southward to Clay City and thence southeasterly, leaving a high hill in Sec. 31. In the center of the township, or central eastern sections, the part under discussion is higher and rolling.

Section 2. Stratigraphy and Coals.

All the divisions from I to VI outcrop in this township. Division VI is practically limited to a high hill or outlier in Sec. 31.

The following sections will serve to show the relative positions of the coals and the intermediate strata.

982. SECTION 323. CONNECTED SECTION ABOUT MIDDLEBURY.—Sec. 31, Fig. 2.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface and drift.....0 ft. to	30	0	..	..	30	0
2. Sandstone	15	0	..	..	45	0
3. COAL VI, 2 ft. to 11 (?) ft.	7	0	7	0	52	0
4. Fire-clay	3	6	..	..	55	6
5. Sandstone and shale	8	6	..	...	64	0
6. Limestone or blue calcareous shale ....7 ft. to	3	0	..	..	67	0
7. Yellow shale	2	0	..	..	69	0
8. Black, bituminous, sheety shale	4	0	21	0	73	0
9. COAL V ....2 ft. to	4	0	4	0	77	0

Coals VI and V are very characteristically developed in this section.

983. SECTION 324. SECTION OF BORING IN HILL NEAR MARKLAND SHAFT.—S. W. ¼ of Sec. 30, Fig. 3. Reported by Mr. Collett.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface soil	4	0	..	..	4	0
2. Shale, clayey	15	0	..	..	19	0
3. Blue shale	3	6	..	..	22	6

		Ft.	In.	Ft.	In.	Ft.	In.
4.	Black, bituminous shale ("impure cannel slate")...	5	0	..	..	27	6
5.	COAL V	4	6	4	6	32	0
6.	Clay shale	5	10	..	..	37	10
7.	Sandy shale	15	0	..	..	52	10
8.	Blue shale	7	0	..	..	59	10
9.	Shale and sandstone.......	4	0	..	..	63	10
10.	Blue shale	8	0	39	10	71	10
11.	COAL III?	3	2	3	2	75	0
12.	Fire-clay	1	6	..	..	76	6

It would seem probable that the drilling was on the hill a little southwest of the shaft.

984. SECTION 325. SECTION IN MARKLAND SHAFT.—Sec. 30 (1). Fig. 4. Reported by Mr. Collett.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface soil	5	0	..	..	5	0
2.	Gray sandstone	5	0	..	..	10	0
3.	COAL VI?	2	0	2	0	12	0
4.	Fire-clay, hard	6	6	..	..	18	6
5.	Black, sheety shale........	3	6	..	..	22	0
6.	Hard shale, place of Coal V?	9	6	..	..	31	6
7.	Fire-clay	7	6	..	..	39	0
8.	Black shale	11	0	..	..	50	0
9.	Gray shale	14	6	..	..	64	6
10.	White sandstone	3	6	..	..	68	0
11.	Black shale	14	0	70	0	82	0
12.	COAL III?	3	6	3	6	85	6

Coal IV appears to be lacking in both of these sections. As a rule, however, it is quite persistent. A boring from the Jett farm will show its position.

985. SECTION 326. SECTION OF BORING, JETT FARM.—Sec. 33, N. ½ of S. E. ¼; Fig. 5. Reported by Mr. Collett.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface clay and drift.....	32	0	..	..	22	0
2.	COAL IV? (rotten)	2	0	2	0	24	0
3.	Fire-clay and sandstone....	4	2	..	..	28	2
4.	Black shale	4	8	8	10	32	10
5.	COAL V?	0	6	0	6	33	4
6.	Fire-clay and white sandstone	16	8	..	..	50	0
7.	Blue shale	11	10	28	6	61	10
8.	COAL IV	3	2	3	2	65	0
9.	Shaly fire-clay	7	6	..	..	72	6
10.	Blue and black shale......	18	1	25	7	90	7
11.	COAL III	3	1	3	1	93	8

The rotten coal first met in this bore has probably been reduced in thickness by the preglacial or glacial erosion to which it has evidently been subjected.

986. SECTION 327. SECTION ON SHIDLER FARM.—N. ½ of N. W. ¼, Sec. 33, Fig. 428. Reported by Mr. Collett.

		Ft.	In.	Ft.	In.
1.	Clay, boulder clay, sand, etc.........	55	0	55	0
2.	Dark blue shale	39	6	94	6
3.	Gray shale and fire-clay	10	2	104	8
4.	Gray sandstone	5	7	110	3
5.	Hard white sandstone	21	0	131	3
6.	Shaly sandstone	7	2	138	5
7.	Limestone	0	8	139	1
8.	Dark clay shale	11	6	150	7
9.	Dark shale	0	6	151	1
10.	COAL I (bony)	0	7	151	8
11.	Dark shales, with iron balls	3	0	154	8
12.	Gray, blue and black shales..........	35	9	190	5
13.	Shaly clay	2	4	192	9

This boring, after finding Coals III to V missing, was continued to Coal I and beyond. The Mansfield sandstone is represented by about 33 ft. of sandstone. The presence of limestone over Coal I is unusual and may be questioned.

987. DISCUSSION OF SECTIONS.—Drift Deposits and Erosion.—It is probable that all the coals are wanting in the northeastern part of the township, due to the preglacial erosion of Eel river valley. It would appear probable that other channels will be found in time. Evidences of one were found in borings on the Jett farm, N. ½ of S. E. ¼, Sec. 33, as reported by Mr. Collett. Two of these borings were as follows (Sects. 328 and 329):

	Ft.	In.
Surface clay	16	0
Boulder clay—silt	31	0
Blue clay	5	0
Boulder clay	16	0
Quicksand, not passed	2	0
	70	0

Surface clay	14	0
Boulder clay—silt	14	0
Quicksand	11	6
Yellow clay and gravel	9	3
White clay	2	2
Float sandstone	1	6

	Ft.	In.
Quicksand	8	4
Boulder clay	4	7
Clay and sand, not passed	2	7
	72	0

988. Division VI.—This division is developed in the top of the hill at Middlebury, where it consists of Coal VI, and an overlying sandstone. Coal VI is here reported to reach a thickness of 11 ft. at several places. As none of the workings were open, this could not be verified. Mr. Collett gives the details at one point where it was 7 ft. thick, and it probably will not average any thicker than that. See Fig. 444. It is reported as having one or two clay partings, and from

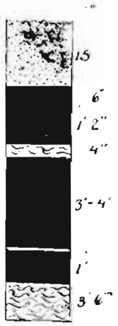


Fig. 444. Section of Coal VI at Middlebury.

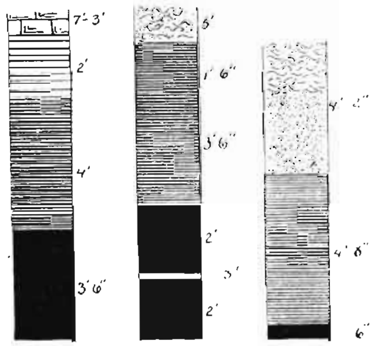
descriptions we would infer a smooth parting near the top and bottom, making it in its details much like Coal VI, as developed near Turner, Stanton, and in northeastern Vigo county. It appears to lack in quality what it has gained in thickness, the general report being that it sells only when bad roads prevent the hauling of more desirable coal. It is possible that by rejecting certain parts of the seam a more desirable coal could be marketed. With much doubt, thin coals in the Markland shaft, and the boring given from the Jett farm, have been correlated with Coal VI. In the case of the Markland shaft, the top of the shaft was judged to be about on a level with the nearest outcrop of Coal V, a quarter of a mile south. This would indicate a dip of 35 or 40 ft. at least in the quarter mile. At the outcrop of Coal V mentioned, there is a very high north dip, sufficient to carry Coal VI to the place assumed in the Markland shaft, if continued. Again, to the east of Middlebury, Coal VI appears to outcrop on the eastern side of the hill, 6 ft. thick and well above the flat country to the east.

Therefore, the finding of a 2-ft. coal in a boring on that much lower land, does not suggest Coal VI. Its position, however, relative to the coals assumed to be Coals III and IV, and the character of the strata accompanying the little 6-in. bed occurring only a few feet farther down, give some weight to that correlation. For the present it must remain in doubt.

The following analysis by Mr. Cox will show the composition of this coal:

Mine.		Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Moisture.	Ash.	Total Waste.
E. Cooprider, top	Sec. 31	91.50	47.50	44.00	4.00	4.50	9.50
E. Cooprider, middle	Sec. 31	89.00	44.00	45.00	2.50	8.00	10.50
E. Cooprider, bottom	Sec. 31	92.50	42.00	50.50	3.00	4.00	7.00
John Cooprider, top	Sec. 31	91.50	47.00	44.50	3.00	5.50	8.50
John Cooprider, bottom	Sec. 31	89.00	47.50	41.50	3.50	7.50	11.00
Average		90.70	45.60	45.10	3.20	6.00	9.30

This shows a coal poor in fixed carbon, rich in volatile combustible matter, and with a high percentage of ash.



445 Phipps. Sec. 30.
446 Cooprider. Sec. 30.
447 Jett. Sec. 33.

Figs. 445-447. Sections of Coal V in T. 10 N., R. 6 W.

989. Division V.—This division is best developed in the Middlebury hill. Coal V there ranges from nothing to 4 ft. 6 in., and is usually quite characteristically overlain by the black sheety shale, often highly bituminous, and this in turn is often overlain by a shaly

limestone, ranging up to 6 or 7 ft. in thickness. Coal V is here generally reported as a caking coal, of somewhat better quality than Coal VI, and at one place where it is divided by a clay parting is claimed to be for half its thickness a good quality of cannel coal.

Over most of the area, Coal V, or the coal so correlated, shows only as a thin seam, seldom more than 18 in. thick. It is commonly overlain by limestone, and generally by blue shale. Aside from near Middlebury, it is nowhere workable. In the next township south, drillings show two coals above Coal IV. It seems probable that one of these, and I think the upper, is at the horizon of Coal V, the other coal then becoming Coal IVa. It may be, therefore, that the thin bed of coal met with over much of the eastern part of this township above the workable coal is Coal IVa.

An analysis of this coal from the Ambrose Phipp's place by Mr. Cox gave:

MINE.	Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Moisture.	Ash.	Total Waste.
Phipps, top .... Sec. 30....	91.50	39.50	52.00	3.00	5.50	8.50
Phipps, middle .... Sec. 30....	93.00	44.50	48.00	2 00	4.50	6.50
Phipps, bottom .... Sec 30....	87.00	47.00	40.00	2.50	10.50	13.00
Average..................................	90.50	43.66	46.83	2.66	6.83	11.33

Taken as a whole, this bed is low in fixed carbon, and high in ash. It is evident, however, that the upper part is much better than the lower part, the latter bringing down the average. The coal at this point is described as brilliant black, semi-block coal in moderately thick laminae, with charcoal partings, running into a caking coal at the bottom, with pyrite. The whole is much iron stained.

990. Coal IV is the bed principally worked. See Figs. 6 to 8, of Plate XXXIII. This appears to be generally a solid bed, though a bench mining of hard coal is occasionally reported. It is a non-caking or splint coal, semi-block in structure, and generally clean and pure. The slips, as a rule, are not as marked nor as regular as about Brazil, the distance between face slips, as far as measured, running from 10 to 17 in., and between butt slips averaging about 14 in. In thickness the bed varies from 4 ft. 6 in. to nothing, with an average of a little over 3 ft. The roof is usually shale and varies from good to very poor.

Even where good, it will only remain so a limited time, as a rule. Coal IV appears to have run out at the Markland shaft.

991. Coals III and II appear to form a solid bed in this area, the bone coal of Coal II merely making a parting of bone or "cannel" from 0 to a few inches in thickness (Figs. 10, 11, Plate XXXIII). At the old Markland shaft this coal bed is reported to have been a caking coal. When this area was examined, no opening to Coal III could be found, so it was not seen. In places the top coal is reported as semi-caking. Mr. Cox describes the coal at the Markland shaft as follows:* "This is a bright, black laminated block coal, with very distinct charcoal partings. Four inches of the middle of this seam is a glossy, jet black, caking coal, with only one-half per cent. of ash; it bears a close resemblance to the mineral Albertite from Novia Scotia. On exposure to the air it breaks into small, irregular fragments, and burns like a pine knot when once ignited. Underlying the bottom are 3 or 4 in. of bone coal, containing considerable pyrites." The analysis of this coal by Mr. Cox gave as follows:

MINE.	Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Moisture.	Ash.	Total Waste.
Markland, top .... Sec. 30 (1)....	94 00	36.00	58.00	2.00	4.00	6.00
Markland, middle .... Sec. 30 (1)....	97.00	33.50	63.50	2.50	.50	3.00
Markland, bottom .... Sec. 30 (1)....	95.00	36.00	59.00	2.50	2.50	5.00
Average..................................	95.33	35.16	60.16	2.33	2.33	4.66

These analyses bear out the good reputation that the coal appears to have enjoyed.

992. Division II.—Several of the bores in Sec. 33 go into a considerable thickness of shale below what is taken as Coal III, indicating erosion at those points of the Mansfield sandstone and the deposition of shales in its place.

993. Division I.—The boring on the Shidler place passed through Division I, showing only about 33 ft. of sandstone and Coal I 7 in. thick. The division outcrops along the northern edge of the township, and is well exposed on Eel river just north of the township line. It does not give evidence of containing any workable coal.

*7th Ann. Rep., p. 51.

Section 3. Structure and Distribution of Coals.

994. STRUCTURE.—The lack of data in the northern part prevents any determination of the structure there. From the Harrison mine, Sec. 27, to the Diamond mine, Sec. 19, little or no change of level is observable, except as an instrumental survey might show a difference of surface level. The high hill in Sec. 31 appears to be in part a structural hill, if, as seems probable, the coals in the hill, which outcrop there well above the surrounding level ground, at short distances in every direction, pass below the surface of the lower level. Lack of exposures prevented any detailed examination of the structure.

995. SECTIONS 3, 4, 5, 6, 7, 8, 9, 17 AND 18.—No outcrops of coal were found in these sections. The land is, as a rule, nearly level, or sloping gently to Eel river, offering little opportunity for exposures, and it is probable that the coals have been removed over a covered channel of some width along the general course of Eel river. It is probable that no workable coal exists in any of these sections, unless it be in the southern or eastern parts of Secs. 3, 9, 17 and 18. Coal III may underlie the southern edge of Sec. 3, the eastern edge of Sec. 9, and most or all of Secs. 17 and 18. Coal IV may be found under working conditions in Secs. 17 and 18. Coal I probably underlies all of these sections, but it is not probable that it acquires a working thickness.

996. SECTION 10.—Coal III appears to be just below drainage, and was only reported as struck in the well at the Cole place, Sec. 10 (2), where it was 3 ft. thick and 15 to 18 ft. deep in the well.

Coal IV has been stripped on the R. V. Cole and David Salisbury places, Sec. 10 (3, 4, 5). The coal here is reported as 3 ft. 4 in. thick, without partings, but having 1 in. of bone at the top and about 3 in. of soft coal at the bottom, which is mined in (Fig. 6). Both face and butt slips are developed, the former about 20 in. apart, the latter 13 to 16 in. apart. The coal is reported of good quality, though slacking in time. Boulder clay forms the roof as far as mined. Below is 6 in. of fire-clay, then bluish white sandstone. The dip is east of south. Estimated 1¼ acres taken out on the two farms.

Coal is also reported as struck in Zerger's well, Sec. 10 (6) (loc. ?), at about 10 ft. Coal IV probably laps over the edge of Sec. 9.

997. SECTIONS 15 AND 16.—Coal IV? has been stripped on the John Chilson place, Sec. 15 (1) (loc. ?), where it is reported as being 4 ft. thick, not blocking, and as having a shale roof. It has also been stripped on the Maybough place. In Sec. 16, Mr. Ream (Sec. 16 (1)), reports 3 ft. of coal as met in his well at 50 ft., having only boulder clay and surface above it, and below it red clay-like material to 83 ft., where a very hard "fire-clay" was struck. The indications seem to indicate Coal IV of workable thickness as underlying most of Sec. 15 and the southeastern two-thirds of Sec. 16 at about drainage level. Coal III lies probably 20 or 30 ft. lower, and is likely to contain some workable coal. The roof may prove an obstacle to mining in these sections.

998. SECTIONS 20, 21 AND 22. These sections are probably underlain by Coals III and IV, with much coal of workable thickness, if a satisfactory roof can be had. Some coal has been stripped on the Chris. Shaffer place in the S. W. ¼ of Sec. 22 (loc. ?), and in the S. E. ¼ of the same section a test shaft, Sec. 22 (2), is reported to have found Coal IV, 4 ft. 6 in. thick at between 50 and 60 ft., with Coal V thin over. A well on the Duncan place, Sec. 22 (3), passed through surface 12 ft., white sandstone and a little shale to Coal V, 18 in. thick, at 37 ft. In 1898 the Harrison No. 3 mine was opened in the ¼ section.

999. SECTION 19.—Coal IV is here 70 to 100 ft. below the railroad, and is being mined extensively. At the Burnham mine, Berger & Terry, operators, it is 70 ft. to Coal IV, ranging from 2 ft. 6 in. to 4 ft. 6 in., with an average of 3 ft. 6 in. The section of the shaft here is given as: Surface and boulder clay, 30 ft.; sandstone, 16 ft.; blue shale, 24 ft.; Coal IV, 3 ft. 6 in. (Fig. 7). The coal has a bench mining of free coal 18 in. from the bottom. It is semi-block, having both sets of slips which usually extend the entire thickness of the coal. The slips range from 18 in. to 2 ft. apart. This coal occurs in basins, the thickest coal coming in the swamps, and the thin on the edges. A little sulphur shows in the seams, otherwise it is quite free of sulphur, and is reported to weather well. Few irregularities are encountered in mining. Diamond mines Nos. 1 and 2 are now worked out and abandoned. The coal was reported there as 4 ft. thick, and about 100 ft. deep.

At the Briar Hill mine, Sec. 19 (1), Coal IV is 116 ft. deep, ranging from 2 ft. 6 in. to 4 ft. 6 in., with an average of 3 ft. 6 in. (Fig. 8). Coal V, 8 in. thick and overlain with black shale and limestone, is reported to have been passed at 85 ft. The bench mining of hard coal comes 2 ft. from the bottom. The coal is a semi-block, having tight slips, the face slips pretty well marked, the butt slips less so; face slips reported as running N. 75° E. Slips all about 18 in. apart. In general, the coal is quite free of sulphur and shale. A little gas is sometimes found near the bottom. The roof is a blue to gray clay shale 27 ft. thick, and said to be good if it does not stand too long. The floor is a fine fire-clay 2 ft. 6 in. thick. The mining is done in this clay, using Harrison machines, and the 16 in. taken up is raised to the surface, and has been quite extensively sold, some 9,000 tons having brought 90 cents a ton on board the cars, in a single year. Two 3-ft. faults are reported in this mine, one on the southwestern and the other on the northwestern side, the latter running about N. 65° E. The coal is undulatory, often getting thicker to the rise instead of thinner. Below the fire-clay is reported "sand and flinty gravel," and a 2-ft. bed of coal 6 ft. below the worked bed. Some 62½ acres are reported worked out here.

1000. SECTION 27.—The depth and character of Coals III and IV in this section may be taken from their description at the Harrison No. 1 and 2 mines. At Harrison No. 2 mine it is 75 ft. to Coal IV, which here varies from 2 ft. 8 in. to 4 ft. 6 in. in thickness, with an average of 3 ft. 10 in. (Fig. 9). The seam appeared solid, being a little softer at the top than elsewhere. It has from 0 to 1½ in. of bone at the top and bottom. It is mined at the bottom. The roof is gray shale and poor. The floor is fire-clay. The coal has to be shot, being a semi-block, with tight slips, the face slips running N. 18° W., not extending full thickness of coal and being from 10 to 17 in. apart, as far as measured. Butt slips 14 in. apart. Neither slips are as regular nor as marked as in block coal around Brazil. The coal occurs in basins and thins to the rise. Coal V, 18 in. thick, was passed through in sinking the shaft. At Harrison No. 1 mine the roof was considered extremely dangerous. Coal III was sunk to and worked a little in No. 1 mine, but its depth and thickness could not be learned. A good deal of trouble is experienced with the numerous small rolls met with. The 80 acres attached to No. 1 mine are worked out, and about 40 acres of No. 2 are worked out. The company still has some 600 acres north and east of here. (No. 3 mine has since been started in Sec. 22.)

1001. SECTIONS 28 AND 29.—These sections give promise of yielding much coal. The Brazil Block Coal Company have large holdings in Sec. 28.

1002. SECTION 30.—Coal III? was formerly worked in this section at the Markland shaft. The coal was here 82 ft. deep and 3 ft. 6 in. thick. See ¶¶983, 984, and Figs. 4 and 10. The coal here has already been described in ¶991, the section being:

	Ft.	In.
Choice block coal	1	8
Glistening "albertite"	..	4
"Splinty cannel" (bone?)	..	4
Semi-block	1	2
Total	3	6

The bench described as "splinty cannel" is supposed to be the bone coal usually forming the top of Coal II. If so, the bed is really Coal II—III. The roof was here a gray and blue shale, full of ferns and other plants.

Drillings in the N. E. 40 acres of this section are reported to give the coal there an average of 4 ft. 2 in.

In the S. W. corner of the section Coal V has been worked on the Uriah Cooprider place. A partial section there gave: Surface, 5 ft.; black, bituminous shale, 1 ft. 6 in.; drab to black sheety shale, 3 ft. 6 in.; coal, 2 ft.; fire-clay, 1 ft.; (rest hidden). The section in the drift is reported to average: Coal, 2 ft.; fire-clay, 3 in.; cannel coal, 2 ft. It is said that four carloads of this cannel coal were shipped to Terre Haute, and tested and reported to be a fair quality of cannel coal.

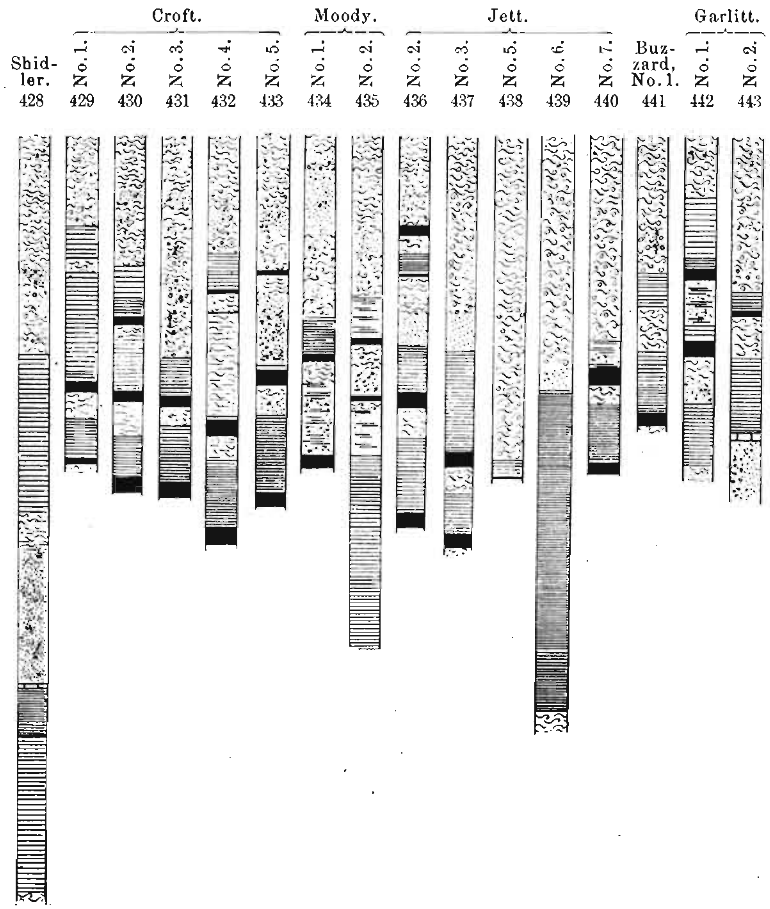
1003. SECTION 31.—In the N. W. corner of this section Coal VI has been stripped in a ravine on the Cooprider place, and was reported to vary up to 11 ft. thick. A short distance down the ravine extensive stripping was being done in 1897 to obtain the limestone over Coal V for road material. The limestone is here 5-6 ft. thick and is said to be 20 ft. above Coal V here. Coal V has been mined some just north of Middlebury beside the road. The limestone here appears to be quite close to the coal.

South of Middlebury Coal VI has been worked by Horton, Arnot and others. Southeast of town, at the Arnot bank, Coal VI is reported as ranging up to 11 ft. in thickness. It is here overlain by 10 to 15 ft. of sandstone. On the Dr. Hale place, northeast of town, three drifts have been opened at which the coal is reported to range from 6 to 9 ft. thick. The only place Coal VI was seen was at one of these, where, the drift being only partly filled up, 3 ft. of the top of the coal was exposed. The coal at this point has a sandstone roof, which seemed to hold up well, as this drift had been opened fourteen years without the roof caving in.

Middlebury is on the top of an irregular hill said to be 92 ft. above the railroad at Clay City.

1004. SECTION 32.—The horizons of Coals III, IV and V (?) underlie this section, and it would seem probable that considerable workable coal may be found there.

1005. SECTION 33.—This section has been carefully proven, and is largely held by the Brazil Block Coal Company. The following drill-



Figs. 428-443. Set of borings in Sec. 33, T. 10 N., R. 6 W.

ing records furnished Mr. Collett by the company some years ago give quite a complete idea of the relative position and value of the coals under it and are instructive as showing what may be expected in this field in the way of variation of the coals and accompanying beds. The land will not vary more than 20 ft. in level.

1006. SECTION 330. SECTION ON CROFT FARM.—S. ½ of N. E. ¼, Sec. 33, Fig. 429.

	Ft.	In.	Ft.	In.
Surface clay, 15 ft.; boulder clay, 8 ft.	23	0	23	0
Blue shale	7	9	30	9
COAL V (?)	0	3	31	0
Fire-clay, 3 ft. 3 in.; blue shale, 25 ft.; same, slaty, 2 ft. 6 in.	30	9	61	9
COAL IV	2	10	64	7
Fire-clay, 6 ft. 6 in.; blue shale, 8 ft. 3 in.; same, slaty, 1 ft.	15	9	80	6
COAL III	1	0	81	4
Fire-clay, not passed.				

1007. SECTION 331. SECTION SAME FARM.—Fig. 430.

	Ft.	In.	Ft.	In.
Surface clay, 14 ft. 6 in.; boulder clay, 9 ft.; yellow clay, 9 ft. 6 in.	32	9	32	9
Yellow shale, 9 ft.; blue shale, 3 ft.; same, slaty, 1 ft. 3 in.	13	3	46	0
COAL V (?)	1	10	57	10
Fire-clay, 2 ft. 6 in.; gray shale, 13 ft. 3 in.	15	9	63	7
COAL IV	2	4	65	11
Fire-clay, shaly, 8 ft.; blue and black shale, 10 ft. 9 in.	18	9	84	8
COAL III	3	6	88	2

1008. SECTION 332. SECTION ON SAME FARM.—Fig. 431.

	Ft.	In.	Ft.	In.
Surface clay, 14 ft.; boulder clay, 41 ft.	55	0	55	0
Blue shale, slaty	9	2	64	2
COAL IV	2	4	66	6
Fire-clay, 4 ft. 6 in.; blue and gray shale, 13 ft. 6 in.	18	0	84	6
COAL III	3	3	87	9

1009. SECTION 333. SECTION ON SAME FARM.—Fig. 432.

	Ft.	In.	Ft.	In.
Surface clay and drift	29	6	29	6
Gray shale	9	0	38	6
COAL	0	8	39	2
Sandy clay	4	6	43	8
COAL	0	2	43	10
Fire-clay, gray, shaly, 25 ft. 5 in.; black shale, slaty, 6 in.	25	11	69	9
COAL IV	3	3	73	0
Fire-clay, shaly, 6 ft. 6 in.; blue and black shale, 16 ft. 9 in.	23	3	96	3
COAL III	4	0	100	3

1010. SECTION 334. SECTION ON SAME FARM.—Fig. 433.

	Ft.	In.	Ft.	In.
Clay and drift	34	10	34	10
COAL	0	7	35	5
Fire-clay, sandy, 4 ft. 8 in.; gray sandstone, 18 ft. 9 in.; blue shale, slaty, 1 ft.	24	5	59	10
COAL IV	3	4	63	2
Shaly clay and sandstone, 7 ft. 4 in.; blue and black shale, 19 ft. 6 in.	26	10	90	0
COAL III	3	6	93	6

1011. SECTION 335. SECTION OF BORING ON JETT FARM.—N. ½ of S. E. ¼, Sec. 33, Fig. 436.

	Ft.	In.	Ft.	In.
Surface clay and drift	22	0	22	0
COAL (VI?), rotten	2	0	24	0
Fire-clay and sandstone, 4 ft. 2 in.; black shale, 4 ft. 8 in.	8	10	32	10
COAL (V?)	0	6	33	4
Fire-clay and white sandstone, 16 ft. 8 in.; blue shale, 11 ft. 10 in.	28	6	61	10
COAL IV	3	2	65	0
Fire-clay, shaly, 7 ft. 6 in.; blue and black shale, 18 ft. 1 in.	25	7	90	7
COAL III	3	1	93	8

1012. SECTION 336. SECTION ON SAME FARM.—Fig. 437.

	Ft.	In.	Ft.	In.
Surface clay and drift	44	6	44	6
Sandstone, 9 ft. 3 in.; blue shale, 25 ft. 9 in.	35	0	79	6
COAL IV	3	6	83	0
Fire-clay, "stony," 6 ft. 6 in.; blue and black shale, 10 ft. 6 in.	17	0	100	0
COAL III	3	0	103	0
Fire-clay	1	0	104	0

1013. SECTION 337. SECTION ON SAME FARM.—Fig. 438.

	Ft.	In.	Ft.	In.
Surface clay, 14 ft. 6 in.; boulder clay, 14 ft.; yellow clay, 11 ft. 6 in.; quicksand, 3 ft. 6 in.; boulder clay, 6 ft.; soft clay and sand, 32 ft. 6 in.	82	0	82	0
Gray shale	4	0	86	0
COAL IV?	0	6	86	6
Fire-clay	0	3	86	9

1014. SECTION 338. SECTION ON SAME FARM.—Fig. 439.

	Ft.	In.	Ft.	In.
Surface clay, 7 ft.; boulder clay, 51 ft.	58	0	58	0
White sandstone, 5 ft.; blue and black shale, 63 ft. 2 in.; dark sandy shale, 15 ft.; stony fire-clay, 5 ft. 9 in.	88	11	146	11

In this boring the thin top coal is cut out and the two main coals have locally thinned out.

1015. SECTION 339. SECTION ON SAME FARM.—Fig. 440.

	Ft.	In.	Ft.	In.
Surface clay, 18 ft. 6 in.; boulder clay, 33 ft. 9 in.	52	3	52	3
Sandstone and sandy shale	7	9	60	0
COAL IV	3	10	63	10
Fire-clay, 4 ft. 6 in.; dark shale, 14 ft. 4 in.	18	10	82	8
COAL III	2	9	85	5

1016. SECTION 340. SECTION OF BORING ON MOODY FARM.—S. ½, N. W. ¼, Sec. 33, Fig. 434.

	Ft.	In.	Ft.	In.
Surface clay, 5 ft.; boulder clay, 3 ft.; sand, 13 ft.; boulder clay, 22 ft. 6 in.	43	6	43	6
Gray shale	9	0	52	6
COAL	1	9	54	3
Fire-clay, 4 ft. 3 in.; sandstone and gray shale, 17 ft. 6 in.	21	9	76	0
COAL	2	10	78	10
Black shale and fire-clay	0	8	79	6

1017. SECTION 341. SECTION ON SAME FARM.—Fig 435.

	Ft.	In.	Ft.	In.
Surface clay, 13 ft.; boulder clay, 3 ft.; quicksand, 1 ft. 6 in.; boulder clay, 3 ft. 6 in.; quicksand, 4 ft. 6 in.; boulder clay, 14 ft. 4 in.; white clay, 2 ft. 8 in.	42	6	42	6
White sandstone and shale	10	6	53	0
COAL, "rotten"	1	6	54	6
Fire-clay, 5 ft. 11 in.; gray sandstone, 6 ft. 1 in.	12	0	66	6
COAL, "rotten"	0	9	67	3
Fire-clay, 1 ft. 6 in.; gray sandstone and shale, 10 ft. 9 in.; dark blue shale, 42 ft. 3 in.; gray shale, 3 ft. 6 in.; dark blue shale, 2 ft.; hard white sandstone, 1 ft. 2 in.	61	2	128	5

1018. SECTION 342. SECTION OF BORING ON GARLITT FARM.—S. W. ¼, S. W. ¼, Sec. 33, Fig. 442.

	Ft.	In.	Ft.	In.
Surface clay	15	6	15	6
Gray shale, 15 ft. 8 in.; blue shale, 2 ft. 3 in.	17	11	33	5
COAL	2	1	35	6
Fire-clay, 3 ft. 1 in.; sandstone and gray shale, 11 ft. 6 in.; blue shale, 3 ft. 6 in.	18	1	53	7
COAL	3	1	56	8
Fire-clay and shaly sandstone, 11 ft. 5 in.; blue shale, 14 ft. 1 in.; fire-clay, sandstone and shale, 3 ft. 10 in.	29	4	86	0

1019. SECTION 343. SECTION ON SAME FARM.—Fig. 443.

	Ft.	In.	Ft.	In.
Surface clay, 14 ft.; boulder clay, 23 ft. 8 in.	37	8	37	8
Blue shale	4	9	42	5
COAL	1	0	43	5
Fire-clay, 10 ft. 4 in.; blue shale, 5 ft. 6 in.; hard gray shale, 12 ft. 6 in.; gray limestone, 1 ft. 2 in.; hard gray sandstone, 15 ft. 4 in.	44	10	88	3

1020. SECTION 344. SECTION OF BORE ON BUZZARD FARM.—S. E. ¼, S. W. ¼, Sec. 33, Fig. 441.

	Ft.	In.	Ft.	In.
Surface clay, 24 ft.; drift gravel, 3 ft.; boulder clay, 5 ft. 10 in.	32	10	32	10
Gray shale	8	2	41	0
Place of coal:				
Fire-clay, 11 ft. 6 in.; gray shale, 8 ft. 6 in.; blue shale, with plates of sandstone, 6 ft. 9 in.	26	9	67	9
COAL	2	6	70	3
Fire-clay	0	6	70	9

1021. SECTION 345. SECTION ON SAME FARM.—

	Ft.	In.	Ft.	In.
Surface clay, 5 ft. 6 in.; boulder clay, 50 ft. 6 in.; quicksand, 9 ft. 6 in.; boulder clay, 8 ft.; blue clay, 7 ft.; gravel, 2 ft. 6 in.	83	0	83	0
Sandstone	5	0	88	0

An examination of these bores with the two given in ¶987 shows that apparently an ancient channel of considerable width crossed the section, near the center, as nearly as can be judged without definite locations of the different borings. The course of the channel can not be determined, but it may be depended upon to have cut out a broad, irregular belt through which the coals have been largely removed. It would not be surprising if it be found that this channel cuts across Secs. 29 and 20.

1022. SECTION 34.—Coal has been worked in the S. W. ¼ of this section on the Barrick place, by a shaft and two slopes. The coal is reported to have ranged from 2 ft. 6 in. to 3 ft. 6 in., with an average of 3 ft. The section of this coal given by Mr. Collett is:

	Ft.	In.
Block coal ....2 ft. to	1	2
Bright cubic coal	1	0
Splinty "cannel"	..	8
	2	10

The overlying shales contain many fossiliferous ironstone concretions. The section doubtless contains some workable coal.

TOWNSHIP 9 NORTH, RANGE 6 WEST. (PART IN CLAY COUNTY.)

Section 1. Geography.

1023. LOCATION.—This partial township is in the S. E. corner of Clay county. The part of it north of Eel river is all in Harrison township; that south of Eel river is in Lewis township.

1024. TOPOGRAPHY.—The most of the area is slightly rolling, becoming somewhat broken to the northeast, while the southwestern corner, south of Eel river, is river bottom, too flat to drain well.

1025. DRAINAGE.—Eel river, with broad bottoms, crosses the southwestern corner. White Oak creek and a creek which heads just west of Coal City are the principal tributaries.

1026. RAILROAD COMMUNICATIONS.—The E. & I. R. R. crosses the northeastern corner of the township.

Section 2. Stratigraphy and Coals.

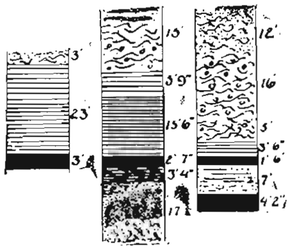
1027. STRATIGRAPHY.—Notwithstanding the number of sections obtained just east and north of this area, some question remains as to the proper stratigraphical position of several of the coals here.

Coal V is characteristically exposed on the Kress place, in Sec. 6, as follows (Sect. 346):

		Ft.	In.
Black, sheety, bituminous shale		4	0
COAL V	18 in. to	2	2

In one or two places a limestone was noted which might have belonged above it.

Three borings made on the Van Horn farm, on the E. ½ of the N. E. ¼ of Sec. 3, show the compositions of Divisions III and IV, in part.



Figs. 448-450. Borings on the Van Horn farm, Sec. 3-9-6.

1028. SECTION 347. SECTION OF BORING ON VAN HORN FARM.—E. ½, N. E. ¼, Sec. 3 (J. C., p. 445), Fig. 448.

	Ft.	In.
1. Surface, soil, etc	3	0
Division IV—		
2. Gray shale	23	0
3. COAL IV	3	9

1029. SECTION 348. ANOTHER BORING ON SAME FARM.—Fig. 449 (J. C., p. 445).

	Ft.	In.	Ft.	In.
Surface, soil, etc	15	0	15	0
Division IV—				
Clay shale	5	9	20	9
Blue shale	15	6	36	3
COAL IV	2	7	38	10
Shaly COAL (?)	3	4	42	2
Division III—				
Shaly sandstone	17	0	59	2

1030. SECTION 349. ANOTHER BORING, SAME FARM.—Fig. 450 (J. C., p. 445).

	Ft.	In.	Ft.	In.
Surface, soil, etc	12	0	12	0
Boulder clay	16	0	28	0
Red clay	5	0	33	0
Division IV—				
Dark slaty shale	3	6	36	6
COAL IV	1	6	38	0
Division III—				
Shaly sandstone	7	0	45	0
COAL III	4	2	49	2
Shaly sandstone	1	6	50	8

These sections show the presence of two workable coals, which are assumed to be Coals III and IV. Drillings south of Coal City show two small seams still above these, one of which is assumed to be Coal V and the other and lower one Coal IVa. Coal IVa in the sections mentioned acquires a thickness of up to 2 ft. 6 in. Coals III and IV range from 9 to 30 ft. apart, but averaging nearer the former than the latter number. In thickness Coals III and IV vary greatly, lying apparently in small basins much separated, so that they are not encountered at all in many drillings, or are so thin that their correlation is difficult. Over small areas they will average 3 ft. or a little over, ranging up to 4 ft. 10 in. These divisions contain much sandstone in thicknesses of up to 30 ft. In one place in a quarry 15 ft. of massive sandstone in Division IV is seen overlying shales with unconformability. These sandstones are quarried some for foundations.

1031. DIVISION I, as reported in borings just outside of this area, ranges from 40 to 120 ft. in thickness, most of that being the massive Mansfield sandstone. Coal I appears to be very limited in thickness and distribution. It possibly outcrops above Eel river where that stream flows out of Sec. 34, and is not far below for some distance up the river. In the northern part of the township it will probably be from 75 to 150 ft. below drainage.

Section 3. Structure and Distribution.

1032. STRUCTURE.—Across Secs. 3-6 the dip is slight, yet noticeable, for in Sec. 3, Divisions III and IV are about at drainage level, while in Sec. 6 Coal V is about at drainage. From Sec. 3 southward no dip is observable to Sec. 22, though south of that it is not unlikely that the coal rises to the south, just as it does a mile or two farther east. The lack of exposures in the southern part of the township makes the position of the coals there very uncertain. The evidence from the township next south, however, would indicate that Division IV, and possibly part of Division III, keeps above the level of the bottoms of Eel river over all of the southern sections.

1033. SECTION 3.—Coals III and IV are both above or close to drainage level in this section. The borings on the Van Horn place were given in ¶¶1028-1030. One of these coals, probably IV, has been mined a little by stripping on the Foxworthy place, Sec. 3 (1), and by drifting on the Garlitt place, Sec. 3 (2); the coal being reported as 3 ft. thick at each place. In the S. W. ¼, 2 ft. of coal is reported as outcropping on the Guthrie place, Sec. 3 (6). A drilling farther up the same small branch found two 6-in. coal beds, one of which is supposed to be the 2-ft. bed farther down, possibly Coal IV.

1034. SECTION 4.—In the N. E. ¼, Coal IV (?) was, many years ago, stripped in the bottom of a branch, Sec. 4 (1). More recently a gin shaft was opened by Messrs. Coan, Wills and Tigert, Sec. 4 (2), which reached the coal at about 12 ft. Coal 14 to 18 in. thick has been reported as stripped in the N. W. ¼ on the Roush place, Sec. 4 (3) (loc. ?), and in the S. W. ¼ on the Kittle place, Sec. 4 (4) (loc. ?); thickness not known.

1035. SECTION 5.—An outcrop, perhaps of Coal V, was noted in the road, Sec. 5 (1), almost up to the general level of the north part of the section. More or less coal has been cut out in this section by preglacial erosion, as shown by a drilling on the Warner place, Sec. 5 (2), where a drilling is reported to have gone 75 ft. down into an old river bottom.

1036. SECTION 6.—Coal V is just above drainage in the N. W. ¼ and has been mined by stripping and drifting in several places on the Kress farm, Sec. 6 (1). Coal V is there 18-26 in. thick, with a clay parting 2 in. from the bottom, and a small sulphur band immediately underlying; 4 ft. of black, bituminous, sheety shale make up the cover. The bottom 2 in. band of coal is a bright coal, the rest is a dull black coal, containing much ash, the bottom foot being cleaner than the rest. Dip northeast.

In the S. E. ¼, on the Croft place, old Berger, Sec. 6 (7), a coal was formerly mined by drifting a little. The coal is reported as running from 2 ft. to 4 ft. 6 in. thick. The section here as given by Mr. Collett is (Sect. 350):

	Ft.	In.
Soil	0	0
White and yellow micaceous shaly sandstone	5	0
Pyritous gray sandy shale	2	10
COAL IV ....2 ft. to	4	6
Fire-clay	3	0

He describes the coal as a "choice resinous caking coal, very pure and free from sulphur, and burns with much flame to a white ash without slag or clinker. It is an excellent blacksmith coal and would probably answer for gas-making." It is a little difficult to understand why a coal of that grade should lie unmined as it has for the past twelve years.

Beside the road there shows (Sect. 351):

	Ft.	In.
Gray shaly sandstone	10	0
COAL	..	6
Fire-clay	2	0+

This is apparently on the same level as the old drift up the branch, and is probably the same Coal (IV or IVa). The dip here is strongly south. A short distance down the branch a drilling is reported as showing 6 in. of coal, which outcrops near by.

1037. SECTION 7.—This section is rendered slightly hilly by sand-dunes. In the S. E. corner, and across the line in Sec. 18, coal has been mined by slope and shaft on the Richard Edmondson place. The coal is reported as a caking coal, with some sulphur, and not extra good, 3 ft. thick. No details could be obtained. This is just on the edge of Eel river bottom, and may be Coal V.

1038. SECTION 8.—No data obtained, but it is probable that preglacial erosion has cut out the horizon of the workable coals.

1039. SECTION 9.—Coal has been worked in the N. E. ¼, on the Whipo place, by a slope, where it is reported as 2 ft. 6 in. thick, with a shale roof. Drillings are reported as showing the coal to get thinner away from the slope. Little data was obtained favoring the idea that any extensive deposits of workable coal will be found in Secs. 4 to 9, inclusive.

1040. SECTION 10.—In the S. E. ¼ the Northall shaft was sunk to the coal many years ago, but as the railroad (T. H. & S. E.) was only built to Clay City, it was abandoned before the road was extended. No information could be obtained as to depth and thickness of the coal.

A drilling on the Barrick place, in the S. W. ¼ of Sec. 10 (2), is reported by Mr. Barrick as follows (Sect. 352):

	Ft.	In.	Ft.	In.
Surface	11	0	11	0
Shale, 2 ft.; white sandstone, 10 ft.; gray shale, 8 ft.; black shale, 1 ft.; gray shale, 2 ft.; very white sandstone, 1 ft.	24	0	35	0

	Ft.	In.	Ft.	In.
Fire-clay	6	..	41	0
Shale	?	?	..	..
COAL and shale	..	2	41	2+
Fire-clay	2	?	43	2+

Across the road from Mr. Barrick's house, and 15 to 20 ft. lower, is an outcrop of blue to brown shaly fossiliferous limestone. This was not passed through in the well at the house, but was struck at 25 ft. in the well at the next house east. Should suppose this to be the limestone over Coal V.

1041. Section 15.—In the S. E. ¼ of this section Coal IV is just about at drainage level. On the Wagstaff place is an old shaft not worked in the last twelve years, and a new shaft being sunk in 1897, Sec. 15 (1). The latter started about 15 ft. above the creek and reached the coal at 12 ft. The shaft passed through gray fossiliferous shale and characteristic "fake" in going down. The coal is reported to show a very thin parting about the middle, the lower bench being the more solid. A little south of this and still on the same farm a nonconformity shows well where some stone was quarried for the abutments for the New Brunswick bridge (see Fig. 451).

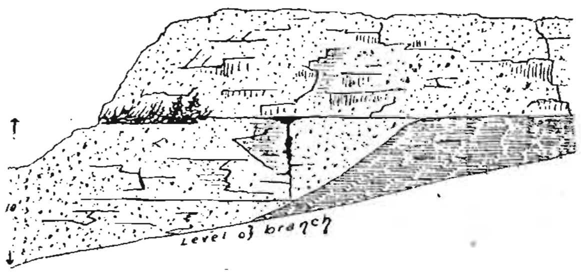


Fig. 451. Nonconformity on Wagstaff place, Sec. 22-9-6.

Just south of this, on the Sparks place, the top bed immediately underlies the massive sandstone exposed in the quarry, while the lower bed, 3 ft. thick, is reported to lie only 4 or 5 ft. below, with shale between. The lower bed is here just about on a level with the creek.

These coals extend to the west, with a considerable thickness of cover, and may contain some workable basins.

1042. Section 22.—In the N. E. ¼ of this section, Coal III (?) is still just about at drainage level with Coal IV (?), 10 to 13 ft. above. On the Murphy place, formerly the Winters place, Coal IV is 18 in. thick, with a shale roof; reported to be a good, hard block coal. Coal III is there 3 ft. thick, with a shale roof and fire-clay floor. It is reported as a shooting coal without partings, and not of as good a quality as the upper bed.

1043. Sections 16-21, 27-34.—Near the center of Sec. 28, on the Duncan place, coal 1 ft. 6 in. to 2 ft. 4 in. thick has been worked a little. It is said to have about 2 ft. of sandstone over it and fire-clay under it. From the level at which this occurs, it would seem likely that this is Coal III or IV. In the N. E. ¼ of N. E. ¼ of Sec. 28, in a well on the Duncan place, coal is reported as found at 50 ft. A well near this, but 10 to 15 ft. lower, seems to have been dug in sandstone. An 80-ft. drilling on Mr. B. White's place, in Sec. 28, is reported as passing no other rock but sandstone, which was very soft. Drillings north of Easter P. O. to a depth of 75 ft. are reported to find only surface and drift material.

These facts strengthen the belief that the sections being considered contain practically no workable coal. Coals III and IV would seem to both lie above the immediate bottoms of Eel river and the flat country south and west, though passing under the elevated land east and north.

Township 12 North, Range 7 West.

Section 1. Geographic.

1044. Location.—This township lies southwest of Brazil and is the second township from the north on the west side. It corresponds to Posey of the civil townships.

1045. Topography.—The central and western part of the township is a level plain, becoming slightly rolling and broken in the northern and southern parts. The streams cut down from 25 to 75 ft., usually, without exposing coal-measure rocks. In Sec. 6 are some gravel ridges or hills apparently of morainic origin.

1046. Transportation Facilities.—The Vandalia railroad crosses the northern and central portions of the township, giving a direct outlet east and west. The Brazil branch of the E. & I. R. R. crosses the northeastern corner.

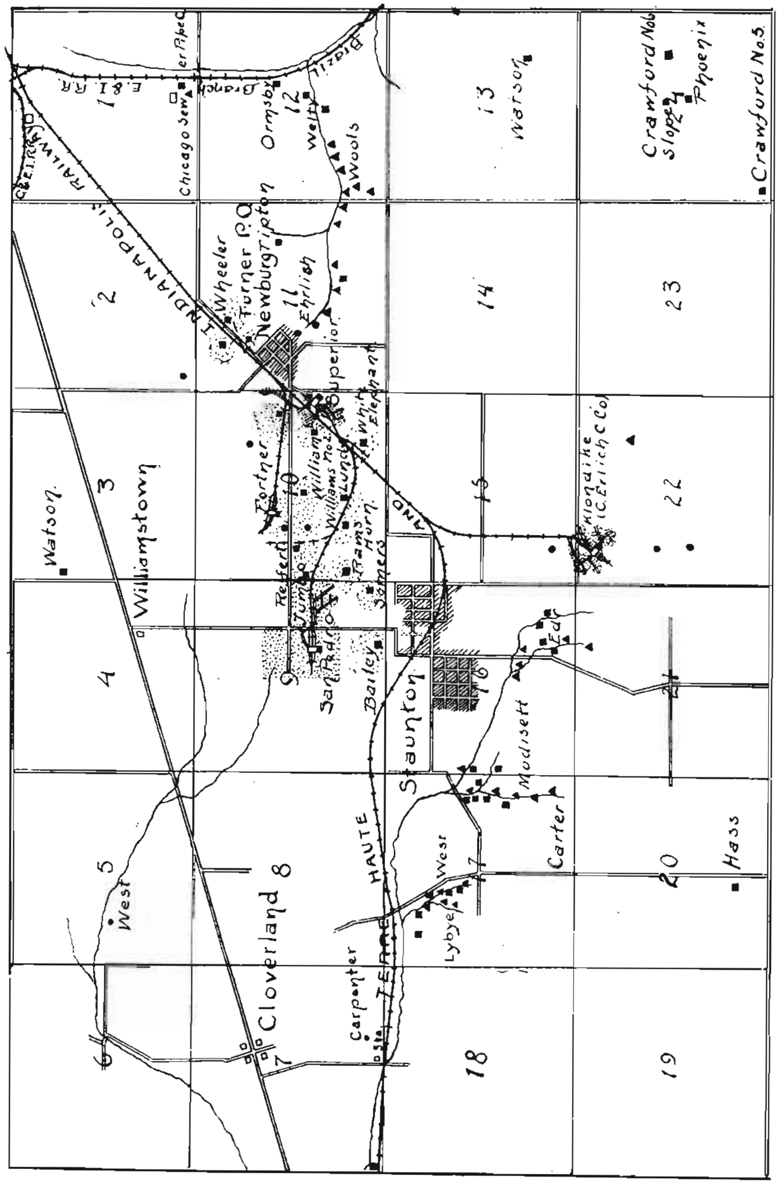
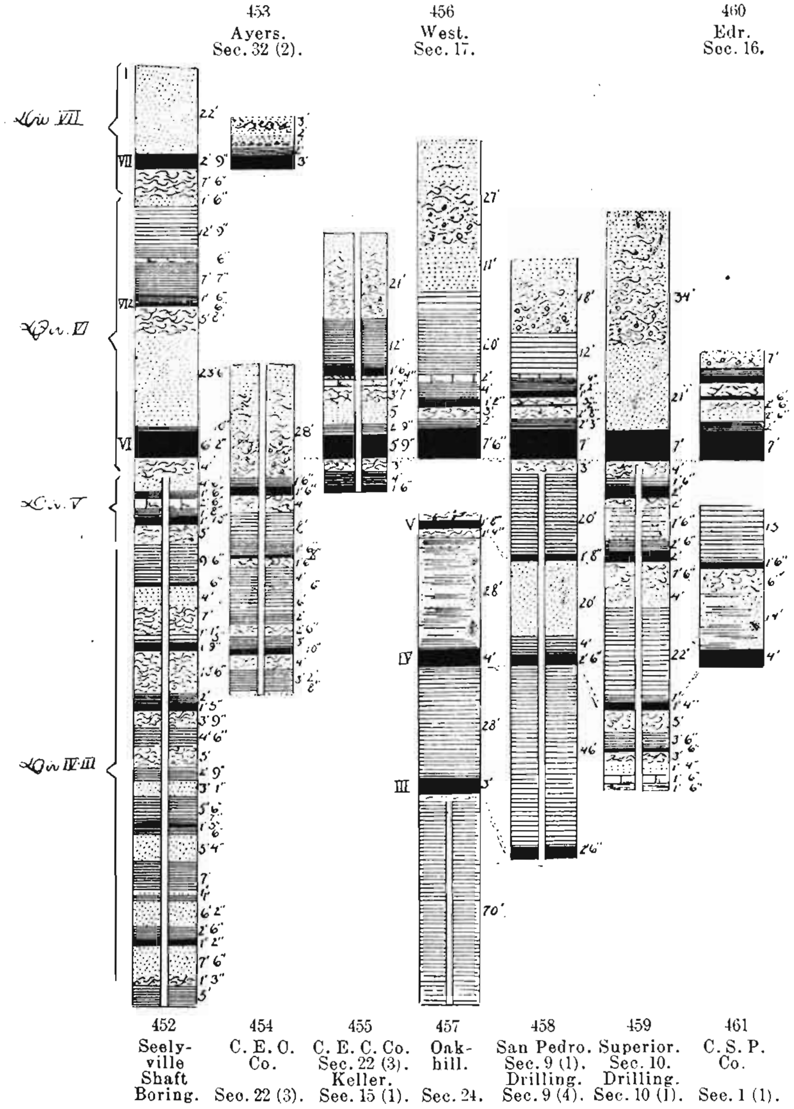


PLATE XXXIV. Sketch map of part of T. 12 N., R. 7 W.

Section 2. Stratigraphy and Coals.

1047. DIVISIONS CONTAINED.—All the divisions from VII downward are contained in this township. Coal VI is the most important coal.



Figs. 452-461. Columnar sections in T. 12 N., R. 7 W.

1048. SECTIONS OF DIVISIONS VI AND VII.—The stratigraphy of these two divisions may be conveniently considered first.

Coal VII is only found over a limited area in the western part of the township, and no section was found in the township showing its position relative to the coals of Division VI. The nearest point at which this relation is shown is at Seelyville, two miles west in Vigo county. The section of the old Seelyville shaft as reported by Mr. Cox is therefore introduced.

1049. SECTION 353. SECTION OF OLD SEELYVILLE SHAFT.—By Mr. Cox. Fig. 452.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Drift	11	0	..	..	11	0
2. Quicksand	5	0	..	..	16	0
3. Boulder clay	15	0	..	..	31	0
Division VII—						
In the Lochner shaft at Seelyville Coal VII is overlain by 22 ft. of sandstone, which is the first rock shown.						
4. COAL VII	2	9	2	9	33	9
5. Fire-clay	7	6	..	..	41	3
Division VI—						
6. Sandstone	1	6	..	..	42	9
7. Clay shale	12	9	..	..	55	6
8. Ferruginous limestone ("fossil ore")	0	6	..	..	56	0
9. Clay shale	7	7	..	..	63	7
10. Slaty shale	1	6	31	4	64	1
11. COAL VIb	0	6	0	6	64	7
12. Fire-clay	5	8	..	..	70	3
13. White sandstone	4	0	..	..	74	3
14. Dark sandstone	5	0	..	..	79	3
15. White sandstone	14	6	..	..	92	9
16. Clay shale	0	10	30	0	93	7
17. COAL VI	6	2	6	2	99	9
18. Fire-clay	4	0	..	..	103	9

1050. SECTION 354. SECTION AT AYRES'S BANK.—Sec. 32 (2), by Mr. T. Watson. Fig. 453.

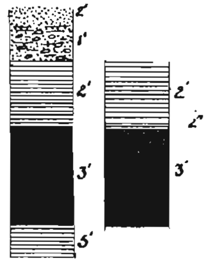
	Ft.	In.
1. Drift	3	0
2. Sandstone, with small feeders of coal near base	2	0
3. Conglomerate limestone pebbles, ½ to 2 in. in diameter, in sandstone matrix	1	0
4. Shale, drab-colored, with coal "feeders"	2	0
5. COAL VII	3	0

This conglomerate cover to Coal VII has been noted at a number of places. In some places it lies immediately on the coal, and in places is wanting entirely. It is usually very irregular in thickness, as is the shale which in this case underlies it. The main cause of this irregularity is due to the fact that the overlying sandstone lies with unconformability on the shale and coal.

1051. COAL VII is usually a rich caking coal, without partings, and in this township averages about 3 ft. thick. In other places the irregularity in its thickness, due to the erosion which preceded the laying down of the sandstone, proves a great obstacle to its working, and it would be reasonable to expect the same difficulty in this area to prevent its being extensively worked. Mr. Watson calls it a semi-block at the Ayres mine in Sec. 32. In general, this coal is best and most regular where the erosion has spared the original shale roof.

In the Seelyville shaft it will be noticed that Coal VIb is 29 ft. above Coal VI. In the Lochner shaft a little west it is 47 ft. above Coal VI. Southeast of Cloverland and about Staunton and Turner is Coal VIa, only 5 to 10 ft. above. This appears to have run out at Seelyville and to the south and west of there. There also appear here traces of a little coal which, it will be remembered, occasionally showed between Coals VI and VIa in northern Vermillion county.

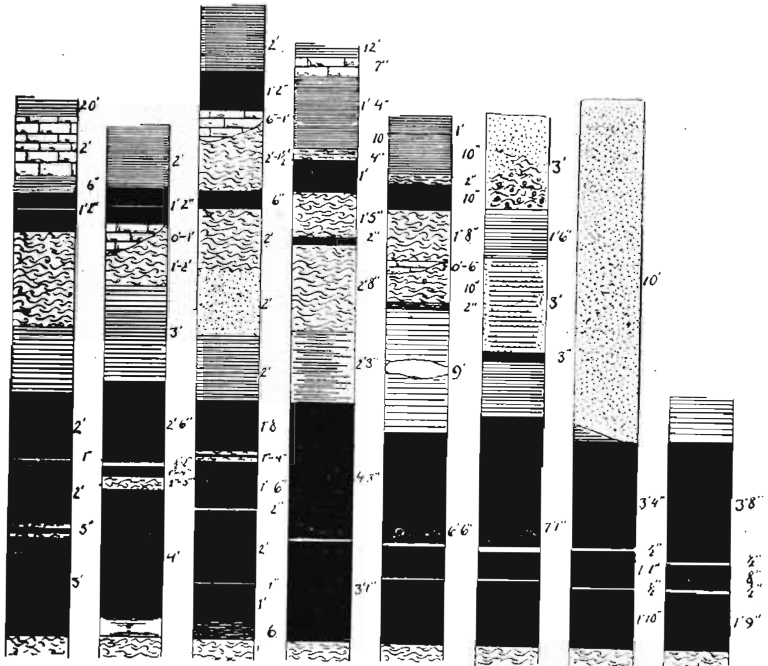
1052. COAL VI lies so near the surface that in giving the sections it will be convenient to refer both to the small scale figures which show the general relations and to the large scale figures which show the details.



462 Ayers. Sec. 32 (2). 463 Rule. Sec. 32.

Figs. 462-463. Sections of Coal VII in T. 12 N., R. 7 W.

In the section on the old West and Brittain places in Sec. 17, we will take the top 50 ft. as given by Mr. Cox in his first Ann. Rep., p. 65. The part of his section below Coal VI (L of his section) was



Figs. 464-471. Sections of Coal VI, T. 12 N., R. 7 W.

found to be in error. Coal VI does not, as he supposed, rise above the level of the creek in descending the stream, but passes under far enough to bring Coal VIa below drainage for a short distance, and beyond which a slight change in the dip brings it above the stream again, and it was at the latter place that it was seen and mistaken by Mr. Cox for Coal V (K of his section). The accompanying diagram, Fig. 478, will show the structure down the ravine.

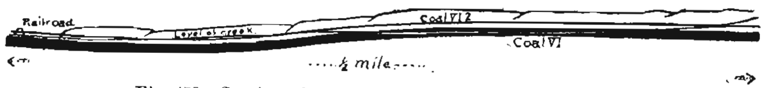


Fig. 478. Section along ravine in the N. W. ¼ of Sec. 17.

1053. Section 355. Section on Alfred West Farm.—Sec. 17, Figs. 456 and 464.

	Ft.	In.	Ft.	In.
1. Surface soil and drift	27	0	27	0
Division IV—				
2. White sandstone	11	0	38	0

	Ft.	In.	Ft.	In.
3. Shale	20	0	58	0
4. Hard blue limestone, which breaks with a conchoidal fracture	2	0	60	0
5. Shale	..	6	60	6
6. COAL VIa (VI_2 of Fig. 478)	1	2	61	8
7. Fire-clay, yellow and gray	2	6	64	2
8. Shale, drab	2	0	66	2
9. COAL VI—Coal, 2 ft. 0 in.; fire-clay, 1 in.; coal, 2 ft. 0 in.; fire-clay, with thin band of coal, 5 in.; coal, 3 ft. 0 in.	7	6	73	8

On the stream that heads on the Carter place in the S. E. corner of Sec. 17, was obtained the following connected section:

1054. Section 356. Section on Modesett Farm.—Sec. 19 (1-12) (connected), Fig. 465.

Division VI—	Ft.	In.	Ft.	In.
1. Surface	5	0	5	0
2. Black, sheety, bituminous shale	2	0	7	0
3. COAL VIa	1	2	8	2
4. Limestone ....0 ft. to	1	0	9	3
5. Fire-clay ....1 ft. to	2	0	11	2
6. Drab shale	3	0	14	2
7. COAL VI—Coal, 2 ft. 6 in.; clay parting, ½-2 in.; coal, 1-4 in.; clay parting, 2-5 in.; coal, 4-0 in.+	7	5	21	7

The whole thickness of the coal was not seen, the rest being hidden by water and mud, but it is reported to be as high as 8 or 9 ft.

1055. South of Staunton was obtained the following connected section (Sec. 357):

Section on David Edr Place.—Sec. 16 (1-6), Fig. 466.

	Ft.	In.	Ft.	In.
1. Surface	4	0	4	0
2. Black shale, sheety, bituminous, jointed	2	0	6	0
3. Gray shale	..	1	6	1
4. COAL VIa	1	2	7	3
5. Shaly limestone ....6 in. to	1	0	8	3
6. Fire-clay ....2 ft. to	1	6	9	9
7. COAL ....4 in. to	..	6	10	3
8. Fire-clay ....2 ft. to	2	6	12	9
9. Sand and shale into sandstone, 2 ft. to	2	6	15	3
10. Dark blue or black shale	2	0	17	3

	Ft.	In.	Ft.	In.
11. COAL VI—Coal, 1 ft. 8 in.; clay parting, 1 in. up to 4 in.; when it has 2 in. of coal in the center, 1 in. to 4 in.; coal, 6 in. to 1 ft. 2 in.; clay parting, 2 in.; coal, 3 ft. 0 in.; pyrite or shale band, 1 in.; coal, 1 ft. 0 in.; soft black rotten coal?, 6 in.	7	11	25	2

The coal section here resulting from the combinations of detached exposures is probably a little thicker than any single section would be, 7 ft. 6 in. giving nearer the maximum thickness.

A number of drillings have been made by the Ehrlich Coal Co. in Secs. 15 and 22. A few of these will be of interest here as showing the variation of the strata overlying Coal VI. Only the first is figured.

1056. SECTION 358. SECTION OF DRILLING BY EHRLICH COAL CO. —Sec. 22 (3), Fig. 454.

	Ft.	In.	Ft.	In.
1. Surface and boulder clay	21	0	21	0
Division VI—				
2. Black sheety shale, "chip slate"	12	0	33	0
3. COAL VIa	1	6	34	6
4. Fire-clay	..	4	34	10
5. Limestone, "flinty," very hard	1	4	36	2
6. Fire-clay	3	7	39	9
7. Sandstone	5	0	44	9
8. Gray shale	2	9	47	6
9. COAL VI, with 7 in. parting	5	9	53	3

1057. SECTION 359. SECTION OF DRILLING BY SAME COMPANY. —Sec. 22 (2).

	Ft.	In.	Ft.	In.
1. Surface and boulder clay	29	0	29	0
Division VI—				
2. Black sheety shale, "chip slate"	6	0	35	0
3. COAL VIa	..	10	35	10
4. Fire-clay	2	6	38	4
5. Gray shale	5	6	43	10
6. Brown shale (described as a kind of "mother coal")	2	8	46	6
7. COAL VI	6	6	53	0
8. Fire-clay	1	7	54	7

In another drilling these normal strata and Coal VIa have been removed and replaced with sandstone.

1058. SECTION 360. SECTION BY SAME COMPANY. Sec. 22.

	Ft.	In.
1. Surface and boulder clay	12	0
Division VI—		
2. Sand	4	0
3. Sandstone	25	8
4. Shale	..	3
5. Coal	5	6

1059. SECTION 361. SECTION AT OLD BAILEY SHAFT.—Just north of Staunton (E. T. C., p. 64).

	Ft.	In.
1. Clay and gravel	9	0
2. Boulder clay	10	0
Division VI—		
3. Sandstone	12	0
4. COAL VI	7	0
5. Bone coal ....8 in. to	1	0
6. Fire-clay	5	0
	44	0

In the manway at the San Pedro mine was obtained the following:

1060. SECTION 362. SECTION AT THE SAN PEDRO MINE.—Sec. 9 (1), Figs. 458 (top) and 467.

	Ft.	In.	Ft.	In.
1. Surface and drift	18	0	18	0
Division VI—				
2. Dark blue shale	12	0	30	0
3. Gray limestone, not regular	..	7	30	7
4. Black sheety shale	1	4	31	11
5. Black shale, jointed	..	10	32	9
6. Soft shaly clay	..	4	33	1
7. COAL VIa	1	0	34	1
8. Fire-clay	1	5	35	6
9. COAL	..	2	35	8
10. Fire-clay	2	8	38	4
11. Sandy shale	2	3	40	7
12. COAL VI—At face: Coal, 3 ft. 11 in.; clay, ½ in.; coal, 2 ft. 10 in. At shaft: Coal, 4 ft. 3 in.; clay, ½ in.; coal, 3 ft. 1 in.	7	7½	47	11½

At the Fortner mine the coal is so near the surface that several rooms have caved in in a little ravine to the southwest of the shaft. As showing the change in the overlying measures in a couple of hundred yards, due principally to the unconformability in Division VI, sections at three of these cave-ins will be instructive.

1061. SECTION 363. SECTION AT FORTNER MINE.—Sec. 10 (9), Fig. 468.

		Ft.	In.
Division VI—			
1.	Black sheety shale	1	0
2.	Black jointed shale, fossiliferous	..	10
3.	Soft gray shale or clay ... 0 in. to	..	2
4.	COAL VIa	..	10
5.	Drab fire-clay	1	8
6.	Limestone, gray, irregular in thickness.. 0 in. to	..	6
7.	Fire-clay, drab	..	10
8.	Bone coal, or black bituminous shale	..	2
9.	Soft gray clay shale, resembling fire-clay	9	0
10.	COAL VI ... 6 ft. to	7	0

1062. SECTION 364. SECTION AT FORTNER MINE.—100 yds north of last, Fig. 469.

		Ft.	In.
1.	Surface sand	3	0
Division VI—			
2.	Blue shale	1	6
3.	"Fake"	3	0
4.	COAL ... 0 in. to	..	3
5.	Blue shale	1	8
6.	COAL VI	7	1

1063. SECTION 365. SECTION AT FORTNER MINE.—100 yds. north of last, Fig. 470.

		Ft.	In.
Division VI—			
1.	Soft gray to yellow sandstone with carbonaceous partings	10	0
2.	Blue shale ... 0 in. to	..	6
3.	COAL VI—Coal, 3 ft. 4 in.; clay parting, ½ in.; coal, 1 ft. 1 in.; clay parting, ½ in.; coal, 1 ft. 10 in.	6	3

1064. SECTION 366. SECTION AT SUPERIOR MINE.—Sec. 10 (3), Fig. 459.

		Ft.	In.
1.	Surface and boulder clay	34	0
2.	Sandstone, 18 ft. to 30 ft. average	21	0
3.	COAL VI, ... 6 ft. to	7	0

At the Tipton drift, the most eastern point at which Coal VI was found, it showed the following:

1065. SECTION 367. SECTION AT TIPTON DRIFT.—Sec. 11 (1), Fig. 471.

		Ft.	In.
1.	Surface	2	0
2.	Drab shale	1	6
3.	COAL VI—Coal, 3 ft. 8 in.; clay parting, ½ in.; coal, 8 in.; clay parting, ½ in.; coal, 1 ft. 9 in.	6	2

These sections show with considerable detail the stratigraphy of Division VI in the central part of the township, and the structure of Coal VI. Division VI contains one workable coal, ranging from 5 to 9 ft. thick, with sometimes one, but more often two partings, a small coal about 1 ft. thick usually showing a parting about the middle, and occasionally a very thin and irregular intermediate bed. The coal designated Coal VIa, usually called the rider locally, is reported to be a very pure coal and one of the best coals for blacksmithing purposes to be found. Attention was called above to the marked unconformability existing above this coal. In many places the erosion had cut away Coal VIa and the measures usually accompanying that bed, and often it has cut into Coal VI, reducing its thickness to a foot or two. This sandstone makes a solid roof but not a desirable one on account of the uneven way it cuts down into the coal, and the coal at such points, having been exposed by the erosion which preceded the deposition of the sandstone, is generally reported as of a poorer quality. In some places the shale roof appears to be excellent, but in other places is so poor that some of the top of the coal has to be left to support it. Below Coal VI there is often found a bench of bone coal up to a foot thick. Just how persistently this underlies the main coal could not be learned. It was especially noted close to Staunton, both north and south. It is sometimes separated from the body of the coal by shale or sulphur and not by a clay parting. Below that is usually 3 to 4 ft. of fire-clay.

Mr. Cox gives the following analysis of Coal VI from the old Bailey shaft just north of Staunton:

Fixed carbon	47.30	
Volatile combustible matter	39.70	
Total combustible matter		87.00
Moisture	7.00	
Ash	6.00	
Total waste		13.00

Prof. Noyes gives the following analysis of this coal from the Ray mine in Vigo county, just west of this township:

Fixed carbon	44.21	
Volatile combustible matter	40.25	
Total combustible matter		84.46
Moisture	7.57	
Ash	7.97	
Sulphur	4.01	
Total waste		19.55

Pounds of water evaporated per pound of coal, 12.4.

These analyses correspond quite closely if the sulphur be neglected. They show a coal rather low in fixed carbon, above the average in volatile combustible matter, moisture and ash, and very high in sulphur. The coal has the reputation of being a good, strong, caking coal, excellent for steam or domestic purposes, but requiring some care in mining and in its preparation for the market to insure freedom from sulphur, shale or clay.

1066. Divisions V to I outcrop north and east of the area of Coal VI and are pierced by bores sunk below Coal VI within the area of the latter. These borings show an increase in the number of coals to the west, and such a diminution in the thickness of the main coals that it becomes difficult to recognize them with certainty west of where they pass under Coal VI. East and north of the outcrops of Division VI, Coals III and IV, or at least one of them, is usually workable.

The relations of the three coals, III, IV and V, are best shown by the section at the White Oak shaft, given in ¶870, and shown for comparison in Fig. 457. The relation of Coals IV and V to each other and to the accompanying strata, can be well seen by referring back to the section given at the Brazil shaft, only a few rods north of this township at its N. E. corner. See ¶813 and Fig. 366.

In addition to the sections referred to above, the following sections in this township will show the stratigraphy of Divisions III to V:

1067. Section 368. Section at Clay Pit of Chicago Sewer-Pipe Works.—Sec. 1 (2), Fig. 461.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface clay	10	0	..	..	10	0
Division V—						
2. Drab clay shale...10 ft. to	15	0	..	..	25	0
3. COAL V	1	6	1	6	26	6
4. Fire-clay	6	0	..	..	32	6

	Ft.	In.	Ft.	In.	Ft.	In.
Division IV—						
5. Sandstone grading into shale	14	0	20	0	46	6
6. COAL IV 3 ft. 6 in. to 4 ft. 6 in.	4	0	4	0	50	6

1068. Section 369. Section of Drilling on Armstrong Place.—By Mr. C. Ehrlich. Sec. 10 (1), Fig. 459 (lower part).

	Ft.	In.	Ft.	In.	Ft.	In.
To top of Coal VI	51	0	..	..	51	0
Division VI—						
1. COAL VI	7	0	7	0	58	0
2. Fire-clay	4	0	..	..	62	0
Division V—						
3. Gray shale	1	6	5	6	63	6
4. COAL Va	2	0	2	0	65	6
5. Fire-clay	2	0	..	..	67	6
6. Sandy shale (fake)	1	6	..	..	69	0
7. Black shale	1	0	..	..	70	0
8. Black sheety shale	1	6	6	0	71	6
9. COAL V	2	0	2	0	73	6
Division IV—						
10. Fire-clay	7	6	..	..	81	0
11. "Hard rock" (sandstone)	4	0	..	..	85	0
12. Light shale	22	0	..	..	107	0
13. Dark shale	1	0	34	6	108	0
14. COAL, poor	1	4	1	4	109	4
Division III—						
15. Fire-clay	5	0	..	..	114	4
16. Hard gray shale	3	6	8	6	117	10
17. COAL	0	6	0	6	118	4
18. Fire-clay	3	0	..	..	121	4
19. "Hard flinty rock" (limestone)	1	4	..	..	122	8
20. Limestone, impure	1	6	..	..	124	2
21. "Black rock," and shale	1	6	..	..	125	8

1069. Section 370. Section of Boring near San Pedro Mine.—Sec. 9 (4), Fig. 458 (lower part). By Mr. John Andrews (E. T. C., p. 64).

	Ft.	In.	Ft.	In.	Ft.	In.
Division VI—						
1. COAL VI	7	0	7	0	7	0
2. Fire-clay	3	0	..	..	10	0
Division V—						
3. Shale with iron balls	20	0	23	0	30	0
4. COAL V	1	8	1	8	31	8

	Ft.	In.	Ft.	In.	Ft.	In.
Division IV—						
5. Soft sandstone	20	0	..	..	51	8
6. Shale	4	0	24	0	55	8
7. COAL IV, here a caking coal	2	6	2	6	58	2
Division III—						
8. Shale	46	0	46	0	104	2
9. COAL III?	2	6	2	6	106	8

1070. SECTION 371. SECTION NEAR NEW SHAFT OF EHRLICH COAL CO.—Sec. 22, Fig. 454.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	28	0	..	..	28	0
2. Shale	1	6	..	..	29	6
Division V—						
3. COAL Va	1	6	1	6	31	0
4. Clay	4	0	..	..	35	0
5. Gray shale	8	0	..	..	43	0
6. Black sheety shale ("chip slate")	1	6	13	6	44	6
7. COAL V	0	8	0	8	45	2
8. Clay	1	6	..	..	46	8
Division IV—						
9. Clay shale	4	0	..	..	50	8
10. Sandstone	0	6	..	..	51	2
11. Gray shale	6	0	..	..	57	2
12. Dark shale	2	0	..	..	59	2
13. Place of Coal?						
14. Clay	2	6	..	..	61	8
15. Shale	3	0	19	6	64	8
16. COAL	0	10	0	10	65	6
17. Clay	4	0	..	..	69	6
18. Shale	5	2	..	..	74	8
19. Hard rock	0	8	..	..	75	4

A possible source of error occurs in this section with No. 8, which was in question, being either 18 in. or 18 ft., our copy of the record being obscure.

A short distance from this drilling another drilling showed (Sec. 372):

	Ft.	In.
Boulder clay	16	0
COAL VI	7	0

Indicating the position of Coal VI in the preceding section. A comparison with a drilling by Mr. Ehrlich just north of the shaft on the Kellar place is of interest.

1071. SECTION 373. SECTION OF BORING ON KELLAR PLACE.—Sec. 15 (1), Fig. 455 (lower part).

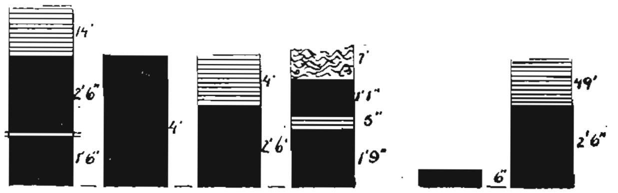
	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface and boulder clay.	22	0	..	..	22	0
Division VI—						
2. Fire-clay	10	0	..	..	32	0
3. Gray shale	3	0	..	...	35	0
4. COAL VI	6	0	6	0	41	0
5. Fire-clay	3	0	..	..	44	0
Division V—						
6. Black sheety shale ("chip slate")	4	0	7	0	48	0
7. COAL V?	1	6	1	6	49	6

1072. SECTION 374. SECTION OF BORING IN SEELYVILLE SHAFT.—At Seelyville, Vigo county. Reported by Mr. Cox, 7th Ann. Rep., p. 83, Fig. 452 (lower part).

		Ft.	In.	Ft.	In.	Ft.	In.
	Division VI—						
III	1. COAL VI in mine........	6	2	6	2	6	2
	2. Fire-clay	4	0	..	..	10	2
	Division V—						
	3. Sandstone	4	6	..	..	14	8
	4. Black shale	1	6	..	..	16	2
	5. Limestone, impure	2	6	..	..	18	8
	6. Black shale	1	8	14	2	20	4
Ls	7. COAL V	1	10	1	10	22	2
	8. Fire-clay	5	0	..	..	27	2
	Division IV—						
	9. Clay shale	9	6	14	6	36	8
Ls	10. COAL IVa?	0	6	0	6	37	2
	11. Sandstone	4	0	..	..	41	2
	12. Fire-clay	7	0	11	0	48	2
II?	13. COAL IV, top bench.....	1	1	..	..	49	3
More probably	14. Shale	0	5	..	..	49	8
L.S.	15. COAL IV, bottom bench..	1	9	3	3	51	5
	16. Fire-clay	10	6	..	..	61	11
	Division III?—						
More probably	17. Black shale	2	0	12	6	63	11
Coal II	18. COAL IIIb?	1	5	1	5	65	4
Minshall	19. Fire-clay	3	9	..	..	69	1
	20. Clay shale	4	6	..	..	73	7
	21. Fire-clay	5	0	..	..	78	7
	22. Clay shale	2	9	..	..	81	4
	23. Sandstone	3	1	..	..	84	5
	24. Clay shale	5	6	..	..	89	11
More	25. Black shale	0	7	25	2	90	6
probably M.B.	26. COAL IIIa?	0	5	0	5	90	11
	27. Clay shale	1	6	..	..	92	5

		Ft.	In.	Ft.	In.	Ft.	In.
28.	Sandstone	5	4	..	..	97	9
29.	Clay shale	7	0	..	..	104	9
30.	Sandstone	1	0	..	..	105	9
31.	Clay shale	1	0	..	..	106	9
32.	Sandstone	6	2	..	..	112	11
33.	Shale	2	6	24	6	115	5
34.	COAL III?	1	2	1	2	116	7
35.	Sandstone	7	6	..	..	124	1
36.	Fire-clay	1	3	..	..	125	3
37.	Gray shale	5	0	..	..	130	3

Examining these sections it appears that there are two coals within the first 20 ft. below Coal VI. In Sect. 374 the upper is overlain by limestone. In Sects. 369 and 371 it is the second coal that is overlain by black shale. It would thus seem that black shale is apt to overlie each of the coals, and it gives them a strong resemblance to the two coals outcropping at Lodi in the township just north. In this case, however, it would seem that one of these coals is Coal V, but which



472 C. S. P. Wks. Sec. 1 (2). 473 Ormsby. Sec. 12. 474 San Pedro. Sec. 9 (4). 475 Seelyville, Vigo Co. 476 S. E. ¼ Sec. 13. 477 San Pedro. Sec. 9 (4).

Figs. 472-475. Sections of Coal IV in T. 12 N., R. 7 W.
Figs. 476, 477. Sections of Coal III in T. 12 N., R. 7 W.

one? Just east of Turner, coals supposed to be VI, V and IV, outcrop in a ravine. There the coals taken to be V and VI are only from 6 to 8 ft. apart, and at several places there is reported to be a coal up to 3 ft. thick, covered with black sheety shale and lying within 10 to 12 ft. of the bottom of Coal VI. In the correlation of these coals in the above sections, the one overlain by black shale is in each case called Coal V. It must be admitted that by so doing the question is simply dodged without being answered. It is assumed with much doubt that the coal found at about 50 to 60 ft. below Coal VI is at the horizon of Coal IV, Coal III occurring from 10 to 75 ft. below Coal IV. Whether the bottom coal in the Seelyville section belongs at the

horizon of Coal III, as indicated above, or to Division II, is a question we are not prepared to answer. It is sufficient to note here that as far as these drillings indicate anything they show that there is no workable coal below Coal VI in this township, and that is supposed to have included the horizons of workable coals to the east.

Section 3. Distribution of Coals.

It will be convenient for the purposes of this discussion to divide the township up as follows: Secs. 1, 12, 13 and 24; Secs. 2, 3 and 4; Secs. 14, 23, 25, 26, 35 and 36; Secs. 9 to 11, 15-17, and 22; Secs. 5 to 8, 18 to 21, 27 to 34.

1073. SECTIONS 1, 12, 13 AND 24.—Practically all the mining that has been done on the coals of Divisions III and IV has been done in these sections. Coal III appears to be thin and pockety or wanting altogether over much of this area, while Coal IV appears to be of good workable thickness under most or all of the area of these sections.

At the depot at Brazil, Coal IV is 72 ft. deep and 3 ft., or a little over, thick. At the Chicago Sewer-Pipe Works it is 38 ft. deep, and ranges from 3 ft. 6 in. to 4 ft. 6 in. in thickness. The section at this point was given in ¶1067, and Fig. 461. The coal here has been worked some but not worked out. At the clay pit, shale No. 2 of section is being worked. It is mixed with $\frac{1}{4}$ to $\frac{1}{5}$ of the surface clay in the manufacture of sewer pipe. In the pit this shale rests on an 18-in. bed of Coal (V), which there has a high dip to the northeast. At this point it is reported as 20 ft. above Coal IV, but due to its high dip, which it maintains, it is said to come within 8 in. of Coal IV under the company's office. In the opposite direction from the shaft it is reported that what is considered as the same seam, 18 in. thick, is observed at one point only 5 ft. above Coal IV, and a short distance further comes down so that it is only separated from that coal by a thin clay parting. Fig. 479 shows the relations as described. If correctly reported, the facts have a special interest for their bearing on the question of the relative positions of Coals IV and V, in other places where occasionally a thin coal is found overlying Coal IV quite closely, and some question was raised as to whether it was Coal V or just a local pocket of coal between Coals IV and V. Such pockets are known to occur, but this case would tend to confirm the idea that in general it is Coal V, which locally decends to within a short distance of Coal IV. The close proximity of the coals under the office is said not to be maintained but a short distance, when they gradually separate again. A 4-ft. fault is said to occur just beyond where the coals come together to the south of the shaft. Coal IV here has the bench mining 18 in. from the bottom (see Fig. 472).

1074. In Sec. 12 coal has been mined in the N. E. ¼ Sec. 12 (1), at the Ormsby mine, where the coal is reported as 4 ft. thick (Fig. 473), and at Welty's just south of the center of the section, by gin

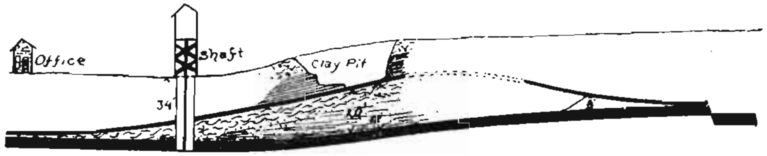


Fig. 479. Section at the Chicago Sewer-Pipe Company's shaft and clay pit.

shafts, Sec. 12 (2 and 3). The coal is here reported as 30 ft. deep and up to 4 ft. 8 in. thick. Going west up the small stream that heads at Turner, the coal appears to rise and to outcrop on the John Wools place near and at the west side of the section. The coal outcropping on the John Wools place was not exposed so that it could be examined, so that much doubt exists as to the correctness of assuming it to be the same as the coal at Welty's. Its thickness was variously reported from 2 to 5 ft. It is said to be a semi-block, its blocking properties being much more marked to the east of the road than to the west. In going from Wools's to Welty's it appeared to dip faster than the slope of the stream, so passing under the stream. Even then it would require a dip of at least 20 ft. in a quarter of a mile to reach the depth of the coal at Welty's. That is not an unusual or impossible dip, and in view of the facts obtained, it seemed the most reasonable supposition to suppose that it did dip so. See Fig. 480. The question is chiefly of interest on account of the bearing on the distance between Coal IV and Coal VI, and will be referred to again further on. There appears to be considerable unworked coal in this section, though probably all at the horizon of Coal IV.

1075. In Sec. 13 drillings on the Phelps place in the N. W. ¼ are reported to show 3 ft. 10 in. of block coal. The coal in the northern part of this section has not been worked. In the S. E. ¼ Coal III? is 65 ft. deep at the Watson No. 7 shaft, from which it has been extensively worked. It is said both Coals III and IV were workable. In the S. E. 40 acres of this section it is said that a number of drillings showed Coal III to range from 3 to 9 in. thick (Fig. 476).

1076. In Sec. 24 it is said that the work was all on Coal IV, which is now well worked out. Coal III is reported to have varied from 3 in. to 4 ft. in thickness, not being as workable as at Hoosierville or further east. The roof of Coal IV is reported as very bad. In this section were Crawford shafts Nos. 5 and 6 of the Crawford Coal Co., and the Phoenix and South Slope of the P. Ehrlich Company. The coal is reported to have been 48 ft. deep at the Phoenix mine, and to have been reached by a slope at the South Slope mine, just a short distance north.

1077. SECTIONS 2, 3 AND 4.—Except for the outcropping edge of Coal VI, which probably laps over the southern edge of these sections more or less, the only workable coal is Coal IV. A test shaft has been sunk at the western side of Sec. 3 by the Watson-Little Co., and it is said that that, with the drilling that has been done, shows a fine basin of semi-block coal at least 3 miles long, extending through these sections. No mining has been done in these sections except, as far as ascertained, on the Keneda place or Pierce place, in the S. E. corner of Sec. 3. Since writing above, some mining has been done at the Watson shaft. See description of township just north. Recently drilling is said to have shown good workable coal in S. E. ¼ of Sec. 3, south of the National Road.

The coal on the Keneda place was reported by Mr. Cox to be an outcrop of Coal VI, but from reports I judge it to be one of the thin coals between VI and IV. In the S. W. corner of Sec. 2 a 225-ft. drilling by C. Ehrlich is reported as not showing any workable coals.

1078. SECTIONS 14, 23, 25, 26, 35, 36.—As far as ascertained, no mining is being or has been done on these sections. The eastern limit of Coal VI crosses Sec. 14 so as to apparently overlie a considerable portion, if not at least half of the section, and probably touches Sec. 13. Reports indicate that some workable coal at the horizon of Coal IV exists in Secs. 14 and 23. Secs. 25, 26, 35 and 36 are largely prairie, drillings to a depth of 50 to 75 ft. being reported to pierce only boulder clay and to go into quicksand.

1079. SECTIONS 8-11, 15-17, AND 22.—Sec. 11 contains some very high ground, and around the foot or flank of this is the eastern outcrop of Coal VI. At the Tipton drift in the N. E. ¼, Sec. 11 (1), the coal is 6 ft. thick, with two clay bands ½ in. thick and 8 in. apart, the upper band being 3 ft. 8 in. from the top of the coal (see Fig. 471). The roof here is a drab shale, and so poor at the outcrop that 2 ft. of coal is left to protect it. It is in the head of a little branch and probably higher than is the upland of Sec. 12. The top block, or Coal IV, is reported to be 60 or 80 ft. below this.

Just northeast of Turner are the old openings of the Wheeler or Modisett mines. These worked many years and doubtless took all the workable coal in the N. W. ¼ of Sec. 11. One of the men who worked in the Modisett bank claimed that the coal there dipped strongly to the northeast, so that at center of the north side of the section it was thought to be 100 ft. below the surface. The evidence from other sources hardly bears that out.

At Mr. C. Ehrlich's house in Turner, Coal VI is 37 ft. deep. A short distance east it is 17 ft. deep, and a few rods further it is only 5 ft. to it, the coal being 7 ft. thick. Down the branch aways, a 2-ft. coal, overlain by 2 ft. of black, sheety shale is exposed and has been stripped and worked by drift. This is supposed to be Coal V. A few rods further east it passes under the creek, and there appears about 8 ft. above it 2 ft. of coal overlying reddish brown shale. This upper 2 ft. of coal would seem to correlate with the first 2 ft. of coal in the boring in Sec. 10 (1), No. 4 of Sect. 369, and thus would seem to be Coal Va. Going down to the gravel road at the eastern side of the section is the coal stripped on the Wools place.

In Fig. 480 the broken lines show the supposed relation of the beds through the center of the section. The dotted lines suggest another relation.

1080. Section 10.—This section is probably entirely mined out, except in very limited areas. The only mine operating when visited was the Superior mine. In sinking the shaft for this mine, as described by Mr. Ehrlich, they sank in a cut-out, so that they missed the coal sought, but 18 ft. below the level of Coal VI, went into a bed claimed to be 4 ft. thick. Discovering the mistake, they went up the proper distance and drifted into the coal. If this was simply a cut-out, the 4-ft. bed was evidently one of the lower beds, probably Coal V. The thickness in this case suggests that the failure of the borings so far made below Coal VI to find workable coals, may be largely accidental, and indicating that the thick coals lie in pockets of very limited extent. In reporting on this mine in 1896, Mr. Fisher says: "The shaft was sunk on a fault which threw the coal down about 16 ft., consequently only one side of the mine is being worked." The mine being idle when visited, no personal examination was made. The coal is here 6 to 7 ft. thick, averaging 6 ft. 6 in., with a clay parting 3 ft. from the top. It is 62 ft. to the bottom of the coal, the section being as given in ¶1041, Fig. 459. The top bench is reported to be the best

coal. The roof is generally sandstone, uneven and full of rolls, which are said to cut much of the coal down to 2 ft. or 2 ft. 6 in.

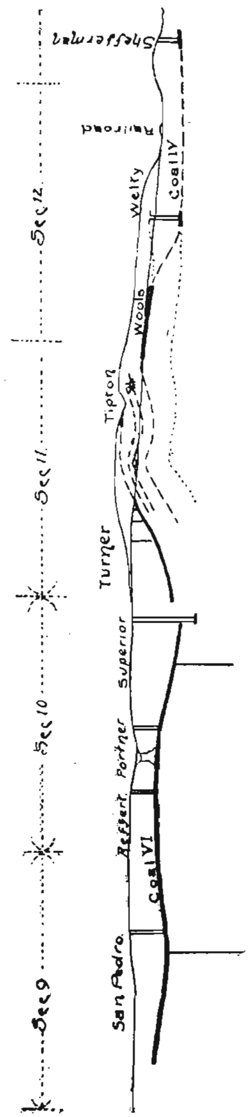


Fig. 480. Section from the San Pedro shaft to Shefferman shaft.

There is some shale roof, and under that the coal is more even, and of better quality. In places preglacial erosion has cut the roof and coal out. The floor is fire-clay, containing some bone coal. In places Coal VIa 18 in. thick is found. Below Coal VI, here 12 ft., is reported a 3-ft. coal bed, with black shale over, and below that three beds are claimed about 17 ft. apart, each with shale over and fire-clay under, the beds being 17, 9 and 8 in. respectively. A deep drilling on the Armstrong place, Sec. 10 (1), was reported in ¶1068. A group of sections southwest of the Fortner mine, of Coal VI and overlying strata was given in ¶¶1061-1063, Figs. 468-470.

The following is a list of the mines in this section: Superior, Fortner, Williams No. 1, Williams No. 2, White Elephant No. 1, White Elephant No. 2, Lunda, Raffert, Jumbo, Ram's Horn.

1081. SECTION 9.—In this section Coal VI is from 30 to 40 ft. below the level. At the old Bailey mine, just north of Staunton, the coal was 31 ft. deep, and 8 ft. thick, including a bottom bench of bone coal 1 ft. thick. It had the thin parting of fire-clay 3 ft. to 3 ft. 6 in. from the top. At the old Somers mine, just northeast of Staunton, Coal VI was 7 ft. 5 in. thick, with one clay parting. Coal VIa was here 15 ft. above Coal VI. At the San Pedro mine, Sec. 9 (1), Coal VI is 40 ft. deep, and ranges from 6 ft. 6 in. to 7 ft. 6 in. The coal in the mine runs very regular, as far as examined by the writer. The coal being everywhere 6 ft. 6 in. or over, the smooth roof and level dry floor in the entries made it one of the pleasantest mines in the State to examine. The section, as obtained in the manway, was given in ¶1060, and Fig. 467. The roof is shale, with about 3 in. of "draw slate." The coal seems to contain a good deal of sulphur, which makes it slack readily and clinker some. The coal is reported as rising to a crop-out to the west of the San Pedro mine.

A section of the strata below Coal VI, as obtained by a drilling in the S. E. ¼, was given in ¶1069.

1082. SECTION 15.—Coal VI is supposed to underlie all of this section, though so near the surface that it is probably cut out in places and has too thin a roof to be worked in others. A drilling in the S. W. ¼ showed Coal VI 6 ft. thick and 35 ft. deep, but with only 3 ft. of gray shale for roof material. See ¶1071.

1083. SECTION 16.—Coal VI is above drainage in this section and has been stripped and worked by drift from an early day. Coal was dug here about 1840 by Michel Coombs, and wagoned to Terre Haute. Afterward, the railroad's coming led to the opening up of the mines in Sec. 10, by Williams and others. Some mining is still done here. The section at the David Edr drift bank south of Staunton, is given in ¶1055, and Fig. 466. The coal here varies from 6½ to 7½ ft. in thickness, with two clay partings and a shale and sulphur parting near the bottom, with soft bone coal at the bottom. At the northernmost

exposures the normal roof strata have been removed and their places taken by a coarse-grained, cross-bedded sandstone, which lies on the irregularly eroded surface of the coal. It would seem quite possible that in places the coal as well as the roof might be found removed, and its place taken by the sandstone. There is said to be no coal under Staunton, and not a great many acres have been mined in the S. E. ¼; otherwise the coal of this section does not appear to have been taken.

1084. SECTION 17.—Coal VI is about at drainage in this section, but passing below drainage to the north. It has been extensively stripped in ravines in the N. W. and S. E. quarters. In the S. E. ¼ on the Carter and Modisett places, and S. E. 40 acres of the N. E. ¼, and just over the line in Sec. 16, the coal is just at drainage level and varies up to 8 ft. thick. Several drifts have been opened upon it here. The connected section is given in ¶1054, and Fig. 465. At one point the coal has a sandstone roof. Coal VIa has been worked here some. The black shale roof of Coal VIa contains many large limestone septaria here, as at Edr's in Sec. 16. At the only drift that was open, a foot of the top coal was left to protect the roof.

In the N. W. ¼ of the West and Brittian places, Coal VI just comes up to drainage, as shown in Fig. 478; the section here was given in ¶1053, and Figs. 456 and 464. It has been stripped all along the ravine and drifted upon at a few places. Near the mouth of the ravine the section over Coal VIa is (Sect. 375):

	Ft.
Brown to drab shale	5
Blue shale	10
Black sheety shale	4
Coal VIa, with parting	1

Coal is reported to formerly have been mined just north of the mouth of this ravine. The greater part of this section has not been mined upon, and may be supposed to contain much coal.

1085. SECTION 22.—Coal VI here lies near the surface, ranging from 20 to 50 ft. deep in the western part and rising to outcrop in the eastern part. It has been stripped at one point in the N. E. ¼ where its outcrop was exposed. Several drillings furnished by the C. Ehrlich Co., have been given in ¶¶1056-1058, and Figs. 454 and 455. Of other drillings furnished the writer, the coal averages 6 ft. 8½ in., some of the drillings showing that it is cut out and others only showing 2 or 3 ft. of shale under the soft glacial deposits. A shaft (the Klondike) was being sunk to this coal by the C. Ehrlich Coal Co. in 1897.

1086. SECTIONS 5-8, 18-21, 27-34.—These sections are supposed to be entirely underlain by Coal VI, the strata and coals exposed all belonging above that coal. As far as ascertained, all the mining in these sections has been on Coal VII, which runs about 3 ft. thick or less. The survey of these sections was made by Dr. Thomas L. Watson. In Sec. 5, on the West place, 3 ft. of coal is reported to have been found in a well just about at drainage. Dark blue shale over. Supposed to be Coal VII. In the S. W. corner of Sec. 7, Coal VII, 2 ft. 6 in. to 3 ft. thick, is about 4 ft. above Lost creek. It is overlain by 4 ft. 6 in. of shale, and above that is 6 ft. of massive, coarse-grained, shaly sandstone. It has been mined here a little. Recent drilling (February, 1899,) on the W. S. Carpenter land, 300 or 400 yds. northeast of Cloverland Station, by Mr. West, is reported to have found Coal VI 6 ft. 10 in. thick at a depth of 38 ft., the coal having a rock cover 24 ft. thick.

In the N. E. ¼ of Sec. 18 Coal VIa is just below the bed of Lost creek, as shown by the following section exposed in the bluff (Sect. 376):

	Ft.	In.
Drab shale	4	0
Drab shaly limestone.........2 in. to	0	4
Dark blue shale, with large limestone concretions	4	0
Calcareous shale, full of nodules	..	2
Dark blue shale to water	1	0

In Sec. 29, on Wm. Turner's land, it is reported that a well dug there some time ago went through 7 ft. of coal; depth not known.

In Sec. 32 Coal VII is near the surface or outcropping, and has been mined and stripped to some extent. At the Sickles shaft it is 3 ft. thick and 12 or 15 ft. deep. The coal was good, but more water was encountered than could be handled, so only a few bushels were taken. Sec. 32 (1).

At the Ayer's bank, Sec. 32 (2), of which a section was given in ¶1050, the coal is 3 ft. thick with shale roof and underlain by 5 ft. of dark shale (Figs. 453 and 462). The coal is just at drainage here; about ½ acre taken.

At the Rule bank, Mr. Watson reports the coal as a semi-block, 3 ft. thick, overlain by 2 ft. of drab shale with occasionally 1 or 2 in. of bluish black shale just over the coal (Fig. 463). The coal is just at drainage. A slight anticline was noticed here which lifted the coal so that it was cut out for about 100 ft. At the Wyatt bank the same section is seen.

1087. In the S. W. corner of Sec. 32, Coal VII, "semi-block," 2 ft. to 2 ft. 2 in. has been stripped on the Chas. P. Rector place. It has a black shale roof 2 ft. thick.

1088. In Sec. 33, on the John H. Coates place, 7 ft. of coal is reported to have been struck at 47 ft. A 6-in. bed of cannel coal is reported at 35 ft.

TOWNSHIP 11 NORTH, RANGE 7 WEST.

1089. GEOGRAPHIC.—All of this township west of Birch creek is in Perry of the civic townships; the area east of Birch creek is in Sugar Ridge. The township is extremely level, sloping very gently to the south and east from the northwest.

The E. & I. R. R. crosses the township near the center.

1090. STRATIGRAPHY AND COALS.—As coal was only seen at one point the stratigraphy cannot be given with any certainty. It is judged to be very similar to that of the township just north, except that Coal VIa may be lacking, while Coal VIb is fairly well developed. Coal VI appears to run thinner than to the north.

The only coal that seems to have been more than simply tested is the surface coal west and south of Cory, which is thought to come at the horizon of Coal VIb. Its resemblance to Coal V made its identity a little questionable, but from the standpoint of levels taken from Coal VII just north of the township line it seems more probable that it is Coal VIb than Coal V. It is upon this assumption that Coal VI has been traced through this township as shown on the map.

1091. DISTRIBUTION AND LOCAL DETAILS.—The highest coal, Coal VIb, appears to underlie the dividing ridge between the Wabash and Eel rivers. The exact distance below to Coal VI was not obtained, but is supposed to be such as to make it underlie practically the western two-thirds of the township. The two eastern tiers of sections are believed to be entirely underlain by the block Coals III and IV.

Coal reported to be 3 ft. thick has been stripped on the Jefferson Miller place, in the N. W. 40 of Sec. 3. This is about the level at which Coal VI is judged to come to outcrop, and it has therefore been assumed to be at that horizon.

For the same reason the coal that has been stripped on the Cobal place, in the N. W. corner of Sec. 14, has been assumed to be at the horizon of Coal VI. The coal here is reported to be 3 ft. thick. Over it were exposed 4 to 5 ft. of light brown sandstone.

It is said that just north of this, in the S. W. corner of Sec. 11, a drilling found 4 ft. of coal at a depth of 45 ft., and still below a second bed 3 ft. 7 in. thick. At Art P. O. a 1-ft. bed of coal is reported in wells at a depth of 18 ft., while at a depth of 40 ft., 4 ft. of caking coal is said to be found.

In the S. W. ¼ of Sec. 17, Coal VIb has been worked from shafts and slopes at a number of points.

At the Geo. C. Utter bank, operated by Geo. Deal, the section shows as follows (Sect. 377):

	Ft.	In.
Surface	6	0
Black sheety shale, with limestone boulders	3	0
Coal VIb—Semi-block coal, 1 ft. 3 in.; partings of soft bone, 1 in. to 3 in.; caking coal, 1 ft. 3 in.	2	9

The upper bench shows quite regular slips, the face slips being from 18 in. to 30 in. apart, while the east and west butt slips are from 10 to 18 in. apart. This coal is non-caking. The lower bench, which is a caking coal, has less regular slips than the upper bench. Though breaking joints with the slips in the upper bench, they have about the same direction. Coal has been worked from the Phillips and other old shafts in this immediate neighborhood, and it has been stripped at one or two points to the west. It is said to thicken to the west. It is said to dip south for aways (26 ft. in 40 rods), then rises to an outcrop. It outcrops on the Miller place, in the N. W. ¼ of Sec. 17.

Drillings in Secs. 20 and 21, at or near Cory, are reported to have found coal at various depths, some workable.

Coal has been stripped for blacksmithing on the Cooper place, in the N. W. corner of Sec. 28. In the N. W. of S. E. of Sec. 28, on the Daniel Spears place, a well starting on the level is reported to have found 2 ft. 4 in. of coal at 21 ft. In the S. W. of S. E. of this section, a well on the Dalripple place is said to have struck 4 ft. 6 in. of coal at 47 ft.

The upper coal is said to have been found in a well on the L. Bates place, in the S. E. 40 of Sec. 29, at about 20 ft.

For many years Coal VIb was stripped on the Schofield and Jackson farms, in the N. W. ¼ of Sec. 33. The coal here is said to be 2 ft. 4 in. thick, with a parting of soft bone ("mother coal") 7 in. from the bottom. The upper bench is said to be a semi-block, to carry most of the sulphur, and to be softer than the bottom. The bottom coal is described as a good caking coal.

In the S. E. 40 of Sec. 33 a shaft was started on the John Niece farm, to reach a 3-ft. coal found at 40 ft. The shaft was sunk to

with in 13 ft. of the coal, when an explosion killed those sinking the shaft, and the enterprise was abandoned. Sandstone is said to extend almost the whole distance to the coal.

Near Saline City, in Sec. 25, some drilling has been done to the lower coals. A group of these made just across the township line to the east were given in the discussion of that township. One of these, which went 45 ft. below the worked coal, reported only fire-clay, shale and sandstone. In two bores on the Jamison farm, adjoining Saline at the west and north, three coals are found.

1092. SECTION 378. SECTION IN JAMISON'S FIRST BORE.—Sec. 25 (J. C., p. 460).

	Ft.	In.	Ft.	In.	Ft.	In.
Surface	14	0	..	..	14	0
Boulder clay	8	0	..	..	22	0
Clay and gravel	11	0	..	..	33	0
Soft sandy shale	15	0	..	..	48	0
Blue shale	12	0	..	..	60	0
COAL IV (?)	2	10	2	10	62	10
Fire-clay	1	6	..	..	64	4
Sandy shale	13	0	14	6	77	4
COAL IIIa (?)	0	10	0	10	78	2
Fire-clay	2	0	..	..	80	2
Sandy shale	13	0	15	0	93	2
COAL III (?)	2	5	2	5	95	7
Blue sandstone	2	6	..	..	98	1

1093. SECTION 379. SECTION OF JAMISON'S SECOND BORE.—Sec. 25.

	Ft.	In.	Ft.	In.	Ft.	In.
Surface clay	15	0	..	..	15	0
Sand and gravel	25	0	..	..	40	0
Blue clay	13	0	..	..	53	0
Shale	3	0	..	..	56	0
COAL IV (?)	2	11	2	11	58	11
Fire-clay	2	0	..	..	60	11
Sandy shale	11	7	13	7	72	6
Splinty COAL IIIa (?)	0	8	0	8	73	2
Fire-clay	1	6	..	..	74	8
Gray shale	10	6	12	0	85	2
COAL III (?)	1	6	1	6	86	8
Sandstone	0	6	..	..	87	2

These sections would seem to show the introduction of a coal between Coals III and IV. The upper coal was the one reached by the shaft south of Saline City.

The drillings given and reported would suggest the presence of some workable coal in this township. It is possible the block coals will yield some basins along the eastern edge, while Coal VI, 3 to 4 ft. thick, appears to underlie the western two-thirds, and ought to yield some coal.

TOWNSHIPS 9 AND 10 NORTH, RANGE 7 WEST.

1094. GEOGRAPHY.—These townships include all of Lewis and parts of Perry, Sugar Ridge and Harrison of the civic townships.

All of the area east of Eel river is practically bottom land or a gentle slope to the river. Likewise the northern half of 10-7 is nearly level or gently sloping. Several square miles in the northeastern quarter of this township make a large basin, which is completely flooded by a low dam across the mouth of Splunge creek. West of Eel river and south of this the land becomes rolling, then hilly. In 9-7 the northeastern half of the township is practically river bottom. Along the western side of this township runs a flat ridge, breaking down to the east in ravines of some depth.

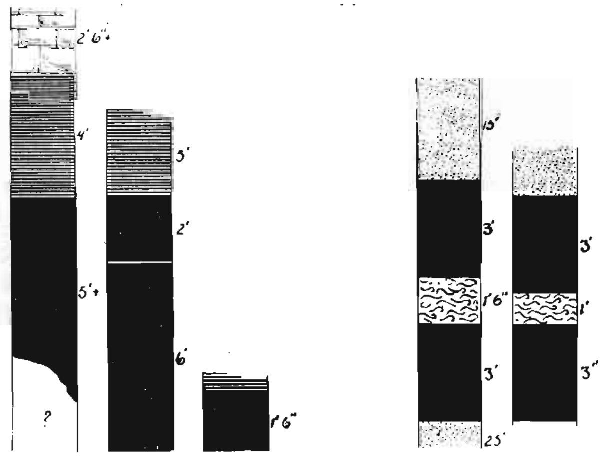
1095. STRATIGRAPHY.—The stratigraphy of this area has been much in doubt. The stratigraphy at the north and south, as far as could be observed, appeared to correspond well. In each end there appeared to be an upper coal overlain by a black sheety shale, with a marine fauna, and sometimes that in turn overlain by limestone. This coal varied from 8 ft. to 1 ft., but thick coal appeared both at the north and south. Below it a short distance, and under a considerable bed of sandstone, was found a workable bed of coal. As these coals appear to maintain about the same level above Eel river through the two townships, their correlation appeared certain, and the outcrop was mapped accordingly. Later it was discovered that while the two coals to the south were undoubtedly Coals IV and V, that the similar coals to the north were probably Coals VI and VIb. Due to the scattered nature of the data and the lack of outcrops or drillings giving sections, it was necessary to study the field by levels, as far as those were known, nor could very certain results be reached in that way. It now seems probable that a rapid dip carries Coal V from the top of the ridge in the southern part of T. 9 N., R. 7 W., to the level of Eel river at the mouth of Splunge creek, and at still lower levels farther north and northwest. (While this appears to be fairly well settled, we have not been able to entirely put away the thought that our corre-

lation of Coals VI and VII north and south of this area may be in error, and that Coal V south of this area corresponds with what we have called VIb to the north. Compare Coal V at Alum cave with Coal VIb at Parker's (Sec. 3-10-8).

As nearly as could be determined, the strata of this area extend from Division VI downward. A drilling on the John Harris place, in Sec. 20-10-7, gave as follows:

1096. SECTION 380. SECTION OF BORE ON JNO. HARRIS'S PLACE. Sec. 20.

	Ft.	In.
1. Surface	22	0
2. Gray shale (probably sandstone)	8	0
3. Black shale	7	0
4. Coal V?	1	0
5. Gray shale (probably sandstone)	6	0+
6. Black shale	6	0—
7. Coal IV	3	6
8. Fire-clay	5	0



481 Valley. Sec. 19. 482 Goebel. Sec. 19. 483 Crawford. Sec. 18. 484 Row. Sec. 27. 485 Burr. Sec. 27.

Figs. 481-483. Sections of Coal V in T. 9 N., R. 7 W.
Figs. 484, 485. Sections of Coal IV in T. 9 N., R. 7 W.

Judging from an exposure of No. 2 in the bank of Eel river, and an examination of the drillings, it seems probable that the "gray shale" of the section is a sandstone. At one point on the same farm Coal V is 2 ft. 2 in. thick.

The upper of the two coals, known at the south to be Coal V, is a thick coal locally, running from 1 ft. 6 in. to 8 ft. 6 in. thick. Its roof is of black sheety shale, with sulphur nodules which tend to extend into the coal. Above is often a limestone, frequently 6 or 8 ft. thick. This is the coal worked at Alum Cave, just at the county line.

A section at the Row bank, in Sec. 27-9-7, gave as follows:

1097. SECTION 381. SECTION AT ROW SHAFT.—Sec. 27-9-7, Fig. 484.

	Ft.	*In.*
Surface	6	0
Sandstone	15	0
COAL IV, upper bench	3	0
Fire-clay parting	1	6
COAL IV, lower bench	3	0
Shaly, micaceous sandstone (reported)	25	0
COAL III (reported)	5	0?

Coal IV of this section is considered the same as the coal at Linton. It was spoken of by those using it as an excellent coal, burning to a white ash and not caking.

1098. DISTRIBUTION IN TOWNSHIP 10 NORTH, RANGE 7 WEST.—Definite information about the coal was obtained only in the southwestern quarter of this township. Coal V, as defined above, outcrops at the old dam at the mouth of Splunge creek. At an outcrop on the Jno. Harris place, in the N. W. of N. E. of Sec. 20, it was 1 ft. thick, overlain by 6 ft. of black shale, which, towards the bottom, becomes sheety; above it 4 ft. of ferruginous sandstone shows; below the coal is fire-clay. A little to the south, on the same farm, the coal thickens up to 2 ft. 2 in., and is only about 10 ft. above Eel river. It has been drifted upon there. A drilling showing Coal IV to be only 12 ft. below, or about on a level with Eel river, was given above, ¶1096, Sect. 381.

Coal IV is reported to have been passed through in a well on the Schumonts place, S. E. of N. W. of Sec. 20, the coal being 3 ft. 6 in. thick. It is also reported as passed through in an 80-ft. well on the Wm. McCulle place, in the S. W. of N. W. of Sec. 20. The outcrop would then appear to run about as given on the map to where both coals were passed through in a 48-ft. well on Lanning's place, in the N. E. of S. E. of Sec. 30. Here all that could be learned was that the upper bed was about 1 ft., or a little over, thick, and was struck at about 16 or 18 ft. From there the outcrop is traced around to where Coal V is worked on the Peter Scamihorn farm, in Sec. 36, just across the line in Vigo county. The coals are next met with in Secs. 32 and 33.

Just south of Neal's Mill and the river bridge, coal has been dug on Mrs. Brown's place, N. E. of N. W. of Sec. 32. The coal is here just on the level or a little below the level of the river bank. No coal was seen, but yellow sandstone shows above. The coal is reported 3 to 4 ft. thick. Coal has also been dug on the Shidler place, N. W. 40 of Sec. 33, coal reported 4 ft. thick; and on Wood's place, in N. W. of S. E. of Sec. 33. Sandstone is reported over the coal at each place.

1099. Assuming our correlation to be correct, Coal VI would appear to enter the northwestern quarter of this township, but its distribution is not known. Coals III, IV and V should underlie this area, Coal IV lying from 20 to 60 ft. below Coal V. They may prove workable.

1100. In the southeastern quarter township, Coals VI and V would appear to be lacking. As it appears probable that the present bottoms of Eel river represent the filling of an old channel, it is possible that all the coals will be found cut out over them, at least in the center of the old channel.

1101. Due to the conditions just mentioned, it seems probable that little if any coal will be found in the northeastern quarter township.

1102. DISTRIBUTION IN TOWNSHIP 9 NORTH, RANGE 7 WEST.—It is assumed that the coal at Neal's Mill, mentioned just above, with sandstone over it, is the same as the coal overlain with sandstone struck near Howesville, and at other points in the south half of this township, and as at each of the datum points on this coal, situated about in the line of strike, the coal appears to lie just above the level of Eel river, the outcrop of the lower coal was judged to about follow the edge of the bottom land, and was drawn accordingly, while the outcrop of the upper coal was drawn so as to follow contours from one outcrop to the next around the hills.

With a single exception, all the points at which information was obtained on Coal IV were in the southeastern quarter of this township. At the MacAnally place, in the S. E. of Sec. 21, this coal was struck at 20 ft., but was not gone through.

In Sec. 27 it is being worked at the banks of Mrs. Maria Row and Mr. Chas. Miller. The section at the former bank was given above. The coal appears in two 3-ft. benches, separated by 1 ft. 6 in. of hard fire-clay, with a sandstone roof (Fig. 484). A 5-ft. bed of coal is reported to underlie this by 25 ft., with hard white sandstone between.

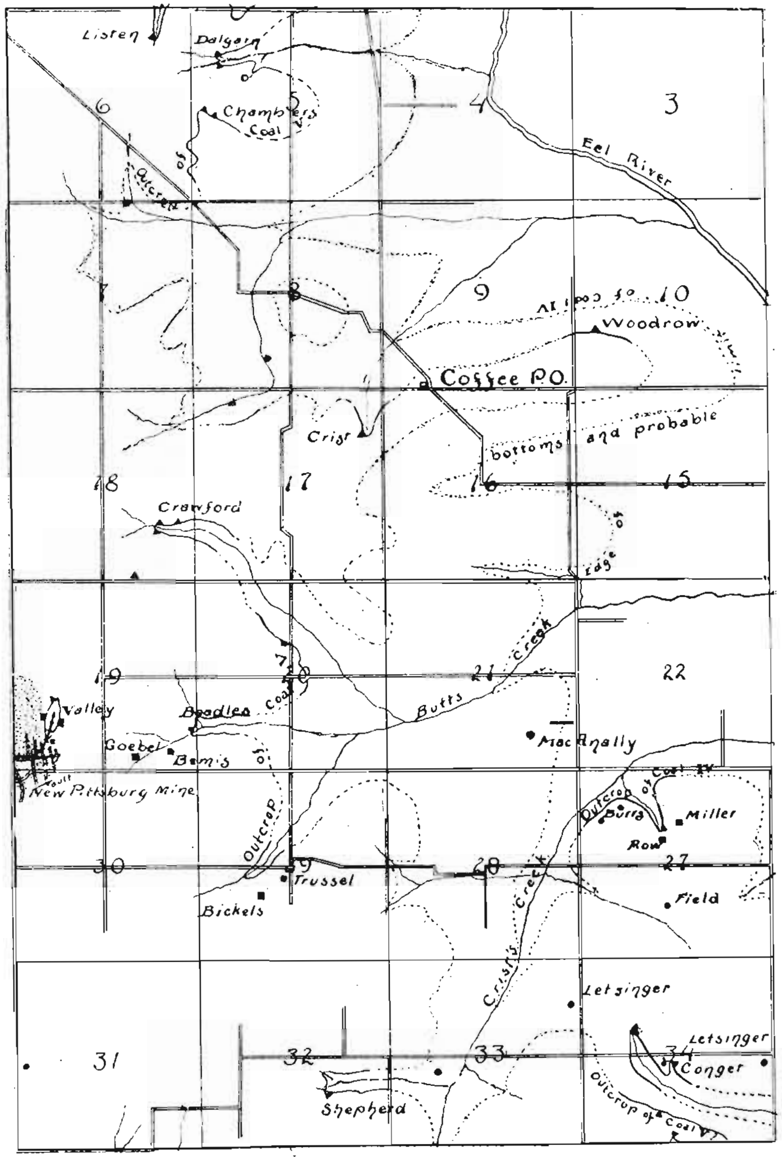


PLATE XXXV. Sketch map of part of T. 9 N., R. 7 W.

On the Victor Burr place the coal is close to the surface and is reported as 6 to 7 ft. thick, with 1 ft. of fire-clay in the middle (Fig. 485). This coal was also struck in a well on the Field place, in Sec. 27, at some depth.

In Sec. 34, 3 to 4 ft. of coal is reported to have been stripped on the Geo. M. Conger place, near the center of the section. The roof where not drift was sandstone. Near the center of the east side of Sec. 34 coal was struck in a well at Mr. Letsinger's house, at 20 ft. As this is on much higher ground, we should have expected to find Coal V at about this level, but the material thrown out of the well does not support that expectation, as only yellow sandstone and coal show. Thin coals, overlain by black sheety shale, were reported as occurring in the ridge crossing the S. W. ¼ of this section.

Coal IV has been worked at a number of points in Secs. 35 and 36, but was not exposed at any of them when this area was examined. Of these might be mentioned, on Daniel Miller's place, in the N. W. of Sec. 35, the Lester & Lester place, near the center of Sec. 36, and several places along the "Lake" east of the center of Sec. 36. The coal at the latter place is said to be a non-caking coal, burning without clinkering to a white ash. Coal III is reported to lie a short distance below.

Coal V has been stripped at the Listen place, in the N. E. ¼ of Sec. 6; Dalgarn place, S. W. of N. W. of Sec. 5, and Thos. E. Chambers place, N. W. of S. W. of Sec. 5. The coal here runs from 2 ft. 6 in. to a reported thickness of 3 ft. 6 in. Over it is 1 ft. 4 in. of dark blue sandy shale, then 1 ft. 8 in. of black sheety shale, with pyritized fossils.

In the N. W. ¼ of Sec. 17, there is exposed in a branch 6 ft. of shaly sandstone, 6 ft. of sandy shale, 1 ft. 6 in. of coal. The stratigraphic position of this coal is uncertain. Coal has also been dug on the Crist place in the N. E. ¼ of Sec. 17, and the Woodrow farm in the S. W. ¼ of Sec. 10. In Sec. 18 Coal V has been stripped on the old Crawford place. It is reported to be 18 in. thick and has a roof of the characteristic black sheety shale (Fig. 483). Some fragments of limestone suggested the presence of the limestone so commonly found over the coal at the south. The coal is here between 50 and 75 ft. below the divide.

In Sec. 19 this coal is not more than 30 ft. below the top of the ridge. At the old Valley mine of the New Pittsburg Coal and Coke Co., Coal V has been extensively mined, and coal in this quarter section is still being worked from their No. 1 shaft across the county line.

At the old workings 5 ft. of coal were exposed without reaching the bottom. The roof here is black sheety shale 4 ft. thick, having above two benches of limestone, each 18 in. thick, and separated by 6 in. of shale (Fig. 481).

On the east side of the divide and at approximately the same level, Coal V has been reached by the Goebel shaft in the S. W. of S. E. of Sec. 19. The section here shows 12 ft. of dirt, 5 ft. of black shale, 8 ft. of coal. The coal here is said to average 8 ft., ranging up to 8 ft. 6 in. There is said to be a clay parting 0 to ½ in. thick 2 ft. from the top. As the bottom foot of coal is poor, it is left to timber on in mining (Fig. 482).

At the Bemis shaft the coal is said to run between 8 and 9 ft., and a little further down the ravine is stripped on the Beadle place.

In Sec. 29 the coal, 6 ft. thick, is reached at a depth of 8 ft. in Mr. Geo. Bickel's shaft. In Elijah Trussel's well it is reported as 8 ft. thick at a depth of 9 ft., and is overlain by 5 ft. of black shale.

In the S. E. ¼ of Sec. 32 coal has been stripped on the David Shepherd farm. Limestone is said to outcrop above in the hollow.

From the above it would appear that through Secs. 29-32 Coal V is of unusual thickness and to be found not far below the level of the flat divide running from Jasonville to Centerville. Here it is usually overlain by the black sheety shale, with limestone above. The ridge here appears to be anticlinal in structure. In the northern part of Sec. 19 the dip appears to carry the coal farther below the ridge, while the coal is much diminished in thickness, and the limestone is not conspicuous. Still further north the dip continues to carry the coals to slightly lower levels. The coal has here a thickness of from 3 ft. 6 in. down. It maintains its black sheety shale roof, but the limestone was nowhere seen. The area underlain by the coal is shown on the map.

The horizon of Coal VI is supposed to underlie the highest part of the ridge in Secs. 6 and 7. No evidence of this was found.

The evidence suggests that Eel river flows in a broad syncline. It is probable that a preglacial erosion has removed all the coal from under its bottoms, and probably from all or most of the area in this township east of the river.

1103. SUMMARY OF COAL OF CLAY COUNTY.—

Divisions contained: I, II, III, IV, V, VI and VII.
Coals contained: I, Ia, II, III, IIIa?, IV, IVa, V, Va, Vb, VI, VIa, VIb, VII.

ROUND NUMBER ESTIMATES.

Coal VII.

Worked area	1 acre	× av. thickness,	3 ft. ×	1,000 =	3,000 tons.
Workable area....	4 sq. mi. ×	"	3 ft. ×	750,000 =	3,000,000 tons.
Unworkable area.	5 sq. mi. ×	"	2 ft. ×	1,000,000 =	10,000,000 tons.
Total area	9 sq. mi.	...			13,003,000 tons.

Coals VIa and VIb.

Worked area.....	10 acres	× av. thickness,	1½ ft. ×	1,000 =	15,000 tons.
Workable area....	1 sq. mi. ×	"	2 ft. ×	750,000 =	1,500,000 tons.
Unworkable area.	50 sq. mi. ×	"	1 ft. ×	1,000,000 =	50,000,000 tons.
Total area	51 sq. mi	...			51,000,000 tons.

Coal VI.

Worked area	1 sq. mi. ×	av. thickness,	6 ft. ×	500,000 =	3,000,000 tons.
Workable area....	25 sq. mi. ×	"	5 ft. ×	500,000 =	62,500,000 tons.
Unworkable area.	24 sq. mi. ×	"	2 ft. ×	500,000 =	24,000,000 tons.
Total area	50 sq. mi	...			89,500,000 tons.

Coals Vb, Va, IVa, III?, II, Ia.

Unworkable area.	50 sq. mi. ×	av. (aggregate) thickness,	5 ft. ×	1,000,000 =	250,000,000 tons.

Coal V.

Worked area	½ sq. mi. ×	av. thickness,	4 ft. ×	500,000 =	1,000,000 tons.
Workable area....	20 sq. mi. ×	"	3 ft. ×	500,000 =	30,000,000 tons.
Unworkable area.	30 sq. mi. ×	"	1 ft. ×	1,000,000 =	30,000,000 tons.
Total area	50 sq. mi	...			61,000,000 tons.

Coal IV.

Worked area	20 sq. mi. ×	av. thickness,	3½ ft. ×	500,000 =	35,000,000 tons.
Workable area....	30 sq. mi. ×	"	3 ft. ×	500,000 =	45,000,000 tons.
Unworkable area.	150 sq. mi. ×	"	2 ft. ×	1,000,000 =	300,000,000 tons.
Total area	200 sq. mi	...			380,000,000 tons.

Coal III.

Worked area	10 sq. mi. ×	av. thickness,	3 ft. ×	500,000 =	15,000,000 tons.
Workable area....	30 sq. mi. ×	"	3 ft. ×	500,000 =	30,000,000 tons.
Unworkable area.	200 sq. mi. ×	"	1 ft. ×	1,000,000 =	200,000,000 tons.
Total area	240 sq. mi	...			245,000,000 tons.

Coal I.

Unworkable area.	50 sq. mi. ×	av. thickness,	1 ft. ×	1,000,050 =	50,000,000 tons.

Number of coals contained: 14.
Greatest thickness recorded: Coal V, 8 ft.+; Coal VI, 7 ft. 3 in.; (Rep.) 9 ft. to 11 ft.
Area underlain by coal: 250 sq. mi.
Area underlain by workable coal: 100 sq. mi.
Estimated total tonnage of coal: 1,000,000,000.*

*Mr. Cox estimates this county to contain 4,464,000,000 tons of *workable* coal, or almost thirty times as much as our estimate. (E. T. C., p. 69.)

Estimated total tonnage of coal removed or lost: 50,000,000.
Estimated total tonnage of workable coal left: 150,000,000.
Number of mines working ten men or over in operation (1898): 30.
Number of mines working less than ten men in operation: 18.
Total number of mines in operation: 48.
Large mines not in work: 91.
Small mines not in work: 100+.
Strippings and outcrops, etc.: 511.

XXIII. VIGO COUNTY.

1104. REFERENCES AND FIELD WORK.—

1838, 1853, 1859. D. D. Owen, Cont. of Rep. of a Geol. Reconn. of Indiana in 1838, pp. 38-39. (D. D. O.)

1862 (1859-60). R. Owen, Rep. of Geol. Reconn. of Indiana, pp. 170-171. (R. O.)

1862 (1859-60). Leo Lesquereux, same, pp. 329-331. One columnar section. (L. L.)

1871 (1870). E. T. Cox, 2d Rep. of Geol. Surv., pp. 124-135. Two columnar sections. (E. T. C., '70.)

1876 (1875). E. T. Cox, 7th Ann. Rep. of Geol. Surv., pp. 78-115. Detailed report; map, twenty columnar sections; one cross section; thirteen coal analyses. (E. T. C.)

1896 (1895). W. S. Blatchley, Dept. Geol. and Nat. Resources, 20th Ann. Rep., pp. 71-76. Two columnar sections. (W. S. B.)

1897 (1896). W. A. Noyes, same, twenty-first Ann. Rep., p. 106. One coal analysis from this county. (W. A. N.)

1897 (1896). J. T. Scovell, same, 22d Ann. Rep., pp. 507-576. Detailed report; map; twenty-seven columnar sections, former coal analysis repeated. (J. T. S.)

1897. J. T. Scovell, G. H. Ashley, field work for this report. On account of Mr. Scovell's familiarity with the geology of this county he was asked to accompany the writer on a ten days' trip over the county in order to obtain certain practical data not previously obtained by him, and to get the relations of the coals of this area to those outside. A comparison of the reports will show how largely I have drawn on Mr. Scovell's report, many of the passages, especially on topography, etc., being taken verbatim, for which privilege I wish to express my thanks.

1105. LOCATION AND EXTENT.—Vigo county is situated on the western boundary of Indiana, about midway between Lake Michigan and the Ohio river. It has an extent of 24 mi. from north to south, and is a little less than 17 mi. in average width, having an area of about 406 sq. mi.

The county is bounded on the north by Vermillion and Parke counties, on the east by Clay county, on the south by Sullivan county, and on the west by Clark and Edgar counties, Illinois.

According to the United States survey, the county is in townships 10, 11, 12 and 13 north of the base line of Indiana, which is 38° 30′ north latitude, and in ranges 7, 8, 9, 10 and 11 west of the second principal meridian, which is 86° 28′ west of Greenwich.

1106. ELEVATIONS.—The elevations of the following important localities are taken from railway levels, and are adjustable to the level of the rail at the Union Station at Terre Haute, near the center of Sec. 22-12-9. This point, as given by Gannett, is 492 ft. above tide; by some it is given as 485 ft.:

	Ft.
Rail at the Union Station (Gannett)	492
Ellsworth, on the Logansport road	492
Atherton, on the north county line	523
Hill one-half mile east of Atherton	625
Rosedale, one mile north of county line	537
Grant, on Big Four railroad	516
Fontanet, Nevins township	539
Coal Bluff, on Otter creek	553
Lodi, on the county line	564
Perth, on the plateau in Clay county	633
Point one mile west of Seelyville	596
Seelyville Station	585
A point one mile east of Seelyville	604
East county line on the Vandalia	583
Spring Hill Junction, west of center of Sec. 11-11-9	516
Honey creek bridge, N. E., N. W. 17-11-8	505
Lockport Station	569
Highlands east of Lockport	622
County line, on the Southeastern railroad	614
Honey creek bridge, on the Evansville road	509
Youngstown Station	578
Albin's hill, beyond Youngstown	604
Hartford or Pimento	600
County line on Evansville road	575
Farmersburg, one-half mile south of line	573
The west county line on the Vandalia	544
Point one mile west, on the plateau	581
Station at St. Mary's	555

	Ft.
Sandford, on the county line west	625
Morainic Hills, near Sandford	655
Yaw's Hill, N. E. ¼ Sec. 18-10-8	673
Crapo's Hill, N. W. ¼ Sec. 20-10-8	663
Surface of Lake Erie	573
Surface of Lake Michigan	582
Wabash river, low water	445

1107. GENERAL TOPOGRAPHY AND DRAINAGE.—"Vigo county is a portion of a double slope. Its rocky strata incline westward toward the Mississippi and southward toward the Ohio, the westward slope being the more rapid. This circumstance seems to have had much to do in determining the topography of the county. The river flowing toward the south crosses the more rapid slope nearly at right angles. This dip of the strata westward probably causes the river to crowd its western bank, making it more abrupt than the eastern. The tributary streams flow easterly and westerly, with a trend toward the south, this trend being more pronounced in the western streams. The southerly dip of the rocks not only causes a southerly trend in the direction of the streams, but it causes them to crowd their southern banks, making them more abrupt than the northern. In general there are no streams flowing toward the north, the south branch of Honey creek being the only stream of any size flowing in that direction. The greater portion of the surface of the county slopes toward the river, but portions of Riley and Pierson townships are in the valley of Eel river. The divide between the two rivers is a massive body of land lying in Linton and the western part of Pierson townships, and trending northeasterly through Riley township. The N. E. ¼ of Sec. 18, 670 ft., and Sec. 20, 660 ft, of Pierson township are the highest points in the county. Sec. 1 of Linton township, and Sec. 6 of Pierson, and portions of Riley have an elevation of from 640 to 650 ft., which is about the same as the higher portions of Fayette, Nevins and Lost Creek townships. While the strata in general dip to the west, there are some local exceptions or irregularities. In Sec. 1, Linton township, there is a sharp dip to the east, and another in Riley township, with some evidences of another in Pierson, but the evidence is not sufficient to determine whether the divide is an anticline or not. This divide is a rocky mass with just a thin veneering of boulder clay and soil, and must have divided these valleys in preglacial times.

"The most marked feature in the topography of the county is the immediate valley of the river. It is from five to six miles wide and extends through the whole length of the county, but as the river forms the western boundary of the southern third of the county, only that

portion of the valley on the east of the river belongs to Vigo county. This valley is an old channel that has been partly filled with sand and gravel. The numerous wells drilled in Terre Haute and vicinity shows the rock bed of this old channel to be from 120 to 150 ft. below the general level of Terre Haute. The high land just east of the river, in the north part of the county, was part of an island in the ancient river. The channel east of the island is now occupied by Raccoon creek of Parke county. This eastern channel of the old river accounts for the sudden widening of the valley just south of the county line. In Prairie Creek township there is another island. The narrow channel east of the island is now occupied by Prairie creek. The valley of the river turns abruptly towards the west above the island and is somewhat narrow below. The main channel of the old stream was along the west bank. The rocky banks, the islands, the main channel, the secondary channels and shallow places are so well defined that we can almost see the old river, whose waters carved out such a broad, deep trough through our county. The river and its flood plain occupies the western one-third of the valley. The river washes the western bluff at Durkey's Ferry and its flood waters wash them at various places. The greater portion of the flood plain is from 14 to 18 ft. above low water in the river, and scattered over them there are many ponds and sluggish streams, indicating a very uneven surface. Between the flood plain and the bluffs there are fragments of a low terrace, which is sometimes of gravel and sometimes of rock. The eastern two-thirds of the valley is occupied by a massive gravel terrace, which has a somewhat irregular surface. Through Otter Creek township it is much higher along the river, sometimes rising to 70 or 80 ft. above low water, then sloping gently eastward. In Harrison township it is not more than 50 ft. above low water, and while there are low ridges and shallow valleys trending toward the south there is no slope toward the east. Through Honey Creek and Prairieton townships the terrace gradually diminishes in elevation until it finally fades into the flood plain of Prairie Creek township. Large portions of this terrace are flat and not well drained, so that they were originally swamps, marshes, wet prairies and ponds. The island that projects into the northern part of the county may, perhaps, be called a portion of the river valley. Where crossed by the county line the elevation is about the same as that of the high lands west of the river, but it soon begins to descend toward the south, and within two miles has merged imperceptibly into the terrace. The surface is somewhat broken along the upper portions of Clear creek.

"The terrace is continuous into the valley of Racoon creek, and the ancient Raccoon creek doubtless flowed into Vigo county, but while small portions of Nevins township are drained into this creek, it hardly seems necessary to describe its valley.

"The highlands on either side of the valley have an elevation of from 100 to 200 ft. above the river, the bluffs in some cases being quite abrupt. The greater part of the county is drained by the Wabash and its tributaries. The principal streams from the west are Brouilett's creek, Coal creek, Sugar creek (with several large branches), Clear creek and Hawk creek. These streams rise in Illinois and flow southeasterly into the river through valleys from one-quarter to one-half a mile wide and from 30 to 80 ft. in depth. The streams from the east are Otter creek, Lost creek, Honey creek, Prairie creek, Turman's creek and Busseron creek. Portions of Pierson and Riley townships are drained by Splunge creek into Eel river. The valleys of the river and its tributaries seem to be the channels of an earlier drainage system that have been partly filled with sand and gravel, so that in many cases the beds of the present streams are from 25 to 100 ft. above the rocky beds of the older channels. These smaller streams for much of the summer are 'lost creeks,' a fairly good stream among the hills disappearing in the sands and gravels of the main valley.

"That portion of the county drained by Splunge creek slopes gently toward Eel river, and the soil seems to be sedimentary, appearing to have been deposited over the bed of an ancient lake.

"The topography of Vigo county presents no very striking characteristics, but shows many very interesting features. The post-glacial drainage system is young and has not yet been able to reveal the ancient topography in detail. East of the river the drainage in general follows the dip of the strata and the old drainage lines, so that the recent topography is probably quite like the old. On the west of the river, however, there is evidence of different lines of drainage, and other evidence which indicates a wide divergence between recent and ancient topographies."

1108. Development and Transportation.—"In Vigo county the conditions are specially favorable for successful coal mining, for the growing of grain and market garden products, for stock raising and for many forms of manufacturing.

"The population and wealth of Vigo county, being the second in the State, the growth and development of Terre Haute, the fourth city in the State, give some indication of the material resources of this county."

The Vandalia railway crosses from east to west, the Big Four from northeast to southwest. Starting from Terre Haute are the C. & E. I. R. R. to the north, the T. H. & L. to the northeast, the E. & T. H. to the south, the E. & I. to the southeast; the C. & I. C. R. R. crosses the northeastern corner, and there Otter creek branch runs down Otter creek.

1109. Post-Carboniferous Geology.—Reference has been repeatedly made to gravel terraces and other deposits along the Wabash valley. As Mr. Scovell has made a careful study of these, it was thought best to defer any extended notice of them to this point where use could be made of the descriptions prepared by him. "The thickness of the boulder clay in Vigo county is from nothing up to 150 ft. The thicker beds are probably in older channels. Frank Leverett, who has given the matter much attention, says that the average thickness of this portion of Indiana is about twenty-five feet.

"In coal mines abundant evidence is found of much more extensive erosion than appears upon the surface. The Union mine, at Fontanet, is about 110 ft. deep, through hard pan 55 ft., and rock 55 ft. But within 150 yds. of the shaft the rock has been cut away and the boulder clay rests on the coal; while a few yards farther, in the same direction, the coal has disappeared, the rock and coal both being cut out by erosion and afterward replaced by sand, gravel and boulder clay. It is a common thing for the miner along Otter creek or Racoon creek, and in other localities, to find the coal that is less than 125 ft. below the plateau surface cut out by sand bars, gravel beds or boulder clay. So common and extensive are these old channels, that Mr. Talley, of the Coal Bluff Mining Company, tells me they never buy 40 acres of coal land without drilling at least four prospect holes in order to make sure they are buying coal and not simply boulder clay. Near Fontanet one drill hole penetrated boulder clay 120 ft. At St. Mary's it is 100 ft. to bed rock, and at Sandford it is about 150 ft. A little beyond it is 180 ft. to shale, while the rock comes near the surface within a short distance of each of these localities. The south part of the county would probably yield similar testimony if it were tested with a drill. These facts indicate extensive local erosion prior to the glacial period, and, I think, indicate that the proportion between the main river and its local tributaries was formerly much the same as at present. These channels vary in depth. The river wells reach bed rock about 80 ft. below low water in the river, or about 365 ft. above tide, while the plateau in many places is over 600 ft. above tide. Wells in other parts of Terre Haute reached shale at about the same distance below the river, so that we are sure that a considerable portion of the main valley was formerly 225 ft. or more below the general surface of the uplands. The tributary channels are probably much shallower than the main valley, but little is known of them beside an occasional well. Drift materials are known to be of considerable thickness in the valleys of Sugar creek and of Otter creek. The beds of the present streams are from 60 to 80 ft. below the general surface of the uplands, and the bed of the old channel is at least as much as 60 to 80 ft. lower still. The walls of these old channels, where exposed, are often quite abrupt, so that the county in all the myriads of years had not been base-leveled. It is evident that a vast amount of material has been removed from Vigo county by erosion, but when we consider the length of time, the amount does not seem to be relatively great, and it seems probable that for much of the time this region was near the level of the sea, so that the action of eroding agents was weak and ineffectual."

After describing the formation and advance of the ice sheet, and the spreading out of the boulder clay on its retreat, he says: "This material filled up the old drainage channels, so that the surface was a plain of gently undulating surface.

"But the floods from the retreating ice soon began to form drainage channels, sometimes reopening old channels in general, but occasionally cutting off some bend, giving rise to many curious features in the streams of glaciated areas. The retreating ice for a long time made a dam across the Maumee valley, so that a lake was formed. The surplus waters of this Maumee lake were discharged across the divide near Ft. Wayne into the Wabash valley, and through it to the gulf. This extra supply of water seems to have cleared the old valley of boulder clay, at least in this region. While the new drainage channels were being opened, the surface of the boulder clay weathered into soil, and became covered with vegetation. The remains of this vegetation, partially decayed, mingled with the clay, forming a black soil. Similar soils are formed at the present time on poorly-drained tracts in the northern latitudes. This old soil occurs in the eastern and southern parts of the county, under several feet of material deposited at a later period.

"Above this old soil there is a deposit of loess. 'Loess is a fine-grained, yellowish silt or loam, which overspreads the southern portion of the glacial drift in North America. It consists principally of quartz grains, but it usually contains a variety of such other minerals as occur in the drift. It is apparently derived from the drift, either by the action of water or of the wind. It often contains calcareous matter, which partially cements it. Sometimes irregular nodules of lime and of iron and of manganese oxide are found in this material. It also often contains fossil shells of land and fresh water mollusks, and occasionally remains of insects and bones of mammals. It has a strong tendency to vertical cleavage, and usually presents nearly perpendicular banks on the borders of streams which erode it.' It occurs at several places along the bluffs east of the river, and probably west of the river as well, but I have not noticed it there. There is a thick deposit in the bluff on the Bloomington road; in the bluff just south of Otter creek and in the bluff at Atherton on the north line of the county. Over this loess there is, in southern Indiana, a continuous layer of pale silt called 'white clay,' which is the surface soil over much of the uplands of Vigo county.

"Later, a second ice sheet overspread the country, reaching as far south as the northwestern part of our county, including Sandford. When the ice sheet halts for some time accumulations of gravels, sands and clays are formed by the materials dropped by the melting ice. Such accumulations are called moraines. Sometimes a continuous ridge of considerable extent occurs, but more generally the moraine consists of low, rounded hills. The hills east and northeast of Sandford are parts of the Shelbyville or Wisconsin moraine that marks the southern boundary or limit of a second ice sheet. The moraine extends northeasterly across the river into Parke county, being well marked to the north of Atherton. In the northwestern part of Fayette township the white clay has been covered by a deposit of darker material brought down and deposited by this later ice.

"At several places in bluffs of boulder clay I have found old wood from twenty to forty-five feet below the surface. Sometimes this old wood was fragile, soon crumbling on exposure to the air; in other cases it was in good condition, and is still firm after being exposed to the air for a year. Wood has been found in digging wells in different parts of the county, so that old wood is quite common in the boulder clay of Vigo county. The specimens found were of cone-bearing trees, probably some kind of cedar. One specimen showed over thirty rings of growth in a quarter of an inch. One ring was composed of only two layers or rows of ducts. These narrow rings of growth seem to indicate that there had been more winter than summer in the life of that little tree or shrub.

"The glacier accounts, in a general way, for the soils and drift materials of the uplands, but the soils and other materials in the valleys need explanation. The old channel of the river was swept of boulder clay, probably by water from outside its ordinary water shed. After a time the ice melted out of the Maumee valley, and the waters of Maumee lake found a new outlet. The Wabash, diminishing in power, began silting up its bed with sand and gravel. This process continued until, in Vigo county, there was deposited a bed of gravel 20 mi. long and four to five mi. wide, and over 100 ft. thick. This bed is of unknown extent toward the north and south. The great masses of gravel at Lafayette, and at intervening points, are, perhaps, parts of the same great bed. How can it be accounted for? In the record of some of the deep wells, the upper portion of the drift materials is shown to be coarse, while the lower is of smaller size. This, if a fact, suggests delta formation. One who studies the gravel pit will feel sure that the sands, gravels and boulders were arranged by water, but under what circumstances could the water get these rocky fragments of varying sizes together? A study of the upper portions, as seen in the gravel pits, suggests stream action, and possibly the whole mass was a delta formation whose upper portions were rearranged by stream action. Of something over 600 gravel stones examined, about 35 per cent. were limestones; the remainder were fragments of different kinds of granite rocks. The fragments vary in size from fine sand up to stones six inches in diameter, with occasional large boulders. The surface features, at least, seem the work of a strong stream. The ridge, just west of Seventeenth street, which extends southward east of the old canal, seems to be an old sandbar. The ridge along Fifth street, which terminates in Strawberry Hill, is apparently another old sandbar. This mass of sand and gravel in the main stream must have dammed up some of the tributary streams, forming long, narrow lakes.

"Later, the river seems to have become narrower and more rapid, possibly on account of elevation of the northern portions of the continent, so that the western one-third of the valley was cut down some 20 ft. or more, leaving the eastern two-thirds as a gravel terrace. The margin of the terrace has a direct course a little west of south from three miles north of the county line in Sec. 13-14-9 to Sec. 5-11-9, Honey Creek township, where it turns to the southwest.

"Sometime after this the energy of the river seems to have been concentrated upon narrower limits, and a channel was cut deeper into the gravel, leaving a narrow fringe of second terrace or second bottom along the western bluff, which is about 30 ft. above low water in the present river, while the main terrace rises from 40 to 70 ft. above the low water. Then the river ceased to erode the gravel, and even when in flood it can only work over the materials of its own floodplain. As one watches the river when in flood, with its deep, strong current, and finds it unable to erode the gravel, he cannot help wondering as to what manner of a stream it was that cut out that great mass of gravel and carried it to unknown distances below. The river flows along or near the western bluffs, and its tributary streams flow along the southern bluffs. This is universal. There is hardly a rocky cliff or bank of boulder clay that does not face toward the north or toward the east. I can think of only two or three exceptions along the narrow parts of Coal creek valley. This is perhaps due to the fact that the strata generally dip toward the south and west. It is possible that the main current of the stream that deposited the gravel was on the west, and that the gravel was not as deep on the west. If true, the later streams had less work to do than we have ascribed to them. The lands of Vigo county were surveyed in 1815 and 1816. The meander of the river made at that time was not carefully done and the records are incomplete, so that no very definite conclusions can be reached as to the amount of change made in the course of the river since that time. But it seems certain that in no instance since that date has the river been able to erode the gravel. Those portions of its channel, where at least a fringe of timber has been left along the river, have not materially changed. But on the curves, where the timber has been cut away, the erosion has been extensive, so that the bed of the river has moved from 600 to 800 ft. as at the bends in S. E. Sec. 8, and S. W. Sec. 16-12-9, and in S. W. Sec. 32-12-9, Harrison township.

"The main terrace descends gradually towards the south from the north part of Honey Creek township to the northern part of Prairie Creek township, where it becomes the flood plain. Whether the terrace formerly extended farther south and has been cut down by erosion to its present extent and form, or whether it never extended any farther than at present, and has the original termination modified only by ordinary atmospheric influences, are questions which I can not solve. I am inclined to the opinion that the high terrace never extended much beyond its present position.

"Just above Clinton, Vermillion county, about five miles north of our county line on the west side of the river, a section of the high terrace terminates quite abruptly. It rises about 60 ft. above low water, while the second terrace on which Clinton stands rises from 35 to 40 ft. above the same level. The river valley is narrow, only about two miles wide in this locality. The high terrace appears again about two miles below, but on the east side of the river, and in full force just below the narrow place in the valley. The high terrace does not seem to have been formed in the narrow portion of the channel. Many streams flowing into the main valley are lost in the sands and gravel. In time some of them brought down clay enough from the hills to puddle large areas of sand, making it impervious to water, and marshes, swamps and wet prairies were formed. Fort Harrison prairie, which extended through nearly the whole length of the county was largely wet prairie that had its origin in obstructed drainage. The Macksville terrace across from Terre Haute is a typical gravel terrace, but much of the second bottoms is really a rocky shelf. Near the I. & St. L. R. R., it is a shelf of shale above Coal 'N' (VII). South of Sugar creek, for some distance, it is a shelf of limestone. Other interesting features of the old valley might have been mentioned, but enough has been said to show that the channel of the ancient Wabash contains many interesting problems for the one who has time and opportunity for studying them.

"The tributary valleys differ widely from the main valley. In them the drainage was purely local, and it, at times, was not relatively as strong as in the main valley. The great floods from the retreating glacier soon ceased to influence the local streams, but continued for centuries to strengthen the river. Changes of level that would materially affect the character of the main stream might have little effect on the tributary. The boulder clay was all removed from the main channel in a comparatively short time, while the tributaries are still, after thousands of years, working on the boulder clay with which the glaciers long ago filled their channels.

"In general, the tributaries seem to have cut downward as rapidly as the river, but could not open their channels to the full width as did the river. When the river silted up its channel with sands and gravel, they filled theirs mainly with sand, the local streams not being able to move as coarse material as the river. In some instances, at least, the main stream filled its channel so rapidly as to shut off the tributary stream, making it a pond or lake. In one of the branch valleys of Sugar creek, on the N. W. ¼, S. E. ¼, Sec. 22-12-10, there is a deposit of very fine laminated clay, with occasional partings of fine sand, the whole resting in a trough of boulder clay. Where this deposit outcrops on the main creek it is from 12 to 15 ft. in thickness, becoming thinner as it extends back from the creek. In some places it has the appearance of shale, but to the touch it is fine clay. I found some similar material about a quarter of a mile down the creek, which seems to indicate that the deposit was formerly more extensive, but had been carried away by erosion. I once saw an extensive deposit of similar material in Sullivan county, northeast of Merom.

"The deposit is an interesting one, and indicates that this valley was occupied by quiet water for centuries, and that then the barriers were removed, the lake flowed away and the obstructed drainage system was reopened. The valley of Sugar creek, in Secs. 16, 22 and 23, is wider than below, and the same thing seems to be true of East Little Sugar creek, in Secs. 12 and 13. None of the other valleys have a similar form. The flood plain of the tributary streams is of different material from that of the main stream. It is more local in its character—sometimes clayey and impervious, again sandy or loamy. In many cases the smaller streams carry away valuable materials from their flood plains, while in general the river leaves its flood plain covered with a coating of rich, fertilizing sediments.".

1110. Coal Measures.—"The strata which outcrop in the county, or are easily reached by mining shafts, belong to the carboniferous period. These strata consist of coals, sandstones, shales, sandy shales and limestones. Each stratum varies in composition and thickness, and those near the surface were extensively eroded and furrowed with broad and deep channels during the millions of years that measure mesozoic and cenozoic times. At the close of the glacial period these valleys were filled with boulder clay, and in many cases the hills were covered with a thick mantle of the same material. By subsequent erosion much of the boulder clay was carried away, and some portions replaced by sand and gravel. These circumstances make it difficult to trace the upper strata with any degree of certainty."

The strata generally dip gently toward the west and perhaps toward the south, the general dip being often obscured by local variations which are often quite abrupt. On account of the westerly dip of the rocks of Vigo county the uppermost strata are on the west of the river. The following is a somewhat generalized section of the strata of the county. It was originally planned to represent the stratigraphy of each county by leads, as below, but the difficulty of obtaining satisfactory averages as a basis led to the abandonment of the plan in most of the counties, especially those containing principally the lower coals, where great variation of thickness of the strata exists.

Divisions.	Coals.	Range in Feet.	Average. Ft.	In.	
IX			50	0	Shales and sandstone.
VIII		2-30	25	0	Shale, limestone, black shale.
	VIIIa		1	0	Thin coal.
			45	0	Fire-clay, limestone, shale.
	VIII	0- 4½	3	0	Coal worked up Coal creek, not generally workable.
VII			60		Fire-clay, limestone, sandstone, shale.
	VII	0- 5	4	0	Coal worked at West Terre Haute, west of Seelyville, Hartford; upper bed at Seelyville.
VI		5-30+	20	0	Fire-clay, shale, limestone and black shale.
	VIb	0- 7	2	0	Coal found at Grant, and workable at Lockport and in Pierson twp.
		30-70+	30	0	Fire-clay, shale, sandstone, limestone and black shale.
	VIa	0- 2	1	0	Thin coal, rider at Fontanet and Coal Bluff.
		5-20+			Fire-clay, shale.
	VI	0- 7½	5	0	"Big Vein." Main coal at Coal Bluff, Fontanet, Grant, Seelyville. Workable but not developed over most of rest of county.

Divisions.	Coals.	Range in Feet.	Average. Ft.	In.	
V			25	0	Fire-clay and shale, black shale.
	Vb	0- 2½			Thin coal, exposed near Lodi.
			20	0	Fire-clay, shale. Coal, thin, only noted in bore at Seelyville. Shale, sandstone, black shale.
	Va	0- 2½			Thin coal, exposed near Lodi.
			35	0	Fire-clay, shale, black shale.
	V	0- 3+			Rider in block coal field.
IV			30?	0	Fire-clay, sandstone, shale.
	IV	0- 5			Main or upper block coal in Clay county.
III			25?	0	Fire-clay and shale.
	III	0- 3			Lower block coal in Clay county.
I			?		Shale and sandstone, Mansfield.
	I		?		Horizon of Coal I. Not reported in county.

From the above it appears that two of the coals are generally workable, two others are workable in certain areas, while it is barely possible that some day some of the lower coals may be found worth mining, at least one of them being reported of workable thickness at several places.

1111. Sub-Coal Measure Strata.—Below is given the section of a deep well drilled at Terre Haute.

1112. SECTION 382. SECTION OF DEEP BORE AT TERRE HAUTE. —S. E. of S. W. Sec. 21-12-10. (E. T. C., '70, p. 126.)

			Total.	
	Ft.	In.	Ft.	In.
Sand and gravel	100	0	100	0
Division VI—				
Clay shale	64	6	164	6
COAL VI	6	2	170	8
Division V—				
Hard sandstone	2	3	172	11
Clay shale	10	0	182	11
COAL Va	3	0	185	11
Clay shale	4	3	190	2
Gray sandstone	5	10	196	0
Clay shale	...	10	196	10
Gray sandstone	6	0	197	4
Clay shale	12	9	210	1
Soft black shale	6	0	216	1
COAL V	0	9	216	10
Division IV—				
Soapstone	7	7	224	5
White sandstone	30	3	254	8
Salt Water from this Sandstone.				
Blue shale	7	2	261	10
COAL IV	2	3	264	1
Division III—				
Black shale	10	0	274	1
White clay shale	3	0	277	1
Black shale	15	0	292	1
White clay shale	8	0	300	1
Black shale	3	3	303	4
COAL III	3	0	306	4
Division I or II—				
Clay shale	17	8	324	0
Sand rock	3	0	327	0
Clay shale	20	0	347	0
Sand rock	10	0	357	0
Blue shale	22	0	379	0
BOTTOM OF COAL MEASURES?—				
Limestone	2	0	381	0
Blue shale	31	0	412	0
Light shale	5	0	417	0
Blue shale	60	0	477	0
Sandstone	7	0	484	0
Blue shale	24	0	508	0
Sandstone	3	0	511	0
White shale	10	0	521	0
Blue shale	147	0	668	0
Hard, sandy shale	11	7	679	7
Hard gray sandstone	14	5	694	0
Hard limestone	11	0	705	0

			Total.	
	Ft.	In.	Ft.	In.
White limestone	24	0	729	0
Gray limestone	2	0	731	0
Limestone	14	0	745	0
White limestone	82	0	827	0
Clay shale	3	0	830	0
Brown limestone	35	0	865	0
Clay shale	5	0	870	0
Limestone	9	0	879	0
Clay shale	6	0	885	0
White limestone	7	0	892	0
Clay shale or gypsum?	2	0	894	0
White limestone	21	0	915	0
Gray limestone	5	0	920	0
Limestone and clay shale	5	0	925	0
Gray limestone	5	0	930	0
White limestone	15	0	945	0
Fine blue limestone	2	0	947	0
Strong Sulphur Water.				
Dark gray limestone and flint	73	0	1,020	0
Light gray limestone	7	0	1,027	0
Blue gray limestone	7	0	1,034	0
Clay shale (fire-clay)	26	0	1,060	0
Gray limestone	24	0	1,084	0
Gray sandstone	3	0	1,087	0
Clay shale (fire-clay)	5	0	1,092	0
Quartz and shale, mixed	166	0	1,258	0
Quartz, slate and clay shale	3	0	1,261	0
Slate rock	21	0	1,282	0
Clay shale	33	0	1,315	0
Slate rock	7	0	1,322	0
Clay shale	235	0	1,557	0
Strong Salt Water at 1,557 ft.				
Clay shale and sandstone	10	0	1,567	0
Fine sandstone	15	0	1,582	0
Blue clay shale	40	0	1,622	0
TOP OF DEVONIAN—				
Black shale	15	0	1,637	0
Red shale	5	0	1,642	0
Oil.				
Black shale	15	0	1,657	0
Oil.				
Limestone	5	0	1,662	0
Black shale	5	0	1,667	0
Oil.				
Gray limestone—*Oil near the top*	149	0	1,816	0
Sulphur water at about 1,800 ft.				
Gray sand rock	23	0	1,839	0
Limestone	73	4	1,912	4
Sulphur water at 1,840 and 1,912 ft.				

As indicated, the coal measures are supposed to extend to nearly 400 ft. The exact location of the bottom cannot be certainly told, but it is believed not to be below the limestone struck at 379 ft., or about 360 ft. below low water in the Wabash. Not sufficient study has yet been given to the Kaskaskia to determine whether it increases in thickness to the west, or decreases in thickness. If the latter, it is possible that the coal measures extend 100 to 200 ft. deeper. The Lower Carboniferous will be observed to be largely shale, with a large admixture of limestone and some sandstone. Then comes the black shale, marking, it is believed, the top of the Devonian. Below that is limestone, which is probably at the top Corniferous, but running into the Niagara below. The Trenton may be looked for at about 2,800-3,000 ft. provided there is no general thinning out of the Silurian strata to the west.

Township 13 North, Ranges 7 (in Part) and 8 West.

1113. Geographic.—This area includes all of Nevins and the eastern half of Otter creek of the civic townships.

1114. Topography.—"Otter creek, rising by several branches, generally in Clay county, drains a large and interesting area of country, including the greater part of Nevins township and the southern portion of Otter Creek township. The two main branches unite near the western boundary of Nevins township. The valleys of these streams are from one-eighth to one-fourth of a mile wide, the stream usually nearer the southern bluff, which is generally more abrupt and more frequently rocky. The southern tier of sections in Nevins township is drained by a third branch, which enters the main stream in the southeast part of Otter Creek township. The branches of these streams are not large, nor numerous, but the land along the streams is badly broken up. On the divide between the north branch and Racoon Creek valley there are several sections of good farm land, and some between the two branches, but fully one half of the township is too much broken for first-class farm land.

"The extreme southeastern portion of Otter Creek township is very broken; the heavy bluffs south of the creek extending westward into Sec. 31. North of the creek there are some hills, but no regular bluff. There is also some broken land in Secs. 5, 6 and 7, but in general the surface of this township is well adapted to agricultural purposes."

1115. Transportation.—The area is well supplied with transportation, no part of it being two miles from a railway, and nearly all of it being within one mile of railway. See sketch map, Plate XXXVI, p. 704.

1116. Stratigraphy.—As shown on the chart, this area includes from Division VI down. Coal VI is the only coal worked in the area, though Coal IV is extensively worked just across the line, and some of the other coals have been worked a little at a few points.

The following sections will show the stratigraphy as developed in Secs. 7, 8, 18-13-7.

1117. Section 383. Section on Otter Creek.—N. E. of N. W. Sec. 18, Fig. 4 (top), Plate XXXVI, p. 704.

	Ft.	*In.*
1. Gray to brown shale ....6 ft. to	8	0
2. Dark blue shale	..	6
3. Dark blue shaly limestone.................0 in. to	..	3
4. Dark blue shale, with iron balls..................	4	0
5. Black, bituminous, sheety shale.................	2	0
6. COAL VIa hidden.		

The following two sections show the strata from Coal VIa to Coal VI.

1118. Section 384. Section near Victor Shaft.—N. W. of N. E. of Sec. 18, Fig. 9.

	Ft.	*In.*
1. Black sheety shale..............................	1	0
2. COAL VIa—Coal, 1 ft. 0 in.; parting, 2 in.; coal, 10 in.	2	0
3. Fire-clay, with large limestone boulders..........	4	0
4. Massive sandstone	2	0
5. Shaly sandstone	4	0
6. Shaly sandstone, massive	3	0
7. Shaly "fake" to blue shale	3	0
8. COAL VI (Fig. 17)—Coal, 1 ft. 6 in.; sulphur band, ½ to 2 in.; coal, 2 ft. 0 in.; clay band, 1 in.; coal, 0 to 4 in.; clay band, 1 in.; coal, 2 ft. 0 in.+......	6	0

1119. Section 385. Sections at Bell's.—N. E. of S. W. of Sec. 8, Fig. 4.

	Ft.	*In.*
1. Surface sand and clay....................3 ft. to	6	0
2. Black, sheety, bituminous shale..................	1	11
3. COAL VIa—Coal, 11 in.; parting, ½ in.; coal, 9 in..	1	8½
4. Dark fire-clay	0	6
5. Light fire-clay	3	0
6. Limestone, gray, like boulders...................	1	0
7. Light blue shale	6	0
8. COAL VI	6	0

Up the ravine, through which the C. & I. R. R. approaches Coal Bluff from the east, there is exposed at one point below Coal VI; see Fig. 4.

	Ft.	In.
Fire-clay ....3 ft. to	4	0
Shaly sandstone, solid at bottom	5	0
Shale and shaly sandstone	5	0

No complete section was found connecting Coal VI with Coal Vb. They were estimated to be about 25 ft. apart here. Coals Vb and Va are exposed at a number of points along the bank of Otter creek toward Lodi. The following gives the section obtained:

1120. SECTION 386. SECTION ON OTTER CREEK.—S. E. of N. E. of Sec. 8, Figs. 4 and 14.

	Ft.	In.	Ft.	In.
1. Drab shale, with bands of coal........	5	0	5	0
2. Line of lime concretions..........	0	2	5	2
3. Blue shale	8	0	13	2
4. Calcareous shale, fossiliferous	0	6	13	8
5. Black, bituminous, sheety shale.......	2	0	15	8
6. COAL Vb	2	0	17	8
7. Fire-clay	1	0	21	8
8. Gray sandstone	0	3	21	11
9. Gray shale	4	0	25	11
10. Line of lime concretions.......0 in. to	0	6	26	5
11. Blue shale ....1½ ft. to	2	0	28	5
12. Sheety shale	1	0	29	5
13. COAL Va	2	3	31	8
14. Fire-clay to low water in creek........	3	0	34	8

1121. These two coals are believed to be the same as the two coals in the drilling at the Gladstone mine, the dip being very sharp to the north. A section of that drilling, beginning below the lower of the two coals and carried down to Coal III, will show what underlies this area and the relative position of Coal VI, the "big vein," to Coal IV, the upper block coal. Coal V is wanting in this section.

1122. SECTION 387. PART OF SECTION OF DRILLING AT GLADSTONE MINE.—Sec. 4-13-7, Fig. 4.

	Ft.	In.	Ft.	In.
1. COAL Va	1	3	1	3
2. White shale	4	5	5	8
3. Blue shale	15	0	20	8
4. Sandstone	10	0	30	8
5. Gray shale	3	0	33	8
Place of Coal V.				
6. Fire-clay	7	0	40	8
7. Shale, blue	25	0	65	8
8. Sandstone	7	3	72	11
9. Shale, gray	4	0	76	11
10. COAL IV	4	2	81	1
11. Fire-clay	3	0	84	1
12. Shale, blue	10	7	94	8
13. Coal and shale	0	6	95	2
14. COAL III	0	6	95	8
15. Fire-clay	1	0	96	8

The relation of Coals Vb and Va has been much in question. Mr. Cox placed them above Coal VI. Others have thought that they were the two parts of Coal VI widely separated. A very careful examination of the ground seemed to establish their relative position, as given above, with much certainty. Later, complete sections were found in Parke county, which confirmed that relation.

The following sections from Secs. 29 and 30-13-7 show the stratigraphy in the southern part of the partial township.

1123. SECTION 388. SECTION ON OTTER CREEK NORTH OF ELSIE P. O.—N. W. of N. W. of Sec. 30-13-7, Fig. 5 (top).

	Ft.	In.	Ft.	In.
1. Soil, etc.	28	0	28	0
2. Gray to drab shale	20	0	48	0
3. Dark blue shale	1	0	49	0
4. Hard, blue, calcareous shale..........	0	2	49	2
5. Dark blue shale	5	0	54	2
6. Black, bituminous, sheety shale.......	2	0	56	2
7. COAL VIa (Fig. 13)—Coal, 9 in.; shale parting, 1-2 in.; coal, 5 in..........	1	4	57	6
8. Gray fire-clay	2	0	59	6
9. Hard, gray to brown, calcareous sandstone	1	0	60	6
10. Gray shaly sandstone	1	6	62	0
11. Gray to brown, hard, micaceous sandstone	0	6	62	6
12. Gray, shaly sandstone	3	0	65	6
13. Gray sandstone, with carbonaceous partings	1	6	67	0
14. Blue shale	4	0	71	0
15. COAL VI (Fig. 19)—Coal, 1 ft. 6 in.; sulphur band, ...; coal, 2 ft. 6 in.; clay band, ...; coal, 1 ft. 0 in.; sulphur band, ...; coal, 1 ft. 0 in......	6	0	75	0

1124. SECTION 389. SECTION NORTH OF FOLEYVILLE ON OTTER CREEK.—S. W. of N. E. of Sec. 30, Fig. 5.

	Ft.	In.
1. Gray shale	10	0
2. Fake, running into sandstone	3	0
3. Light gray clay shale	3	0
4. COAL VI—Coal, 1 ft. 0 in.; knife-edge parting, ...; coal, 2 ft. 8 in.; clay parting, ½ in. to 1 in.; coal, 4 in. to 6 in.; clay parting, ¼ in. to ½ in.; coal, 2 ft. 0 in.	6	3½
5. Fire-clay	6	0
6. Brown shale	8	0
7. COAL Vb	1	0
8. Fire-clay	1	0

East of Foleyville, and apparently beginning just below the above, there was observed:

1125. SECTION 390. SECTION ON OTTER CREEK.—S. W. of N. W. of Sec. 29.

	Ft.	In.
1. Sandstone, coarse-grained, cross-bedded	2	0
2. Blue shale, with lines of ironstones	4	0
3. Dark drab fossiliferous limestone.........6 in. to	1	0
4. Gray shale	1	0
5. Black, bituminous, sheety shale	2	0
6. COAL Va (?)	2	0

A short distance east of this a drilling on the Jno. C. Huffman place reached Coal IV (?). The part of this below the coal just given is as follows:

1126. SECTION 391. SECTION (IN PART) OF DRILLING ON HUFFMAN PLACE. Sec. 29, Fig. 5 (bottom).

	Ft.	In.
Fire-clay	8	0
Gray shale	10	0
White sandstone	12	10
Sandy shale	15	7
Clay	7	0
Shale	15	5
Sandstone	5	0
Shale	8	10
COAL IV	4	6

At Grant a section may be made by combining the exposed section, the Grant shaft, and a boring near the same point.

1127. SECTION 392. EXPOSED SECTION AT GRANT.—Sec. 27-13-8, Fig. 6 (top). (E. T. C., p. 105).

	Ft.	In.
1. Drift	8	0
2. Hard, black, bituminous, cannel-like shale, 6 ft. to	8	0
3. COAL VII?—Coal, 1 ft. 10 in.; shale parting, 2 in.; coal, 10 in.	2	10
4. Clay and clay shale, with large limestone concretions	6	3
5. Black, pyritiferous substance, with soft, carbonaceous substance resembling charcoal	0	4
6. COAL VIb	1	1
7. Underclay	1	0

1128. SECTION 393. SECTION AT GRANT MINE SHAFT.—Sec. 27-13-8, Fig. 6.

	Ft.	In.	Ft.	In.
1. Surface	6	0	6	0
2. COAL VIb	2	0	8	0
3. Fire-clay	2	0	10	0
4. "Hard pan and sand mixed," probably a sandy shale or shaly sandstone	20	0	30	0
5. Gray shale	7	0	37	0
6. Black shale	10	0	47	0
7. COAL VIa	1	6	48	6
8. Fire-clay	4	6	53	0
9. Gray shale	27	0	80	0
10. COAL VI (Fig. 16); coal 1 ft. 6 in.; sulphur band, 0 to 1 in.; coal, 2 ft. 8 in.; bone coal, ½ in. to 3 in.; coal, 2 ft. 0 in.	6	6	86	6
11. Fire-clay ....2 ft. to	0	0	..	..
12. Bone coal and shale...........2 in. to	1	10	..	..

As the above section was received from the mine superintendent after the area was visited, it was not known whether or not the upper coal corresponds with the 4 ft. to 0 coal, which we have called Coal VII in the preceding section. As, however, our notes indicate that the shaft started just at or below the level of that coal, it is thought more probable that the first coal of this section corresponds with the second coal (No. 6 of the preceding section). That would indicate two coals between Coals VI and VII, which would seem to correspond with Coals VIa and VIb of Parke and Vermillion counties.

Starting above the level of Coal VIa was the bore whose record follows:

1129. SECTION 394. SECTION OF BORE AT GRANT.—Sec. 27, Fig. 6 (bottom). (E. T. C., p. 105.)

		Ft.	In.
1.	Sand and clay	73	0
2.	Clay shale	19	3
3.	Sandstone	3	0
4.	Black shale	2	0
5.	COAL V?	2	6
6.	Under clay	1	10
7.	Clay shale	12	0

1130. SECTION 395. SECTION AT UNION MINE.—Sec. 12. Fig. 77.

		Ft.	In.	Ft.	In.
1.	Surface	4	0	4	0
2.	Sand	7	0	11	0
3.	Clay, drift	14	0	25	0
4.	Boulder clay	2	0	27	0
5.	Sand	1	0	28	0
6.	Boulder clay	55	0	83	0
7.	COAL VIa	2	0	85	0
8.	Fire-clay	2	0	87	0
9.	Light shale	6	6	93	6
10.	Sandstone	1	6	95	0
11.	Gray shale	8	0	103	0
12.	COAL VI	7	0	110	0
13.	Fire-clay	3	0	113	0

As showing the thickness of shale overlying Coal VIa, the following section is given:

1131. SECTION 396. SECTION ON WEBSTER FARM.—N. W. of Fontanet, Fig. 773.

		Ft.	In.	Ft.	In.
1.	Surface	3	0	3	0
2.	Sand	17	0	20	0
3.	Gravel	1	0	21	0
4.	Blue shale	10	0	31	0
5.	Blue shale rock	44	0	75	0
6.	Shale	18	0	93	0
7.	COAL VIa	1	8	94	8
8.	Dark clay	..	10	95	6

At the Parke County Coal Co.'s No. 10 mine, drillings report from 4 to 42 ft. of sandstone over Coal VI (Fig. 10).

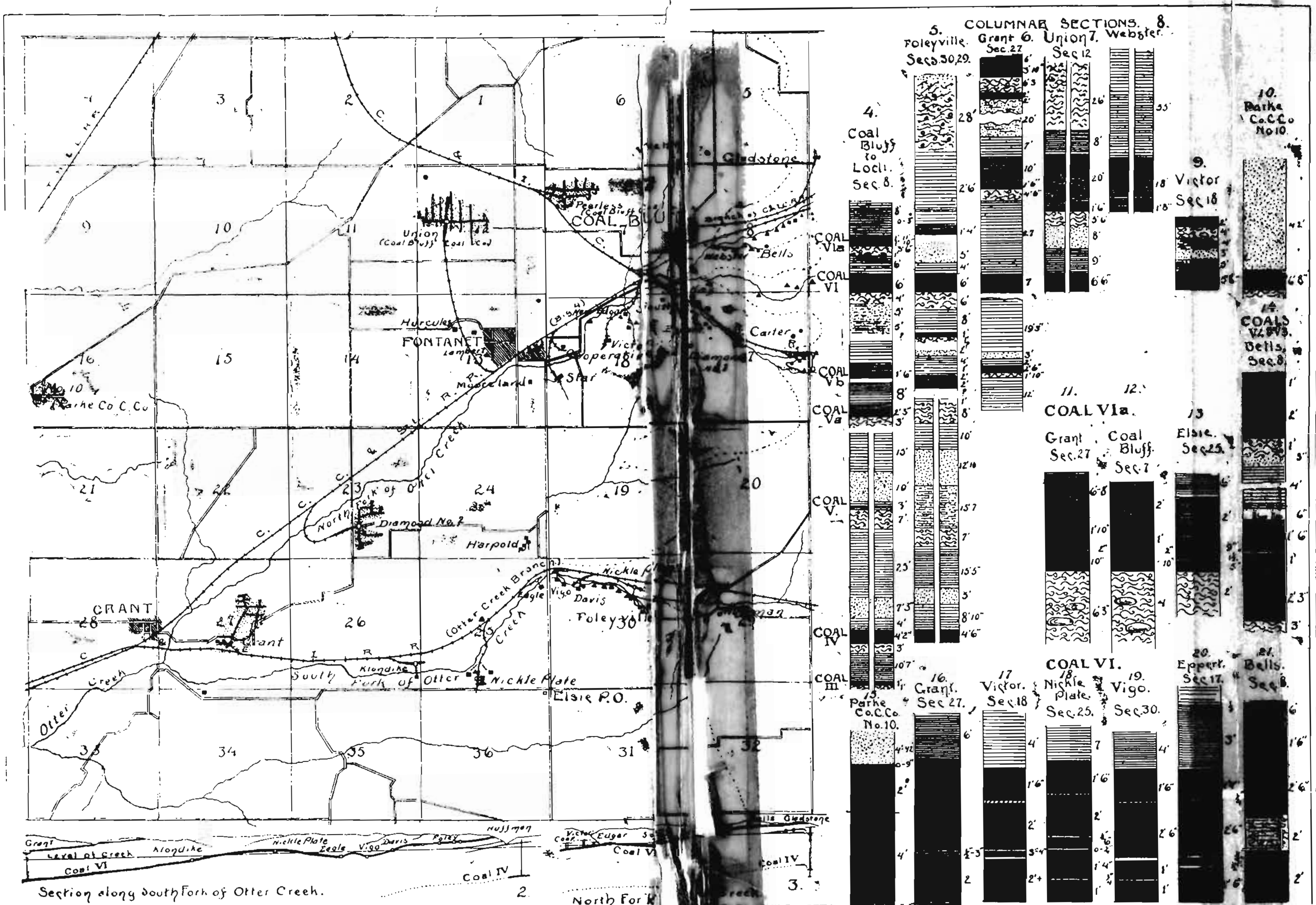
1132. DIVISION VI.—As given above, this division contains two, or, locally, three coals, the lower of which is the principal coal of the county. Aside from the coals, the division is at most points largely

made up of shale. To the west, as is found south of this area, sandstone predominates. Coal VIa, the "rider" of the "big vein," is an easily recognized bed. It is a double bed, having a parting usually a little below the middle. It generally runs from 18 in. to 2 ft. in thickness. At Grant mine there is a bed running from 0 to 1 ft. in thickness, which so closely resembles this bed in details and the character of its under clay that it was at first thought to be the same bed. But as figures obtained later showed that it came about 80 ft. above Coal VI, with another bed between, it was apparent that it belonged at the horizon of Coal VIb, VIc, or VII. It is generally reported an excellent blacksmith coal. The roof, as usual, is a black, sheety shale, usually capped by a small thickness of shaly limestone, which runs into calcareous shale. The fire-clay under is generally calcareous, and often shows large limestone boulders.

1133. COAL VI.—The most constant features of this coal are, a sulphur or pyrite band, usually about 18 in. from the top, and a clay and shale band, often double, near or below the middle. Where single, this dirt band runs from 0 to 3 or 4 ft. in thickness, and, when thicker, there is usually a parting of coal in the center of it, the appearance often becoming that of two bands 2 to 4 in. apart. At Parke County Coal Co.'s No. 10 mine, the parting is reported to be absent, while at Bell's mine, on the eastern edge, it is reported to increase up to 2 ft. in an old east entry. Sometimes still another band is found about 1 ft. from the bottom, the coal often being very sulphury and not worked.

It may be judged from the amount marketed that the quality of the coal is good. Its greatest drawback seems to be in its softness, which makes the proportion of small coal large, and prevents its being much handled. Thus it is not an uncommon thing for the coal to be shipped half lump and half slack. The coal tends to clinker some, and to form a rather large amount of ash. Analyses by Mr. Cox showed this coal to have the following composition:

	Webster and Brammel.		
	Top.	*Bottom.*	*Moreland.*
Fixed carbon	48.00	47.50	47.50
Volatile combustible matter	46.00	45.50	43.50
Total combustible matter	94.00	93.00	91.00
Ash	3.00	4.00	4.50
Moisture	3.00	3.00	4.50
Total waste	6.00	7.00	9.00



COAL FIELDS AROUND COAL BLUFF, FONTANET AND GRA[NT] ... [VI]GO COUNTY.

PLATE

This shows a low percentage of fixed carbon, and a high percentage of gas. Ash and moisture in small amounts.

The roof is generally a light-colored shale, and though often good, is often very poor. The floor is a rather soft fire-clay, which tends to creep in places badly.

1134. DIVISION V contains two and probably three coals, all very much alike, and none workable. They are each overlain by black, sheety shale, which, in turn, is often capped with a thin limestone or band of calcareous shale containing fossils.

1135. DIVISION IV contains Coal IV, workable on the edge of this territory, but generally reported not workable to the west. See description of this coal at the Gladstone mine, as given under Clay county.

1136. DISTRIBUTION AND LOCAL DETAILS OF COAL IN TOWNSHIP 13-7 (PART IN VIGO COUNTY), SECS. 5 AND 6.—This is high ground and is supposed to be all underlaid by Coal VI except the eastern edge of Sec. 5. The coal, however, is near the surface and liable to have been cut out by the preglacial erosion, or to have too poor a roof. As showing how little good roof Coal VI may have over it, notwithstanding its depth, the following boring is of interest:

SECTION 396A. SECTION OF DRILLING ON DANIEL WEBSTER FARM.—S. W. 40 of Sec. 5, near west side (E. T. C., p. 89).

		Ft.	In.	Ft.	In.
1.	Surface soil and clay	3	0	3	0
2.	Sand	1	0	4	0
3.	Plastic potter's clay	5	0	9	0
4.	Sand	8	0	17	0
5.	Boulder clay	10	0	27	0
6.	Sand	1	6	28	6
7.	Boulder clay	8	6	37	0
8.	Sand	1	0	38	0
9.	Boulder clay	8	0	46	0
10.	Plastic potter's clay	7	0	53	0
11.	Sandy shale	13	8	66	8
12.	COAL VI	7	0	73	8

This boring started on the high tableland, so that the depth of the coal brings it about on a level with the coal at Coal Bluff. East of this, on the same farm, the following well was drilled:

SECTION 396B. SECTION OF WELL ON SAME FARM.—(E. T. C., p. 89.)

		Ft.	In.	Ft.	In.
1.	Surface soil and clay	15	6	15	6
2.	Sand	8	0	23	6
3.	Potter's clay	9	6	33	0
4.	Gray shale	4	0	37	0
5.	Black shale	13	0	50	0
6.	Coal and shale	3	0	53	0
7.	Shale	5	0	58	0
8.	COAL and black shale	4	6	62	6

Not knowing the starting point of this well, it can not be told whether the two coals here correspond to the coals outcropping near Lodi or not.

1137. In Sec. 7 the coal is deeper, being 101 ft. deep at the Peerless mine. Here the coal averages 7 ft. thick. A section would show (Sect. 397):

		Ft.	In.
1.	Sandstone	..	..
2.	Black shale over gray shale	4	6
3.	COAL VI- Sulphur band, 0 to 1 in.; coal, best coal, 1 ft. 6 in.; sulphur band, 1 in.; coal, 2 ft. 6 in.; "dirt band," 1 in. to 4 in.; coal, 6 in.; "dirt band," ½ in.; coal, 2 ft. 0 in.; trace of bone and sulphur, ...; coal, sulphury and poor, 6 in.	7	6½
4.	Fire-clay 2 ft. to	4	0
5.	Sandstone	..	..

The coal is good but soft, the top bench being the best and the bottom the poorest. The roof is gray shale, overlain by black, and except 4 in., which comes down, is good. The fire-clay tends to creep badly. An interesting fault met in this mine is figured in Fig. 10 of Plate II, from a description by the mine superintendent.

1138. SECTION 8.—Coal VI is cut out in this section along Otter creek and the branch from the south, nearly to Coal Bluff. The section at Bell's was given above. The coal here averages 6 ft., running up to 7 ft. In the S. W. 40 of this section coal has been stripped extensively. Farther up the coal was formerly dug on the Webster & Brammel place, north of the creek, and on the old Daniel Webster place, by the Litchfield Coal Company, south of the creek. At the ford to Mr. Bell's house the coal is at creek level, but in 200 yds. to the east it has risen until 20-30 ft. above the creek. In the east entry at the Bell mine the coal is said to have split at the "dirt band" until the two parts were 2 ft. apart, and at a well a short distance east the two parts were reported to be 10 or 12 ft. apart. It seems probable that the two beds struck were Coals Vb and Va. At Bell's, in the creek below the opening, on Coal VI, Coal Vb is brought up to the surface of the creek. At the rock dam on this place is exposed an interesting lenticular mass of sandstone lying unconformably in the shales over Coal Vb, also a fault or break in the coal. The section here is the top of Sect. 386, ¶1120. Farther up, the rest of that section is exposed and at the same point is the fault figured in Fig. 12 of Plate II. The two coals keep just above the creek to Lodi.

Coals Vb and Va crop out at a number of places along the ravine in the southern part of this section. They have been stripped some and appeared to be about 12 ft. apart, overlain by black sheety shale and some limestone.

1139. SECTION 17.—Coal VI underlies nearly all of this section. It has been worked some at the center of the east line of the section on the Carter place. The coal here is just at creek level, and about 10 ft. below the level of the C. & E. I. R. R. The whole thickness of the coal could not be seen, but it measured 3 ft. 9 in. to the clay parting, with appearances of another clay parting 6 or 8 in. lower. The coal appeared to be at least 7 ft. thick. The sulphur band is 16 in. from the top. Where seen, the roof was only boulder clay. It is said that while the coal shows a thickness of 7 ft. all around the edge of this hill, it was found to run out in a few yards when the hill was entered. It would seem probable that the coal in the hill had been cut out by preglacial erosion. A couple of drillings near the Carter house are reported to have shown as follows (Sects. 398, 399):

	Ft.	In.
Surface	10	0
Sand	3	0
Boulder clay	15	0
Soft shale	2	9
COAL VI	6	3

	Ft.	In.
Surface	11	0
Boulder clay	8	0
Clay	5	0
Clay shale	1	9
Shale	1	0
COAL VI	5	7

Following down the railroad to the N. W. ¼ of the section, the coal is found well exposed. It has been stripped and drifted upon at a large number of points. In the S. E. of N. W. of this section the coal rises some feet above the creek. The two bands at the center show very distinctly here. The following measurements may be taken as typical of the coal in the N. W. ¼ (Sects. 400, 401, Fig. 20):

	Ft.	In.	Ft.	In.
Soil	..	..	2	0
Boulder clay	..	..	12	0
Fake, sandy	15	0	6	0
Top COAL	1	5	1	4
Sulphur band	..	½	..	¼
COAL	2	3	2	6
Clay band ½ in. to	..	1	..	½
COAL	..	5½	..	3½
Clay and sulphur band	..	¼	..	½
COAL	1	2	1	6
Fire-clay	4	0	..	..

At a drift on the Eppert place the roof is a clay shale, which comes down for 2 ft. To prevent this, 6 in. of the top of the coal is left. Here also a streak of bone coal occurs over Coal VI in a position corresponding with a similar coal at Stanton and Turner, in Clay county. A section here showed over the coal (Sect. 402):

	Ft.	In.
Surface	2	0
Sandstone, cross-bedded	1	6
Drab clay shale	1	6
Shaly sandstone 0 to	..	6
Sandy fake	2	0
COAL ½ in. to	..	2
Blue clay shale	3	0
COAL VI	5	4

1140. SECTION 18.—Coal VI through this section is not far below the level of Otter creek, and north of the center of the section an anticline brings it above the creek level to outcrop. Sections obtained along the creek have already been given. The following mines have operated in this section, none of them being in work when visited, and most of them being worked out:

South mine.
Co-operative mine.
New Edgar mine.
Star mine.
Victor mine.

At these mines the coal is reached at depths varying from 15 ft. at the Victor to 45 ft. at the Star mine. The coal runs about as given above.

1141. SECTIONS 19, 20, 29-32.—Probably over half of this area is overlain by Coal VI, but it is near the surface and is liable to be cut out, to run to a crop-out, or not to have a workable roof. It is, or has been, worked quite extensively in the north half of Sec. 30, at the Vigo and Davis slopes, and the old Nickel Plate mine. The section at the former two has been given, Figs. 750, 719. From Foleyville nearly to the township line the coal is 10 to 15 ft. above the creek level. It then dips rapidly to the west, and at the Davis slope is just about at creek level. At the Vigo mine, just west, it is some distance below the creek. Just west of the road it rises to within 5 or 6 ft. of creek level; then at the Eagle slope it is said to be 13 to 18 ft. below the creek, but rises and outcrops in the creek a little farther west. See Fig. 2. At the Davis mine the coal runs about $^5/_9$ lump. The coal as given in the section runs from 5 ft. to 6 ft. 6 in. The coal here is said to be cut off a quarter of a mile south of this slope by preglacial erosion, the coal rising rapidly to the south. Along Otter creek, west of Foleyville, on the Jas. Foley place, in addition to the drifts the coal was stripped with a steam shovel. This allowed the taking out of a block the full thickness of the coal for exhibition at the World's Fair in 1893. The block is reported to have weighed 7,400 lbs. The coal runs from 5 ft. 6 in. to 7 ft.

North and east of Foleyville, Coal Vb and Va are exposed and the lower has been stripped at two or three places. The section of the strata accompanying these coals was given above. On the John C. Huffman place a drilling has been put down to Coal IV, showing that coal to have a thickness there of 4 ft. 6 in. The section was given above.

It is reported that drillings near the Davis mine found two beds of semi-block coal, the first 100 ft. and the second 140 ft. below Coal VI. They were said to run 3 ft. 6 in. to 3 ft. 10 in.

1142. DISTRIBUTION AND LOCAL DETAILS IN TOWNSHIP 13-8, SECS. 1 TO 11.—These sections may all be considered as underlain by the horizon of Coal VI, the coal being of good workable thickness except where removed by the preglacial erosion. The coal will probably average over 100 ft. deep over this area, so that it would not seem probable that it was more than cut out in the channels of streams. It is not improbable, however, that it will be found removed over

much of the flat strip of country through which the T. H. & L. R. R. runs, as that was formerly a broad valley.

1143. SECTION 12.—Two columnar sections have been given from this section. To show the irregularity of the old preglacial surface and how liable Coal VI is to have its roof reduced to an unworkable thickness, or even the coal bed carried away, the following additional sections are given. In the first of these Coal VI has been removed and the first coal struck is Coal Vb or Va:

1144. SECTION 403. SECTION OF BORE NO. 1, COAL BLUFF MINING CO.—N. W., N. W., Sec. 12.

	Ft.	In.	Ft.	In.
1. Surface	10	0	10	0
2. Sand or gravel	77	0	87	0
3. Boulder clay	22	0	109	0
4. Fire-clay	3	0	112	0
5. Black shale	6	6	118	6
6. COAL Vb or Va	2	6	121	0
7. Very dark fire-clay	2	0	123	0

1145. SECTION 404. SECTION OF BORE NO. 4.—Northwest of Fontanet.

	Ft.	In.	Ft.	In.
1. Surface and sand	30	0	30	0
2. Boulder clay	60	6	90	6
3. Sandy shale	5	0	95	6
4. Gray shale	4	6	100	0
5. COAL VI	7	0	107	0
6. Fire-clay		6	107	6

1146. SECTION 405. SECTION OF BORE NO. 9.—Same.

	Ft.	In.	Ft.	In.
1. Surface sand	27	0	27	0
2. Boulder clay	36	0	63	0
3. Shale and Coal VIa	2	6	65	6
4. Fire-clay	5	6	71	0
5. Gray sandstone	5	0	76	0
6. Hard rock	3	0	79	0
7. Gray shale	5	6	84	6
8. COAL VI	7	0	91	6

The average of these and a number of other sections shows the coal to run about 7 ft. thick here, ranging from 6 ft. 6 in. to 7 ft. 6 in. At the Union mine of the Coal Bluff Coal Company, Coal VI is 100 ft. deep; see section above. The coal runs about 7 ft. thick, as in the Peerless mine. The roof is shale in places, in others sandstone or boulder clay. Mr. Scovell described above an interesting feature about this mine in finding great boulders of boulder clay lying in gravel which at one point made the roof of this mine. Near the bottom of the shaft the roof was very poor, but good roof is found at the present workings (1897). A fault was found crossing the mine southeast of the shaft; 175 yds. east of the shaft the downthrow was 9 ft.; 125 yds. south of the shaft the downthrow was 2 ft. Nearly all the coal is saved in this mine.

1147. SECTION 13.—The following sections in this section may be given as showing the thickness of Coal VI, the stratification and the position of Coal VIa:

1148. SECTION 406. SECTION ON MORELAND'S FARM.—¼ mi. from Fontanet. (E. T. C., p. 90.)

	Ft.	In.	Ft.	In.
1. Sand and clay	22	0	22	0
2. COAL VIa	1	4	23	4
3. Fire-clay	3	0	26	4
4. Sandstone and sandy shale	4	0	30	4
5. Gray shale	8	0	38	4
6. COAL VI	5	10	44	2

1149. SECTION 407. SECTION ON JOSIAH LAMBERT'S FARM.—Near center of Sec. 13. (E. T. C., p. 91.)

	Ft.	In.	Ft.	In.
1. Yellow sand	5	0	5	0
2. Boulder clay	8	0	13	0
3. Quicksand	24	0	37	0
4. Shale	1	0	38	0
5. COAL VIa	1	6	39	6
6. Fire-clay	3	0	42	6
7. Black shale	3	0	45	6
8. Gray shale	7	0	52	6
9. Clay shale	3	0	55	6
10. COAL VI	7	0	62	6

A large amount of the coal in this section has been removed through the old Hercules shaft just west of Fontanet, now abandoned.

1150. SECTIONS 14-22.—The only mine in these sections is the Parke County Coal Company's No. 10 mine. The coal is here about 100 ft. deep and 6 ft. 6 in. thick. The dirt band is said not to have been found here, though a knife-edge parting occurs 2 ft. from the top (Fig. 15). The upper 2-ft. bench is rather poor coal, the lower 4-ft. bench is good coal. Still below is 6 to 8 in. of poor bottom coal containing sulphur. The roof is generally sandstone and good; in places a few inches of shale comes between the sandstone and coal. The floor is fire-clay, but is said to give no trouble creeping.

Secs. 14, 15, 20, 21 and 22 would appear to be entirely underlain by Coal VI, except in the channels of small preglacial streams, but Secs. 17, 18 and 19 are in the course of the old channel of Raccoon creek and are liable to have had the coal removed.

1151. SECTION 23.—The coal has been found in this section at the Diamond No. 2 mine. Coal VI is here 65 ft. deep and has the usual characteristics of this bed farther east.

1152. SECTION 24.—The coal is well exposed here in the S. E. 40, on the Harpold place, where it has been worked by stripping and by drifts. The depth of stripping here was about as great as was observed anywhere in this State, the face of the stripping showing about 20 ft. of surface and shale. A section here showed:

1153. SECTION 408. SECTION AT HARPOLD STRIPPING.—S. E. 40, Sec. 24.

	Ft.	In.
1. Sandstone	..	..
2. Drab shale, some shaly	8	0
3. Black shale	..	2
4. COAL VI—Coal, top, 1 ft. 6 in.; band, 0 to 2 in.; coal, 2 ft. 6 in.; band, 0 to 2 in.; coal, 1 ft. 6 in.	5	10

1154. SECTION 25.—At the old Eagle slope the coal is reported to be 13 to 18 ft. below the level of Otter creek. The coal is the same as at the Vigo and Davis slopes just east, previously described. A short distance west the coal is said to rise and outcrop in the creek. At Ehrmandale the coal was formerly stripped. It is now mined extensively at the Nickel Plate mine. A section here of the coal and roof showed:

	Ft.	In.
1. Sandstone, yellow or brown, coarse-grained, cross-bedded	10	0
2. Shale, gray, resembling fake in places	0 to 7	0
3. COAL VI—Coal, sulphury, 1 ft. 6 in.; sulphur band; coal, best, 2 ft. 0 in.; clay band, ½ in.; coal, 6 in.; dirt band, ¼ to 0 in.; coal, 1 ft. 4 in.; band, ¼ in.; coal, best, 1 ft. 0 in.	6	4¾
4. Fire-clay	1	0+

The best coal is the 18 in. forming the bottom of the second bench, and the 1 ft. of bottom coal. The top bench contains the most sulphur. The coal is soft, about half of it going through the screens. It slacks readily, clinkers some and yields considerable ash, as does most of this coal in this area. The roof is shale on the east side of the ravine; about 4 in. is regularly taken down and the rest held if possible. If it starts to cut it will come down in flakes or masses, according to condition until the sandstone is reached. To the west the shale has been removed and much of the top bench of the coal, the sandstone making the roof, and the coal being reduced to a thickness of about 5 ft. No trouble has been had with the creeping of the floor.

Near the center of Sec. 25 Coal VIa is exposed about 8 ft. above the grade of the railroad. The section here is (Sect. 409):

		Ft.	*In.*
1.	Black sheety shale	1	0+
2.	COAL VIa or b	1	0
3.	Fire-clay	2	6
4.	Shaly sandstone	5	0
5.	Massive sandstone	3	0

1155. SECTIONS 26-36.—Coal VI appears to be below drainage in all of these sections. Coal VII is found over a small area east of Grant and probably over a small area in Secs. 31 to 33, as indicated on the large map. The coal east of Grant, correlated as Coal VII, varies greatly from that bed as developed to the south, but corresponds with it as developed west of Terre Haute and around Clinton. It is here overlain by a black sheety shale, with 6 ft. of blue shale above that. It has been mined some and found to range from 4 ft. to nothing in thickness, its occurrence being in pockets. In quality it ranged from fair to worthless. The 2 ft.? coal occurring below it probably represents the Coal VIb of Parke and Vermillion counties, the thickening of the strata between Coals VI and VII to the north explaining its distance below Coal VII there.

At the Klondike slope Coal VI is only 8 or 10 ft. below the bottoms of Otter creek.

Coal VI has been extensively worked at the Grant mine. The section here was given above. The coal averages 6 ft. 6 in. thick, with a $\frac{1}{2}$ to $1\frac{1}{4}$ in. sulphur band on top; a 0 to 1 in. sulphur band 15 to 18 in. from the top, and a $\frac{1}{2}$ to $3\frac{1}{2}$ in. band of bone coal 2 ft. from the bottom. The top coal is reported the best. For a roof there is 6 ft. of black shale, then gray shale; these serve well, there being no draw slate. Under the coal is from 0 to 2 ft. of fire-clay, then from 2 in. to 2 ft. of bone coal and shale. Where these were 22 in. thick the bone coal made up 14 in. of the space. The fire-clay tends to creep here,

and this tendency is met by driving 21-ft. rooms with two 9-ft. pillars and one 15-ft. pillar in rotation. The two thin pillars are then drawn, allowing the roof to settle, and so relieving the pressure. See Part

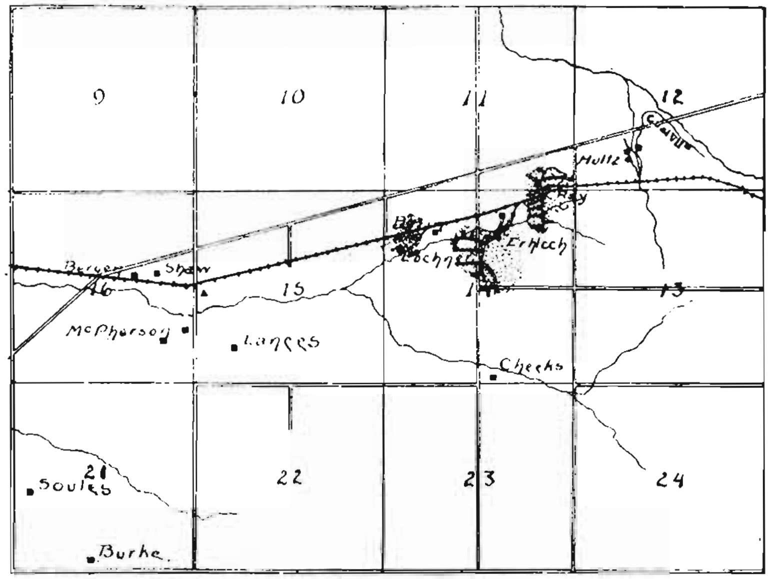


Fig. 486. Sketch map of part of T. 12 N., R. 8 W.

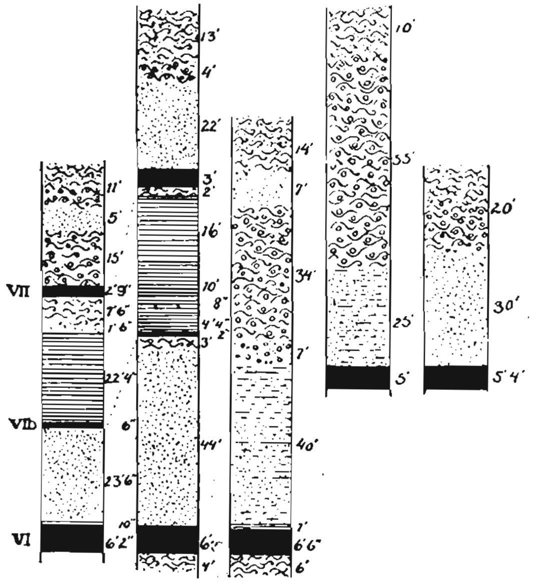
IV. The coal rises to the northeast. The coal is here about 75 ft. below Otter creek, and to the west may be expected to be found at increasingly greater depths, the dip being not far from 20 ft. to the mile on an average.

TOWNSHIP 12 NORTH, RANGE 8 WEST.

1156. GEOGRAPHIC.—This township corresponds to Lost Creek of the civic townships. It lies east of Terre Haute.

1157. TOPOGRAPHY.—Lost creek is a small stream that drains the central portion of Lost Creek township, flowing through Harrison township into the river. The valley is shallow and the banks are seldom abrupt. Some of the smaller branches of the Otter creeks are evidently young streams, but the main creeks seem to flow in old channels. The valley of Lost creek seems to be of recent origin. The extreme northeastern portion of Lost Creek township is drained by a branch of Otter creek, and a few sections in the southeast are drained by branches of Honey creek, while a portion of the southwest is drained by Church's run. Secs. 1, 2, 11, 12, 34 and 35 contain about all the broken land of this township. Some sections, as 22, 23, 27 and 28, are nearly level, seeming to have about the same surface that was left by the glacier, as the drainage channels have not penetrated them to any extent.

1158. TRANSPORTATION.—The Vandalia railroad crosses the township from east to west.



487 Seelyville. Sec. 14. — 488 Lochner. Sec. 14. — 489 Ray. Sec. 11. — 490 Burke. Sec. 21. — 491 McPherson. Sec. 16.

Figs. 487-491. Columnar sections in T. 12 N., R. 8 W.

1159. STRATIGRAPHY.—The following sections will serve to exhibit the stratigraphy of this township:

1160. SECTION 410. SECTION OF SEELYVILLE SHAFT AND BORE. —Sec. 14, Fig. 487; see, also, Fig. 452. (E. T. C., p. 83.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Drift	11	0	..	..	11	0
2. Quicksand	5	0	..	..	16	0
3. Boulder clay	15	0	..	..	31	0
4. COAL VII	2	9	2	9	33	9
5. Fire-clay	7	6	..	..	41	3

	Ft.	In.	Ft.	In.	Ft.	In.
6. Sandstone	1	6	..	..	42	9
7. Clay shale	12	9	..	..	55	6
8. Fossil ore	0	6	..	..	56	0
9. Clay shale	7	7	..	..	63	7
10. Shale	1	6	31	4	65	1
11. COAL VIb	0	6	0	6	65	7
12. Fire-clay	5	8	..	..	71	3
13. White sandstone	4	0	..	..	75	3
14. Dark sandstone	5	0	..	..	80	3
15. White sandstone	14	6	..	..	94	9
16. Clay shale	0	10	30	0	95	7
17. COAL VI	6	2	6	2	101	9
18. Fire-clay	4	0	..	..	105	9
In Bore—						
19. Sandstone	4	6	..	..	110	3
20. Black shale	1	6	..	..	111	9
21. Bastard limestone	2	6	..	..	114	3
22. Black shale	1	8	14	2	115	11
23. COAL	1	10	1	10	117	9
24. Fire-clay	5	0	..	..	122	9
25. Clay shale	9	6	14	6	132	3
26. COAL	0	6	0	6	132	9
27. Sandstone	4	0	..	..	136	9
28. Fire-clay	7	0	11	0	143	9
29. COAL, top bench	1	1	..	..	144	10
30. Shale	0	5	..	..	145	3
31. COAL, bottom bench	1	9	3	3	147	0
32. Fire-clay	10	6	..	..	157	6
33. Black shale	2	0	12	6	159	6
34. COAL V?	1	5	1	5	160	11
35. Fire-clay	3	9	..	..	164	8
36. Clay shale	4	6	..	..	169	2
37. Fire-clay	5	0	..	..	174	2
38. Clay shale	2	9	..	..	176	11
39. Sandstone	3	1	..	..	180	0
40. Clay shale	5	6	..	..	185	6
41. Black shale	0	7	25	2	186	1
42. COAL IVb?	0	5	0	5	186	6
43. Clay shale	1	6	..	..	188	0
44. Sandstone	5	4	..	..	194	4
45. Clay shale	7	0	..	..	201	4
46. Sandstone	1	0	..	..	202	4
47. Clay shale	1	0	..	..	203	4
48. Sandstone	6	2	..	..	209	6
49. Shale	2	6	25	6	212	0
50. COAL IV?	1	2	1	2	213	2
51. Sandstone	7	6	..	..	220	8
52. Fire-clay	1	3	..	..	221	11
53. Gray shale	5	0	..	..	226	11

Some doubt must remain as to which coals in this section correspond with Coals V, IV and III. A study of the coals and spaces to the east and in the river well at Terre Haute suggests that No. 34 of the section is Coal V, and No. 50 is Coal IV, Coal III not being reached. The two coals 14 ft. apart found just below Coal VI would then correspond to Coals Vb and Va of the preceding township and Parke county, but the double coal, Nos. 29 to 31, has not been met with elsewhere. From the stratigraphy it is thought that the lowest coal corresponds to Coal IV, and the next coal above to Coal IVb, rather than that the two correspond to Coals IV and III.

1161. SECTION 411. SECTION OF HECTOR SHAFT.—(Lochner Coal Company), Sec. 14, Fig. 488. (J. T. S., p. 540.)

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1.	Soil and sub-soil clays	13	0	..	..	13	0
2.	Hardpan, boulder clay	4	0	..	..	17	0
3.	Sandstone, with black seams and fossils	22	0	..	..	39	0
4.	COAL VII	3	0	3	0	42	0
5.	Fire-clay	2	0	..	..	44	0
6.	Shale, light colored	16	0	..	..	60	0
7.	Shale, bituminous slaty	10	0	..	..	70	0
8.	Limestone, brown, some fossils	0	8	..	..	70	8
9.	Shale, black, some fossils	4	4	33	0	75	0
10.	COAL VI	0	2	0	2	75	2
11.	Fire-clay	3	0	..	..	78	2
12.	Sand rock, white silicious	44	0	47	0	122	2
13.	COAL VI—Coal, 2 ft. 0 in.; knife-edged parting; coal, 2 ft. 0 in.; dirt band, 2 in.; coal, 3 ft. 0 in.	7	2	7	2	129	4
14.	Fire-clay and sandstone	5	0	..	..	134	4

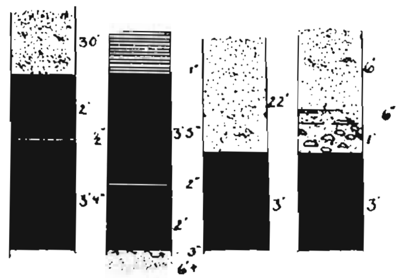
1162. SECTION 412. SECTION AT RAY MINE.—N. E. $\frac{1}{4}$, Sec. 14, Fig. 489.

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1.	Surface	14	0	..	..	14	0
2.	Gray sand	7	0	..	..	21	0
3.	Boulder clay	34	0	..	..	55	0
4.	Gravel	7	0	..	..	62	0
5.	Shaly sandstone	41	0	..	..	103	0
6.	Shale ......1 to	2	0	..	..	105	0
7.	COAL VI	6	10	6	10	111	10
8.	Fire-clay	1	6	..	..	113	4

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
9.	Iron ore	1	2	..	..	114	6½
10.	Fire-clay	..	8	..	..	114	2
11.	Black shale	1	6	4	10	115	8
12.	COAL Vb	2	0	2	0	117	8
13.	Fire-clay	1	6	..	..	119	2

1163. SECTION 413. SECTION AT BURKE BROS.' SHAFT.—S. E. of S. W. of Sec. 21, Fig. 490. (J. T. S., p. 533.)

		Ft.
1.	Surface soil, white and yellow clay	10
2.	Boulder clay	55
3.	Shaly sandstone	25
4.	COAL VII?	5
		95



492 McPherson. Sec. 16. 493 Soule. Sec. 21. 494 Lochner. Sec. 14. 495 Hultz. Sec. 12.

Figs. 492-495. Coal VII in T. 12 N., R. 8 W.

1164. SECTION 414. SECTION AT MCPHERSON'S MINE.—Sec. 16, Fig. 491. (E. T. C., p. 109.)

		Ft.	*In.*
1.	Soil and drift	20	0
2.	Sandstone	30	0
3.	Black shale	..	..
4.	COAL VII(?)—Coal, 2 ft. 0 in.; shale, ½ in.; semi-block coal, 3 ft. 4 in.	5	4½
5.	Clay	..	..
		55	4½

These sections show a preponderance of sandstone, heavy beds appearing over both Coals VII and VI, the sandstone over Coal VI reaching a thickness of over 40 ft. around Seelyville.

1165. Division VII and Coal VII.—As far as found, this division in this area consists of one coal, workable, and a massive stratum of sandstone having a thickness of at least 20-30 ft. The coal in this township ranges from 3 ft. to over 5 ft.? 6 in., provided our correlations are correct. When thin it appears to be a solid bed, as in Figs. 494 and 495. When thick it shows a shale parting near the center. An analysis of this coal from the McPherson mine gave Mr. Cox as follows:

Fixed carbon	56.50	
Volatile combustible matter	37.00	
Total combustible matter		93.50
Ash	4.00	
Moisture	2.50	
Total waste		6.50

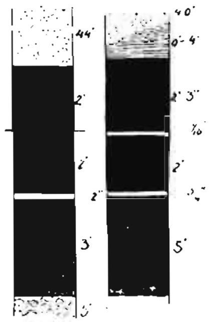
It is a caking coal, slacks readily, does not clinker much. The roof is shale or sandstone, the shale when found usually being quite thin. As a rule the roof is good.

As suggested, there has been some question as to whether the coal at McPherson's, Soule's, and Burke Bros.' mines was not Coal VI instead of Coal VII, as has been generally assumed. The coal of these mines is nearly as thick as Coal VI at Seelyville, and has only one thin dirt band, as has Coal VI at the Lochner shaft. The shale and sandstone roof is very similar, even to a thin band of shale on top of the coal, which quickly weathers to clay when reached by the air. Further, at the Soule mine air shaft, pieces of limestone were picked up which had doubtless come from above the coal. Were these from stratum No. 8 of the Lochner shaft section, or from a limestone bed which overlies the sandstone over Coal VII around West Terre Haute? Again, the dip at the Soule mine is to the southeast rather than to the southwest. However, lacking the exact elevation of the coals at the several points, and having no borings from intermediate points, the writer is constrained to accept the verdict of those who have given the subject more time, and to consider all of these coals Coal VII. The resemblance, if it is not more, is of some interest.

1166. Division VI and Coal VI.—This division shows two of the three coals found to the north, Coals VI and VIb, but Coal VIb appears much thinner than at points to the north or south. Coal VIa appears to have run out here and to the south. As usual, Coal VIb is overlain by black sheety shale and that in turn by limestone, while

between the limestone and Coal VII only shale is reported. Coal VIa of Coal Bluff, Stanton and Coxville appears to have been removed and replaced by sandstone, or never to have been deposited at all.

Between Coal VIb and Coal VI is principally massive sandstone. Coal VI runs about 7 ft. thick where worked about Seelyville. It



496 Lochner. Sec. 14. 497 Ray. Sec. 11.

Figs. 496-497. Coal VI in T. 12 N., R. 8 W.

occurs here in three benches of nearly equal thickness, the upper two benches, however, only being separated by a very thin parting or by nothing more than a smooth parting.

The following analysis of this coal from the Ray mine by Mr. Noyes will show its composition:

Fixed carbon	44.21	
Volatile combustible matter	40.25	
Total combustible matter		84.46
Ash	7.97	
Moisture	7.57	
Sulphur	4.01	
Total waste		19.55

As showing the comparative results obtained by Mr. Noyes and Mr. Cox, the following analysis is of interest. It is of the coal from the old Seelyville shaft which adjoined the Ray mine on the southwest:

Fixed carbon	48.00		50.00	
Volatile combustible matter	45.00		43.50	
Total combustible matter		93.00		93.50
Ash	3.50		3.50	
Moisture	3.50		3.00	
Total waste		7.00		6.50

The general reputation of this coal of being a strong steam coal, but containing considerable impurity, confirms the correctness of the analysis just given.

The roof is a shale overlain by sandstone, or the sandstone comes down, making the roof. When it is shale it is liable to come down to the sandstone and thus be very poor; otherwise the roof is good. The floor is fire-clay. No trouble with creeping was reported.

1167. DIVISIONS I TO V.—As far as may be judged from the Seelyville drilling, these divisions, while containing considerable coal, do not carry any workable coal and so need not engage our attention. The horizon of Coal I probably lies between 200 and 250 ft. below Coal VI.

1168. DISTRIBUTION AND LOCAL DETAILS.—It will be convenient first to consider the coal in the area of the sketch map, Secs. 9-16 and 21-24, then Secs. 1-8, 17-20, 27-34, then Secs. 25, 26, 35 and 36.

1169. SECTIONS 9 AND 10.—No coal is known to have been mined in these sections. Coal VII and VI should both be workable under them, Coal VII at depths of from 40 to 80 ft. and Coal VI at depths of from 100 to 150 ft.

1170. SECTION 11.—The section at the Ray mine was given above, ¶1162, Sect. 412; Fig. 489. The coal is 100 ft.? deep and ranges from 5 to 7 ft. in thickness, with an average of 6 ft.

The coal shows: Top coal, 2 ft. 3 in.; parting, 1-16 in.; middle bench, best coal, 2 ft.; parting, ¾ in.; coal, 3 ft. See Fig. 497. Over the coal is usually 2 to 3 in. of soft shale weathering to clay. The roof is generally shale from 0 to 4 ft. 6 in. thick, with an average of 2 ft. About 6 in. usually comes down, and unless propped within a day or two all tends to come down. On the north side of the mine the roof is sandstone, with only a few inches of draw slate between it and the coal. In a few places "white top" or white clay makes the roof. The shale usually carries a great many stems and plant fragments. A number of faults were noticed in this mine. One of 5 ft. 6 in. downthrow is figured in Fig. 498. A small fault, having in one entry a downthrow of 2 ft. 3 in., where passed in another entry, showed as a sandstone vein, no downthrow being discernible. See Fig. 7 of Plate III.

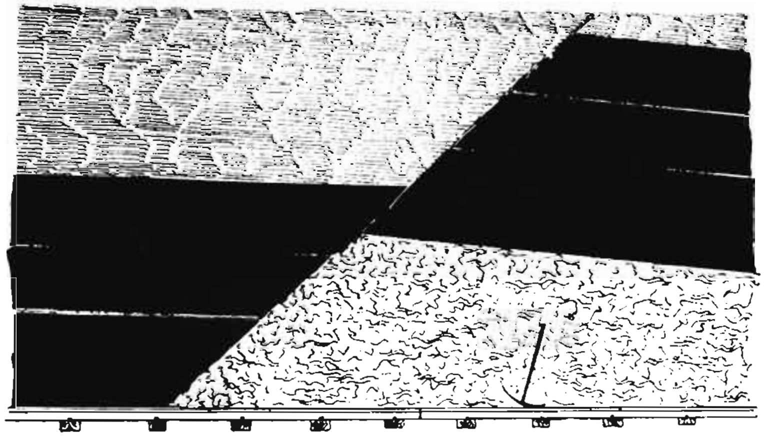


Fig. 498. Five and one-half ft. fault in the Ray mine.

1171. SECTION 12.—Coal VII has been mined a little in the S. W. ¼ of Sec. 12, on the Hultz place. The section here shows (Sect. 415):

		Ft.	*In.*
1.	Coarse-grained, gray to red sandstone, with plant remains	6	0
2.	Sandstone and shale	..	6
3.	Iron nodules in matrix of yellow sandstone, 6 in. to	1	0
4.	COAL VII ..2 ft. 6 in. to	3	2
5.	Hidden, shale (?)	5	0
6.	Ferruginous, fossiliferous limestone	?	?
7.	Shale	2	0
8.	Black sheety shale	?	?
	Place of Coal VIb.		
9.	Dark fire-clay	?	?

The peculiar "conglomerate" overlying Coal VII has been noticed at a number of places. No partings could be detected in the coal, which is a bright black, rich-looking coal (Fig. 495). Coal VII has also been worked a little in the N. W. of S. E. of Sec. 12.

Coal VI may be looked for some 40 ft. below the level of the stream which crosses the center of the section.

1172. SECTION 13.—The conditions here are much the same as in Sec. 12, except that as the divide runs through this section instead of a stream, the coal should be looked for a little deeper than in the former section.

1173. SECTION 14.—Coal VII was formerly reached in this section by a shaft on the Perrin place, exact location not known. This shaft was 43 ft. deep, and the coal is reported to be 5 or 6 ft. thick. Coal VI was formerly worked from the old Seelyville shaft. The section of the shaft and of a boring made from the bottom of it was given above, ¶1160, Sect. 410, Figs. 487 and 452, and an analysis of the coal was given in ¶1166. At present Coal VI is being worked at the Seelyville mine, owned by Julius Ehrlich, and the Hector mine, of the Lochner Coal Company. The former is only worked a little. A section of the shaft of the latter was given above. The coal here runs from 5 to 7 ft. in thickness, with an average of 6 ft. or over (Fig. 496). The roof here is good; the entries, 12 ft. wide, require no timbering. The sandstone making the roof is nearly white, a coarse-grained sandstone, weathering into nearly white sand. No faults or other irregularities have yet been met in this mine.

In the S. W. of the S. E. of Sec. 14, Coal VII has been stripped and drifted upon on the Samuel Cheek place. It is reported as 2 ft. 6 in. thick and to have no roof but gravel and boulder clay.

1174. SECTION 15.—Coal VII has been exposed at a few places in this section. There was formerly reported to have been a gin shaft on the McPherson place, near the center of the west line of the section. In the N. E. of the S. W. of the section, 20 in. of coal is reported on the Lances place.

1175. SECTION 16.—Coal VII has been worked here by shafts and drifts on the McPherson, J. S. Bergen and Shaw places. The section at the first of these places was given above, also an analysis of the coal. The coal crops out here so it can be mined by drifting. The coal is 15 ft. below the railroad level and 29 ft. below the level of the same coal at Seelyville. As given above, its thickness is over 5 ft., with a ½-in. shale parting above the center (Fig. 492).

1176. SECTION 21.—What is supposed to be Coal VII is mined at two places in this section. At the Burke Bros. shaft, in the S. E. of the N. W. of the section, the coal is 5 ft. thick and 90 ft. deep. The section here was given in ¶1163, Sect. 413, Fig. 490.

At the Soule Bros. shaft it is 76 ft. to the bottom of the coal, which averages 5 ft. 6 in. in thickness. A measurement gave: Top bench, 3 ft. 5 in.; black shale parting, 2 in.; bottom bench, best coal, 2 ft. (Fig. 493). The coal is a caking coal, and, while it slacks readily, does not clinker much. What sulphur is found in it occurs in bands over the shale band. The roof is generally a blue shale, and good, though 6 to 8 in. comes down. It is found to hold better in the rooms than in the entries. Just over the coal is 1 to 2 in. of soft shale, which weathers to clay when reached by the air. In places the sandstone comes down, making the roof. At such points the top coal tends to stick to the roof, and breaks up when mined.

Below the coal is 2 to 3 in. of fire-clay, then 6 ft. of gray, even-grained sandstone.

1177. SECTIONS 22-24.—Making the necessary allowances for differences of surface elevation, Coals VII and VI should be found in these sections at depths corresponding with those found in the sections just north. Coal VII probably thins down to 3 ft. toward the east, but Coal VI may be expected to maintain its thickness of from 5 to 7 ft.

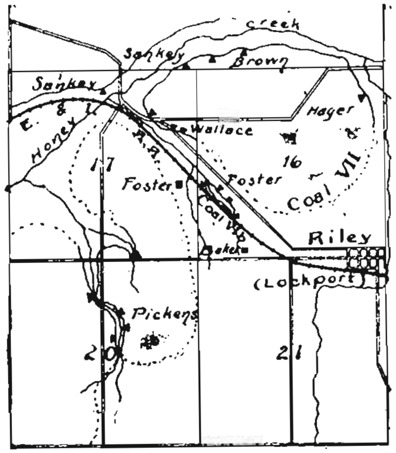
1178. SECTIONS 1-8, 17-20, 27-34.—These sections are supposed to be entirely underlain by Coal VI, except possibly in some preglacial stream channels. Its depth from the level of the tableland will vary from about 70 or 100 ft. to nearly 200 ft.; the dip appears to be about 20 ft. to the mile to the west. Coal VII, on account of its proximity to the level of the preglacial surface, will probably be irregular in its distribution, but in a general way should be found over most of the area except the northeastern corner. It will probably not prove workable over more than a portion of the area.

1179. SECTIONS 25, 26, 35 AND 36.—In the S. E. ¼ of Sec. 26, 8 to 10 ft. of light brown, micaceous sandstone, full of plant remains, are exposed in the face of the quarry on the Greenbury Triplet place. Coal 2 ft. 6 in. thick is reported struck in a drilling at a depth of 22 ft., the sandstone extending down to the coal. This is supposed to be Coal VII. It lies here about 50 ft. below the general level. On the E. Phillips place, near the center of Sec. 36, a well is said to have found 5 ft. 4 in. of coal at a depth of 61 ft., or 75 to 80 ft. below the level. The well is said to have passed through 53 ft. of surface and drift, then through 8 ft. of shale to the coal. Supposed to be Coal VI, though this would seem to place Coal VI only 30 ft. below Coal VII. In the S. W. ¼ of Sec. 35, an 80 ft. well, starting from high ground, is said to have passed through from 18 in. to 2 ft. of coal, depth not known. The information obtained in this corner of the township was not as definite as could have been desired, and leaves some doubt as to the exact position of the coals, but, if properly interpreted, would seem to show that Coal VI lies about 100 ft. or over below the level of the tableland.

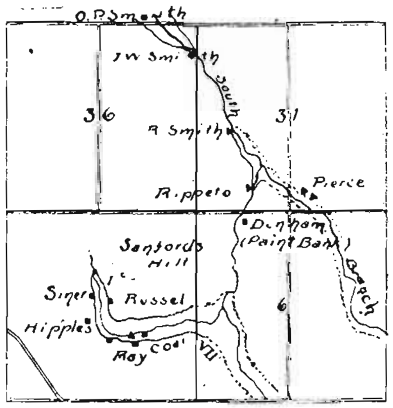
Township 11 North, Range 8 West.

1180. Geography.—The township lies southeast of Terre Haute and corresponds with Riley of the civic townships.

1181. Topography.—Honey creek, rising in Clay county, flows through the northwestern portion of Riley township. It is about the size of Otter creek, but has a much longer course in the county than any other creek. It drains the north and west of Riley township. "In its southwesterly course to Sec. 10, in Riley township, the valley



499



500

Fig. 499. Sketch map of coal field near Riley, T. 11 N., R. 8 W.
Fig. 500. Sketch map of coal field at corner of Ts. 10 and 11 N., Rs. 8 and 9 W.

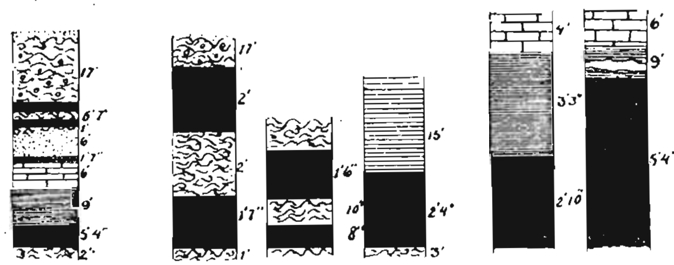
is somewhat symmetrical, but in its westward course the south bank is much more abrupt and extensive as it continues into Sec. 21 of Honey Creek township, while the north bluff stops in Sec. 13 and is not strong there. It has several branches from the east and southeast, but the largest is the south branch, which drains parts of Pierson and Linton townships, being the north side of the highest elevation in the county. The valleys of this branch and its tributaries are deep, but somewhat irregular, perhaps more bluffy on the west, but not much difference. The southeast portion of Riley township lies in the valley of Eel river, and is drained by Splunge creek. The surface of this township along Honey creek is much broken, but the greater portion of the township has a good surface."

1182. Transportation.—The E. & I. R. R. crosses the township from west to east.

1183. Stratigraphy.—No information concerning Coal VI was obtained in this township, as little drilling appears to have been done, and the only outcrops observed were of Coals VII and VIb. The section of the old Somerset mine shows their relations.

1184. Section 416. Section of Somerset or Foster Mine.—N. E. of S. E. of Sec. 17, Fig. 501 (E. T. C., p. 107).

	Ft.	In.	Ft.	In.
1. Soil and clay	17	0	17	0
2. COAL VII—Coal, soft, poor, 2 ft. 0 in.; clay parting, 2 ft. 0 in.; coal, good, 1 ft. 7 in.	5	7	22	7
3. Fire-clay	1	0	23	7
4. White sandstone	6	0	29	7
5. Black bituminous shale	1	7	31	2
6. Impure limestone	6	0	37	2
7. Black, bituminous shale	9	0	46	2
8. COAL VIb	5	4	51	6
9. Fire-clay, hard	2	0	53	6



501 Foster. Sec. 17. 502 Foster. Sec. 17. 503 Pickens. Sec. 26. 504 Rippeto. Sec. 31. 505 Foster. Sec. 16. 506 Foster. Sec. 17.

501. Columnar section at Foster shaft, Sec. 17-11-8.
502-504. Sections of Coal VII.
505-506. Sections of Coal VIb.

This shows the interesting features of Coal VII divided and Coal VIb a workable bed. The sandstone overlying Coal VII becomes less prominent in this region, so that in the southwestern corner of the township, instead of sandstone, Coal VII has 50 ft. of shale over it. This shale is characterized in places by numerous bands of iron ore. The space between Coal VII and the limestone over Coal VIb varies greatly; at one point in Sec. 31 the two are separated only by 4 in. of fire-clay. Coal VI was about 50 ft. below the limestone No. 6 of above section at Seelyville, and in Sullivan county to the south is from 20 to 30 ft. below, so that it would seem reasonable to look for the horizon of Coal VI at from 35 to 45 ft. below the limestone mentioned.

1185. Coals VII and VIb.—Coal VII was not seen of a workable thickness in this township, though it probably does acquire such a thickness locally. Coal VIb is the coal that has been worked and is reported of thicknesses up to 7 ft. At the only point seen it measured 2 ft. 10 in. It appears to be without partings and is characterized by the roof of black shale and the overlying limestone.

At the Somerset mine the top 4 in. of the coal was soft and sulphury. The lower part, on analysis, gave Mr. Cox the following result:

Fixed carbon	51.00	
Volatile combustible matter	43.00	
Total combustible matter		94.00
Ash, white	1.50	
Moisture	4.50	
Total waste		6.00

This indicates a good grade of coal.

1186.—Distribution and Local Details.—In a general way it would appear that Coal VII was confined to the north and west parts of the township. Close to Lockport or Riley P. O. the outcropping strata belong below Coal VII, nor were any of the strata above Coal VII or the coal itself noted south of Lockport. They appear in the southwestern corner of the township, and a mile and a half west of Lockport, also northwest and north. In the northeastern corner of the township it has been thought the strata exposed in the creek banks belonged above Coal VII, which is there below drainage. In Sec. 1, 3 ft. of coal is reported to have been struck at about 10 ft. on the Earl Phillips place, in the N. E. of the S. E., and on the E. Rector place, on the S. E. of S. W. of this section. In Sec. 11 what is probably the same coal is reported to have been struck at a depth of about 25 ft. below Stone Quarry creek. From the position of Coal VII to the north and west of Lockport it would seem to require an eastward dip to carry this coal to the positions of the coals just mentioned, and in view of the lack of details, suggests that these coals may be Coal VIb. Coal VII is, however, characteristically exposed 2 mi. N. E. of the northeastern corner of this township, in Clay county.

Further down Honey creek Coal VII outcrops and has been stripped on Mrs. Hager's place, N. E. of N. E. of Sec. 16; Wm. Brown's place, S. E. of S. W. of Sec. 9, and M. Sankey's place, S. W. of S. W. of Sec. 9, S. E. of S. E. of Sec. 8, and S. E. of N. W. of Sec. 17. It also outcrops in the N. E. ¼ of Sec. 17 and S. W. of S. E. of same section, at the latter place being only about 15 ft. below the general level. The old Somerset or Foster shaft is in the N. E. of S. E. of Sec. 17. The section here was given above. At the Foster drift, in the N. W. of S. W. of Sec. 16, Coal VIb measured 2 ft. 10 in. in thickness at the mouth of the entry (Fig. 505). The coal is said to reach a thickness of 5 ft. to the north. The roof here is black shale, sheety toward the bottom, 3 ft. 3 in. thick; above that is 4 ft. of gray limestone with a parting in the middle.

In the south bank of the creek, opposite this drift, is what appears to be a double fault, a block some yards long having dropped about 5 ft. In the S. E. of S. W. of Sec. 16 it is about 14 ft. to Coal VIb at the Baker or Galaspie shaft. The limestone is here solid, 3 ft. 3 in. thick; coal could not be seen.

In Sec. 20 Coal VII follows up a small branch, on the Pickens place, the section exposed showing coal 1 ft. 6 in.; fire-clay, 10 in.; coal, 8 in. (Fig. 503).

In Sec. 31 Coal VII outcrops along the south branch of Honey creek at about creek level. The section at one point shows (Sect. 417, Fig. 504):

	Ft.	In.
Gray clay shale, with iron bands	15	0
COAL VII	2	4
Fire-clay	3	0+

The coal here has a south dip, and at the south section line is reported to be 30 ft. below the creek. Just north of the above outcrop the coal is underlain by limestone, the fire-clay having thinned to 4 in. Six in. of the limestone are exposed. The shale over Coal VII appears to have a thickness of 50 ft. at the south line of the section. The ironstone bands mentioned, being harder than the shale, make regular projecting bands 1 ft. to 18 in. apart.

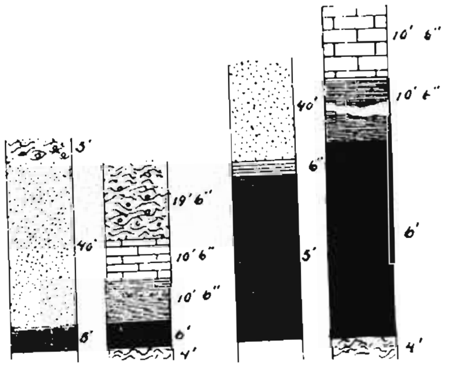
Township 10 North, Range 8 West.

1187. Geography.—This township lies in the southeastern corner of the county, and agrees with Pierson of the civic townships.

1188. Topography.—"The northwestern portion of Pierson's township is drained into Honey creek, the eastern portion into Eel river through Splunge creek and branches, and the southern portion is drained by the branches of Busseron's creek. Secs. 32 and 33 and parts of Secs. 6, 28, 34 and 35 are considerably broken. The balance of the township has a good surface and is well adapted for agricultural purposes."

1189. Transportation.—No railroads at present (1897) enter this township. The nearest roads are the E. & I. R. R., 2½ mi. north; the E. & T. H. R. R., 1½ mi. west, and the New Pittsburg branch of the E. & T. H. R. R., 2 or 3 mi. south.

1190. Stratigraphy.—The stratigraphy of this township has not been satisfactorily worked out, due to the lack of information. What is taken to be Coal VII has been exposed and worked in the southwestern corner and reached in a drilling in the northwestern corner. Coal VIb, assuming the first correlation to be correct, has been struck, or its presence indicated at several points in the north central and south central parts of the township, while in the southeastern corner of the township, about on a level with the last mentioned outcrops,



507 508 509 510

Figs. 507, 509. Columnar and coal sections at Forbes's mine, Sec. 32.
Figs. 508, 510. Same at Parker mine, Sec. 3.

is an outcrop of very similar coal, but which other evidence suggests is Coal V. Coal VI was not certainly located in the township, so that we are unable to say whether it is practically thinned out or that the coal in the southeastern corner is Coal VIb and VI is below and does not outcrop in this township. Coal VII runs from 3 ft. to 6 ft. in thickness, with generally a shale roof overlain by sandstone, but locally the shale is wanting and the sandstone lies immediately on the coal. This coal here usually shows a parting 8 in. from the bottom. It usually has a very irregular roof when that is sandstone, making the coal vary in thickness from 6 ft. down to nothing. In the northwestern corner the shale, which is of a fine quality, suitable for the manufacture of clay products, is up to 50 ft. thick, while in the southwestern corner the overlying sandstone is up to 40 ft. thick. The section at the Forbes shaft is as follows:

Section 418. Section at B. W. Forbes's Shaft.—S. E. of S. W. of Sec. 32, Figs. 507, 509 (J. T. S., p. 534).

	Ft.	In.
1. Soil and sub-soil	5	0
2. Sandstone, mostly compact	40	0
3. Shale, with lime nodules	..	6
4. COAL VII .6 ft. to	4	6
5. Fire-clay and shale	7	0

Immediately below the fire-clay of this coal there was noted, both just north and just south of this township, a bed of limestone. Sometimes a little sandstone may be found between the fire-clay and the limestone. It is supposed to be this limestone which thickens up and underlies all the central part of the township. At the Parker or Pierce shaft the section includes this limestone and the underlying coal.

Section 418a. Section at Pierce Shaft.—S. W. of N. W. of Sec. 3, Figs. 508, 510.

	Ft.	In.
1. Surface	19	6
2. Gray sandstone, only edge struck	..	..
3. Limestone	10	6
4. Shale, gray to dark drab to black and sheety	10	6
5. COAL VIb, 4 ft. 6 in. to 7 ft.	5	0
6. White fire-clay	4	0+

This thickening is very unusual for Coal VIb, which only ran from 2 in. to 0 at Seelyville, and to the south is not reported south of the northern edge of Sullivan county; while where more persistent this coal seldom reaches a thickness of more than 3 ft. It is to be remembered that this bed is at a different horizon from Coal VIa at Stanton and Coxville, this being over the sandstone, while that is under. The two beds have always been considered the same and were called "M" by the older reports.

1191. Distribution of Coals.—Coal VII appears to be confined to the western third or half of the township as mapped. In the N. E. of N. W. of Sec. 6 the shale above this bed has been dug for the manufacture of paint. The coal is reported to lie 32 ft. below the "Paint bank," and to be 18 in. thick. As there are still 15 to 20 ft. of shale over the "Paint bank," there is indicated a thickness of about 50 ft. of a fine grade of shale.

The coal was not seen again until Sec. 32 was reached. Here it has been worked in the S. E. of S. W., on the Jas. Forbes place, the section being as given in Sect. 418 above.

The coal here is from 4 ft. to 6 ft. thick, with a ½ to 1 in. parting of shale 4 to 6 in. from the bottom. The roof is shaly sandstone, though in places a small thickness of shale intervenes between the coal and sandstone.

Coal VII has also been worked just west in the S. W. 40 of Sec. 32, on the G. W. Peters farm.

Coal VIb is reported to have been found on the Meirs place, in the N. W. ¼ of Sec. 2, and on the Ray place, in the S. W. ¼ of the same section. In Sec. 3 it has been worked at the Wm. Pierce or Parker mine. The coal here averages 5 ft., ranging from 4 ft. 6 in. to 7 ft. Close to the shaft the coal changes in thickness from 4 ft. 8 in. to 6 ft. 6 in., as shown in the accompanying sketch, Fig. 511.

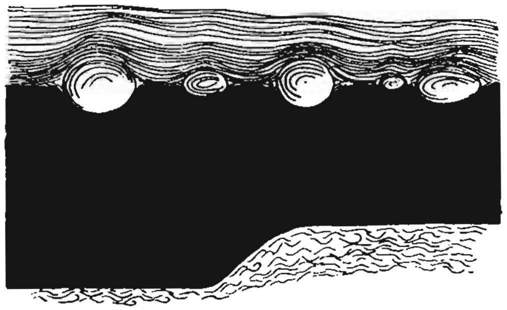


Fig. 511 Sketch showing sudden change in thickness of coal at Parker or Pierce mine.

The coal is 41 ft. 6 in. deep in the present shaft. The roof is a black sheety shale, containing many iron or limestone boulders projecting down into the coal. The floor is a very white fire-clay. The coal is not considered suitable for blacksmithing, and is said to thin to the rise as the lower coals commonly do. At the shaft the dip is sharply to the north. In its general features this coal very strikingly resembles Coal V, as seen at Alum Cave and elsewhere in Sullivan and Greene counties.

At the center of the N. W. ¼ of Sec. 13, coal is reported to have been struck in a well. No limestone is mentioned, but as 10 ft. 6 in. of white limestone is said to be found on slightly lower ground at the schoolhouse a quarter of a mile east of the center of Sec. 14, this coal is thought to be the same as Pierce's coal or Coal VIb. Drillings a quarter of a mile west of the center of Sec. 13 are said to first strike sandstone and find water in that.

In the center of Sec. 15 it is said that an old drilling showed between 5 and 7 ft. of coal, depth not known. On Mrs. Laren's place, near the center of the west side of Sec. 15, coal is reported to have been struck at 35 ft., being overlain by 4 to 5 in. of "hard flint rock" and that in turn by about 25 ft. of soft sandstone.

At Soonover P. O., on Mr. J. M. Huff's, coal was struck in the barn well at 10 ft., said to be of good quality.

In the N. E. 40 of Sec. 33, coal overlain by black sheety shale has been dug some on the Biggs place, back of the schoolhouse. The fossils in this shale are gilded with pyrite. The same coal is also struck in Mr. Taylor's well, in the N. W. 40 of Sec. 34.

In the S. E. 40 of Sec. 34 a well on Mr. Jas. H. Richey's place is reported to have passed through approximately the following section (Sect. 418b):

(1) Clay, 12 ft.; (2) boulder clay, 65 ft.; (3) very hard yellow sandstone (?), 16 ft.; (4) soft shale, 10-11 ft.; (5) very hard shale, 18-20 in.; (6) COAL (at 100 ft.), 5 ft.; (7) fire-clay, 12-13 ft. As this well started about 25 ft. above an outcrop of Coal VIb, just across the Sullivan county line, it seems probable that Coals VII, VIb and VI are all cut out here, and the coal found may be Coal V. From the description of the sandstone No. 3, it was thought it might have been at least in part limestone. A drilling a little farther back from the edge of the bluff might have shown all the coals from VII to V, inclusive.

In the S. E. of the N. E. of Sec. 36 some coal has been stripped on the Schemmerhorn place. The bed is reported to be over 2 ft. thick and is overlain by a black, sheety shale, with pyritized fossils. The stratigraphic position of this coal has been much in doubt. Across Secs. 33 and 34 there appears to be little or no rise of the strata to the east. If this continued to the eastward across Secs. 35 and 36, the Schemmerhorn coal would evidently be at the horizon of Coal VIb. On the other hand, a lack of dip from here for two miles to the south would carry this coal into Coal V at the Wells place, in Sec. 12-9-8. It is doubtless the same as the coal on the Harris, Listen and Dalgarn places, in Clay county, and if those coals are at the horizon of Coal V, this is also at the horizon of Coal V. No data was found which would settle this question satisfactorily. It is then still an open question whether Coal VI is cut out in the southeastern corner of this township as suggested on the colored map, or lies 20 to 30 ft. below drainage.

Mr. Earl Phillips, who has done some drilling in the area of the old reservoir, writes that he finds there 3 to 4 ft. of coal 130 ft. down, "with 4 in. of draw slate and then sand rock 60 ft. thick. There were three seams above this from 1 ft. to 2 ft. The third of these had 5 ft. of black slate on top."

This, with the data obtained just south in Sullivan county, suggests that Coal VI is thin in this township.

Township 13 North, Ranges 9 and 10 (in Part) West.

1192. Geography.—These townships occupy the north-central and northwestern part of the county, and correspond to Fayette and the western half of Otter Creek of the civic townships.

1193. Topography.—"Fayette township is mainly drained by Coal creek. A few little streams flow into Brouillet's creek and the river, and a few sections are drained by East Little Sugar creek. Coal creek rises in Illinois and the west part of the township and flows southeasterly into the river. Its channel is deep, narrow and rocky, and its bluffs are abrupt. It seems to be a new or recent valley. The same is true of its branches and of two or three small streams that flow directly into the river.

"Four or five sections in the northeast of Fayette are in the main valley, but the balance is upland. There are several sections of broken land along Coal creek and the river bluffs, but the greater part has a good surface. This surface in the west is diversified with gently rounded hills of various sizes that rise from 20 to 40 ft. above the surrounding level. Frank Leverett, of the United States Geological Survey, says they are parts of the Shelbyville or Wisconsin moraine. Both north and south of Coal creek the surface inclines gently from the State line to the bluff near the river, forming one of the finest slopes in the county."

1194. Transportation.—The Big Four railroad crosses the southwestern corner of this area. East of the river the C. & E. I. R. R., the T. H. & L. R. R., and the Big Four all just lap the limits of 13 N., 9 W.

1195. Stratigraphy.—The following sections will serve to show the stratigraphy of this area:

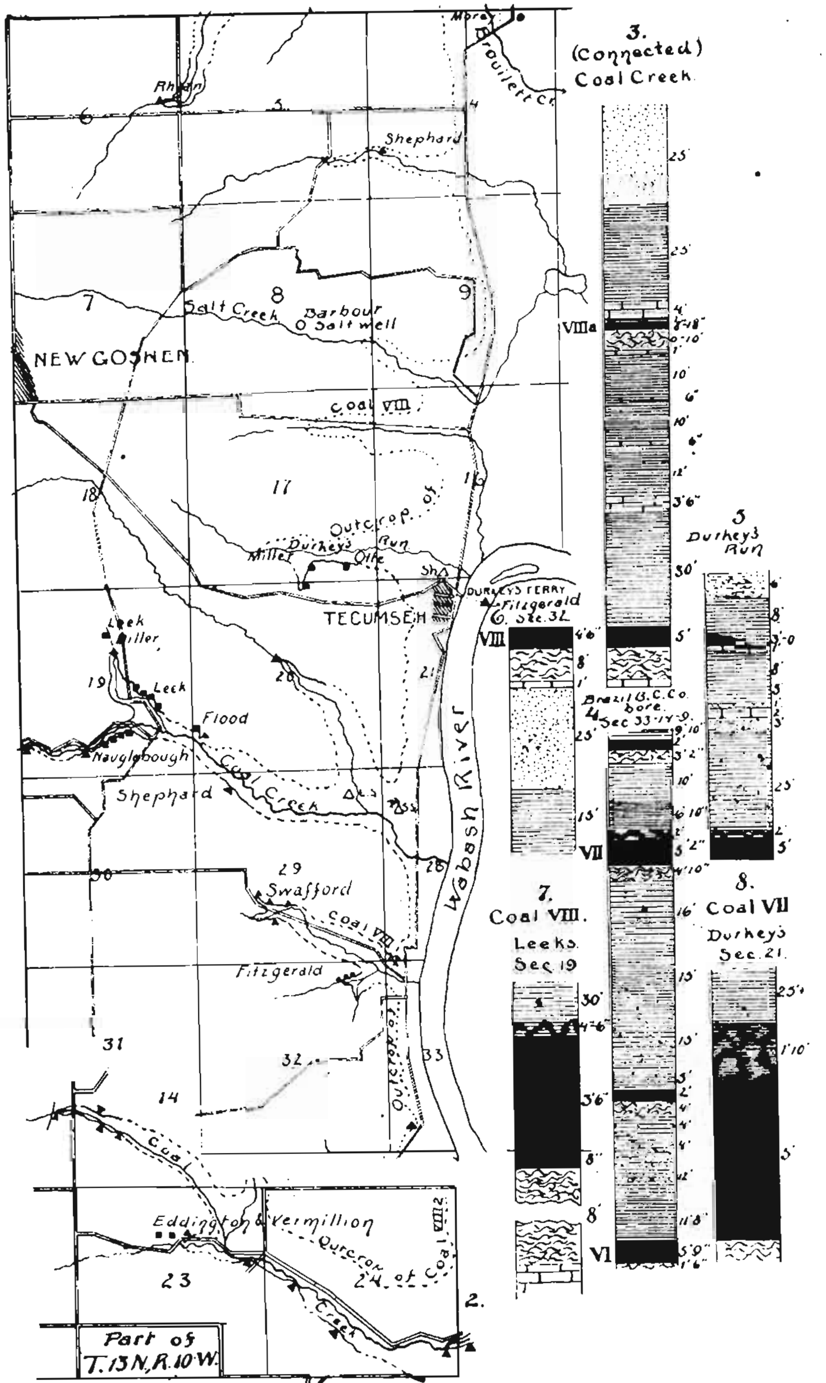


Plate XXXVII. Sketch maps and columnar and coal sections from T. 13 N., Rs. 9 and 10 W.

1196. SECTION 419. SECTION IN N. E. 40, SEC. 32-13-9, ON FITZGERALD'S PLACE.—Fig. 6.

		Ft.	In.
1.	COAL VIII	4	6
2.	Hidden, fire-clay	8	0
3.	Hard brown limestone	1	0
4.	Shaly sandstone ....10 ft. to	25	0
5.	Drab clay shale	15	0

This section reaches almost to Coal VII.

Coal creek offered one of the best opportunities observed for getting the stratigraphy of the higher strata, and so was gone over with some care. As the section varies greatly from point to point, the details will be given instead of a generalized corrected section.

1197. SECTION 419A. SECTION ON COAL CREEK.—Secs. 14 and 15, Fig. 3 (in part).

		Ft.	In.
1.	Boulder clay with fragments of coal	30	0
2.	Iron stone band	..	1
3.	Brown sandy shale	1	0
4.	Brown sandstone	..	3
5.	Drab clay shale, with a few lines of ironstone	25	0
6.	Dark, bituminous, fossiliferous limestone....0 to	4	0
7.	Black shale	1	0
8.	COAL VIIIa ....8 in. to	1	6
9.	Fire-clay, fine drab ....2 ft. to	5	0
10.	Nodular limestone ....0 ft. to	1	0
11.	Shale	4	0

The upper limestone did not show in Sec. 15. Limestone No. 10 shows at one point in Sec. 14, but a little beyond has disappeared and seems to have been carried in solution down into the joints of the underlying shale, forming there a network of limestone veins. These are nearly pure limestone at the center, but grade into shale in a short space either side.

On the branch from the southwest which joins Coal creek in Sec. 23, the following section is exposed:

1198. SECTION 420. BLUFF SECTION NEAR EDDINGTON AND VERMILLION MINE.—Sec. 14-13-10, Fig. 3 (in part).

		Ft.	In.
1.	Sandy shale to compact buff sandstone	25	0
2.	Drab clay shale, with few ironstones	20	0
3.	COAL VIIIa	..	8
4.	Fire-clay	2	0

This section is continued to Coal VIII in the E. & V. shaft.

1199. SECTION 421. SECTION OF EDDINGTON AND VERMILLION SHAFT.—N. E. of N. W. of Sec. 23 (J. T. S., p. 530).

	Ft.	In.	Ft.	In.
Shale, light colored, fine quality	5	0	5	0
Limestone, impure and shaly	0	6	5	6
COAL VIIIa, of inferior quality	0	8	6	2
Shale, of good quality	34	0	40	2
Limestone, clayey	8	0	48	2
Shale	34	0	82	2
COAL VIII	4	8	86	10

Just below the junction of the two branches, in the S. E. of N. E. of Sec. 23, the following section shows in the bank:

1200. SECTION 422. SECTION ON COAL CREEK.—Sec. 23, Fig. 3 (in part).

		Ft.	In.
1.	COAL VIIIa	1	0
2.	Hidden, fire-clay and shale	6	0
3.	Drab shale	10	0
4.	Hard layer (limestone?)	..	6
5.	Drab shale	10	0
6.	Sandstone	..	3
7.	Conglomerate of clay and sandstone in limestone matrix	..	3
8.	Drab shale	12	0
9.	Limestone (exposed)	1	0

The section from this limestone to Coal VIII can be obtained on the Geo. Flood place, in the S. W. of S. W. of Sec. 20.

1201. SECTION 423. SECTION ON FLOOD PLACE.—Sec. 20, Fig. 3 (lower part).

		Ft.	In.
1.	Solid, buff-colored limestone	3	6
2.	Light drab shale	30	0
3.	COAL VIII	4	0
4.	Fire-clay	8	0
5.	Limestone	..	..

This limestone crops out again in the N. E. $\frac{1}{4}$ of Sec. 29, while, farther down, near the river road, is a bluff of sandstone. Up Durkey's run, in Secs. 16 and 17, the following section was obtained:

1202. SECTION 424. SECTION IN DURKEY'S RUN.—Secs. 16, 17, Fig. 5.

		Ft.	In.
1.	Brown shaly sandstone	6	0+
2.	Drab, sandy shale, with ironstones	8	0
3.	Limestone replaced in Sec. 17 by a conglomerate of sandstone, lumps and sheets of coal, pieces of kaolin and clay.....1 ft. to	2	0
4.	Fine blue clay shale	8	0
5.	Light brown shale	5	0
6.	Brown shaly sandstone	3	0
7.	Shaly sandstone and blue shale	1	0
8.	Hard sandstone to limestone.....1 ft. to	2	0
9.	Brown sandstone	3	0
10.	Blue shale, with ironstone nodules containing fossils	25	0
11.	Clay shale, with leaves.....1 ft. to	1	8
12.	Black sheety shale.....0 ft. to	1	10
13.	COAL VII, in river bed (reported)	5	0

In a small drain from the north the space between the two limestones is almost entirely taken up by shaly sandstone. There seems to have been an erosion period entered into the sequence of events following shortly the laying down of the upper limestone, and the overlying coal. In the main ravine no trace of Coal VIII was seen, except the fragments in the conglomerate at the horizon of upper limestone; but in a ravine from the south the coal has been worked, apparently lying just above the upper limestone. As showing the stratigraphy to Coal VI, one of the borings by the Brazil Block Coal Company just across the county line is refigured in Fig. 4. See Vermillion county for section. Suffice to say that it finds Coal VI about 6 ft. thick and about 100 ft., or over below Coal VII, or 150 or 200 ft. below Coal VIII. One 2-ft. coal comes between Coals VII and VI. It will be noted that the 2 ft. or less of coal found around Clinton and in this well has not been definitely recognized in this county.

In the N. E. ¼ of Sec. 4 a drill hole on the Wm. Morey place, in Brouillet creek valley, which started about 25 ft. above low water in the Wabash, was reported to have shown four workable coals in a depth of less than 200 ft. Though we give a copy of the record as given by Mr. Scovell, the section varies so widely from other records or from the observed strata that no attempt will be made to correlate the extra coal beds.

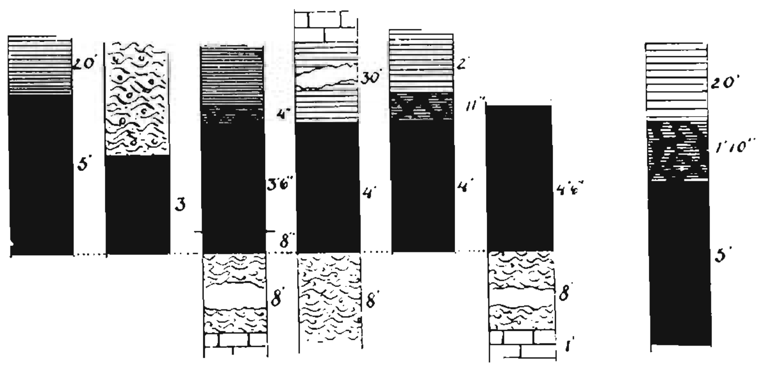
1203. SECTION 425. SECTION OF DRILLING ON MOREY PLACE.—Sec. 4 (J. T. S., p. 542).

		Ft.	In.	Ft.	In.
1.	Surface soil, sand and gravel	4	0	4	0
2.	Shale	50	0	54	0
3.	Sandstone	1	8	55	8
4.	COAL	3	6	59	2
5.	Fire-clay and sandy shale	12	0	71	2
6.	Black rock and gray shales	5	0	76	2
7.	COAL	4	9	80	11
8.	Iron band and black shale	2	2	83	1
9.	COAL	3	11	87	0
10.	Fire-clay	3	0	90	0
11.	Limestone	9	6	99	6
12.	Shale, gray	10	6	110	0
13.	Sandy shale and sandstone	34	0	144	0
14.	Iron band and gray shale	5	4	149	4
15.	COAL	1	6	150	10
16.	Shale and iron band	10	0	160	10
17.	Sandy shale and iron band	12	4	173	2
18.	Sandstone	14	0	187	2
19.	Gray shale	2	0	189	2
20.	COAL VI?	6	6	195	8

These sections show three workable coals known to underlie or outcrop in this area, with at least one thin coal outcropping. The strata above Coal VIIIa, shaly sandstones overlying a fine body of shale, appear to be the highest strata outcropping in the county. Coal VIIIa is a thin, non-workable coal, 8 to 18 in. thick, sometimes overlain by black shale and limestone. The limestone does not appear to be very persistent, however. Below Coal VIIIa to Coal VIII is principally shale, with a bed of limestone, in places solid and of sure thickness, in other places more or less nearly wanting or broken up into a number of thin beds which are scattered through the shale. This shale is often of a fine grade and apparently suitable for the production of clay products.

1204. COAL VIII varies from 3 to 5 ft. in thickness. It is a solid bed, except for a knife-edge parting 6 to 8 in. from the bottom. The coal below this parting, though as pure as the rest, is softer. The sulphur occurs in masses, easily removable. The roof is usually a black, bituminous shale running to bone coal, 0 to 12 in. thick. Above it is a good thickness of solid shale. The roof is reported to be good. Under the coal is 6 to 8 ft. of fire-clay, which in turn is underlain by limestone. This is the same as the Brouillet creek coal in Vermillion county and probably has much the same character as that coal. An analysis by Mr. Cox of this coal from the stripping of E. S. Rhyan, in Sec. 6-13-9, gave as follows:

Fixed carbon	48.50	
Volatile combustible matter	43.50	
Total combustible matter		92.00
Ash, flesh	6.00	
Moisture	2.00	
Total waste		8.00



512 Rhyan. Sec. 6. — 513 Miller. Sec. 17. — 514 Leeks. Sec. 19. — 515 Flood. Sec. 20. — 516 Naugle-baugh. Sec. 19. — 517 Fitzgerald. Sec. 32. — 518 Durkey's Ferry. Sec. 21.

Figs. 512-517. Coal VIII in T. 13 N., R. 9 W.
Fig. 518. Coal VII at Durkey's Ferry.

Below Coal VIII are found one or two beds of limestone, with shale or shaly sandstone between when there are two; then a massive sandstone, quarried at several points; then a fine grade of shale to Coal VII.

1205. Coals VII and VI have not been worked in this area. In quality, thickness, etc., they are supposed to maintain the figures found for them around Clinton and Terre Haute.

1206. Distribution and Local Details.—Coal VI probably underlies the whole area and possibly with a workable thickness under all of the area, unless it be in the southeastern corner of 13 N., 9 W., where it may have been removed by the preglacial erosion. Coal VII is probably confined entirely to the west side of the river, unless it occurs in the hill east of Atherton, in Sec. 1-13-9. It is probably below the river level from Durkey's ferry north, and not much, if any, above from there to the south. It is reported to have been found in the river bed at Durkey's ferry 5 ft. thick.

Coal VIII is confined to the west side of the river. Its approximate line of outcrop is shown on the maps. In following this from the north, the coal is first seen at the E. S. Rhyan place, in Sec. 6-13-9. The coal is here in the bed of the branch and has been extensively stripped. The coal appears to run from 4 to 5 ft. without discernible partings (Fig. 512). Over it is 20 ft. of gray to blue sandy shale, with about 15 ft. of soil and drift still above. One interesting fault is noticed here in the bed of the creek. The coal seems to have been broken by a twisting motion, resulting in a considerable lateral displacement, though the vertical displacement will not amount to more than 6 in. In the midst of the clay filling is a wedge-shaped block of coal 4 ft. long by 1 ft. wide.

In Sec. 4 the coal has been stripped along a branch on the Shephard place.

In Sec. 17 several drifts have been opened on this coal in the branch south of Durkey's run, on the Peter Miller and Emma Otte places. The coal here appeared to be above 3 ft. thick, overlain with boulder clay (Fig. 513).

This coal has been worked at a number of places up Coal creek, in Secs. 19, 20 and 29. On the A. D. Nauglebaugh place, in S. E. of S. W. of Sec. 19, Coal VIII has been stripped at creek level. It is 4 ft. thick, overlain by 11 in. of bone coal, with 2 ft. of blue shale showing above (Fig. 516). From here, going down the stream, the coal gets farther above drainage and has been worked by a large number of openings. At one of these, the Samuel Leek bank, the coal measured 4 ft. 2 in., overlain by 4 in. of bone coal. The knife-edge parting is here 8 in. from the bottom (Fig. 514). The roof of black shale is good, though a good many clay cut-outs are met with. The coal carries a good deal of sulphur, but in form to be easily removed. The coal has also been worked near here, at the Leek shaft and Miller stripping, in S. W. of N. E. of Sec. 19; Geo. Flood place, S. W. of S. W. of Sec. 20 (Fig. 515), and Shephard place, in N. W. of N. W. of Sec. 29.

Coal VIII has been stripped at a number of points on the Swaffard place, formerly the Holleran place, N. E. of S. W. of Sec. 29, an outcrop at one point showing 4 ft. of coal.

In the N. E. $\frac{1}{4}$ of Sec. 32 the coal has been worked by stripping and two drifts on the Fitzgerald place. At one opening the coal showed a thickness of 4 ft. 6 in.—the top 1 ft. 9 in. being left for a roof. The section here was given above (Fig. 6 of Plate XXXVII, and Fig. 517). There is an excellent bed of shale exposed at this point. In Sec. 33 the coal has been worked a little in the S. W. ¼. The limestone is exposed below it. As far as could be judged from the sections along Coal creek, there is but little, if any, dip to the westward, and this coal should be looked for at about 50-75 ft. above the level of low water in the river. In a bore put down at Sanford, this coal, as well as the thin coal above it, appeared to be absent, and the first coal struck at 224 ft. may be Coal VII. If so, it implies a dip of about 50 ft. from the river to that point. Though we give the record of this boring, it fails so much of corroboration by what was seen in Coal creek, but a short distance away, that we have not used it in our calculations.

1207. SECTION 426. SECTION OF BORING AT SANFORD.—Sec. 20-13-10 (E. T. C., p. 94).

		Ft.	In.	Ft.	In.
1.	Surface	15	0	15	0
2.	Sand	6	0	21	0
3.	Sand and clay	4	0	25	0
4.	Boulder clay	66	0	91	0
5.	Brown clay	10	3	101	3
6.	Blue clay	8	4	109	7
7.	Sand	0	4	109	11
8.	Blue clay	37	6	147	5
9.	Black shale	1	3	148	8
10.	Fire-clay ← VIII	4	5	153	1
11.	Limestone	6	5	159	6
12.	Red clay	2	0	161	6
13.	Limestone	3	0	164	6
14.	Clay shale	2	8	167	2
15.	Limestone	0	9	167	11
16.	Red shale	7	6	175	5
17.	"Hardpan"	2	9	178	2
18.	Limestone	3	0	181	2
19.	Sand and clay	4	0	185	2
20.	Limestone	1	9	186	11
21.	Red shale	1	6	188	5
22.	Sand and blue clay	5	3	193	8
23.	Sandstone	3	10	197	6
24.	Black shale	8	3	205	9
25.	Black hard stone	0	9	206	6
26.	Black shale	4	2	210	8
27.	Bastard limestone	0	8	211	4
28.	Shale	7	5	218	9
29.	Clay shale	5	3	224	0

		Ft.	In.	Ft.	In.
30.	Rotten COAL VII	4	7	228	7
31.	Sandstone	0	6	229	1
32.	Fire-clay	7	2	236	3
33.	Sandstone	4	0	240	3

Sanford having an elevation of 625 ft., makes the coal in this section come at an elevation of about 400 ft. or 45 ft. below the level of low water at Terre Haute.

At the shaft of Eddington and Vermillion, Coal VIII is 82 ft. deep and 4 ft. 8 in. thick.

In the upper valley of Coal creek only Coal VIIIa outcrops. Sections here have already been given.

TOWNSHIP 12 NORTH, RANGES 9 AND 10 (IN PART) WEST.

1208. GEOGRAPHY.—These townships lie about, and west of, Terre Haute, in the north-central and northwest-central part of the county, and correspond to Harrison and most of Sugar Creek of the civic townships.

1209. TOPOGRAPHY.—"Harrison township lies almost wholly in the valley of the river, and has generally a good surface.

"Sugar Creek is the largest of the townships, and topographically is perhaps the most interesting. Big Sugar creek runs from west to east across the center of the township. It is a strong stream, having a course of 20 or 25 mi. in Illinois before entering the county. In Vigo county the valley is from 70 to 100 ft. deep and from one-half to three-fourths of a mile wide. The creek in general is near the south bank, which is much more abrupt than the one on the north. In Sec. 23-12-10 the creek cuts through the limestones above Coal 'N.' At this point the rock channel is not more than 30 rods wide, while the valley proper is as wide as ever. In N. E. ¼, Sec. 25, where it joins the main valley, the rocky walls of this valley are not more than 40 rods apart. Above Sec. 23 the walls of the channel in this county are mainly of boulder clay. Sugar creek receives only two or three small streams from the south, but has two large branches from the north. West Little Sugar creek, which, rising in Illinois, enters at the northwest corner of the township, and, flowing a little east of south, joins the main stream in the east part of Sec. 22-12-10. And East Little Sugar creek, which rises in Fayette township near Coal creek, and, flowing southerly, enters the big creek in the W. ½ of Sec. 30-12-9. A branch of this creek rises in Sec. 34, Fayette township, and, flowing a little east of south, enters the east branch in Sec. 24-12-10, so that the northern portion of the township is drained by three nearly parallel streams, each of which has a deep, narrow valley. Each of these streams shows some rocks in its banks or bed, but in general their channels are in boulder clay. The narrow channels of the main stream and of the east branch in their lower course suggest the idea that these streams may flow in recent or post-glacial channels in the lower part of the course. The rocky strata dip toward the west, but the surface inclines toward the east, and the thick beds of boulder clay toward the west may have changed the drainage area somewhat, so that a much larger territory is tributary to the present Wabash than to the ancient stream. Clear creek, rising in Illinois, enters the county in the south part of Sec. 28-12-10, and, flowing southeasterly, joins the river in Sec. 11-11-10. Its valley is as deep as that of Sugar creek, but not as wide. Its channel is also rocky and narrow in its lower course. The extreme southern portion of the township is drained by two streams that rise in Secs. 3 and 4-11-10, and running in nearly parallel courses, flow into Hawk creek, which flowing through Sec. 16, reaches the river near the center of Sec. 22-11-10. The surface of the township is very much broken, more so than that of any other township. The long river bluff, and the bluffs of two streams that cross the township, and the bluffs along the three streams that drain the northern portion, occupy fully 75 per cent. of the area of the township. The rocks associated with Coal 'N' (VII) crop out along the river bluffs and to some extent in other places, but in general the bluffs are of boulder clay, and one comes to think of the township as a mass of boulder clay and other glacial debris, through which the surplus waters are digging channels, as day by day they work at their task of carrying these materials down to the gulf. This task is only well begun. Wide areas on the divides are practically level, with no established drainage lines, showing little evidence of change since the retreat of the ice. The tributary streams, with their deep, narrow, V-shaped channels, are reaching up into these areas and rapidly curtailing their extent. One can find numerous instances of from six to ten of these little streams heading up into one 20-acre tract. Similar features occur to some extent in Fayette township, and east of the river also, but in no place are they as well marked as in Sugar Creek township. These peculiar forms of relief give the region a new and unfinished appearance. The broken nature of the surface is well indicated by the direction of the roads of the township."

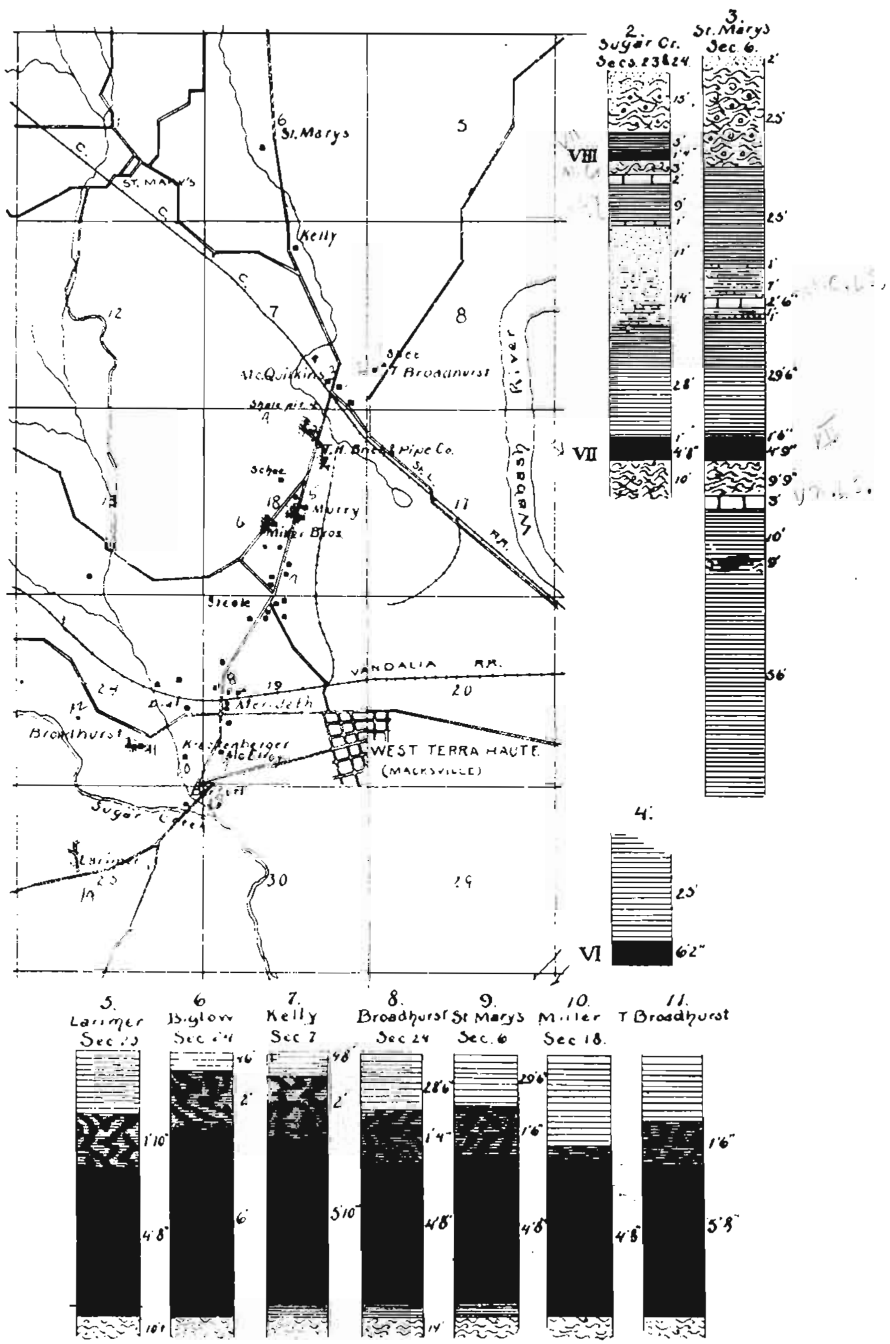


PLATE XXXVIII. Sketch map, columnar and coal sections from T. 12 N., Rs. 9 and 10 W.

1210. TRANSPORTATION.—This area is well supplied with transportation facilities, as nearly all of the railroads that enter the county run into this area.

1211. STRATIGRAPHY.—Divisions VII and VIII outcrop in this area, though here containing only one workable coal, while below drainage occur the other divisions, with as many as six coals reported, at least one of which, probably Coal VI, is of good workable thickness. It is from the section of the river well that we get most of our information concerning the coals below drainage. Mr. Cox, in giving the record of this well in his second report, says: "Experienced borers were employed, and the record of the strata passed through may be relied on as accurate." "The record of bore No. 2 has been carefully made and each layer tested to determine its character, consequently the sandstones and limestones are correctly placed." Mr. Andrews, of Patricksburg, Clay county, who contributed largely toward the enterprise of sinking this well, told the writer that in the upper part of the well great care was taken to get an accurate section of the coals and the accompanying strata, poles being used instead of the usual rope, in order to secure more correct measurements. Yet, notwithstanding all this, a core drilling through the coal measures, or say to a depth of 400 or 500 ft., would yield information worth many times the cost, and would settle at once whether Terre Haute is not underlain by a good workable bed of coal. It is of interest to compare this record with the records of the upper part of some of the other wells sunk for water or oil in Terre Haute or near there.

The following records have been reduced to the level of low water in the river by subtracting fifty feet, as they all commenced at about that elevation above the river.

1212. SECTION 427. SECTION OF THE KINSER WELL.—Located between Fourteenth and Fifteenth streets, just east of the center of Sec. 22-12-9, near Liberty avenue. (J. T. S., p. 520.)

			Total.	
	Ft.	*In.*	*Ft.*	*In.*
Soil, gravel and sand	130	0	80	0
Shale or soapstone	70	0	150	0
Sandstone	10	0	160	0
Shale or soapstone	90	0	250	0
Sandstone	70	0	320	0
Shale or slate	130	0	450	0
Sandstone	140	0	590	0
Limestone	360	0	950	0

1213. SECTION 428. SECTION OF THE BIG FOUR WELL.—In the N. E. corner of the N. W. ¼ of Sec. 23-12-9. (J. T. S., p. 521.)

			Total.	
	Ft.	*In.*	*Ft.*	*In.*
Soil	6	0	..	..
Gravel	10	0	..	..
Sand	102	0	68	0
Shale or soapstone	117	0	185	0
Sandstone or limestone	2	0	187	0
Shale or soapstone	207	0	394	0
Salt water at 265 ft., 78 ft. below top of this shale.				
Limestone or sandstone	41	0	435	0

1214. SECTION 429. SECTION OF THE EXCHANGE WELL.—Situated a little west of the center of Sec. 22-12-9. (J. T. S., p. 521.)

	Ft.	*In.*	*Ft.*	*In.*
Soil and coarse gravel	80	0	30	0
Sand, fine	45	0	75	0
Shale and slate	65	0	140	0
COAL at 88 ft. below low water in river.				
Limestone	5	0	145	0
Shale	95	0	240	0
Limestone	10	0	250	0
Shale	40	0	290	0
Limestone	20	0	310	0
Shale or soapstone	210	0	520	0

1215. SECTION 430. SECTION OF THE ALDEN WELL.—On the N. W. ¼ of Sec. 23-12-9. (J. T. S., p. 522.)

			Total.	
	Ft.	*In.*	*Ft.*	*In.*
Sand and gravel	130	0	80	0
Shale or soapstone	110	0	190	0
Limestone	20	0	210	0
Shale or slate	300	0	510	0

1216. SECTION 431. SECTION OF THE ELLIOTT WELL.—Located near the west line of Sec. 23 and Wabash avenue, Terre Haute. (J. T. S., p. 522.)

			Total.	
	Ft.	*In.*	*Ft.*	*In.*
Sand and gravel	128	0	78	0
Shale or soapstone	260	0	338	0
Sandstone	35	0	373	0
Limestone	40	0	413	0

In the Guarantee Well No. 3, located between Eighth and Ninth streets, near Wabash avenue, the shale was found at 84 ft. below low water, the first heavy limestone at 537 ft., top of the "oil sand" limestone at 1,569 ft., which rock was penetrated to 1,577 ft. and 3 in.

In the Guarantee Well No. 4, located on Tenth-and-a-Half street, between Wabash avenue and Chestnut street, shale was found at 85 ft. below low water, and a vein of coal six to seven feet thick at 305 ft., and blue lick or sulphur water at 1,590 ft.

In the Guarantee Well No. 5, near southwest corner South Fifth street and Farrington street, on the S. E. ¼, N. E. ¼ Sec. 28-12-9, shale was found at 106 ft. below low water, and the top of the first limestone at 700 ft., the top of the "oil sand" limestone at about 1,700 ft., which was penetrated about 22 ft.

1217. SECTION 432. SECTION OF GUARANTEE WELL NO. 6.—Northeast corner of Third and Mulberry streets, N. W. ¼, S. E. ¼ Sec. 21-12-9. (J. T. S., p. 523.)

			Total.	
	Ft.	In.	Ft.	In.
Soil, gravel and sand	128	0	78	0
Shale of varying shades	44	0	122	0
Coal, apparently good quality	5	0	127	0
Shales and sandstone	308	0	435	0
Limestone	40	0	475	0

1218. SECTION 433. SECTION OF AN ARTESIAN WELL.—Drilled at St. Mary's on the N. E. ¼ of S. W. ¼, Sec. 6-12-9, by "The Sisters of Providence," the mouth of the well being about 100 ft. above low water in the Wabash river. (J. T. S., p. 524.)

			Total.	
	Ft.	In.	Ft.	In.
Surface soil and yellow clay	20	0	..	..
Blue clay	55	0	..	..
Blue clay and quicksand	25	0	Low water.	
White shale	25	0	25	0
COAL, probably Coal VII	5	0	30	0
White shale—fire-clay and shale	65	0	95	0
COAL	6	0	101	0
White shale—fire-clay and shale	90	0	191	0
COAL, probably Coal VI, the big vein	10?	0	201	0
Fire-clay and white shale	50	0	251	0
White sand rock	40	0	291	0
White shale	229	0	520	0

"These different wells were drilled for water, oil or gas, and not for coal, nor for scientific purposes, consequently little attention was given to coal seams, or to an accurate record of the strata passed through.

"The ordinary plunger drill was used so that the materials passed through in a distance of from five to seven feet were in general well pulverized and thoroughly mixed, making it difficult to mark the division between strata with accuracy, and often it was impossible to judge of the nature of the rock beyond the fact that it was easy or difficult to drill. The measurements were generally made by the rope, which, as the depth increased, became more and more uncertain. These remarks apply to many of the records made, but in some cases samples were preserved and measurements were made with a steel tape line, and in some cases the record keeper knew how to test for limestone. The wells all enter the shale below the gravel and sand. This shale, having the irregularities of an old river bed, accounts in the main for the varying thickness of the gravel. The record of Guarantee No. 5 seems to indicate a dip of the strata toward the south. The river well shows shale 64 ft., coal 6 ft. 2 in., and shows four other veins within 125 ft. The Guarantee No. 6 shows shale 44 ft. to coal 5 ft. 8 in., but shows no coal below. The Guarantee No. 4 shows coal 6 ft., 120 ft. below the top of the shale, but no coal below. Coal is mentioned in the record of the Alden well, but no definite record was made."

When the method of drilling those wells is considered, it is not so much a wonderment that the later wells failed to strike the coals mentioned in the river well, as that the river well found the coals and obtained their thickness with so much detail. Yet, of the two sides, as the river well record is in accord with what the general conditions lead us to expect, it may be accepted until a better record is obtained.

Of the divisions occurring above drainage our knowledge is quite accurate and fairly comprehensive, as shown by the following sections:

1219. SECTION 434. CONNECTED SECTION ALONG SUGAR CREEK.—Fig. 2. (From notes by J. T. S.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface soil, shale, clay	1	0	..	..	1	0
2. Subsoil, yellow clay	4+	0	..	..	5	0
3. Boulder clay	10+	0	..	..	15	0
4. Shale	5+	0	..	..	20	0
5. COAL VIII	1	4	1	4	21	4
6. Fire-clay and shale	3	0	..	..	24	4
7. Limestone crystalline fossiliferous	2	0	..	..	26	4
8. Shale, light-colored to red	6 to 12	0	..	..	38	4
9. Limestone, impure, flinty	1	0	..	..	39	4
10. Sandstone, massive	11	0	..	..	50	4
11. Sandstone, merging into shale	14	0	..	..	64	4

	Ft.	In.	Ft.	In.	Ft.	In.
12. Shale, bluish, with ironstones in upper part	28	6	72	6	92	10
13. Bone coal	1	0	..	..	93	10
14. COAL VII	4	8	4	8	98	6
15. Fire-clay	10	0	..	..	108	6

1220. SECTION 435. SECTION AT SUGAR CREEK COAL MINES.—Sec. 19-12-9. (E. T. C., p. 125.)

	Ft.	In.
1. Limestone	3	0
2. Sandy shale	8?	0
3. Sandstone	10	0
Top of shaft:		
4. Dark blue clay shale	24	0
5. Shale and ironstone balls	3	0
6. Bluish clay shale	24	0
7. Calcareous fossiliferous shale	..	6
8. Black bituminous shale	2	0
9. COAL VII—Caking coal, good quality, 3 ft. 6 in.; fire-clay, ½ in.; caking coal, 10 in.; fire-clay, 3 in.; caking coal, 6 in	5	1½

1221. SECTION 436. SECTION AT BARRICK & SON'S MINE.—Sec. 25-12-10. (E. T. C., p. 92.)

	Ft.	In.
1. Drift, clay and soil	20	0
2. Schistose sandstone	10	30
3. Limestone fossiliferous	1	0
4. Siliceous shale and clay shale, with ironstone	30	0
5. Gray, light-colored clay shale	12	0
6. Black shale	1	6
7. COAL VII	4	6
8. Fire-clay	10	0

1222. SECTION 437. SECTION AT BIGELOW & CO.'S MINE.—Sec. 24-12-10. (E. T. C., p. 93.)

	Ft.	In.
1. Covered to top of hill	50	0
2. Sandstone	10	0
3. Gray clay shale, with ironstone and fossil shells	46	0
4. Black shale	2	0
5. COAL VII	6	0

1223. SECTION 438. SECTION AT BROADHURST MINE.—S. E. ¼ Sec. 24-12-10. (J. T. S., notes.)

	Ft.	In.
1. Soil, yellow clay and hardpan	13	0
2. Limestone	2	0
3. Gray shale free from sand	12	0
4. Limestone, bastard, flinty	1	0
5. Sandstone, massive, shaly, merging into blue shale	14	0
6. Blue shale, very fine	28	6
7. Shale, or bone coal	1	0
8. COAL VII	4	9
9. Fire-clay	6	0+

1224. SECTION 439. SECTION AT ST. MARY'S MINE.—Sec. 6-12-9, Fig. 3. (J. T. S., notes.)

	Ft.	In.	Ft.	In.
1. Soil	2	0	..	..
2. Boulder clay	25	0	27	0
3. Shale	11	0	38	0
4. Limestone	1	0	39	0
5. Sandstone, shaly	7	0	46	0
6. Limestone, flinty rock	2	6	48	6
7. Shale	1	0	49	6
8. Blue sandstone	1	0	50	6
9. Shale	29	6	80	0
10. Bone coal	1	6	81	6
11. COAL VII	9	9	91	3
In drilling:				
12. Fire-clay	9	9	101	0
13. Limestone, impure	3	0	104	0
14. Shale, with small boulders	10	0	114	0
15. Shale and COAL, perhaps clay	9	0	123	0
16. Shale, white, with flinty boulders	56	0	179	0

1225. As shown by the Sugar creek section, Coal VIII has been reduced in this area until it is not workable. Below it are commonly found the two beds of limestone from 5 to 12 ft. apart, and below these sandstone and shale to Coal VII. The following extracts from Mr. Scovell's descriptions of the strata between Coal VII and VIII apply to this area.

"The fire-clay and shale on Coal creek and northward is from 6 to 10 ft. in thickness. Toward the south the variation in thickness is through a wider range. In every place that I have been able to examine this material it has been a fine clay shale, free from grit. In a bluff on Coal creek on the S. W., N. W., Sec. 28-12-9, in the lower part of this shale there is a thin layer of fine-grained, siliceous rock about one foot in thickness. It is light brown in color and is traversed by tubes of varying size that possibly may have been worm tubes. It seems to be of limited extent. Toward the south this limestone becomes a hard, somewhat crystalline rock, from 2 to 3 ft. in thickness. It has been quarried on Secs. 24 and 25-12-10, and quite extensively on N. W. ¼ Sec. 15-11-10. It was used in the construction of the old National road, for bridge piers and road bed, and has been used for foundations and riprapping, for which it seems well adapted. It contains a few fossils, but the rock is so hard that it is seldom possible to get out a fossil in good condition.

"The shale below this limestone is from three to twelve feet thick, resting usually on limestone below. This is a fine clay shale, generally free from impurity of any kind, but sometimes it is seamed with limestone, sometimes it is reddish or bluish, sometimes white or gray.

"In Fayette township, where examined, it was of a light color. On Sec. 23-12-10, and on the S. W. Sec. 11-11-10, it is light colored, but on S. ½ Sec. 25-12-10, and on the E. ½ Sec. 15-11-10, and at other places it is highly colored, but always of a fine quality. The shale from H. T. Thorp's place, Sec. 23-12-10, belongs to this bed. It is mentioned in the 20th Report Indiana Geol. Surv., page 73. Near the center of Sec. 23 the two limestones outcrop in the bank of Sugar creek, and are separated by twelve feet of this valuable shale. But about a quarter of a mile west the limestones outcrop again with not more than three feet of shale between them, and this containing quantities of limestone, generally in boulders. The boulders were of blue fossiliferous limestone, the fossils prominent on the eroded surfaces. The boulders contained masses of calcite, which often formed beautiful crystalline cavities.

"The lower limestone varies greatly. In the southern part of the county it is seldom as thick and never of as good quality as the upper one, and is called by the miners bastard limestone. As it forms a thin layer over the sandstone below, they sometimes fail to recognize it as limestone. On Secs. 5, 7 and 18-12-9, both limestones become nodular and irregular in stratification.

"The sandstone below this limestone is sometimes massive and of uniform texture, forming a good quarry stone, as on S. W. 28, N. W. 28, and S. W. 16-13-9, but toward the south it is fragile and shaly. It merges into a sandy shale which sometimes has a peculiar wavy structure. These sandy shales merge into fine clay shales below, so that it is difficult to say how much there is of either of the three strata below the limestone. Perhaps the following section on Sec. 24-12-10 will be about an average. Sandstone, 12 ft; sandy shale, 10 ft.; clay shale, 30 ft."

1226. Coal VII (Figs. 5-11) is the only coal at present worked in this area, but it is quite extensively worked. As far as seen the coal

has no partings. Mr. Cox reports two in the Sugar creek mine examined in 1871. The following analyses of this coal in this area by Mr. Cox shows its composition. The first figures (A) are from Barrick & Son's mine, the others (B) from the old McQuilkin mine.

	A.		*B.*	
Fixed carbon	48.20		47.50	
Volatile combustible matter	44.50		44.50	
Total combustible matter		92.70		92.00
Ash	4.30		3.50	
Moisture	3.00		4.50	
Total waste		7.30		8.00

Though containing considerable sulphur, it appears to be in a form that admits of its ready separation. The roof is uniformly a bone coal, or black bituminous shale, the bottom 4 in., which is usually separated from the rest by a smooth parting, is the richest in carbon. There is sometimes a smooth parting between the main coal and the bone coal, but quite often the lower 4 in. of the bone coal comes down with the coal proper. The bone above makes a good roof if not disturbed. Above it is a soft, jointed shale, excellent for the manufacture of clay products, but making a very poor roof. This bone overlying the coal is the source of much gas in the mines, though on account of their shallowness, no serious trouble has yet been had with it. Below the coal is usually 10 to 15 ft. of fire-clay. This makes a good floor as long as dry, but as soon as it is wet it begins to creep, and gives much trouble.

1227. Coal VI.—It is said that a drilling made on the west side of the river, of which no record could be obtained, found Coal VI 6 ft. thick and 125 ft. below Coal VII. In the river well it is about 165 ft. below and reported 6 ft. 2 in. thick. In the artesian well at St. Mary's it is reported as 10 ft. thick and 161 ft. below Coal VII. One driller, who claimed to have put down a drilling purposely to test this 10-ft. coal, claimed to have found only 4 in. at that horizon. It may be said that at Clinton Coal VI is about 170 ft. below Coal VII. At Hartford they are reported to be 130 ft. apart. At the north line of the county they are about 100 ft. apart. At Seelyville they are about 80 ft. apart. Through most of Sullivan county they are about 40 ft. apart. From this it will be seen that the distance apart of the two coals is quite variable, but seems to increase from south to north and east to west in this county. Had no data been obtained in this area as to the depths of Coal VI it would have seemed reasonable to place it between 125 and 150 ft. below Coal VII. As to quality, roof, floor, etc., of this coal, we may only judge from what is known in the northeastern part of the county, at Clinton, Rosedale, and in Sullivan county, which see.

1228. Distribution and Local Details.—It seems safe to assume that this whole area is underlain by Coal VI and probably of a workable thickness. From the practical standpoint the coals under Coal VI may be neglected. They may be worked in the distant future.

Coal VII is probably above the level of the river, so that it is cut out over the area east of the river, and on the west is found outcropping in the bluffs between high and low water levels. A slight dip carries it lower to the west.

It is mined from a number of openings for the local trade, quite a large amount of coal being mined in the aggregate.

At the mine of the Sisters of Providence at St. Mary's in the Woods it is about 90 ft. to the coal, which is 4 ft. 8 in. thick (Fig. 9). The sulphur occurs in boulders easily gotten out. There are many slips in the coal, and a few rolls, or clay cut-outs have been met. Above the coal is 18 to 22 in. of bone coal with a smooth parting 4 in. from the bottom. This makes a good roof if it is not allowed to be acted upon by gas. Over it is a shale-like "joint clay," which is not suitable for a roof. The fire-clay is 12 ft. thick, and would heave if allowed to get wet. The method is used here of driving entries to lines and mining back rooms 21 ft., and leaving 15-ft. pillars.

1229. Section 440. Section at Jas. H. Kelly's Mine.—Sec. 7, Fig. 7. (J. T. S., notes.)

		Ft.	In.
1.	Soil	12	0
2.	Boulder clay	7	0
3.	Clay shale, yellow	6	0
4.	Clay shale and sand	5	0
5.	Clay shale, grayish	48	0
6.	Bone coal	2	0
7.	COAL VI	5	10
8.	Fire-clay	2	2+

The old McQuilkin shafts were in the S. E. 40 of Sec. 7.

In the S. W. 40 of Sec. 8 are the shafts and strippings of Thomas Broadhead and Mr. Shee. At the shaft the coal was 30 ft. deep. The coal was 5 ft. 8 in. thick with 18 in. of bone over. The last had a smooth parting 4 in. from the bottom (Fig. 11).

A well being put down for gas in May, 1899, in the S. E. ¼ of Sec. 9, reports striking Coal VI at 126 ft.

In the N. E. ¼ of Sec. 18 this coal is being worked at the Terre Haute Brick and Pipe Co.'s works. It is here 28 ft. to the coal, which is 4 ft. 4 in. thick. The coal has no bands or partings, and the sulphur is in boulders. Over the coal is 20 in. of bone, with a smooth parting 4 in. from the bottom. This 4 in. of bone tends to come down with the coal. The rest of the bone holds well if not broken into. The shale above does not make a good roof. This shale is mined by a slope just east of shaft, and in a stripping over to the west. The bone coal yields much gas. The roof, and sometimes the coal, have sometimes been cut out by the preglacial erosion.

At the E. R. Murry mine near the center of Sec. 18 the coal is 27 ft. deep and 4 ft. 8 in. thick. A section here shows (Sect. 441):

		Ft.	In.
1.	Surface and soil	3	0
2.	Light shale	7	6
3.	Dark shale	15	0
4.	Bone coal	1	6
5.	COAL VII	4	8

The coal here is close to the outcrop and full of seams. There are some clay rolls which cut the coal out. The sulphur is in boulders, which are readily separated. The bone coal overruns from 2 in. to 2 ft. In places 2 ft. of the bottom of the coal is what the miners call "mother coal," soft, crumbly, fissile, rash coal.

At the Miller Bros. mine the coal is 85 ft. deep and 4 ft. 8 in. thick (Fig. 10). There is no noticeable variation in the thickness of the coal. Sulphur bands run through irregularly and abundantly, but can all be gotten out. Over the coal is 3 to 4 in. of bone coal, making a good roof, with soft gray shale over that. The gray fire-clay is soft and tends to creep when wet.

At the Meredith mine in Sec. 19 it is 60 ft. to the coal, which is 4 ft. 10 in. thick, not varying much from that either way. The bone coal is 16 in. thick, and makes an excellent roof if not broken into. Above is soft shale. The fire-clay below is very fine, without grit, and has been dug into 4 ft. The abundant sulphur can be separated readily.

At Peter Krackenberger's mine the coal is 39 ft. deep and averages 4 ft. 9 in.

At the mine of Messrs. J. N. & G. Broadhurst in Sec. 24 the coal is 85 ft. deep and averages 4 ft. 8 in. in thickness, not varying more than

4 in. from that (Fig. 8). The coal is without partings and seems to vary but little in quality from top to bottom. As usual, the sulphur, though abundant, can be readily separated. The coal gives a white ash when properly prepared or cleaned. The bone coal is 16 in. thick and yields a good deal of gas, though not enough under the conditions to be serious. The fire-clay is 14 ft. thick, and, as usual, when wet becomes very soft and tends to creep, offering the greatest obstacle met with in mining. Their present plan is to drive the entries to the limits and work back to the shaft. Some coal was lost here before learning how to manage the fire-clay. The following sketch was made of a roll or "horse back" in the mine, which differs from the rolls commonly met with (Fig. 519).

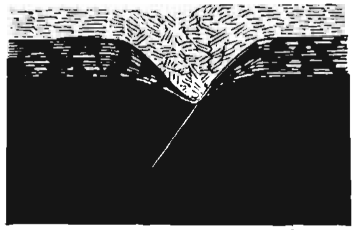


Fig. 519. "Roll" in Broadhurst mine.

At the Larimer mine in Sec. 25 the coal is 110 ft. deep and 4 ft. 8 in. thick. Coal VIII was passed through at about 40 ft. in this shaft. Over the coal is first 6 in. of bone, which is taken down, then from 22 to 28 in. of bone coal forming the roof and serving well (Fig. 5). The fire-clay under is hard, dark drab, and gives little trouble unless water be allowed to stand on it. It is 10 ft. and over thick, and some has been put on the market, which is said to have brought $2.00 a ton. But little trouble is had here with "cut-outs" or "slips."

On the S. W. of the S. E. of this section on the Harris place is a characteristic exposure of the two limestones underlying Coal VIII. The section is as follows (Sect. 442. J. T. S., notes.):

		Ft.	In.
1.	Soil, etc	3+	0
2.	Boulder clay	15+	0
3.	Shale, light-colored, with limestone nodules	3	0
4.	Limestone, massive, few fossils	2+	0
5.	Shale, reddish, much slickensided	5+	0
6.	Limestone in layers, less compact than No. 4	1	0
7.	Sandstone, shaly	10+	0

An interesting section on Sugar creek is seen in Sec. 23-12-10 on Mrs. Meredith's place. The section is as follows (Sect. 443):

		Ft.	In.
1.	Blue shale	1	0
2.	COAL VIII	1	0
3.	White fire-clay, soft and fine	2	0
4.	Blue clay shale	3	0
5.	Limestone, conglomeritic	1	0
6.	Blue shale, containing eroded boulders of fossiliferous limestone, and loose fossils scattered abundantly in shale	5	0
7.	Limestone, in creek bed, not seen	..	..

Coal VIIIa was not seen in this area but was observed a short distance across the Illinois line on the Milton Catts place on the National road, Sec. 5-11-10. The section is given for comparison (Sect. 444, in part from J. T. S., notes.)

		Ft.	In.
1.	Soil	3	0+
2.	Boulder clay	10	0+
3.	Sandstone, some massive, some shaly, to shale	20	0+
4.	Fossiliferous limestone 0 to	..	2
5.	Gray to black shale	1	0
6.	Black sheety shale	1	6
7.	COAL VIIIa	1	3
8.	Fine fire-clay	1	0
9.	Hidden	3	0
10.	Limestone, in creek bed	1	0+

Townships 10 and 11 North, Ranges 9 and 10 West.

1230. Geographic.—As the data in these townships is meagre and scattering they may well be considered together. They correspond to Honey Creek, Linton, Prairieton, and Prairie Creek of the civic townships.

1231. Topography.—"A few sections of Honey Creek township lying south of the main stream and along the south branch are broken, but by far the greater portion of the township has a good surface. The southeastern portion, about one-third, is upland; the balance is in the river valley. Some of the valley land is low and flat and has been drained with considerable difficulty.

"Prairieton is wholly in the main valley. Along the river there is considerable flood-plain, and several bayous, but, in general, the surface is good, although some parts are marshy or swampy.

"Prairie creek rises by three branches in the north half of Linton township. These branches unite in Sec. 8 of Linton township, forming Prairie creek. The creek flows westerly, and in the W. ½ of Sec. 7 enters the east branch of the old valley, and in Sec. 12 of Prairie Creek township turns southwesterly to the S. W., N. W. Sec. 26, thence westerly to the center of Sec. 30; thence southerly into the river in Sec. 13-9-11 in Sullivan county. A branch rising in Sec. 21, Linton township, flows into the main stream in Sec. 24 of Prairie creek, and it receives quite a large branch from the north in Sec. 27. The branches seem to occupy recent valleys. They are comparatively shallow, and the bed of the stream is often rocky or of boulder clay. The branch of the old channel occupied by the main stream is about three-quarters of a mile wide, with some high bluffs and some low, sandy hills. Prairie creek and its branches drain the greater part of Prairie Creek township. Parts of Secs. 9 and 10 drain into Greenfield bayou, and parts of Secs. 35 and 36 are drained southward by branches of Thurman's creek. Nearly one-half of the township lies in the main valley and is mainly flood-plain. The valley of Prairie creek, or the old channel east of the island, occupies about four sections, so that more than one-half of the township is bottom land. There is some broken land along the bluff lines, but it would not amount to more than three or four sections. The northern part of Linton township is drained by the branches of Prairie creek, while the southern part is drained southward by the branches of Thurman's creek. Sec. 1 and parts of 2 and 12 are drained by the south branch of Honey creek, while Sec. 36 and parts of 25 and 35 are drained toward the south by a branch of Busseron's creek. Portions of Secs. 6, 7 and 18 are in the old channel, but the greater part of the township is high land. The valleys of the streams are comparatively narrow and shallow, and there is very little broken land."

1232. Transportation.—The E. & T. H. R. R. crosses the eastern edge of this area, while the E. & I. R. R. just crosses the northeastern corner.

1233. Stratigraphy.—The best section of the strata overlying Coal VIIIa was obtained in the bluff west of the Wabash on the Chas. Murphy place in Sec. 30-11-10.

1234. Section 445. Section on Ashmore Creek.—Clarke County, Illinois. (J. T. S., p. 529.)

		Ft.	In.
1.	Sandstone, reddish, compact or shaly	50	..
2.	Sandstone, shaly, with thin partings of coal	2	..
3.	Shale, gray, free from grit	2	..
4.	Limestone, massive, many fossils	2	..
5.	Shale, gray, decomposed	1	..
6.	Shale, dark colored	1	6
7.	Shale, slaty, splitting into broad sheets	2	..
8.	COAL, apparently of good quality	1	6
9.	Fire-clay and shale	5	..

"Some of the limestone was clayey, but seemed to resist well the action of the atmosphere, weathering evenly on the outcrop. The slaty shale in some places was interstratified with thin layers of coal, and the layers were in many cases covered with gypsum crystals. The sandstone on Ashmore creek forms cliffs of beautiful dark brown stone, that is uniform in texture and color.

At Vigo P. O. in Sec. 29-10-10, the same coal shows, with the following section showing in the bluff of prairie creek.

1235. Section 446. Section on Prairie Creek at Vigo P. O.

		Ft.	In.
1.	Fossiliferous limestone, shaly layers through it	3	6
2.	Gray shale	1	6
3.	Black sheety shale	2	6
4.	COAL VIIIa	1	1
5.	Soft, gray fire-clay	5	0
6.	Gray to drab shale, with sandstone veins	6	0
7.	Gray to light brown shaly sandstone	4	0+

Below this is reported 15 ft. of soft sandstone and shale in a drilling.

A drilling near Middletown, N. W. ¼ Sec. 35-10-10, by Mr. S. E. K. Fisk, commencing in a little valley, struck Coal VIIIa at 13 ft., then through 65 ft. of shale into 1 ft. of coal, probably Coal VIII. After passing through 100 ft. of shale, sandstone and a little limestone the drill struck 3 ft. 6 in. of coal, supposed to be Coal VII. Below this two or three thin beds were struck in the next 250 ft. This gives roughly the distance from Coal VIIIa to Coal VIII, and suggests that Coal VI is thin in this area. A section obtained near the mouth of Prairie creek at the narrows of the Wabash a few miles southwest in Sullivan county, will show better the strata between Coals VIIIa and VIII.

1236. SECTION 447. SECTION AT NARROWS OF WABASH.—Sec. 25-9-11, part of section by John Collett in Sullivan county. (Report, 1870, p. 204.)

	Ft.	In.	Ft.	In.
1. Crinoidal limestone	2	6	..	..
2. "Marl clay" (decomposed limestone)	1	8	..	..
3. Black sheety shale	1	0	..	..
4. COAL VIIIa	..	6	0	6
5. Fire-clay	3	0	..	..
6. Bituminous clay shale	4	0	..	..
7. Drab clay shale	5	0	..	..
8. Quarry sandstone	15	0	..	..
In shaft:				
9. Compact banded sandstone	4	0	..	..
10. Drab shale with iron nodules	14	0	..	..
11. Cream-colored clay shale	4	0	49	0
12. COAL VIII	2	6	2	6

In the section of the boring at Sullivan, the same report, p. 193, he gives this section between the two coals:

1237. SECTION 448. PART OF SECTION AT SULLIVAN, SULLIVAN COUNTY.—(J. Collett, '70, p. 193.)

	Ft.	In.	Ft.	In.
1. Limestone	..	3	..	..
2. Black shale	..	8	..	..
3. COAL VIIIa	..	2	0	2
4. Gray sandy fire-clay	8	0	..	..
5. Clay shale, iron nodules	7	0	..	..
6. Brown sandstone	20	0	..	..
7. Gray sandstone	10	0	..	..
8. Clay shale	10	0	..	..
9. Clay shale ("soapstone")	20	0	75	0
10. COAL VIII and shale	..	9	0	9

On the Hodges place, Sec. 17-10-9, Coal VIII shows 10 in.+ thick, overlain by 20 ft. of clay shale as in the sections given.

In like manner it is necessary to go across the line into Sullivan county to get a section connecting Coals VIII and VII. The nearest section obtainable is at the old Standard shaft.

1238. SECTION 449. PART OF SECTION AT STANDARD SHAFT, SULLIVAN COUNTY.—(Same, p. 216.)

	Ft.	In.	Ft.	In.
1. COAL VIII	0	9	0	9
2. Fire-clay	5	0	..	..
3. Hard limestone	2	6	..	..
4. Clay	5	0	..	..
5. Mottled limestone	3	2	..	..
6. Green clay	7	0	..	..
7. Red clay	6	0	..	..
8. Green and red clay mixed	9	0	..	..
9. "Slickened" clay	8	0	..	..
10. Sandstone, soft, with carbonaceous partings	30	0	..	..
11. Compact sandy white shale	6	0	..	..
12. Sandy shale, plant remains, with coal 1 to 2 in. thick	25	0	..	..
13. Hard clay shale	13	4	..	..
14. "Fern bed" gray clay shale	1	8	121	8
15. COAL VII	4	10	4	10

This shows the characteristic limestone underlying Coal VIII and shows a marked similarity to the corresponding sections in the north part of Vigo county. These coals appear from these and other sections to be about 120 to 130 ft. apart toward the south part of the county.

At Hartford, Sec. 14-10-9, the section to Coal VII was (Sect. 450, E. T. C., p. 102).

	Ft.	In.
1. Soil and drift	37	0
2. Solid, gray sandstone	40	0
3. Gray clay shale, with fossil plants	10	0
4. COAL VII	3	6

Coal VI (?) is reported to lie 130 ft. below Coal VII here, and to be at least 6 ft. thick.

At Farmersburg, and to the south, Coal VI lies from 40 to 50 ft. below Coal VII. It is known that the space between these two coals increases to the north of Sullivan county, and reported drillings would indicate that a considerable portion of this increase took place in the south part of Vigo county. It may be safe to say that Coal VI should be looked for between 75 and 125 ft. below Coal VII. For details of sections see Sullivan county, or above in this county.

1239. DISTRIBUTION AND LOCAL DETAILS, T. 11 N., R. 9 W.—Coal VI is supposed to underlie all of this township with workable thickness and at a depth of about 200 ft. below the level upland.

Coal VII probably underlies all of the hill land of this township, but is cut out in the old preglacial channel of the Wabash, including all the northwestern half of the township, also along the bottom of Honey creek and some of its tributaries.

Mr. Cox reports this coal to lie 100 ft. deep at Youngstown in Sec. 26. In the S. W. of the S. E. of Sec. 25, on the O. P. Smith place, a shaft has been sunk 14 ft. to a coal which was thought to be Coal VIb. No limestone was noted in the material thrown out in digging the shaft, though some black, sheety shale was found, and gray and brown sandstone. A little further up the creek on the J. W. Smith place, in the N. E. of N. E. of Sec. 36, Coal VII has been mined on close to creek level by a drift, now fallen in.

1240. Distribution and Local Details in T. 10 N., R. 9 W.—Coal VI is believed to entirely underlie this township. A drilling at Pimento or Hartford at the old shaft is said to reach a coal at 130 ft. and to have gone into it 5 ft. 6 in. without going through, the limit of the drilling tools being reached at that distance.

Coal VII practically underlies the whole of this township. At the shaft at Pimento or Hartford, S. W. of S. E. of Sec. 14, it is reported 100 ft. in depth, and Coal VIII is said to have been struck near the top of the shaft. It is said to average 3 ft. 2 in. in thickness, running up to 3 ft. 10 in. As described by Mr. Duncan McCullum, formerly superintendent there, the top of the coal was very irregular, the sandstone roof running evenly, but these irregularities being filled with a conglomerate mass of iron and lime nodules, this rock running from 1 in. to 2 to 5 ft. in thickness. From 9 to 12 in. from the top, and following the irregularities of the top, was a ½-in. sulphur band. A knife-edge parting came 8 in. from the bottom. Between the coal and sandstone roof came ⅛ to ¼ in. of black shale. Below was 7 ft.+ of fire-clay, full of carbonaceous filaments. The coal is said to have been very rich and to make an excellent coke, but was too thin to mine profitably. In places the sandstone lifted, allowing several feet of shale to make the roof. Of these shales Mr. Cox writes (E. T. C., p. 102): "The roof shales contain an abundance of well-preserved filices and trunks of Sigillaria, Lepidodendron and Calamites. It is a grand sight to go down into this well-arranged mine and see the ceiling in the entries, from which the coal has been removed, covered with its diversified fossil flora. Immense trunks of Sigillaria extend across this roof and are flanked by branching ferns that cover all the intervening spaces between the trunks of Sigillaria and Calamites with a rich foliage of glossy, black leaves on a matrix of bluish gray argillaceous shale. Indeed, the fossil flora of this mine excels in variety and perfect preservation of the plants any place that I have ever visited. A trunk of Sigillaria was measured, with the assistance of underground manager Duncan McCullum, and found to be eight and a half feet in diameter."

An analysis of the top and bottom of this coal by Mr. Cox gave:

Fixed carbon	49.00		51.00	
Volatile combustible matter	41.00		42.00	
Total combustible matter		90.00		93.00
Ash	7.50		4.50	
Moisture	2.50		2.50	
Total waste		10.00		7.00

This coal has been mined at several places along Russel's run in Sec. 1. A section at Sanford Hill at this point gave (Sect. 451. J. T. S., note book):

		Ft.	*In.*
1.	Soil, white and yellow clay	8	0
2.	Boulder clay	2	0
3.	Sandstone, reddish and shaly	10	0
4.	Shale, light colored	5	0
5.	Sandstone, shaly	5	0
6.	Sandstone, compact	9	0
7.	Shales, light bluish, many fossils	17	0
8.	COAL VII	3	3
9.	Fire-clay and shale	3	0+

The lower part of this section is from the shaft of I. S. Hipple in the S. E. of S. W. of Sec. 1. The coal is here 3 ft. thick without parting. The bottom foot is not as good as the rest. Coal has been stripped for 30 years in the branch to the east of this. On the Ray place it has been mined by stripping, then by a slope, then by a shaft, starting part way up the hill. It has also been mined on the Siner place, N. E. of S. W. of Sec. 1, and Russel place N. W. of S. E. of same section. It is said that in this mine the coal was followed until it started to dip north so sharply as to appear to be "standing on end."

The western part of this township appears to be underlain by Coal VIII. The limestone supposed to lie but a short distance below it is noticed on the Geo. W. Sullen place in the N. W. ¼ of Sec. 15, close to the Sullivan road. The limestone here is conglomeritic in form, and in weathering leaves a great quantity of small nodules. In a small drain near the center of Sec. 16, on the Randolph place, the limestone is 1 ft. 6 in. thick, in part solid and in part double, with only an irregular crevice between the parts. A short distance above it is what would be at first taken for an outcrop of coal, but which, on closer inspection, appears to be an irregular layer of eroded pieces of coal imbedded in the bottom of the boulder clay. On the Steven

Hedges place, in Sec. 17, an outcrop supposed to be of Coal VIII is seen, overlain by 20 ft. of clay shale. The limestone under this coal was also noted at one or two points in the south part of the township.

In the S. E. corner of the township appears to be a small area of Coal VIIIa. On the Wm. H. Pound place, in the N. ½ of Sec. 30, the section obtained gave (Sect. 451):

		Ft.	In.
1.	Gray shale	5	0
2.	Limestone, with shale, full of fragments of fossils	2	0
3.	Blue shale	0	6
4.	Shaly limestone, as above	0	6
5.	Blue to black shale	2	0
6.	Black shale, splitting in thin sheets	2	0
7.	Brown shale	3	0
8.	COAL VIIIa (exposed)	1	8+

The coal here is just below the creek level, and in its dip just about follows the creek.

At a well on the Van Gilder place, in S. E. ¼ of Sec. 19, the coal is 18 in. thick at a depth from the level of 26 ft. In the branch northeast of the house, where it had been stripped, it was 12-14 in. thick, overlain by black, sheety shale.

1241. Distribution and Local Details, T. S. 10 and 11 N., R. 10 W.—Coal VI probably underlies all of this area and at a depth of between 150 and 200 ft. below the Wabash. It may be found locally to be of workable thickness, though it is not known to be so.

The horizon of Coal VII underlies all of this area. It is, however, probably cut out along most or all of the old filled channel of the river through T. 11 N., R. 10 W.

The horizon of Coal VIII underlies all but the northeastern corner of T. 11 N., R. 10 W. It is probably cut out all along the preglacial channel of the river, and in this case that includes a large part of the area. In the north part of T. 11 N., R. 10 W., this coal outcrops along the foot of the bluff on the west side of the river. It has been found on the Cassiday and Bell places in Sec. 15-11-10. It does not appear to attain to a workable thickness.

Coal VIIIa is confined to T. 10 N., R. 10 W., in this county, unless it just overlaps the county line in the north part of 11-10. All data in reference to it was obtained in 10-10. It there outcrops around the edge of the old preglacial island which makes up Johnson's hill; also along the bluff and branches on the south side of Prairie creek.

This coal has been stripped a little on the Elliott place in the S. E. 40 of Sec. 24 and on the M. Piety place just northeast of Middletown

in S. W. ¼ of Sec. 26. At the latter place the limestone and black, sheety shale overlying the coal were seen. It outcrops again down Prairie creek in Sec. 28, near Vigo P. O., 1 ft. 1 in. thick. A section here was given above. In Sec. 16, south of Hutton P. O., it outcrops and has been stripped on the C. C. Paddock and J. E. Dent places. At the latter place the roof showed limestone 2 ft.; shale, bottom black and sheety, 3 ft.; gray to blue shale, 3 ft.; to coal, not exposed.

On the Hutton place, just north of Hutton P. O., the section at a fresh outcrop showed (Sect. 452):

		Ft.	In.
1.	Bluish brown shale	2	6
2.	Limestone, running out in places.....0 to	1	0
3.	Gray to black shale, sheety at bottom	3	8
4.	Gray to blue shale	3	6
5.	COAL VIIIa (exposed)	..	6

Just north, at a stripping on the E. Paddock place, the section shows as follows (Sect. 453):

		Ft.	In.
1.	Limestone	..	10
2.	Shale	..	6
3.	Grayish-blue fossiliferous limestone	1	6
4.	Blue to black sheety shale	2	0
	Coal VIIIa hidden.		

It is reported that a drilling was made in this stripping to a depth of 165 ft. without striking any coal, shale being the principal rock found. This drilling should have passed through Coal VIII at from 50 to 75 ft., and probably did not reach Coal VII, which lies over 100 ft. lower.

This coal outcrops again on the J. R. Piety place, well up upon Johnson's hill. In the N. W. ¼ of Sec. 15 a drilling is reported to have struck this bed at 60 ft. and a second bed at 90 ft. The position of the coal on the Piety place indicates anticlinal structure in this hill.

On the A. R. Reed place, in the S. W. 40 of Sec. 13, the limestone and shale were struck in a well with 18 to 20 in. of coal below.

1242. Summary of Coals of Vigo County.—

Divisions contained: VIII-I, inclusive.
Coals contained: VIIIa, VIII, VII, VIb, VIa, VI, Vb, Va, V, IV, III, I?

ROUND NUMBER ESTIMATES.

Coal VIIIa.

Unworkable area	40 sq. mi. ×	av. thickness,	½ ft. ×	1,000,000 =	20,000,000 tons.

Coal VIII.

Worked area	10 acres ×	av. thickness,	4 ft. ×	1,200 =	48,000 tons.
Workable area	30 sq. mi. ×	"	4 ft. ×	500,000 =	60,000,000 tons.
Unworkable area .	75 sq. mi. ×	"	1 ft. ×	1,000,000 =	75,000,000 tons.
Total area	105 sq. mi				135,000,000 tons.

Coal VII.

Worked area	1 sq. mi. ×	av. thickness,	4 ft. ×	500,000 =	2,000,000 tons.
Workable area	100 sq. mi. ×	"	4 ft. ×	500,000 =	200,000,000 tons.
Unworkable area .	100 sq. mi. ×	"	2 ft. ×	1,000,000 =	200,000,000 tons.
Total area	200 sq. mi				402,000,000 tons.

Coals VIb and VIa.

Worked area	2 acres ×	av. thickness,	5 ft. ×	1,250 =	12,000 tons.
Workable area	5 sq. mi. ×	"	3 ft. ×	500,000 =	7,500,000 tons.
Unworkable area .	360 sq. mi. ×	"	1 ft. ×	1,000,000 =	360,000,000 tons.
Total area	365 sq. mi				367,000,000 tons.

Coal VI.

Worked area	1½ sq. mi. ×	av. thickness,	6 ft. ×	500,000 =	1,500,000 tons.
Workable area	300 sq. mi. ×	"	4 ft. ×	500,000 =	600,000,000 tons.
Unworkable area .	100 sq. mi. ×	"	2 ft. ×	1,000,000 =	200,000,000 tons.
Total area	400 sq. mi				800,000,000 tons.

Coals Vb–I.

Workable area	100 sq. mi. ×	av. thickness,	3 ft. ×	500,000 =	150,000,000 tons.
Unworkable area .	300 sq. mi. ×	"	5 ft. ×	1,000,000 =	1,500,000,000 tons.
Total area	400 sq. mi				1,650,000,000 tons.

Number of coals contained: 11+
Greatest thickness recorded: 7+ Coal VI in Nevins township.
Area underlain by coal: 400 sq. mi.
Area underlain by workable coal: 300 sq. mi.
Estimated total tonnage of coal: 3,375,000,000 tons.
Estimated total tonnage of coal removed or lost: 6,560,000 tons.
Estimated total tonnage of workable coal left: 1,000,000,000 tons.
Number of mines, working ten men or over, in operation: 15.
Number of mines, working less than ten men, in operation: 25.
Total number of mines in operation: 40.
Large mines abandoned: 15.
Small mines not in work: 75.
Strippings and outcrops: 125.
Total number of openings to coal: 255.

XXIV. GREENE COUNTY.

1243. REFERENCES AND FIELD WORK.

1862 (1859). Richard Owen, Rep. of a Geol. Reconn. of Ind., p. 171. One analysis. (R. O.)

1862 (1859). Leo Lesquereux, same, pp. 332-334. One coal section. (L. L.)

1869 (1869). E. T. Cox, 1st Ann. Rep., Geol. Surv. of Ind., pp. 86-109. Detailed report, map, seven columnar and coal sections, three coal analyses. (E. T. C.)

1896 (1895). W. S. Blatchley, Dep. of Geol. and Nat. Res., 20th Ann. Rep., pp. 87-90. Two sections containing coal; discusses clays and shales. (W. S. B.)

1896 (1895). T. C. Hopkins, same, pp. 310-311.

1897 (1896). W. A. Noyes, same, 21st Ann. Rep., pp. 105-106. Three coal analyses.

1897 (April, May, June). C. E. Siebenthal, field work for this report, assisted by the writer, in townships 6, 7, 8 north of range 7 west.

Section 1. Geographic.

1244. LOCATION AND EXTENT.—Greene county is a rectangle lying south of Clay and Owen counties, west of Monroe, north of Knox, Daviess and Martin, and east of Sullivan. It is 30 mi. long by 18 mi. wide, and has an area of 540 sq. mi. It occupies townships 6, 7 and 8 north of ranges 3-7 west.

1245. ELEVATION.—In elevation this county ranges from about 475 ft. above tide where White river flows out, to over 800 ft. in the eastern and northeastern part. White river at Bloomfield is given as 490 ft. A. T. Along the I. & V. R. R., which keeps in the valley of White river, the elevations are: Worthington, 522 ft.; Dixon, 530 ft.; Switz City, 526 ft.; Lyons, 509 ft.; Marco, 482 ft.

1246. GENERAL TOPOGRAPHY AND DRAINAGE.—With the exception of the western part of Wright township and parts of Center and Jackson townships, all of the drainage is to White river, which flows south across the center of the county. The main branches from the east are Richland, Beech, Plummer's and Doan's creeks; from the west, Latta's, Buck and Black creeks. Indian creek, along the eastern edge of the county, runs into the east fork of White river.

East of White river the topography is much broken, as suggested in the cross sections on the colored map. As the dividing ridge between the two forks of White river is approached, the elevations reach probably over 300 ft. above White river, and 150 to 250 ft. above the adjacent drainage. The divides are usually narrow, as are the stream channels, with steep slopes between. As the river is approached, the topography becomes less broken. West of the river are extensive marsh-like prairies, evidently filled-up valleys, while the divides between are broad rolls rising from 25 to 75 ft. above the level prairies. In the northwestern part of Stockton and in nearly all of Wright township, the stream channels are narrow with rather steep banks rising to narrow divides.

1247. Railroad Facilities, Etc.—The Indianapolis & Vincennes Railway crosses the county in a southwesterly direction, keeping west of White river. It also sends a branch to the Linton coal field and Dugger in Sullivan county. The Evansville and Indianapolis Railway runs north and south across the center of the county. The St. Louis, Indianapolis and Eastern Railroad, formerly the Illinois and Indiana Railroad runs to Switz City from the west, while from the same place the Switz City branch of the C., I. & L. Ry. (Monon) runs southeast out of the county. In 1899 the Indiana Southern Railroad is being extended from Elnora to Linton, and two or three other roads or branches are being planned to reach the Linton field. As yet, no manufacturing of importance is carried on in the county.

Section 2. Stratigraphy.

1248. Pleistocene Deposits.—As shown on the map, the eastern or southeastern end of the county was not overrun by the ice; over the uplands of the rest of the county the drift is generally met with, though usually less than a score of feet in depth. In the lowlands and prairies the deposits are found to be of considerable depth, often over 100 ft., these places evidently being old valleys filled up. Some interesting deposits occur along the glacial border in eastern Greene county. As the ice pushed its way southeast across the county it overran the lower courses of many of the streams flowing west to White river, thus effectually damming them up. Small lakes were thus formed. In time

these filled up. Then the ice retreated and the streams resumed their old channels. In most cases they immediately began clearing this lake deposited material out. As this was in the upper part of their courses, where the current had some power, most of the streams have about rid their channels of all vestiges of these deposits. Along Richland creek, in Beech Creek township, however, much material yet remains in the form of gravel terraces mantling the bluffs of the banks of the streams. In places these terraces are over a quarter of a mile broad. In the case of a branch of Clifty creek, in the southeastern part of Center township, instead of clearing out the deposit laid down in the ice-bound lake, the water finds its way down through the mass at several places and flows away underground to appear in the old channel further down. In this case it would appear quite possible that the water had found a passage under the ice before the glacier retreated. The result is a flat filling in the valley to which the name of "American Bottoms" has been given.

1249. Coal Measures.—Divisions I to VII are found in this county. Divisions VII, VI, V and IV each contain commercially workable coal; Divisions III and I contain coals workable locally for local trade or possibly in some cases for a limited shipping trade. Division IV contains one coal in addition to the workable coal; Division III contains at least three coals; Division I is thought to contain two coals. As at present developed, the principal bed is Coal IV, or the Linton coal. No exact correlation is assumed between Divisions III and IV of this county, and III and IV of Clay county. The following table shows the relative position of the coals in the columnar section.

Division VII—
1. Sandstone and shale.
2. COAL VII (Rider at Dugger), 3 to 4 ft. thick. Very limited.

Division VI—
3. Fire-clay, limestone (?), sandstone, shale.
4. COAL VI, Dugger coal, about 6 ft. thick, with three partings.

Division V—
5. Fire-clay, shales, limestone, black sheety shale.
6. COAL V, Alum Cave coal, up to 7 ft. thick. Limited to range 7 west.

Division IV—
7. Fire-clay, sandstone, shale.
8. COAL IVa, rider at Linton.
9. Fire-clay, sandstone, shale.
10. COAL IV, Linton coal, 5 ft. to 6 ft. 10 in. thick. Coal principally worked.

Division III—
11. Fire-clay, thin; sandstone, shale.
12. COAL IIIb, local, wanting to east.
13. Fire-clay, sandstone, shale.
14. COAL IIIa, local.
15. Fire-clay, sandstone, shale.
16. COAL III. Coal east of Bloomfield.

Division I—
17. Mansfield sandstone.
18. COAL Ia (?), or I?. (Reported by Cox.)
19. Sandstone.
20. COAL I (A of previous reports).

1250. LOWER CARBONIFEROUS.—The Kaskaskia is well represented in this county by limestone and sandstone, with some shales. The uppermost limestone, which is not very persistent here, usually is found but a few feet below Coal I or the equivalent horizon. This limestone, while often absent, attains a thickness of 20 ft. in places. Then comes a variable thickness of sandstones and shales, and below that still heavier beds of limestone. The lower limit of the Kaskaskia is somewhat in dispute, as by some it is drawn at the top of this lower limestone, by others part way down in it. The lower part of this limestone is probably of St. Louis age, and extends down into the Mitchel limestone.

TOWNSHIPS 6, 7 AND 8 NORTH, RANGES 3 AND 4 WEST.

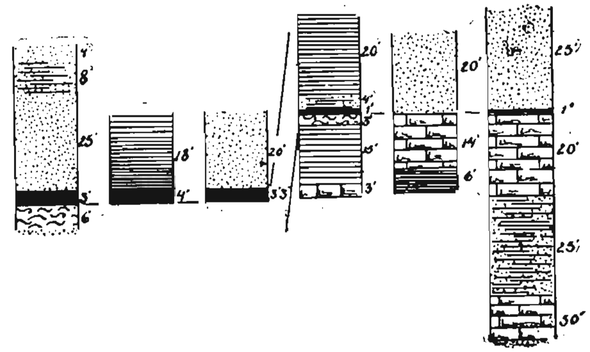
1251. GEOGRAPHIC.—This area includes the eastern two-fifths of Greene county. It corresponds to all of Beech Creek, Center and Jackson townships, and the eastern half of Highland, Richland and Taylor townships.

The topography has been sufficiently described under the general topography of the county.

The Switz City branch of the Monon railway cross the southern part of the area.

1252. STRATIGRAPHY.—Two coals occur in this area, though the upper coal is found only in the three southwestern townships. No good sections were obtained connecting the two coals. The lower coal occurs just at the bottom of the coal measures and corresponds to Coal I. The upper coal is supposed to come above the Mansfield sandstone, and so to be Coal II or III. It will be called Coal III, with the understanding that no correlation is intended with Coal III of Clay county. The massive sandstone overlying it gives it a strong resemblance to

what is called Coal II in the southern counties, typically exhibited at Cannelton, Perry county. Its correlation with the coal called Coal III west of White river and around Linton is not above question. The following group of sections gives a partial view of the coal and overlying strata:



520	521	522	523	524	525
Inman. Sec. 20-7-4.	Dawson. Sec. 32-6-3.	Eisenogle. Sec. 16-6-4.	Monon tunnel. Sec. 28-6-3.	Sexton. Sec. 15-6-3.	Beech Creek. Sec. 12-7-4.

Figs. 520-522. Columnar sections in Division III, Ts. 6-8 N., Rs. 3-4 W.
Figs. 523-525. Columnar sections in Division I and Lower Carboniferous, Ts. 6-8 N., Rs. 3-4 W.

1253. SECTION 454. SECTION AT JAS. INMAN MINE.—N. W. of S. W. of Sec. 20-7-4, Fig. 520. (C. E. S.)

	Ft.	In.
1. Slope, concealed	?	?
2. Flaggy sandstone	4	0
3. Sandy shale	8	0
4. Massive sandstone, iron spotted, cross-bedded	25	0
5. COAL III	3	0
6. Fire-clay	6	0
7. Sandstone	?	?

The massive sandstone in this section strongly resembles the Mansfield sandstone, so that the coal is easily mistaken for Coal I.

1254. SECTION 455. SECTION AT GEO. W. VEST'S MINE.—N. E. of S. W. of Sec. 28-7-4, Fig. 527. (C. E. S.)

	Ft.
1. Massive buff sandstone	4
2. Shaly, bluish, hard sandstone	1
3. Black sheety shale	6
4. COAL III	2

1255. SECTION 456. SECTION AT AMOS DAWSON'S SHAFT.—S. W. of N. W. of Sec. 32-6-3, Fig. 521. (C. E. S.)

		Ft.	*In.*
1.	Shale	18	0
2.	COAL III (3 to 5 ft.)—Coal, 8 in.; clay, 6 in.; coal, 3 ft. 0 in.	4	2
3.	Fire-clay.		

1256. SECTION 457. SECTION AT SIMON EISENOGLE'S MINE.—S. W. ¼, Sec. 16-6-4, Fig. 522. (C. E. S.)

		Ft.	*In.*
1.	Massive sandstone	20	0
2.	COAL III. 3-in. clay band in middle	3	3

The following sections are in Division I or below:

1257. SECTION 458. SECTION AT EAST END OF LITTLE MONON TUNNEL.—N. E. of S. E. of Sec. 28-6-3, Fig. 523. (C. E. S.)

		Ft.	*In.*
1.	Soft, dark shale	20	0
2.	Heavy, sandy shale, with sigillaria	4	0
3.	Bone Coal I	1	0
4.	Fire-clay	3	0
5.	Olive-green shale	3	0
6.	Soft, dark drab clay shale	12	0
7.	Shaly limestone and shale	3	0

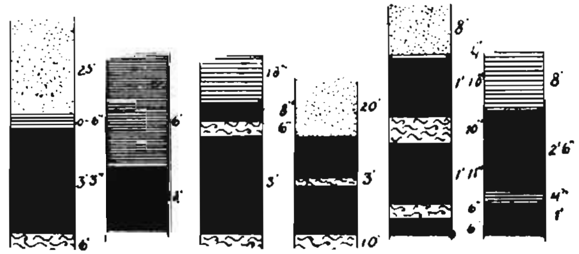
1258. SECTION 459. SECTION AT WM. SEXTON'S SPRING.—S. W. of S. E. of Sec. 15-6-3, Fig. 524. (C. E. S.)

		Ft.	*In.*
1.	Massive buff sandstone (Mansfield)	20	0
2.	Heavy limestone (lower carboniferous)	14	0
3.	Bluish clay shale	6	0

1259. SECTION 460. SECTION ON BEECH CREEK.—Sec. 12-7-4, Fig. 525. (E. T. C.)

		Ft.	*In.*
1.	Brownish-gray sandstone in thick beds (Mansfield)	25	0
2.	Shale, horizon of Coal I	..	1
3.	Buff-colored limestone (lower carboniferous)	20	0
4.	Gray, sandy shales, partly covered	25	0
5.	Bluish limestone, with intercalations of sandstone, mostly covered	50	0
		120	1

1260. COAL III.—Some sections of this coal were given above. In the four sections figured from township 7 N., R. 4. W., it runs in thickness 2 ft., 3 ft., 2 ft. 5 in., 2 ft. As these sections are all taken from mines, they represent the maximum rather than the minimum.



526 Inman. Sec. 20-7-4. 527 Vest. Sec. 28-7-4. 528 Dawson. Sec. 32-6-3. 529 Eisenogle. Sec. 16-6-4. 530 Hays. Sec. 16-6-4. 531 Phillips. Sec. 21-6-4.

Figs. 526-531. Sections of Coal III in Ts. 6-8 N., Rs. 3-4 W.

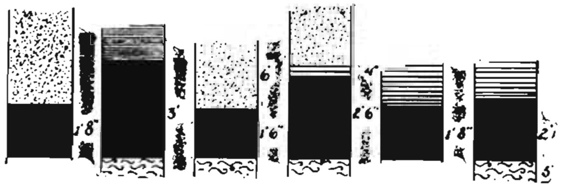
Two of these have a good sandstone roof, the others black shale. Two are underlain by fire-clay and one by sandstone as far as known. Of the four from T. 6. S., Rs. 3 and 4 W., the thickness runs from 3 ft. to 4 ft. 3 in., not including one or two clay bands. The Hays coal reported by Mr. Cox is said to have had two clay bands. The section as given by Mr. Cox is as follows:

1261. SECTION 461. SECTION AT T. HAYS' MINE.—Sec. 16-6-4, Fig. 530. (E. T. C., p. 98.)

		Ft.	*In.*
1.	Slope, covered space to top of hill	30	0
2.	Coarse-grained, buff sandstone	8	0
3.	Black shale	..	0¼
4.	COAL III—Coal, 1 ft. 10 in.; clay parting, 10 in.; coal, 1 ft. 11 in.; clay parting, 6 in.; coal, 6 in.	5	7

At all points where observed by Mr. Siebenthal it had only one parting in this area, which ran from 3 to 6 in. in thickness. This parting appears to come sometimes near the top, sometimes near the bottom, and sometimes in the middle of the bed. In two of these cases the roof is shale; in two, sandstone. The coal is usually a semi-block, generally mined by shooting, but not always. The quality is variable, being very poor in places and good in others. At most of the outcrops this coal shows a thickness of less than 2 ft., and often of less than 1 ft.

1262. Coal I. The horizon of this coal underlies a large share of these townships, as shown on the map. As suggested by the columnar sections, however, it is wanting over considerable areas. The sections given above, being taken from mines, show more nearly the maximum development of the coal than the average. These show a thickness of 3 ft. in only one case out of the eight; of between 2 and 3 ft. in



532	533	534	535	536	537
Ogg. Sec. 32-8-3.	Barnes. Sec. 2-8-4	Long. Sec. 7-8-4.	Hill. Sec. 20-7-4.	Smiley. Sec. 28-6-3.	Rawlins. Sec. 29-6-3.

Figs. 532-537. Sections of Coal I in Ts. 6-8 N., Rs. 3-4 W.

only two cases, the rest being under 2 ft. in thickness. A large proportion of isolated outcrops show a thickness of less than 1 ft.; from which it is readily seen that little, if any, workable coal exists at the horizon in this area. Sandstone predominates as a roof, though shale or black shale occurs in many cases. The coal is usually a semi-block, and, on the whole, rather poor, though good in places.

1263. Distribution and Local Details of Coal in T. 8 N., R. 3 W.

As shown on the map, only the horizon of Coal I is found in this township. This occupies the tops of the ridges over an isolated area in the north part of the township; also the tops of the ridges in the southern and southwestern part of the township. In this northern isolated area coal was found at only one point. That was on the Jno. T. Burket farm, in Sec. 11. The evidence suggests that over most of this area Coal I is lacking, the massive sandstone of Division I lying on the Lower Carboniferous rocks, or separated from them only by shale. Thus, in the S. E. of S. W. of Sec. 2 there is exposed 30 ft. of the sandstone with the Kaskaskia limestone 2 ft. thick below, but no coal. Still below that is a thickness of 100 to 120 ft. of Kaskaskia shales, sandstones and clays. At McVille, N. W. corner of Sec. 10, limestone is reported in the wells at a slight depth. As Mansfield sandstone is found 25 ft. below the top of these wells 300 yds. north, and as no limestone

outcrops are seen at the level reported, it is possible a mistake has been made in the determination of the rock. Thus, one well showed: Soil, 10-12 ft.; limestone, 32 ft. Another one, 35 ft. south, is reported as giving: Soil and clay 9 ft.; black streak, 3 in.; interval, 14 ft.; limestone, 12 ft.

In the southern area coal was found at only two places, at the Neidigh farm in the S. W. of S. E. of Sec. 31, and at the R. W. Ogg bank on the P. M. Cook place in the N. W. of S. E. of Sec. 32. At the former place the coal was 20 in. or more thick, a sandstone bluff appearing above the coal (Fig. 532.)

1264. Distribution and Local Details in T. 8 N., R. 4 W.—Only the horizon of Coal I occurs in this township. It is still confined to the ridges, being cut out across all valleys. Coal has been struck in a number of places in the top of the ridge running north from Newark. In the S. E. $\frac{1}{4}$ of Sec. 2 Mr. V. H. Cosner struck coal in his well, going 5 or 6 in. into it. In a hole a little northwest he went 1 ft. into the coal. At an opening 500 yds. south the coal was 20 in. thick, but was not worked because cut out by a "slip." On Mr. William Hanson's farm, N. $\frac{1}{2}$ of S. W. $\frac{1}{4}$ of Sec. 2, Coal I has been worked at two places. The coal runs from 26 to 32 in. with an average of 30 in. The coal is a semi-block. The roof is a black shale and good, though 4 in. comes down. Below is 4 or 5 ft. of fire-clay. Reported not suitable for blacksmithing. This bed outcrops on the west side of the same 40 acres, while a 6-in bed of coal was struck in a well on the top of the ridge, and 30 to 50 ft. above the main bed.

In the S. E. of S. W. of Sec. 2 this coal is worked on the Jas. Barnes place. Coal I here runs from 28 to 38 in. thick, with an average of 3 ft. (Fig. 533). It is a semi-block with seams, but partly mined with powder. The roof is a black shale, holding well, with fire-clay below. Blacksmiths report it as not suitable for their work. At the wells at both houses 6 in. of coal was struck 50-60 ft. above the main bed. The well at Mr. Barnes's house gave: Soil, etc., 20 ft.; sandstone, 10 ft.; coal, 6 in.

At Mr. Frank B. Philpot's bank, in the N. E. of N. W. of Sec. 11, Coal I is about thirty inches thick. The roof is soft black shale 10 to 12 ft. thick, all of which holds. Some horsebacks are met with, as in the preceding mine. Above the black shale roof is 10 to 15 ft. of shaly sandstone. Coal is reported to outcrop in the N. E. of N. E. of Sec. 11; N. W. of S. E. of Sec. 12, 2 in. thick; S. E. of N. W. of Sec. 13; and at two places in the S. W. of N. W. of Sec. 13; S. W. of N. E. of Sec. 26; S. E. of N. W. of Sec. 26; S. E. of S. E. of Sec. 35; N. W. of N. W. of Sec. 22; and two places on the S. E. of N. E. of Sec. 16.

On Perry Long's farm, in the N. W. of S. E. of Sec. 9, Coal I is 18 in. thick. It is a semi-block with 6 ft. of massive sandstone for a roof, and a fire-clay floor (Fig. 534). At the Reid Vandeventer bank, S. W. ¼ of Sec. 9, the coal is said to have been 30 in. thick. The mine is now caved in. At Geo. Dillon's, in the S. W. of S. W. of Sec. 8, Coal I is 10 in. thick. In the S. W. ¼ of Sec. 7, Coal I on the David Bland place is 14 in. thick, overlain by 14 ft. of black to blue shale, and that by 20 to 30 ft. of massive, shaly sandstone. The coal is underlain by 50 ft. of sandy shales, with sandstone and limestone still below.

In Sec. 17 the coal outcrops 10 in. thick on the Wm. Graves farm in the N. E. of N. W. of the section, and with about the same thickness in the S. W. ¼ of the section. In Sec. 19 there is a fine face of quarryable sandstone in ledges from 3 in. to 3 ft. thick, on the Isaac Phipps farm N. W. of N. E. of section.

In the N. W. of N. W. of Sec. 29 the following section is exposed near the road: Ferruginous, flaggy sandstone, 20 ft.; blue and gray clay shale, 15 ft.; Coal I concealed. In Sec. 30, 500 yds. northwest of this is an excellent example of recent erosion in the shape of a 50-ft. gully in the drift which is said to have been eroded in the last thirty years.

Other outcrops of Coal I in this township were noted in the N. E. of N. E. of Sec. 30, 1 ft. thick; N. W. of S. E. of Sec. 30; S. W. 40 of Sec. 33. In the N. W. 40 of Sec. 32, Coal I has been mined a little on the H. H. Larver place. The seam is a semi-block 19 or 20 in. thick, which can be mined without powder. The roof is shale and good, the floor fire-clay.

1265. Distribution and Local Details, T. 7 N., R 3 W.—Only the horizon of Coal I is found in this township, and, as in the township just north, it is confined to the highest parts of the divides. In the eastern part of the township it underlies a narrow, irregular area along the divide between the two forks of White river. Coal outcrops were only noted in the N. E. of N. W. of Sec. 12; S. W. of N. E. of Sec. 14, and N. W. of N. E. of Sec. 27 at Cincinnati. It is probable that the coal is thin or wanting along the ridge, though where present should be found as mapped.

Along the ridges in Secs. 3, 4, 5 and 6, the horizon of Coal I underlies the top of the ridge as mapped. Coal was only found at one place, in the S. W. of N. W. of Sec. 6.

Along the ridge north of what is known as the American bottom, in Secs. 15 to 18, outcrops of Coal I were noted just S. E. of the center of Sec. 17 and in the N. W. of the N. E. of Sec. 18. Coal was also struck in a well on the Uland place near the center of Sec. 18.

In Sec. 21 the coal outcrops on the Kinsey Cullison place in the N. W. of the S. W. North of the center of Sec. 16 the sandstone of Division I shows a thickness of from 30 to 40 ft.

In the S. W. of N. E. of Sec. 30, Coal I has been mined on the Richard Hardesty place. The coal is described as a dry block coal, 20 to 24 in. thick, that could not be mined with powder and did not

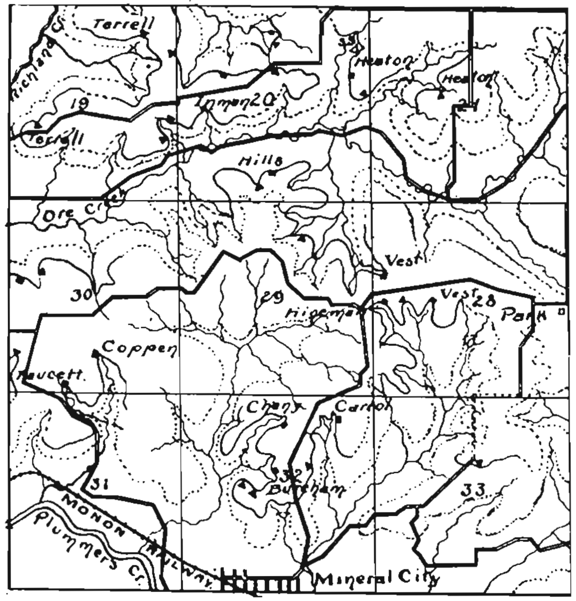


Fig. 538. Sketch map of part of T. 7 N., R. 4 W.

kindle easily. The Kaskaskia limestone, as found in the next hollow, must come very close to the coal here. The same coal has been worked also at the Freeman Rutledge bank, just west in the S. E. of the N. W. of Sec. 30. It is reported to have run up to 3 ft. 6 in. in thickness, and is well spoken of by blacksmiths.

South of North Clifty creek the Mansfield sandstone occupies the tops of the ridges as shown on the map. Coal was only found at one point. That was at the Isaac Lewis bank in the N. E. of the S. E. of Sec. 31. The coal here was only 1 ft. thick, but a bright coal well spoken of by blacksmiths.

1266. Distribution and Local Details in T. 7 N., R. 4 W.—This township contains the horizons of Coal I, and of what will be called Coal III. The horizon of Coal I underlies the hill tops in the eastern and northern parts of the township, but the southwest dip carries it low enough so that the horizon of Coal III is caught in the hill tops in the southwest part of the township.

In the area north of Beech creek and east of Richland creek the coal underlies the top of hills as mapped. An outcrop was noticed in Sec. 2 S. W. of N. E., where Coal I was 6 in. thick; also an outcrop in the S. E. of S. W. of Sec. 2. In the S. E. of N. E. of Sec. 12 was the section given above (Sect. 460, ¶1259).

Northeast of Richland creek, about Tulip, the Mansfield sandstone caps the hills and Coal I is exposed in outcrop in the S. W. of S. E. of Sec. 4, the N. W. of S. E. of Sec. 12, where it is 1 ft. thick, and the S. W. of S. E. of Sec. 7.

South of Beech creek in the eastern half of the township the Mansfield sandstone caps the ridges from Heaton P. O. west and southwest, also the ridge between the American bottoms and Clifty creek. Coal I was reported to outcrop in the S. W. of N. W. of Sec. 13. In the S. E. of N. E. of Sec. 15 the same coal outcrops 10 in. thick.

In the western part of Sec. 15 Coal III is found in the ridge outcropping in the S. E. of N. W. of the section just east of the schoolhouse.

South of Richland creek, in the western half of the township, the horizon of Coal I is found lower down the hills, while some 40 ft. above is the outcrop of Coal III. In the S. W. of S. E. of Sec. 17 Coal I has been worked some, the thickness here being 26 in. The section here shows: Coal I, 2 ft. 2 in.; hidden, 30 ft.; shale, ?; sandstone, 10-20 ft.; limestone, 25 ft.; sandstone, 8-10 ft. Coal I outcrops again in S. E. 40 of Sec. 8, reported 22 in. thick, and in the N. W. 40 of Sec. 16.

In Sec. 19 Coal III at Malachi Terrell's, in the N. E. of N. E. of section, is 3 ft. thick. It is also exposed on the Wm. Terrell place in the N. W. of S. W. and in the N. E. of S. E. of this section.

In Sec. 20 Coal III outcrops on the John Heaton place in the N. E. ¼, and north of the center of the section. Coal I? has been stripped in the N. E. of N. W. of the section, and mined by drifts on the James Inman farm S. W. of N. W., and H. Hill's farm in the S. E. of S. W. At the Inman bank, where coal has been mined for forty years, the seam is 3 ft. to 3 ft. 7 in. thick. It is described as a semi-block, the top coal being soft. Powder is used to mine with. At the entrance the roof is sandstone; further in it becomes shale, 6 to 8 in. coming down. Below the coal is about 6 ft. of fire-clay (Fig. 526). The section here was given above (Sec. 454). The sandstone over the coal forms a massive overhanging bluff 25 ft. high. The coal is somewhat sulphury. At the Hill bank the coal is 29 or 30 in. thick. It is a semi-block, mined with powder. The roof is a heavy sandstone, with 4 in. of draw slate between. Below is a fire-clay (Fig. 535).

In the S. E. of the N. W. of Sec. 21, Coal III is 30 in. thick on the Jas. Heaton place.

In Sec. 28, at the James M. Vest mine, S. W. of N. W., formerly the Holtzclaw or Shryer mine, Coal III is 28 to 32 in. in thickness and a semi-block. Over the coal is 12 ft.? of shale, which is taken down in the entries. Above that is sandstone. The fire-clay is 6 to 12 in. thick. The coal contains too much sulphur for blacksmithing.

In the N. E. of the S. W. of this section, Coal III is mined on the Geo. W. Vest farm. The coal is 2 ft. thick and too nearly a block coal to shoot. The roof is black sheety shale, 4 to 6 ft. thick, with sandstone over. The floor is a hard rock. The section here shows (Fig. 527) (Sect. 462, C. E. S.).

	Ft.	*In.*
Massive buff sandstone	4	0
Shaly, bluish, hard sandstone	1	0
Black sheety shale	6	0
COAL III?	2	0

At the Geo. Hineman mine, formerly the Cushman mine, on the next 40 west, Coal III is 28-32 in. thick, a non-shooting, semi-block coal, reported of good quality; the roof is of clay shale, and soft. The floor is hard sandstone. In places the coal is cut out by the preglacial erosion. Coal I is here 40 ft. below and 1 ft. thick.

In the N. E. ¼ of Sec. 29 Coal I is 6 in. thick. In Sec. 30 Coal III, in the S. W. of N. W. is worked at the D. M. Hildebrand bank, now owned by Dr. Asbury. The coal is 26 in. thick, a non-shooting, semi-block, not suitable for blacksmithing. The roof is black shale and good. Coal III is also found in the S. W. 40 of this section, and on the Robt. Coppen farm in the S. W. of S. E.

In the N. E. of the N. W. of Sec. 31 Coal III was formerly worked on the Levi and Leslie Faucett place. It was reported to have been 3 ft. thick.

In the S. E. of the N. W., and S. W. of the N. E. of Sec. 32, Coal III is 2 ft. thick where it has been worked on the Levi D. Burcham place. In the N. W. of the N. E. of this section Coal III has been worked on the Ezra Chaney place. The coal is 29 in. thick and has a soft shale roof. Above that is 16 to 18 ft. of sandstone. The fire-clay is thin and below is 8 ft. of sandstone. Coal III is also found on Mr. Ben Carrol's.

1267. Distribution and Local Details, T. 6 S., R. 3 W.—Coal in this township is limited to the western two-thirds. Over most of that area only Coal I is found, and then only in the ridges. In Secs. 29-31 is a small area of Coal III.

In the northern half of the township the Mansfield sandstone caps the hills as shown on the map. Coal I has been found in this area at the following points: N. W. of N. E. of Sec. 2, on the Enoch Turpin farm; S. W. of S. W. of Sec. 2; N. W. of N. W. of Sec. 7; N. E. of N. W. of Sec. 8; S. W. of S. E. of Sec. 8, where the coal is 2 to 3½ in. thick; and S. W. of Sec. 9 on Mrs. Mary Hutson's farm. No coal even approaching a workable thickness has been found in this area.

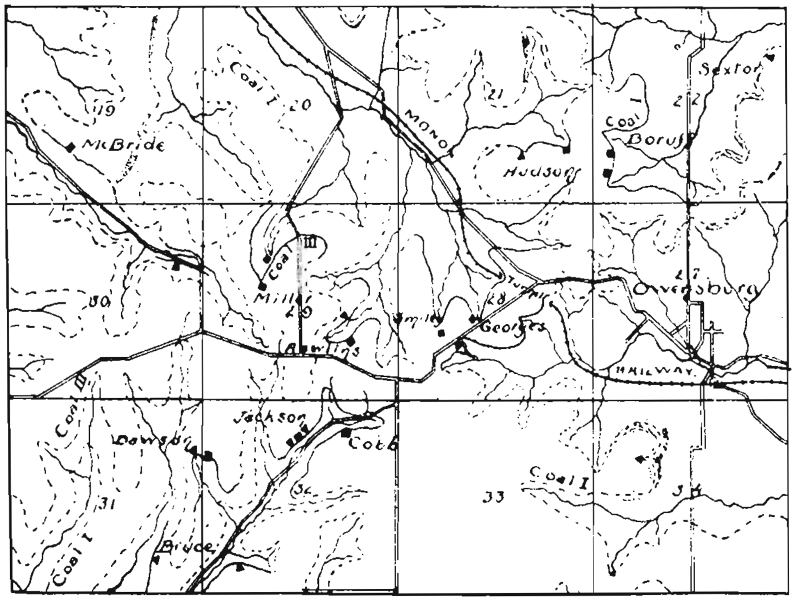


Fig. 539. Sketch map of part of T. 6 N., R. 3 W.

In the area of the sketch map, west of Owensburg, Coal I has been extensively worked. On the Wm. Sexton place in the N. E. ¼ of Sec. 22, Coal I is 11 in. thick. On the J. D. Boruff farm, in the S. W. 40 of this section, Coal I 18-21 in. thick has been worked. The coal is described as a non-shooting, semi-block, and good, but work was abandoned on account of the dip. The roof is shale, the floor fire-clay about 5 ft. thick.

In the S. W. ¼ of Sec. 21 Coal I is 14 in. at an outcrop on the Hudson place. A drift opened near this showed a still less thickness of coal.

In Sec. 19, Coal I is 24 in. thick on the Isaac McBride farm, but not of good quality.

The section at the end of the little Monon tunnel was given above. See Sect. 458. A little west of the tunnel Coal I was formerly worked quite extensively, the coal being 1 ft. 6 in. thick. It is said that ten to twelve carloads a week were shipped from the tunnel switch. At Thos. George's bank in the N. E. of S. W. of Sec. 28 the coal 18 to 20 in. thick was mined from several drifts. At a new drift opened in 1896, the coal was only 8 in. thick. At a small bank east of the road the coal was also too thin to work. South of the road the Mansfield sandstone shows a massive thickness of 25 to 30 ft., with Coal I outcropping just beneath. The sandstone here lies well for quarrying. In the N. W. of the S. W. of Sec. 28 is the Millard Smiley shaft. Coal was long worked here by drifts. The seam is 19 to 20 in. thick, a non-shooting, semi-block (Fig. 536). The roof is shale and said not to be good, having many rolls, some of which nearly cut the coal out.

Coal I is worked in the S. E. ¼ of Sec. 29 at the John Rawlins drift. It is here 18 to 26 in. thick, a non-shooting, semi-block. The roof is clay shale and good. Below it is 5 ft. of fire-clay (Fig. 537). A few rolls were met with. The coal contains too much sulphur for a blacksmith coal. In the N. W. ¼ of this section Coal I at Harrison Miller's bank is 26 to 30 in. thick. A 1-ft. bed outcrops 100 ft. above.

In Sec. 31 Coal I is 30 in. thick at Mr. Geo. Bruce's in the S. E. ¼. In the S. W. of N. W. of Sec. 32 Coal III is worked on the H. and N. E. Dawson farm by drift and shaft. In the shaft it is 18 ft. to the coal, only shale showing. The coal is reported to run from 3 to 5 ft., averaging 4 ft. One section of the seam showed: Coal, sulphury, 8 in.; clay, 6 in.; coal, 3 ft. (Fig. 528). Further in the two benches run together. In places rolls thin the coal down. The coal is mined with powder, breaking up fine. The roof is shale and good, bottom is said to be good blacksmith coal.

North of the center of Sec. 32 Coal I is mined on the Jefferson, Jackson and John Cobb places. It runs from 24 to 30 in., averaging about 28 in. The roof is clay shale and sandstone, and good. The fire-clay is 2 ft.± thick. Mr. Cobb also has banks at the old mill a quarter of a mile east, the coal there being 20 to 24 in. thick.

1268. DISTRIBUTION AND LOCAL DETAILS IN T. 6 N., R. 4 W.—The horizons of Coals I and III underlie most of this township. Division III occupies only the upper part of the high land, and is not found here north of Plummer's creek. Coal I is found lower down but still above drainage.

Division I occupies the top of the ridge north and northeast of Koleen. In Sec. 2 coal 1 has been dug into on the Joseph Horn farm in the S. E. of N. E., the coal being 1 ft. thick, and on the David Howell farm in the N. E. of the S. W. The coal is found on the Ashcroft place in the N. W. of N. E., and is 26 in. thick at an outcrop in the S. E. of the N. W. In the N. W. of the S. W. of this section Coal I is 20 in. thick on the Joseph Hondbrook place. The Kaskaskia limestone shows a face of 25 ft. at a quarry a mile east of Koleen. It is quarried for road material, for which purpose it seems to be well qualified. At the Rock spring, near this, the limestone is overlain by a projecting ledge of sandstone 30 ft. thick. The limestone and sandstone outcrop again on a point 600 yds. west of Koleen. On the Ed. Hassler place in the S. E. 40 of Sec. 4, Coal I has been opened lying above this sandstone, 20-30 ft. of which are exposed. Coal I outcrops in the S. W. and N. W. of the N. W. of Sec. 6; and in the S. E. 40 of Sec. 6 Coal III is found on the Jno. Foultz place. Outcrops of Coal I are found in the N. E. ¼ of Sec. 9 and S. W. ¼ of Sec. 10, at the latter place running 12 to 20 in. in thickness.

In Sec. 16 Coal III outcrops and has been worked at several places. On Margaret Hays' place in the S. E. of N. E. of section it is 18 in. thick. In the N. W. ¼ it has been worked a little at Herbert Reynolds and D. Bennett's bank on Mrs. Connell's land. The coal is here 2 ft. thick. At the northern drift the roof is a laminated gray clay shale 3 ft. thick. At the drift, 50 ft. south, the coal lies under 3 ft. of sandstone, which, at the drift, is being cut off by the rising of the coal. Below the coal is first 4 in. of bone coal or bituminous shale, then 2 ft. of sandstone, then sandy shale. In the S. W. ¼ several drifts have been opened on Mr. Simon Eisenogle's place. Coal III is here from 30 to 40 in. thick, with a 3-in. clay band near the middle (Fig. 529). The roof is made by 20 ft. of solid sandstone, and requires but little timbering, while below the coal is 10 ft. of fire-clay. The coal is a good black, shiny, semi-block coal.

In the N. W. ¼ of Sec. 19, Coal I outcrops 8-10 in. thick in Bogard creek; Coal III, also 10 in. thick, outcrops above, being overlain by sandstone, and underlain by clay. At an outcrop in the S. E. ¼ Coal III is 18 in. thick.

In the N. E. 40 of Sec. 21 the Mansfield sandstone exposes a solid face of 25 to 30 ft., walling in the gorge for 100 yds. Coal I shows in the hollow just below. In the S. W. ¼ Coal III is 2 ft. thick on Geo. Bennett's place. At the Alvin Philips mine Coal III is worked by a shaft and by slopes. At the shaft the coal is 16 ft. deep. A section at the shaft shows: Clay, 8 ft.; shale, 8 ft.; Coal III (coal, 2 ft. 6 in.; shale, 4 in.; coal, 1 ft.), 3 ft. 8 in.; fire-clay (Fig. 531). To the west of the shaft the lower bench thins out and the upper bench gets thinner. In the upper slope the coal was 4 ft. 2 in. thick, with a 4-in. shale band. For blacksmith purposes the lower bench only is used. The coal dips to the east. The coal is said to have been interrupted by numerous irregularities.

In the S. W. ¼ of Sec. 23, Coal I is 8-10 in. thick at an outcrop, and 18 in. thick at a number of outcrops in the S. E. ¼ of Sec. 23 and S. W. ¼ of Sec. 24. It is here not more than 10 ft. above the archimedes limestone, which, up the branch a half mile, shows a thickness of 30-40 ft., with 10 ft. of shale beneath. In the N. E. 40 of Sec. 25, Coal I outcrops, showing coal, 10 in.; fire-clay, 5 in.; coal, 10 in. There appears to be limestone above. In the S. E. of S. W. of Sec. 25, Coal III has been struck in a well, and outcrops close by, 7 in. thick.

Coal I outcrops on the Ellis Dove place, in the N. E. ¼ of Sec. 26, where it is reported to be 4 ft. thick. Coal III outcrops at several places in the N. W. ¼ of this section, being reported 3 ft. thick in the S. W. of the N. W. and 18 in. at an outcrop in the S. W. ¼ of the section.

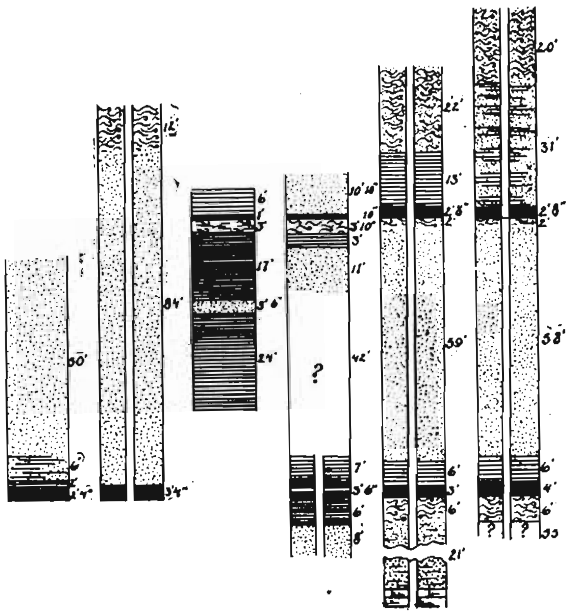
Coal I outcrops under sandstone in the N. E. ¼ of Sec. 27, and Coal III is found on the Dicky place, in the S. W. ¼.

In the N. W. of the N. E. of Sec. 28, Coal III is 18 to 20 in. thick. On the Nancy King place the coal is reported to have been 3 ft. thick, with a 4-in. clay band, much as at the Philips mine. Coal I shows a thickness of 4 to 6 in. at an outcrop in the N. W. ¼ of Sec. 30. In the N. W. ¼ of Sec. 33, Coal I is 10 in. thick at an outcrop, and Coal III 18 in. to 2 ft. thick above on the north side of the ravine. In the S. W. of N. E. ¼ of this section Coal III is 20 in. thick on the Geo. Bennett farm.

In Sec. 34 there appears to be a fault with a downthrow to the north of 50 or 60 ft., running just southeast of Snake Hollow. Near the center of Sec. 34, Coal III is 18 in. thick, and in the N. W. of S. W. of Sec. 35, on the Todd farm, is also 18 in. thick. In the S. W. ¼ of Sec. 36 a well enters Coal III, which is there 10 in. thick, overlain by sandstone and underlain by fire-clay 5 ft. thick. In the S. E. ¼ of this section Coal III has been worked at the M. A. Porter bank, formerly the Foote bank. The coal is 3 ft. thick, the upper 18 in. being a steam coal, and the lower 18 in. a blacksmith or block coal. The roof is clay shale, overlain by sandstone, while below the coal is 4 ft. of fire-clay.

TOWNSHIPS 6, 7 AND 8 N., OF RANGES 5 WEST AND 6 N., OF 6 W.

1269. GEOGRAPHY.—These townships may be characterized as the river townships, as White river, its bottoms and associated preglacial channels give these townships much resemblance in their topographic features and in the distribution of coals. The civic townships included in this area are: All of Eel River, western Highland, eastern Jefferson, western Richland, eastern Fairplay, western Taylor and all of Washington and Cass.



540	541	542	543	544	545
Beech Cr. Sec. 14-7-5.	Worthington. Sec. 21-8-5.	Newberry. Sec. 20-6-5.	Plummer. Sec. 4-6-5.		Lyons. Sec. 4-6-6.

Figs. 540-545. Columnar sections from Ts. 6-8 N., R. 5 W. and T. 6 N., R. 6 W.

1270. TOPOGRAPHY.—The topography of this area is fairly similar for all the townships. White river tends to run near the eastern side of the old valley, so that the hills usually come rather close on the east side, while on the west side are broad bottoms. Most of the area west of the river having the color of Division I is bottom land, subject to overflow in high water. The drill reveals further that these flat prairies are deep fillings and are evidently parts of White River valley

at a time when the land stood 100 ft. or more higher than now above sea level. It would appear that at that time Eel river ran west of Worthington; that White river at that time crossed south of Worthington and probably followed the present line of the E. & I. R. R., the present channel in the north part of T. 7 N., R. 5 W., being of post-glacial age. From near the mouth of Doan's creek, in the same way, the preglacial channel appears to have turned northwest toward the northeastern corner of T. 6 N., R. 6 W., and the coal measures appear to have been largely removed in the township, through its action at that time.

1271. TRANSPORTATION.—These townships are well supplied with railroads, the E. & I. R. R. running through all of them, the I. & V. running through the first and last, and the Switz City branch of the Monon runs through T. 7 N., R. 5 W.

1272. STRATIGRAPHY.—Division I still predominates in this area; Division III occupies a number of more or less isolated areas in the higher ground, and Division IV? is thought to just overlap the edges at a few places. The stratigraphy of these townships is in places very obscure, and in many places the coals are only tentatively assigned to certain horizons.

The following sections are among the best obtained, and in some cases there may be a question as to the accuracy of some of the details.

1273. SECTION 463. SECTION ON BEECH CREEK.—Sec. 14-7-5, Fig. 545. (E. T. C., p. 94.)

		Ft.	*In.*
1.	Sandstone ....40 ft. to	50	0
2.	Shale, sandy a few feet....................5 ft. to	6	0
3.	Black bituminous fissile shale..................	2	0
4.	COAL I	2	4

1274. SECTION 464. SECTION OF WELL ON HILL EAST OF WORTHINGTON.—Sec. 21-8-5, Fig. 541. (C. E. S.)

		Ft.	*In.*
1.	Clay	12	0
2.	Sandstone	84	0
3.	COAL I	3	4
4.	Sandstone	3	0

A blossom of Coal III? occurs near this about on a level with the top of the well.

To the northeast of Worthington, Mr. Cox suggests the presence of a coal bed above Coal I but in Division I. He says (p. 94): "Coal A

(I) is seen at a number of places northeast of Worthington, where it is cut through in the grade of the I. & V. R. R. and lies in close proximity to the subcarboniferous limestone; indeed, it is often separated by only a few inches of fire-clay. Coal B (Ib) lies from 16 to 30 ft. above Coal A (I), being intercolated between two benches of the conglomerate, and is from 4 to 18 in. thick."

1275. SECTION 465. SECTION NORTHEAST OF NEWBERRY.—Sec. 20-6-5, Fig. 542. (C. E. S.)

	Ft.	In.
1. Yellow shale	6	0
2. COAL III?	1	0
3. Sandy fire-clay	3	0
4. Black shale	17	0
5. Ferruginous sandstone	2	0
6. Shelly sandstone	1	6
7. Gray and black shale	24	0
	54	6

If this correlation is correct, Division I here seems to be almost entirely shale as far as exposed.

1276. SECTION 466. SECTION AT QUARRY NORTH OF PLUMMER.—Sec. 4-6-5, Fig. 543. (C. E. S.)

	Ft.	In.
1. Flaggy, soft, disintegrated sandstone	5	0
2. Massive, fine-grained, buff sandstone........4 in to	4	4
3. Soft, buff, stratum sandstone..............1 ft. to	1	6
4. COAL	..	10
5. Fire-clay	3	10
6. White sandy shale, with iron cover	3	0
7. Buff, fine-grained quarry sandstone	11	0

Forty-two feet below this a drilling is reported to have shown—

	Ft.	In.
1. Shale	7	0
2. COAL	..	10
3. "Limestone" (?)	1	6
4. COAL	1	2
5. Shale	6	0
6. Rock	8	0

The resemblance should be noted between this lower coal and the double coal at the Thorp bank, near Linton.

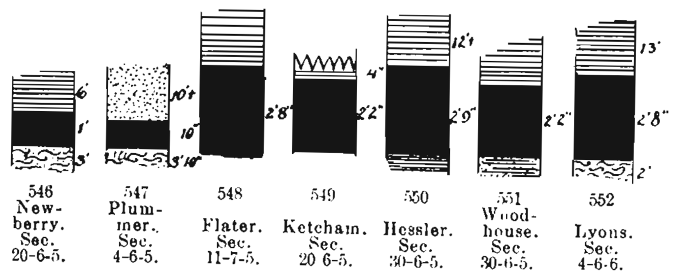
Some drillings made around Lyons appear to have disclosed Coals III and I.

1277. SECTION 467. SECTION OF BORING IN S. W. OF N. W. OF SEC. 4.—Starts from level of depot, or 10 ft. above bottoms. (C. E. S.) Fig. 544.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and clay	22	0	..	..	22	0
2. Shale	13	0	..	..	35	0
3. COAL III (?)	2	8	2	8	37	8
4. Fire-clay	2	0	..	..	39	8
5. Sandstone	59	0	..	..	98	8
6. Shale	6	0	67	0	104	8
7. COAL I (?)	3	0	3	0	107	8
8. Fire-clay	6	0	..	..	113	8
9. Sandstone, etc.	21	0	..	..	134	8
10. Limestone	12	0	39	0	146	8
11. Coal and shale	13	0	?	?	159	8
12. Sand shale	44	0	..	..	203	8

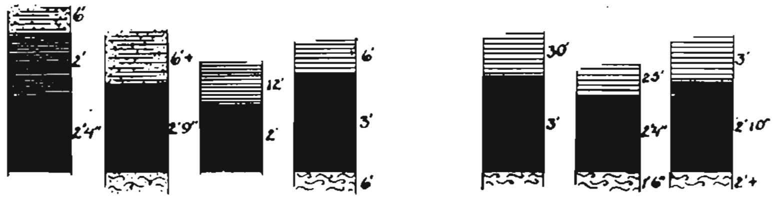
1278. SECTION 468. SECTION OF WELL IN LYONS.—Starting a quarter of a mile north of last, and 16 ft. higher. (C. E. S.) Fig. 545.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and clay	20	0	..	..	20	0
2. Sandstone and shale	31	0	..	..	51	0
3. COAL III (?)	2	8	2	8	53	8
4. Fire-clay	2	0	..	..	53	8
5. Sandstone	58	0	..	..	113	8
6. Shale	6	0	66	0	119	8
7. COAL I (?)	4	0	4	0	123	8
8. Fire-clay	6	0	..	..	129	8
9. "Hard boulder"	55	0	..	..	184	8



Figs. 546-552. Section of Coal III in river townships.

The relation of Coals III and IV? is not very clearly shown. East of the river only one coal was found above Division I. West of the river the coal was judged to be at one horizon, but well sections, especially just west of this area, showed the existence of two coals above the sandstone of Division I, of which the coal exposed appeared to be the upper. On this basis the coal exposed west of the river, near Worthington, is called Coal IV, while to the south and east coals about similarly placed are called Coal III. We are unable to decide whether such separation is correct or not. The coals appear about the same thickness, and in each case here have a shale roof, in many cases this being a black sandy shale.



553 Beech Cr. Sec. 14-7-5. 554 Thompson. Sec. 3-7-5. 555 Irons. Sec. 25-7-5. 556 Lyons. Sec. 4-6-6. 557 Watts. Sec. 7-5-8. 558 Kelsheimer. Sec. 18-7-5. 559 Terry. Sec. 18-7-5.

Figs. 553-556. Sections of Coal I in river townships.
Figs. 557-559. Sections of Coal IV in river townships.

Coal I is seen by these figures to vary greatly in thickness, the greater thickness being reported from drilling, while the observed thickness is usually below 2 ft. It will be noticed that the immediate roof, so far as known, is usually shale. This is usually only a few feet thick, when it is succeeded by the massive sandstone of Division I.

1279. Distribution and Local Details in T. 8 N., R. 5 W.—White and Eel rivers divide this township into three divisions. In the northern part of the township, between White and Eel rivers, both Coal I and Coal III occur. Coal I, especially to the west, is found at about the level of the bottom land, and the edge of the bottom has been drawn to represent its outcrop. Coal III occurs higher up the hill. Coal I outcrops in the S. E. ¼ of Sec. 2; is struck in a well in the S. E. ¼ of Sec. 9; outcrops at several places in the S. W. ¼ of Sec. 11, at one place being 2 ft. thick; and on the John Moore farm, near the center of the quarter, is 27 in. thick. It has been worked a little on the H. D. Haxton place, in the N. W. of N. E. of Sec. 14; near the center of the N. E. ¼ of Sec. 14, on the Henry Darnley place, and on the James Newsom place, in the N. W. of N. W. of Sec. 13, where it is from 16 to 22 in. thick.

Coal III outcrops 2 ft. thick in the S. E. ¼ of Sec. 3, and on the Jesse Dyer farm, in the N. W. of Sec. 10. It shows as a rash or bone

coal in the S. W. ¼ of Sec. 10. In the N. E. ¼ of Sec. 4 it is 30 in. thick on the Taylor Dyer farm, and 6 in. thick in an outcrop in the S. E. ¼ of this section. It also outcrops in the S. E. of the N. E. of Sec. 5, on the Joseph Yancy place.

South and east of White river only Coal I is found, with possibly an additional coal just above Coal I at one point. Coal I outcrops near the N. W. corner of Sec. 23. A little west of the center of this section the following section is exposed on Mrs. Pagett's land (Sect. 469, C. E. S.):

	Ft.	In.
Sandstone ....12 ft. to	20	0
Yellow, sandy shale	8	0
Blue shale ....3 ft. to	4	0
COAL Ib (?)....	1	0
Massive sandstone	5	0
	38	0

South of Big creek Coal I is worked on the Lincoln Milum farm, and shows a thickness of 22 in. on Chas. Reed's farm, the former being in the S. E. ¼ of Sec. 35 and the latter in the S. W. ¼ of Sec. 36.

In Secs. 6, 7 and 18, northwest of Worthington, all of the coal seen was judged to be at one horizon, and that to be the horizon of Coal IV. Coal III was supposed to lie below, somewhat as mapped. Coal IV was formerly worked by drifts in the S. W. ¼ of Sec. 6.

On the Eli Stalap farm, formerly the Adams place, in the N. W. ¼ of Sec. 7, it is claimed that two beds show as follows: Upper coal, 2 ft. 9½ in.; fine clay, 2 ft. 6 in.; lower coal, 4 ft. 2 in. It is claimed that the upper bed either runs out or joins the lower bed as it enters the hill to the southeast.

In the N. E. of the S. W. of Sec. 7 Coal IV is worked on the Henry Watts place. The coal runs from 34 to 36 in. and is a block coal, with clay slips, which prevent the use of powder. The roof is clay shale, 30 ft. thick and not very good. Below is fire-clay. Though containing little sulphur, this is not a blacksmith coal.

At the J. T. McHenry bank, formerly the Chas. Carson mine, in the S. W. of the S. E. of Sec. 7, Coal IV is here from 30 to 34 in. thick. It is a semi-block, having too open slips to shoot well. Above the coal is blue and white shale to the top of the hill. Below is at least 2 ft. of fire-clay. Just south of McHenry's are the old drifts and shafts on the Geo. Heineman place, in the N. W. of N. E. of Sec. 18.

In the N. E. of the N. W. ¼ of Sec. 18, Coal IV is worked on the Mrs. Polly Kelsheimer farm. The coal is 28 in. thick, with but little variation (Fig. 500). It does not show the block seams, yet shoots out in blocks. The roof at the mouth of the entry is white clay, farther back a black shale. The air-shaft shows 25 ft. of white and gray shale. Under the coal is 18 in. of fire-clay, then "hard rock." The coal has too much sulphur for blacksmithing.

In the S. E. of the N. W. of Sec. 18, Coal IV is worked at the Terry Bros. drift. The coal is here 32 to 36 in. thick, a semi-block which shoots well. The roof is gray shale 3 ft. thick, overlain by sandstone. The fire-clay is at least 2 ft. thick (Fig. 559).

Near the center of Sec. 19 a well showed the following section (Sect. 469a, C. E. S.): Clay and earth, 25 ft.; arenaceous shale, 50 ft.; hard sandstone, 26 ft. The well started 20 to 30 ft. above the level of the bottoms.

The Mansfield sandstone outcrops and is quarried along the east side of the hill, just southeast of Worthington. Coal I underlies this hill, and the horizon of Coal III underlies the top of the hill. A section at this point was given above (Sect. 464). At the "rock riffle" south of the center of Sec. 33, Coal I, 18-20 in. thick, is reported in the bed of the river.

The evidence indicates that Coal I has been cut out over a considerable area around Worthington by the preglacial erosion.

The artesian well at Worthington struck no coal. As no record of the well has been published by this department, the following record, made by Mr. Siebenthal from notes and sample bottles in the possession of Mr. A. B. Morris, of Worthington, is introduced (Sect. 470, C. E. S.):

	Ft.
Soil, gravel and sand	90
Sandstone, coarse-grained, sharp	170
Sandy shale, white	15
Limestone and shale, gray to dark	16
Limestone, white	14
Limestone, dark, large pieces	155
Limestone, drab, small pieces	40
Limestone, white, large pieces of calcite	25
Limestone, dark, coarse, no grit	125
Limestone, dark, fine, little or no grit	100
Light, buff powder, little or no grit	20
Gray, fine-grained powder, some grit	80
Darker, fine-grained powder, some grit	35
Lighter, fine-grained powder, some grit	15
Dark flakes (shale), no grit (mineral water)	200
Drab, gray, sticky powder	200
Dark gray, soft flakes	70
Black flakes, flow easily, gas (Devonian)	10
"Niagara rock" (rather coarse)	40
Sandstone, rather dark, quite fine	25
Sandstone, lighter, quite fine	65
Sandstone, still lighter, quite fine, artesian water	55
Sandstone, dark brown, few feet	...
	1,565

1280. Distribution and Local Details in T. 7 N., R. 5 W.—White river divides this township into two nearly equal halves. East of the river Coal III is found in the upper parts of the ridges. Coal I, while above the main drainage, underlies most of the area.

Coal I outcrops on the A. Buchey farm, in the N. W. ¼ of Sec. 2. In the S. W. ¼ of Sec. 3 it is worked at a number of banks. At the John S. Thompson bank the coal is 30 in. to 3 ft. thick, a semi-block, shooting coal (Fig. 554). The roof is a black, ferruginous, sandy shale, of which 6 ft. are exposed. It makes a good roof. A little northeast and above, 30 ft. of Mansfield sandstone outcrop, looking like a good stone for quarrying. The underlying fire-clay is sandy.

A little farther southwest, on the same ¼ section, the same coal is worked on the Joseph Boles place, formerly the Jane Buckner. A little farther southwest, in the S. E. corner of Sec. 4, this coal has been worked on the place of the Sol. Green heirs. The coal there runs from 2 ft. to 2 ft. 6 in. in thickness, and is a semi-block, non-caking coal. The roof is shale, only fair in quality.

In the N. W. ¼ of Sec. 3, 4 ft. of coal is reported in the bed of White river. Coming south, in Sec. 9, Coal I appears to be under the level of the bottoms. Outcrops of Coal III are noted in the S. W. and S. E. ¼ of Sec. 10. At the Nicholas Flater bank, in the N. W. ¼ of Sec. 11, Coal III is 30 to 34 in. thick, a semi-block, some being mined with powder. The roof is clay shale, and good. Beneath the coal is bone coal (Fig. 518). This is said to be a good coal for blacksmithing.

In the S. E. ¼ of Sec. 13, Coal III is 2 ft. thick on the John Kidd farm. This coal is also found outcropping in the N. E. of N. W. of Sec. 15. Near the center of this section Coal I outcrops below the sandstone on the Geo. Catt and Joe Smith farms.

In the N. W. ¼ of Sec. 25, Coal I has been worked at Peter Stone's mine, formerly Wm. Irons's. The coal is 2 ft. thick, overlain by 2 ft. of blue shale, which in turn is overlain by 10 ft. of yellow shale (Fig. 555). The roof is good. About 20 ft. above the mine the shale becomes quite sandy, and 30 or more ft. above, on the east side of the creek, there is exposed 30 ft. of yellow, ferruginous Mansfield sandstone. Near the outcrop the coal shows shale bands and is stained brown. Much of the shale roof has to be taken down to allow the mining of the coal. In the S. W. ¼ of this section, 200 yds. south of the mill, the same coal, 27 in. thick, has been mined on J. O. Pate's place. West of the creek the sandstone below the coal is more prominent than that above. The horizon of the iron ore formerly mined to supply the Richland iron furnace in this same quarter section occurs between the two sandstone beds in the shale. Coal III outcrops in the S. E. ¼ of this section.

West of White river, Coal I, 18 in. thick, is found under the bluff in the S. E. of S. W. of Sec. 4 and down into Sec. 9. Above this, Coal III outcrops just west of the center of Sec. 4, on the Vogel Crantz place, 18 to 20 in. thick, and on the Elijah Moses place, in the south part of the S. W. ¼. At a well at Dory Ingersoll's place, in the S. W. of N. W. of Sec. 4, a drilling is reported to have gone through 4 ft. of coal at a depth of 40 ft.

In the S. W. ¼ of this township, Coal I outcrops at low water beneath a sandstone bluff in the S. W. of N. E. of Sec. 21, and is reported to have been found in the river bed just south of the central-east and west line of Sec. 28. It may be assumed to be at or below low-water mark all through the western half of this township, getting deeper to the west and probably cut out through the old channel running through Secs. 5, 6, 7, 8 and 17.

In this part of the township Coal III is found in wells, indicating its presence over an irregular area as mapped. In the N. W. 40 of Sec. 19 it is reported that coal was struck in dredging the ditch on Marian Bennett's place. In Sec. 20, 1 in. of coal was found at 20 ft. in the R. Rampley well, S. W. ¼. In the S. E. 40 of this section 3 ft. of coal was found in the well at Solomon Dixon's. Over the coal was 12 ft. of gray sandy shale, then 9 ft. of surface and soil. The coal was tested with good results in stoves. Coal is also found in the John O. Hurrah well, in the S. W. of S. E. of Sec. 20; in a well in the N. E. 40 of Sec. 28, and in the N. E. ¼ of Sec. 29, on the Lauran place, where the coal was 3 ft. thick. In the N. W. ¼ of Sec. 29, 18 in. of coal was struck in Chas. Roberts's well at 10 ft., and in Levi Bowers's well at 18 ft. At the latter place the coal has only white soil above, but sandstone below. In the S. E. of S. W. of this section the coal is 3 ft. in a well on the Joseph Vales place. It has no roof. In the N. W. ¼ of Sec. 32, 1 ft. of coal was reported at 6 ft. in the well of Mr. D. Rollison. In the N. W. of N. E. of this section the coal is 3 ft. thick, in the wells of Mr. A. M. Henny and Mr. Wm. Ax, the coal being 40 ft. deep at the latter well.

In the N. W. of N. E. of Sec. 30, Chas. Gillett found 1 ft. of coal at 29 ft. in his well. In John Gheen's well, near the center of the N. E. ¼ of the section, starting 60 to 80 ft. above the river bottoms, 16 in. of coal was found at 22 ft., having 7 ft. of blue clay shale over it, and the boring which was continued 60 ft. farther is said to have passed through two other coals, the lowest one being at the bottom of the well at a depth of 83 ft.

In the N. W. ¼ of Sec. 30, Coal IV (?) was 15 in. at Geo. Stransser's pit, and 14 in. at a depth of 15 ft. at the well, with 1 ft. of coal 6 or 8 ft. below. At Wm. Stransser's the two coals were 4 ft. apart, the upper 15 in. thick, the lower 29 in. In the S. E. of S. W. of Sec. 31 a well on Jos. Benham's place went 80 ft. through sand and quicksand; below that was 6 ft. of sandstone, then 3 ft. of "earth with boulders," then 93 ft. 6 in. of hard sandstone. This indicates that the coal measures are all cut out over much of Sec. 31.

1281. Distribution and Local Details in T. 6 N., R. 5 W.—Coal III (?) appears in the S. W. ¼ and the N. W. ¼ of this township, while in the rest of it only Coal I is found, and then above drainage, except west of the river and in the S. W. ¼. Coal I in this area runs from 10-18 in. or even less.

Coal I is stripped on the Ewell O'Donnell place, in the N. W. of S. E. of Sec. 1, and Marion Utterboch place, in N. E. of S. E. of Sec. 1, being 18 in. thick at this point. At a point in the S. E. of S. W. of this section, Coal I is 15 or 16 in. thick. In Sec. 2 Coal I is 18 in. thick on the Jas. Foster place, in the S. E. 40 acres, where it has been stripped. In the N. W. ¼ of this section it is 10 in. thick. Coal is reported in the river bluff in Secs. 3 and 9. In the N. W. ¼ of Sec. 11, Coal I, 8 to 10 in. thick, has been stripped some. The same is true at different points in Sec. 12, the coal being 18 in. thick in the N. E. ¼, on the Hannah Bucher place. In Sec. 13, Coal I is 1 ft. thick on the Nat. Emory place, and is struck as a thin bed at 40 ft. in the N. W. ¼ of Sec. 14. In the S. W. ¼ of this section this coal has been stripped. In the N. E. ¼ of Sec. 15 it is reported 5 to 6 in. thick. In the S. E. ¼ of the township, Coal I has been stripped or found as follows: S. E. of N. E. of Sec. 22, 18 in. thick at 28 ft. in a well, overlain by 5 ft. of sandstone and underlain by 4 ft. of fire-clay; center of N. E. ¼ of Sec. 24; N. ½ of S. E. ¼ of Sec. 24, where it is 10 in. thick; west side of Sec. 23, 18 in. thick. Below the coal there shows: Blue shale, 4 ft.; solid sandstone, 6 ft.; hard sandstone, 2 ft.; brown, shaly sandstone, 4 ft.; light brown, sandy shale, with sandstone layers, 6 ft. Outcrops in S. E. ¼ of Sec. 27 and N. E. ¼ of Sec. 36. At the last the coal is 1 ft. thick and is overlain by 30 or 40 ft. of shale and sandstone, exposed up the branch. Under the coal is 6 ft. of massive, light brown sandstone, full of plants, with 6 to 8 ft. of shale below.

In the S. W. ¼ township, Coal III? is found at a number of places, and worked in a few. It has for many years been stripped on Uriah Christenberry's place, in the N. E. ¼ of Sec. 29, being 18 in. thick there, with 5 to 6 ft. of stripping. The quality was reported from fair to good. This coal also outcrops near the center of Sec. 28. In the N. W. ¼ of Sec. 20 this coal has been worked at the Thos. Christenberry mine, formerly the Ketcham bank. The coal here ranges from 20 to 28 in. in thickness, with an average of 26 in., and is a semi-block. The roof is a gray iron ore, with 4 in. of draw slate (Fig. 549). Some slips and rolls were met, one cutting the coal out entirely. South of this, in the S. E. ¼ of Sec. 19, was the section given above, ¶1275, Sect. 465. Just south of the railroad, on the central-north and south line of Sec. 30, 40 ft. of yellow and gray shale show above the railroad and 15 ft. of black shale below. A little below this, in the river bank, 15 ft. of sandstone shows; this dips south so as to pass below the water a short distance below.

East and southeast of the center of Sec. 30 are several shafts and strippings. The coal is reported to be a good blacksmith coal. At the Dan. Hessler shaft, in the N. W. of S. E. of Sec. 30, Coal III runs from 30 to 36 in. and is a semi-block coal. Over it in the shaft is 12 ft. of black shale, making a good roof (Fig. 550). The floor is shale. The dip is to the west.

Coal was formerly worked through the Payne shaft across the branch to the north. A little farther north, in the S. W. of N. E. of this section, is the Frank Woodhouse shaft. The coal here ranges from 24 to 28 in. and is a semi-block, which shoots well on the solid (Fig. 551). The roof is a clay shale and good, requiring no timbering in the entries, 1 in. only coming down. The floor is black, sandy shale. The section of the shaft shows (Sect. 471, C. E. S.):

	Ft.
Soil	5
Yellow clay shale	5
Black shale	22
COAL III	2

In Sec. 31 an outcrop in the N. E. of N. W. showed a thickness of 27 in., one in the S. E. of the S. W. 14 in.

In the N. E. of the N. W. of Sec. 4, where the section given above (¶1276, Sect. 466) was obtained, Coal III is 8-10 in. thick and 4 ft. above the railroad; 560 yds. to the south the same coal is 6 ft. below the railroad.

In the S. W. of the N. E. of Sec. 8, 14 in. of coal show in the river bank. Mr. Wm. Ashbaugh, who used to live near this point, claims to have formerly taken coal out of the river, and claims there are three beds there, the lowest being entirely under water, and being 7 ft. thick. The next bed was 3 ft. above this and 16 in. thick, while 12 ft. above was a 12-in. bed. Comment is not necessary.

A well on the Wm. Benham place, in the S. W. of N. W. of Sec. 7, went 90 ft. and struck no coal. A well at Helmar Holmes's, N. E. ¼ of Sec. 18, went 200 or more feet, mostly through sandstone, and struck no coal.

In the N. E. of N. W. of Sec. 18 a well on Marion Jackson's place, starting 20-30 ft. above the level of the bottoms, gave the following section:

	Ft.
Soil, sand and gravel	24
"Shelly rock," shale (?)	50
Hard sandstone	75
COAL ?	

1282. Distribution and Local Details in T. 6 N., R. 6 W.—The main part of this township is old marsh land, representing old erosion basins or channels filled, and, though on the map, Division I is represented as underlying all of its area, it may be strongly questioned if the coal measures have not been entirely removed over a large part of this area. With the data obtainable, however, it is impossible to judge how large an area has thus been cut out. Except about Newberry, our coal data in this township are entirely derived from drillings, and as there is some difficulty in explaining the results of these drillings, they will simply be given as received from the drillers:

1283. Section 473. Section of Drilling in Lyons.—N. E. of N. W., Sec. 4, John Stewart, driller. (C. E. S.)

		Ft.	In.
1.	Soil and clay	20	0
2.	Sand rock	15	0
3.	Shale	1	6
4.	COAL	2	0
5.	Fire-clay	2	0
6.	Sandstone	25	0
7.	Sandstone	75 or 80	0

1284. Section 474. Section of Well on J. D. Edwards's Place, Lyons.—Starting 2 ft. above depot, reported by Mr. Don Ennis, driller. (C. E. S.)

		Ft.	In.
1.	Soil, clay and shale	28 to 30	0
2.	COAL III	1	6
3.	Much hard rock and more or less black shale and clay shale		
4.	COAL I (?), at 110 ft.	2	3

As a result of these drillings and those given in ¶¶1277 and 1278, the Lyons Coal Company, in 1891, sunk a 9 by 18 shaft 105 ft. to the second coal, which had been reported 5 ft. thick. The reported figure proved to have been erroneous, and, after working one winter, the project was abandoned. The coal proved to be a semi-block, with a good shale roof. The underclay was 6 ft. thick, and, from tests made, is said to have made good fire-brick. If the reports are correct concerning the limestone and coal under it, it would appear that the coal worked in the above instance was Coal I, and the coal below the limestone was Kaskaskia coal. One report said there was 6 ft. of coal below the limestone, which is highly improbable. Another report said 1 ft. of bright coal, which is within the range of possibilities.

In the N. E. of S. E. of Sec. 5, 2 ft. 4 in. of coal is reported found at 18 to 20 ft. In the northern part of Sec. 2, wells are said to go 60 ft. into quicksand.

A well on Geo. Bogard's place, N. E. of S. E. of Sec. 3, on a little knob, was reported to show as follows (Sect. 475, C. E. S.):

		Ft.	In.
1.	Soil and sand	16	0
2.	Sandstone	20	0
3.	COAL I?	3	6
4.	Clay shale	2	0
5.	Sandstone	28	0

1285. SECTION 476. SECTION OF WELL ON JOHN D. CHESTNUT'S PLACE.—S. W. of N. W., Sec. 9, as reported by Mr. Don. Ennis. (C. E. S.)

		Ft.	In.	Ft.	In.
1.	Soil and clay	18 ft. to 20	0	20	0
2.	Shale, little	..	..	20	0
3.	COAL	1	8	21	8
4.	Fire-clay	2	0	23	8
5.	Shale	18	0	41	8
6.	Solid sandstone	20 ft. to 60	0	101	8
7.	COAL	3	0	104	8
8.	Variation of rocks	37	0	141	8
9.	COAL	2	6	144	2

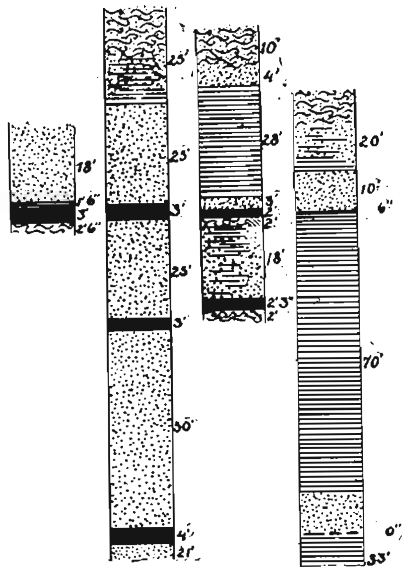
The first coal in this well (3) was reported in Mr. John Stafford's well, in the N. E. ¼ of Sec. 8, at a depth of 25 ft.

A well at Bushrod, at Mr. Teeple's, showed (Sect. 477, C. E. S.):

	Ft.
Black soil	10
Quicksand	86
Sandstone	6

A well in Newberry, in the S. W. of N. E. of Sec. 25, went 199 ft. deep, starting 5 ft. below the railroad. The section is said to have shown somewhat as follows (Sect. 478, C. E. S.):

	Ft.
Soil and earth ......6 to	7
Shale, etc. ......40 to	60 (?)
Sandstone, down to 100 ft.	
Clay shale and gray shale, "drift" and sandstone	70
Black shale	6
Clay shale and gray shale	20
	169



560 Aydelotte Slope. Sec. 12. 561 Aydelotte Drilling. Sec. 12. 562 Darnell Drilling. Sec. 10. 563 Newsom Drilling. Sec. 28.

Figs. 560-563. Columnar sections in T. 8 N., R. 6 W.

At Newberry 1 ft. of bone coal shows, with yellow shale above and fire-clay and blue shale with iron nodules below. The strata here between the mill and dam show considerable disturbance, as expressed in variations in dip.

Township 8 North, Range 6 West.

1286. Geography.—This township corresponds with Smith and the western edge of Jefferson of the civic townships. The northern part is flat, being included in Eel river bottoms; the rest is rolling. No railroads enter or cross the township.

Stratigraphy.—Well sections indicated two coals in this area above Division I, which may, for convenience, be called Coals III and IV, though we hesitate to say that Coal IV of this township corresponds with Coal IV around Linton. Judging only from mines and not outcrops, it would appear that only one coal was found above the sandstone of Division I. This may be due to not distinguishing the coals from point to point, one coal only usually being reported, or it may be that one or both of the coals are irregular in their distribution, so that it is only here and there that both coals occur.

1287. Section 479. Section at Dr. Aydelotte's Slope.—Sec. 12-8-6, Fig. 560. (C. E. S.)

	Ft.	In.
1. Thin, flaggy sandstone	10	0
2. Heavy, flaggy sandstone	8	0
3. Black, sandy shale	1	6
4. COAL	3	0
5. Fire-clay	2	6

1288. Section 480. Section of Dr. Aydelotte's Well.—Sec. 12, Fig. 561. (C. E. S.)

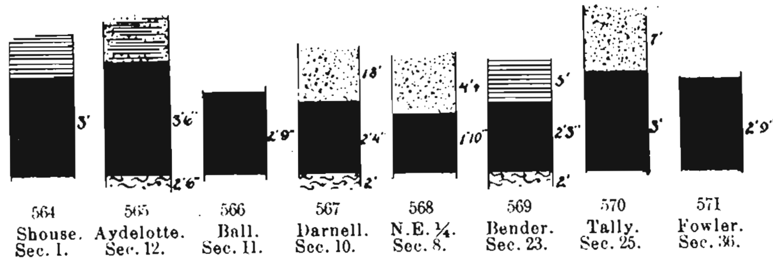
	Ft.	In.	Ft.	In.
1. Soil and clay shale	25	0	25	0
2. Sandstone (?)	20	0	45	0
3. COAL IV?	3	0	48	0
4. Sandstone	25	0	73	0
5. COAL III?	3	0	76	0
6. Sandstone	50	0	126	0
7. COAL I?	4	0	130	0
8. Much hard sandstone	21	0	151	0

1289. Section 481. Section of Well on Darnell Farm.—Sec. 10, Fig. 562. (C. E. S.)

	Ft.	In.	Ft.	In.
1. Soil and dirt	10	0	10	0
2. Shaly sandstone	4	0	14	0
3. Bluish shale	28	0	42	0
4. Dark gray sandstone	3	0	45	0
5. COAL IV?	2	0	47	0
6. Fire-clay	2	0	49	0
7. Shaly sandstone	18	0	67	0
8. COAL III? ....2 ft. 3 in. to	2	4	69	4
9. Fire-clay	2	0	71	0

1290. Section 482. Section of John Newsom's Well.—Sec. 28, Fig. 563. (C. E. S.)

	Ft.	In.
1. Soil and shale	20+	0
2. Soft sandstone	10	0
3. COAL	..	6
4. Shale	70	0
5. Dark sandstone	10	0
6. COAL, indications	..	..
7. Shale	33	0



Figs. 564-571. Sections of Coal (IV and III) in T. 8 N., R. 6 W.

The above figures show the coal exposed and worked to be a solid coal, averaging 3 ft. where being worked and less elsewhere, with either a shale or sandstone roof. It is possible the coal roofed with sandstone is Coal IV, and that roofed with shale Coal III, but that is only a surmise. The coal appears to be a semi-block of fair quality. Nothing is known of Coal I except what is given in Dr. Aydelotte's well.

1291. Distribution and Local Details.—This township appears to be almost entirely underlain by the horizon of Coal III and in large part by Coal IV. Coal I underlies the whole area 75 to 125 ft. below Coal IV.

Coal IV crops out at numerous places in the bank facing north, on the south side of the flat country through which flows the Howesville ditch. We will first follow along this bank, starting from the east.

In the N. E. of S. W. of Sec. 1, Coal IV (?) is worked by drift and shaft on the Sandy Shouse place, formerly the Albert Paget farm. The coal is 3 ft. thick, though said to thicken up to 4 ft. 4 in. to the northeast. The roof is yellow, sandy shale, not extra good (Fig. 564).

Coal is reported at a number of points in the N. E. of S. W. and S. W. of S. E. of Sec. 1, ranging in thickness from 6 in. to 2 ft. 6 in.

In the N. W. of N. E. of Sec. 12 this coal is worked by drift at Dr. Aydelotte's, formerly John Stanley's. The coal ranges from 2 ft. 6 in. to 4 ft. It is a semi-block, caking coal, except the lower 18 in., which is a splint coal. The roof is shaly sandstone and of a fair grade. Below is fire-clay, 2 ft. 6 in. thick (Fig. 565). The coal is not suited to blacksmithing. The section at the slope was given above, as well as the section of a well on Dr. Aydelotte's, in the S. W. of N. E. of Sec. 12.

West of this, coal has been found or worked as follows: N. E. of N. W. of Sec. 12; N. W. of N. W. of Sec. 12; S. W. of N. W. of Sec. 12, on W. P. Ball's place; N. E. of N. E. of Sec. 11, on Ben Fuller's place; S. E. of N. E. of Sec. 11, on David Barton's farm; N. W. of N. E. of Sec. 11, on W. P. Ball's place, where it has been stripped and is 30 in. thick (Fig. 566); S. E. of N. W. of Sec. 11, on John Pierce's farm; N. W. of N. E. of Sec. 11, on L. Stewart's place.

In Sec. 10, 18 in. of coal outcrops on Steven Campbell's place, in the N. E. of the N. W. and in the N. W. of N. W. It is also struck in wells on the Darnell farm, N. E. of S. W. of this section. At the latter place two coals, 2 ft. and 2 ft. 4 in. respectively, were found. See section above (Fig. 567).

In a well on the E. H. Dayhoff place, in the N. E. of Sec. 16, the coal is 2 ft. thick. Coal is reported in a well N. E. of Sec. 17, and is 18 to 20 in. thick in a well in the S. E. of S. E. of Sec. 8. It also outcrops near the center of this quarter section. It is found in wells in the N. E. ¼ of Sec. 8, in one of these wells being 18 to 20 in. thick and 16 ft. deep, with 3 to 4 ft. of sandstone over (Fig. 568). In the N. E. ¼ of Sec. 7 wells drilled to a depth of 35 or 36 ft. found no coal.

Returning to the east through the center of the township, down Lemon creek, we find 4 ft. 8 in. of coal reported on the Geo. Y. Dayhoff place, in the N. W. of N. E. of Sec. 15. In a well in the S. W. of S. E. of this section, a well found the rock at 18 ft. and went 7 in. to it, passing through coal. In the south part of Sec. 14, a well went 40 ft. in quicksand and drift. Coal is reported to outcrop in the S. E. of S. W. of Sec. 22.

In the N. E. of Sec. 23, coal was formerly mined on the Jerry Bender and Pink East farms. The coal is here 10 ft. above Lemon creek bottoms and was 2 ft. to 2 ft. 6 in. thick. Over it is first 5 ft. of yellow clay shale, then 15 ft. of flaggy sandstone. Below the coal is 2 ft. of fire-clay (Fig. 569).

At Wilbur A. Hayes's, in the N. W. of Sec. 24, a well starting 80 ft. above the bottoms passed through 1 ft. of coal at 70 ft. The section is given as follows (Sect. 483, C. E. S.):

		Ft.
1.	Soil and clay	20
2.	Sandstone and shale	50
3.	COAL	1
4.	Sandstone and shale	80
		151

In the N. E. ¼ of Sec. 25 are a number of outcrops on the Mark Hays place. In the S. E. of the N. W. of this section there is the new shaft of Greenville Tally, showing (Sect., C. E. S., Fig. 570):

		Ft.
1.	Soil and sandy shale	27
2.	Sandstone	7
3.	COAL	3

South of the road the coal has been drifted upon on the Leander Manus place. The coal here has also a sandstone roof.

In Sec. 26 a crop was reported in the N. E. ¼, and on the N. E. of S. E. the coal is 2 ft. thick on Mr. H. B. Owen's place.

In Sec. 36 a deep well was bored on the A. P. Slinkards farm, in the S. E. of N. W., which started 40 ft. above the bottoms and is said to have struck coal. Coal outcrops on the 40 acres west of this. In the S. W. of the S. W. of this section is the J. H. Fowler mine, formerly the McKissick mine. The two coals 25 ft. apart are reported to have been worked here. Thinking this was Coal I, as he did all through this township, Mr. Cox insisted that these coals were at the same horizon. Only the upper one has been worked of late. The coal here is 28 in. to 3 ft. thick (Fig. 571).

In Sec. 35 coal is found on the Elias Dayhoff farm, in the N. E. ¼. A report here gave the section as: Coal, 2 ft. 2 in.; space, 12 ft.; coal, 4 ft. Coal is struck in the well of Sol. Stewart, in the N. E. of S. E. of Sec. 34. A section of John Newsom's well, in the S. W. of S. E. of Sec. 28, was given above, ¶1290.

In Sec. 18, S. E. of S. W., 1 ft. of coal, struck at 12 ft. in wells on Mr. W. T. Thompson's, is supposed to be Coal V? (IV or IVa).

On the whole, reports show that probably only a small portion of this township is underlain by workable coal, though whether the area so underlain contains sufficiently large basins of workable coal to pay to mine commercially must be determined in the future.

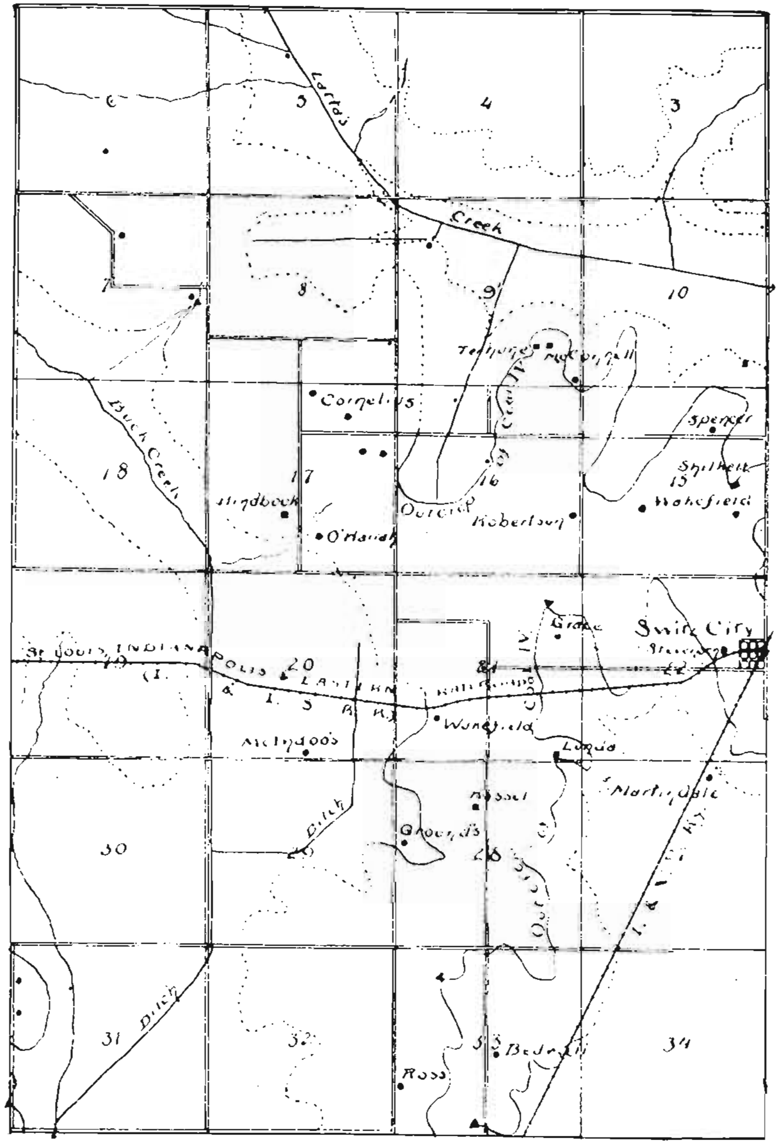
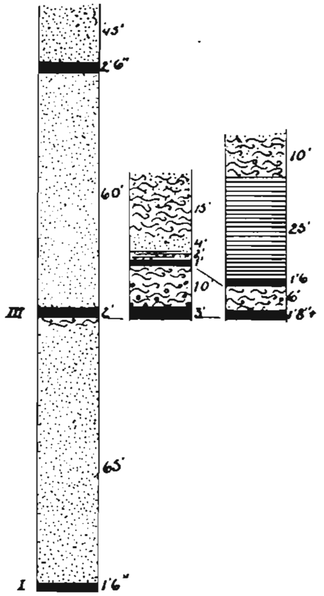


PLATE XXXIX. Sketch map of part of T. 7 N., R. 6 W.

TOWNSHIP 7 NORTH, RANGE 6 WEST.

1292. GEOGRAPHY.—This township, lying west of the center of the county, corresponds to Grant, western Fairplay and a corner of Washington of the civic townships.



572 Ross. Sec. 33. 573 Bedwell. Sec. 33. 574 Robertson. Sec. 16.

Figs. 572-574. Columnar sections in T. 7 N., R. 6 W.

Probably half of the township is flat prairie land, with low rolling divides between. This flat land is found in the S. E. corner and extending up Latta's and Buck's creek, with a width of a mile or more, and appears to be due to the filling of preglacial valleys. Most of this land is now drained by ditches, though subject to overflow at times of high water.

The township is crossed from northeast to southwest by the I. & V. R. R. and entered by the C., I. & L. Ry. (Monon), and St. L., I. & E. R. R. (I. & I. S. R. R.), the latter two meeting at Switz City.

1293. STRATIGRAPHY.—There appear to be two coals outcropping, which are assumed to correspond to Coals IV and III. Below this occurs the horizon of Coal I.

The following drillings were obtained in this township:

1294. SECTION 484. SECTION OF DRILLING ON LAND OF JOHN ROSS.—S. W. ¼, Sec. 33, Fig. 572. John Steward, driller. (C. E. S.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and clay	20	0	..	..	20	0
2.	Sandstone	45	0	..	..	65	0
3.	COAL IV	2	6	2	6	67	6
4.	Fire-clay	2	0	..	..	69	6
5.	Sandstone	60	0	62	0	129	6
6.	COAL III	2	0	2	0	131	6
7.	Fire-clay	2	0	..	..	133	6
8.	Sandstone	65	0	67	0	198	6
9.	COAL I	1	6	1	6	200	0

This drilling starts about 50 ft. above the level of the I. & V. Ry. at the depot at Lyons.

1295. SECTION 485. SECTION OF DRILLING FOR HENRY A. BEDWELL.—Just S. E. of the center of Sec. 33. Fig. 573. (C. E. S.)

		Ft.	In.	Ft.	In.
1.	Soil and clay	15	0	15	0
2.	White sand	4	0	19	0
3.	Sandy shale, red	2	0	21	0
4.	COAL	1	0	22	0
5.	Hard darkish clay and sandstone	10	0	32	0
6.	COAL	3?	0	35	0

1296. SECTION 486. SECTION OF WM. H. ROBERTSON'S WELL.—S. E. corner of N. E. of S. E. of Sec. 16. Fig. 574. (C. E. S.)

		Ft.	In.	Ft.	In.
1.	Soil and clay	10	0	10	0
2.	Shale, soft	25	0	35	0
3.	COAL	1	6	36	6
4.	Fire-clay	6	0	42	6
5.	COAL	1	8+	44	2

In Sec. 20 a well is reported to record a coal below 12 ft. of limestone, as was reported in wells near Lyons.

1297. SECTION 487. SECTION OF McINDOO WELL.—S. W. corner of S. W., S. E. of Sec. 20. (C. E. S.)

		Ft.
1.	Black muck	100
2.	Sandstone and shale	44
3.	Limestone (?)	12
4.	COAL, "not very good"	6
5.	Sandstone and shale	22

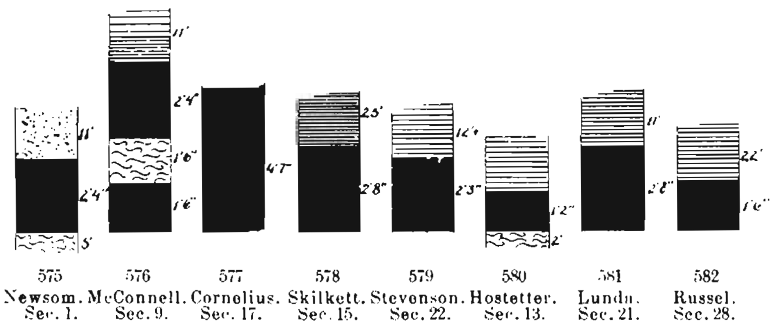
As an illustration of what is met in wells in the prairies of filled-in land, the following section may be quoted:

1298. SECTION 488. SECTION ON JUDGE MARTINDALE'S LAND.—N. E. ¼ of Sec. 27. (C. E. S.)

		Ft.
1.	Sand	3 to 40
2.	Black mud	22
3.	Gravel and sand	3
4.	Black mud, pawpaw wood and leaves in bottom, some gas	141
		206

In such a case it would be evident that the coal measures had been entirely removed.

1299. DISTRIBUTION AND LOCAL DETAILS.—To just what extent the level prairies in the S. E. corner and along Latta's and Buck's creeks are underlain by the horizon of Coals I and III could not be



Figs. 575-582. Sections of coals seen (in the main) in T. 7 N., R. 6 W.

ascertained, but probably to a much less extent than is indicated on the map. The horizon of Coal I is below drainage all through this township. The horizon of Coal III is about at the level of the bottoms on the east side of the township, but passes under drainage level as we go west. Coal IV is above drainage over all of the township; its dip to the west, if correctly correlated, is very slight.

North of Latta's creek are several small areas in which coal is reported; in the S. W. ¼ of Sec. 4, N. E. ¼ of Sec. 10, and N. E. ¼ of Sec. 11. In Sec. 1 a drilling in Dixon is reported as follows:

1300. Section 489. Section of E. N. Gaskin's Well.—S. W. of S. E. of Sec. 1. (C. E. S.)

		Ft.	In.
1.	Soil and clay	10	0
2.	Shaly sandstone	10	0
3.	COAL III?	..	8
4.	Hard sandstone	3	0

In the N. W. ¼ of this section are several openings to Coal IV on Mrs. Clara Newsom's place, formerly the McKissick place. The coal here is 2 ft. 4 in. thick on the crop, and is claimed to thicken to 3 ft. farther back. The coal is a semi-block. The roof is made by a 1-ft. layer of sandstone; above that is 7 to 10 ft. of sandstone, then yellow shale. Below the coal is 4 to 5 ft. of fire-clay, then shale (Fig. 575).

The main body of coal extends through the divide between Latta's and Buck's creeks, separating near the center of the township in two prongs, one going a little south of east, the other going west of south.

In Sec. 6 coal is reported in a well in the S. W. ¼ at 83 ft. In the S. W. of N. E. of Sec. 7 a well is reported as follows:

1301. Section 490. Section of Wm. Brick's Well.—Sec. 7. (C. E. S.)

		Ft.	In.
1.	Soil and clay	20	0
2.	Light yellow sandstone and sandy shale	4	0
3.	Blue shale	18	0
4.	Very hard rock	1	6
5.	COAL	1+	0
6.	Fire-clay	8	0

Coal IV has also been struck in a well and mined a little in the N. E. of S. E. of Sec. 7.

In the N. W. of the N. E. of Sec. 17, 4 ft. 7 in. of Coal IV is reported in a well on the Cornelius place at 67 ft. (Fig. 577), while in another well in the same place, on lower ground, the coal is given as 4 ft. thick and 30 ft. deep. In the S. E. of N. E. of Sec. 17, two wells strike the coal, one at 47 ft., and the other, nearer to outcrop, at 28 ft. The coal has been mined a little in the N. E. of S. W. of Sec. 17, on the F. W. Hindbook place, and in the N. W. of S. E. of Sec. 17, on the O'Harrah place.

In the S. E. of S. E. of Sec. 9, coal is mined by stripping and drifting on the R. E. McConnell farm. The coal is a semi-block and runs from 28 to 32 in. in thickness, the section at the entry showing (Sect. 491, C. E. S.), Fig. 576:

		Ft.	In.
1.	Soil ....2 ft. to	3	0
2.	Yellow shale	7	0
3.	Black shale	4	0
4.	COAL IV?	2	4
5.	Fire-clay	1	6
6.	COAL	1	6

The roof at the entrance appears disturbed and of poor quality, 4 in. of it coming down. Below the coal is reported 1 ft. 6 in. of fire-clay, then 1 ft. 6 in. of coal. This would appear to be the lower bench of Coal IV, though it does not appear certain that it does not correspond to Coal III of Clay county. The dip here is to the southwest. Just west of this the same coal is stripped on the J. B. Terhune place, the coal there being from 2 ft. 6 in. to 3 ft. thick. As above, this is a semi-block coal, and is said to be of excellent quality.

The record of Mr. Robertson's well in the S. W. ¼ of Sec. 16 was given above. In Sec. 15 coal was struck in Mr. J. D. Spencer's well in the N. E. ¼ of the section. The record of the well is given as follows (Sect. 492, C. E. S.):

		Ft.	In.
1.	Soil and clay	9	0
2.	Shale	37	0
3.	"Limestone" (?) hard rock	4	0
4.	COAL IV?	1	6
5.	Fire-clay	..	..

Six hundred yds. north the coal outcrops 18 in. thick with sandstone beneath. In the S. W. ¼ of this section a well on the W. H. Wakefield place reached the coal at 12 ft.

In the S. E. ¼ of Sec. 15 Coal IV is found in a well at 35 ft., and mined by drifting on the J. W. Skilkett farm. The coal is a semi-block running quite regularly about 2 ft. 8 in. thick. The section at the well, 200 yds. southwest of the drift, shows (Sect. 493, C. E. S., Fig. 578).

		Ft.	In.
1.	Soil and clay	10	0
2.	Black shale	25	0
3.	COAL IV (?)	2	8
4.	Fire-clay	..	..

The roof is said to have required considerable timbering. The dip is to the west.

Just west of Switz City in the N. E. ¼ of Sec. 22 coal has been worked at the Stevenson shaft, where it is reported 2 ft. 3 in. thick and 27 ft. deep. It is a semi-block and has a good roof of dark gray shale 12 ft. or more thick (Fig. 579). In a well just northeast of Switz City two beds of coal were struck, the first at 18 to 20 ft., the other, which had a thickness of 8 to 12 in., at some distance below.

Since the report and plates went to press, the records of a number of drillings by Mr. E. L. Ferguson in this county have been found, and, on account of the interest now manifested in this coal field, a few of them will be inserted at this and following points. The following three are from near Switz City:

Boring in edge of Switz City—	*Ft.*	*In.*
Clay	4	0
Sandy shale, 8 ft. 2 in.; dark shale, 8 ft. 4 in	16	6
COAL IV ("block")	3	1
Fire-clay, 3 ft.; clay shale, 2 ft. 6 in.; dark sandstone, 8 ft.; clay shale, 13 ft. 8 in	27	2
Shale and COAL	0	4
Dark clay shale, 7 ft. 5 in.; shale, 6 ft. 8 in	14	1
COAL	0	6
Fire-clay, 10 in.; gray clay shale, 10 ft. 6 in.; fine blue shale, 8 ft. 6 in	19	10
	85	6

Boring near Switz City, ½ mi. west of Latta's creek—		
Surface clay	17	8
Sandy shale	17	10
COAL IV ("good, semi-block")	3	1
Fire-clay, 1 ft. 4 in.; sandstone, 7 ft. 4 in.; fire-clay, 2 ft. 9 in.; very black shale, 8 ft. 6 in.; fire-clay, 9 in.; blue limestone, 5 in.; clay shale, 1 ft.; blue limestone, 2 ft. 5 in	26	6
COAL	0	½
Black shale, 15 ft.; sandy shale, 7 ft.; clay shale, 24 ft.; sandstone, 4 ft.; clay shale, 2 ft.; sandstone, 2 ft. 10 in.	54	10
	117	11½

Drilling close to railroad, near center of Sec. 14-6-7—		
Surface clay	19	0
Sandstone, 1 ft. 9 in.; sandy shale, 4 ft. 3 in.; "clay and coal drift," 4 ft.; sandstone, 14 ft.; black shale, 6 ft.	30	0
COAL	2	2
Fire-clay, 2 ft. 6 in.; clay shale, 8 ft. 10 in	11	4
COAL	..	10
Fire-clay, 10 in.; limestone, 5 ft	5	10
COAL	1	4
Clay shale, 9 ft. 9 in.; black shale, 11 ft. 6 in.; limestone, 1 ft. 6 in	1	9+
	84	3

In the S. W. ¼ of Sec. 23 a well on the Henry Bovenshen place went through 18 in. of coal at a depth of 30 ft. A well on J. D. Spencer's place in the S. W. of N. W. of Sec. 14 went through several small beds of coal from 15 to 18 in., in a depth of 122 ft. A little east of this, coal outcrops 12 to 14 in. thick. In the S. E. ¼ of Sec. 13, Coal III? is worked by a drift by James Hostetter. This mine was formerly known as the John Bennett, or at a still earlier date, as the Jas. Dixon mine. The coal is a semi-block with a blue shale roof, which requires close timbering. Below the coal is 2 ft. and over of fire-clay (Fig. 580). The coal is used some for blacksmithing. In the N. W. of the N. E. of Sec. 25, 2 ft. 6 in. of coal is found in a well at about 20 ft. at Mr. Geo. W. Stranser's.

Returning to the ridge of coal running south from the center of the township we find that Coal IV has been stripped at J. L. Grace's in the N. E. ¼ of Sec. 21, where it is 2 ft. 8 in. thick. At a well a short distance south and about 15 ft. lower, 2 ft. 2 in. of coal was struck at 30 ft., and 1 ft. 8 in. of coal at a lower level. Coal is also struck in the S. W. ¼ of Sec. 21 on the Wakefield place. In the S. E. of S. E. of Sec. 21 Coal IV is mined at the Lunda shaft by Mr. Kates. The coal was mined here by a slope in the early sixties; at the shaft it is 24 ft. deep. The coal runs from 31 to 32 in. in thickness without parting. The roof is black shale 11 ft. thick, with some small rolls (Fig. 581). The bed lies about level with a slight dip to the S. E.

Two of the drillings by Mr. Ferguson, spoken of above, report workable coal at this point some distance below the Lunda coal. They are located as in the S. E. corner of Sec. 21 and N. E. corner of Sec. 28:

Drilling No. 1—	*Ft.*	*In.*	*Ft.*	*In.*
Surface clay	8	0	8	0
Sandy shale, 12 ft.; black shale, 13 ft. 6 in.	25	6	33	6
COAL IV	2	0	35	6
Fire-clay, 3 ft.; clay shale, 7 ft. 4 in.; black shale, 8 in	11	0	46	6
COAL IIIa (?)	1	6	48	0
Fire-clay, 3 in.; sandstone, 9 ft. 6 in.; clay shale, 6 in.; sandstone, 4 ft.; light-colored clay shale, 2 ft. 4 in.; sandstone, 3 in.; gray clay shale, 9 ft. 6 in.; potters' clay, 7 ft.; black shale, 8 ft. 8 in.	42	0	90	0
COAL III (?)	4	11	94	11
Fire-clay.				
Drilling No. 2—				
Surface clay	4	0	4	0

	Ft.	In.	Ft.	In.
Sandy shale, 8 ft. 2 in.; black shale, 8 ft. 4 in.	16	6	20	6
COAL IV	3	1	23	7
Fire-clay, 3 ft.; potters' clay, 2 ft. 6 in.; dark sandstone, 8 ft.; blue clay shale, 13 ft. 8 in.; shale, 4 in.; clay shale, 7 ft. 3 in.; black shale, 6 ft. 8 in.	41	5	65	0
COAL IIIa (?)	0	6	65	6
Fire-clay, 10 in.: dark clay shale, 10 ft. 6 in.; black shale, 12 ft. 2 in.	23	6	89	0
COAL III?	5	1	94	1

In the S. E. of N. W. of Sec. 28 a shaft was sunk in the Peter K. Russell place through 20 ft. of soil and 22 ft. of good shale to 1 ft. 6 in. of coal (Fig. 582). Coal is also reported in the well on the Grand place. In Sec. 33 outcrops of 33-in. coal occur in the N. W. ¼, and an outcrop of 15-in. coal in the S. E. of S. W. ¼. The records of the wells on the Bedwell farm in the N. W. of S. E., and Ross farm in S. W. ¼ of this section were given above. Coal IV is also found in wells in the N. W. ¼ of Sec. 31 close to the road.

Taken as a whole, it will be seen that the workable coal of this area, as a rule, has a thickness of less than 3 ft., and, therefore, is not likely to be extensively worked for some time.

Township 8 North, Range 7 West.

1302. Geography.—This township occupies the northwestern corner of Greene county, and corresponds with Wright of the civic townships.

The divide between the Wabash and the White rivers runs through this township in a nearly north and south line, a little west of the center. In Sec. 33 the divide turns sharply to the west, exactly crossing the S. W. corner of Sec. 32. This divide is about 100 ft. higher than White river, and as the streams, on leaving the township, are little, if any, above high water, it is seen that the most of their descent is close to the watershed, resulting in a rather broken topography. The divide turns northwest from Jasonville, as it enters Clay county. The northeastern corner of the township is flat, and there is some flat land along the larger streams flowing to the east. No railroads enter the township (1898).

1303. Stratigraphy.—Divisions VII to IV outcrop in this township with other divisions below not outcropping. A couple of sections will serve to show the stratigraphy.

1304. Section 494. Section (approximate) in Secs. 31 and 32.—Fig. 2, Plate XL, p. 816. (E. T. C., p. 104.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and drift	18	0	..	..	18	0
2.	Clay shale	2	0	..	..	20	0
3.	COAL VII	4	0	4	0	24	0
4.	Potter's clay, white	2	0	..	..	26	0
5.	Sand shale, with flags	?40	0	42	0	66	0
6.	COAL VI (Dugger bed) ...3 ft. to	6	0	6	0	72	0
7.	Dark fire-clay	?	0	..	..	72+	0
8.	Blue clay shale	4	0	..	..	76	0
9.	Bluish gray sandstone	24	0	..	..	100	0
10.	Fossiliferous limestone	2	0	..	..	102	0
11.	Black, bituminous sheety shale	2	0	32	0+	104	0
12.	COAL V (Alum cave bed)..4 ft. to	6	0	6	0	110	0

1305. Section 495. Section at Uffelman Shaft.—N. W. ¼ Sec. 25, Fig. 3. (C. E. S.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Clay shale, soft	18	0	..	..	18	0
2.	COAL IV (?) and "bastard" cannel coal ...15 in. to	2	6	2	6	20	6
3.	Sandstone	14	0	..	..	34	6
4.	Clay shale	10	0	..	..	44	6
5.	Black shale	9	0	..	..	53	6
6.	COAL III (?)	3	0	3	0	56	6
7.	Fire-clay	1	6	..	..	58	0

On the maps the outcrop of Coal V is drawn as drawn by Mr. Siebenthal on his field sheets in the field. A comparison of the strata accompanying the coals in the eastern part of the township with the stratigraphy around Linton very strongly suggests that the coals in that part of the township, notably in Secs. 12, 24, 25 and 36, and parts of Secs. 11, 14, 23 and 26 belong in Divisions III and IV. Coal V is normally in this area, overlain by black bituminous sheety shale, and that in turn by limestone, and underlain by fire-clay, then by shale. Coal IV about Linton is overlain by clay shale and underlain by sandstone. In the sections, or partial sections mentioned, it will be noted that neither limestone nor black sheety shale was found, while at the few places where stratigraphic details were observable the coal has clay shale over it and sandstone below. It is thought best, however, not to attempt to redraw the lines in the office, and they were left as drawn in the field.

Coal V in this area, as shown by Figs. 11 to 14 of Plate XL, is a coal ranging from 5 to 7 ft. thick. If, as suggested above, the coal mapped as Coal V in the eastern part of the township be excluded, it will be seen that Coal V is normally a thick coal overlain by black sheety shale, and that in turn by limestone. Wherever seen by the writer in this area it appeared to be a poor grade of coal, apt to be full of irregular dirt bands, and the fact that it is so little worked, notwithstanding its thickness and numerous exposures, goes to confirm that view.

1306. DISTRIBUTION AND LOCAL DETAILS.—Division VII is confined to a small area in the south part of Sec. 31; Division VI to a somewhat larger area in the southern part of Sec. 32. Division V is the division outcropping over most of the township. Coal V is nearly everywhere above drainage, so that in the bottoms of the stream valleys the rocks of Division IV are exposed. If the suggestion made above in regard to the correlation of the coals in the eastern sections is correct, then Division IV outcrops over a much larger area in the eastern part of the township than is shown on the maps, and correspondingly the area of Division V should be that much restricted in that direction.

For convenience, we will consider the data obtained east of the watershed first, following around the outcrop, as drawn on the map.

Coal V outcrops on the county line in the N. E. ¼ of Sec. 5, 18 in. thick, and is reported to have been 2 ft. 2 in. in a shaft on Dr. Asbury's place in the N. W. ¼ of Sec. 4. There is also an outcrop of unknown thickness in the N. E. ¼ of Sec. 4.

In the S. E. of N. W. of Sec. 3 coal was struck in a drilling on Nathan Squire's land, and in the S. W. of N. W. of Sec. 3 Coal V is 3 ft. thick at a depth of 6 ft. on the Geo. Edmunson place. Up the fork from the south the coal is in the bed of the creek, and was opened thirty years ago on the James Wright place in the S. E. of S. W. of Sec. 3. The limestone is exposed at places up the branch, and near the center of the N. W. ¼ of Sec. 10 Coal V 4 ft. thick is seen on Isaac Morgan's farm.

On the James Rogers place in the S. W. of S. W. of Sec. 2, and N. W. of N. W. of Sec. 11, wells reach a 7-ft. coal with a thick parting. At the barn the coal was 20 ff. deep and had 9 in. of fire-clay for a parting. The coal here had 4 ft. of black shale over it. The well under the hill reached the coal at 12 ft. Here the coal had 8 in. of clay shale for a parting, while over it was 2 ft. of sandstone, then 2 or 3 ft. of clay shale. The coal is reported of excellent quality. A comparison of this coal with Coal IV, in Sec. 27 of the township next north in Clay county, indicates that they are the same. This coal, 2 ft. thick, and without roof, has been stripped on Henry Sheets's place. Going up the branch the limestone over Coal V is found in a short distance, indicating a small space here between Coals V and IV. Coal V is found on John Wise's place in the N. E. of N. E. of Sec. 10, and further up has been extensively stripped on Geo. Baughman's place in the S. E. of N. E. of Sec. 10, where it is 4 ft. thick, and on Joseph A. Rogers's, in the S. W. of N. W. of Sec. 11, where it has been opened up for many years. In a drilling 40 ft. deep in the N. W. of N. E. of Sec. 11, 10-12 ft. of heavy sandstone was passed through, but no coal. This probably started below Coal V, and the sandstone is the sandstone quarried from Division IV in the western part of the township.

In the N. E. of S. W. of Sec. 11 on John Wolf's place, Coal IV (?) outcrops in the bed of the branch. Following up the stream, outcrops are noted in the N. W. of S. E. of this section in the south bank, and an outcrop of a 1-ft. bed of coal in the S. E. of S. W. of Sec. 11. West of this, in the same quarter section, two wells report each 7 ft. of coal. In the S. E. of S. E. of Sec. 10 is an outcrop with the limestone accompanying. A number of wells in the south half of the S. E. ¼ of Sec. 11 on Perry Squires' place, as also a well on Chas. Trump's place in the N. W. of N. E. of Sec. 14, report 4 ft. of coal at depths of from 13 to 18 ft. These were assumed to be Coal V by Mr. Siebenthal. Up the fork from the south 3 ft. 6 in. of coal outcrops on Isaac Lode's place in the N. E. of S. E. of Sec. 14, and 2 ft. of coal is found at two places in the S. W. ¼ of Sec. 13. On the ridge east of this branch 18 in. of cannel (?) coal is reported from a well in the N. W. of N. E. of Sec. 12, 6 to 8 in. of coal at an outcrop in the N. E. of N. E. of the same section, and 6 in. of coal in a well in the next 40 acres south. These were assumed to be Coal V, but, I am inclined to think, belong in Division IV, and possibly correspond to the "rider" at Linton, or Coal IVa.

Following the outcrop up the north side of Latta's creek we find 4 ft. of coal has been worked on S. O. Beckwith's place at a depth of 22 ft. by shaft in the N. E. ¼ of Sec. 24, while in the same quarter section and a little west is an outcrop of coal 18 in. thick. I am inclined to call the worked coal Coal IV, though mapped as V. In the N. W. ¼ of this section a 4 ft. coal is worked by shaft by Wm. Uffelman. The coal is a semi-block, resembling the Linton coals. It is 30 ft. deep, the section showing as follows (Sect. 496, C. E. S.):

		Ft.
1.	Soil and boulder clay	21
2.	Clay shale	7
3.	Shale, gray	2
4.	COAL IV?	4
5.	Sandstone	15

The character of the roof here, as well as the presence of the sandstone immediately under the coal, leads me to believe that this is Coal IV. The roof is gray shale, 2 in. of which tends to fall, but is usually held; otherwise roof smooth and good. The floor is also smooth and solid.

This coal is found on Ed. Byers's place in the S. E. of S. E. of Sec. 14, and in the S. E. corner of this 40 is 4 ft. thick at a depth of 28 ft. in a well. Coal is 2 ft. 6 in. to 3 ft. thick in a well on the crop in the N. E. of N. E. of Sec. 22, is found in a well on the John Sills place in the S. E. of S. E. of Sec. 15, outcrops at the N. E. ¼ of this 40, also on the Evan Bonham place in the N. E. of S. E. of Sec. 15, and on J. A. McDonald's farm in the S. W. of N. E. of Sec. 15.

In the N. E. of S. E. of Sec. 16 Coal V has been worked by slope and drift on Wm. J. Bonham's farm. It runs from 1 ft. to 2 ft. 6 in. in thickness. It is overlain by 3 ft. of black sheety shale, and that in turn by lenticular masses of blue limestone, with sandstone above. The roof is good. Below the coal is at least 6 ft. of fire-clay. Some rolls were encountered. The coal proved too thin to work. The same coal is also found on J. C. Landrum's farm in the N. E. of S. W. of Sec. 16; Samuel Bonham's, S. W. of S. E. of same section, where it is 4 ft. 6 in. thick, and at Albert Larr's in the S. W. of S. W. of Sec. 15, at Wright P. O.

In the S. E. of N. E. of Sec. 21 Coal V is 2 ft. thick on the old Bonham place. It outcrops in the N. E. of S. E. of Sec. 21. On Albert Rhodes's farm, in the S. E. of S. E. of Sec. 22, it is 2 ft. thick.

Coal IV (?) outcrops in the N. E. of S. W. of Sec. 23 on Louis Gibson's and is struck in a well at Thos. Vaughn's in the S. W. of S. E. of this section at a depth of 24 ft., being 3 to 4 ft. thick. Five ft. of coal is reported in bottom of branch in N. W. of N. E. of Sec. 26.

Coal V has been stripped at the Humphrey bank in the N. W. of the S. W. of Sec. 26. It is overlain by the black sheety shale.

In the N. E. ¼ of Sec. 26, 3 ft. of coal outcrops on the L. G. Chapham place, and at an outcrop a little N. E. of this, coal is 14 in. thick. The section at the Uffelman shaft in the N. W. ¼ of Sec. 25 was given above. Coal is struck in a well on Dr. Morgan's place in the N. E. of the S. W. of Sec. 25, and has been stripped in the S. W. of S. W. of this section on the Sadie Beasley place.

In the N. W. of the N. W. of Sec. 36 coal has been worked at the Wm. Powell bank by drifting. The coal here shows 3 ft. 6 in. of good coal with 6 in. of bone on top. The same coal outcrops on Geo. Sage's farm in the S. W. of N. E. of this section, and is struck in a well on Dietrich Bovenche's in the S. W. ¼, where it is 4 ft. thick.

In the S. W. ¼ of Sec. 35 Coal V, 14 in. thick, overlain by black sheety shale, has been stripped. In the N. W. ¼ of Sec. 35 it is 18 in. thick on Robin Ellis's place (Fig. 10), and 16 in. at J. S. Taylor's in the S. W. of S. W. of Sec. 26.

Next, starting at the north, we will consider the data obtained on the west side of the divide. This is almost entirely confined to Coal V. On the branch which flows west through Secs. 5 and 6, Coal V appears to lie a little above drainage, or else crops out in the creek bottom. The limestone over the coal was noticed in the S. W. ¼ of Sec. 5, and coal was noted in the S. E. of N. W. and N. W. of S. W. of this section. In the N. E. ¼ of Sec. 6 a well in the creek bottom is reported to have gone through 4 in. of coal at a depth of 30 ft. Coal outcrops on the Jacob Nicholson place in the N. W. of the S. W. of this section. On the Joseph Pigg place the coal has been stripped, showing 18 in. of good coal and 18 in. of "rotten" coal, with fire-clay below.

In Sec. 7 the coal outcrops on the Arise Waggedy place in the N. W. 40 on the Geo. H. McCameron farm in the N. E. of S. E. At the last place the coal is 6 ft. thick, while the limestone shows 12 ft. above. Where the branch crosses the line between Secs. 7 and 8 Coal V is 25 or 30 ft. above the creek bed, exposing a 20-ft. bluff of hard sandstone apparently suitable for quarrying. Though cross-bedded in places, the dip here is west or northwest. Going up stream the coal descends to creek level, outcropping in all the finger-like branches at the head of the stream. Thus the limestone and coal are found on the Enos Gadbury place in the N. E. of N. W. of Sec. 8; S. E. of N. E. of same section on the Eugene Hardcastle place, where it is 6 ft. thick, and on Louis E. Letsinger's in the N. W. of S. W. of Sec. 9. The section here shows (Sect. 497, Fig. 11):

	Ft.
Limestone	4
Black bituminous sheety shale	6
Coal V	6

The coal shows some dirt bands near the center, which, however, do not appear to be persistent. There are a number of drifts and outcrops at this point. The coal dips here strongly to the southwest, then rises above the creek, then a few yards west the limestone and black shale are in the creek bed again. In the S. E. 40 of Sec. 8 Coal V is worked at James T. Warrick's drift. The coal is here 6 ft. thick with a dirt seam in the center, not persistent. The coal above the dirt band is a bright coal and better than the lower part, which is dull and heavier and contains more sulphur than the upper part. The lowest 1 ft. of

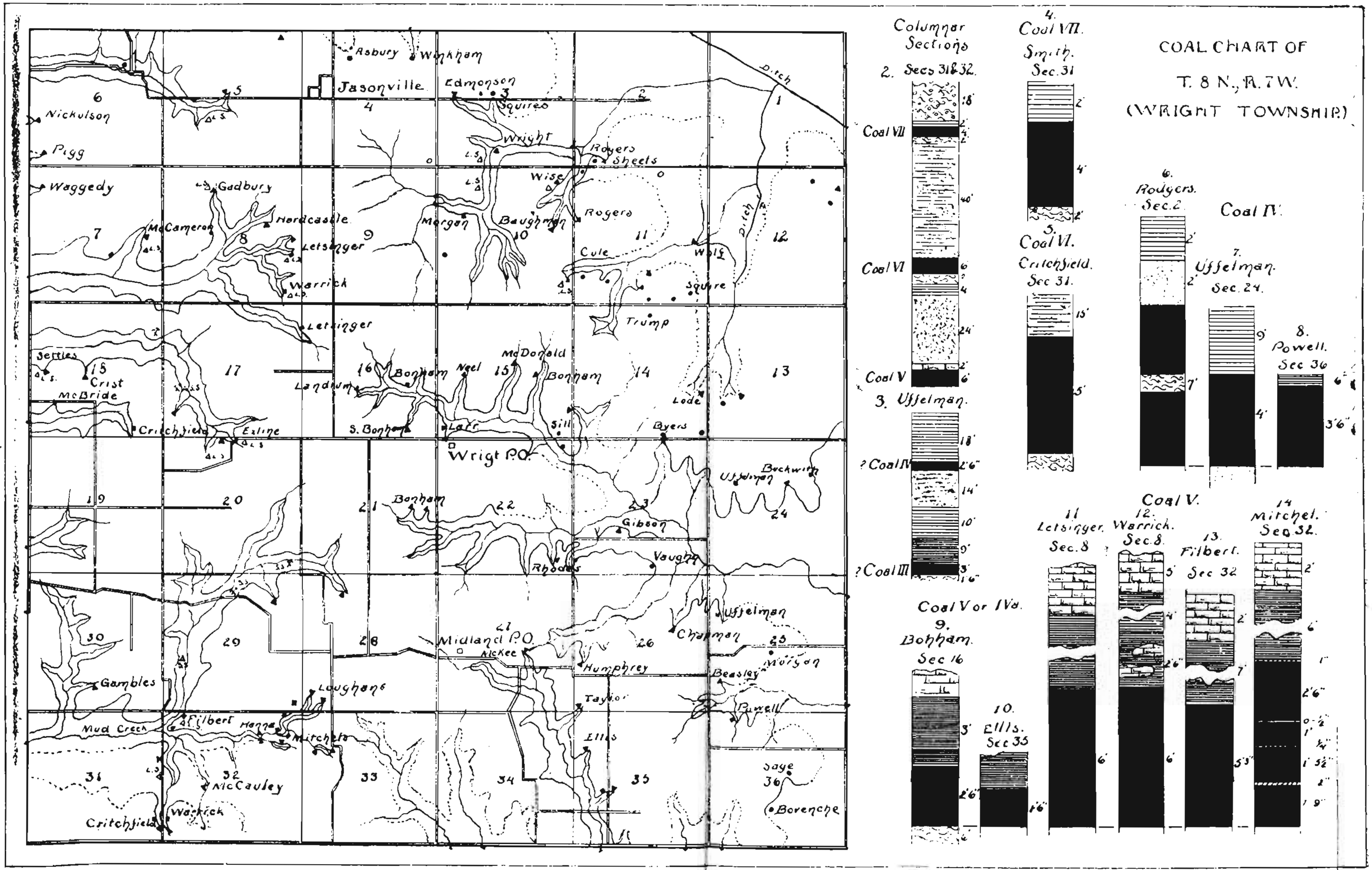

COAL CHART OF
T. 8 N., R. 7 W.
(WRIGHT TOWNSHIP)
Columnar Sections
2. Secs 31 & 32.
Coal VII
Coal VI
Coal V
3. Uffelman.
? Coal IV
? Coal III
4. Coal VII. Smith. Sec. 31
5. Coal VI. Critchfield. Sec. 31.
6. Rodgers. Sec. 2.
Coal IV.
7. Uffelman. Sec. 24.
8. Powell. Sec. 36
Coal V or IVa.
9. Bonham. Sec. 16
10. Ellis. Sec 35
Coal V.
11. Letsinger. Sec. 8
12. Warrick. Sec. 8.
13. Filbert. Sec 32
14. Mitchel. Sec 32.
Jasonville
Wright P.O.
Midland P.O.

PLATE XL.

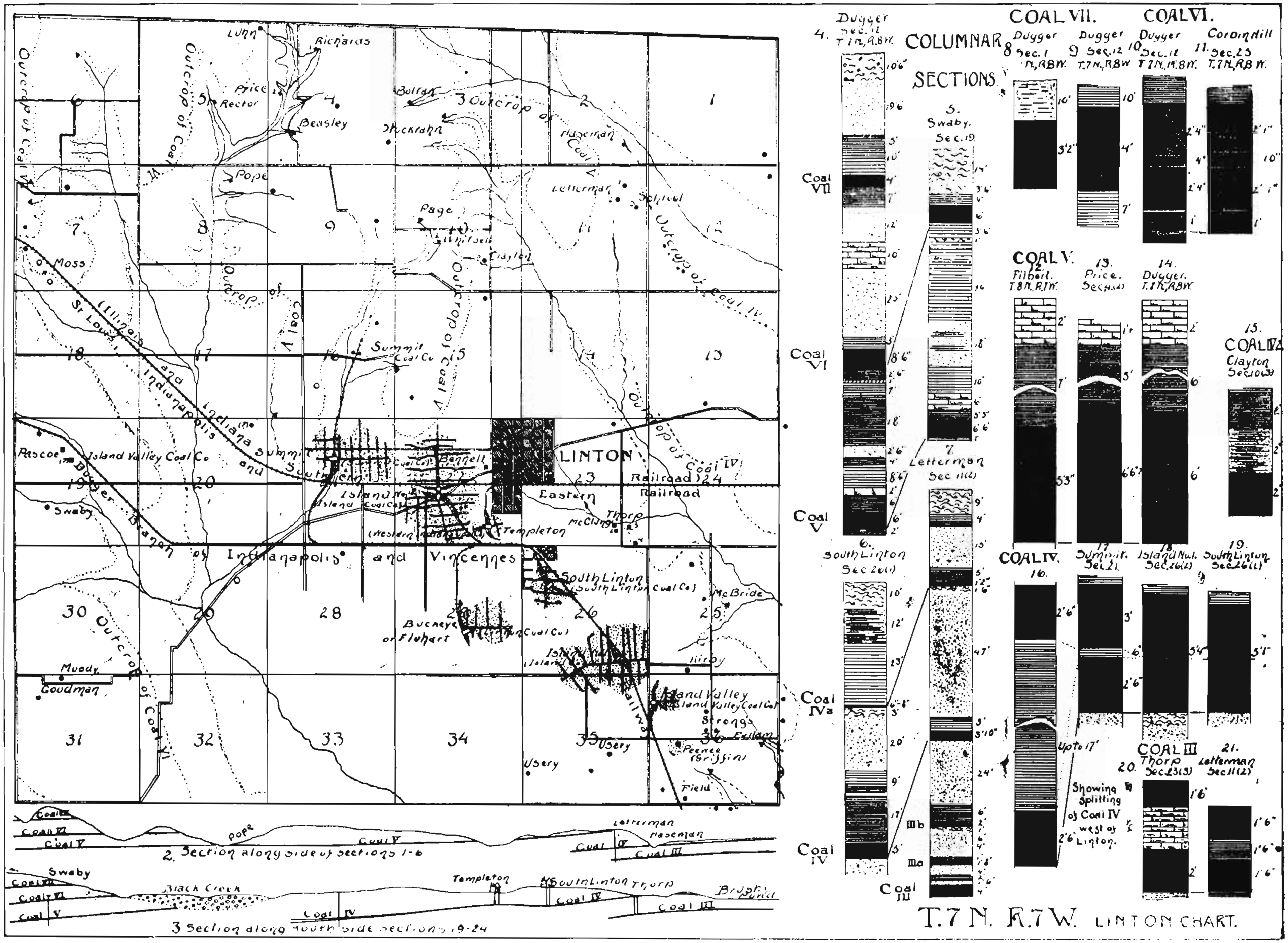

COLUMNAR SECTIONS
COAL VII.
COAL VI.
COAL V.
COAL IV.
COAL III
Coal VII
Coal VI
Coal V
Coal IVa
Coal IV
Coal III
LINTON
2. Section along side of sections 1-6
3 Section along south side sections 19-24
Showing Splitting of Coal IV west of Linton.
T. 7 N. R. 7 W. LINTON CHART.

PLATE XLI.

coal is not used. The roof is the black sheety shale. 1½ in. of which come down. The section at the north drift shows (Sect. 498, Fig. 12. C. E. S.).

	Ft.	In.
Limestone	5-	0
Black shale	4	0
Black sheety shale, with some limestone lenses	2	6
"Draw slate"	..	2
COAL V	6	0
Fire-clay	?	?

At Thos. Letsinger's bank, in the N. E. ¼ of Sec. 17, there is exposed 4 ft. of limestone, 2 ft. of lenses of blue limestone in blue shale, 1 ft. black sheety shale to the coal.

On the next branch to the south Coal V is worked by drifting on the Wm. Settle place in the S. W. of N. W. of Sec. 18. The coal is over 6 ft. thick, with the limestone over. It is also found on the Wm. A. Crist place in the N. E. of S. W. of this section. In the western part of Sec. 17 the coal rises above the creek so as to expose the sandstone of Division IV, which has been quarried there some. Coal V is found on the Wm. Exline place in the S. E. of S. W. of Sec. 17, also in the S. W. of S. W. of the section, and the limestone occurs still further up the branches. The limestone outcrops in the north part of Sec. 20.

On the branch in the south part of Sec. 18 Coal V outcrops on Margaret McBride's farm in the S. W. of S. W., and has been worked on Louis Critchfield's in the S. E. of the S. E. of the section. At the latter place the coal is about 6 ft. thick with 2 ft. 6 in. of black shale over, and limestone above, and about 11 ft. of fire-clay below. It is described as a semi-block, shooting on the solid. At a well at the house the coal is 12 ft. deep and 7 ft. thick.

Going up Mud creek Coal V is found on Jos. W. Gamble's in the S. E. ¼ of Sec. 30, and is worked at the Filbert drift in the N. W. of N. W. of Sec. 32. The section here shows (Sect. 499, Fig. 13):

	Ft.	In.
Gray fossiliferous limestone	2	0
Black sheety shale to black shale	7	0
COAL V	5	3

The coal here is about 12 ft. above the creek. The coal does not impress one well at the entrance of the mine, but is said to be better farther in. Following the branch to the north the coal rises, and for a mile and a half the quarry sandstone, mentioned above, is exposed, sometimes in bluffs 10 to 12 ft. high, with often single ledges 5 and 6

ft. thick. This is quite soft, often nearly white, and has been much used for foundations and chimneys for over 40 years. It will not stand the heat, but is said to stand the weather well, getting slightly harder with time.

Coal V is reported in the N. E. ¼ of Sec. 29 and N. W. ¼ of Sec. 28. It outcrops at several places on Mr. Lougham's farm in the S. W. of S. W. of Sec. 28, and across the line in the S. E. of S. E. of Sec. 29. A test shaft sunk to it found 5 or 6 ft. at a depth of 30 ft. The dip is great enough to carry it down, keeping about at creek level. Coal has been worked on Mitchell's and Hanna's places in the E. ½ of the N. E. of Sec. 32. At the Mitchell mine the coal is boldly exposed in a perpendicular bluff in the face of the bank, making one of the best exposures noted. The section here gave (Sect. 500, Fig. 14):

	Ft.	In.
Limestone	2	0
Black sheety shale	6	0
COAL V—Pyrite band, 1 in.; coal, 2 ft. 6 in.; clay parting, 0 in. to ½ in.; coal, 1 ft. 0 in.; pyrite band, 0 in. to ¼ in.; coal 1 ft. 5½ in.; pyrite band, 1 in. to 2 in.; coal, becoming bony, 1 ft. 9 in	7	0
Shale, with streaks of coal	2	0
Fire-clay, white to blue	3	0

Local anticlines bring the coal up so as to make small exposures on branches in the S. E. of N. E. of Sec. 32 and N. W. ¼ of Sec. 33. The coal outcrops or has been stripped at a number of points down this branch.

Where the dividing ridge turns west, south of Secs. 32 and 31, the westward dip makes it contain small areas of Coals VI and VII.

Coal VI is worked at the Warrick bank in the S. W. of S. W. of Sec. 32 and at the Critchfield bank across the road from it in the S. E. of S. E. of Sec. 31. The section in this region as worked out by Mr. Cox was given above. At the Critchfield mine the coal averages 5 ft. It contains some sulphur which, with care, can be separated. It is said to make too hot a fire for cooking stoves. For a roof there are a few inches of draw slate, then about 15 ft. of shaly sandstone or sandy shale. The coal is here only about 30 ft. below the top of the ridge at the cross roads just south. Mr. Cox reports Coal VII to be 4 ft. thick a quarter of a mile west of this at the Smith mine.

Township 7 North, Range 7 West.

1307. Geographic.—This township lies in the center of the three western townships of Greene county, and corresponds with Stockton of the civic townships.

The southern and eastern portions of the township are flat or rolling, the northwestern quarter rather hilly. The old broad valleys of Blackwater and Buck creeks were filled up during Pleistocene time so as to present at present stretches of prairie, averaging, perhaps, two miles on Blackwater in the southwestern quarter township, where known as the Goose pond, and less at other points. These prairies, while subject to overflow in high water, are now ditched, drained and cultivated. The divide between White and Wabash rivers follows around the north side of Secs. 5 and 6, then turns abruptly south and extends down the western edge of Secs. 6 and 7. This ridge is quite high, and from this high ground the land both to the south and east becomes of less elevation and more rolling in character, so that over most of the north part of the township the divides average from 50 to 75 ft. above the streams, with usually rather gentle slopes.

This township at present furnishes all of the coal shipped out of Greene county, all of it coming from Coal IV. Linton is one of the three largest towns in the county. As yet practically no manufacturing plants have been established here, though the field appears to be a good one for plants desiring a good, yet cheap, fuel. The area is crossed by the St. L., I. & E. R. R. (I. & I. S. R. R.) and by the Dugger switch of the I. & V. Ry.

1308. Stratigraphy.—Divisions VII to IV outcrop in this township, each containing a workable coal, while below occur Divisions I and III. Division VII occupies only a very limited area, and Coal VI a comparatively small area. The following sections will show the stratigraphy and relative position of the beds. In order to show the relation of Coal VII to the coals below it is necessary to introduce a section from just across the line at Dugger in Sullivan county.

1309. Section 501. Drilling at Dugger Mine.—Sec. 12-7-8, Fig. 4, Plate XLI, p. 817.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Earth	10	6	..	..	10	6
2. Sandstone	19	6	..	..	30	0
3. Shale	5	0	..	..	35	0
4. Blue shale	10	0	..	..	45	0
5. COAL VII	4	0	4	0	49	0
6. Clay shale	7	0	..	..	56	0
7. Sandstone	12	0	..	..	68	0
8. Limestone	10	0	..	..	78	0
9. Hard sandstone	25	0	..	..	103	0
10. Shale	3	0	57	0	106	0
11. COAL VI	8	6	8	6	114	6
12. Blue shale	2	6	..	..	117	0
13. Sulphur	1	0	..	..	118	0
14. Very light clay shale, very soft	7	0	..	..	125	0
15. Blue shale, very soft	10	0	..	..	135	0
16. Black shale, very soft	8	0	..	..	143	0
17. Sandstone, very hard	2	6	..	..	145	6
18. Dark blue shale	4	0	..	..	149	6
19. Gray shale	8	0	..	..	157	6
20. Limestone, very hard	2	0	..	..	159	6
21. Black shale	6	0	51	0	165	6
22. COAL IV	6	0	6	0	171	6
23. Black shale	2	0	..	..	173	6

1310. Section 502. Section of Core Drilling on Swaby Place.—Sec. 19, Fig. 5. Robt. Marshall, driller (C. E. S.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Earth	14	0	..	..	14	0
2. "Boulder"	3	6	..	..	17	6
3. Shale	4	0	..	..	21	6
4. COAL VI	6	0	6	0	27	6
5. Blue shale, some soft	5	0	..	..	32	6
6. Gray shale	0	6	..	..	33	0
7. Fire-clay	1	0	..	..	34	0
8. Clay shale	4	6	..	..	38	6
9. Black shale	4	6	..	..	43	0
10. Clay shale	2	6	..	..	45	6
11. Conglomerate	6	0	..	..	51	6
12. Clay shale	1	2	..	..	53	0
13. Conglomerate	3	0	..	..	56	0
14. Clay shale	1	0	..	..	57	0
15. Conglomerate	6	0	..	..	63	0
16. Sandstone	9	0	..	..	72	0
17. Shale and sandstone	1	6	..	..	73	6
18. Sandstone and shale	5	0	..	..	78	6
19. Sandstone	2	6	..	..	81	0
20. Gray shale	10	0	..	..	91	0
21. Hard rock, limestone	6	0	..	..	97	0
22. Black shale	3	3	72	9	100	3
23. COAL V	6	6	6	6	106	9
24. Black shale	1	0	..	..	107	9

1311. SECTION 503. SECTION OF SOUTH LINTON SHAFT.—Sec. 26, Fig. 6.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface and yellow clay	10	0	..	..	10	0
2. Gray sandy shale	12	0	..	..	22	0
3. Shale	23	0	..	..	45	0
4. COAL IVb ......6 in. to	0	8	0	8	45	8
5. Fire-clay	3	0	..	..	48	8
6. Sandstone	20	0	..	..	68	8
7. Blue shale ......7 to	8	0	..	..	76	8
8. Gray shale	1	0	..	..	77	8
9. Dark shale	17	0	49	0	94	8
10. COAL IV	5	0	5	0	99	8
11. Sandstone	0	0	..	..	99	8

No section was obtained connecting Coal V with Coal IV. At the Summit mine Coal IV is 100 ft. deep, while Coal V outcrops in the hill not far away and about on a level with the top of the shaft. From this it is judged that the two coals are there fully 100 ft. apart, though that is an unusually large amount, so much so as to lead to some question as to the correctness of the correlations with Coals V and IV elsewhere.

1312. SECTION 504. SECTION OF DRILLING ON LAND OF JOSEPH LETTERMAN AND OTHERS.—At the center of the N. E. $\frac{1}{4}$ of Sec. 11, Fig. 7.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Clay	9	0	..	..	9	0
2. Clay shale	4	0	..	..	13	0
3. Sandstone	15	0	..	..	28	0
4. Shale	5	0	..	..	33	0
5. COAL IVa	1	2	1	2	34	2
6. Fire-clay	1	6	..	..	35	8
7. Sandstone	47	0	..	..	82	8
8. Shale	5	0	53	6	87	8
9. COAL IV	3	10	3	10	91	6
10. Sandstone	24	0	..	..	115	6
11. Shale	6	0	30	0	121	6
12. COAL IIIb	2	0	2	0	123	6
13. Fire-clay	1	0	..	..	124	6
14. Sandstone	6	0	..	..	130	6
15. "Drift rock"	4	0	..	..	134	6
16. Shale	1	0	12	0	135	6
17. COAL IIIa	1	8	1	8	137	2
18. Sandstone	4	0	..	..	141	2
19. Shale	2	0	..	..	143	2
20. Rock	1	6	7	6	144	8
21. COAL III, upper bench	1	6	..	..	146	2
22. Shale	1	0	..	..	147	2
23. COAL III, lower bench	1	6	4	0	148	8
24. Rock	9	9	..	..	158	5

1313. DIVISION VII, it is seen, shows one coal from 3 to 4 ft. thick, and judging from what is known from it elsewhere, it is of good quality and a rich coal, but too soft to ship well. It should be utilized close to where it is mined. The roof is either a shale or sandstone, and where a sandstone, apt to be very irregular, with feelers of coal extending up over the sandstone rolls.

1314. DIVISION VI contains the coal worked extensively at Dugger and elsewhere in Sullivan county. It runs from 6 to 7 ft. in thickness and is characteristically divided into four benches, the second bench from the top being a thin bench often mined in. The clay band above and below it make often conspicuous white marks on the walls of the mines where it is dug. The bottom bench, usually about 1 ft. thick, is inclined to be bony and is seldom mined. The coal contains much sulphur, but in such a shape that it can be readily removed, and when so cleaned is a strong steam coal. For further details see under Sullivan county. The roof is generally shale, but the shale is liable to be cut out at points where the sandstone comes down to the coal. Often these sandstone-filled channels are quite extensive and cut the coal down in thickness very considerably. Between Coal VII and Coal VI, though somewhat nearer to Coal VII, is usually found a limestone supposed to correspond with the limestone over Coal VIb of Vigo and Vermillion counties, and with limestone at Newburg and elsewhere in the southern counties.

1315. DIVISION V contains an important coal in this township. None of the small banks in this township at which this coal is worked yielded a complete section of the coal, as they were not working and were generally full of water or fallen in. Reports at nearly every point, however, give the thickness of the coal as between 5 and 7 ft. Judging only from the partial exposures seen at the mouths of entries, this coal is of an inferior quality, containing many lenticular dirt streaks and other impurities. However, samples were shown us of coal mined the winter before which would indicate a very good grade of coal, being free from sulphur or dirt and appearing quite rich. This bed is characteristically overlain by several feet of black, bituminous, sheety shale, with a scanty marine fauna and fish scales and other remains. Above that, in turn, is from 2 to 6 ft. of limestone. This division, as a whole, is largely shale, though containing a little sandstone.

1316. DIVISION IV contains the only coal at present worked in Greene county for export. This bed at present (1898) yields annually over 500,000 tons from five contiguous sections of this township, being a larger yield than from any similar area elsewhere in the State. This coal will average 5 ft. or a little over. While in the easternmost mines the coal appears to be a solid coal, there is yet a parting in the middle which to the west becomes more pronounced, and finally, on a northwest and southeast line through the Summit mine and western part of the Fluhart mine the two benches begin to separate, and in a short space, as shown by drillings, they become many feet apart, preventing the working of the coal in that direction. In composition, as shown by the following analysis by Mr. Noyes, this coal contains a greater amount of fixed carbon than the average of Indiana coal, comparing not unfavorably in that respect with Pittsburg coal. The following three analyses are of A, Buckeye or Fluhart; B, Summit; C, Island City No. 1:

	A.		*B.*		*C.*	
Fixed carbon	51.10		52.24		50.50	
Volatile combustible matter	35.69		35.30		35.97	
Total combustible matter		86.79		87.54		86.47
Ash	5.40		5.02		6.41	
Moisture	7.81		7.44		7.12	
Sulphur	0.72		0.61		0.84	
Total waste		13.93		13.07		14.37

The coal is of a semi-block, non-caking or semi-caking coal, and though commonly mined with powder, is found to block out without difficulty. The face of the coal, where developed at all, appears to run about east and west. The roof of the coal is a bluish-gray, clay shale, in some of the mines holding well, while in others a few inches of it come down; on the whole, though it is a good roof, timbers at 6 ft. apart holding well. The floor is excellent, a gray, shaly bituminous sandstone, not a good floor to dig gutters in, but making a solid foundation for posts and pillars. In some of the mines a few inches of fire-clay occur between the coal and sandstone. The coal is quite constant in thickness, a series of measurements made in one of the mines hardly varying an inch from one part of the mine to another.

Between 40 and 60 ft. above coal IV occurs a coal averaging about 18 in. in thickness, Coal IVa. This is generally overlain by shale, though at Island No. 2 shaft said to be overlain by black shale and limestone. At another point the coal was 2 ft. thick and overlain by a shaly sandstone.

1317. Division III, according to the drilling on Mr. Letterman's, as given above, contains three coals, none of them of workable thickness, as the lowest coal occurs in two benches. In a test shaft sunk in Sec. 23 this coal was in two benches of 1 ft. 6 in. and 2 ft. respectively, separated by 20 in. of "hard rock," which, judging from pieces shown the writer, is a limestone.

1318. Distribution and Local Details.—Beginning in the northwestern corner of the township, where the highest and most limited coals occur, we find Coal VII occupying the top of the high ridge along the western edge of Sec. 6 and northwestern part of Sec. 7. This coal has been mined some on the west side of the ridge, just over the Sullivan county line, where it runs over 3 ft. thick. In this township it is reported in a well in the S. W. of N. W. of Sec. 7, being 12 ft. deep and 18 in. thick, its thinness apparently being due to the top having been eroded. It is also reported to outcrop at at least two places in this quarter section.

Coal VI appears to underlie most of Sec. 6 and more than half of Sec. 5, also about half of Sec. 7. It appears to lie about 50 or 60 ft. below Coal VII. It is reported to outcrop in the N. E. ¼ of Sec. 6, is struck at 30 ft. in a well in the N. W. ¼ of Sec. 7, and is reported to be 5 ft. thick in a spring in the N. W. of S. W. of Sec. 7. In the S. W. ¼ of Sec. 7 two core drillings made on the Moss place failed to find this coal. One of these appears to have found only quicksand to a depth of 50 ft. The other probably started below the outcrop of Coal VI and seems to have found Coal V lacking. The section of the latter drilling follows.

1319. Section 505. Record of 3-in. Core Drilling on Moss Place.—Sec. 7, Robert Marshall, driller. (C. E. S.)

		Ft.	*In.*	*Ft.*	*In.*
1.	Earth	12	0	12	0
2.	Sandstone	1	0	13	0
3.	Clay shale and dirt	5	0	18	0
4.	Limestone	6	0	24	0
5.	Limestone	1	0	25	0
6.	Clay shale	0	6	25	6
7.	Black shale	1	0	26	6
	Place of COAL V (?).				
8.	Fire-clay	2	0	28	6
9.	"Drift." "mixture of sandstone and pebbles, dirt and grit." (C. E. S.)	5	0	33	6
10.	White sandstone	20	0	53	6
11.	White sandstone and black shale, "sandy shale." (C. E. S.)	24	0	77	6

		Ft.	In.	Ft.	In.
12.	Clay shale	3	0	80	6
13.	Light shale, mixed with sandstone	8	0	88	6
14.	Sandstone, mixed with shale	8	0	96	6
15.	Sandstone, hard rock	28	0	124	6
16.	Sandstone, soft	2	0	126	6

Going south, Coal VI is found underlying the high land along the county line and outcropping about as shown on the map. The coal has been dug into in the N. W. of N. W. of Sec. 19, being 20 ft. deep. A little southeast it was formerly mined by Messrs. Pascoe, Morgan, Humphrey & Co. It is reported to be 5 ft. thick here, with one or more white shale bands at the middle. It was 25 ft. deep at the mine, the roof being bluish shale overlain by yellow sandstone. Coal is said to be a strong producer of heat. The top of the coal is reported to have shown white seams; the bottom is said to be a shiny black coal very rich in oil. A drilling in this mine in 1898 found Coal V 6 ft. 6 in. thick, overlain by black shale and limestone at a depth of 65 (?) ft. I am informed that the Island Valley Coal Company sunk a shaft in the latter part of 1898 to Coal V, starting a little southeast of the old Pascoe shaft. Later information reports that both Coals V and VI were found thin and disturbed in the newly-dug shaft, though occurring of normal thickness in three drillings made in different directions, and not far from the shaft. In the Swaby drilling this coal showed a thickness of 6 ft., the driller reporting the upper half to be pretty fair, the lower half softer and not so good.

In the N. W. ¼ of Sec. 31 Coal VI has been mined by Henry Goodman, formerly the Bennett bank. The coal is reported 35 ft. deep and 6 ft. thick. For 20 ft. above it occurs shale, the surface and drift making up the rest. The dip here is to the north. The coal gives off much gas. At Mr. Moody's well, a little northwest of the last, the section shows 12 ft. of the surface, 16 ft. of shale, 1 ft.+ of coal.

Coal V covers most of the area northwest of Linton, appearing at creek level or below along the Blackwater creek, it rises nearly to the top of the ridge between Secs. 3, 4, 9 and 10. It has been mined a little by slope (?) at Boulton's, where it is reported to be 7 ft. thick and 14 ft. deep. It outcrops on the Wm. Stockrahn place in the S. W. ¼ of Sec. 3, and is struck in wells on the same place near the center and in the S. E. 40 of Sec. 4, reported to be 7 ft. thick and 40 ft. deep. It has been stripped in the N. W. ¼ of Sec. 10 on the Richard Page place, reported 7 ft. thick, N. E. of S. W. of Sec. 10 on Whitesell place, and found to be 7 ft. thick at a depth of 10 ft. in a well in the N. E. of Sec. 9.

At one point here, the black shale overlying Coal V was seen only about 15 ft. below the level of the broad, flat plateau. The limestone and black shale overlying Coal V were noted in the S. W. corner of Sec. 16 lying just above the level bottoms of Blackwater creek. Going up the creek the coal keeps just about on a level with the creek, and has been mined at the following places: Mrs. Pope's, N. E. ¼ of Sec. 8. The coal is said to be 6 ft. 6 in. at the mouth of the drift, but to have run down to 4 ft. 200 ft. in. It is reported to have had 18 in. of clay in the center. The top 2 ft. of the coal was seen with 2 ft. of black sheety shale above it. Rector's, center of Sec. 5; Beasley's, S. W. ¼ of Sec. 4 (some good coal from this bank was seen); Samuel H. Price, drift, worked many years, coal measured 3 ft. 6 in. to water and mud in mine, full thickness reported to be 7 ft. Some of the coal is left for roof in this mine. Above is 5 ft. of black sheety shale, then 1 ft. (exposed) of limestone, see Fig. 13. At Richard's, N. W. of N. W. of Sec. 4, the coal is reported 7 ft. thick, and 5 or 6 ft. thick at John Luhn's in the N. E. corner of Sec. 5. The limestone shows above the coal here.

In the southwestern quarter of the township the horizon of Coal V would appear to have been cut out by the ancient erosion of the Blackwater creek valley.

Coal IV is reported in a well and old shaft at S. E. corner of Sec. 1, and N. E. corner of Sec. 12, as 3 ft. 4 in. thick at a depth of 28 ft. It has here shale over and sandstone under. A drift has been opened on this coal at the Haseman place in the S. E. ¼ of Sec. 2. In the N. E. ¼ of Sec. 11 Coal IV is given as 5 ft. thick in a well on the Schloot place, and 3 ft. 10 in. at the center of the quarter section on Jos. Letterman's and others, this drilling starting on the top of the ridge and the coal being found at a depth of 87 ft. The coal appears to be cut out across the flat bottom of Buck creek in Sec. 12. Coal IVa was found 10 in. thick on the Letterman place in the N. E. of N. E. of Sec. 11, or 14 in. thick in the well previously quoted. On the J. Clayton place, near the center of S. E. ¼ of Sec. 10, it is ? ft. thick, overlain by 2 ft. or more of hard, blue sandy shale, and that by 2 ft. of black shale. The drilling on the Wm. Stockrahn place in the S. E. 40 of Sec. 4 is reported to have found Coal IV over 6 ft. thick at a depth of 150 ft.

A drilling in the N. W. of N. E. of Sec. 15 gave Coal IV a thickness of 5 ft. 10 in. at a depth of 106 ft. One near the center of the S. W. ¼ of Sec. 15 made it 5 ft. 10 in. at a depth of 135 ft. This started on high ground. Another in the N. W. of S. E. of Sec. 16, where the Summit Coal Company are sinking or have sunk a new shaft, 6 ft.

5 in. of coal at 127 ft. Another drilling a little northeast of the Summit Coal Company's new shaft is reported to have found Coal IV at 135 ft.

At the Summit mine the coal is 95 ft. deep and from 5 to 6 ft. thick. The parting in the coal was 6 in. thick at the shaft. To the east it runs out, to the west and south it increases until it stops further mining in that direction. A boring two miles further to the west is said to have found the two benches 13 ft. apart. Work to the west and south was abandoned after going 100 and 75 yds., respectively. Over the coal is 8 to 10 ft. of blue shale, 2 to 6 in. of which come down. The upper bed, Coal IVa is here 20 in. thick. The coal lies on sandstone. The dip is to the north and no rolls or similar irregularities are found.

A drilling a half a mile or so south of this is said to have passed through 5 ft. of coal at 105 ft. and 5 ft. 6 in. at 160 ft. A drilling in the N. E. ¼ of Sec. 29 in the bottoms of Blackwater or Black creek, went 175 ft. without striking coal.

At Island No. 2 mine the coal is 100 ft. deep and ranges from 4 ft. 10 in. to 5 ft. 2 in., with an average of 5 ft. A rough record of the shaft as given by Mr. Jas. Dunn follows:

1320. SECTION 506. SECTION OF SHAFT OF ISLAND NO. 2 MINE. —Sec. 22, by Jas. Dunn.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	13	0	..	..	18	0
2. Clay shale	25	0	..	..	38	0
3. Hard limestone	1	6	..	..	39	6
4. Black shale	1	0	..	..	40	6
5. COAL IVa	1	6	1	6	42	0
6. Fire-clay	6	0	..	..	48	0
7. Sandstone, micaceous	4	0	..	..	52	0
8. Sandy shale	48	0	58	0	100	0
9. COAL IV	5	0	5	0	105	0

As shown, the coal has a shale roof, 1 or 2 in. of which come down, and a sandstone floor. The dip is to the southwest. This is one of the largest mines in the State, delivering 1,200 tons a day when running full-handed.

The Bennett mine was opened by citizens as a test shaft. It has since been owned by Mr. Bennett, Mr. Homer Law, Mr. Bruce, and, when visited, by the Robinson Bros. It is here 48 ft. to the coal, which averages about 4 ft. 10 in. The shaft showed (Sect. 507):

	Ft.	In.
1. Clay and surface	18	0
2. Gray shale	30	0
3. COAL IV	4	10
4. Sandstone	..	..

About 6 in. of the shale roof comes down in mining. In places the top 4 in. of the coal is soft here. The dip is to the southwest.

A 200-ft. well in Linton is reported to have passed through 5 ft. of coal at a depth of 63 ft. In the northeastern part of town a drilling by Mr. McCloud found the coal at 20 to 25 ft., but it did not have a suitable roof.

Coal has been struck at the mill northeast of town, and at least one other place in the N. E. ¼ of Sec. 23; also, in a well in the S. W. ¼ of Sec. 13.

In the S. E. ¼ of Sec. 23 coal was formerly worked at the Thorp bank, Sec. 23 (2), said to be the first bank to open upon coal in this region. The coal is reported to be 5 ft. thick and 19 ft. deep. Just north of this Barney McClung stripped Coal IV in the branch, where it was 4 ft. 7 in. thick, Sec. 23 (1).

A little east of Thorp's a shaft was sunk 85 ft. to Coal III? which there showed 18 in. of coal; 20 in. of "hard rock" (specimen seen was dark blue limestone); 2 ft. of coal; shale, Sec. 23 (3), Fig. 20. A shaft near the S. E. corner of Sec. 23 (4) is reported to have found at 47 ft. a mixture of coal, fire-clay and shale 7 ft. thick.

At the Templeton mine of the Western Indiana Coal Company Coal IV is 47 ft. deep and runs from 4 ft. 8 in. to 5 ft., with an average of 5 ft. The section here shows (Sect. 508):

	Ft.	In.
1. Clay	17	0
2. Sandstone	3	0
3. Shale	12	0
4. Sandstone	1	0
5. Shale	14	0
6. COAL IV	4	10
7. Sandstone	..	..

Usually a few inches of the roof come down. There is a slight east and west dip from a point 100 yds. east of the shaft.

At the Fluhart or Buckeye mine of the Linton Coal and Mining Company, Coal IV is 71 ft. deep and averages 4 ft. 10 in. thick. As at the Summit mine, the coal here shows the line of splitting, and a shale band, which appears about the middle of the coal, thickens to the west to 6 in. or even 2 ft. A drilling made 1½ mi. to the west is said to have shown the two parts of the bed to be at that point 17 ft. apart. The coal is a semi-block, only caking to a very slight degree. The roof is gray shale, from 1 to 6 in. of which tends to come down. Coal IVa, 18 in. thick, is passed through in the shaft at a depth of 35 to 40 ft. Below the coal is micaceous sandstone. On account of the parting in the coal and the thinning which accompanies it, the coal is not considered workable to the south and west of the shaft. There is a small southwest dip here.

Coal IV is 80 ft. deep at the South Linton mine and averages 5 ft. 1 in. thick. The coal here is a semi-block, white ash coal, without sulphur or clinker, showing in the mine a slight east and west face. The section of the shaft here was given above. The roof is a bluish gray clay shale, holding well. In fact, this mine seemed to afford practically no waste material, as none of the roof came down or is taken down, none of the floor is raised, and there are neither dirt bands nor sulphur balls to be separated from the coal. The floor is a gray, shaly, bituminous sandstone.

At Island No. 1 mine of the Island Coal Company, Coal IV is 63 ft. deep and runs from 5 ft. to 5 ft. 8 in. thick, with an average of 5 ft. 4 in. The shale roof comes down to the extent of 1 or 2 in. in the rooms, but in the entries much more comes down, giving considerable trouble. This, I understand, is due to the jar of the mining machines. The coal here has about 8 in. of fire-clay under it. The dip is quite sharply to the southwest. In mining, the main entry is driven down the line of greatest dip and then supplied with rope haulage, while the cross entries, where mule haulage is used, are run along the strike of the bed. This was the first shipping mine in this field, having been opened in 1883 or 1884.

Coal IV is 48 ft. deep at the Island Valley mine of the Island Valley Coal Company. It ranges from 4 ft. 10 in. to 5 ft. 2 in. with an average of 5 ft. As elsewhere it is almost a non-caking coal. The roof is gray shale, about 2 in. of which come down. Between the coal and underlying sandstone there are here 2 to 4 in. of fire-clay. In the shaft there occurs 15 ft. of clay and surface, about an equal thickness of sandstone, then about an equal thickness of shale, with a thin stratum of sandstone in it.

A number of drillings have been made on the Usery place in the S. ½ of Sec. 35. One in the N. W. of S. E. is reported to have from 5 ft. 6 in. of coal at a depth of 35 ft. Another starting from high ground in the S. W. of S. E. gave 6 to 7 ft. of coal at 85 ft. A third in the S. W. of S. W. gave 3 ft. 6 in. of coal at 31 ft.; 2 ft. of coal at 51 ft., and 6 ft. of coal at 85 ft.

In the N. W. of S. W. of Sec. 36 coal was formerly mined at the "Peewee" bank, or Griffin shaft, owned at different times by Daniel Fields, Wolford & Watson, Griffin & Watson, Sharp & McClung, and Mr. Thorp. The development of this field came largely through the working of this mine. The coal is 28 to 30 ft. deep and from 4 ft. 6 in. to 4 ft. 10 in. thick.

In the S. E. of S. W. of Sec. 36 Coal IV is mined a little on Francis M. Field's land by Messrs. Duke, Smale and Mears. The coal is 30 ft. deep and runs from 5 ft. 2 in. to 5 ft. 8 in. in thickness. The shaft shows the following section (Sect. 509):

	Ft.	*In.*
1. Soil	20	0
2. Light, soft sandstone	..	8
3. Soft, bluish shale	10	0
4. COAL IV	5	4

The roof is soft, requiring much timber, while 1½ to 2 in. of it come down regularly. In a well 300 yds. northwest the coal was 5 ft. 4 in. thick. It outcrops in a ravine 300 yds. east of north, has no roof where struck in a well 200 yds. east, and was not struck at all in a well 500 yds. east and 20 ft. lower. This well went 80 ft. without striking coal.

In a well near the blacksmith shop at the center of Sec. 36 Coal IV is 5 ft. thick, at a depth of 18 ft., being overlain by 2 ft. of clay shale and 16 ft. of soil. At another well 50 yds. east of the last the coal has been removed, only 1 in. remaining; below that the well went 10 ft. in solid gray sandstone. At a well on M. L. Strong's place in the S. E. of N. W. of Sec. 36 Coal IV is 5 ft. 1 in. thick at a depth of 16 ft. It is overlain by 6 in. of clay shale and underlain by 9 ft., at least, of sandstone. On John Kirby's place a well gave the following section (Sect. 510):

	Ft.	*In.*
1. Soil	13	0
2. Shaly sandstone	4	0
3. Shale	1	0
4. COAL IV	5	0

Some 200 bushels of coal were taken out of the well.

At a well on the McBride place, in the S. E. of N. W. of Sec. 25, Coal IV was struck at 25 ft. In a well northwest of this, in the same quarter section, the coal was reported as 4 ft. thick, with 1 ft. of shale over. Just east of the range line, in the N. W. of N. W. of Sec. 31-7-6, the coal is reported 6 ft. thick at 18 ft. In the S. W. of N. W., on the

Ogle place, it is given as 6 ft. thick at 16 ft. In the N. E. of S. E. of Sec. 36, Bartlett Fullam opened a slope. The coal showed a thickness of 2 ft. 6 in., overlain by 3 ft. of black shale. Coal is found at other points in wells along the range line.

Township 6 South, Range 7 West.

1321. Geography.—This township lies in the southwestern corner of Greene county and corresponds to Stafford of the civic townships.

Topographically, a large part of the area is prairie or flat bottom land, subject to overflow in high water, and in part formerly a swamp. In the northeastern corner is the point of the low divide between Brushy and Goose ponds. Then comes the Goose pond, now drained, and the flat land extending southeast from Secs. 3, 4 and 5, then turning south so as to include most of the southeastern quarter of the township. Next to the southwest is a divide of some elevation occupying the southwestern half of the northwestern quarter township and the northeastern half of the southwestern quarter township. The southwestern half of the southwestern quarter township is principally stream bottom, margined by upland along the western edge.

The I. & V. R. R. crosses the southeastern corner of the township.

1322. Stratigraphy.—The stratigraphy of this township, for the most part, was not satisfactorily worked out. Coal was being worked at only one place—in Sec. 1—and there the stratigraphy is clear. Outside of that the information obtained comes largely from wells drilled for water, in the most cases without a record being kept, or if kept, at present lost, so that figures and details are supplied from memory and are not complete enough and accurate enough to allow of their interpretation. Coals outcrop at a few places in the upland in the southwestern part of the township, and have been worked there also, so that some degree of reliance may be put in the position of the coals in Sec. 18, and near there; otherwise the stratigraphy and distribution of coals is not very reliable.

In a general way, Divisions VII to IV outcrop in this area, and the lower divisions presumably underlie. Under the conditions it is deemed best to insert the sections in their places under the head of distribution.

1323. Distribution and Local Details.—Coal IV is worked in the N. W. of N. W., at Joel E. Combs's shaft, operated by Osha Bros. The coal here is from 4 ft. 6 in. to 6 ft. 6 in. in thickness, and 25 or 30 ft. deep. The shaft shows 10 ft. of soil; 15-17 ft. of soft shale, with harder shale on coal. The roof is reported by some as good, by others as too soft to be held up by timbering. Below coal is 1 ft. of fire-clay, then "blue limestone" (sandstone). Another bed is reported to come 12 to 15 ft. below this. This coal outcrops in the N. W. corner of the S. W. of N. W. of Sec. 1, and is struck in a well at 14 ft. near the S. E. corner of the same 40 acres. A well in the S. E. of S. E. of Sec. 1 is reported to have struck 18 in. of coal at 50 ft. A number of wells in the N. W. corner of Sec. 2 and N. E. corner of Sec. 3, on the John Jones, Geo. Palmer and P. Palmer places report coal. At the saw-mill near the center of Sec. 2 a well dug and drilled 35 ft. found no coal. On the Osborne place, in the N. W. ¼, a well is reported to have found 3 ft. 6 in. of coal at a depth of 27 ft. Two wells drilled in the north part of Sec. 12 are reported as follows:

1324. Section 511. Section of Well on Elbert West's Place.—N. W. of N. E. of Sec. 12. B. West, driller, reported from memory. (C. E. S.)

		Ft.	In.
1.	Soil, etc.	20	0
2.	Sandstone, rather hard	15	0
3.	Shale	3	0
4.	COAL	1	6
5.	Fire-clay (?)	15 to 20	0
6.	Sandstone	5 to 6	0
7.	Shale	2 to 3	0
8.	COAL	18 in. to 2	0
9.	Fire-clay (?)	20	0
10.	Sandstone	..	..
11.	Shale	5	0
12.	COAL	2	0
13.	Fire-clay	..	..
14.	Sandstone	..	..
15.	Shale	..	..
16.	COAL	1	6
17.	Fire-clay	..	..
18.	Sandstone	..	..
	Total	213	0

1325. Section 512. Section of M. B. West's Well.—N. W. of Sec. 12, starting about 30 ft. above the level of Goose pond. B. West, driller, from memory. (C. E. S.)

		Ft.	In.
1.	Soil and clay, 25 ft.; sandstone, 15-20 ft.; shale, 5 ft.	50	0
2.	COAL ....6 in. to	1	0
3.	Fire-clay, 20 ft. ?; sandstone, 12-15 ft.; shale, 5 ft.	40	0
4.	COAL	1	6
5.	Fire-clay, sandstone, shale	?	?
6.	COAL ....18 in. to	2	0
7.	Fire-clay, sandstone, shale	?	?
8.	COAL ....18 in. to	2	0
9.	Fire-clay, sandstone, shale	?	?
10.	COAL	2	4
11.	Sandstone ....75 ft. to	80+	0

Assuming these coals to all come below Coal IV, it will be seen that these wells find more coals than are found in more accurate sections.

A couple of sections in the S. W. quarter of Sec. 11 serve to show the composition of deposits in the Goose pond. (Sects. 512a and 512b.) A well on W. F. Vaughn's, in the S. E. of S. E. of Sec. 11, gave: Black muck, 15 to 20 ft.; gray earthy muck, 37 ft.; "boulder," 4 ft.; gravel. Well on same place, S. W. of S. E. of Sec. 11: Black muck, 15-20 ft.; gray clay, 90 ft.; hard, sandy shale, 5 ft.

A well on the Combs place, in the N. E. of N. E. of Sec. 15, is reported to have found two or three small beds of coal in a depth of 107 ft. At the Norris place, in the S. E. corner of Sec. 15, 14 in. of coal is reported at a depth of 12 ft.

Wells in Marco go 40 ft. through blue muck and quicksand before striking rock. A drilling made just west of Marco by Jas. Dunn is reported from memory as follows:

1326. SECTION 513. SECTION OF WELL JUST WEST OF MARCO.—(G. H. A.)

		Ft.	In.
1.	Surface	11	0
2.	Sandstone shale	13	0
3.	Shale	?	..
4.	CANNEL COAL at 35 ft.	0	6
5.	Fire-clay	5	0
6.	Sandstone, white	38	0
7.	Shale ....10 to	12	0
8.	COAL	18	0
9.	Fire-clay	23	0
10.	Sandstone	27	0
11.	Streak COAL	0	0
12.	Fire-clay, soft, white	0	0

1327. SECTION 514. SECTION OF WELL ON H. C. MORGAN'S PLACE.—S. E. of S. E. of Sec. 24, half a mile east of Marco and 20 ft. higher. (C. E. S.)

		Ft.	In.	Ft.	In.
1.	Soil and gravel	27	0	27	0
2.	Soft shale	20	0	47	0
3.	"Hard limestone" (sandstone ?)	44	0	91	0
4.	COAL	1	10	92	10
5.	Sandstone, not very hard	20	0	112	10
6.	COAL	1	6	114	4
7.	Black shale	20	0	134	4
8.	COAL	2	0	136	4

A well 104 ft. deep on Mr. Morgan's place, east of the house and across the range line, went through the two upper coals. Mr. C. F. Heims's well, S. E. of N. W. of Sec. 25, went 140 ft. and struck no coal. Mr. Bennefield's well, near the depot, is reported to have shown the following section (Sect. 515, C. E. S.):

	Ft.	In.
Black muck, etc.	63	0
Hard "limestone" (?)	28	0
COAL	1	6
Soft, light shale ....6 to	10	0
"Hard rock" ....30 to	35	0

The well at the schoolhouse, in the southwest part of Marco, is 165 ft. deep, and started 20 ft. above level of bottom. It is reported to have passed through 14 ft. of surface material, then through sandstone, sometimes hard, to a 1-ft. layer of very hard rock; at about 100 ft. below that was 4 ft. 10 in. of coal, then fire-clay.

At Mr. Morgan's well at barn, on hill north of road turning west from Marco, the coal is given as 3 ft. 3 in. thick, the strata being similar to those found at the schoolhouse. At his windmill well, in the N. E. ¼ of Sec. 23, starting 12 ft. above the bottoms, the coal was 4 ft. 6 in. thick at a depth of 80 ft.

At Hunter & Morgan's well, in the N. W. of N. E. of Sec. 26, the partial section from memory is as follows (Sect. 516, C. E. S.):

	Ft.	In.
Soil, 14 ft.; sandstone, 38 ft.; shale, 2 ft.+		
COAL	1	4
Sandstone or shale.		
COAL	1	0
Shale and sandstone.		

	Ft.	In.
COAL at 89 ft.	3	1
Sandstone.		
COAL	..	10
Shale.		
Sandstone.		
COAL	2	8
Fire-clay.		

It is said that one of the two lower sandstones was 49 ft. thick. In the western part of the township the only section obtained was a drilling on the McDowell place, of which the location is given as 3 mi. south of Corbin hill, or 1 mi. south of Pleasantville, and ½ mi. east. As Pleasantville is about 4 mi. south of Corbin Hill, there is evidently an error, and the location is left in uncertainty. The section follows:

1328. SECTION 517. SECTION OF CORE DRILLING ON MCDOWELL PLACE.—Robt. Marshall, driller. (C. E. S.)

	Ft.	In.	Ft.	In.
1. Earth	12	0	12	0
2. Sandstone	1	0	13	0
3. Clay shale	23	0	36	0
4. Sandstone	4	0	40	0
5. Drift	5	0	45	0
6. Black shale	2	0	47	0
7. Soft COAL	3	0	50	0
8. COAL V (?)	2	0	52	0
9. Black shale	0	6	52	6
10. Fire-clay	6	0	58	6
11. Clay shale and black shale	5	0	63	6
12. Black shale	7	0	70	6
13. Clay shale	10	0	80	6
14. Gray shale	12	0	92	6
15. Clay shale	3	0	95	6
16. Boulders	1	0	96	6
17. Mixed COAL IVa (?)	2	0	98	6
18. Fire-clay	1	0	99	6

Coal VII is supposed to underlie the highest land of Sec. 18 and to extend an unknown distance farther under the top of this divide. An old opening made to coal just southeast of the center of Sec. 18 was judged to have reached Coal VII. The sandstone overlying the coal outcrops in the road just north and a quarter of a mile east. In a ravine in the N. W. ¼ of the section, Coal VI is reported by Mr. Cox to have been worked by Mr. P. O'Haver. The coal at this point he gives (p. 102) as 4 ft. 6 in. to 5 ft. thick, with a roof of black sheety

shale, and above that only a foot or two of soil. At Mr. O'Haver's house the well passed through 30 ft. of sandy shale without reaching the coal.

Not many years ago a shaft was sunk on the old O'Haver place, near the McDowell place, which is reported to have had 3 to 4 ft. of coal at a depth of 18 to 20 ft. There was, however, only a few feet of shale roof over the coal, so that the shaft was abandoned.

A well in the S. W. corner of Sec. 8 is reported to have passed through 18 in. of coal at a depth of 18 ft. Down the hill to the northwest, in the S. E. 40 of Sec. 7, a 3 ft. to 3 ft. 6 in. coal is reported to outcrop. Coal said to be 3 ft. thick, with a sandstone roof, is reported to outcrop and to have been stripped in the S. E. ¼ of Sec. 19. In the N. W. of the N. W. of Sec. 21, on the Maxwell place, a well is reported to strike coal as follows: At 45 ft., 3 ft. of coal, with sandstone roof; at 90 ft., 2 ft. 6 in. of coal, with limestone roof; at 192 ft., 5 ft. 6 in. of coal, well 197 ft. deep.

Another well here on lower ground struck 3 ft. of coal at 28 ft. On still lower ground, in the S. W. of N. W. of this section, a slope 6 ft. deep was run down to this coal. It is said to be a good coal for blacksmithing. Considering the thickness and roof only, this coal corresponds with Coal VII, as developed in Sullivan county. From other standpoints it would seem more likely that it is Coal VI. It has been stripped some in the S. E. of N. W. of Sec. 21, on the Brewer place, thickness 3 ft. Coal 2 ft. 6 in. thick is reported to have been stripped in the S. W. ¼ of Sec. 29 many years ago. In the S. E. of S. W. of Sec. 27, 5 ft. 6 in. of coal is said to have been struck at a depth of 49 ft., or 40 ft. below the prairie, on the Davis place. A well in the N. W. of S. W. of Sec. 34 is reported to have passed through 4 ft. at a depth of 60 ft. As Coal V appears to be just about at the level of the bottom land around Sanborn to the south in Knox county, it is supposed that this coal is about in the position of Coal IV. In the following section, though the coal at 41 ft. is only 8 in. thick, it resembles the Linton coal, or Coal IV, in presence of the sandstone but a short distance below the coal.

1329. SECTION 518. SECTION OF BORE BY HILL BROS.—N. E. of S. E. of Sec. 34. (Collett, Report of Knox County, p. 352.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Clay and sand	16	0	..	..	16	0
2. Sandstone	10	0	..	..	26	0
3. Clay shale	5	0	..	..	31	0
4. Shale	10	0	..	..	41	0

		Ft.	In.	Ft.	In.	Ft.	In.
5.	COAL IV or IVa?	..	8	0	8	41	8
6.	Fire-clay	1	6	..	..	43	2
7.	White sandstone	26	4	..	..	69	6
8.	Clay shale	7	0	..	..	76	6
9.	Sandy shale	3	6	..	..	80	0
10.	Black shale	..	3	38	7	80	3
11.	COAL	..	6	..	..	80	9
12.	Clay parting	..	9	..	..	81	6
13.	COAL	2	8	3	11	84	2
14.	Fire-clay	3	4	..	..	87	6
15.	Potter's clay	5	6	..	..	93	0
16.	Sandstone	5	0	..	..	98	0
17.	Hard limestone	3	5	..	..	101	5
18.	Limestone (?)	21	6	38	9	122	11
19.	COAL	..	10	0	10	123	9
20.	Fire-clay	3	0	..	..	126	9
21.	Potter's clay	6	0	..	..	132	9
22.	Argillaceous sandstone	6	7	..	..	139	4
23.	Blue limestone	2	1	..	..	141	5
24.	Clay shale	..	4	..	..	141	9
25.	Blue limestone	..	5	..	..	142	2
26.	Sandstone	13	0	..	..	155	2
27.	Bituminous clay shale	25	0	..	..	180	2

Drilling by Mr. Ferguson in S. W. of S. E. of Sec. 32-6-7—

	Ft.	In.
Surface clay	10	0
Gray sandstone	24	6
COAL	0	1
Blue sandstone	42	0
Blue clay shale	41	0
Black shale	10	5
Cannel coal? ("tested and found 70 per cent. ash. E. T. C.")	3	2
Semi-block coal	1	8
Fire-clay.		
	132	10

1330. SUMMARY OF COALS OF GREENE COUNTY.—

Divisions contained, VII-I.
Coals contained, VII, VI, V, IVa, IV, IIIb, **IIIa**, III, I.

ROUND NUMBER ESTIMATES.

Coal VII.

Worked area	1	acre × av. thickness,	3 ft. ×	1,200 =	3,600 tons.
Workable area	1	sq. mi. ×	"	3 ft. × 500,000 =	1,500,000 tons.
Unworkable area.	2	sq. mi. ×	"	2 ft. × 1,000,000 =	4,000,000 tons.
Total area	3	sq. mi			5,503,600 tons.

XXV. SULLIVAN COUNTY.

1330A. REFERENCES AND FIELD WORK.—

1862 (1859). Richard Owen, Rep. of Geol. Reconn. of Ind., pp. 171-173. One columnar section. (R. O.)

1862 (1859). Leo Lesquereux, same, p. 339. One columnar section. (L. L.)

1871 (1870). John Collett, 2d Rep. of Geol. Surv. of Ind., pp. 190-240. Twenty-one columnar sections, map, and detailed description. (J. C.)

1871 (1870). E. T. Cox, same, pp. 13-20. Twelve coal analyses. (E. T. C.)

1876 (1875). E. T. Cox, 7th Ann. Rep., Geol. Surv. of Ind., pp. 100, 101. Cross section from Terre Haute to Carlisle. (E. T. C., '75.)

1896 (1895). W. S. Blatchley, Dept. of Geol. and Nat. Resources, 20th Ann. Rep., pp. 91-94. Four columnar sections; describes clays and shales.

1897 (1896). W. A. Noyes, same, 21st Ann. Rep., p. 105. Two coal analyses.

1897. G. H. Ashley, field work for this report.

NOTE.—At the beginning of Part III acknowledgment was given of the use made of the Pennsylvania reports as a model for this one. It must also be acknowledged that this one is open in the main to the same criticism as those—that they are too largely a transcription of field notes. To thoroughly digest field notes so as to draw from them a concise scientific report requires no small amount of time. (In the case of this report it is estimated that to have done this would have postponed the appearance of the report at least a year.) And, further, it is necessary either that the stratigraphy be very simple and regular or that the field work shall have been of so detailed a character as to have left few, if any, unsettled problems. The first of these characters is largely true of the outcropping coals and strata of Sullivan county, and so, though only a month was allotted for the field work of this county, and less taken, the geology of at least the eastern two-thirds of the county was worked out fairly well, and the opportunity was taken to follow more closely than usual the plan of report laid out at the beginning.

G. H. A.

1331. POSITION.—Sullivan county lies on the western border of the State, a little south of the center. It lies south of Vigo, west of Greene and Clay, and north of Knox counties, and is separated from Illinois by the Wabash river.

1332. EXTENT.—The county is a rectangle, with an irregular side on the west. It has a length from north to south of 24 mi., an average width of about 18 mi., but varying from 14¾ mi. to 22¾ mi. It covers all of congressional townships 6 to 9 north of ranges 8 and 9 west, townships 7, 8 and 9 north of range 10 west, and partial townships 6 north of range 10 west, 7, 8 and 9 north of 11 west.

It has an area of about 440 sq. mi.

1333. ELEVATION.—The elevations of the following points are known:

	Ft. A. T.
Farmersburg	573
Currysville	520?
Shelburn	539.8
Sullivan	539.7
Paxton	476.6
Carlisle	494.5

Low water in Wabash at the following points:

Prairie creek	430.95
Nile's Landing	430.15
Hutsonville Ferry	424.69
Turman creek	422.68
Merom Ferry	420.81
I. & I. S. R. R. bridge	418.75
Palestine Landing	416.71
Turtle creek	415.10

1334. TOPOGRAPHY.—As indicated by the cross sections accompanying the colored map, the county is quite level. A typical example of the topography would be described as a nearly flat plain, with an almost imperceptible rise to the drainage divide, but breaking down sharply from 25 to 75 ft. to the drainage channels. As these channels are apt to be broad, with wet bottoms in the spring, a profile across the drainage would resemble a series of U-shaped spaces well apart and connected at the top by bars slightly bent up at the middle. Along the limited area where the upland breaks down into the lowlands of the stream channels is often a narrow belt of comparatively rugged land, but in general this belt is very narrow, the whole descent often being made in a few yards and not infrequently in almost perpendicular banks of drift or loess. The western half of the county, except to the south, drains directly to the Wabash. The rest of the county drains to Busseron creek, which flows southwest diagonally across the country, except a small area in the southeastern corner, part of which drains to White river and part to the Wabash by way of Maria creek. At Merom the river is close to the bluffs, which here are unusually high, so that the town lies about 170 ft. above the river, though but a few rods away horizontally.

1335. STRATIGRAPHY.—For the most part the stratigraphy and distribution of the coals have been worked out with a considerable degree of surety. This is rendered possible by a greater degree of uniformity and persistency of the strata than has been found in most of the area so far treated. This is especially true of Coal VI, which, from Farmersburg to Pleasantville, presents, almost without exception, three partings, with an unusual uniformity in their character and spacing, and in the character of the benches into which they divide the coal. And it is hardly less true of Coal V, with its irregular partings, or none, but everywhere overlain by black sheety shale and limestone, and of Coal VII, always without partings. The relations of the coals of the Busseron basin to those along the Wabash and the streams draining thereto is not quite clear, but we think we have the relation properly worked out. But a limited amount of study was given to the surface coals west of the E. & T. H. R. R., as practically none of them are workable, and from the scattered condition of their outcrops (in one or two cases whole townships being without outcrop or well striking coal), their correlation must necessarily be somewhat uncertain.

1336. TABULAR VIEW OF COALS AND SPACES IN SULLIVAN COUNTY.—

Divisions.	Coals.	Range in Feet.	Average.			
			Ft.	In.		
IX			50	0		Merom sandstone. Massive sandstone along Wabash river.

Divisions.	Coals.	Range in Feet.	Average. Ft.	Average. In.	
	VIIIb	0- 2	0	2	Space, black shale and limestone. COAL VIIIb, thin, local.
		13- 40	24	0	Space, fire-clay, shale, limestone and black shale.
	VIIIa	4-110	0	8	COAL VIIIa, surface coal around Sullivan and to west.
VIII					
		31- 69	48	0	Fire-clay, sandstone, shale.
	VIII	0- 4	1	6	COAL VIII, workable at Merom and up Turman's creek; thin to the east.
VII		90-141	120	0	Fire-clay, *limestone*, sandstone and shale.
	VII	2- 6	3	6	COAL VII, upper worked bed along E. & T. H. R. R., rider in eastern townships.

Divisions.	Coals.	Range in Feet.	Average. Ft.	Average. In.	
		2- 10	5	0	Fire-clay, limestone, shale.
	VIb	0- 2	1	0	COAL VIb, local east of Farmersburg.
VI		30- 60	40	0	Fire clay, sandstone, shale,
	VI	4- 8	6	0	COAL VI, main bed, all large mines, except Alum Cave.
V		30- 60	45		Fire-clay, sandstone and shale, *limestone, black shale.*
	V	0- 9	4	0	COAL V, Alum cave, lower bed at Hymera, etc.
IV		?-100	55	......	Fire clay, sandstone, shale.
	IV	0- 5¼	2	6	COAL IV, in drillings.
III			75	......	Sandstone and shale.

Divisions.	Coals.	Range in Feet.	Average.			
			Ft.	In.		
III	—Cont.					
	III	0- 4⅔	2	0		COAL III, in drillings.
I-II			100	0		Space, sandstone and shale.
	?		2	0		COAL ? in well at Sullivan. Three workable coals outcrop in this county, while one other is workable locally, and three others are reported in drillings as workable.

Township 9 North, Range 8 West.

1337. Geography.—This township lies in the northeastern corner of the county and corresponds with the main portion of Jackson of the civic townships.

The topography is typical; broad, nearly flat divides, rather broad stream channels, uplands breaking down into bottoms precipitously, uplands 50 to 75 ft. above bottoms.

The New Pittsburg branch of the E. & T. H. R. R. runs into and through this township.

1338. Stratigraphy.—Divisions VII to V outcrop in this township. Sections showing the whole of any division or the stratigraphy from one coal to the next are rare and not as reliable as could be

desired. The first section, of the Banholtzer shaft, was obtained by Mr. Collett from one of the men who had worked in the mine. He considered the section as not above question. In the main the section seems to agree with what is found elsewhere, the main difficulty being that the details for the upper coal correspond exactly with those common to Coal VI, while the coal occupies the position of Coal VII.

1339. Section 519. Section at Banholtzer Shaft.—S. W. of S. E. of Sec. 30, Fig. 5, Plate XLII, p. 848. (J. C., p. 217.)

	Thickness of Strata. Ft.	In.	*Coal and Spaces.* Ft.	In.	*Total Depth.* Ft.	In.
1. Soil and clay	8	0	..	..	8	0
2. Siliceous shale and flaggy sandstone, with carbonaceous partings	10	0	..	..	18	0
3. Hard sandstone, nearly compact	7	0	..	..	25	0
4. Light drab clay shale	10	0	..	..	35	0
5. COAL VII	4	0	4	0	39	0
6. Fire-clay, with stigmaria	6	0	..	..	45	0
7. Clay shale, with siliceous layers	3	0	..	..	48	0
8. Brown lime rock	1	2	..	..	49	2
9. Fire-clay, white, soft	0	2	..	..	49	4
10. Hard stone, mottled limestone	5	0	..	..	54	4
11. Light drab clay shale, with small iron nodules	29	0	..	..	83	4
12. Blue clay shale	5	0	49	4	88	4
13. COAL VI	6	8	6	8	95	0
14. Fire-clay	6	0	..	..	101	0

1340. Section 520. Section at B. W. Forbes's Shaft and Hill.—S. W. ¼, Sec. 32-10-8, Fig. 4. (J. T. C., p. 534.)

	Ft.	In.
1. Soil and clay	5	0
2. Sandstone, mostly compact	40	0
3. Shale, with lime nodules	0	6
4. COAL VII ..... 4 ft. 6 in. to	6	0
5. Fire-clay and shale	7	0

Section 521. Section at Sharp Bros.' Bank.—N. E. of N. W., Sec. 5. (J. T. C., p. 534.)

	Ft.	In.
1. Soil and clay	3	0
2. Massive sandstone	26	0
3. Clay shale, fine, light colored	14	0
4. COAL VII	4	6
5. Fire-clay and shale	7	0

1341. Section (Connected) in Lick Fork of Busseron Creek. —Sec. 5, Fig. 3.

		Ft.	In.
1.	Soil	7	0
2.	Drift	8 to 10	0
3.	Shelly sandstone	8	0
4.	Quarry sandstone	15	0
5.	Clay shale	12 to 10	0
6.	COAL VII	5	11
7.	Fire-clay	4 to 6	0
8.	Shale and limestone	2	0+

1342. Section 523. Section at Dick Shaft.—Sec. 30, Fig. 7. (J. C., p. 223.)

		Ft.	In.
1.	Soil and drift	15	0
2.	Shelly sandstone	2	0
3.	Quarry sandstone	3	0
4.	Creamy-colored clay shale	13	6
5.	COAL	6	2
6.	Siliceous clay	3	0
7.	Clay shale	3	0

1343. Section 524. Section of Hymera Shaft.—S. W. of N. E. of Sec. 33, Fig. 6.

		Ft.	In.
1.	Soil and drift	27	0
2.	COAL VIa (?) or VII (outcropping)	..	6
3.	Sandstone	3 to 5	0
4.	Clay shale	12	0
5.	COAL VI	5 to 8	0
6.	Fire-clay	2 to 3	0
7.	"Hard rock."		

1344. Section 525. Section (Approximate) of Ziener Shaft. —S. W. Sec. 27, Fig. 10.

		Ft.	In.
1.	Surface and clay	6	0
2.	Soft clay shale	31	0
3.	Limestone	6	0
4.	Black shale	3	0
5.	COAL V	6	0
6.	Fire-clay.		

1345. Section 526. Section at Alum Cave.—Sec. 24, Fig. 9.

		Ft.	In.
1.	Clay shale and sandstone	30 to 40	0
2.	Limestone	1 to 3	0
3.	Shale	..	6
4.	Limestone	2	6
5.	Black sheety shale	2 ft. 6 in. to 6	0
6.	COAL V 11 ft. (reported)	5 ft. to 9	2
7.	Fire-clay	4	0
8.	Gray shale	10	0
9.	Massive to shaly sandstone.		

Mr. Collett gives a section at this point which was not confirmed, connecting Coals VI and V. Indeed, we found no place within 2 mi. of Alum Cave, where the hills rose stratigraphically above the shale of No. 1 of the above section, and in the area as mapped at which the section is taken, Coal V rises almost to the level of the upland divide. Lest we have been mistaken, as no other section is available, we give his section:

1346. Section 527. Section at Mahan and Stinnett Farms. —Secs. 24, 25. (J. C., p. 219.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil slope.						
2.	Yellow sandstone	25	0	..	..	25	0
3.	Clay shale	4	0	..	..	29	0
4.	Black shale	?	..	..	..	29	0
5.	COAL VI	3	0	3	0	32	0
6.	Fire-clay	4	0	..	..	36	0
7.	Clay shale	20	0	..	..	56	0
8.	Silico-calcareous band	0	4	..	..	56	4
9.	Clay shale, with siliceous flags	40	0	..	..	96	4
10.	Limestone	2	6	..	..	98	10
11.	Parting	..	..	..	..	98	10
12.	Limestone	2	0	..	..	100	10
13.	Black sheety shale	3	2	..	..	104	0
14.	Dark clay marl, "clod"	1	6	69	6	105	6
15.	COAL V, 2 to 11 ft. average	6	6	6	6	113	0
16.	Fire-clay	4	0	..	..	116	0
17.	Drab clay shale	3	0	..	..	119	0
18.	Hard sandstone ...0 to	8	0	..	..	127	0
19.	Compact pyritous clay shale	6	0	..	..	133	0

A core drilling made in this township gave the following record. The whole record is given as showing the depth of the Devonian and Silurian rocks here:

1347. Section 528. Section of Core Drilling.—Fig. 8.

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1.	Clay	18	0	..	..	18	0
2.	Limestone	5	6	..	..	23	6
3.	Black shale	2	0	..	..	25	6
4.	COAL V	7	0	7	0	32	6
5.	Fire-clay	2	6	..	..	35	0
6.	Shale	55	0	57	6	90	0
7.	COAL IV?	5	4	5	4	95	4
8.	Shale	75	0	75	0	164	0
9.	COAL III?	4	8	4	8	165	0
10.	Shale	225	0	..	..	390	0
11.	"Sand"	45	0	..	..	435	0
12.	Shale	130	0	..	..	565	0
13.	Shale	55	0	..	..	620	0
14.	Impure limestone	10	0	..	..	630	0
15.	Shale	40	0	..	..	670	0
16.	Sandy shale	200	0	..	..	870	0
17.	Calcareous shale (limestone ?)	650	0	..	..	1520	0
18.	Shale	200	0	..	..	1720	0
19.	Black shale (Devonian)	100	0	..	..	1820	0
20.	Flinty limestone	65	0	..	..	1885	0
21.	Undetermined rock	54	0	..	..	1939	0
22.	Limestone (Niagara ?)	15	11	..	..	1954	11

1348. Section 529. Section on Brunker or Marts Farm.—N. E. ¼, Sec. 4, Fig. 11.

		Ft.
1.	COAL VII, outcrop.	
2.	Concealed	10
3.	Limestone	1
4.	Shaly sandstone	5
5.	Sandstone	3

1349. Section 530. Section on Brunker Farm.—West of last section, Fig. 12.

		Ft.
1.	Shaly sandstone	20
2.	Limestone	2
3.	Shale	2
4.	COAL VIb	1
5.	Fire-clay	4

The above sections show five workable coals in this area, running from Coal VII to Coal III, and one minor coal, VIb. No coal is exposed in the 40 to 50 ft. of strata found above Coal VII. The major portion of this division, as exposed in these sections, is a sandstone. Between it and the coal at most points is a bed of shale. This is very irregular in thickness, ranging from 0 to 15 ft. It appears to have been deposited on the coal, then to have been subjected to extensive erosion, followed by the deposition of the sandstone. Feeders of coal extend up into this sandstone, so that rock rolls of the type shown in Fig. 602 are of common occurrence in the roof.

1350. Coal VII. Thickness and Physical Details.—This coal was measured 6 ft. thick at the Forbes bank, just across the Vigo county line. It will not average so thick. At the Sharp bank, in Sec. 5, it runs from 3 ft. 6 in. to 6 ft. in thickness, averaging nearly 5 ft. At an old drift a little to the south it measured 4 ft. 8 in. At an outcrop near the center of Sec. 5 it measured 5 ft.—about. At the Baldridge bank it measured 5 ft. 3 in. At all of these places it has a ¼ to 1 in. band about 8 in. from the bottom. At the Halberstadt mine, in Sec. 7, the coal runs from 4 ft. 6 in. to 4 ft. 8 in. At the Romines mine, in Sec. 18, it runs from 4 ft. 6 in. to 5 ft., with an average of nearly 5 ft. At the Banholtzer shaft, in Sec. 30, the coal is given by Mr. Collett as 4 ft. thick. At the Kisner mine, in Sec. 33, it is reported as 4 ft. These figures show this coal to have an average of probably over 4 ft. The average over the whole of its area will probably be below that.

Roof.—We have already seen that the roof is variable, being either shale or sandstone and liable to be rendered irregular by the presence of rolls, over which extend feelers of coal.

Floor.—The floor is in general fire-clay and underlain by limestone. At the Halberstadt mine, in Sec. 7, the fire-clay is lacking and the coal lies immediately upon limestone.

Quality.—The quality of this coal appears to be excellent in freedom from impurity and in richness, but to be a poor coal to ship on account of its tendency to air-slack. It was formerly coked near the Sharp bank, in Sec. 5, and from the results obtained it would appear to be an excellent coal for that purpose. It would seem to invite tests for the making of gas, as, if we mistake not, it would serve well for that purpose.

1351. Division VI.—From the sections given, it would appear that Division VI shows about the following general section:

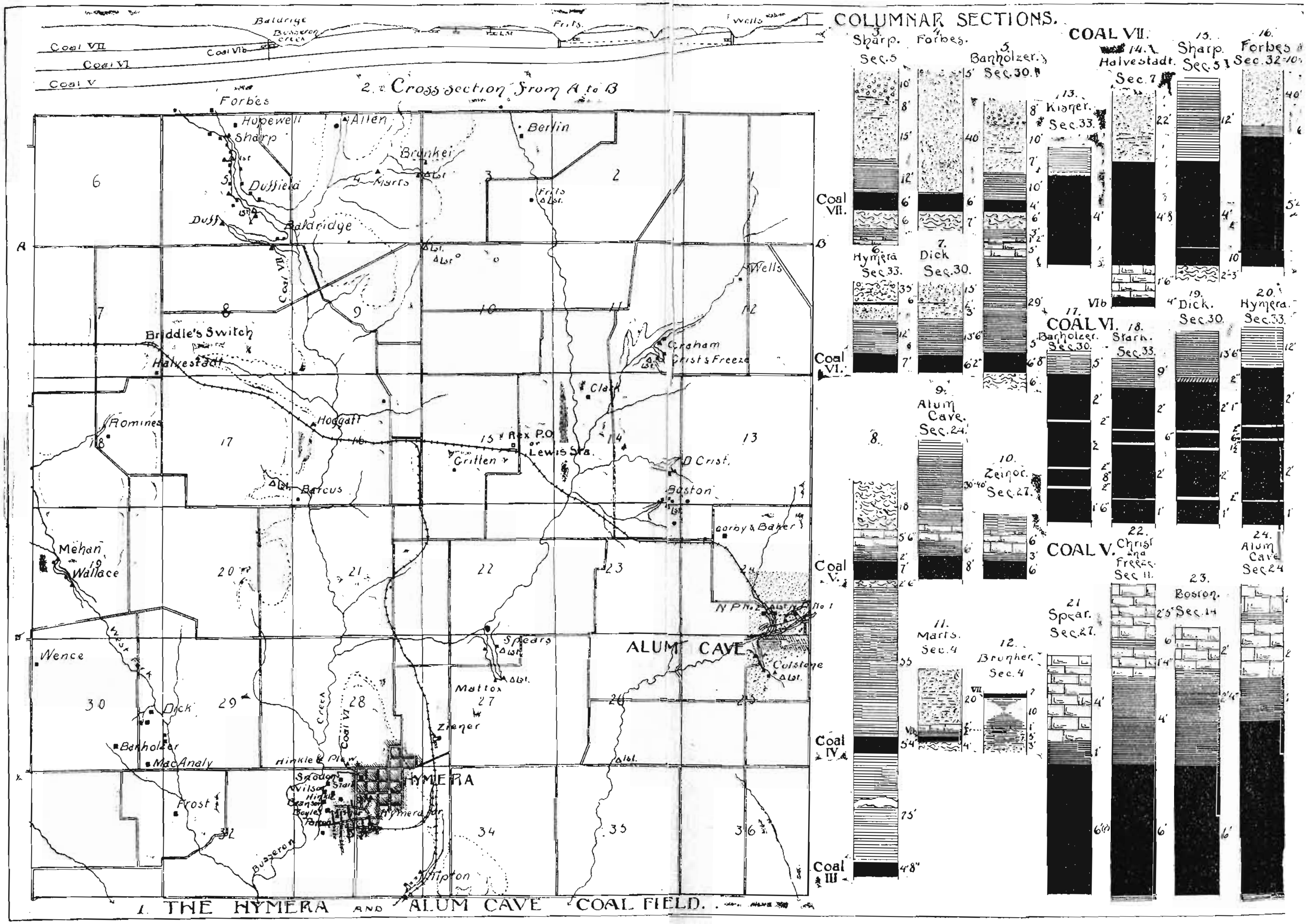

COLUMNAR SECTIONS.
2. Cross-section from A to B
Coal VII
Coal VI
Coal V
Coal VIb
Baldrige
Busseron Creek
Frits
Wells
Forbes
Hopewell
Sharp
Allen
Berlin
Brunker
Marts
Duffield
Duff
Baldridge
Wells
Briddle's Switch
Halvestadt
Graham
Crist & Freeze
Clark
Romines
Hoggatt
Rex P.O. or Lewis Sta.
Critten
D. Crist
Barcus
Boston
Corby & Baker
Mehan
Wallace
ALUM CAVE
Colstone
Wence
Spears
Mattox
Dick
Zener
Banholzer
MacAnaly
Hinkle & Plew
HYMERA
Frost
Busseron
Tipton
Coal VI
Creek
1. THE HYMERA AND ALUM CAVE COAL FIELD.
3. Sharp. Sec. 5
4. Forbes.
5. Banholzer. Sec. 30.
6. Hymera Sec. 33.
7. Dick Sec. 30.
8.
9. Alum Cave. Sec. 24.
10. Zeiner Sec. 27.
11. Marts. Sec. 4
12. Brunker. Sec. 4
13. Kisner. Sec. 33.
14. Halvestadt. Sec. 7
15. Sharp. Sec. 5
16. Forbes Sec. 32
17. Banholzer. Sec. 30.
18. Stark. Sec. 33.
19. Dick. Sec. 30.
20. Hymera. Sec. 33.
21. Spear. Sec. 27.
22. Christ and Freeze. Sec. 11.
23. Boston. Sec. 14
24. Alum Cave Sec. 24
COAL VII.
COAL VI.
COAL V.
Coal VII.
Coal VI.
Coal V.
Coal IV.
Coal III.

PLATE XLII.

	Ft.	Ft.
Fire-clay	0 to	7
Limestone	0 to	18
COAL VIb	0 to	1
Shale, sandstone, shale	about 30	
COAL VI	0 to	8

As noted above, the fire-clay underlying Coal VII is wanting at Halberstadt's shaft, in Sec. 7, but is generally present, often being 6 to 7 ft. thick.

Sometimes there is a little shale between the fire-clay and the limestone, but often not.

At an exposure a little north of the center of Sec. 5 the limestone immediately underlies the fire-clay and shows about 1 ft. of gray, weathered, nodular limestone, then about 1 ft. of brown, nodular limestone. This limestone is taken to be the same as the limestone overlying Coal VIb at many points to the north. This limestone has a thickness of from 1 to 3 ft. in Secs. 3 and 4. In Secs. 9 and 10 reports indicate that it thickens up to a score or more of feet. At a drilling south of Sharp's, in Sec. 5, it was 6 in. thick. At Halberstadt's, in Sec. 7, it is 1 ft. 6 in. thick. At Banholtzer's, in Sec. 30, it is over 6 ft. thick, with a shale parting 5 ft. from the bottom.

1352. Coal VIb was only noted in the northwestern part of the township, and then only in places. On the Brunker place, in Sec. 4, it is 2 ft. thick and separated from the limestone by 2 ft. of shale. At Halberstadt's, Sec. 7, it is 4 in. thick and immediately underlies the limestone.

1353. Space to Coal VI.—In drillings by Mr. Sharp, in Sec. 5, this place is topped by 10 to 12 ft. of "fine white pipe-clay." Then comes sandstone, which appears very irregular in its development, often being absent and sometimes making up most of this space. Below that normally comes 10 to 15 ft. of shale. As with the sandstone and shale over Coal VII, the contact of the shale and sandstone is irregular, indicating erosion of the shale after its laying down and the laying down of the sandstone on this surface. Often the pre-sandstone channels were cut down into the coal, partially or entirely removing it there.

1354. Coal VI.— Thickness and Details.—This coal shows three marked partings, one near the bottom, and two, 6 to 8 in. apart, near the middle. These divide this coal up into four benches, of which the lowest bench is usually poor and is not taken in mining. At the

Banholtzer mine the section of the upper coal as given by Mr. Collett corresponds more closely in its structural details, though not otherwise, with Coal VI than the lower coal. It is possible that the person who gave him the section had confused the beds, a tendency that the writer found to exist in this county where both beds are worked. For the sake of comparison, the details of the upper bed will be given.

MINE.	Location.	Top.		Mining.	Lower.		Bottom.		Total.	
		Ft.	In.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Banholtzer (J. C.)	Sec. 30	1	6	8	1	0	0	8	3	10
Stark	Sec. 33	2	0	6	2	0	1	0	5	6
Dick (J. C.)	Sec. 30	2	1	6	2	0	1	0	5	7
Hymera	Sec. 33	2	6	6	2	10	1	0	6	10

The three clay bands, which usually range from ¼ in. to 2 in., with an average of 1 in. or over, will add from 2 to 6 in. to the totals given for the full thickness of the beds. The section Mr. Collett reports of the lower bed at the Banholtzer shaft, in Sec. 30, is as follows:

	Ft.	In.
COAL	2	0
Shale	..	2
COAL	2	0
Shale	..	2
Good COAL	..	8
Smut parting	..	2
COAL	1	6
	6	8

The total thickness of the bed for different parts of the township is given as follows:

SOUTHERN PART.			NORTHERN PART.	
Name and Location.	Range.	Thickness.	Name and Location.	Thickness.
Starke, section 33	4 ft. 10 in. to 6 ft. 0 in.	5 ft. 0 in.	Frits, section 3	4 ft. 7 in.
Hymera, section 33	5 ft. 0 in. to 8 ft. 0 in.	6 ft. 6 in.	Sharp, section 5	2 ft. 6 in.
Banholtzer, section 36		6 ft. 8 in.	Halberstadt, Sec. 7	2 ft. 0 in.
Dick, section 30		6 ft. 2 in.		

From these it would appear that Coal VI is of good thickness in the southwestern part of the township, but to the north becomes a thin and uncertain coal, as though approaching the edge of the basin.

QUALITY.—Mr. Cox gives the following analysis of this coal in this area from the old Wilson drift, in Sec. 33:

Fixed carbon	51.60	
Volatile combustible matter	45.25	
Total combustible matter		96.85
Ash	0.80	
Moisture	2.35	
Total waste		3.15

This analysis shows a coal of great purity, probably better than the average, being very rich in gas and low in ash. That the coal is of an excellent grade may be judged in a general way from the fact that, with the exception of one mine, this bed furnishes all the commercial coal of Sullivan county, which stands second as a coal producer. The coal analyzed above is described as a "glossy, jet-black color, vitreous fracture, and will soil the hands little more than the cannel coal. The ash is white and does not amount to one per cent. The coke is of fair quality and the gas 6.1 per cent. greater than I found in a sample of the best gas coal from Pittsburg." (E. T. C., p. 16.)

ROOF.—The roof of this coal is usually a blue shale, holding up fairly well. Over this is a sandstone. At Fritz, in Sec. 3, the sandstone lies on the coal. At Halberstadt's, in Sec. 7, the shale was 2 ft. thick; elsewhere the shale runs normally 10-15 ft. in thickness.

FLOOR.—In mining, the bottom bench of coal is usually left as a floor. Below that there is usually fire-clay of at least several feet thickness.

1355. DIVISION V.—This division has here a thickness of from 24 (?) to 75 ft. It was reported that a drilling at the Banholtzer shaft found Coal V "at a depth not exceeding 24 ft. below" Coal VI. At Hymera, Coal V is reported to be 54 ft. below. In the section given by Mr. Collett from Secs. 24 and 25 the coals are 69 ft. 6 in. apart. The rocks of this division appear to be principally shale here nearly to the bottom, where occurs Coal V, overlain by black sheety shale, with lime and pyrite concretions, and over that in turn is limestone. Plate LXXXIII in Part IV and the frontispiece give the appearance of the outcrop of the coal and its overlying rocks. The limestone is usually quite fossiliferous and ranges in thickness from 2 to 6 ft. It is frequently separated into benches by a parting of shale a few inches

thick. The black shale under it runs from 1 ft. to 10 ft., though it is usually less than 5 ft. The group of sections figured gives the following thicknesses for the coal and overlying strata:

	Spear. Sec. 27. Ft.	In.	*Crist & Freeze. Sec. 11.* Ft.	In.	*Boston. Sec. 14.* Ft.	In.	*Alum Cave. Sec. 24.* Ft.	In.
Limestone, top	..	..	2	5	..	..	2	6
Parting of shale	..	..	..	6	..	..	..	6
Limestone, bottom	4	0	1	4	2	0	2	6
Black sheety shale	1	0	4	0	4	4	2	6
COAL V	6	0?	6	0	6	0	8	0

At Alum Cave (New Pittsburg) the coal measured from 8 ft. to 9 ft. 2 in. where exposed in the bluffs. Mr. Crawford, of Sullivan, says that at the thickest point the coal measures 11 ft. It runs down, on the other hand, to 4 ft. The thickness of this bed at other points over the area is as follows: Wells's well, Sec. 12, 2 ft. thick; D. Crist, Sec. 14, 7 ft.; Geo. Barcus's drilling, 7 ft. under 3 ft. of limestone; Zeiner, Sec. 27, 6 ft.; Hymera, 7 ft. These figures show a coal that would seem to average at least 6 ft. A thin clay parting was reported in places to come 2 ft. from the top of the coal. However, there appears to be no regular parting in the coal.

The following analysis was made by Mr. Noyes of the coal at Alum Cave or New Pittsburg mines:

Fixed carbon	42.17	
Volatile combustible matter	42.60	
Total combustible matter		84.77
Ash	8.74	
Moisture	6.49	
Sulphur	3.18	
Total waste		18.41

Messrs. J. R. McTaggart and H. W. Carver made some analyses of the New Pittsburg coal in 1895, with the following results:*

	A.		*B.*	
Fixed carbon	39.93		40.40	
Volatile combustible matter	39.92		42.23	
Total combustible matter		79.85		82.63
Ash	13.31		11.48	
Moisture	6.83		5.89	
Total waste		20.14		17.37

*American Chemical Society, Vol. 17, p. 843.

They also give ultimate analyses of the same coals:

	A.	B.
Carbon	62.88	65.26
Hydrogen	5.07	5.17
Nitrogen	1.01	1.17
Oxygen	13.06	13.25
Ash	17.98	15.15
Sulphur	7.46	5.88
Iron, calculated	6.53	5.14

These indicate a coal having a rather large amount of ash and sulphur. Thus, the ash and sulphur in an analysis of Lancaster block coal made at the same time show 3.07 and 0.62, respectively, with 0.54 of iron, as compared with 15.15, 5.88 and 5.14, respectively, in the case of the better of the two samples from here. Nevertheless this coal appears to be a strong steam coal, and when washed, as it is extensively at Alum Cave, is found to be a desirable coal.

The roof of this coal is usually good. When the thickness of the shale is slight, however, it tends to come down, leaving the limestone as a roof.

The floor is quite often black shale, otherwise fire-clay. Sandstone horsebacks are sometimes met with.

1356. DIVISIONS III AND IV.—All that is known of these divisions in the township is from a core drilling (given above), which showed Coal IV to have a thickness of 5 ft. 4 in. at a depth of 57 ft. 6 in. below Coal V, and Coal III 4 ft. 8 in. at a depth of 75 ft. below Coal IV, the intermediate strata being almost entirely shale. The presence of Coal IV, 5 to 6 ft. thick, a little east and at Linton, suggests the possibility of its being workable under part of this area. Unless there are overlapped strata the bottom of the coal measures should be found within 250 ft. below Coal V.

1357. DISTRIBUTION AND STRUCTURE. NORTHEAST QUARTER TOWNSHIP.—As nearly as could be ascertained, Coal VI is above drainage in Sec. 1. It was thought to underlie the divide along the east side of Secs. 1 and 12, being about 30 ft. from the summit. It would seem to underlie the N. W. corner of the section. Going westward, the dip carries it rapidly below the plateau, so that near the center of the E. ½ of Sec. 3 it is thought to be the coal struck at 27 ft. on Philip Fritz's place, in the N. E. of S. E. of section. The coal was found in a test shaft starting just above the level of the branch. The limestone near the top of Division VI outcrops at several places along this

branch, in Sec. 3, just above the creek level, and on the Berlin place, near the north line of the section, Coal VIb, a few inches thick, has been dug a little in the creek bed. Traces of Coal VII appear above this, and on the Brunker place, at the west section line. It is, however, so close to the bottom of the drift that from a commercial standpoint it may be said not to underlie this section. Coal V is below drainage in Secs. 1 to 3. In Sec. 12 it is 20 ft. deep in a well on the Wells place, S. E. of N. W. of section. Down this branch to the southwest Coal V rises to drainage and is probably a little above drainage through the S. E. part of Sec. 11 and all of Secs. 13 and 14. At Crist and Freeze and Graham banks, as well as at an old bank north of Graham's, it is about 10-15 ft. above the stream. In the north part of Sec. 10 the limestone in Division VI is found abundantly and quite near the surface and at depths that indicate a slight dip to the east. Apparently this limestone, which, through Sec. 3, keeps just above the level of the creek, runs into the limestone over Coal V, in Sec. 14. This it certainly would do if it maintained the dip it has in Sec. 3, and this apparent running together proved very confusing. A transit measurement across one 40 acres showed a descent of the stream of 9 ft., or 36 ft. to the mile, and, as the nearest outcrops are about 1½ mi. apart, it follows that if the dip changes to a level from Mr. Fritz's it would be 50 ft. above the creek at the middle of Sec. 14. As the columnar distance between the limestones is probably nearly, if not quite, double that, it indicates that if our correlations are correct there must be a dip to the north of 30 or 40 ft. to the mile across Sec. 11 and parts of Secs. 14 and 3. At D. Crist's and Boston's mines, Coal V is only about 20 ft. below the level of the plateau; the rise to the east, if continued, would carry it out in Sec. 13, but there comes in an eastward dip which carries it lower, so that it underlies quite an area to the east in Clay county. Coal VI is supposed to underlie the western part at least of Secs. 10 and 15.

1358. SOUTHEAST QUARTER TOWNSHIP.—Division V is the surface formation over all of these sections, except a small area of Division VI, in the S. W. part of Sec. 34 and in the bottoms of the two main streams. Where well exposed around Alum Cave, in Secs. 24 and 25, a good idea is obtained of how complicated the detailed structures may be; see Fig. 21, in Part I. From the mouth of the No. 2 mine the dip to the west is so strong that rope haulage is used to draw the cars to the entrance when they are hauled by mules through the No. 1 mine to the tipple farther east. Up the branch that enters from the south opposite the coke ovens is seen an interesting case of torsional folding. Near the mouth of the branch there is a high dip to the east, so that the coal, while at creek level on the east side, is high up the bank on the opposite side of the narrow ravine. A short distance south the dip is reversed, and, while the coal appears in the east bank 10 ft. above the creek bottom, on the west side 40 ft. away Mr. Colstone has driven a slope following the coal which starts at creek level, the dip being about 1 ft. in 3 ft. At the Gorby and Baker shaft, the coal is reported as 60 ft. down and from 2 ft. to 2 ft. 6 in. thick, with a foot of black shale over, then boulder clay and surface. There is some question as to whether this is Coal V or not. At the Spears mine, in the N. W. of N. E. of Sec. 27, and the old Mattox mine, in the S. W. of N. E. of the same section, Coal V is mined in the creek bottom or by drift just above the level of the creek. At the Zeiner shaft, Coal V is found at a depth of 46 ft. and the dip from there to the southwest is quite sharp. In the S. W. part of Sec. 34 the dip carries Coal V to quite a depth, and a small area of Coal VI underlies the high land there, though without sufficient roof.

1359. Northwest Quarter Township.—Coal VII appears to underlie all the high ground in this area, but is cut out along Busseron. On the Brunker place, east side of Sec. 4, it is seen just underlying the drift. In this section it is too near the surface to be of value. At Mr. Jas. Allen's, in the N. E. of N. W. of Sec. 4, it appears in the bank just below the drift, the limestone of Division VI appearing just below, while Coal VIb, with its black shale roof, is found at a depth of 25 ft. in a well that starts but little above the creek level. In the S. W. of the N. E. of Sec. 4, on the Marts place, Coal VIb outcrops but 2 ft. below the limestone.

In Sec. 5, Coal VII outcrops along a fork of Busseron 8 or 10 ft. above the creek at the Baldridge bank, in the S. E. 40, and at a varying height above the creek at a large number of drifts that have been worked at one time and another for fifty years, until it passes below drainage near the north line of the section, where it is, or has been, mined by slopes and shaft by the Sharp Bros., Hopewell and Forbes. A drilling here is said to have struck Coal VI 50 ft. below Coal VII, but only 2 ft. 6 in. thick. It is there overlain by shale, then sandstone.

At the Thos. Halberstadt mine, in the S. E. corner of Sec. 7, Coal VII is 33 ft. deep. At the Romaine or Geo. Halberstadt mine, Coal VII is 11 ft. deep, and Coal VI is reported to be 40 ft. lower and only 2 ft. thick, the strata between being principally sandstone, except 2 ft. of brownish-gray shale over the coal. Outcrops of Coal VII occur in

the S. W. ¼ of Sec. 8, and on the Hoggatt place, in the N. E. ¼ of Sec. 16. In the S. E. corner of this section a drilling on the Geo. Barcus place, which started about 30 ft. above the bottom of Busseron, is reported to have passed through 3 in. of coal at 45 ft., and 7 ft. of coal under 3 ft. of limestone at 74 ft. It makes it look as though the 7-ft. coal was Coal V, the 3-in. coal Coal VI, and Coal VII lies either above the top of the drilling or is cut out at that point. The finding of limestone, presumably that near the top of Division VI in the ravine a short distance northwest of this, seems to strengthen this interpretation.

At No. 4 schoolhouse, in the S. W. ¼ of Sec. 17, which is a high point, it is reported to be 60 or 65 ft. to Coal VII, 4 ft. thick, with 12 ft. of shale over it and boulder clay above that. In the N. E. of Sec. 16 a well starting 19 ft. above the bottoms is reported to have passed through a few inches of coal at almost 40 ft.

1360. Distribution in Southwest Quarter.—In this area Coal VII appears to be above drainage and to rise to outcrop somewhere near a central north and south line, so as to really only underlie the western half of the area. Coal VI appears to be above drainage in the three eastern sections, but to be below in the others. Coal V is below drainage in all of this area.

Coal VII outcrops along the branch in the western part of the area and has been worked by drifts at a little above drainage or stripped in the creek bed at a number of points on the Mehan and Wallace farms, in the western part of Sec. 19. It has also been found in the S. E. ¼ of Sec. 30 and S. W. ¼ of Sec. 29. At the Banholtzer shaft, according to the section given above, it was 35 ft. deep, and Coal VI was 88 ft. deep. The top of this shaft was estimated to be not over 15 ft. below the top of the McAnally or Snowdon shaft, at the schoolhouse in the S. E. 40 of this section. At the latter shaft it is said to be 80 ft. to Coal VI, which would appear to be here at a level midway between the two coals at Banholtzer's. On the other hand, at the old Jack Frost mine, in the N. W. ¼ of Sec. 32, which starts in the valley and about 15 ft. above the creek, Coal VI is said to be 75 ft. deep. This would carry it as far below what has been taken to be Coal VI at Banholtzer's as the coal at Snowdon is above. In addition to the places mentioned, coal has been worked at the Abe Wence place, in the N. W. ¼ of Sec. 30, and at the Dick place, in the S. E. ¼ of the same section. At the former shaft it is said three beds were struck, the second bed being 2 ft. thick, and the third, which occurred under limestone, was said to consist of 3 or 4 ft. of cannel (?) coal overlying 3 ft. of caking coal.

In Sec. 33, Coal VI is extensively worked at the Hymera mine, where it is 50 ft. deep, and in 1899 they are sinking to Coal V. At the Hinkle shaft it is 45 ft. to Coal VI, the roof of the coal being: "Draw slate," 4-6 in.; clay shale, 9 ft.; sandstone, 8 ft.; boulder clay and surface to top. Around the foot of the creek bluff, west and southwest of Hymera, are a number of slopes and drifts. Of these may be mentioned Hinkle and Plew's, Stark's, Snowdon's, Wilson's, Branson's, Bolye's and Patton's. Their location is shown on the map. Coal VI outcrops in the road at the foot of the bluff west of Hymera, and Coal V is said to have been struck at 80 ft. at the church on the hill just above. Coal V is reported to underlie Coal VI by 54 ft. here. In the Hymera mine the coal rises rapidly to the north or northeast. Some 50 ft. from the shaft a 6-ft. fault was encountered, to overcome which the direction of the entry was changed so as to secure an easy slope, and a short rope haulage put in, worked by a small engine at the head of the slope. A very limited area of Coal VII has been worked west of the Hymera mine by Mr. Kisner. In the S. E. corner of Sec. 33, Coal VI outcrops at creek level, and a slope has been driven to it, known as the Tipton or Murdock mine. A switch and tipple were partly built, but abandoned before completion.

1361. SUMMARY OF COALS.—

Divisions contained, VII-III.
Coals contained, VII, VIb, VI, V, IV, III.

ROUND NUMBER ESTIMATES.

Coal VII.

Worked area......	25 acres	× av. thickness,	4 ft. × 1,200 =	120,000 tons.
Workable area ...	6 sq. mi. ×	"	3 ft. × 500,000 =	9,000,000 tons.
Unworkable area .	6 sq. mi. ×	"	2 ft. × 1,000,000 =	12,000,000 tons.
Total area.....	12 sq. mi			21,120,000 tons.

Coal VI.

Worked area......	150 acres	× av. thickness,	5 ft. × 1,200 =	900,000 tons.
Workable area....	5 sq. mi. ×	"	5 ft. × 500,000 =	12,500,000 tons.
Unworkable area .	15 sq. mi. ×	"	2 ft. × 1,000,000 =	30,000,000 tons.
Total area	20 sq. mi			43,400,000 tons.

Coal V.

Worked area......	300 acres	× av. thickness,	6 ft. × 1,200 =	2,160,000 tons.
Workable area....	20 sq. mi. ×	"	6 ft. × 500,000 =	60,000,000 tons.
Unworkable area .	15 sq. mi. ×	"	2 ft. × 1,000,000 =	30,000,000 tons.
Total area	35 sq. mi			92,160,000 tons.

Coal IV (and IVa?)

Workable area....	5 sq. mi. ×	av. thickness,	3 ft. × 500,000 =	7,500,000 tons.
Unworkable area.	30 sq. mi. ×	"	1 ft. × 1,000,000 =	30,000,000 tons.
Total area	35 sq. mi			37,500,000 tons.

Coal III (IIIa, IIIb, etc.?)

Workable area....	1 sq. mi. ×	av. thickness,	4 ft. × 500,000 =	2,000,000 tons.
Unworkable area .	35 sq. mi. ×	"	1 ft. × 1,000,000 =	35,000,000 tons.
Total area.....	36 sq. mi			37,000,000 tons.

Number of coals contained: 6+.
Greatest thickness recorded: 9 ft. 2 in. Coal V at Alum Cave.
Average thickness: About 4 ft. for Coals VII, VI and V.
Area underlain by coal: 36 sq. mi.
Area underlain by workable coal: 30 sq. mi.+
Estimated total tonnage of coal: 230,000,000.
Estimated total tonnage of coal removed: 3,000,000.
Estimated total tonnage of workable coal left: 91,000,000.
Number of mines working ten men or over in operation: 3.
Number of mines working less than ten men in operation: 9.
Total number of mines in operation: 12.
Large mines abandoned: 0.
Strippings, outcrops, etc.: 81.
Total number of openings to coal: 93.

TOWNSHIP 8 NORTH, RANGE 8 WEST.

1362. GEOGRAPHY.—Secs. 1 to 4 and 9 to 12 are in Jackson township. Secs. 5 to 8 and 17 to 20 are in Hamilton township. Secs. 13 to 16 and 27 to 36 are in Cass township.

1363. TOPOGRAPHY.—Divides nearly level, especially in northeastern and western parts; stream valleys usually broad; slopes usually abrupt. Usual height of divides above streams about 50 ft., being less in the southwestern part and more in the northeast and eastern parts.

1364. TRANSPORTATION.—The Jackson Hill and Star City branch of the E. & T. H. R. R. enters the north part of the area. The Illinois and Indiana Southern railroad crosses the southern edge of the area.

1365. STRATIGRAPHY.—Divisions VII to V outcrop in this area. The following sections show the stratigraphy as developed in this area. The section at Dugger is figured to show the complete section. For description, see next township:

1366. SECTION 532. SECTION AT STAR CITY SHAFT.—Sec. 6, Fig. 2, Plate XLIII, p. 864.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface and drift	15	0	..	..	15	0
2. Shaly sandstone or shale overlying sandstone	45	0	..	..	60	0
3. "Slickened" shale	20	0	..	..	80	0
4. COAL VII ....4 ft. to	4	6	4	6	84	6
5. Fire-clay	6	0	..	..	90	6
6. Limestone	3	0	..	..	93	6
7. "Slickened" shale ....18 ft. to	20	0	29	0	113	6
8. COAL VI ....4 ft. 6 in. to	6	0	6	0	119	6
9. Shale	10	0	..	..	129	6

1367. SECTION 531. SECTION AT FARNSWORTH SHAFT.—Sec. 32 (W. S. B.), Fig. 3.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	12	0	..	..	12	0
2. Sandy shale	20	0	..	..	32	0
3. Blue shale	5	0	..	..	37	0
4. COAL VII	3	4	3	4	40	4
5. Fire-clay	9	0	..	..	49	4
6. Limestone	2	0	..	..	51	4
7. Hard gray flint	..	8	..	..	52	0
8. Blue shale, with ironstones	18	0	29	8	70	0
9. COAL VI	5	6	5	6	75	6
10. Shale.						

1368. SECTION 532. SECTION AT BUELL'S SHAFT.—Sec. 35, Fig. 4.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Light brownish-gray sandstone, shaly at bottom	8	0	..	..	8	0
2. Gray shale, with line of nodules, 6 in. to	2	0	..	..	10	0
3. COAL VII	4	0	4	0	14	0
4. Fire-clay ....3 ft. or	4	0	..	..	18	0
5. Sandstone	24	0	..	..	42	0
6. Light-gray shale	12	0	..	..	54	0
7. Dark-blue shale	..	6	40	6	54	6
8. COAL VI	5	3	5	3	59	3
9. Fire-clay, "only in places."						

1369. SECTION 533. SECTION AT PIGG'S BANK.—Sec. 36 (?) (J. C., p. 221), Fig. 5.

	Ft.	In.
1. Slope	20	0
2. Drift	20	0
3. Shelly sandstone	10	0
4. Compact quarry sandstone ....10 ft. to	20	0
5. Clay shale	1	8
6. Dark, calcareous shale	0	8
7. COAL VI	5	2
8. Fire-clay	5	0
	82	6

1370. SECTION 534. SECTION AT BUSH CREEK MINE.—Sec. 31, Fig. 6.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	8	0	..	..	8	0
2. Gray sandy shale	25	0	..	..	33	0
3. Blue shale	15	0	..	..	48	0
4. COAL VII ....4 ft. to	4	6	4	6	52	6
5. Fire-clay	6	0	..	..	58	6
6. Sandstone (?)	19	6	..	..	78	0
7. Black shale	6	0	31	6	84	0
8. COAL VI	5	0	5	0	89	0
9. Fire-clay.						

1371. SECTION 535. SECTION AT D. RING'S AND J. EVERHART'S.—Secs. 3 and 4 (J. C., p. 222), Fig. 8.

	Ft.	In.
1. Slope.		
2. Quarry sandstone ....8 ft. to	10	0
3. Clay shale, with iron nodules ....1 ft. to	2	0
4. Dark calcareous clay ....0 ft. to	..	8
5. Black sheety shale, fish fins and scales..1½ in. to	0	3
6. COAL VI	5	2
7. Fire-clay, sometimes compact and siliceous	5	0
8. Clay shale ....5 ft. to	3	0
9. Brown limestone	1	8
10. Clay in branch	0	0
	27	9

This section presents several unusual features, notably the black sheety shale overlying the coal, and the limestone below the coal.

1372. SECTION 536. SECTION AT BARNES'S (SEXTON'S) BANK.—Sec. 13 (J. C., p. 220), Fig. 9.

	Ft.	In.
1. Soil	5	0
2. Drift	15	0
3. Clay	1	0
4. Soft, flaggy sandstone	5	0

	Ft.	In.
5. Dark drab shale, with carbonaceous partings, changing to flagstones	18	0
6. Clay shale	2	0
7. Limestone	4	0
8. Calcareous shale, pyritous	1	0
9. Black sheety shale	1	8
10. COAL V	5	6
11. Fire-clay	5	0
	63	2

1373. SECTION 537. SECTION ON MRS. THOMPSON'S.—Sec. 34, Fig. 7.

	Ft.	In.
1. Shaly sandstone	30	0
2. Blue clay shale in shaft	16	0
3. COAL VII	3	4
4. Fire-clay.		

1374. These sections show Divisions V to VII to each contain a coal which is workable, as far as our information goes. Division VII shows a thickness of up to 65 ft. without the whole thickness being exposed. In nearly every case shale immediately overlies the coal, and that in turn is overlain by sandstone, often shaly; the shale varies in thickness from 6 in. to over 40 ft., while in one section the shaly sandstone is given as 45 ft. Coal VIII occurs in the western and southwestern part of the township.

1375. DIVISION VI varies in thickness from 30 ft. to nearly 60 ft., but seems to average not far above the lower figure. The limestone which to the north overlies Coal VIb is only noted in three of the sections, from which we may conclude that it is not very persistent here. Aside from the limestone and underclay of Coal VII, the rocks are principally a massive sandstone underlain by a clay shale, the latter lying on Coal VI. The contact of the clay shale and the sandstone is one of unconformity, being very irregular, so that the sandstone often extends down to or into the coal, making rock rolls.

1376. DIVISION V yielded no complete sections in this area. From what is known at points a little outside it may be judged to have a thickness of from 30 to 60 ft. with an average of 45 or 50 ft. Shales appear to predominate in this division, though sandstone of considerable thickness is often found. As usual, the bottom of the division above the coal shows a black, bituminous sheety shale, overlain by limestone.

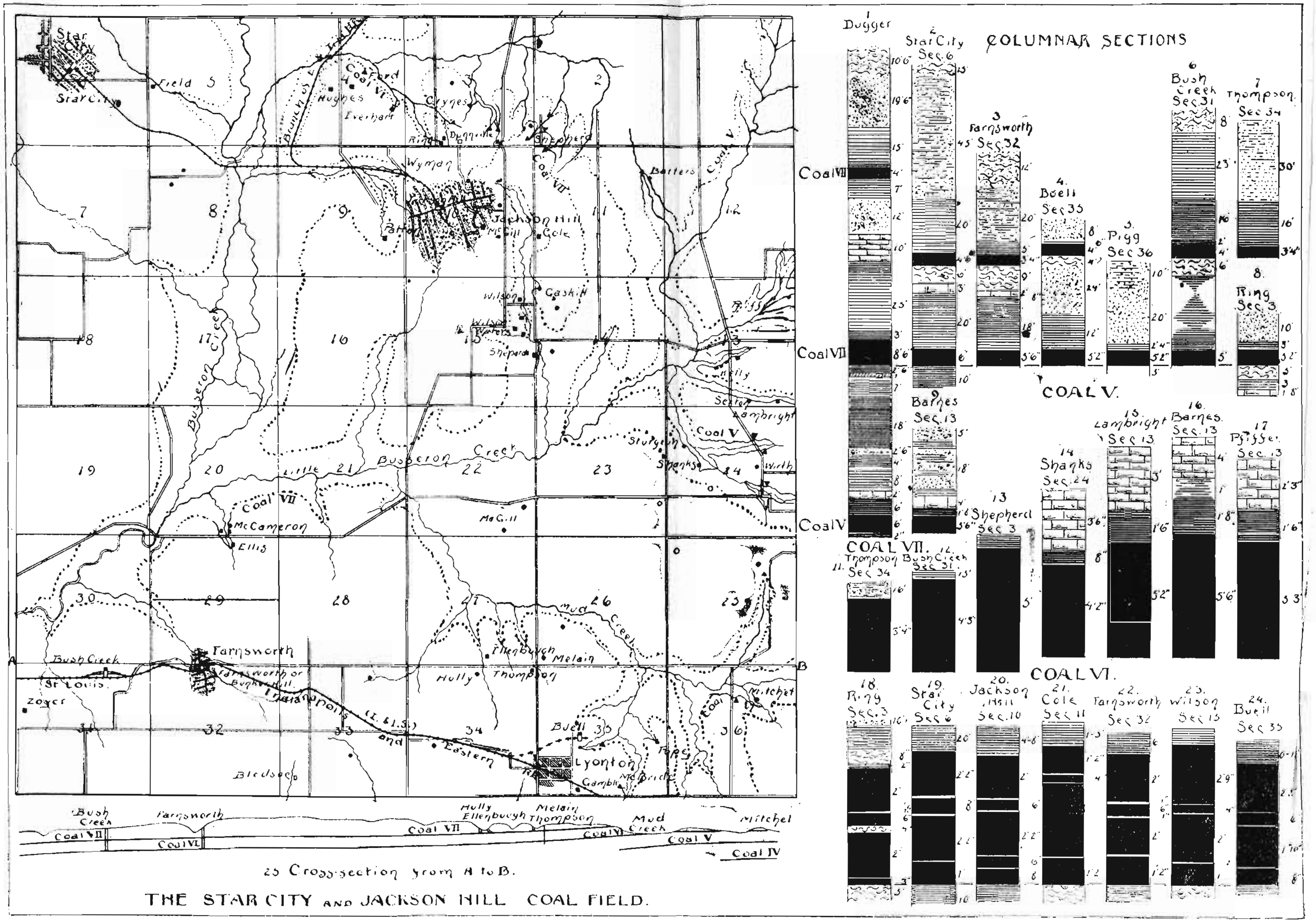
1377. COAL VII. (FIGS. 11-13.) THICKNESS AND DETAILS.—This coal appeared in most places in this area as a solid coal, without bands and overlain by shale. The thickness and roof may be tabulated as follows:

PLACE.	Section.	Roof.	Thickness.
Shepard	3	Shale	5 ft. 0 in.
Jackson Hill	10	?	4 ft. 0 in.
Gaskill	14	?	5 ft. 0 in.
Star City	6	20 ft. shale	4 ft. 6 in.
Field	5	Shale	4 ft. 5 in.
Ellenbough	27	Shale	3 ft. 6 in.
Thompson	34	16 ft. shale	3 ft. 4 in.
Buell	35	6 in. shale	4 ft. 0 in.
Melain	26	?	3 ft. 0 in.
Gamble	35	?	4 ft. 0 in.
Ellis	29	6 ft. shale	2 ft. 10 in.
Farnsworth	32	5 ft. shale	2 ft. 4 in.
Bush Creek	31	41 ft. shale	4 ft. 0 in.
Zaayer & Allman	31	?	3 ft. 6 in.

An average of the thicknesses given is a little under 4 ft., but considering the preponderance of data where the coal is thin it seems safe to take 4 ft. as an average. It will be noticed, however, that the coal shows a tendency to become thin to the south, the measurements in the north half of the township averaging about 1 ft. thicker than those to the south. On the Gaskill and Ellis places the coal is reported to show a parting in the middle.

The roof is shale as far as learned of, though often overlain by sandstone, in which case we would expect the shale to come down, leaving the sandstone as a roof. As far as could be learned the roof is generally fair, but much subject to rock rolls. From what was seen of this coal at other points we would expect to find the roof rather uneven, making the coal vary greatly in thickness. Considering the predominance of shale roof here, that may not be true in this township. The floor, as far as could be learned, is fire-clay, which serves well.

QUALITY.—Reports indicate that this coal is quite pure, but is not a good coal to ship, as it breaks freely when exposed to the weather.



COLUMNAR SECTIONS
1 Dugger
2 Star City Sec. 6
3 Farnsworth Sec. 32
4. Buell Sec. 35
5. Pigg Sec. 36
6 Bush Creek Sec. 31
7 Thompson Sec. 34
8. Ring Sec. 3
Coal VII
Coal VI
Coal V
COAL V.
COAL VII.
COAL VI.
Star City
Jackson Hill
Farnsworth
Lyonton
Bush Creek
Busseron Creek
Little Busseron Creek
Mud Creek
Indianapolis and Eastern
25 Cross-section from A to B.
THE STAR CITY AND JACKSON HILL COAL FIELD.

PLATE XLIII.

At Harterville or Jackson Hill the town pump is said to get water from this coal bed.

An analysis of this coal from the Farnsworth mine, made for this report by Mr. Noyes, gave:

Fixed carbon	43.89	
Volatile combustible matter	34.40	
Total combustible matter		78.29
Ash	9.64	
Moisture	12.07	
Sulphur	1.03	
Total waste		22.74

Pounds of water evaporated per pound of coal, 11.71.

1378. Coal VI.—As in the preceding township, this coal shows everywhere four benches, separated by three very persistent clay bands. The following table will show the thickness of the coal and benches at various points in the township.

NAME.	Section.	Benches.									
		Upper.		Middle.		Lower.		Bottom.		Total.	
		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Shepard	3	2	3	0	6	0	6	1	0	6	0
Ring (J. C.)	3	2	0	0	6	2	0	0	3	5	4
Star City	6	2	2	0	8	2	2	1	0	6	0
Jackson Hill	10	2	0	0	6	2	2	1	2	6	0
Cole	11	1	2	0	4	3	4 ?	1	2	6	4
Farnsworth	32	2	0	0	6	2	0	1	2	5	10
Wilson	15	2	9	0	4	2	0	1	0	6	4
Buell	35	2	2	0	6	1	10	0	8	5	4
Pigg (J. C)	36 ?	2	0	0	6	2	6	0	0	5	2
Bush Creek	31	2	0 ?	0	8	2	0	0	0?	5	2
Zaayer & Allman	31	2	0	0	10	2	0	1	0	5	10

The bottom bench is usually bony and not often mined. The thin bench in the middle is variable, sometimes being as good as the rest, and in other cases very poor.

An analysis of this coal from Star City, by Mr. Noyes, gave as follows:

Fixed carbon	48.77	
Volatile combustible matter	38.53	
Total combustible matter		87.30
Ash	3.30	
Moisture	9.40	
Sulphur	1.23	
Total waste		13.93

This shows a coal of more than the average amount of combustible matter, a large amount of moisture, and much smaller amounts of ash and sulphur than is shown by most of the analyses of Coal VI.

Mr. Cox gives two analyses of this coal: A, from the Pigg bank, Sec. 36; B, from the Wilson mine, in Sec. 15:

	A.		*B.*	
Fixed carbon	49.00		52.00	
Volatile combustible matter	42.50		43.00	
Total combustible matter		91.50		95.00
Ash	2.50		2.00	
Moisture	6.00		3.00	
Total waste		8.50		5.00

This coal is apt to carry much sulphur, but usually in large nodules, which can be more or less easily separated. The roof is normally shale, which generally holds well except where the thickness of the shale is small. Many of the mines have practically no draw slate. In places the coal is much interrupted by rock rolls where the sandstone fills old channels. In the Buell mine these old channels seemed to be part of a drainage system flowing to the southwest, as the smaller channels run into the larger ones in that direction, and the larger ones perceptibly increased in size to the southwest.

The floor is usually the bottom bench of bone coal and, of course, serves well.

1379. Coal V.—This is a solid coal, overlain, as usual, with black sheety shale and limestone. Some of these sections are as follows:

Name.	Section.	Limestone. Ft.	In.	Black Shale. Ft.	In.	Coal V. Ft.	In.
Batters	11	..	..	..	..	5	0
Pfiffer	13	2	3+	1	6	5	3
Kelly	13	..	..	..	..	4	7
Lambright	13	3	0	1	6	5	2
Barnes	13	4	0+	2	8	5	6
Shanks	24	3	6	..	8	4	2

Such of this coal as was seen did not appear of excellent quality, as it seemed to tend to have thin, irregular shaly streaks all through it. Parts of the coal in places look very good.

The roof is everywhere black sheety shale, with iron and lime concretions, which may extend down into the coal, otherwise the roof is good. The floor is fire-clay as far as observed.

1380. Distribution.—Division VIII is found only along the western edge of the township, but extending east to the south of Mud creek into Secs. 33 and 34. Division VII is above the main drainage over practically the whole township. Division VI is below drainage in southwestern two-thirds of the township. Coal V is above drainage only in Secs. 1, 12, 13 and 24.

In Sec. 1 only Division V or below occurs. Coal V outcrops about at creek level. A well on the Batters place, in the S. W. corner of the section, found only 5 in. of coal at 110 ft., which should be low enough to be Coal V.

In Sec. 2, Coals VII and VI underlie the high hill in the S. W. corner. Coal VII outcrops in the road near the Shepard house, and VI is reported to outcrop down the branch a short distance below. Coal V underlies the rest of the section and is reported to outcrop in the N. W. ¼.

In Sec. 3, Coal VII occurs in the high ground in the S. E. corner. It is said to have been 5 ft. thick just south of Mr. Shepard's house where dug into. At the well at the house it is 18 ft. deep and 5 ft. thick. Coal VI underlies most of the south half of the section, where it has been mined at numerous places. It has been dug at several places on the Shepard place, in the S. W. of S. E. of section, partly by stripping and partly by drifting. It is well up the hill above the creek. On the Caynes place, in the N. E. of S. W., it has been stripped a little, the top bench measuring 2 ft. 4 in. It is reported in a well a little west of the center of the section. In the S. E. of the S. W. coal was noted in a spring just north of Dunnville; and just west were the old Ring slope and shaft, the coal here being 6 ft. thick, though with poor roof. See section above. This is said to have been much sought for by blacksmiths.

In Sec. 4, Coal VI is just about at drainage, running under to the west. The coal has been stripped at the Everhart place, in the S. E. of S. E., and also at several places on the Ford farm, in S. W. of N. E. On the Hughes farm it has been mined both by shaft and slope.

In Sec. 5, Coal VI has passed under drainage and Coal VII is but little above on the west side of the broad bottom of Busseron creek. At the west section line it has been reached by a shaft on the Andy Field place, where it is reported as 4 ft. 5 in. thick. In the creek bank there showed above the mouth of the shaft 8 ft. of shaly sandstone, overlying 6 ft. of shale.

In Sec. 6, Coal VI is extensively worked at the Star City mine of Messrs. Harter and Hafer. Coal VII is here 80 ft. deep and from 4 ft. to 4½ ft. thick, and Coal VI 125 ft. deep and from 4 ft. 6 in. to 6 ft. thick, not including the bottom bench of shaly coal 1 ft. thick. The top coal is the best here; roof, blue shale; floor, shale, as in section given above. The dip is to the southwest. A few horsebacks and other irregularities are found.

Sec. 7 is probably entirely underlain by both Coal VI and Coal VII. Sec. 8 is probably entirely underlain by Coal VI, which, in a well in S. W. of N. W., was reported to have been found at 100 ft., with a thickness of 5 ft. 9½ in. A 2-in. coal struck at 18 ft. in a well in the N. E. of N. W. is supposed to be Coal VIII. Coal VII is probably cut out across the broad bottom of Busseron creek.

Coal VI is probably below drainage in Sec. 9, unless it be in the N. E. ¼. It has been worked at the Wyman bank, which starts just above creek level, and at the old Patton bank, where it is said to be 28 or 30 ft. deep. Coal VII probably underlies the high land in the south part of the section.

In Sec. 10, Coal VI is extensively worked at the Jumbo or Jackson Hill mine. The coal here is about 20 or 25 ft. deep at the shaft and averages about 5 ft. 10 in. of workable coal in addition to the bony lower bench. There is here from 4 to 8 ft. of black, bituminous shale over the coal, then from 2 to 15 ft. of sandstone. The coal is not far below the branch level at the shaft. There is a good deal of sulphur and shale in the coal in poor shape to be gotten out, and rolls and horsebacks are also met with. Coal VII, 4 ft. thick, is reached at 36 ft. at the well at the schoolhouse, and, judging from the water, must be very free from sulphur. It was also noted in a spring just north of the Jackson Hill mine, and was reported as having formerly been worked by Mr. J. McGill south of Hartersville or Jackson Hill.

Coal VII underlies the western part of Sec. 11 and outcrops in the N. W. ¼. It is struck in a well in the S. W. of N. W. Coal VI underlies the western half or more of the section and is mined at Mr. Cole's mine. It is at the shaft 36 ft. deep and ranges from 6 ft. 2 in. to 6 ft. 10 in., with an average of 6 ft. 4 in. The bands average ½ in. thick here. The roof is shale, 1 ft. 3 in. to 5 ft., and comes down badly. Over that is 25 ft. of sandstone. Coal V is here 50 ft. below Coal VI and has over it hard limestone. Below Coal VI, at this mine, is 1 ft. of fire-clay, 6 ft. of sandstone, 18 ft. of "fine fire-clay," then sandstone. Coal VII here is 4 ft. 6 in. thick. Coal V outcrops in the branch bottom in the N. E. ¼ and has been stripped and drifted upon on the Batters place. It is 5 ft. thick.

In Sec. 12, Coal V is just above the creek level, as shown by the position of the limestone.

In Sec. 13 it occupies about the same position relative to drainage and is well exposed at a number of points. In the N. E. of N. E., on the Pfiffer (?) place, where it is several feet above the level of the creek. South of the center of the section it is at creek level and has been opened upon at several places on the John Kelly or old McBride place. The coal exposed measured 4 ft. 7 in., with pyrite bands, probably not persistent, at 11 in. and 2 ft. 8 in. from the top. Light-brown sandstone is exposed in the creek bed below the coal. Above the coal is 1 ft. 6 in. or more of black sheety shale, then 3 ft. 6 in. of limestone, the lower foot of which is much decomposed. In the S. E. part of the section the coal is well exposed at places on the Oriston Lambright place, formerly the Sexton place and Barnes place. The coal measured 5 ft. 2 in., but near the top appears to have a good many irregular bony or dirty streaks in it. The limestone, 3 ft. thick, is light gray and quite fossiliferous.

Sec. 14 contains a small area of Coal VII in the N. W. ¼, where it has been mined a little on the J. B. Gaskill place by Mr. Willy. It is reported as 5 ft. thick, with a 2-in. bony band, the lower part being the best. Coal VI was struck in a well in the N. W. of S. W. of section, and probably underlies about half of the section.

In Sec. 15, Coal VI is just below drainage, or for a short space in the N. E. ¼ is brought above the creek by an anticline. It is at present worked by Messrs. Wilson and Waters, the coal being about 25 ft. deep at their shaft and runs from 5 ft. to 5 ft. 6 in. of workable coal. It has been mined at numerous places north and south of this, on the old Wilson and Shepard places. Coal VII probably underlies most of the section, as well as Sec. 16. In Sec. 17, Coal VII is probably cut out by Busseron creek, but it doubtless underlies practically all of Secs. 18 and 19 at about creek level or below.

In Sec. 20, Coal VII is just above creek level and has been drifted upon on the McCameron place. Coal VI is said to have been reached here by a shaft.

Coal VII is believed to occupy the high ground of Secs. 21 and 22. Under most of the latter section Coal VI would be the first coal met. It has been struck on the low divide near the road at 35 ft., and at 16 ft. on the creek bottom south of this, both on the McGill place.

Coal VI doubtless underlies part of Sec. 23, but how much can not be told. A well in the S. E. of S. E. went 33 ft. through boulder clay or gravel into solid blue mud.

A well in the S. W. ¼ of Sec. 24 struck no rock at 27 ft. Coal V is about at creek level. It is well exposed in the N. W. ¼ at the Sturgen bank, and Shanks, formerly the Shivers, bank. The limestone here is quite fossiliferous. The coal measures 4 ft. 2 in. and at this point is 3 ft. above the creek, but passes below the level of the creek a short distance southeast. Coal looks only fair.

In the N. E. ¼ of Sec. 25 coal was struck at 25 ft. in a well and outcrops in head of branch. Thought to be Coal VI. A well in the N. W. corner of the area struck sandstone at about 30 ft.

Coal VII underlies the S. W. corner of Sec. 26. It was 3 ft. thick at a depth of 12 ft. in a well near the creek bottoms. A 147-ft. well in the S. W. corner of the section, on the J. B. Melain place, is reported to have gone into Coal V and its overlying limestone.

Coal VI probably underlies all of Sec. 27, and Coal VII the southern part of the section. It has been dug at several places on the Ellenbough or old Cochran place. It is reported to average 3 ft. 6 in. As far as seen the roof was light-gray shale. Both Coal VI and Coal VII underlie practically all of Sec. 28, and Coal VIII may be found a few inches thick in the highest ground.

The same is true of Sec. 29. Coal VII has been mined in the N. E. ¼, on the Samuel Ellis place, where it measures 2 ft. 10 in., overlain by 6 ft. of soft bluish-gray clay shale.

Coal VII is about at or below creek level in Sec. 30. In Sec. 31, Coals VII and VI underlie practically all of the section. At the Bush Creek mine, in the N. E. ¼, Coal VII is 4 ft. thick and 49 ft. deep, Coal VI 5 ft. or over thick and 84 ft. deep. The dip here is to the southwest. The top coal here is not as good as the bottom coal. The roof holds up or else comes down for some distance. Sandstone rolls are met with. But little work has been done in the lower seam.

In the N. W. ¼, Coal VI is reached at 80 ft. at the Zaayer and Allman shaft, being from 4 ft. 6 in. to 5 ft. in thickness, with an average of 4 ft. 10 in., not including the bottom bench of 1 ft. thickness.

The coal is quite uniform in quality, the top being a trifle the best. There are 2 or 3 in. of draw slate, then sandstone over the coal, with 4 ft. of limestone above. Coal VII was found at 40 ft., with a thickness of 3 to 4 ft., a coal of good quality. There is a slight dip to the west here.

Sec. 32 has about the same conditions, Coal VIII underlying the higher ground. Coal VI is extensively mined at the Bunker Hill or Farnsworth mine, where it is 72 ft. deep and yields 4 ft. 2 in. to 4 ft. 8 in. of workable coal, besides from 12 to 16 in. of poor coal below. The coal is a rich-looking coal, said to be a good steam coal. The dip is to the west. Coal VII is found at a depth of 37 ft. and is 3 ft. 4 in. thick; see section above. The top of Coal VI is here reported to be the best.

Coals VI and VII both underlie Secs. 33 and 34. Coal VIII is reported at a number of points in Sec. 33 from a few inches to a foot thick. Coal VII is worked on Mrs. Thompson's place by a gin shaft, formerly Robert Pigg's place; the coal is here about 20 ft. deep and 3 ft. 6 in. thick. The dip is east of north. This coal has been struck in a 10-ft. well on the Holly place, and at a few other places in this section.

In Sec. 35, Coal VII outcrops, underlying all of the W. ½ of the section and more. At the Buell shaft, Coal VII outcrops in the creek bed a few feet below the level of the top of the shaft. It is reported 4 ft. thick. Coal VI is found at 45 ft. in the shaft, but an anticline brings it up so as to just expose its top a short distance down the branch to the east. It is reported as 56 ft. below the level of the railway at Lyonton. In parts of the mine the dip to the southwest was as high as over 4 ft. per 100 ft. The top of Coal VII, as exposed in the creek bank, shows great irregularity. The sandstone rolls in this mine are of interest. In places they cut the coal entirely out, while 16 ft. away it is 8 or 10 ft. up to the sandstone from the top of the coal, and a little farther 16 ft. The largest of these channels was 12 ft. broad.

To the northeast the entries ran into an area where the coal ran out quite sharply, with every appearance of having been burned in that far from the outcrop. The clay had the appearance of having been highly heated, and in an entry driven beyond the end of the coal the bedding of the roof appeared to sag down as though allowed to settle by reason of the removal of the coal. Coal VII has been reached by a shaft by Mr. Gamble in the S. E. of S. W. of Sec. 35, where it is reported 60 ft. deep and 4 ft. thick. Coal VII outcrops on the McBride, formerly the Usery place, and Pope places, in this section.

In Sec. 36, Coal VII occupies a limited area, and Coal VI appears to be above drainage. The latter has been worked on Mrs. Mitchell's place, in the N. E. ¼, where it is reported as 5 ft. thick. It is overlain by brown shale. Mr. Collett located a bank in this section on Mr. Pigg's place, but no trace of it could be found.

1381. SUMMARY OF COALS.—

ROUND NUMBER ESTIMATES.

Divisions contained: VIII-I?
Coals contained: VIII, VII, VI, V, + (IV, etc.)

Coal VII.

Worked area......	50 acres. ×	av. thickness.	4 ft. ×	1,200 =	240,000 tons.
Workable area....	10 sq. mi. ×	"	4 ft. ×	500,000 —	20,000,000 tons.
Unworkable area.	5 sq. mi. ×	"	2 ft. ×	1,000,000 —	10,000,000 tons.
Total area	15 sq. m.				30,000,000 tons.

Coal VI.

Worked area......	400 acres. ×	av. thickness,	5 ft. ×	1,200 =	2,400,000 tons.
Workable area...	20 sq. mi. ×	"	5 ft. ×	500,000 =	50,000,000 tons.
Unworkable area.	5 sq. mi. ×	"	2 ft. ×	1,000,000 =	10,000,000 tons.
Total area	25 sq. mi.				62,4 0,000 tons.

Coal V.

Worked area......	10 acres. ×	av. thickness,	5 ft. ×	1,200 =	60,000 tons.
Workable area...	20 sq. mi. ×	"	5 ft. ×	500,000 =	50,000,000 tons.
Unworkable area.	15 sq. mi. ×	"	2 ft. ×	1,000,000 =	30,000,000 tons.
Total area	35 sq. mi.				80,060,000 tons.

Coals of Division IV.

Unworkable (?) area 36 sq. mi. × av. thickness, 3 ft. × 1,000,000 = 108,000,000 tons.

Coals of Divisions III–I.

Unworkable (?) area 36 sq. mi. × av. thickness, 5 ft. × 1,000,000 = 180,000,000 tons.

Number of coals contained: 4+.
Greatest thickness recorded: 7 ft. Coal VI at Star City and Jackson Hill.
Area underlain by coal: 36 sq. mi.
Area underlain by workable coal: 30-35 sq. mi.
Estimated total tonnage of coal: 460,000,000.
Estimated total tonnage of coal removed: 2,484,000.
Estimated total tonnage of workable coal left: 120,000,000.
Number of mines working ten men or over in operation: 3.
Number of mines working less than ten men in operation: 12.
Total number of mines in operation: 15.
Large mines abandoned, or not working: 2.
Strippings and outcrops, etc.: 67.
Total number of openings, etc., to coal: 84.

Townships 7 and 6 North, Range 8 West.

1382. Geography.—These townships lie on the eastern border of the county, south of the center and in the southeastern corner, and correspond to the south part of Cass, all of Jefferson and the east part of Haddon of the civic townships. The topography tends to be somewhat more rolling than in the preceding townships. No large streams cross the area. Buttermilk creek, in the north part, being the largest in T. 7 N., R. 8 W. Maria creek rises in the south part of this township and becomes of some size in T. 6 N., R. 8 N. The I. & I. S. R. R. crosses the northeastern corner of this area, and the Dugger branch of the I. & V. enters the area from the east.

1383. Stratigraphy and Coals.—Three coals are known to outcrop in this area, and two coals are known to underlie. These belong to the bottoms of Divisions VIII to IV. Coals VII, VI and V are workable.

Coal VIII usually runs less than 18 in. in thickness. No sections were obtained here showing its position relative to Coal VII, but from sections in the row of townships to the west it would appear to lie nearly 100 ft. above Coal VII, a limestone, frequently double, occurring often but a short distance below it.

In Sec. 9-6-8 this limestone is well exposed at several points. It shows double where the drainage leaves the section just above creek level. The upper bed is there about 15 in. thick, of a brownish or reddish color ("Red rock"), and separated by several feet of light soft shale or fire-clay from the lower bench, which is 3 or 4 ft. thick. (Compare section at Pioneer [Currysville] shaft, given beyond.) A drilling here starting just below the level of the limestone gave:

1384. Section 538. Section on Hume Place.—Sec. 9-6-8.

		Ft.
1.	Soil and clay	10
2.	"Hard rock," sandstone?	40
3.	COAL VII	1
4.	Fire-clay	?
5.	"Hard rock"	20

In the N. E. ¼ of this section a well at Mr. Booker's house is reported to have struck Coal VIII 5 or 6 in. thick at 20 ft. and to have just reached the limestone at 40 ft., making Coal VIII 20 ft. above the limestone. Another drilling here, near the creek, struck the limestone

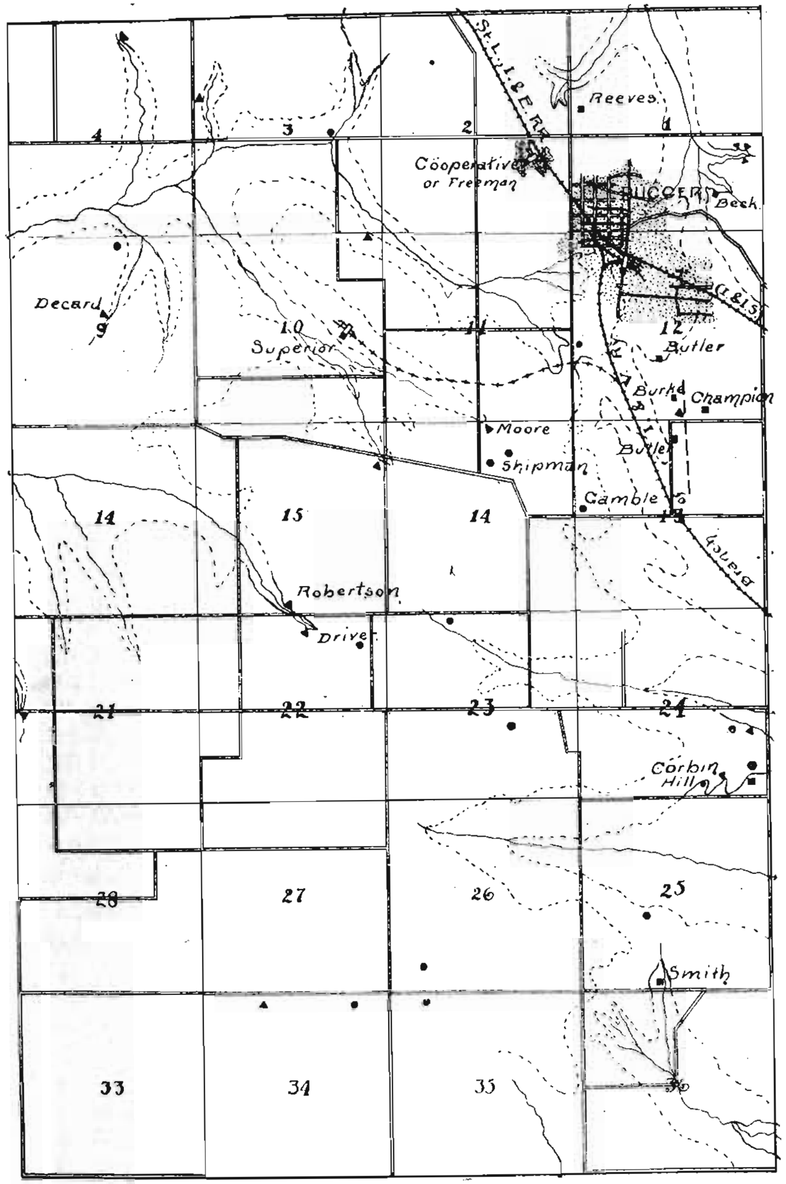
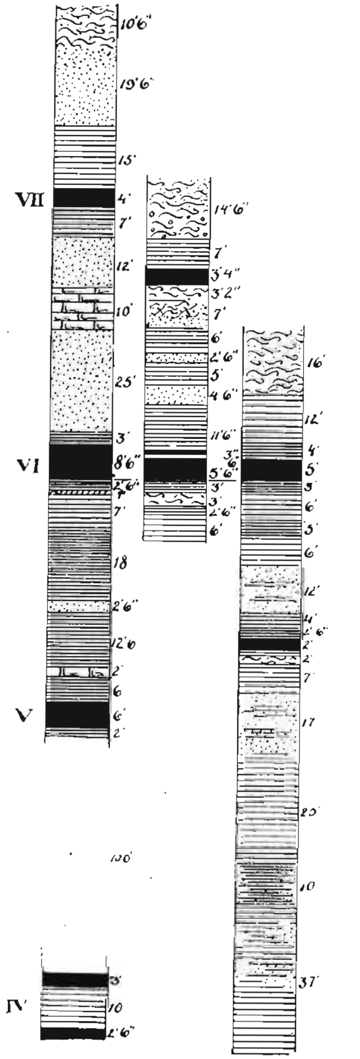


Plate XLIV. Sketch map of Part of T. 7 N., R. 8 W.

15 in. thick at a depth of 3 ft. (The limestone outcrops in the creek bed.) At 30 ft., 3 in. of very hard rock was passed through, and at 39 ft. black shale and coal, three-fourths of it being coal (Coal VII). Then comes 50 ft. of gray sandstone to Coal VI, 3 ft. thick.



583 Dugger. Sec. 12. — 584 Corbin Hill. Sec. 24. — 585 Swaby. Sec. 19-7-7.

Figs. 583-585. Columnar sections in T. 7 N., R. 8 W.

The following sections show the stratigraphy connecting Coals VII, VI and V.

1385. SECTION 539. SECTION OF DUGGER SHAFT AND DRILLING.—Sec. 12-7-8, Fig. 583.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Earth	10	6	..	..	10	6
2. Sandstone	19	6	..	..	30	0
3. Shale	5	0	..	..	35	0
4. Blue shale	10	0	..	..	45	0
5. COAL VII	4	0	4	0	49	0
6. Clay shale	7	0	..	..	56	0
7. Sandstone	12	0	..	..	68	0
8. Limestone	10	0	..	..	78	0
9. Hard sandstone	25	0	..	..	103	0
10. Shale	3	0	57	0	106	0
11. COAL VI	8	6	8	6	114	6
12. Black shale	2	6	..	..	117	0
13. Sulphur	1	0	..	..	118	0
14. Very light clay shale, very soft	7	0	..	..	125	0
15. Black shale, very soft	10	0	..	..	135	0
16. Black shale, very soft, occasionally "hard head"	8	0	..	..	143	0
17. Sandstone, very hard	2	6	..	..	145	6
18. Dark-blue shale	4	0	..	..	149	6
19. Gray shale	8	6	..	..	158	0
20. Very hard limestone	2	0	..	..	160	0
21. Black shale	6	0	51	6	166	0
22. COAL V	6	0	6	0	172	0
23. Black shale	2	0	..	..	174	0

The following drilling was made a little north of the Corbin Hill shaft and struck Coal VII, which outcrops just above the mouth of the shaft.

1386. SECTION 540. SECTION OF DRILLING AT CORBIN HILL.—Sec. 24-7-8, Fig. 584. (C. E. S.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Earth	9	6	..	..	9	6
2. Drift	5	0	..	..	14	6
3. Clay shale	7	0	..	..	21	6
4. COAL VII	3	4	3	4	24	10
5. Fire-clay	3	2	..	..	28	0
6. Drift	7	0	..	..	35	0
7. Clay shale	6	6	..	..	41	6
8. Sandstone	2	6	..	..	44	0
9. Clay shale	5	0	..	..	49	0
10. Hard stone and sand	4	6	..	..	53	6
11. Shale	11	6	40	2	65	0

		Ft.	In.	Ft.	In.	Ft.	In.
12.	COAL	0	3	0	3	65	3
13.	Sandstone	0	6	..	..	65	9
14.	COAL VI	5	9	5	9	71	6
15.	Black shale	3	0	..	..	75	0
16.	Fire-clay	3	0	..	..	78	0
17.	Black shale	2	6	..	..	80	6
18.	Clay shale	6	0	..	..	86	6

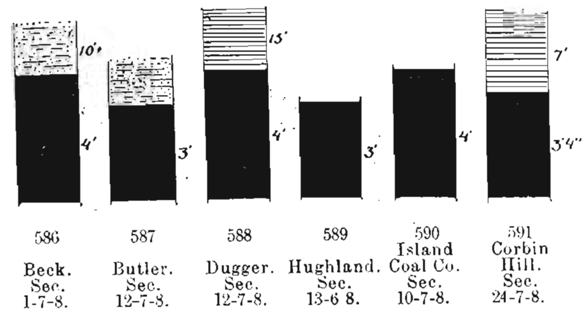
1387. SECTION 541. SECTION IN LOW GROUND SOUTH OF CORBIN HILL.—Sec. 25-7-8, Fig. 585.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Earth	16	0	..	..	16	0
2.	Clay shale	12	0	..	..	28	0
3.	Black shale	4	0	..	..	32	0
4.	COAL VI	5	0	5	0	37	0
5.	Black shale	3	0	..	..	40	0
6.	Clay shale	6	0	..	..	46	0
7.	Black shale	5	0	..	..	51	0
8.	Clay shale	6	0	..	..	57	0
9.	Conglomerate and clay shale	9	0	..	..	66	0
10.	Sand	5	0	..	..	71	0
11.	Black shale	0	6	..	..	71	6
12.	Sandstone	1	0	..	..	72	6
13.	Clay shale and sandstone	2	0	..	..	74	6
14.	White sandstone	0	6	..	..	75	0
15.	Sandstone, dark	3	0	..	..	78	0
16.	Clay shale, dark	3	0	..	..	81	0
17.	Clay shale, white	1	0	..	..	82	0
18.	Black shale	2	6	47	6	84	6
19.	COAL V	2	0	2	0	86	6
20.	Black shale	1	0	..	..	87	6
21.	Fire-clay	2	0	..	..	89	6
22.	Clay shale	3	0	..	..	92	6
23.	Gray shale	4	0	..	..	96	6
24.	Sandstone and clay shale	16	0	..	..	112	6
25.	Sandstone and gray shale	1	0	..	..	113	6
26.	Gray shale	25	0	..	..	138	6
27.	"Copperas stone"	10	0	..	..	148	6
28.	Shale and hard stone	37	0	..	..	185	6

These sections show considerable variation as far as they go. The limestone a short distance below Coal VII shows in the Dugger section, as well as the limestone over Coal V. Division VI, according to these, varies from 40 to 57 ft., Division V from 47 to 52 ft.

1388. COAL VIII.—In most places this coal is of so little importance that its thickness could not be learned. As far as determined, the following thickness will show about its range:

NAME.	Location.	Ft.	In.	NAME.	Location.	Ft.	In.
Jones	Sec. 10-6-8	1	0	Allsman	Sec. 20-7-8	1	0
Booker	Sec. 9-6-8	......	6	Robertson	Sec. 15-7-8	1	6
Dunbars	Sec. 4-6-8	1	6	Gamble	Sec. 13-7-8	2	2
John Cox	Sec. 4-6-8	1	3	Shipman	Sec. 14-7-8	1	6
......	Sec. 10-6-8	1	0	Shipman	Sec. 14-7-8	1	2
......	......	......	......	Chambers	Sec. 8-7-8	1	6



Figs. 586-591. Sections of Coal VII in Ts. 6 and 7 N., R. 8 W.

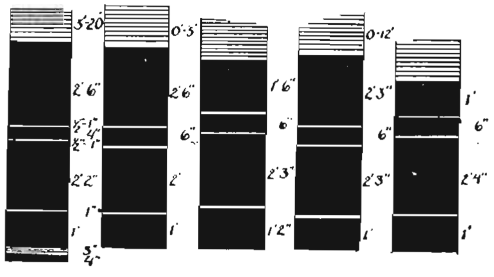
1389. COAL VII.—This coal was found to have been worked at but few points. The following table will show how it runs in thickness in this area:

NAME.	Location.	Ft.	In.	NAME.	Location.	Ft.	In.
Beck	Sec. 1-7-8	3-4	0	Bedwell	Sec. 1-6-8	3	6
Butler	Sec. 12-7-8	3	0	Hughland	Sec. 13-6-8	3	0
Dugger	Sec. 12-7-8	4	0	Sisson	Sec. 11-6-8	2-6	0
Co-operative	Sec. 2-7-8	3	0				
I. C. Co	Sec. 10-7-8	4	0				
Corbin Hill	Sec. 24-7-8	3	4				

It is probable that this coal will hardly average 3 ft. in thickness at all the places dug, and much less for the area as a whole. It is a solid coal, with usually a sandstone roof.

1390. COAL VI.—This coal shows about the same characteristics as in the preceding townships. There are everywhere the three partings dividing it into four benches, of which the lowest is bony and the middle of the worked benches thin. The following table will show how the benches run at different points:

NAME.	Location.	Upper.		Middle.		Lower.		Bottom.		Total.	
		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Dugger	Sec. 12-7-8	2	6	0	4	2	2	1	0	6	0+
Co-operative	Sec. 2-7-8	2	4	0	4	2	4	1	3	6	3
Champion	Sec. 12-7-8	2	6	0	4	2	2	1	0	6	0
Superior	Sec. 10-7-8	2	4	0	6	2	2	1	0	6	0+
Butler	Sec. 13-7-8	1	6	0	6	2	3	1	2	5	6
Corbin Hill	Sec. 24-7-8	2	3	0	6	2	3	1	0	6	0
Ward	Sec. 12-6-8	1	0	0	5	2	2	1	0	4	9+
Padgett	Sec. 13-6-8	1	0	0	6	2	4	1	0	5	0



592 Dugger. Sec. 12. 593 Superior. Sec. 10. 594 Butler. Sec. 13. 595 Corbin Hill. Sec. 24. 596 Padgett. Sec. 13-6-8.

Figs. 592-596. Sections of Coal VI in Ts. 6 and 7 N., R. 8 N.

At the following additional places the thickness was obtained, but not all the details:

NAME.	Location.	Ft.	In.	NAME.	Location.	Ft.	In.
Purcell	Sec. 1-6-8	6	10	Rose	Sec. 12-6-8	3	10+
Spencer	Sec. 1-6-8	6	6	Sage	Sec. 12-6-8	3	9+
Bedwell	Sec. 1-6-8	5	0	Wilson	Sec. 12-6-8	4	8
Gibbs ?	Sec. 11-6-8	3	0	Booker	Sec. 9-6-8	3	0

In several of the cases first given, definite figures for the upper and lower benches were not obtained, more than that they were of about equal thickness, or the upper an inch or two the thicker, or some similar statement. The parting ran from $\frac{1}{4}$ in. to 1 in. in thickness. The middle bench of the worked coal ranges between 4 and 6 in. A noticeable thinning of the upper bench occurs around Pleasantville.

In quality this coal is, as usual, a strong steam coal, with a tendency to carry a large amount of sulphur. In places this is principally in the form of nodules that are easily removed, but at times the sulphur strikes all through the coal. Coal sent from Pleasantville is said to have taken the first premium at the Louisville exposition some years ago, and the coal there is generally reported to be of superior quality.

The following analysis of this coal was made by Mr. Noyes for this report:

Fixed carbon	43.67	
Volatile combustible matter	37.61	
Total combustible matter		81.28
Ash	7.42	
Moisture	11.30	
Sulphur	3.13	
Total waste		21.85

Pounds of water evaporated per pound of coal, 12.0.

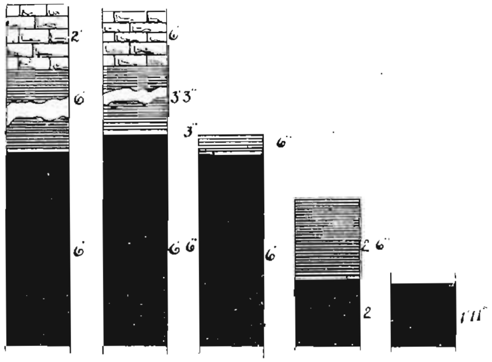
This analysis does not indicate as superior a grade of coal as it is generally claimed to be.

The roof of this coal here is generally shale and of considerable thickness. This holds fairly well for a while, but where entries remain open many years, as at Dugger, the shale will come down to a height of 15 or 20 ft.

The floor is apt to be a black shale, often with coal bands below. Thus at Dugger there is below the bottom bench of coal $\frac{1}{2}$ in. to 3 in. of shale, with a hard band in places, then 3 to 4 in. of good coal, then 3 to 4 ft. of black fire-clay, while 8 ft. below the coal was found 3 in. of black, cannel-like shale. At the Ward mine, at Pleasantville, there is below the bottom bench of coal 4 or 5 in. of bone coal, then 2 ft. or over of black shale, with white fire-clay below that. At the Padgett mine there is 2 ft. 6 in. of black shale below the coal, then 2 to 3 ft. of fire-clay, then gray shale.

1391. Coal V does not outcrop in this area, but is reached at a number of places by drilling and otherwise. It is usually overlain by its characteristic black shale and limestone. The following table will show its thickness at a few points:

NAME.	Location.	Limestone.		Black Shale.		Coal V.	
		Ft.	In.	Ft.	In.	Ft.	In.
Dugger	Sec. 12-7-8	2	0	6	0	6	0
Bedwell	Sec. 1-6-8	?	?	......	6	6	0
Corbin Hill	Sec. 24-7-8	......	......	2	6	2	0
Rose	Sec. 12-6-8	......	......	?	?	1	11
Swaby	Sec. 19-7-7	......	......	......	......	6	6



597 Dugger. Sec. 12-7-8. 598 Swaby. Sec. 19-7-7. 599 Bedwell. Sec. 1-6-8. 600 Corbin Hill. Sec. 24-7-8. 601 Rose. Sec. 12-6-8.

Figs. 597-601. Sections of Coal V in Ts. 6 and 7 N., R. 8 W.

These sections indicate that while Coal V tends to hold its thickness here, it can not be entirely depended upon, and suggest that it will be found to be unimportant under the western part of the area.

Coal IV was only reported as having been found at Dugger at a depth of 100 ft. below Coal V and to be split into two beds of 3 ft. and 2 ft. 6 in. thickness, separated by 10 ft. of shale, and so not workable. It seems hardly probable that workable beds would be found at still lower depths, though a 7-ft. coal is reported as found at Sullivan at a depth of over 500 ft.

1392. Distribution in T. 7 N., R. 8 W.—Coal VIII is found in the high divide extending southwest from Dugger. It usually is what

is called a surface bed, being struck in upland wells and outcropping in the heads of streams.

Coal VII underlies nearly the whole area and usually not far above drainage.

Coal VI underlies practically all of the area except as it is cut out along some of the stream bottoms in the southeastern corner of this region.

In Sec. 1, Coal VIII is probably found in the high ground just north of Dugger. Coal VII lies well above drainage, so that it is probably cut out across the watershed in the south part of the section. It has been mined a little on the Beck place and Dugger place, in the S. E. ¼. At the former is well shown the peculiar rock rolls so common in the roof of this seam. (See Fig. 602.)

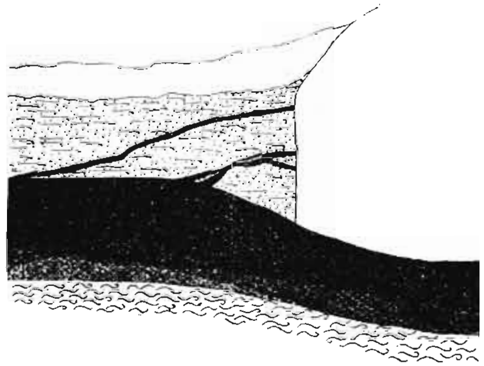


Fig. 602. Partial exposure of "rock roll" with overlying thin partings of coal. Very characteristic of Coal VII. From side of open cut at small drift mine on Beck property, Sec. 1-7-8.

This coal has also been dug on the Reeves place, in the S. W. of N. W. of Sec. 1, where the roof is a light-brown shaly sandstone. Coal VI underlies and is mined from the Dugger shaft. Coals VII and VI underlie practically all of Sec. 2. At the Dugger Co-operative Coal Company's shaft, Coal VII is 60 ft. deep and Coal VI 100 ft. deep. The bearing-in bench is 4 to 5 in. thick here, the good coal 5 ft. thick; roof, shale, 2 to 4 in. of which tends to come down. Floor is shale. Some rolls are met with.

In Sec. 3, Coal VII would appear to be cut out in the valley of Buttermilk creek, though it lies but little above the creek level.

In Sec. 10, much the same conditions prevail, Coal VII being cut out along the main stream. It is said to outcrop 4 ft. thick in the N.

E. corner of the section and N. W. ¼, and in the Superior shaft was only 3 in. thick, just the outcrop having been cut through. Coal VI was reached at about 60 ft., and where fully developed ran about as at Dugger. Much trouble was encountered in the entries driven in this mine on account of sandstone-filled channels. It is said that the entry driven north ran into a series of these running to the west, and trouble was also had in the east entry, though, when abandoned, both entries appeared to be getting into territory with more regular roof. Under these sandstone channels the coal was cut down to 2 or 3 ft. The equipment of the mine being destroyed by fire in 1893, the mine was temporarily abandoned. It is said the Island Coal Company, of Linton, who own the mine, holds about 1,000 acres adjacent to the mine. In Sec. 11 about the same conditions prevail as in Sec. 2.

In Sec. 12, Coal VII probably underlies but little more than the western half. It is found at a depth of 50 ft. in the Dugger shaft, while Coal VI is found at 92 ft. Coal VII, while given as 4 ft. thick, is said to be very variable. The bottom bench of Coal VI, as usual, is not mined, though in places it is a good coal. The top bench is the best coal here. A most interesting series of faults are found in the Dugger mine. Fig. 2 of Plate III was sketched from one of them. They are usually wide at the top and bottom and narrower in the center. There is usually more or less displacement of the coal, the strata on one side bending up and on the other down, but in opposite directions from the method in a simple monoclinal fault. In the case figured the folding was not marked, the coal returning to its original level in about 20 yds. In other cases the ends of the strata were very noticeably folded up or down. The material of the "roll," as the faults are locally called, varies. At one place it was sandstone ground up. More often it is crushed shale in the upper part and fire-clay in the lower part. Where examined at one point it consisted of clay, which, along the edge of the coal, enclosed a great many pieces of coal from the size of one's hand or larger, down. The most of these faults extend entirely across the mine, with no regular direction, crossing each other in all directions. The mine boss said he always found them just under the tops of the hills in the surface topography. They appear to extend more or less nearly to the surface, and when dug through, the filling material often comes down for some distance up. At one point in an entry three of these crossed each other almost in one point, as shown in the sketch (Fig. 603). At this point the roof had come down for 25 ft. or more, leaving a dome-shaped hole. In Fig. 6 of Plate III is shown a small clay vein, noticed about 10 ft.

from a large fault. It is said to run all through the mine, keeping parallel to the fault. To the northeast the entry rises for about 1,300 ft., then the dip is north, east and south. The northeast entry is 2,800 ft. long. The west and south entries make the trip to the southwest part of the mine over a mile long. About 200 out of 600 acres have been taken. About 100 ft. below Coal V there is reported 5 ft. 6 in. of coal, not including 10 ft. of shale, which starts 3 ft. from the top.

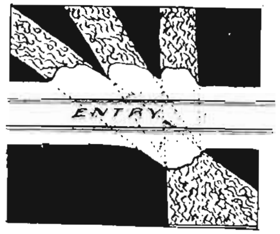


Fig. 603. Plan of part of entry in Dugger mine, showing the intersection of three faults. These faults are of the type shown in Fig. 2 of Plate III, and at this point the roof has come down to a height of 40 ft.

Coal VIII was noted 6 in. thick in a well in the N. W. of S. W. of Sec. 12. In the N. E. of the S. W. of Sec. 12, some coal has been dug on the Butler place from Coal VII, the coal being 3 ft. thick. Coal VI was formerly worked on a small scale on the Burke place, south of Butler's, and more extensively at the Champion slope. The coal here is much as at Dugger, yielding 5 ft. of workable coal. The coal outcrops just at creek level and proved to have too poor a roof.

In the N. W. of N. E. of Sec. 13, Coal VI is worked at the Butler mine. The coal is 17 ft. 6 in. deep and about 4 ft. 6 in. thick. The 6-in. bearing-in bench is 18 in. from the top and is shaly and poor, not being used. In the S. W. of N. W. of Sec. 13, Coal VIII is reported as 26 ft. deep and 18 in. thick on the Gamble place.

In Sec. 14 two wells on the Shipman place struck 14 and 18 in. at about 30 ft., while coal outcrops north of this on the Moore place.

In Secs. 15 and 22 Coal VIII is above drainage and was found or reported at the following places: Robertson place, S. E. of S. W. of Sec. 15, 18 in. thick, where it has been stripped for blacksmithing; S. E. of N. E. of Sec. 15; J. E. Driver's place, stripped in the N. W. of N. E. of Sec. 22, and in well at house, where it is 32 ft. deep; this is on the main divide.

In Sec. 23, Coal VIII is said to be 10 or 12 ft. deep in the N. W. ¼, and 22 ft. deep and 2 ft.+ thick, overlain by shale in the S. E. ¼.

In the N. ½ of the S. E. ¼ of Sec. 24, Coal VII was reached at 17 ft. in a well which went 2 ft. into it without going through. This brings Coal VII a score or so of feet above drainage here. In the S. E. of S. E. of Sec. 24 is the Corbin Hill shaft, where Coal VII outcrops just above the shaft, while Coal VI is found at 50 ft., with the thickness and section given above. This would carry Coal VI a score or so of feet below the bed of the creek to the south, while Coal VII is about as far above drainage. Coal VII outcrops west of Corbin Hill shaft; also is found at 14 ft. in a well in the N. E. of S. W. of Sec. 25. In the S. E. of S. W. of Sec. 25, Coal VI is worked at the Smith bank at about 50 ft. The coal is a shiny black, rich-looking coal, with a good deal of sulphur. In Secs. 26 to 36, Coal VIII is found or outcrops as follows: S. W. ¼, Sec. 26, a few inches at 18 ft.; S. W. ¼, Sec. 34; N. W. ¼, Sec. 35.

In the western half of T. 7 N., R. 8 W., Coal VII is probably not far above Buttermilk creek, and probably soon passes under to the west. It was reported to be found in a well in the N. W. of N. E. of Sec. 9 at 15 ft., and outcrops 2 to 4 ft. thick on the Decard place, near the center of the section.

Coal VIII has been dug some on the Chambers place, in the east part of Sec. 8, where it is 18 in. thick. Coal VIII is also reported at the following places: Dan Powers, S. E. ¼, Sec. 7; Bennett, N. W. ¼, Sec. 18, 10-12 in. thick; S. W. ¼, Sec. 18, in drilling; N. E. ¼, Sec. 19; S. E. ¼, Sec. 19, 1 ft. thick, on Allman place; several places in the N. E. ¼, Sec. 20, on J. H. Mason's place; N. E. ¼ of Sec. 20, on Robbins place; S. W. ¼, Sec. 21. This coal probably underlies all the high ground of this township, but usually at a very slight depth.

1393. Distribution in T. 6 N., R. 8 W.—In Sec. 1, Coal VI is worked at the Spencer shaft. The coal is about 35 ft. deep, overlain by hard gray shale. It is 6 ft. 6 in. thick, including the 1 ft. of bottom shaly coal. The coal is a shiny black, rich-looking coal, carrying a good deal of sulphur. Just east of there the well at Mr. Purcell's is said to have struck 6 ft. 10 in. at 25 ft. A drilling a little south of the well is said to have passed through a 3-ft. bed and a 3 ft. 6 in. bed, separated by 11 ft. of sandstone, but at what depth was not known.

Drillings on the Bedwell place, on the W. ½ of Sec. 1, are reported by Mr. Cox, the driller, to have found: 3 ft. 6 in. of coal at 18 ft. (Coal VII); 3 ft. 0 in. of coal at 45 ft. (Coal VI); 6 ft. 0 in. of coal at 96 ft. (Coal V), with very hard rock 6 in. above Coal V.

Coal VIII is reported as follows in Secs. 3 and 4: N. E. ¼ of Sec. 3, on Milburn place; S. E. of N. E. of Sec. 3, on McCameron place, in well; N. W. of N. W. of Sec. 3, on Davidson place, 1 ft. thick at 14 to

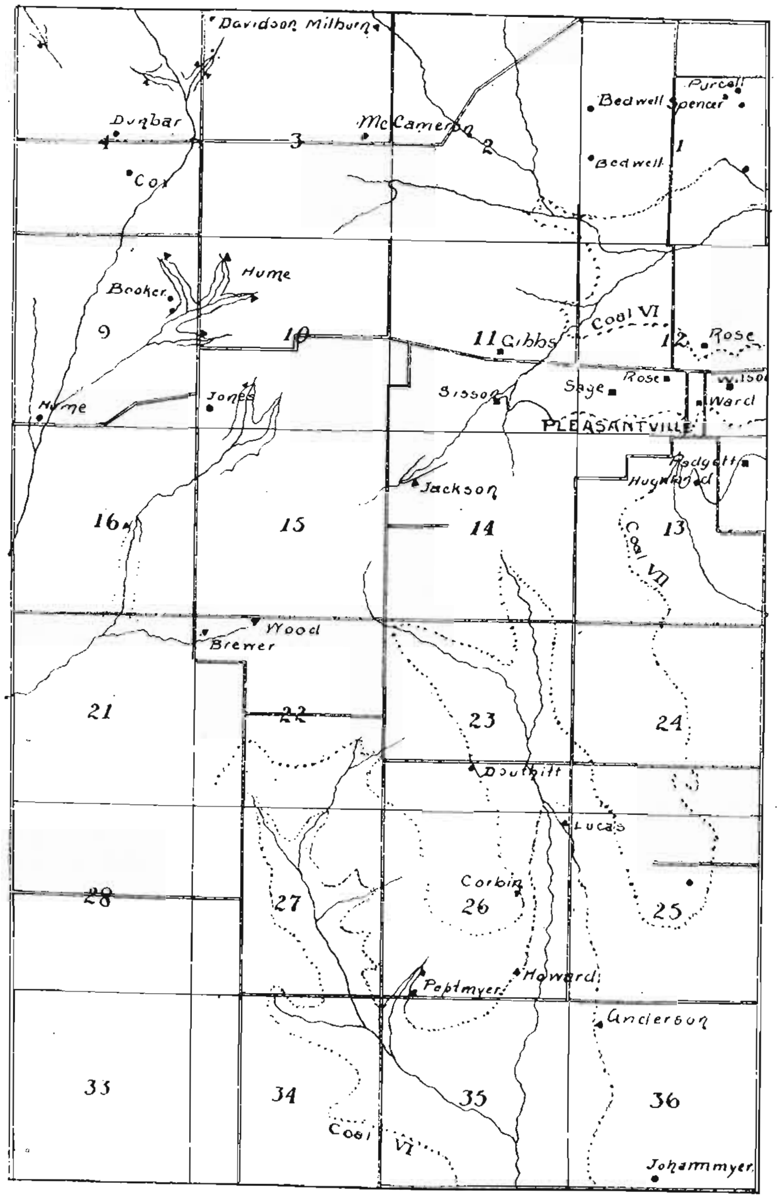


Plate XLV. Sketch map of part of T. 6 N., R. 8 W.

18 ft.; same quarter at bridge; across creek and road from last, in Sec. 4; N. W. of N. E. of Sec. 4; N. W. ¼ of Sec. 4; center of Sec. 4, on Dunbar place, 18 in. of coal at 18 ft.; N. W. of N. E. of section, on John Cox place, 18 in. of coal at 18 ft.; the coal here having a high northeastern dip, as it is said the bottom of the coal on one side was level with the top on the other side.

In Secs. 9 and 10, in addition to the outcrops and coals mentioned above, in ¶1383, Coal VIII outcrops in the N. E. of N. E. of Sec. 9; N. W. of N. W. of Sec. 10; S. E. of N. W. of Sec. 10, on Hume place, where it is 10-12 in. thick; N. W. of S. W. of Sec. 10, 5 or 6 in. thick; S. W. of S. W. of Sec. 10, on the Jones place, being 1 ft. thick, overlain by 16 ft. of sandstone and 14 ft. of surface, and underlain by 3 ft. of shale; in N. E. of S. W. of Sec. 10.

In the S. E. ¼ of Sec. 11, coal has been dug at the Gibbs place, being found at a depth of 30 ft., and reported 3 ft. thick, and soft. Also on the Sisson place, where the coal is said to lay in rolls, with a thickness of from 2 to 6 ft.

In the S. W. ¼ of Sec. 12 is the Sage bank, operated by Hugh Rose. The coal is 30 ft. deep and 3 ft. 9 in. thick. Much trouble is experienced here with "horsebacks." East of this, in the same quarter section, is the Rose bank, where the coal is 20 ft. deep, 3 ft. 10 in. thick, and underlain by 7 ft. of shale. North of town a shaft was put down by Mr. Rose, presumably to Coal V, which here only contained 23 in. of good coal, overlain by 20 ft. of shale. The coal was struck at a depth of 32 ft. No limestone or black shale was seen here. At the old Wilson bank, east of town, the coal is reported as 4 ft. 8 in. thick, the lower 10 in. not being workable, coal 20 ft. deep. At the Ward bank, in town, formerly the Smith bank, the coal is 39 ft. deep and 4 ft. 9 in. thick in benches as given above, the bottom bench being poor and not mined. The floor was mentioned above. The roof consists of 30 ft. of shale. Coal VII underlies the high ridge in the south part of Pleasantville. It has been mined some at the Hughland bank, in the W. ½ of the N. E. ¼ of Sec. 13, where it is 3 ft. thick and has a sandstone roof. In the N. E. of N. E. of Sec. 13, Coal VI has been mined on Dr. Padgett's land. The coal is 40 ft. deep—of which depth but 4 or 5 ft. is shale—and is 5 ft. thick, including the shaly coal at the bottom, 1 ft. thick. The details of benches were given above. The floor is black shale, 2 ft. 6 in. thick. It is claimed the coal around Pleasantville is better than the average run of Coal VI.

The limestone supposed to come near the top of Division VII was noted in the S. E. of the N. E. of Sec. 15, near the top of the ridge. A short distance down the branch, in the N. W. ¼ of Sec. 14, a 4-in. bed of coal is reported on the Jackson place. The elevation of this limestone suggests the possibility of it coming in Division VIII. A coal 2 ft. or more thick is reported to outcrop in the bottom of the branch, near the center of Sec. 16. Coal was reported to outcrop in the N. E. ¼ of Sec. 18, on the Reynold place, and to have been struck in a well in the S. E. ¼ of Sec. 19, on the Lambeth, Smith and Deithan places.

Coal was reported to outcrop on the Brewer and Wood places, in the N. W. ¼ of Sec. 22. In Secs. 23 to 36 coal has been found or worked as follows (locations uncertain in most cases): Isaac Douthitt, S. W. ¼ of Sec. 23; Lucas, N. E. ¼ Sec. 26; Ed. Collins, formerly Howard, S. E. ¼ of Sec. 26; Peptmyer, said to be about 4 ft. thick, but poor; at exposure in road near this bank there shows 2 ft. of brown sandstone, 5 ft. of gray shale, 2 ft. 6 in.+ of coal; Anderson, formerly Smith, in N. W. ¼ of Sec. 36; Simon Johannmyer, S. E. of S. W. of Sec. 36, coal at 20 ft. in well.

1394. SUMMARY OF COALS.—

ROUND NUMBER ESTIMATES.

Divisions contained: VIII-IV+.
Coals contained: VIII, VII, VI, V, IV+.

Coal VII.

Worked area.....	5 acres. ×	av. thickness,	4 ft. ×	1,200 =	24,000 tons.
Workable area...	30 sq. mi. ×	"	3 ft. ×	500,000 =	45,000,000 tons.
Unworkable area.	30 sq. mi. ×	"	1½ ft. ×	1,000,000 =	45,000,000 tons.
Total area....	60 sq. mi				90,240,000 tons.

Coal VI.

Worked area.....	300 acres. ×	av. thickness,	5 ft. ×	1.200 =	1,800,000 tons.
Workable area...	40 sq. mi. ×	"	4 ft. ×	500,000 =	80,000,000 tons.
Unworkable area.	20 sq. mi. ×	"	2 ft. ×	1,000,000 =	20,000,000 tons.
Total area....	60 sq. mi				101,800,000 tons.

Coal V.

Worked area.....	½? acres. ×	av. thickness,	2 ft. ×	1,200 =	1,200 tons.
Workable area...	30 sq. mi. ×	"	5 ft. ×	500,000 =	75,000 000 tons.
Unworkable area.	40 sq. mi. ×	"	1 ft. ×	1,000,000 =	40,000,000 tons.
Total area....	70 sq. mi				115,001,200 tons.

Coals of Division IV.

Unworkable area. 70 sq. mi. × av. thickness, 3 ft. × 1,000,000 = 210,000,000 tons.

Coals of Divisions III-I.

Unworkable area. 70 sq. mi. × av. thickness, 3 ft. × 1,000,000 = 210,000,000 tons.

Number of coals contained: 5+.
Greatest thickness recorded: 8 ft. 6 in.? Coal VI at Dugger.
Area underlain by coal: 70-72 sq. mi.
Area underlain by workable coal: 50-60 sq. mi.
Estimated total tonnage of coal: 726,000,000.
Estimated total tonnage of coal removed: 2,000,000.
Estimated total tonnage of workable coal left: 200,000,000.
Number of mines working ten men or over in operation: 2.
Number of mines working less than ten men in operation: 13.
Total number of mines in operation: 15.
Large mines not in work: 3.
Strippings, outcrops, etc.: 80.
Total number of openings, etc., to coal: 98.

Townships 6, 7, 8, 9, North of Range 9 West.

1395. Geography.—These townships occupy the center of the county from north to south. Of the civic townships, they correspond to Curry, most of Hamilton and Haddon, and part of Gill.

The topography follows the type for this county; flat divides, and broad-bottomed streams, flanked by steep bluffs.

The Evansville & Terre Haute railroad runs the whole length of this row of townships, and they likewise contain the principal towns of the county. The St. Louis, Indianapolis & Eastern railroad (Illinois & Indiana Southern) crosses the center of the row from east to west.

1396. Stratigraphy.—The following sections will show the stratigraphy of these townships and serve as a basis for much of the county:

1397. Section 542. Section at Berlin Shaft.—Sec. 1-9-9, Plate XLVI. (L. L., p. 339.)

	Ft.	In.	Ft.	In.
1. Drift and soil	10	0	10	0
2. Soft, micaceous shales	8	0	18	0
3. Sandstone (hard and compact)	23	0	41	0
4. Soft stone	3	0	44	0
5. Shale, with plants	3	0	47	0
6. COAL VII	3	6	50	6
7. Space mostly sandstone	40	0	90	6
8. COAL VI	5	4	95	10

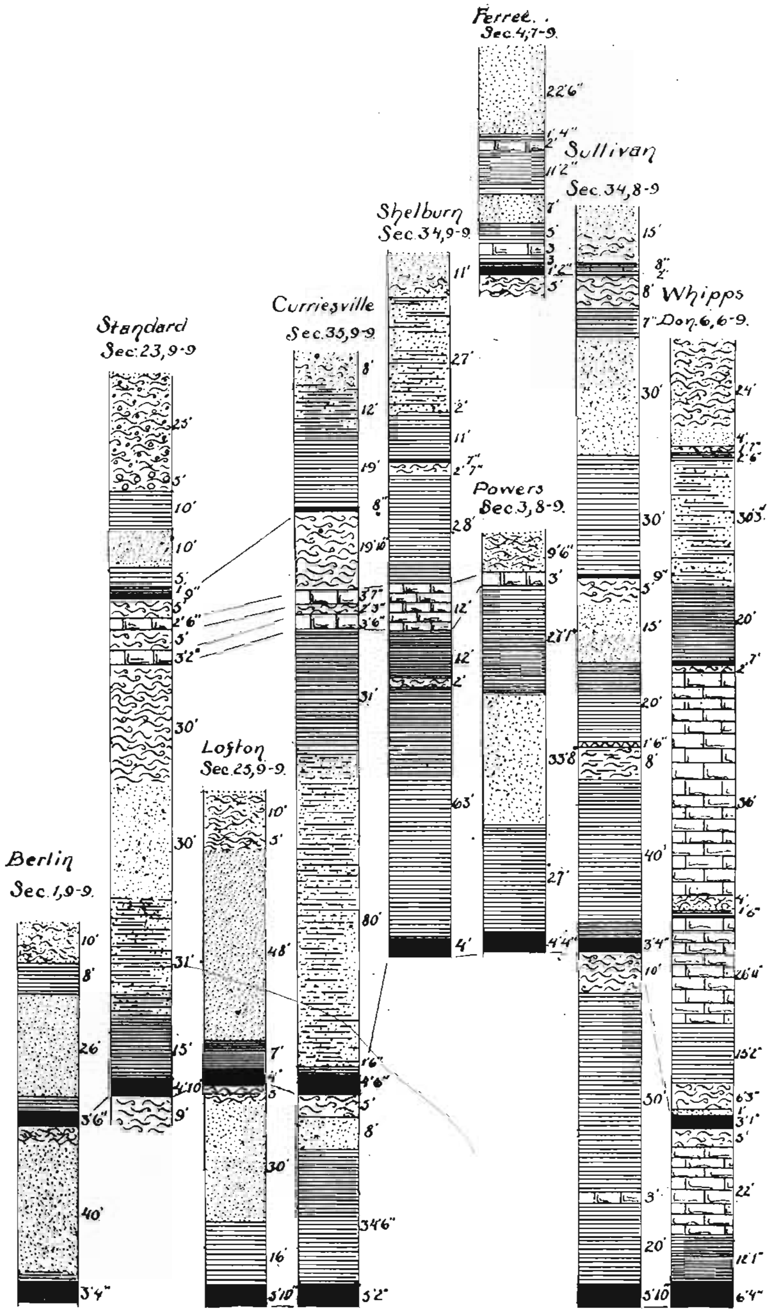


Plate XLVI. Columnar sections in Ts. 6-9 N., R. 9 W.

1398. SECTION 543. SECTION OF STANDARD SHAFT.—S. W. ¼, Sec. 23, Plate XLVI. (J. C., p. 216.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and glacial drift	25	0	..	..	25	0
2.	Clay, with iron balls	5	0	..	..	30	0
3.	Clay shale, thin, bituminous partings	10	0	..	..	40	0
4.	Compact sandstone	10	0	..	..	50	0
5.	Banded clay shale, carbonaceous remains	5	0	..	..	55	0
6.	Black, calcareous "clod," with fossils	0	9	..	..	55	9
7.	Black shale	0	3	..	..	56	0
8.	COAL VIII	0	9	0	9	56	9
9.	Fire-clay	5	0	..	..	61	9
10.	Hard limestone	2	6	..	..	64	3
11.	Clay	5	0	..	..	69	3
12.	Mottled limestone	3	2	..	..	72	5
13.	Green clay	7	0	..	..	79	5
14.	Red clay	6	0	..	..	85	5
15.	Green and red clay mixed	9	0	..	..	94	5
16.	Slickened clay	8	0	..	..	102	5
17.	Soft sandstone, carbonaceous partings	30	0	..	..	132	5
18.	Compact siliceous white clay shale	6	0	..	..	138	5
19.	Sandy clay shale, plant remains, with coal 1 to 2 in. thick	25	0	..	..	163	5
20.	Hard clay shale	13	4	..	..	176	9
21.	Fern bed, gray clay shale	1	8	121	6	178	5
22.	COAL VII—Good coal, 1 ft. 1 in.; choice coal, 1 ft. 8 in.; fair coal, 2 ft. 1 in.	4	10	4	10	183	3
23.	Fire-clay	9	0	..	..	192	3

1399. SECTION 544. SECTION OF PIONEER SHAFT AND BORE.—N. W. ¼ of Sec. 35, Plate XLVI. (J. C., p. 212.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil	2	0	..	..	2	0
2.	Boulder clay	6	6	..	..	8	6
3.	Siliceous shale, pyritous partings	12	0	..	..	20	6
4.	Clay shale, slickened	19	0	..	..	39	6
5.	COAL VIII	0	8	0	8	40	2
6.	Dark, bituminous clay, slickened	1	4	..	..	41	6
7.	Fire-clay, plastic	10	0	..	..	51	6
8.	Fire-clay, sandy	8	6	..	..	60	0
9.	Brown limestone, compact	3	7	..	..	63	7
10.	Green clay	2	3	..	..	65	10

		Ft.	In.	Ft.	In.	Ft.	In.
11.	Blue limestone	3	6	..	..	69	4
12.	Blue clay shale, pyritous	16	0	..	..	85	4
13.	Argillaceous shale, with plants	15	0	..	..	100	4
14.	Siliceous clay shale, with thin layers of small ironstone concretions 2 to 3 ft. apart, with some parts compact, argillaceous sand rock	80	0	..	..	180	4
15.	Light-colored clay shale	1	6	141	8	181	10
16.	COAL VII—Choice coal, 1 ft. 0 in.; smut trace, —; good coal, 1 ft. 6 in.; smut trace, —; laminated coal, 2 ft. 0 in.	4	6	4	6	186	4
17.	Fire-clay	5	0	..	..	191	4
	(Bottom of shaft, bore.)						
18.	White sandstone	8	0	..	..	199	4
19.	Clay shale, bands of iron ore	34	6	47	6	233	10
20.	COAL VI	5	2	5	2	239	0
21.	Fire-clay at bottom	0	0	..	..	239	0

The shaft is now extended to Coal VI.

It is said that 36 ft. below Coal VI, Coal V was found 8 in. thick, overlain by 2 ft. of shale, and that by 2 ft. of cannel or bone coal or black shale, with a few inches of shelly limestone just above.

1400. SECTION 545. SECTION AT SHELBURN SHAFT.—S. E. ¼, Sec. 34, Plate XLVI. (J. C., p. 214.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil	3	0	..	..	3	0
2.	Yellow boulder clay	8	0	..	..	11	0
3.	Shelly sandstone and clay shale, with bituminous partings	27	0	..	..	38	0
4.	Hard quarry sandstone	2	0	..	..	40	0
5.	"Water vein, 16 brls. per hour."						
6.	Clay shale, with plant remains	11	0	..	..	51	0
7.	Black clod, crinoid stems and arms of many species very abundant	0	7	..	..	51	7
8.	COAL VIII	0	7	0	7	52	2
9.	Hard siliceous fire-clay	2	0	..	..	54	2
10.	Clay shale, bituminous partings	28	0	..	..	82	2
11.	Fossiliferous limestone	2	0	..	..	84	2
12.	Argillaceous limestone, "marble"	10	0	..	..	94	2
13.	Dark, argillaceous shales	12	0	..	..	106	2
14.	Choice fire-clay	2	0	..	..	108	2
15.	Clay shale	12	0	..	..	120	2
16.	Compact, siliceous clay shale	35	0	..	..	155	2
17.	Blue clay shale	10	0	..	..	165	2

	Ft.	In.	Ft.	In.	Ft.	In.
18. Light clay shale	6	0	119	0	171	2
19. COAL VII, 3½ ft. to 6 ft. average	4	0	4	0	175	2
20. Since then the shaft has been sunk to	..	..	..	..	250	0
21. COAL VI, at 250 ft. up to 7 ft. 6 in.	7	0	..	..	257	0
22. Fire-clay	2	0	..	..	259	0

1401. SECTION 546. SECTION OF SHELBURN WELL.—S. E. ¼, Sec. 35. (J. C., p. 215.)

	Ft.	In.
1. Shaft in drift	14	0
2. Dark clay shale	24	5
3. Gray clay shale	12	6
4. Brown	3	9
5. Hard rock (ironstone)	1	8
6. Clay shale	3	9
7. Hard rock—iron nodules	0	10
8. Sandstone or shale	4	5
9. Clay shale	6	6
10. COAL VII	4	6
11. Fire-clay	0	0

This started just below the double limestone of Division VII, which was observed cropping out in the adjoining bluff to the south.

1402. SECTION 547. SECTION OF LOFTON SHAFT.—Sec. 25, Plate XLVI.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil	10	0	..	..	10	0
2. Yellow clay	5	0	..	..	15	0
3. Sandstone	48	0	..	..	63	0
4. Black shale	7	0	..	..	70	0
5. COAL VII	4	0	4	0	74	0
6. Fire-clay	5	0	..	..	79	0
7. Sandstone	30	0	..	..	109	0
8. Shale	16	0	51	0	125	0
9. COAL VI	5	10	5	10	130	10

1403. SECTION 548. SECTION IN BORING ON POWER'S FARM.—S. E. ¼, Sec. 3-8-9, Plate XLVI. (J. C., p. 195.) Starts a few feet below Coal VIII.

	Ft.	In.
1. Shaft in drift	9	6
2. Double limestone	3	1
3. Clay shale, bituminous partings	7	10
4. Gray shale	19	3
5. Sandstone (argillaceous?)	33	8

	Ft.	In.
6. Clay shale	5	6
7. Dark clay shale	3	0
8. Clay shale	18	6
9. COAL VII	4	4
10. Fire-clay	0	0

1404. SECTION 549. SECTION OF SULLIVAN OIL WELL.—Sec. 34-8-9, Plate XLVI, as prepared from memory for Mr. Collett by Mr. Beardslee, who superintended the drilling. (J. C., p. 193.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil	5	0	..	..	5	0
2. Gray clay, with thin partings of white sand and pebbles	8	0	..	..	13	0
3. Glacial "hard pan" or boulder clay	2	0	..	..	15	0
4. Limestone	0	3	..	..	15	3
5. Black shale	0	8	..	..	15	11
6. COAL VIIIa	0	2	0	2	16	1
7. Gray, siliceous fire-clay	8	0	..	..	24	1
8. Clay shale, iron nodules	7	0	..	..	31	1
9. Brown sand rock	20	0	..	..	51	1
10. Gray sand rock, sharp	10	0	..	..	61	1
11. Clay shale	10	0	..	..	71	1
12. Clay shale	20	0	..	..	91	1
13. COAL VIII and shale	0	9	0	9	91	10
14. Clay	5	0	..	..	96	10
15. Sand rock	15	0	..	..	111	10
16. Clay shale	20	0	..	..	131	10
17. Flint (?), iron ore	1	6	..	..	133	4
18. Shaly clay	8	0	..	..	141	4
19. Clay shale	40	0	90	0	181	4
20. COAL VII and shale (average 3 ft. 4 in. mine)	1	6	1	6	182	10
21. Clay	10	0	..	..	192	10
22. Clay shale	50	0	..	..	242	10
23. Double limestone, flinty	3	0	..	..	245	10
24. Clay shale	20	0	83	0	265	10
25. COAL VI and shale	4	0	4	0	269	10
26. Clay	10	0	..	..	279	10
27. Clay shale	30	0	..	..	309	10
28. Sandstone	20	0	..	..	329	10
29. Shale	10	0	..	..	339	10
30. Clay shale	30	0	..	..	369	10
31. White sandstone	8	0	..	..	377	10
32. Clay	8	0	..	..	385	10
33. Clay shale	35	0	..	..	420	10
34. Sandstone	30	0	..	..	450	10
35. Clay	10	0	..	..	460	10

	Ft.	In.	Ft.	In.	Ft.	In.
36. Clay shale	50	0	..	..	510	10
37. Hard rock	10	0	..	..	520	10
38. Clay shale	20	0	..	..	540	10
39. Shale	1	6	272	6	542	4
40. COAL (?)	7	0	7	0	549	4

The coal at the bottom of this boring is claimed by some of the reliable citizens of Sullivan to have been from 20 to 26 ft. thick. However, until that is confirmed, we will let the record stand as originally written.

1405. SECTION 549A. SECTION OF SULLIVAN COAL SHAFT.—Given from memory by Mr. Joseph Hanford, who sunk it.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil and clay	20	0	..	..	20	0
2. Sandstone, gray and brown	20	0	..	..	40	0
3. "Blossom of Coal" VIII	0	0	0	0	40	0
4. Clay shale	30	0	..	..	70	0
5. Limestone	2	0	..	..	72	0
6. Clay	4	0	..	..	76	0
7. Limestone, mottled	4	0	..	..	80	0
8. Clay	10	0	..	..	90	0
9. Clay shale	20	0	..	..	110	0
10. Blue shaly sandstone	40	0	..	..	150	0
11. Clay shale and roof shale	50	0	160	0	200	0
12. COAL VII	3	6	3	6	203	6
13. Fire-clay	10	0	..	..	113	6
14. Sandstone and shale	37	0	47	0	250	6
15. COAL VI	5	0	5	0	255	6

Under the circumstances the record can only be considered as an approximation. Shortly before the writer's visit, the Winterbottom shaft of the Sullivan Coal Company had been extended from Coal VII to Coal VI. The strata between the two coals showed as follows:

1406. SECTION 550. SECTION OF PART OF SULLIVAN COAL COMPANY'S SHAFT.—S. E. ¼ of Sec. 36-8-8.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Coal VII, at 38 ft.	3	0	3	0	41	0
2. Fire-clay, soft and white	6	0	..	..	47	0
3. Sandstone	24	0	..	..	71	0
4. Shale	10	0	40	0	81	0
5. Coal VI .5 ft. to	5	4	5	4	86	4
6. Bone coal and shale	2	0	..	..	88	4
7. "Hard rock"	..	8	..	..	98	0
8. Shale.						

1407. SECTION 551. SECTION AT FERREE'S QUARRY AND UP BUCK CREEK.—Sec. 4-7-9, Plate XLVI. (J. C., p. 195.)

	Ft.	In.
1. Hard, flaggy sandstone, with shelly layers interchanging	20	0
2. Compact flagstone	0	10
3. Ferruginous sandstone	1	8
4. Shaly clay shale	1	4
5. Good "pepper mix" limestone	2	0
6. Clay shale, dark, pyritiferous partings	9	6
7. Siliceous flags	0	10
8. Clay shale	0	10
9. Irregular sandstone (Continued on Boon's land.)	4	0
10. Flaggy sandstone	3	0
11. Clay shale, iron nodules	5	0
12. Shelly limestone	3	0
13. Calcareous shale .4 ft. to	2	0
14. Black shale .1 ft. to	0	0
15. COAL VIIIa	1	2
16. Fire-clay to creek	5	2

1408. SECTION 552. SECTION OF WELL ON WHIPPS PLACE.—Donation 6-6-9, from report by J. C. on Knox county, p. 330. See Plate XLVI. Bored by Mr. W. Adams.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	24	0	..	..	24	0
2. Red sandstone	4	0	..	..	28	0
3. Fire-clay	1	7	..	..	29	7
4. Sandy shale	2	6	..	..	32	1
5. Clay shale and flaggy sandstone	30	3	..	..	62	4
6. Gray shale	8	0	..	..	70	4
7. COAL VIII	0	7	0	7	70	11
8. Fire-clay	2	0	..	..	72	11
9. White limestone	20	0	..	..	92	11
10. Soft gray limestone	36	3	..	..	129	2
11. Fire-clay	4	0	..	..	133	2
12. Sandstone	1	0	..	..	134	2
13. Black shale	0	6	..	..	134	8
14. Hard gray limestone	26	11	..	..	161	7
15. Gray shale	15	2	..	..	176	9
16. Fire-clay	6	3	..	..	183	0
17. Sandstone	1	0	113	1	184	0
18. COAL VII	3	1	3	1	187	1
19. Fire-clay	5	0	..	..	192	1
20. Limestone	5	0	..	..	197	1
21. Parting.						
22. Limestone	5	0	..	..	202	1
23. Parting.						

		Ft.	In.	Ft.	In.	Ft.	In.
24.	Limestone	4	0	..	..	206	1
25.	Parting.						
26.	Limestone	8	..	..	..	214	1
27.	Gray clay shale	12	1	39	1	226	2
28.	COAL VI	6	4	6	4	232	6
29.	Fire-clay	5	0	..	..	237	6
30.	Gray, flinty limestone, very hard.	5	0	..	..	242	6

The very unusual quantity of limestone in this record suggests what a comparative study of other drillings by Mr. Adams renders almost certain, that an error has been made in the determination of some of the material brought up, especially the limestone. This view is strengthened by the absence of limestones in the shaft at Carlisle.

1409. SECTION 553. SECTION (PARTIAL) OF CARLISLE SHAFT.—Don. 29-6-9.

		Ft.	In.
1.	Surface.		
2.	Clay shale? sandstone?	32	0
3.	COAL VIII (?), at 50 ft. 1 ft. to	1	2
4.	Sandstone, etc.	150	0
5.	COAL VII, at 200 ft.	3	0
6.	Fire-clay	8	0
7.	Limestone 3 ft. to	7	0?
8.	"Dirt," fire-clay, etc. (?)	14	0
9.	Sandstone about	10	0?
10.	Gray shale 8 in. to	3	0
11.	COAL VI, at 245 ft.	5	4
12.	Black shale, with layers of coal 1 in. and less. 3 ft. to	4	0
13.	Hard sandstone.		

1409A. SECTION 553A. SECTION AT VAN FOSSEN'S MILL.—Sec. 9-6-9. (J. C., p. 208.)

		Ft.	In.
1.	Drab, siliceous shale 5 ft. to	8	0
2.	Shelly limestone, crinoid stems	0	10
3.	Blue and drab clay marl	1	2
4.	Black, bituminous clay marl, with fossils	1	4
5.	Black sheety shale	0	5
6.	Black shale	1	4
7.	Dark, bituminous clay shale	1	2
8.	Black shale	1	0
9.	COAL VIIIa, flat, pyritous	1	2
10.	Fire-clay	5	10
11.	Clay shale, with iron nodules at creek	..	..

On the whole, these sections show quite a persistence of the strata and considerable uniformity of the coals.

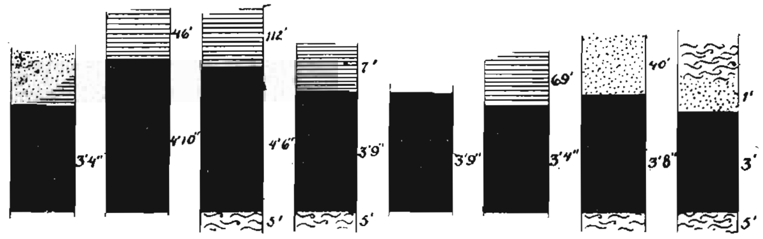
1400x. DIVISION VIII shows two coals, neither of which is of workable thickness in this area. The upper coal is very thin and occurs close to the surface where found. It is 1 ft. 2 to 8 in. thick on the Boon land and Kelly land, in Sec. 5-7-9, but generally is only a few inches thick. It is characteristically overlain by black sheety shale and limestone, as was found in southwestern Vigo county, near Middletown, and up Prairie creek. Around Sullivan it would appear that Coal VIIIa is the highest coal, as the Merom sandstone is quarried but a short distance above it. At Sullivan it is 75 ft. from Coal VIIIa to Coal VIII, the space being about equally divided between sandstone and shale. Coal VIII seems to always run under 1 ft. in thickness in this area, sometimes being overlaid by shale and in other places by a black shale and a black, calcareous "clod" (possibly a decomposed limestone), which is full of fossils.

1401x. DIVISION VII has one coal, workable, though but little worked at present. For ready comparison, we may make a table of the coal, showing its thickness, roof and floor.

NAME.	Location.	Sandstone.		Shale.		Coal VII.	Average.		Fire-clay.	
		Ft.	In.	Ft.	In.	Ft. In. Ft. In.	Ft.	In.	Ft.	In.
Farmersburg	Sec. 2-9-9	....	....	?	?	2 0 to 4 0	3	4	?	?
Berlin	Sec. 1-9-9	?	?	0	0	0 0 to 4 0	3	0+	....	....
Standard	Sec. 23-9-9	30	0	46	0	....	4	10	....	....
Shelburn shaft	Sec. 34-9-9	0	0	77	0	6 0 to 3 6	4	0	....	....
Shelburn well	Sec. 34-9-9	4	0	112	0	....	4	6	5	0
Lofton	Sec. 25-9-9	48	0	7	0	3 6 to 4 0	3	9	5	0
Powers' bore	Sec. 3-8-9	33	8	27	0	....	4	4	....	....
Rich	Sec. 14-8-9	....	....	....	....	3 6 to 4 0	3	9	....	....
Sullivan	Sec. 34-8-9	15	0	69	6	....	3	4	10	0
Bryant Bros	Sec. 35-8-9	....	....	....	....	2 0 to ? ?	....	....	....	....
Eaton	Sec. 36-8-9	....	....	?	?	1 8 to 12 0	3	0	6	0
Paxton	Sec. 26-7-9	40	0	....	....	....	3	8	....	....
Carlisle	Don. 29-6-9	?	?	....	....	....	3	0	8	0
Whipps	Don. 6-6-9	1	0	....	....	....	3	1	5	0

It will be seen by this that this coal is easily of workable thickness, and it has been worked to a considerable extent, though the finding of Coal VI but a short distance below of a much greater thickness has led to the abandoning of about all mining operations on it at present.

It would seem probable that this bed underlies this whole area at a depth of between 150 and 200 ft. below the level of the E. & T. H. R. R., and with an average thickness of 3 ft., with a range of from 0 to 6 ft.



604	605	606	607	608	609	610	611
Farmersburg. Sec. 2-9-9.	Standard. Sec. 23-9-9.	Shelburn. Sec. 34-9-9.	Lofton. Sec. 25-9-9.	Rich. Sec. 14-8-9.	Sullivan. Sec. 34-8-9.	Paxton. Sec. 26-7-9.	Carlisle. Don. 29-6-9.

Figs. 604-611. Sections of Coal VII in Ts. 6-9 N., R. 9 W.

Mr. Cox gives an analysis of this coal at (A) Pioneer shaft, at Currysville, and (B) and (C) of two specimens from the old Standard shaft, as follows:

	A.		*B.*		*C.*	
Fixed carbon	51.50		55.20		54.00	
Volatile combustible matter.	43.50		40.10		38.50	
Total combustible matter		95.00		95.30		92.50
Ash	1.00		2.90		2.50	
Moisture	4.00		1.80		5.00	
Total waste		5.00		4.70		7.50

These indicate a coal of above the average quality. Mr. Cox describes this coal from the Pioneer shaft as "a good, strong coal * * * Has a bright-black color, breaks into cubes more or less coated with thin scales of semi-transparent calcspar. A cubic foot of this coal will weigh as much as a cubic foot of Pittsburg coal and give a very fair coke and large quantity of gas" (E. T. C., p. 17). As shown in the table given the roof is usually shale, overlain by sandstone, though the sandstone shows a constant tendency to come down on to the coal, at which points the roof is rolling and uneven and the coal is apt to be reduced in thickness. "Feelers" of coal commonly extend over the rolls or downward projections of the sandstone into the coal (known locally as "waves" or "bags"), rendering them very liable to come down, a frequent feature of the roof of this bed. The floor is usually

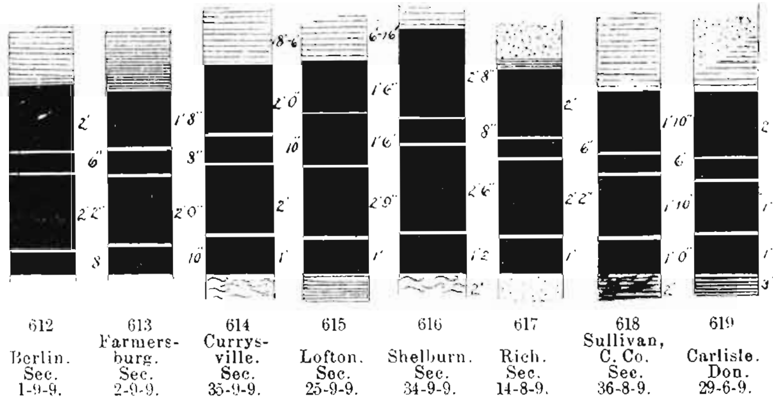
fire-clay. In many cases the sandstone over Coal VII is lacking or is represented only by sandy shales, in which case the shales show a thickness of up to 100 ft. or over. Near the top of the division is one of the most characteristic beds of the whole series, one or two beds of limestone. In most cases the limestone occurs in two beds, separated by from a few inches to several feet of clay. This limestone is thought to be the same as the limestone found below Coal VIII up Brouillet's creek and in western Vigo county, notably around West Terre Haute, and up Sugar and Coal creeks. It outcrops at numerous points along the eastern part of these townships. As a whole, Division VII will be seen to have a thickness of from about 100 to 150 ft.

1402x. Division VI.—This division varies in thickness from about 40 ft. to over 80 ft. In general it is made up of from 5 to 10 ft. of fire-clay, and the rest sandstone and shale, the former overlying. The proportions of these two rocks vary greatly, in some cases being nearly all sandstone and in others nearly all shale, suggesting what is found elsewhere, a nonconformity between the two.

1403x. Coal VI is the main coal worked in this area and would appear to be of workable thickness under this whole area. In some cases shafts have been sunk in this area without even a preliminary test drilling, so confident are many of finding workable coal. The following table will show the uniformity of this coal:

NAME AND LOCALITY.	Range.	Upper.		Bearing in.		Lower.		Bottom.		Aver.	
	Ft. In. Ft. In.	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Berlin, Sec. 1-9-9	....	2	0	0	6	2	2	0	8	5	4
Farmersburg, Sec. 2-9-9	....	1	8	0	8	2	0	0	10	5	2
Currysville, Sec. 35-9-9	....	2	0	0	10	2	0	1	0	5	6
Lofton, Sec. 25-9-9.............	5 8 to 5 10	1	6	1	6	2	9	1	0	5	9
Kettle Creek, Sec. 35-9-9	....	1	8	0	8	1	8	1	0	5	0
Shelburn, Sec. 34-9-9	6 0 to 7 6	2	8	0	8	2	6	1	2	7	0
Rich, Sec. 14-8-9	5 6 to 5 10	2	0	0	6	2	2	1	0	5	7
Sullivan C. Co., Sec. 36-8-9	5 0 to 5 4	1	10	0	6	1	10	1	0	5	2
Carlisle, Don , 29-6-9...........	....	2	0	0	7	1	6	1	2	5	3

From these figures it will be seen that Coal VI averages in these townships about 5 ft. 6 in., with no noticeable thickening or thinning in any particular direction. It shows a range in total thickness of from 5 ft. to 7 ft. 6 in., including the bottom bench, which is shaly and sulphury and seldom mined. The other three benches show about the same relative thickness as in the townships to the east. These figures for the benches, it will be understood, are averages, and the thickness is apt to vary from those from 1 to 4 in. In the case of the bench mining or bearing-in bench, the variation is seldom more than an inch or two. In the above figures the clay partings above and below the bench mining, which are from $\frac{1}{2}$ in. to 1 in. thick, are counted with the upper and lower benches. Between the lower bench



Figs. 612-619. Sections of Coal VI in Ts. 6-9 N., R. 9 W.

and bottom bench the clay band is usually 1 or 2 in. thick and is not included in the above thickness. As indicated by the analysis given of the Star City mine, this coal is a strong steam coal, carrying much sulphur in the mine, as a rule, but in such form that most of it can be separated.

Much gas is met with in mining this coal, and numerous and often very serious accidents have resulted. Better ventilation is reducing this danger somewhat, but accidents still occur, and much care has to be taken on that account. The roof of this coal is usually shale, often of but slight thickness, overlain by sandstone, as shown in the following table:

Name and Locality.	*Roof.*
Berlin, Sec. 1-9-9	Shale, a few ft. thick (?).
Farmersburg, Sec. 2-9-9	Dark shale, not thick.
Currysville, Sec. 35-9-9	1 ft. 6 in. to 6 ft. shale, then sandstone, draw-slate 0 to 6 in., no rolls, fairly good.
Shelburn, Sec. 34-9-9	4-10 in. of draw-slate.
Lofton, Sec. 25-9-9	6-16 ft. of shale, some rolls, never cut coal out.
Rich, Sec. 14-8-9	2-3 in. of draw-slate, sandstone rolls cut coal down 14 in. at the most.
Sullivan Coal Co., Sec. 36-8-9	10 ft. of shale, then sandstone, no-draw slate as as far worked.
Carlisle, Don., 29-6-9	8 in. to 3 ft. of gray shale, then sandstone, rolls of sandstone and sometimes other matter occasionally cut out all but bottom bench.

The floor is somewhat variable, as shown below:

Name and Locality.	*Floor.*
Currysville, Sec. 35-9-9	Shaly fire-clay.
Shelburn, Sec. 34-9-9	2 ft. of fire-clay, 1 ft. of impure limestone (?), blue fire-clay.
Lofton, Sec. 25-9-9	Shale.
Rich, Sec. 14-8-9	"Hard rock."
Sullivan Coal Co., Sec. 36-8-9	2 ft. of bone coal and shale, 8 in. "hard rock" shale.
Carlisle, Don., 29-9-6	3 to 4 ft. of black shale with thin streaks of coal, hard sandstone. In places horsebacks of sandstone cut out the underlying black shale and the bottom bench of the coal.

The limestone occurring near the top of Division VI is only reported in the drillings at Sullivan and Carlisle.

1404x. Division V and Below.—Nothing is known of the coals below Coal VI, except what is given in the record of the well at Sullivan and at Currysville. That indicates one coal of good thickness, according to all accounts.

Some data received in July, 1899, indicate that Coal V is workable at Hymera and suggest that it may prove of value under part of these townships. The datum in question consists of a record of strata passed through in sinking the Hymera shaft from Coal VI to Coal V. As it was received too late to insert under the proper township, it may be inserted here:

Section from Coal VI to Coal V at Hymera.—

	Ft.	*In.*
COAL VI	6	0
Blue sandy shale mixed with fire-clay, 8 ft.; red sandstone, 30 ft.; coarse white sandstone, 8 ft.; jointed sandstone, 5 ft.; clay shale, 9 ft.; limestone, 8 ft.; black shale, 5 ft.	73	0
COAL V	7	0

1405x. Distribution of the Coal.—According to the sections given, Coal VIIIa is only certainly found in the well at Sullivan. Coal VIII appears to underlie nearly all of the area, except some of the stream valleys on the east.

At the Berlin shaft, Coal VII, which is struck at 50 ft., was estimated to lie about 40 ft. below the level of the creek, or 85 or 90 ft. below the level at Farmersburg. At the Farmersburg shaft it lies 160 ft. deep, indicating a dip to the west of about 100 ft. to the mile between the two points. Coal VI is found 40 ft. deeper at each point. Coal VII was worked here by Mr. Sharp and others in a very early day, a tramway extending from these mines to the railroad at Farmers-

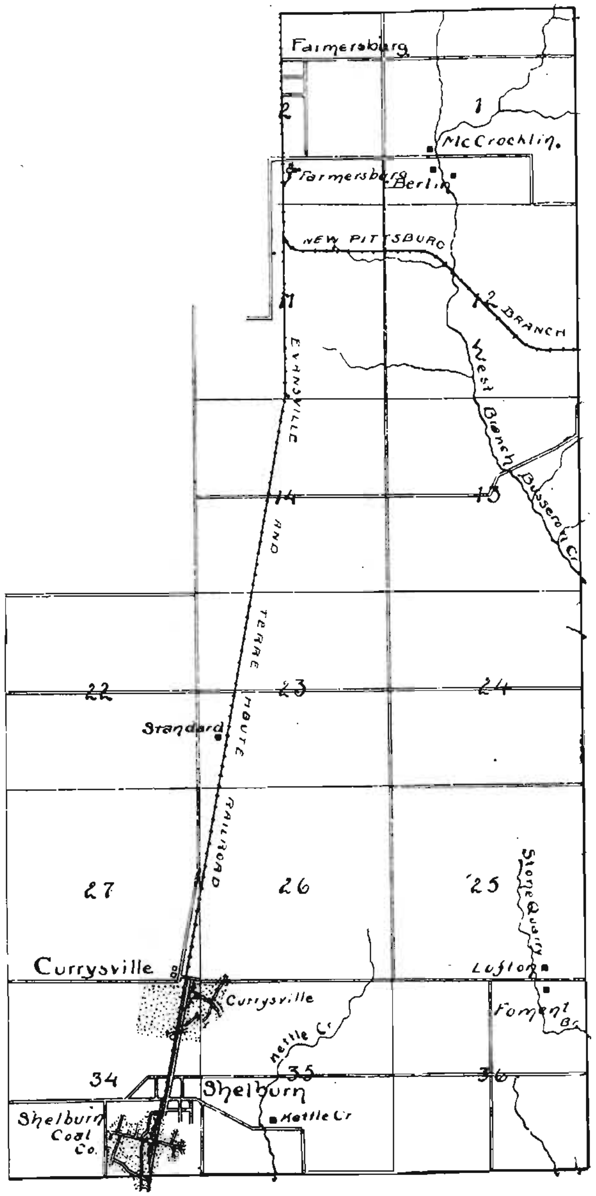


PLATE XLVII. Sketch map of part of T. 9 N., R. 9. W.

burg when visited by Mr. Lesquereux, about 1860. The prevalence of the sandstone rolls discouraged mining, and all recent work has been on Coal VI. Mr. Sharp says that in his old shaft on the east side of the creek a coal (Coal VIII) was struck just at the top of the shaft and bottom of the boulder clay. The limestone below Coal VIII outcrops a short distance down the creek from the present bank. A mine was formerly run by Mr. McCrocklin on the north side of the road, across from the Berlin shaft. Coal VII was worked and mining abandoned finally on account of the rolls and gas. At Farmersburg, Coal VII has been worked with difficulty on account of the unevenness of the roof.

The following record of the old Ascension Coal Company's shaft at Farmersburg was obtained in June, 1899. It bears the date of April 12, 1876:

	Ft.	In.	Ft.	In.
Surface, 5 ft.; yellow clay, 10 ft.; gravel, 2 ft.; blue clay, 30 ft.; yellow clay, 2 ft 6 in	49	6	49	6
Limestone, 3 ft. 6 in.; dark-blue clay shale, 5 ft. 6 in.; clay shale, with iron bands, 10 ft. 6 in.; clay shale, 10 ft. 10 in.	30	4	79	10
COAL VIII	1	4	81	2
Blue clay shale, 10 ft.; shaly sandstone. 8 ft. 6 in.; compact white sandstone, 10 ft.; compact clay shale, 25 ft. 6 in.	54	0	135	2
COAL VII	3	6	138	8
Fire-clay	3	6	142	2

At the old Standard shaft, in Sec. 23, Coal VII was reached at 177 ft. 9 in. As far as learned, Coal VI was not worked here.

At the Lofton mine, which starts from but a few feet above the level of Stone quarry branch, Coal VII was reached at 80 ft. and Coal VI at 120 ft. On the south side of the road, at this point, was formerly the Froment shaft.

At Currysville, Coal VII is reached at 182 ft. and Coal VI at 234 ft. Mr. Collett thus describes the fern bed overlying Coal VII at this point: "The roof shales of Coal L (Coal VII) in this mine is a rich herbarium of the age of coal. For profusion of species and perfect preservation of plants, I have not seen its equal. A list mentioning those found in a hurried examination is given above; but words can not picture nature's beautiful fresco work of fern leaves, vining annularias, and feathery astero-phyllites, relieved by sculptured trunks of Lepidodendra, Stigmaria and Sigillaria. One of the latter, 20 ft.

long, with its flattened diameter of several inches, not perceptibly diminished at either extremity, tells of vigorous life in this past period of the earth's existence."

Coal V, 8 in. thick, is reported 36 ft. below Coal VI here.

At Shelburn, Coal VII is found at 172 ft., and Coal VI at 250 ft. The dip is to the north, amounting to 17 ft. between the two shafts. In the ravine east of Shelburn, Coal VI is reached at the Kettle Creek mine at a depth reported to be 173 ft., the coal being 5 ft. thick, including the 1 ft. of poor coal at the bottom. Coal VIII is said to outcrop at points in this ravine.

In T. 8 N., R. 9 W., Coal VII was reached in two borings in Sec. 3; see above. Coal VI is being mined at the Rich, formerly the Schofield, bank. The coal is here, starting a little below the general level, reached at 180 ft. Coal VII was first worked, 3 ft. 6 in. thick; then the shaft was continued to Coal VI, which has a thickness of 5 ft. 6 in. to 5 ft. 10 in., including 1 ft. to 1 ft. 2 in. of the bottom bench not worked.

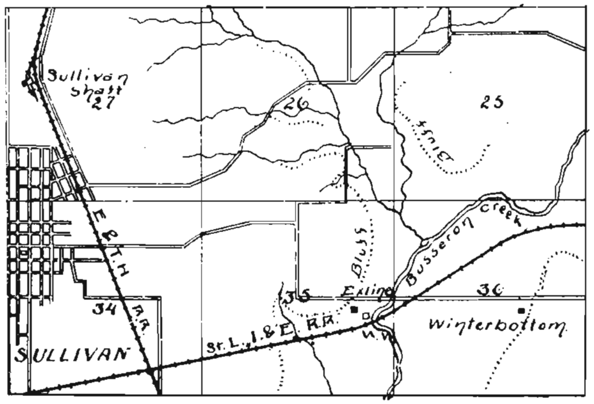


Fig. 620. Sketch map of part of T. 8 N., R. 9 W.

The section of the Sullivan oil well was given above. Later a shaft was sunk to Coals VII and VI. Coal VII is reported to have been found at 185 ft. and to have been 3 or 4 ft. thick. Coal VI was found at 265 ft., and ran up to 6 and 7 ft., all told. I believe that it is said that a serious gas explosion was the cause of the mine being abandoned. It is reported in 1899 that this mine has been reopened, Coal VII only being worked.

A mile east of Sullivan, on the western side of Busseron bottom, Bryant Bros. and Exline were, in 1897, sinking a shaft from Coal VII to Coal VI. Coal VII is reported to be 64 ft. deep here, but was

found too thin to work. Three-fourths of a mile east, on the eastern edge of the bottom, is the Eaton or Winterbottom shaft of the Sullivan Coal Company. Coal VII was here 38 ft. deep and Coal VI 81 ft. deep. Coal VII at the shaft showed a thickness of 12 ft., but when mining commenced it was found that this was just a local thickening. See Fig. 15 in Part I. Coal VIII outcrops at a number of points in ravines around Sullivan. A section a mile or two southwest was given above. At Paxton, Coal VIII is struck in wells east of town at depths of from 25 to 30 ft., and ranging from 18 in. down. A drilling by Mr. Lotson is given as striking 3 ft. 8 in. of coal at about 200 ft. Coal VI should be found from 40 to 80 ft. lower.

The following record of a boring at Paxton was obtained in June, 1899:

	Ft.	In.	Ft.	In.
Surface clay, 14 ft.; clay shale, 10 ft.; sandstone, 40 ft.; "shell," 17 ft.; clay shale, 20 ft.; sandstone, 28 ft.; "shell," 27 ft.; sandstone, 5 ft.	156	0	156	0
COAL VII	3	6	159	6
Fire-clay, 5 ft.; gray limestone (?), 20 ft.; soft limestone (?) and shale, 17 ft.	42	0	201	6
COAL VI	6	1	207	7

A record of the Whipps well, near Carlisle, was given above. This well was bored with hollow rods and the strata examined for limestone, with acid. A comparison of other wells by the same driller shows a very unusual amount of limestone, suggesting, as these well records do not agree in that respect with the outcrops or with other wells, that some error existed in the testing. North of Carlisle the Carlisle Coal and Mining Company are working Coal VI. Coal VII, 3 ft. thick, is found at a depth of 200 ft., and Coal VI, 5 ft. 2 in. thick, at 245 ft. A partial section was given above.

1406x. Summary of Coal.—

Divisions contained: VIII-V+.
Coals contained: VIIIa, VIII, VII, VI, V+.

Round Number Estimates.

Coal VII.

Worked area......100 acres × av. thickness,	3 ft. ×	1,200 =	360,000 tons.
Workable area....150 sq. mi. ×	"	3 ft. ×	500,000 =	75,000,000 tons.
Unworkable area . 50 sq. mi. ×	"	2 ft. ×	1,000,000 =	100,000,000 tons.
Total area.....100 sq. mi.				175,360,000 tons.

Coal VI.

Worked area......200 acres × av. thickness,	5 ft. ×	1,200 =	1,200,000 tons.
Workable area....100 sq. mi. ×	"	5 ft. ×	500,000 =	250,000,000 tons.
Unworkable area . 25 sq. mi. ×	"	2 ft. ×	1,000,000 =	50,000,000 tons.
Total area.... 125 sq. mi....................................				301,200,000 tons.

Coals in Divisions VIII, V and IV.

Unworkable coal..125 sq. mi. × av. thickness, 3 ft. × 1,000,000 = 375,000,000 tons.

Coals in Divisions III to I.

Unworkable coal..125 sq. mi. × av. thickness, 2 ft. × 1,000,000 = 250,000,000 tons.

Number of coals contained: 5.
Greatest thickness recorded: 7 ft. 6 in. Coal VI at Shelburn.
Area underlain by coal: 140 sq. mi.
Area underlain by workable coal: 125 sq. mi.
Estimated total tonnage of coal: 1,100,000,000.
Estimated total tonnage of coal removed: 1,500,000.
Estimated total tonnage of workable coal left: 325,000,000.
Number of mines working ten men or over in operation: 4.
Number of mines working less than ten men in operation: 7.
Total number of mines in operation: 11.
Large mines abandoned: 1.
Strippings, outcrops, etc.: 22.
Total number of openings, etc., to coal: 34.

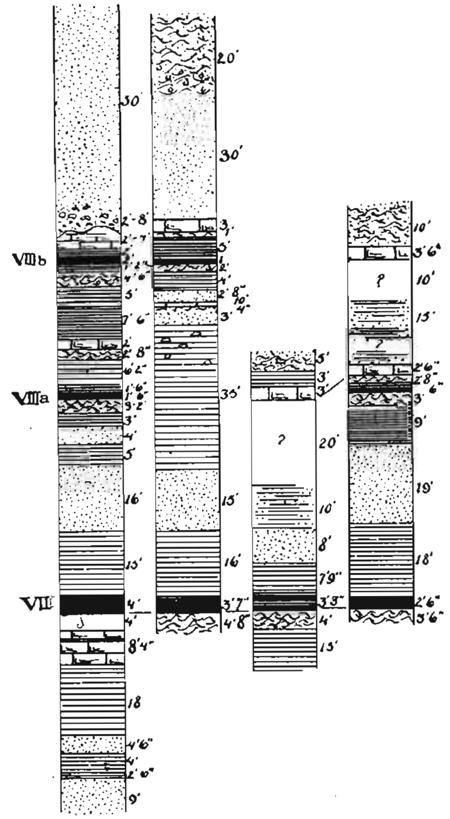
TOWNSHIPS 6-9 NORTH OF RANGES 10 AND 11 WEST—(IN INDIANA.)

1407x. GEOGRAPHY.—This area includes a little over the western third of the county, taking in all of Fairbanks, Turman, most of Gill and part of Haddon of the civic townships. As a rule the surface is level and sandy, with only a few rock exposures, and those confined principally to the larger streams or the bluffs of the Wabash. When visited in 1897 no coal was being mined in this area, though the water was being taken out of a mine at Merom, and coal is said to have been mined a little at a few other points. In places the Merom sandstone forms notable bluffs along the streams, and at Merom there is produced a hill rising 170 ft. above the river, from the top of which a magnificent view is afforded.

The St. L., I. & E. R. R. (I. & I. S. R. R.) crosses the area south of the center.

1408x. STRATIGRAPHY.—According to our interpretation of the stratigraphy, only Divisions VIII and IX are exposed in this area.

Coal VIII is of interest here as attaining a workable thickness. The following sections were made by Mr. Collett at a time when early explorations and mining ventures yielded much more information about the strata than can be obtained now. The most complete section, and the one that to a large extent serves as a type, is the one at Merom:



621 Merom. Sec. 7, 7-10. — 622 Barnes. Sec. 9, 8-10. — 623 Dix. Sec. 26, 9-10. — 624 Narrows. Sec. 24, 9-11.

Figs. 621-624. Columnar sections in Ts. 6-9 N., Rs. 10-11 W.

1409x. SECTION 554. SECTION AT MEROM HILL.—Sec. 7-7-10,
Fig. 621. (J. C., p. 196.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Loess and drift	30	0	..	..	0	0
2. Soft sandstone, upper beds disintegrating ....20 ft. to	25	0	..	..	55	0

		Ft.	In.	Ft.	In.	Ft.	In.
3.	Massive sandstone, with ferruginous seams and veins. 10 ft. to	25	0	..	..	80	0
4.	Conglomerate, pieces of shale, coal, pebbles and sandstone, bedded in calcareous materials....2 ft. to	8	0	..	..	88	0
5.	Productal limestone ...2 ft. to	4	0	..	..	92	0
6.	Dark clay shale	2	0	..	..	94	0
7.	COAL VIIIb	2	0	2	0	96	0
8.	Black shale	1	2	..	..	97	2
9.	Fire-clay and pyritized pebbles	4	6	..	..	101	8
10.	Light-drab clay shale	5	0	..	..	106	8
11.	Bituminous shale, small iron nodules	7	6	..	..	114	2
12.	Crinoidal limestone, crinoid fragments very abundant	2	0	..	..	116	2
13.	Marl clay	1	6	..	..	117	8
14.	Drab clay marl	1	2	..	..	118	10
15.	Dark, bituminous and calcareous shale, soft	6	2	..	..	125	0
16.	Black sheety shale	1	6	30	6	126	6
17.	COAL VIIIa, fat, caking	1	6	1	6	128	0
18.	Good fire-clay	2	8	..	..	130	8
19.	Fire-clay, pyritous	1	6	..	..	132	2
20.	Dark clay shale, ironstone pebbles	3	0	..	..	135	2
21.	Siliceous flagstone	2	0	..	..	137	2
22.	Light-blue argillaceous flagstone	2	0	..	..	139	2
23.	Light-blue clay shale, with nodules	5	0	..	..	144	2
Section in Shaft—							
24.	Laminated sandstone	6	0	..	..	150	2
25.	Quarry sandstone	10	0	..	..	160	2
26.	Hard sandy shale, large nodules	6	0	..	..	166	2
27.	Gray sandy shale	4	0	..	..	170	2
28.	Clay shale	5	0	47	2	175	2
29.	COAL VIII—Choice caking coal, 2 ft. 0 in.; clay parting, —; shaly coal, 0 ft. 10 in.; clay parting, 0 ft. ½ in.; rash coal, 1 ft. 2 in.	4	0	4	0	183	2
Section in Bore—							
30.	Fire-clay	4	0	..	..	183	2
31.	Hard rock (double limestone)	2	0	..	..	185	2
32.	Clay shale	0	4	..	..	185	6
33.	Hard rock (double limestone)	6	0	..	..	191	6
34.	Shale and clay shale	18	9	..	..	210	3
35.	Hard rock	4	6	..	..	214	9

		Ft.	In.	Ft.	In.	Ft.	In.
36.	Clay shale	4	0	..	..	218	9
37.	Soft rock	1	0	..	..	219	9
38.	Clay shale	1	6	..	..	221	3
39.	Sand rock	9	0	..	..	230	3

The nonconformity between Divisions VIII and IX shows well here, the conglomerate occurring at the base of the upper formation. In places the coal in this conglomerate occurs in perfect basins in miniature, as shown in Fig. 625, from a sketch.

Fig. 625. Sketch showing miniature coal basin in eroded depression in limestone at base of Merom sandstone, Merom.

The following two sections are from Turman's creek, and were in part verified:

1410. SECTION 555. BARNES-LADD SECTION.—Sec. 9-8-10, Fig. 622. (J. C., p. 201.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil, etc.	20	0	..	..	20	0
2.	Merom sandstone, ferruginous	30	0	..	..	50	0
3.	Productal limestone, rich in fossils	3	0	..	..	53	0
4.	Calcareous shale	1	0	..	..	54	0
5.	Dark, bituminous shale	5	0	..	..	59	0
6.	COAL VIIIb, rash	1	0	1	0	60	0
7.	Fire-clay	2	0	..	..	62	0
8.	Dark clay shale	4	0	..	..	66	0
9.	Coarse, hard sandstone	2	8	..	..	68	8
10.	Crinoidal limestone, shelly	0	10	..	..	69	6
11.	Place of Coal VIIIa?.						
12.	Fire-clay	0	4	..	..	69	10
13.	Flaggy sandstone	3	0	..	..	72	10
14.	Drab shale, large iron nodules	10	0	..	..	82	10
15.	Gray shale, pyritous partings	25	0	..	..	107	10
16.	Quarry sand rock	15	0	..	..	122	10
17.	Hard siliceous clay shale	4	0	..	..	126	10
18.	Siliceous clay shale, large iron nodules	7	0	..	..	133	10

		Ft.	In.	Ft.	In.	Ft.	In.
19.	Light-colored clay shale, small, round iron nodules	5	0	78	10	138	10
20.	COAL VIII—Choice B. S. coal, 2 ft. 0 in.; clay partings, 1 in.; black shale, 5 in.; clay, 1 in.; bone coal, 1 ft. 0 in.	3	7	3	7	142	5
21.	Dark slicken clay	0	8	..	..	143	1
22.	Fire-clay, light blue	4	0	..	..	147	1
	Bed of Turman's creek.						

1411. SECTION 556. SECTION AT DIX'S BANK.—Sec. 26-9-10, Fig. 623. (J. C., p. 203.)

		Ft.	In.
1.	Glacial clay and modified drift ... 20 ft. to	5	0
2.	Clay shale, good, flat iron nodules	3	0
3.	Crinoidal limestone	3	0
4.	Covered	20	0
5.	Siliceous and micaceous shale	10	0
6.	Quarry sandstone	8	0
7.	Light-colored clay shale	5	0
8.	"Black clod," softened pyrites	0	6
9.	Same, but softer	1	0
10.	Rough, black, sheety shale, fish fins	1	3
11.	Cannel Coal VIII, shaly	1	0
12.	Black sheety shale	1	3
13.	COAL VIII, fat, caking	1	0
14.	Fire-clay, gray	4	0
15.	Clay shale	8	0
16.	Clay shale, with band of mammillary iron nodules	2	0
	Turman's creek.		

The following sections are obtained on the banks of the Wabash, in the northwestern part of the county:

1412. SECTION 557. SECTION AT THE NARROWS.—Sec. 25-9-11, Fig. 624. (J. C., p. 204.)

		Ft.	In.
1.	Soil, etc. ... 20 ft. to	10	0
2.	Productal limestone, fossils	3	6
3.	Covered ... 6 ft. to	10	0
4.	Siliceous shale and covered	15	0
5.	Crinoidal limestone fossils	2	6
6.	Marl clay	1	8
7.	Black sheety shale	1	0
8.	COAL VIIIa	0	6
9.	Fire-clay	3	0
10.	Bituminous clay shale	4	0
11.	Drab clay shale	5	0
12.	Quarry sandstone	15	0

		Ft.	In.
Shaft—			
13.	Compact, banded sandstone	4	0
14.	Drab shale, with iron nodules	14	0
15.	Cream-colored clay shale	4	0
16.	COAL VIII	2	6
Bore—			
17.	Fire-clay	3	6
18.	Hard stone at bottom	0	0

The following section from the west side of the river is of value as indicating the position of the coals and strata in Divisions V-VII:

1414. SECTION 559. SECTION AT LA MOTTE WELL.—Palestine, Illinois. (J. C., p. 209.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and clay	5	0	..	..	5	0
2.	Shale or clay shale	15	0	..	..	20	0
3.	Sandstone (quarry)	10	0	..	..	30	0
4.	Clay shale	6	0	..	..	36	0
5.	COAL VIII	1	0	1	0	37	0
6.	Fire-clay	13	0	..	..	50	0
7.	Bastard limestone (double L. S.)	3	0	..	..	53	0
8.	Fire-clay	5	0	..	..	58	0
9.	Limestone (double L. S.)	2	6	..	..	60	0
10.	Stratified shale	8	0	31	0	68	0
11.	COAL VII	3	6	3	6	71	6
12.	Fire-clay	4	0	..	..	75	6
13.	Sandstone	43	0	..	..	118	6
14.	Shale	5	0	..	..	123	6
15.	Hard sandstone	4	0	..	..	127	6
16.	Clay shale and shale	8	0	64	0	135	6
17.	COAL VI	4	6	4	6	140	0
18.	Fire-clay	5	0	..	..	145	0
19.	Shale, etc.	4	0	..	..	149	0
20.	Dark shale	15	0	..	..	164	0
21.	Gray sandstone	4	0	..	..	168	0
22.	Dark shale	39	0	..	..	207	0
23.	Gray sandstone	17	0	..	..	224	0
24.	Black shale	3	0	87	0	227	0
25.	Rotten Coal V	3	0	3	0	230	0
26.	Fire-clay	5	0	..	..	235	0
27.	Sandstone	22	0	..	..	257	0
28.	Reddish shale, "red keel"	1	0	..	..	258	0
29.	Shale	4	0	..	..	262	0
30.	Sandstone	4	0	..	..	266	0
31.	Variegated shale, dark, green, yellow and brown, with a 1-ft. seam of bituminous tar, having an offensive odor	30	0	..	..	296	0
32.	Soft sandstone, becoming harder towards the bottom	7	0	..	..	303	0

1415. These sections show Coal VIII to be thicker than in the eastern part of the county, though, on account of the partings and the large percentage of the seam that is shaly, it is hardly of a commercially workable character. Below, separated by only fire-clay, comes the limestone characteristic of the upper part of Division VII. Over Coal VIII in this area is usually shale, then hard sandstone, suitable for quarrying. The upper part of the division contains quite persistently two limestones, often a score or more feet apart. Beneath each of these is a coal horizon, though it is seldom that coal is found at both horizons at the same place. Between the coal and the limestone usually occurs a black sheety shale, and in many cases some clay or "marl," which would seem to be the result of decomposition of the limestone. Overlying all of these is the Merom sandstone, the nonconformity showing well at Merom.

1416. Coal VIII in this area usually shows two partings, dividing it into three benches. Of these only the upper bench, which ranges from 1 ft. to 2 ft. in thickness, is of good quality; then comes a 1-in. parting of white clay, then from 3 to 10 in. of bony coal or more often black shale and pyrite, then one or two inches of white clay, then about a foot or a little over of bony coal, making a total of from 3 ft. 6 in. to over 4 ft., though with seldom more than 2 ft. of good coal. This is a good, rich coal.

1417. Distribution of Coals.—Coal VIII, which, in the sections along the E. & T. H. R. R., was usually 40 or 50 ft. deep, is reached by the down-cutting of Turman's creek and exposed above drainage. Along the Wabash river it lies about at low-water level, though often below. Coal data is confined to the valley of Turman's creek and the bluff of the Wabash.

Beginning with the former, we find along the lower course of Turman's creek Coal VIII is below drainage, but Coals VIIIa or VIIIb are often exposed and with a thickness of up to 18 in., and have been mined a little at several points on the old Pogue or present Standard place, in Sec. 13-8-11, and further up in Sec. 18. In Secs. 8 and 9-8-10 occurs the section given above on the Barnes (now Conner)-Ladd places. Coal VIII here rises above drainage and has recently been worked by Messrs. J. Shroyer and W. M. Clam, as the "Big Hill Coal Company," on the Dodd place. The coal is reached at 6 ft. in the shaft, and shows 2 ft. of good coal, 6 in. of black, hard band, 1 ft. of fair coal. The roof is blue shale and good. Above this, up the creek, Mr. Collett reports coal as follows: Coal VIIIa on Annis place, Sec. 3-8-10; Alkire, Sec. 2-8-10; Geo. Alkire, Sec. 1-8-10; Coal VIII on McKinney place, Sec. 1-8-10; Dix, Sec. 35-9-10 (see section given above); DeBaum, Sec. 15-9-10; S. Johnson, Sec. 10-9-10. Starting at the north end of the bluff of the Wabash, Coal VIIIa, which we found being dug at a number of points on Prairie creek in Vigo county, is here found in the bluff and the small valleys which open into the main valley. It is here an 18-in. seam, and, with Coal VIII, was formerly worked a little at many points, at none of which, as far as could be learned, has work recently been done. Of these may be mentioned Dilley, Sec. 6-9-10; DeCamp, S. E. of Sec. 7-9-10; Starky, N. W. of Sec. 8-9-10; Welch, S. W. of Sec. 8-9-10; Dilley, N. E. of Sec. 8-9-10; Welch, N. W. of Sec. 18-9-10, and Hunter, N. W. of Sec. 18-9-10. At these places Coal VIII has about the general section given above. At the "Narrows" Coal VIII was formerly reached by a shaft by Badger Bros., the section of which was given above. As elsewhere, considerable drifting failed to find coal of satisfactory thickness, and work was abandoned. Coal VIIIa is reported as formerly worked on the Van Vleck place, in Sec. 2-8-10.

The section at Merom has been given above. Coal VIIIb is found at Mr. Berry's and Mr. Foote's springs, where it has been tried, but proved to be too bony. Coal VIIIa, 18 in. thick, outcrops well up the bluff, and has been well worked out along the crop from some half dozen openings. Coal VIII has been reached by shaft. The shaft on Mr. Foote's place was being bailed out when visited preparatory to reopening; the shaft is 64 ft. deep and shows principally sandstone separated by from 7 to 9 ft. of shale from the coal. The coal is reported to show 2 ft. of good coal, 2 to 3 in. of clay, 1 ft. 6 in. of bone coal, with 7 to 8 ft. of fire-clay below. A drilling on Mr. Foote's place, east of Merom, is reported to show 4 ft. of coal. A half mile east of Merom a drilling on the D. W. Lahr place is reported to have gone 300 ft., starting 68 ft. below the top of the bluff at Merom. Coal VIII, 3 ft. 6 in. thick, was struck at 90 ft. At something over 100 ft. lower Coal VII, 6 in. to 1 ft. thick, was found. As this leaves about 100 ft. of well, it would seem as though the horizon of Coal VI must have been reached, though a thickening of Division VI to the west might easily have carried it below the bottom of the well.

In general, it would seem, then, that drillings in this area are liable to first encounter Coal VIII, 3 or 4 ft. thick, but not workable, and should find Coal VI at from 150 to 250 ft. lower. The record of the LaMotte well, at Palestine, Illinois, suggests the possibility of its being workable over at least part of the area. It is probably the only coal worth seeking, unless the deep coal at Sullivan should later prove of value.

1418. SUMMARY OF COALS.—

Divisions contained: IX to ?.
Coals contained: VIIIb, VIIIa, VIII, VII, etc.

ROUND NUMBER ESTIMATES.

Coal VIII, VIIIa, VIIIb.

Worked area....	10 acres	× av. thickness,	3 ft. ×	1,200 =	3,600 tons.
Workable area...	10 sq. mi. ×	"	3 ft. ×	500,000 =	15,000,000 tons.
Unworkable area	140 sq. mi. ×	"	1 ft. ×	1,000,000 =	140,000,000 tons.
Total area..	150 sq. mi				155,000,000 tons.

Coal VII.

Workable area...	50 sq. mi. ×	av. thickness,	3 ft. ×	500,000 =	75,000,000 tons.
Unworkable area	100 sq. mi. ×	"	1 ft. ×	1,000,000 =	100,000,000 tons.
Total area.	150 sq. mi				175,000,000 tons.

Coal VI.

Workable area ..	50 sq. mi. ×	av. thickness,	5 ft. ×	500,000 =	125,000,000 tons.
Unworkable area	100 sq. mi. ×	"	2 ft. ×	1,000,000 =	200,000,000 tons.
Total area..	150 sq. mi				325,000,000 tons.

Coals in Divisions V to I.

Unworkable area 150 sq. mi. × av. thickness, 10 ft. × 1,000,000 = 1,500,000,000 tons.

Coals contained: 5+.
Greatest thickness recorded: 4 ft. Coal VIII at Merom.
Area underlain by coal: About 150 sq. mi.
Area underlain by workable coal: 75-100 sq. mi.
Estimated total tonnage of coal: 2,155,000,000.
Estimated total tonnage of coal removed: 3,600.
Estimated total tonnage of workable coal left: 215,000,000.
Number of mines working ten men or over in operation: 0.
Number of mines working less than ten men in operation: 2.
Total number of mines in operation: 2.
Large mines abandoned: 0.
Strippings, outcrops., etc.: 32.
Total number of openings, etc., to coal: 34.

1419. SUMMARY OF COAL OF SULLIVAN COUNTY.

Coals contained: VIIIb, VIIIa, VIII, VII, VIb, VI, V, IV, III, etc.
Greatest thickness recorded: 9 to 11 (?) ft. Coal V at Alum Cave.
Area underlain by coal: 440 sq. mi.
Area underlain by workable coal: 365 sq. mi.
Estimated total tonnage of coal: 4,650,000,000.
Estimated total tonnage of coal removed or left as pillars: 9,000,000.

Estimated total tonnage of workable coal left: 950,000,000.
Number of mines working ten men or over in operation: 12.
Number of mines working less than ten men in operation: 43.
Total number of mines in operation: 55.
Large mines not in work: 6.
Strippings, outcrops, etc.: 233.
Total number of openings to coal: 282.

XXVI. LAWRENCE COUNTY (COAL MEASURE AREA).

1420. REFERENCES AND FIELD WORK.—

1874 (1873). John Collett, 5th Ann. Rep. Geol. Surv. of Ind. Detailed geology of county (pp. 260-314), map, numerous columnar sections. (J. C.)

1875 (1874). E. T. Cox, 6th Ann. Rep. Geol. Surv. of Ind., pp. 13-15. One columnar section. (E. T. C.)

1898. J. A. Price, field work for this report.

GEOGRAPHIC.—As the coal measures only occupy a few square miles in the southwestern part of the county, we need only concern ourselves with that area. The coal measures of Lawrence county is contained in townships 3, 4 and 5 north of range 2 west, or in the civic townships of Indian creek and Spice valley, principally in the latter, with an area of about 20 sq. mi.

The topography is rugged, the hills rising often 250 ft. above the surrounding streams.

1421. STRATIGRAPHY.—Only Division I outcrops in this county, with one coal horizon, which, however, seldom has any coal. But not infrequently at the horizon of Coal I appears a bed of kaolin of great purity and value. Thin coal appears at one or more horizons well down in the Kaskaskia or Lower Carboniferous rocks. A section made at the Gardner kaolin mine shows the relations of this lower horizon to the horizon of Coal I.

1422. SECTION 519. SECTION AT DR. J. GARDNER'S KAOLIN MINE.—Sec. 11-4-3. (E. T. C., p. 14.)

		Ft.	*In.*
1.	Soil and subsoil	3	0
2.	Mansfield sandstone	100	0
3.	Porcelain clay, horizon of Coal I	6	0
4.	Iron ore	4	0
5.	Marly and sandy shale	4	0
6.	Kaskaskia sandstone	50	0

		Ft.	In.
7.	Kaskaskia limestone, with archimedes	17	0
8.	Marly shale	10	0
9.	Sandstone	40	0
10.	Limestone	6	0
11.	COAL 1 in. to	0	3
12.	Mitchell (St. Louis) limestone	150	0
		390	3

The following sections by Mr. Collett show the position, etc., of the Lower Carboniferous coal.

1423. SECTION 520. SECTION ONE MILE WEST OF FAYETTEVILLE.—Sec. 15-5-3. (J. C., p. 292.)

		Ft.	In.
1.	Sandstone	30	0
2.	Bituminous, fossiliferous limestone	6	0
3.	Shaly COAL	..	6
4.	Laminated fire-clay	2	6
5.	Blue and gray shale	25	0
	Etc.		

This coal was worked by James Tannehill.

1424. SECTION 521. SECTION AT MICHAEL WAGNER'S.—Sec. 19-5-2. (J. C., p. 293.)

		Ft.	In.
1.	Mansfield sandstone, partly hidden	90	0
2.	Bituminous or gray shale	12	0
3.	Black shale and COAL	..	10
4.	Pyritous shale	10	0
5.	Blue limestone to branch	8	0

1425. SECTION 522. SECTION AT SHILOH MILL.—S. E. ¼ Sec. 19-5-1. (J. C., p. 289.)

		Ft.	In.
1.	Chert and covered	50	0
2.	Banded blue limestone	12	0
3.	Chalky white clay	4	0
4.	Sandy and calcareous shale	3	6
5.	Black bituminous shale "BONE COAL"	..	3
6.	Shaly limestone	1	0
7.	Hard blue limestone	3	4
	Etc.		

1426. SECTION 523. SECTION ON SPIDER CREEK.—Near Bedford. (J. C., p. 280.)

		Ft.	In.
1.	Clay and chert	30	0
2.	Shaly limestone and shale	8	4
3.	"COAL BONE" shale, rich in petroleum	..	3
4.	Hard gray, bituminous limestone	3	6
	Etc.		

1427. SECTION 524. SECTION AT CAMPBELL'S CAVE.—Near Bedford. (J. C., p. 281.)

		Ft.	In.
1.	Clay and chert	10	0
2.	Bituminous limestone	2	6
3.	"COAL BONE," shale	..	3
4.	Dark, bituminous limestone	2	0
	Etc.		

1428. SECTION 525. SECTION ON J. E. BRYANT'S PLACE.—Sec. 19-4-2. (J. C., p. 295.)

		Ft.	In.
1.	Massive sandstone, Mansfield 125 ft. to	70	0
2.	Laminated sandstone	15	0
3.	Bituminous limestone, Kaskaskia	10	0
4.	Siliceous shale	20	0
5.	Shale and limestone to White river	50	0
		165	0

1429. SECTION 526. SECTION AT HURON.—(J. C., p. 297.)

		Ft.	In.
1.	Mansfield sandstone, with "wedges and pockets of white sand"	40	0
2.	Bituminous limestone	18	0
3.	"Place of rash coal"	..	4
4.	Thin bedded "Chester gritstone"	65	0
5.	Heavy bedded "Chester gritstones"	6	0
6.	Blue limestone	16	0
7.	Red and blue clay	2	0
8.	Clay shale and pyrite	4	0
9.	Black slaty COAL	..	8
10.	Clay shale	1	8
11.	Gray limestone, with flints	16	0
		169	8

1430. SECTION 527. SECTION AT CONNELLY'S HILL.—S. E. ¼ Sec. 4-3-2. (J. C., p. 298.)

		Ft.	In.
1.	Sandy soil, with hemitite	10	0
2.	Mansfield sandstone, with stems of fossil plants	45	0
3.	Bituminous, fossiliferous limestone	14	0
4.	Place of rash coal	..	8
5.	Laminated and shaly sandstone, with parting of chert	55	0
6.	Shaly limestone, containing chert and parting of sandstone	30	0
7.	Cherty limestone in cave	8	0
8.	Shaly limestone, with black flint	6	0

These sections show no coal at the horizon of Coal I but a shaly or bone coal at a horizon just below the upper Kaskaskia limestone or 10-15 ft. below the horizon of Coal I and in the Lower Carboniferous. They further show that this coal is seldom more than a black bituminous shale, not thick enough to work if of good enough quality. It has been dug a little on Corie Pruett's place in the S. W. ¼ of Sec. 18-5-2, where it is reported 11-12 in. thick.

Mr. Price found that Coal I existed at a few places at least, and has been mined a little. At an old drift on the L. D. Van Dyke farm south of the center of Sec. 32-3-2, the coal is reported as 4 ft. thick, of good quality, without sulphur bands. An outcrop of a 3-ft. coal is reported on Mr. W. H. Edmond's place. It has a sandstone and shale roof.

In its distribution the horizon of Coal I extends out in the top of the ridge south of Beaver creek. Also in a somewhat larger area between Beaver creek and White river. A very limited area occurs along the county line in Secs. 6, 7 and 18 of township 5 N., R. 2 W., and it caps a number of high conical hills in Secs. 16 and 21-5-2.

There is probably no workable coal in the county.

XXVII. MARTIN COUNTY.

1432. REFERENCES AND FIELD WORK.—

1862 (1859-'60). Richard Owen, Rep. of a Geol. Reconn. of Ind., pp. 173-177. One cut. (R. O.)

1862 (1859-'60). Leo Lesquereux, same report, pp. 318-321. One columnar section.

1871 (1870). E. T. Cox, 2d Rep. Geol. Surv., pp. 81-124. Detailed report, map, four columnar sections, eleven coal analyses, three page cuts. (E. T. C.)

1872 (1872). Cyrus Mendenhall, 3d and 4th Ann. Reps. Geol. Surv. Letter to Mr. Cox mentioning coals, etc. (C. M.)

1896 (1895). W. S. Blatchley, 20th Ann. Rep., Dept. Geol. and Nat. Reso., pp. 100-103. Discusses clay and gives one columnar section. (W. S. B.)

1896 (1895). E. M. Kindle, same, pp. 329-268. Map of southeastern part of county and three columnar sections. (E. M. K.)

1896. G. H. Ashley, field work for this report.

1897. G. H. Ashley and C. E. Siebenthal, two days' trip across county at beginning of field season.

1898. J. A. Price, worked out distribution of sandstone in eastern part of townships 4 and 5 north of range 3 west. (J. A. P.)

1898. E. M. Kindle, made some notes in crossing from Shoals into Dubois county. (E. M. K., '98.)

Section 1. Geography.

1433. LOCATION AND AREA.—Martin county occupies townships 2 to 5 N. of R. 3 and 4 W.; also the eastern row of sections in range 5 W. in townships 2 to 4 N. and 1 N. north of White river; also township 1 N. two north rows of sections in R. 3 W. and R. 4 W. to White river, beyond which the White river forms the southern boundary. It lies just east of Daviess county, south of Greene, west of Lawrence and Orange, north of Dubois. It has an area of 240 sq. mi.

1434. DRAINAGE AND RELIEF.—Except in the extreme northern part the drainage is entirely into the East Fork of White river. This river is a stream of some importance, having its head in the eastern central part of the State. Its course is shown on the map. Its main tributaries from the north are Indian creek and Boggs creek; from the east Beaver creek and Lost river.

The abundant shales giving to Daviess county so much of its level character are here wanting, and massive sandstones and limestones prevail. Moreover, most of the county is unglaciated. It therefore has all the characteristic ruggedness of a region in which those conditions prevail. North of White river the drainage is a little west of south and the main valleys and ridges partake of the same direction. Between Indian and Boggs creeks is an almost continuous ridge from 100 to 250 ft. above the valleys. From it project numerous nearly level arms between the branches of the two creeks. As a rule the ridge summits are narrow, the stream bottoms broad and level. The tributaries to Boggs creek from the west are larger than from the east and head up against the heads of Prairie creek, and as to some extent they reach west into the shales of Divisions II and III they do not head against such a high narrow ridge as on the east, but rather into a divide, high at the north but gradually running out to the south, which has for the most part moderate slopes, most of which can be cultivated. East of Boggs creek the country is so broken that the greater part of it cannot be cultivated.

East of White river the drainage and general trend of ridges and valleys is from east to west, with north and south ridges between the tributaries of the larger streams. This section is still more rugged than that north of White river, due to the Mansfield sandstone here being more massive and probably thicker. As before, the ridges are narrow on top, the valleys broad. Often the Mansfield sandstone produces high perpendicular bluffs, or nearly as steep slopes, 50-100 ft. high. The cross sections on Plate XLVIII will give a fair idea of the relief. As the relief is to a large degree based on the position of the Mansfield sandstone, the structure is an element of some importance in controlling that relief.

Among the more interesting topographical features are the "Pinnacle," a high projecting point of rock a short distance up the river from Shoals. Not far from this and about a half a mile north of West Shoals is a "pillar" or "needle" mass of Mansfield sandstone in the head of a ravine which has been given the name of "jug rock." See cut at end of the description of this county. It is 42 ft. high, and shows crossbedding near the top, and near the bottom some grit. Many interesting exposures occur in the bluffs along White river.

The topography at Shoals and Hindostan Falls is of interest as showing a post-glacial change in the course of White river. See Plate XLVIII. Both above and below Shoals the river occupies a broad, nearly level, valley. At Shoals such a valley exists to the east of town, joining the river valley north and south of town, but at this point the river flows through a narrow rocky gorge. The *shoals* in its bed show that it is still cutting out this new channel for itself. It is evident that Shoals occupies what was formerly the end of the projecting point from the ridge back of West Shoals. The whole valley having been filled up to at least 40 or 50 ft. above its present level during or following the glacial period, when the river began to cut down its channel again for some reason it cut across this buried point instead of following its old longer channel east of town. The writer's attention was directed to this feature by Mr. Frank Leverett of the United States Geological Survey. Much the same thing occurred at Hindostan Falls, except that the large "ox bow" was cut off with quite a saving of distance. The river is now cutting its way through the rock, resulting at one point in a fall of about 3 ft.

"Rock houses," formed by the weathering and erosion of the shales underlying the Mansfield sandstones, are occasionally met with and as a result of their formation in places hugh blocks of the massive sandstone sometimes occur at the foot of some of the cliffs. The scenery is often wild and picturesque.

1435. Development and Transportation.—The chief towns are Shoals, the county seat, and Loogootee. Burns City and Short are thriving stations on the Southern Indiana Railway. There are, besides, about twenty small post offices, villages or stations, including Dover Hill and Mt. Pleasant, each at one time the county seat. Hindostan, at one time the county seat, was practically wiped out by a contagious disease.

The B. & O. S. W. Ry. crosses the county from east to west near the center, and the Southern Indiana Railway crosses the northern part. Some difficulty would probably be experienced in getting much of the coal of this county to the railroad on account of the very steep grades. It is probable that some kind of electric or rope haulage device will be necessary.

Section 2. Stratigraphy.

1436. Chester or Kaskaskia.—A typical exposure of this formation is given by Mr. Kindle as taken at Foote's spring in the S. W. ¼ of the S. W. ¼, Sec. 11, T. 7 N., R 2 W., as follows:

1437. SECTION 528. SECTION AT FOOTE'S SPRING.—(E. M. K., p. 331.)

	Ft.
1. Slope, with Mansfield sandstone fragments	18
2. Upper Kaskaskia limestone	15
3. Upper Kaskaskia sandstone	35
4. Middle Kaskaskia limestone	16
5. Lower Kaskaskia sandstone	30
6. Lower Kaskaskia limestone (exposed)	5

From this it is seen that the Kaskaskia is to the east of this region made up of two thick beds of sandstone with some shale and three thinner beds of limestone.

At the Cedar bluff in N. E. ¼ of Sec. 6, T. 3 N., R. 3 W., the following section was noted:

1438. SECTION 529. SECTION AT CEDAR BLUFF.

	Ft.
1. Mansfield sandstone, with grit .....20 ft. to	40
2. Upper Kaskaskia limestone	15?
3. Upper Kaskaskia sandstone	28
4. Middle Kaskaskia limestone	24

In Sec. 8, N. E. ¼, T. 2 N., R. 3 W., the following partial section was noted:

1439. SECTION 530. SECTION IN SEC. 8-2-3.—On Spring Branch.

	Ft.
1. COAL II?	?
2. Mansfield sandstone, gritty	24
3. COAL I	1½
4. Hidden	18
5. Shaly sandstone	8
6. Upper Kaskaskia limestone	5
7. Upper Kaskaskia sandstone and shale	36
8. Middle Kaskaskia limestone	15?

This section is not very reliable as the exposures were scattered along Spring branch its whole length and unconnected in many places.

In a drilling in the ravine just south of the Union Coal Company's mine in the S. W. ¼ of the S. E. ¼ of Sec. 10, T. 4 N., R. 5 W., the Kaskaskia formation is supposed to have been passed through for some distance. The drilling by Mr. Paul Hinton is as follows (Sect. 531):

	Ft.	In.
1. Surface, 5 ft.; (2) sandstone, 17 ft. (Mansfield sandstone); (3) shale, 1 ft.; (4) Coal I, 1 ft. (?). Coal measures	23	0
5. Limestone (Upper Kaskaskia?)	1	6
6. Sandstone, 12 ft.; (7) shale, 6 ft.; (8) sandstone, 16 ft.; (9) shale, 2 ft.; (10) sandstone, 20 ft.; (11) shale, 2 ft.; (12) sandstone, 27 ft.	91	0
13. Shale (possibly representing middle limestone)	35	0
	150	6

In the S. W. ¼ of Sec. 22, T. 3 N., R. 5 W., a drilling by Mr. Hinton gave the following (Sect. 532):

	Ft.	In.
1. Surface, 15 ft.; (2) quicksand, 55 ft.; drift	70	..
3. Sandstone, 45 ft. (Mansfield sandstone?); (4) shale, 12 ft.; (5) sandstone, 15 ft.; (6) hard limestone, 3 ft.; (7) shale, 2 ft.; (8) coal, 6 in.; (9) fire-clay, 6 ft.; (10) gray shale, 45 ft.; (11) black shale, 27 ft.; (12) fire-clay?	155	6
	225	6

If the coal in this section is Coal I then no Kaskaskia limestone appears in this section. It is possible, however, that the coal represents the coal below the upper limestone as reported between Shoals and Loogootee, and in Orange county. In that case the upper Kaskaskia limestone is number (6) and is 3 ft. thick.

These sections, and many similar though less complete sections, seem to show a tendency of the formation to replace its limestone by shale and sandstone to the westward, provided that the limestone found below the coal in several sections is correctly correlated with the upper Kaskaskia limestone. If these two limestones are only local it would seem probable that the Kaskaskia was deeply eroded if not entirely removed and the lower part of the coal measures laid down in its place. The increased thickness of the lower part of the coal measures in western Daviess and Knox counties lends support to this view. (See Plate XLIX.)

The middle Kaskaskia limestone is a semi-crystalline limestone, gray to pink, often oolitic. The upper sandstone is rather coarse-grained, usually of a light color and in several places appeared to be a suitable sandstone for building purposes. Often it is in layers from a few inches to several feet in thickness, which will facilitate quarrying. Locally it is suitable for whetstones.

The distribution of the Lower Carboniferous in this area is shown on the map.

1440. DIVISION I.—For several reasons the development of Division I in this county may be taken as the type. 1. It contains better and more workable coal in this county than in any other. 2. It is probably as well exposed here as at any other point. 3. Unless it be at Cannelton on the Ohio river, it shows a greater thickness than anywhere else. 4. The gritty or conglomeritic facies is better exposed here than anywhere else. It will therefore be described a little more in detail here than is usual. Notwithstanding the facts given, its stratigraphy and position north of White river are very obscure. At many places there is found a coal within from 5 to 30 ft. of the Lower Carboniferous limestone, which is unhesitatingly placed in Division I. At many other places it is from 35 to 75 ft. by the barometer from the limestone to the first coal, and yet surrounded by conditions that suggest that the coal is in Division I. Notwithstanding that the barometer was used constantly in this work, and an attempt was made to sketch in the topography of much of the county, it remains that the stratigraphic position of the coal at many places is in doubt. It has, therefore, been necessary, in the area north of White river, to name the coals arbitrarily. Where the coal is found close to the Kaskaskia limestone or below a gritty sandstone it will be called Coal I. Where the coal lies 100 ft. or more above the limestone or even at a somewhat less distance above a known horizon of Coal I it will be called Coal III. Where it lies above a gritty sandstone or more than 50 ft. above the limestone it will be called Coal II, it being understood that it has not been decided whether this coal lies at a horizon in Division I as understood elsewhere to the north, or lies above what corresponds to Division I. As the coal generally assigned to the horizon of Coal II is of some importance, it is shaded on the map as though it lay above the Mansfield sandstone. The coal at many of these questionable points is overlain by a massive sandstone, but as massive sandstones appear to be found at several horizons in this county, it is believed that nothing short of a detailed instrumental survey will properly straighten them out.

1441. RELATIONS OF DIVISION I TO LOWER CARBONIFEROUS.—In many places the Mansfield sandstone appears to be perfectly conformable with the underlying limestones of the Lower Carboniferous. In many places, however, there is a marked contrast between closely adjacent outcrops. Thus, as an illustration, on Beach creek, west of Shoals, the bluff on the east is Mansfield sandstone to the bottom of the valley, while well up the opposite hillside outcrops the underlying limestone. (Plate XLVIII.) A half mile southeast the gritty sandstone lies about 75 ft. above the limestone, with a coal in the space between, while a few rods away the sandstone lies directly on the limestone. Many other places might be cited. In some places there is evidence of faulting, as at the Southern Indiana Railway tunnel north of Dover Hill, but more often the true explanation would seem to be that these are irregularities of the Lower Carboniferous surface upon which, or into the hollows of which, the lowest measures were laid down.

1442. MANSFIELD SANDSTONE.—This, the principal member of this division, is a massive, coarse-grained, commonly cross-bedded, occasionally gritty or conglomeritic sandstone. It is commonly from 50 to 70 ft. thick, running from a few feet to 400 or more feet, often seamless, sometimes broken up into layers of varying thickness. This sandstone is poorly exposed in northern Martin county but well exposed in the southern part of the county. The conglomeritic phase shows well in the neighborhood of White river from near Dover Hill to 3 or 4 mi. below Shoals. The quartz pebbles are in places scattered through the sandstone, in others gathered in little clusters or pockets such as are common in the depressions between high and low tide on any modern shore. Where the matrix is a dark red, as is often the case from the iron carried, the white quartz pebbles show very prominently. In places this stone carries large quantities of geodes, often many inches in diameter; as, for example, at the old Clements mine, near the quarry switch east of Loogootee, where the ground is almost paved with geodes, and many large ones were noted in the ravine just south of Mt. Pleasant, near Trippy's.

In regard to the source from which the material of this sandstone came the following suggestion is made:

As shown by Mr. Hopkins, a part of the pebbles and fragments and some of the coarse-grained sandstone probably came from the chert and geodes of the Lower Carboniferous to the east. This still leaves unaccounted for a large part of the coarse-grained sandstone of which the fine-grained sandstones to the east are not considered as capable of having furnished the supply, and resource is had to suitable supplies many hundreds of miles distant. It is, I think, generally assumed that the Cincinnati arch is of Pre-Carboniferous rather than Post-Carboniferous age. It must then have formed a shore during the laying down of the limestone and fine-grained sandstones of the Lower Carboniferous. It would then be in the natural order of things to expect that these limestones and fine-grained sandstones were replaced to eastward by the usual shore deposits of coarse-grained sandstone, and even of gravel, becoming later coarse-grained sandstone and conglomerate. No trace of any such sandstones or conglomerates exists to-day, nor, on the other hand, do there exist, as far as I know, any traces of any strata occupying the vertical and geographical position these shore deposits are assumed to have occupied. They have all been removed during the long period or periods of erosion through which they have been exposed. Furthermore, though grits and conglomerate are confined to the Mansfield sandstone, coarse-grained sandstones are not uncommon at much higher geologic levels in the coal measures; as, for example, the solid bed of coarse-grained sandstone 65 ft. thick at High Rock in Daviess county, which Mr. Cox and Mr. Collett assumed without question to be the Mansfield sandstone, but which proves to be about the middle of the coal measures series; also the but slightly, if at all, finer-grained sandstones on Veale's creek and at Merom rock and many other places. These may be assumed to have come from the erosion of the Mansfield sandstone, and quite possibly did, but it seems quite as probable that they had the same source as the Mansfield sandstone, except that conditions were not favorable for the transportation of the coarser pebbles and fragments. And again, Mr. Siebenthal reports small patches or outliers of what is supposed to be the Mansfield sandstone well over to the east of Lawrence county, suggesting that it probably formerly covered most, if not all, of the Lower Carboniferous at present exposed, and that much at least of its material which is clearly recognized as having come from the Keokuk or Harrodsburg limestone must have come from the part of that formation now gone. On this suggestion it is quite possible that any coarse pebbles in the Mansfield sandstone, which cannot be recognized as having come from the Lower Carboniferous as at present known, may have come from the erosion of shore conglomerates of that age which were laid down far to the east of the present outcrops of Carboniferous rocks.

In southern Martin county the Mansfield sandstone is usually a strongly-marked horizon, showing itself in numerous perpendicular cliffs, many of which are indicated by (M. S.) on Plate XLVIII. It forms bluffs along White river at frequent intervals from near Dover Hill almost to where it turns west to the southern boundary of the county.

North of Dover Hill perpendicular bluffs are infrequent and seldom more than 10-20 ft. high, and appear at different horizons.

Aside from the coals met in deep drillings in western Daviess and Knox counties, of which it is not known how many, if any, belong to this division, two coals are found in this division. These have been designated Coals I and Ia.

1443. Coal I. Extent.—As a horizon it is nearly coextensive with the extent of Division I, following in outcrop nearly the line of outcrop between the coal measures and the Lower Carboniferous. As a bed of coal, however, it does not cover nearly that area, as the irregular surface of the Lower Carboniferous on which it was laid down seems to have projected above the swamp or water over considerable areas, so that it is a very common thing to find the Mansfield sandstone resting directly on the Kaskaskia limestone or sandstone without a trace of coal or shales. Often in such cases a short distance away the coal with two or three score of feet of shales and other beds are found lying between the Mansfield sandstone and the limestone. Again in many places the coal is lacking, and in the same horizon lies a bed of kaolin. This shows well at Johnson and Chenoweth's coal mine and kaolin bank on opposite sides of Millstone branch near Shoals. In eastern Martin and Lawrence counties it is commonly wanting, while kaolin occurs at its horizon.

1444. Thickness.—The following table will give a general idea of the general thickness of Coal I over the area of Martin county.

Township.	Range.	Least.	Greatest.			Average.				
			Ft.	*In.*		*Ft.*	*In.*		*Ft.*	*In.*
1	3	0	2	3		1		to	1	6
2	4	0	3	8		1		to	2	
3	4	0	4	..		1	6	to	2	
4	3	0	3	0		1		to	1	6
4	5	0	2	2	(3 ft. 6 in.?)	1	6	to	(+?)	
5	4	0	2	0		1		to	1	6
2	3	0	1	10		1		to	1	6
3	3	0	3?	.		1		to	1	6
3	5	0	3	6		1	6	to	2	
4	4	0	2	4		1		to	1	6
5	4	0	3	..		1	6	to	2	
5	5	0	3	..		1	6	to	2	

This table reveals a general tendency for Coal I to become thicker to the west, though there are many exceptions. As a rule, the greater thicknesses are apparently quite local. Still greater thickness is claimed at places, 6 ft. being reported in a few places, however it is believed the figures given will be found to be nearly correct and that, not including points at which the coal is entirely gone, it will hardly average more than 1 ft. 6 in. (See mining table under Martin county.) Mr. Cox gave it an average of 2 ft. 6 in., but a majority of the coals quoted by him as Coal I ("A") do not belong in this horizon.

1445. CHARACTER.—As a rule, this coal is quite hard and firm, a good semi-block, resists weathering, shows little sulphur, but is frequently associated with shaly or bone coal. This may occur either at the top or bottom, or in the center. In places this bed appears to be entirely bone, while in other places it appears to be of unusual excellence. The following analyses made by Mr. Cox are from points where the coal is known to be Coal I.

MINE.	Location.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Horn & Co.	Sec. 3-2-4	42.50	52.00	94.50	2.50	3.00	5.50
Turner	Sec. 31-3-3	45.50	41.50	87.00	9.00	4.00	13.00
Munson's Ridge	Sec. 23-3-4	50.00	45.50	95.50	1.50	3.00	4.50
Willow Valley	Sec. 14-3-3	48.00	46.75	94.75	2.50	2.75	5.25

The bed can be recognized only by finding the Kaskaskia limestone a short distance below or the Mansfield sandstone a short distance above, either at the point where the coal occurs or at no great distance.

Coal I has been found of a thickness of 2½ ft. or over in the following quarter townships: T. 3 N., R. 4 W., N. W. and S. E.; T. 3 N., R. 5 W., S. E.; T. 4 N., R. 3 W., N. W.; T. 5 N., R. 3 W., N. W.; T. 3 N., R. 5 W., N. E. (T. 4 N., R. 5 W., N. W.?).

COAL Ia.—This coal bed, defined as the upper of two beds, where two coal beds occur below the Mansfield sandstone, was certainly noted at only one locality, about Mt. Pleasant, Martin county. It shows in a drilling on Mr. Hinton's farm, northwest of Mt. Pleasant, with a thickness of 1 ft., overlain by 10 in. of shale, and with 1 ft. of fire-clay beneath. Again it shows in the ravine south of Mt. Pleasant, near Trippy's, where it is 8 in. thick and overlain by heavy sandstone. If the workable coal in the ridge west of Dover Hill should prove to be Coal I, then Coal Ia occurs there, according to reports.

1446. DIVISION III.—This division is here defined as the coal measures of this county which lie above the Mansfield sandstone or

Division I. At a few points it is thought that the highest hills in the county may include small patches of Division IV, but as no workable coal is known at any of these points, it will be assumed for convenience that only Division III occurs in this county above Division I. At least three coals are known above the Mansfield sandstone, though as a rule only one or two of them are found. The lowest of these is frequently workable, and often of an excellent quality. Mr. Cox gives the following analyses of this coal, as found in Sampson Hill, south of Shoals:

MINE.	Location.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Baker, upper part	Sec. 8-2-3	51.25	44.75	96.00	1.50	2.50	4.00
Baker, lower part	Sec. 8-2-3	48.75	47.50	96.25	.75	3.00	3.75
Sampson Hill, bone at top	Sec. 6-2-3	28.50	25.00	53.50	41.00	5.50	46.50
Sampson Hill, middle	Sec. 6-2-3	53.00	44.00	97.00	1.00	2.00	3.00
Sampson Hill, bottom	Sec. 6-2-3	47.00	48.00	95.50	1.50	1.50	4.50

These analyses show a coal of unusual strength and purity.

In thickness this coal varies from 4 ft. or some over down, usually averaging where being mined about 3 ft. There is a parting in the middle in some places, but not always. It is, however, safe to presume that there are large areas where it is not workable, and that these greatly exceed the areas of workable coal.

As the coals that will be referred to here as Coal II will doubtless be found later to belong to one or the other of the horizons of Coal I or Coal III, they will not be separately discussed here.

Section 3. Distribution and Details of Coal.

TOWNSHIPS 5 AND 4 NORTH, RANGE 3 WEST.

1447. The coal in these townships is confined to the western half. The extent of the Mansfield as traced out by Mr. Price is shown on the large map. A factor of uncertainty exists in this line through the possible confusing of the upper Kaskaskia sandstone with the Mansfield. This certainly appears to have been done at Short Station and Harrisonville, as drawn on the field sheets, but has at those points

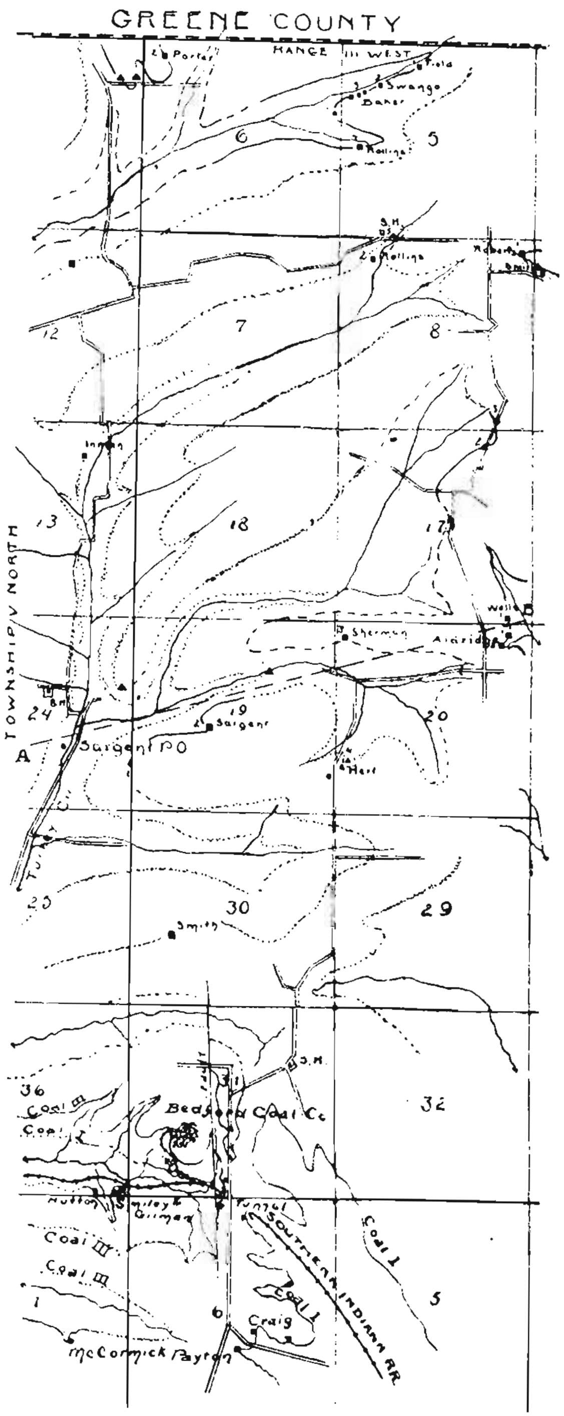
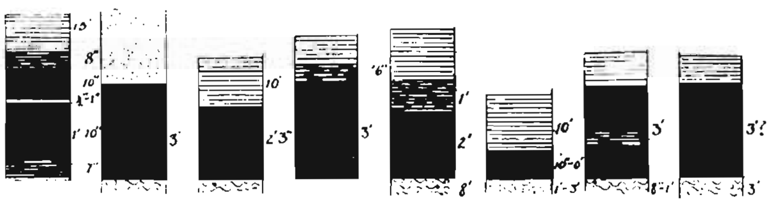


Fig. 626. Sketch map of parts of Ts. 4 and 5 N., Rs. 3 and 4 W., Martin County.

been at least partially corrected on the colored sheet. In the absence of coal, the main value of this line here is in showing the outcrop of the horizon of kaolin, which in this region replaces the coal. Kaolin is found abundantly in this county and always at the horizon of Coal I. It is also to be noticed that the two are never found at the same place, though often they occur but a short distance apart. Mr. Lesquereux suggested that the kaolin was the result of the burning out of the coal bed. He mentions that a clay ironstone overlying the kaolin looks as though it has been roasted. (L. L., p. 320.) The writer had come to the same theory from his observations in the field. In the first place, the absence of the coal where the kaolin occurs does not appear to be due to the thinning out of the coal; for, on the other hand, it was found in places that the coal which occurs often but a few rods away is of an unusual thickness, as, for example, on the Johnson and Chenoweth place, west of Shoals, the coal and kaolin are only separated by a narrow ravine. On the west, Coal I is about 3 ft. 4 in. thick, and apparently does not lie in a small pocket, while east of the ravine is found the kaolin in the same horizon. Moreover, in addition to the iron ore mentioned by Mr. Lesquereux, the deposit is frequently overlain by a soft pinkish sandstone (see W. S. B., pp. 102, 103). A similar sandstone is observed at a place on Roaring creek, in Parke county, where the bed of coal has been burnt out beyond all question. Instances of the burning out of a coal bed from the outcrop, while not common, are found from time to time, and several cases have been found in the progress of this survey, and numerous cases of coal mines burning are found to-day in this State, some of them having been on fire for nearly a score of years. The conditions in the latter case are, however, more favorable than where the coal burns from the outcrop. Another factor is the apparent resemblance often observed of baked fire-clay to kaolin. Whether an analysis in this case would show a close resemblance, I do not know. The theory that the kaolin of this region results from the action of the burning out of a coal bed on its underclay is simply given as a suggestion.

1448. Coal I is the principal coal of this area, and, as a rule, is, in this area, from 50 to 100 ft. above the main branches of Indian creek and from 50 to 150 ft. below the top of the divide between Indian and Boggs creeks. Its thicknesses at points where it is being mined are given in Figs. 629 to 634. According to these, which may be considered as maxima, it ranges from 3 ft. down. In two of the sections it is overlain by bone coal, and in one has a band of bone in the middle; otherwise it is solid. The roof in all the cases given is shale, though as a rule it is but a few feet above to the massive sandstone. This roof shale commonly contains many plant remains. As a rule, this coal is a caking or semi-caking coal, and usually appears to be of excellent quality.

1449. Coal III is, for the most part, confined to the higher parts of the divide. A fault in Sec. 31-5-3 throws the strata down about 40 ft. to the west and brings Coal III well down the ridge at that point, so that a higher coal is found over it. This was the only place where what was thought to be the coal above the Mansfield sandstone



627 Bedford Coal Co. Sec. 31. | 628 Porter. Sec. 6. | 629 Field. Sec. 5. | 630 Swango. Sec. 5. | 631 Smith. Sec. 9. | 632 S. I. R. R. Tunnel. Sec. 31. | 633 Craig. Sec. 6. | 634 Donihue. Sec. 17.

Figs. 627 and 628—Coal III in T. 5 N., R. 3 W.
Figs. 629 to 632—Coal I in T. 5 N., R. 3 W.
Figs. 633 and 634—Coal I in T. 4 N., R. 3 W.

beyond question was well exposed (see Fig. 635). It is there 3 ft. 4 in. thick, including 7 in. of bone coal at the bottom. It is overlain by 8 in. of shale and bone, then by 15 ft. of blue shale. The coal appears to be good.

The horizon of the coal at many points is yet in question. Beginning at the north, there may be mentioned the Amos Porter bank, in the N. W. ¼ of the N. W. ¼ of Sec. 6, Fig. 628. The coal is 3 ft. or less in thickness, underlain by fire-clay and overlain by sandstone or shale. The coal appears to be a good block, with an occasional clay seam. The horizon of this coal is in question.

Along the branch in the N. W. ¼ of Sec. 5 are a number of openings. The farthest north is the Field (formerly Davis) bank. The coal there is reported as 2 ft. 3 in. (Fig. 629). It is overlain by 10 ft. of bluish clay shale, with 1 ft. of sandstone showing above that. At the Swango bank, a short distance below, the coal measured 3 ft., with a few inches of bone over, then a shale roof (Fig. 630). The coal is a block or a semi-block. Below this there are a number of openings on the Baker place, and old openings on the Rollins place, in the S. W. ¼ of the section. An outcrop was noticed in the road in the S. E. of S. W. of this section that, by barometer, is 90 ft. above the coal at

Rollins, and was, therefore, taken as marking the horizon of Coal III. Down the branch from this, in the N. W. ¼ of Sec. 8, is a recent opening on the Rollins place. The coal here is reported as about 2 ft. 6 in. thick. In the N. E. ¼ of Sec. 8, coal was formerly stripped in the branch bottom on the Roberts place. The same coal is mined by a drift in the N. W. ¼ of Sec. 9, at the Smith mine. Here the coal shows 2 ft. of good coal, overlain by 1 ft. of bone (Fig. 631). The roof is shale, the floor fire-clay. Coal from the Roberts stripping is said to have been formerly wagoned to Bedford for blacksmithing, for which it was much liked. Though by barometer this coal was made 40 ft. above the coal at Rollins's, in Sec. 5, it would appear to be the same coal.

Outcrops of the upper coal were seen in the road in the S. E. ¼ of Sec. 8 and N. E. ¼ of Sec. 17.

In the S. E. ¼ of Sec. 17 and N. E. of Sec. 20, coal has been dug on the Wells and Aldridge places. The coal is here 83 ft. (bar.) below the top of the divide. There is a heavy sandstone outcropping both above and below this coal, and, though somewhat in question, is thought to belong at the horizon of Coal I. In the N. E. ¼ (?) of Sec. 20, coal has been dug on Sherman Brock's place. The coal is reported as 2 ft. 6 in. thick, not including 6 in. of bone. Its vertical position was not determined. In the S. W. ¼ of Sec. 20 there are reported to be four coals, as follows (Sect. 533):

	Ft.	In.
COAL ....6 in. to	..	8
Space ....14 ft. to	16	0
COAL	..	11
Space, mostly sandstone (?)	30	0
COAL ....18 in. to	2	0
Space ....10 ft. to	12	0
COAL	1	6?
	63	1

The highest coal would seem to be high enough to be in Division III.

In the S. W. ¼ of Sec. 19, Coal I? has been mined at the Sargent bank. The coal measured at the crop 2 ft. 1 in., with a clay shale roof. The coal is here 30 ft. (bar.) above the limestone, which, in turn, is 40 ft. above the creek.

In Sec. 30, Mr. John Smith reports two coal beds upon his place, 25 or 30 ft. apart. The upper bed he reports as from 2 ft. 6 in. to 3 ft. in thickness, and the lower bed the same. Their vertical position was not obtained.

In the N. E. ¼ of Sec. 31, the Mansfield sandstone reaches to the top of the ridge, and makes considerable bluffs just west of and below the road. Coal III is found in the highest part of the ridge, in the center of the section, but is cut out across the low places over the S. I. R. R. tunnel. The sections at the two ends of the tunnel are as follows (Sects. 534, 535):

West End.	*Ft.*	*In.*
Sandstone, hidden	....	...
Shale or shaly sandstone	6	0
Massive sandstone	8	0
COAL I .... 1 in. to	1	0
Sandstone, shaly at top	8	0
Clay shale, slate colored, with 7 thin beds of limestone	15	0
Limestone	6	0

East End.	*Ft.*	*In.*
Sandstone, hidden	....	..
Gray sandstone	6	0
Blue shale	10	0
Sandstone	4	0
Shale	10	0
Sandstone	3	0
Shale	10	0
COAL I .... 8 in. to	..	10
Sandstone .... 1 ft. to	3	0
Shale with thin beds of limestone (Kaskaskia)	20	0
Limestone	....	..

Just west of the tunnel the strata are faulted with a downthrow of about 40 ft. to the west (Fig. 635). This brings Coal III well down into the hill, though it is still 50 or 60 ft. above Coal I. Another coal, 3 ft. thick, is reported to be found 60 ft. above. Coal III is extensively worked here by the Bedford Coal Company. The workable coal measured in several places showed quite uniformly 2 ft. 9 in., with a ½ to 1

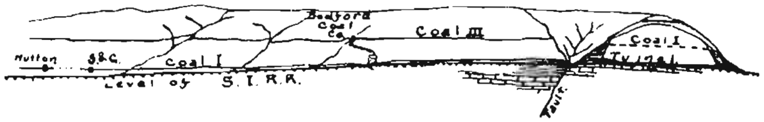


Fig. 635. Sketch showing position of Coals I and III at and west of the Southern Indiana Railroad tunnel.

in. parting 10 in. from the top. Below it is from 5 to 7 in. of bone, while over it is first 8 in. of shale and bone, then 15 ft. of blue shale. The lower bench is a good blacksmith coal, and all of it is good for steam or household purposes.

In T. 4 N., R. 3 W., coal is found in the S. E. ¼ of Sec. 5, on the John Cecil and J. Simpson places, the coal at the latter being 14 in. thick. South of the center of Sec. 6 considerable coal has been dug at the Payton and Craig banks. The coal at these mines runs about 3 ft. thick, including from 4 to 7 in. of bone coal at the center (Fig. 633). It all blocks out. The bottom is good for blacksmithing. The roof

is shale and the floor fire-clay. It was at first thought that this was the same coal as the Dobson or Bedford Coal Company's coal, but further investigation, including the finding of the fault mentioned above and the presence of the upper Kaskaskia limestone along the hill to the east and but at a slightly lower level, showed this to be Coal I. A short distance to the east and at a lower level occur bluffs of massive sandstone that strongly resemble the Mansfield, but the upper Kaskaskia limestone is found at the top of the bluff, showing that it is of Lower Carboniferous age. Coal I at Peyton's is about 100 ft. or over below the top of the ridge, so that it is probable that Coal III occurs in the ridge near the top.

In the N. W. ¼ of Sec. 17, coal has been dug on the Donahue place, and is reported as ranging up to 3 ft. thick, overlain by shale and underlain by 3 ft. of fire-clay. Coal has been mined here a little since the '50's. In the N. W. ¼ of Sec. 18, coal has been mined on the Porter place, where it is reported as 2 ft. thick. Judging from the elevation, this is Coal III. Coal I has also been found or mined from outcrop in the S. W. corner of Sec. 17, N. E. ¼ of Sec. 19, S. W. corner of Sec. 20. At the first of these, on the McBride place, the coal is said to be 18 in. thick and a cannel; at the second, on the Neal place, the coal is also said to be 18 in. thick.

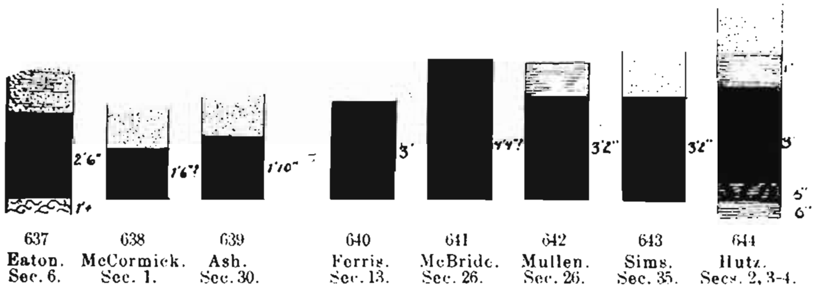
Townships 5, 4, and North Half of 3 North, Range 4 West, and 4 and 3 North, 5 West (part in Martin County.)

1450. Coals I and III are recognized in this area, with one or two additional minor horizons. Then there are coals found in the ridge west and north of Dover Hill and northeast of Loogootee, of which the position is in doubt, those near Dover Hill having the strongest affinities with Division I, those near Loogootee with Division III. They will be called Coal II, and may be said to represent all of the workable coal in the area.

Coal I, over the whole area where its position was not in doubt, was found to be a thin coal, nowhere going over a thickness of 2 ft. That it does go over 2 ft. in places is quite probable.

In townships 5-4 it underlies all but the main valleys, while Coal III is confined to the higher land north of Furse creek and around Burn City. Reports would indicate that some parts of the divide between Furse and Turkey creeks were high enough to catch Coal III, but no such points were seen here.

North of Furse creek, Coal III is reported in the S. W. ¼ of Sec. 2, in two places, and Coal I is said to have been 4 ft. thick in a drilling in the N. W. ¼ of Sec. 3. South of Furse creek, Coal I has been dug at the Inman place, in the N. E. ¼ of Sec. 13, in the S. W. ¼ of Sec. 11, and on the Osborn place, on the line between Secs. 20 and 21. The coal at the last mentioned place measured from 20 to 24 in. at the outcrop, but is reported to have been 2 ft. 6 in. of good coal in the



Figs. 637 to 639. Coal III in western part of T. 4 N., R. 4 W.
Figs. 640 to 644. Coal I or III? in divide between Indian and Boggs creeks, Ts. 3 and 4 N, R. 4 W.

mine. The roof is sandstone. Massive sandstone outcrops above it, and to what appeared to be the top of this sandstone was 90 ft. (bar.) above the coal. On a high point near Sargent P. O., in Sec. 24 (?), on about the same level as the coal worked by Mr. Sargent, in Sec. 19-5-3, there is an outcrop of Coal I, where it is said that the bed is represented by two benches, each 1 ft. thick, separated by 3 ft. of fire-clay, with irregular veins of coal running from one bench to the other (Fig. 645). The coal is here about 70 ft. above the level of Turkey creek. Going down the creek, the level of the coal is found to descend almost to creek level south of Huff Station or Blankenship P .O.

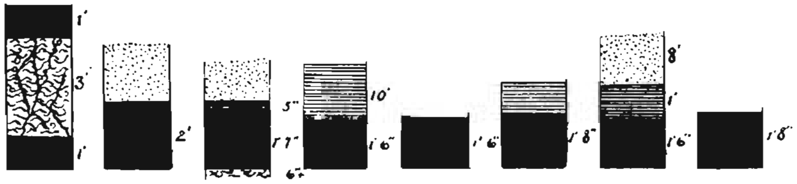
In the S. E. corner of Sec. 36, Coal I has been worked at the Smiley and Gilman bank, where the coal is 2 ft. thick, but the top 5 in. appears to be a bony coal. The roof is sandstone. The Kaskaskia limestone outcrops here, in the creek bank, less than 20 ft. below the coal. Just west of this an opening has been made by Mr. Hutton. The coal here is 29 in. thick, the bottom being a block and the top a bituminous coal.

Around Burn City is a considerable area of Coal III, though at but a slight depth. At the railroad cut east of town, in the S. W. ¼ of

Sec. 32, is an interesting illustration of the gradation from a non-bituminous clay shale to a bone or cannel coal. There is exposed from 10 to 12 ft. of shale, which, starting from a dark gray at the top, gradually becomes darker and more bituminous, until the bottom 3 ft. has in it enough carbonaceous matter to burn well, though leaving about half its bulk of ashes. It is said, however, by those who burnt what was thrown out in digging the cut, that the bottom of this bony coal burnt with but little more ashes than an average bituminous coal. Above the shale lies 10 ft. of soft, yellow, cross-bedded sandstone. All the strata have a strong dip to the southwest. Down the road to the east outcrops of sandstone suggest the presence of the Mansfield sandstone. At the cross-roads a mile west of Burn City coal is reported in a well at a depth of 8 to 10 ft. At a still lower level coal outcrops were noticed beside the roads to the east and south, as well as a mile north. This would seem to be about in the right position for Coal III. Still below this, in the bed of the branch on the W. L. Storms place, coal outcrops, supposed to be Coal I.

In T. 4 N., Rs. 4 and 5 (in part) W., the Kaskaskia limestone is found at numerous places along Boggs creek and up many of its branches, also in the eastward flowing branches in the southeastern corner of the area. The principal coal is a coal in the divide between Boggs and Indian creeks, in Secs. 13, 24, 25, 26 and 35, and it there appears to be the middle one of three coals. Outcrops of one coal are found in the top of the ridge by the roadside at a number of points, of which may be mentioned on the Ferris place, S. E. of N. E. of Sec. 13; Mitchell place, S. E. of S. E. of Sec. 13, in the S. E. of S. W. of Sec. 24; in the S. E. of S. W. of Sec. 23, N. W. of N. W. of Sec. 26; N. E. of N. E. of Sec. 27; S. W. of N. E. of Sec. 35, on Sims's place. These outcrops are all so near the summit of the ridge that the coal in a direction transverse to the direction of the ridge would usually have an extent of but a few rods. It nowhere appears to have been opened upon, so that its thickness and quality are unknown. It is probably thin. It undoubtedly lies above the Mansfield sandstone. Below this level there appear to be at least two or three coals.

Farther down the hill at a number of points occurs the worked coal mentioned above. At the Ferris place, Coal II was given as 50 ft. below the coal on the ridge, while 40 ft. below was still another coal, the top of the limestone as far as observed being 48 ft. (bar.) lower still. At the McDonald place the coal lies, by different barometric readings, 57 or 65 ft. below the coal on the top of the ridge. At the Sims bank, Coal II was 26 ft. (bar.) below the top coal. At Hutz's mine it was 24 ft. (bar.) below, while the limestone was first found down the branch 68 ft. lower still. In the west part of Sec. 23 coal outcrops in the road 100 ft. below the coal in the top of the ridge, while in Sec. 27, at the Lundy bank, it is 120 ft. below. These figures and other facts make it look as though the Hutz coal was not the lowest bed, though no coal was actually seen below it. It would appear that the lowest bed should be looked for at a depth of 100 to 125 ft. below the coal in the top of the ridge, while the workable coal appears to lie only from 25 to 75 ft. below. The following figures will show how Coal I ranges in thickness:



645	646	647	648	649	650	651	652
Sargent. Sec. 24, 5-4.	Osborn. Sec. 21, 3-4.	Smiley & Gilmore. Sec. 36, 5-4.	Banks. Sec. 2, 4-4.	Stiles. Sec. 25, 4-4.	Lundy. Sec. 27, 4-4.	Paint Bank. Sec. 2, 3-4.	Dawson. Sec. 10, 4-4.

Figs. 645 to 652. Sections of coal I in Ts. 3-5 N., R. 4 W.

Beginning in the northeastern part of the township, Coal III is found near the top of the ridge, in Secs. 1, 2, 11 and 12. It has been dug into on the McCormick place, where it appeared to be about 18 in. thick, with a sandstone roof and shale above that. It is struck in a well and outcrops on the Baker place, in the S. W. of Sec. 2 and N. E. of Sec. 10. A wagon load of coal is said to have been taken out at one point in a ravine here that, by barometer, is 125 ft. below the upper coal, but 28 ft. above the lowest coal. Coal I has been worked on the Banks place, N. E. ¼ of Sec. 2, where 18 in. of coal was exposed at but a few feet above the level of the creek. It is overlain by 10 ft. of shale. At the Baker bank, in the S. E. ¼ of Sec. 3, the coal measured 18 in., overlain by shale. It is reported as good for steam purposes, but not for blacksmithing. The dip is here to the south. The same bed also, just above the level of the bottom of Boggs creek, has been worked on Mr. Bowers's place, in north part of Sec. 10, and Andris's place, in S. W. ¼ of Sec. 3.

Three or four coals are reported on the Ferris place, in the N. E. ¼ of Sec. 13. One of these, well down the ridge, is workable, being reported to be 3 ft. thick; 40 ft. below is reported to be a 6-in. bed, and 50 ft. above, another bed, while at the highest point of the ridge

is still another. Which of these two uppermost beds corresponds with the coal in the top of the ridge farther south is not certain, but it seemed to be the lower, as the upper appeared to be 30 or 40 ft. higher

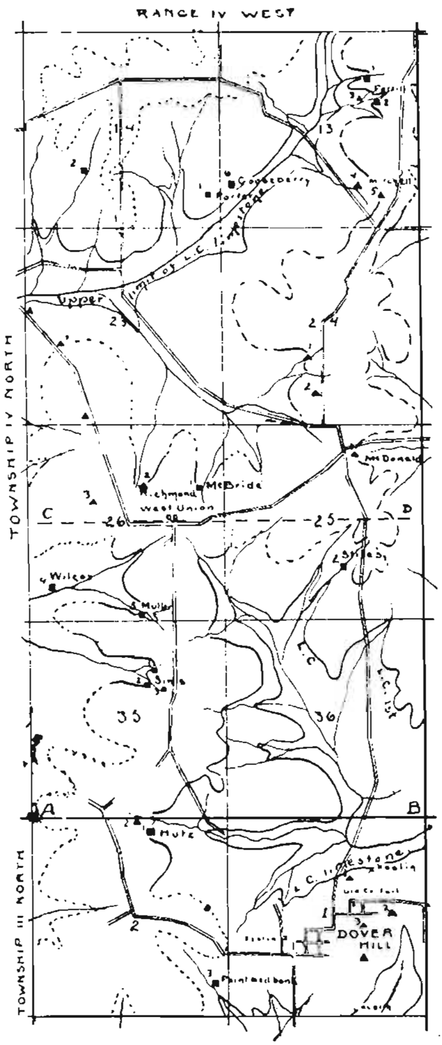


Fig. 636. Sketch map of part of Ts. 3 and 4 N., R. 4 W., Martin county.

than the two nearest outcrops of the top bed to the south. At John Mitchell's, two beds outcrop 63 ft. (bar.) apart. The upper one is near the top of the ridge. From outcrops on the east side of the ridge it would appear that the lower bed was less than 3 ft. above the limestone. Coal I is reported to have been worked a little on the Gooseberry and Porter places, in the S. W. ¼ of Sec. 13 and S. E. ¼ of Sec. 14. Coal was also struck in the S. W. ¼ of Sec. 14.

In Sec. 23 an outcrop of Coal I was noticed about 40 ft. above the level of the creek, while 100 ft. higher is found outcrops of the coal on top of the ridge. At 53 ft. above the lower bed an outcrop of fire-clay was noticed which was thought might indicate the position of Coal II; considerable sandstone shows about 15 ft. above the lowest bed. In Sec. 25 outcrops were reported at the top of the ridge in the S. E. of S. W. ¼, and at lower levels in the N. E. of S. W., and in the S. E. ¼. In Sec. 25, coal is found on the McDonald place, just below the forks of the road, in the N. E. ¼, and on the Albert Stiles place, in the S. W. ¼. The coal at Stiles's appeared to be but a few feet above the limestone, while at McDonald's, which the barometer made 40 ft. higher, it was 88 ft. down the branch to the northeast to the limestone. In this, as in many other cases, it may be that the upper Kaskaskia limestone is wanting. The coal at Mr. Stiles's is from 16 to 20 in. thick and said to be of good quality. In Sec. 26 the ridge coal outcrops at several points. North of West Union Schoolhouse, coal is said to have formerly been worked by Mr. McBride and is reported to have been 4 ft. 4 in. thick. In the S. E. ¼, Coal II has been dug some on the Mullen place, where it measured 3 ft. 2 in. The roof is shale and poor. Coal is reported as having been found at several places on the John Richmonds place, near the center of Sec. 26. In Sec. 27, coal 20 in. thick has been dug some. This is well down towards the level of Boggs creek. In Sec. 35, Coal II has been mined some on the Sims place, where it runs a little over 3 ft. While in places it carries a good deal of sulphur, in places it is said to be a good blacksmith coal. At the south line of this section Coal II was formerly mined extensively at the Hutz bank. It is said that this mine at one time practically supplied the town of Shoals with coal, which indicates a good grade of coal. Poor methods are said to have caused the trade to go elsewhere. The section given by Mr. Cox showed 3 ft. of good coal overlying 6 in. of bone coal. Over the coal is 6 to 12 in. of bluish shale, then a bluish sandstone resembling closely that over Coal III at Sampson Hill. A coal said to be 3 ft. thick is reported to outcrop 24 ft. above. Whether this is the coal at the top of the ridge farther north could not be told. According to the barometer, a considerable mass of sandstone outcropping a quarter of a mile northeast appears to come between the two coals in level.

West of Boggs creek, in T. 4 N., R. 4 W., coal was only seen at a few places. Coal III at the Eaton mine has already been mentioned.

In Sec. 7, Coal I (?) has been found on Mr. John D. Laughlin's from 22 to 28 in. thick, N. E. ¼; also on Mr. John G. Tonn's place, in the S. E. ¼. Coal I here seems to lie just above creek level. Down the creek, in Sec. 16, the Lower Carboniferous limestone is well exposed. Coal I is reported to outcrop a little north of the schoolhouse, east of the center of Sec. 16. Well up on the ridge, in the S. W. ¼ of Sec. 9, Coal III is said to have a thickness of 2 ft. North of the center of Sec. 21, two outcrops of coal are seen in the road, 25 ft. apart, and the lower 80 ft. above the limestone. In the S. W. of Sec. 20, coal is reported to have been struck in a well on the Ash place; this is but a little above the creek bottoms. In the N. E. of Sec. 30, coal has been mined a little; also on the Ash place. The coal measured 22 in., with a sandstone roof; thought to be Coal III.

In the eastern row of sections of T. 4 N., R. 5 W., which is in Martin county, Coal I has been worked or found at a number of places. In Sec. 12, at the Raggles place, in N. E. corner, reported 18-20 in. thick; on John D. Laughlin's, S. E. of N. E., 18 in. thick; on Martin Keller's place, S. E. ¼, 22 in. thick, and on the Woodruff place, also in the S. E. ¼. On a small branch in the S. E. ¼ of Sec. 13 coal has been worked on the Strange place, N. E. of S. E., where the coal is reported 23 in. thick; Miles place, N. W. of S. E.; Keck place, where, at three openings, the coal measured 21, 24 and 26 in., respectively. The roof in each case is sandstone, the floor fire-clay, 2 or 3 ft. thick at least. Just a little south of these, 20 in. of coal has been stripped on the Hynes place.

In the N. E. ¼ of T. ~~4~~ 3 N., R. ~~3~~ 4 W., a coal was noticed on the Dover Hill-Shoals road, in the N. E. ¼ of Sec. 13, and the same coal was dug into many years ago on the Grant Sanders place, in the S. W. of Sec. 12, which appeared to lie just above the coarse, gritty sandstone supposed to characterize Division I. By the barometer, however, this coal is only about 35 ft. above outcrops of Kaskaskia limestone, a short distance north. Whether a high south dip comes in between was not determined. A section at Dover Hill, made by Mr. Lesquereux, gave as follows:

1451. SECTION 536. SECTION AT DOVER HILL.—(L. L., p. 320.)

	Ft.	In.
1. Covered space	10	0
2. "Millstone grit"	70	0
3. Sandstone and ferruginous shales	20	0
4. Carbonate of iron	3	0
5. Chocolate-colored soft shales, with plants	7	0
6. COAL, somewhat shaly (I)	3	0
7. Ferruginous fire-clay	10	0
8. Sub-carboniferous, oolitic limestone to creek	5	0

A section of Dr. Sims's well, as given by him, is as follows:

1452. SECTION 537. SECTION OF WELL AT DOVER HILL.—

		Ft.	In.
1.	Surface	9	0
2.	Sandstone	60	0
3.	Fine-grained shaly sandstone	60	0
4.	Horizon of Coal I	..	..
	To kaolin and limestone	..	..

It was claimed there that 18 in. of good coal had been dug into at points just south and east of town and at a much higher elevation than the horizon of Coal I as given in these sections. Just north of Dover Hill, Coal I is reported as occurring 30 or 40 ft. above the top of the limestone, while half way up the hill a 10-in. bed of coal had been found. At a number of places around Dover Hill, kaolin replaces Coal I. At Yarnell's, just north, the kaolin is 3 to 5 ft. thick. A quarter of a mile west of the old court house site, 1 ft. 6 in. shows in the road, and a half mile south of town a hole in the branch was dug into kaolin.

In the S. E. corner of Sec. 2, Coal I has been dug into, where it is 16 to 18 in. thick and overlain by, first, 1 ft. of black shale, then forming the roof is a bed of massive sandstone 8 ft. or more thick. The dip is to the southwest and seems to contain a good deal of sulphur. A short distance below there is a heavy deposit of variously tinted, ferruginous shale and clay. In Mr. R. Owen's report is an interesting picture and section combined of this locality, which gives about as follows for the section at this place:

1453. SECTION 538. SECTION AT PAINT BANK.—Sec. 2-3-4. (R. O., p. 174.)

		Ft.	In.
1.	Sandstone in background.....about	60	0
2.	Shale	3	0
3.	COAL.....2 ft. to	4	0
4.	Potters' clay.		
5.	Iron ore and paint.		
6.	Archimedes limestone to creek.		
	Nos. 4, 5 and 6 amount to from 15 ft. to	18	0

An attempt was once made to manufacture paint here on a large scale.

Coal I keeps above drainage in most of this quarter township, and in addition to the places named has been found on the Haines place, S. E. of S. E. of Sec. 11, where it is reported 2 ft. thick, and is overlain

by gritty sandstone; Isaac Dawson's place, in S. E. of S. E. of Sec. 10, where it is 18 to 20 in. thick and lies only about 15 ft. above an outcrop of Kaskaskia limestone in the creek. Also on the Taylor Stanley place it is 18 in. thick and underlain by a fine, white, chalk-like clay.

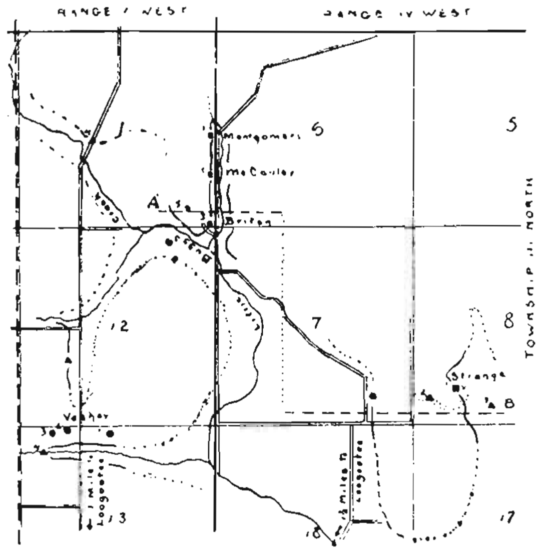


Fig. 653. Sketch map of parts of T. 3 N., Rs. 4 and 5 W.

In the N. W. ¼ of T. 3 N., R. 4 W., and Secs. 1, 12 and 13 of T. 3 N., R. 5 W., Coal I outcrops at a number of places along Buzzard run, in Secs. 16 and 17, lying just at or a little above creek level. West of Boggs creek is some workable coal, of which the stratigraphical position is in doubt.

The following sections were obtained in this area:

1454. SECTION 539. SECTION ON VANHOY PLACE.—1½ mi. north of Loogootee, from drilling by Mr. Paul Hinton, Fig. 654.

		Ft.	In.
1.	Surface	4	0
2.	Sandstone	12	0
3.	Shale	1	0
4.	COAL	1	3
5.	Fire-clay	7	0
6.	Shale	10	0
7.	Limestone, impure	1	4
8.	Shale	9	0
9.	COAL	..	6
10.	Fire-clay	3	0

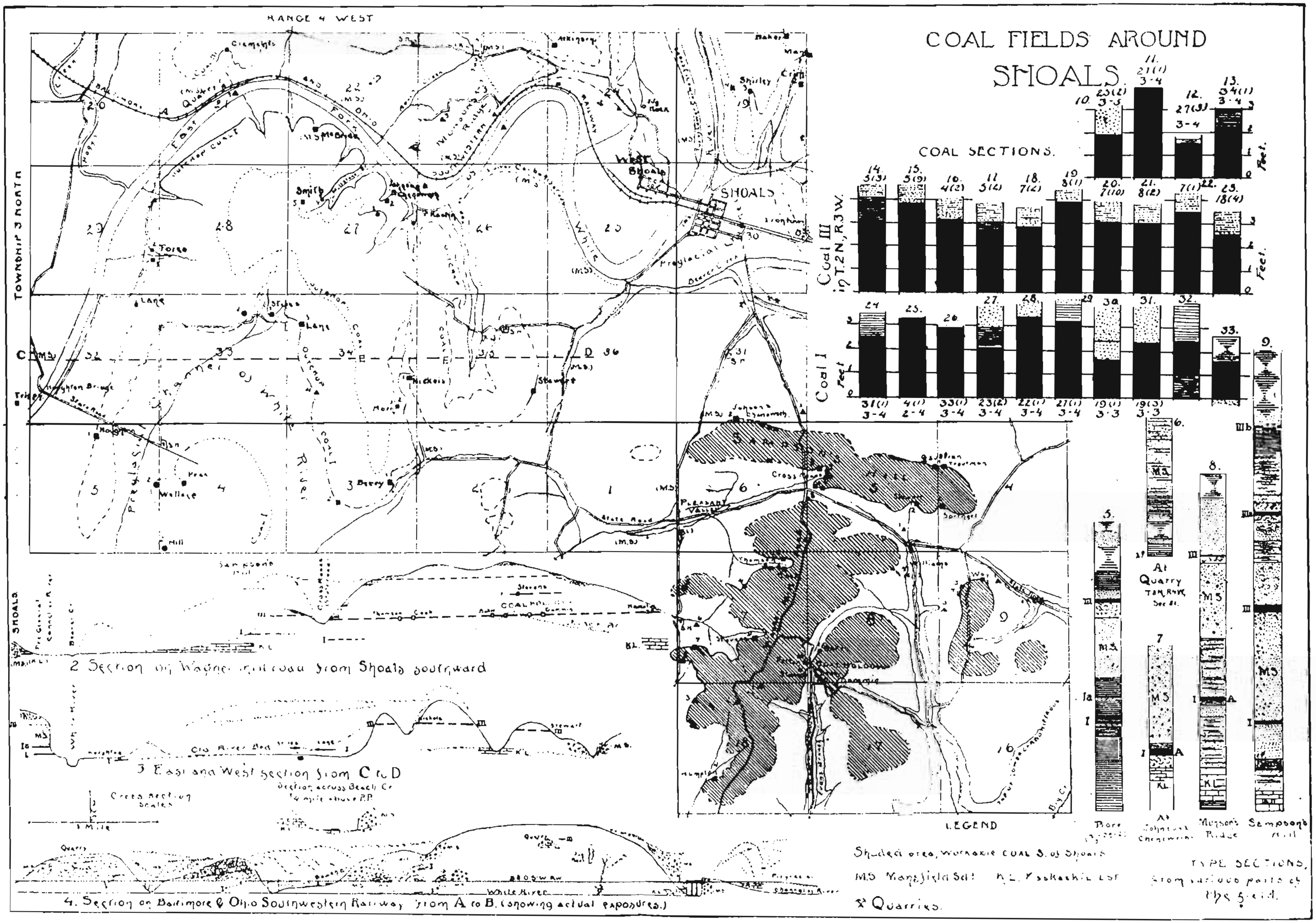
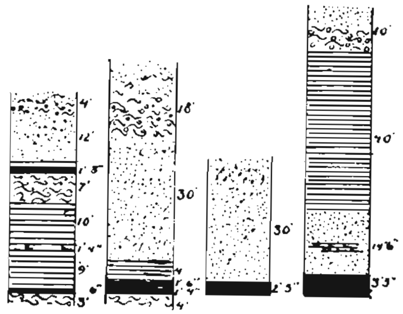


PLATE XLVIII.

1455. SECTION 539A. SECTION OF DRILLING ON VANHOY PLACE.—On hill back of coal mine, Fig. 655.

		Ft.	In.
1.	Surface	18	0
2.	Sandstone	30	0
3.	Shale	4	0
4.	Black shale, like cannel coal	1	6
5.	COAL	1	4
6.	Fire-clay	4	0



654 VanHoy. Sec. 13, 3 5. — 655 VanHoy. Sec. 13, 3-5. — 656 Briton. Sec. 1, 3-5. — 657 Strange. Sec. 8, 3-4.

Figs. 654 to 657. Columnar sections in area of sketch map—Fig. 653.

1456. SECTION 540. SECTION IN S. E. ¼ OF SEC. 7-3-4.—Fig. 657.

		Ft.	In.
1.	Surface	10	0
2.	Shale	40	0
3.	Hard limestone, with limestone	14	6
4.	COAL	3	3
5.	Bone coal	1	0

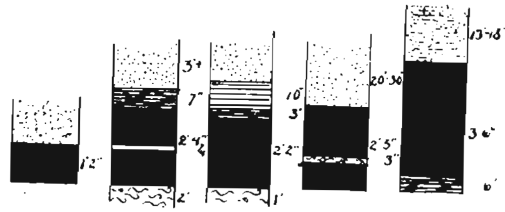
1457. SECTION 541. SECTION AT BRITON BANK.—Sec. 1-3-5, Fig. 656.

		Ft.	In.
1.	Sandstone	30	0+
2.	COAL	2	5
3.	Fire-clay	..	..

1458. SECTION 542. SECTION AT STRANGE BANK.—Sec. 8-3-4, Fig. 662.

		Ft.	In.
1.	Drab shaly sandstone	13 ft. to 18	0
2.	COAL	3 ft. to 4	0
3.	Fire-clay	4	0

At the Strange bank there is reported to be another coal 40 ft. below or in the position of Coal I. Mr. Hinton claims that the coal 40 ft. below is the same as the coal being mined, and that a fault comes between. One thing favoring that view is that at the Strange bank the coal dips 25 ft. in the first 150 ft., and in a drilling on the west side of the hill (Sect. 540) is 42 ft. below high water, or lower than the lower coal on the east side of the ridge. The coal is said to rise rapidly to the north and south of the entrance.



658 Sec. 12, 5-3. — 659 Montgomery. Sec. 1, 5-3. — 660 McCauley. Sec. 1, 5-3. — 661 Briton. Sec. 1, 5-3. — 662 Strange. Sec. 8, 4-3.

Figs. 658–662. Coals in area of sketch map of Fig. 653.

In many ways the coal at the Strange bank resembles Coal III as developed in Daviess county. It has a parting about in the middle of cannel-like coal, ½ to 1 in. thick.

About 50 ft. above is an outcrop of a coal bed reported to be 16 or 18 in. thick.

In Sec. 1-3-5, coal is worked at several places along the eastern section line. At the Briton bank the coal is 2 ft. 4 or 5 in. thick, with 3 in. of fire-clay coming 10 in. from the bottom. The roof is sandstone, said to be 20 or 30 ft. thick in the air-shaft. The floor is fire-clay. The coal is said to be a non-caking coal.

At the McCauley bank, farther north, the coal measures 2 ft. 2 in., with 2 or 3 in. of bone over. Above that is 8 or 10 in. of drab shale, then sandstone. The coal shows no parting. The floor is fire-clay, 1 ft. being exposed. About 200 yds. farther north some coal has been mined on the John Montgomery farm. The section shows (Sect. 543, Fig. 659):

		Ft.	In.
1.	Sandstone	3	0+
2.	Bone coal	..	7
3.	Upper bench of COAL	1	2
4.	Clay	..	¼
5.	Lower bench of COAL	1	2
6.	Fire-clay	2	0+
7.	Shale	6	0+

The same coal outcrops in the S. W. ¼ of Sec. 1. This coal is here above high water. It has a strong resemblance to the Strange Bros.'s coal in many ways, yet to assume that it is the same is to assume a fault or sharp fold with downthrow or dip to the east or southeast amounting to at least 45 ft. If the theory be correct that the coal at the Strange bank is the same as the coal in the creek bed 40 ft. below, we should have here two parallel faults with a combined downthrow of over 80 ft. The question requires for its solution more careful work than we have had time to give it. The Briton coal outcrops again in the S. W. ¼ of Sec. 12, where it is 14 in. thick, overlain by sandstone. In the N. W. ¼ of Sec. 13 the coal outcrops and has been dug on the VanHoy place; the sections given above show the stratigraphy there.

Distribution in T. 3 N., R. 3 W.

1459. This township contains practically only Division I. Its distribution is indicated on the map. Coal I is everywhere well above drainage, on the eastern side of the township getting well up toward the hilltops, while on the western side it is usually only 20 to 70 ft. above White river, and at Shoals what has generally been assumed to be Mansfield sandstone forms a perpendicular bluff extending below the bed of White river. There appear to be two beds here below the Mansfield.

Coal I has been mined some on the Field place, in Sec. 3. The gritty sandstone shows above the drift. Coal is reported to have been taken from two levels in the N. ½ of Sec. 10. These levels are 43 ft. (bar.) apart, and the limestone is reported to outcrop at least 40 ft. lower and a quarter of a mile down the branch. These figures raise some question as to whether one or both of these coals may not be above the Mansfield sandstone. In the southeastern quarter township coal was seen only at the Harding bank, in the N. E. ¼ of Sec. 26. The coal here measured 17 in., overlain by 6 ft. of clay shale, then massive sandstone. Below is 2 ft. of fire-clay, and the Kaskaskia limestone lies but a few feet below. No coal was seen at what was thought to be the horizon of Coal I, in Secs. 35 and 36. Coal 18 in. thick is reported in wells in the S. E. ¼ of Sec. 34, on the Tomlinson place. In the northwestern quarter township, Coal I has been mined at the Albert Towl bank, in the N. E. ¼ of Sec. 16. The coal here is 16 to 18 in. thick, a semi-block of apparently good quality, burning without clinker to a white ash. In Sec. 16, Coal I has been found at a number of points all around the Simon and Thomas Asbell places, coming about 75 ft. below the top of the ridge and 60 or 70 ft. above the river. It has also been worked on the Henry Holt place, S. W. corner of Sec. 17, by Mr. Stout, being 18 in. thick there. The limestone is reported to outcrop about 40 ft. below. A little southwest in Sec. 18 it is worked at the Baker bank, being from 20 in. to 2 ft. thick, but the lower 1 ft. of that is bony, leaving only 1 ft. to 0 of good coal. It is overlain by 2 ft. of shale and underlain by 2 ft. of fire-clay.

In the S. W. ¼, Coal I has been worked at the Mann bank, in the N. W. of N. W. of Sec. 20; at the Crim bank, in the N. E. ¼ of Sec. 19, and at two places at the Brisco banks, on Dr. Shirley's land. The coal here is reported to be 2 ft. 4 in. thick. It is overlain by soft sandstone, while sandstone crops out abundantly in the creek bank near by and at a higher level. On the west side of this ridge the coal is said to be 16 in. thick. It is claimed that Mr. Joseph Girkin struck 3 ft. of coal in a well in the south edge of Sec. 20. Coal I has been worked at the Gaddis mine, in the N. E. ¼ of Sec. 29. Coal I has been exposed at several places in Sec. 32, but nowhere workable as far as learned.

Coal I has been opened in the S. E. ¼ of Sec. 31, on the Fordice land. It is here only 30 or 40 ft. below Coal III.

At Shoals the Mansfield sandstone shows as a bluff of massive sandstone 40 ft. high at the river back of the high school. It is strongly cross-bedded, as seen on Main street just north of the railroad, "composed of loosely cemented, coarse sand, with some mica and numerous well-rounded quartz pebbles." In the northern part of town it is said that the wells strike limestone instead of sandstone, suggesting either faulting or nonconformity.

Distribution in Southern Half of T. 3 N., R. 4 W., and Secs. 24, 25 and 36 of T. 3 N., R. 5 W.

1460. Considering first an area north of White river, beginning at Shoals, we have there, as noted above, the Mansfield sandstone, extending below the bottom of White river. A short distance up the river, on the west side, Division I is well exposed at the "Pinnacle," where the sandstone shows in a vertical cliff, estimated from 110 to 170 ft. high, this being underlain at the base by 10 ft. of Kaskaskia limestone. A few yards north of the junction of the two roads running north from West Shoals is an interesting example of the weathering of the massive sandstone, known as the "Jug Rock." It stands near the center of a narrow ravine, but a few rods from its head. It is a columnar mass of cross-bedded sandstone, 42 ft. high, 16 ft. in diameter near the base, but, bulging somewhat, narrows toward the top to about 5 ft. and is capped by a slab of much harder stone 23 ft. in diameter. The lower part is quite conglomeritic. (See Fig. 663.) The highest part of the ridge near the Jug Rock seems to be high enough to catch Coal III, of which some traces were found near the center of Sec. 24. Almost below where the road turns north to Dover

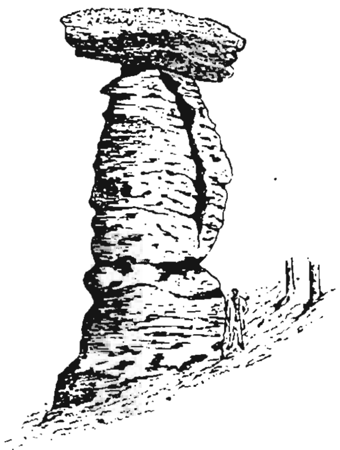


Fig. 663. Sketch of "Jug Rock" (omitting background). Situated in a ravine, half a mile north of the court house.

Hill, on the south face of the ridge, the sandstone has been quarried some. Through Sec. 24 the hill slope facing the river and railroad shows numerous bluffs of sandstone, and near the railroad are many blocks of conglomerate which have fallen from above. Following the railroad a little over a mile from Shoals, the Kaskaskia limestone is seen well above the railroad track and 40 ft. or more above the river bed at Shoals, indicating either faulting, unconformity or a strong east dip between. No evidence of east dip was seen. The top of the limestone here is about 18 feet above the railroad, and 12 ft. thick. Then, for 750 ft., the sandstone lying on the limestone is continuously exposed north of the track, the line of contact being about 12 ft. above the track. A little farther on, partly concealed, the limestone is below the level of the track. A short distance beyond a coal bed appears in the face of the cliff above the railroad. A section by Mr. Cox, believed to be at this point, gave as follows (Sect. 544, E. T. C., p. 89, Fig. 8):

		Ft.	In.
1.	Soil and "drift" (beyond limits of drift)	20	0
2.	Thick and thin bedded sandstone	35	0
3.	COAL III ("B")	?	?
4.	Fire-clay	?	?
5.	Massive conglomerate	65	0
6.	Iron ore	2	6
7.	Black shale, with coal plants	3	0
8.	COAL I ("A")	2	6
9.	Brash coal	..	10
10.	Potters' clay	7	0
11.	Sandy shale	25	0
12.	Oolitic limestone	30	0
13.	Clay shale	5	0
14.	COAL	..	6
		196	4

The crest of the ridge is low just at this point, and as far as exposed the section obtained here was as follows (Sect. 545):

		Ft.	In.
1.	Top of ridge, at this point the conglomerate seems to lie above this level, some fragments of it being found on top of the ridge here, but none below.	..	..
2.	Thin bedded shaly sandstone	24	0
3.	Ferruginous shaly sandstone	10	0
4.	COAL I	1	8
5.	Bone coal	1	0
6.	Shale	3	0
7.	Sandstone	6	0
8.	Hidden	12	0
9.	Sandstone to railroad track	18	0
10.	Concealed to river	..	..

As the coal is cleanly exposed in the bluff for some distance, a series of measurements were made to show the variations in it (see Fig. 7, Part I).

	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Ferrug. sandstone	10	0	10	0	10	0	..	..	..	..
Bone coal	..	..	..	..	0	10	0	7	0	6
Coal	1	8	1	8	0	10	0	9	0	6
Parting	..	..	0	¼	0	2½	0	½	..	..
Coal	..	..	..	..	..	..	0	½	..	..
Parting	..	..	..	..	..	..	0	3	..	..
Bone coal	1	0	1	1	0	11	1	0	1	0
Parting	..	..	..	..	0	6	0	3	..	..
Shale	3	0	3	0	9	0	6	0	2	0

About 1,000 ft. beyond, the dip becomes sharp to the west and carries the coal below the track, it being overlain here by 15 to 20 ft. of shaly sandstone. For 100 yds. the strata are hidden, then for 30 or

40 ft. a 12-ft. bluff of limestone faces the track. Above it is 8 or 10 ft. of shale, then sandstone. For the next 100 yds. traces of the limestone are seen, suggesting its presence; then the sandstone dips down sharply and appears to replace the upper half of the limestone, as though unconformable. For the next 100 yds. the limestone shows a thickness of 12 or 15 ft. above the level of the track. Then the sandstone comes down to the track and to the end of the ridge, in the N. W. 40 of Sec. 26, the sandstone makes perpendicular cliffs 75 ft. high, very coarse grit or fine conglomerate in composition, and with a marked dip to the south or southwest. (See Fig. 4, Plate XLVIII, p. 954.)

Going up Beech creek, Coal I is reported to have been found in the N. W. of S. W. of Sec. 23, just about on a level with the bottoms of the creek. At the Dover Hill-Loogootee road, on the east side of the valley, the Mansfield sandstone makes a bluff extending below the level of the bottoms, while on the west side the Kaskaskia limestone outcrops 15 or 20 ft. above the bottoms. Whether these numerous jumps are due to faulting or to nonconformity can not be told. That they are not due to rapid eastward dips would seem probable from the fact that no east dips were observed, notwithstanding the abundant exposure of rock. And, while it seems quite probable that part of this is due to unconformity, the rapid dips met with east of the several displacements, as well as the different elevations at which Coal I or other members of Division I are found, suggest that faults are largely responsible for the conditions observed. In the N. W. 40 of Sec. 24, Coal I outcrops on the Robert Atkinson place; including the bone and all, it is said to measure about 3 ft. It is overlain by soft sandstone. It is here over 40 ft. (bar.) above the level of the bottoms of Beech creek.

Across the north part of Sec. 22 the road crosses a low divide, so low and broad as to suggest a possibility of its once having been the channel of White river. The present river channel, just south of this, is comparatively narrow, with a precipitous bluff on the north, which adds strength to the theory that the river here, as at Shoals, cut across a projecting point. The limestone outcrops at a spring in the N. W. ¼ of Sec. 22, overlain by massive sandstone. Along the railroad south of this the dip is quite strongly to the west. At the east end of the bluff the section shows 30 ft. of thin-bedded shaly sandstone, overlain by 40 ft. of massive sandstone. At 200 yds. farther west the dip has brought the bottom of the massive bed to within 5 ft. of the level of the track, a dip of 4 ft. in 100. Just north of the center of Sec. 21 comes another high bluff. The following section shows above the railroad.

1461. SECTION 546. SECTION NEAR QUARRY.—Sec. 21, Fig. 6.

		Ft.	In.
1.	Heavily bedded sandstone	10	0
2.	Shaly sandstone, much of it heavily bedded, 30 ft. to	40	0
3.	Shale and sandstone	10	0
4.	Hidden	3	0
5.	Sandstone	3	0
6.	Shale, black	5	0
7.	Level of COAL I (?), reported	1	6

The coal is but a little below the level of the railroad here. There is reported to have been found 22 in. of coal in the river bed at this point. Above the section given and back from the face of the bluff, Coal III has been mined some at the Clements bank. The coal here is reported at from 3 to 4 ft. thick, the upper part of the coal being said to be the best. The abundance of geodes at this point has already been referred to; the geodes vary from ¼ in. to 4 or 5 in. in diameter.

In the S. E. ¼ of Sec. 18 is an exposure of massive sandstone close to the railroad track that is supposed to be Mansfield sandstone, and if correctly correlated it would indicate that Coal I was little, if any, below drainage. A drilling in the same quarter section by Mr. Hinton is reported to have shown 7 ft. of "hard rock" at 100 ft., overlain by shale, with sandstone most of the way down.

At Loogootee it is reported that a well sunk by the railroad company for water struck 2 ft. of coal at a depth variously given as 75 or 90 ft. At the station and down the track to the east exists a preglacial channel, now filled up. In the north part of town coal is reported in a well at 15 ft. at a level that would bring the seam about 8 ft. below the level of the station. This coal is supposed to overlie the Mansfield sandstone as exposed down the track to the east.

Southeast of Loogootee, on the Mt. Pleasant road, was noticed the outcrop of a bed 48 ft. above the coal bed at Loogootee. Along the west bank of the river, in Secs. 29 and 32, can be traced the bed of massive sandstone mentioned in Sec. 18. Just east of Mt. Pleasant this is exposed in a perpendicular cliff, and is, not without some question, correlated with the Mansfield sandstone. It is underlain by one or two coals which have been dug into at several places around Mt. Pleasant. They were best exposed at Mr. Trippy's, just south of town. In a ravine there was observed a 4-in. seam of coal in the center of 10 to 12 ft. of shale. At 37 ft. (bar.) below, with sandstone between, is an 8-in. bed of coal, overlain by massive sandstone. At 15 ft. (bar.) lower, and near the mouth of the ravine, is found a bed of coal composed of 4 in. of good coal at the bottom, then 4 in. of bone, then 22 in. of good coal, with a shale roof (Fig. 24). The coal has long been stripped here and appears to be quite free of sulphur. Numerous geodes have weathered out of the sandstone in this ravine. Also was noticed an old sandstone stump which had been found standing up through the coal.

The following section of a drilling by Mr. Hinton on the Hinton farm, in the S. E. of Sec. 25, is said to start below the highest coal in this ridge and is supposed to have struck the surface coal at Loogootee, and below went into the two coals at Trippy's. It gives a good columnar section at this point:

1462. SECTION 547. SECTION OF DRILLING ON MR. HINTON'S FARM.—In a hollow, Sec. 25-3-5, Fig. 5, of Plate XLVIII.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	10	0	..	..	10	0
2. Shale	10	0	..	..	20	0
3. Sandstone	5	0	..	..	25	0
4. COAL III	2	0	2	0	27	0
5. Fire-clay	8	0	..	..	35	0
6. Sandstone	35	0	..	..	70	0
7. Shale	10	0	53	0	80	0
8. COAL Ia	1	0	1	0	81	0
9. Clay	1	0	..	..	82	0
10. Shale	10	0	11	0	92	0
11. COAL I with 1 ft. band in center	4	6	4	6	96	6
12. Fire-clay	1	0	..	..	97	6
13. Blue shale	53	0	..	..	150	6

SECTION 548. SECTION IN HOLLOW.—Half a mile south of last, Sec. 36-3-5.

	Ft.	In.
1. Surface	4	0
2. Sandstone	4	0
3. Yellow clay	3	0
4. Sandstone	40	0

On the Brooks place, in the S. E. ¼ of Sec. 36, it is said that at a depth of about 80 ft. from the top of the hill or 40 ft. below the level of Friends' creek, 6 ft. of coal was found overlain by 40 ft. of shale.

South of White river, in this township, Coal I lies just above drainage. At the Johnson and Chenoweth bank, in the N. E. ¼ of Sec. 27, the coal is from 2 ft. 6 in. to 3 ft. 6 in. thick, with from 6 in. to 3 ft. 6 in. of black shale separating it from the Mansfield sandstone, which is here conglomeritic and massive, 40-50 ft. thick. Below is 3 ft. and over of fire-clay, then comes the Kaskaskia limestone. Some of this coal was seen that was claimed to have been exposed to the weather

seven years, and it appeared as solid as when freshly mined, indicating an unusual degree of purity. Coal was mined at this point at a very early day, and shipped down the river in flat boats. An attempt was at one time made to mine this coal extensively and carry it across the river on a wire rope, but the equipment failed to work satisfactorily, and the attempt was abandoned. Just east of this, across a small branch known as Millstone branch, the coal is replaced by a 4 ft. 6 in. bed of kaolin, or, according to the suggestion above, it would be said that the coal had burnt out, kaolinizing the underclay, which now is all that lies between the Kaskaskia limestone and the Mansfield, which rises in a bluff above it for 40 ft. The kaolin is 4 ft. 6 in. thick. Just south of this, in the S. W. ¼ of Sec. 27, and 110 ft. above Coal I, coal said to be 18 in. thick is found in a well.

It is said no coal is found under the sandstone from the kaolin mine up to Beaver creek bridge, in Sec. 25. In the N. W. ¼ of Sec. 27 both the upper and lower coals are reported on Mrs. Smith's place, Coal III being given as 18 in. thick and Coal I as 38 to 40 in. thick. In the S. W. ¼ of Sec. 22 the coal has been worked at the McBride place. The coal is reported to be from 3 ft. to 3 ft. 6 in. thick. In places it is overlain by shale, but in general by several feet of soft sandstone containing lines and masses of coal from ½ in. to 4 or 5 in. thick, much as in the figure given from Sand creek, Parke county. Above this rises a perpendicular bluff of sandstone for 50 or 60 ft. An outcrop was noted in the N. E. of Sec. 29 a little above high-water mark. The coal is said to have been 3 ft. thick on the Force place, in the S. E. ¼ of Sec. 29, and to have been dug on the John Lane place, in the N. E. ¼ of Sec. 32. Most of Sec. 33 is taken up by the flat plain of the old channel of White river. In the N. W. ¼ of the N. E. ¼ of Sec. 33, Coal I is reported as 4 ft. thick in a well, while it is 3 ft. thick in the Stiles bank, in the N. E. of N. E. of Sec. 33. It has also been worked a little at the Lane bank, in the N. W. ¼ of Sec. 34. Coal III (?) is struck in the S. E. ¼ of Sec. 34, at the Horn and Nickols banks, being said to have only shown 2 ft. 6 in. of good coal at the latter, and at the Stewart bank, in the S. E. ¼ of Sec. 35. The Mansfield makes 20-ft. bluffs along the branch in the S. W. part of Sec. 36, and along the river, in the S. W. part of Sec. 25, the bluffs are 50 or 60 ft. high, with 6 to 8 ft. of Kaskaskia limestone exposed below. A half mile below the mouth of Beaver creek the limestone rises until the section is approximately: Mansfield sandstone, 25 ft.; limestone, 35 ft.

Townships 2 and 3 (in part) North, Range 3 West.

1463. Geography.—This area is in the southeastern corner of Martin county, and includes most of Lost River and Columbia of the civic townships. Except along the valley of Lost river, the topography is very rugged, the hills rising 250 ft. or more above drainage. No railroads enter the area.

1464. Stratigraphy.—Coal I or its horizon underlies most of the area, but is hardly of a workable thickness anywhere. About 70 ft. above it lies Coal III or II, which runs from 3 ft. to 4 ft. thick, and is of excellent quality. Still above that are one or two higher coals. The section obtained by Mr. Cox at Sampson Hill, in the N. W. ¼ of T. 2 N., R. 3 W., differs so greatly from those obtained by this survey that it may well be given for reference.

1465. Section 549. Section at Sampson Hill.—(E. T. C., p. 93.)

	Ft.	In.	Ft.	In.
1. Covered space, mostly sandstone	70	0	70	0
2. Bluish gray shale with good ironstones	25	0	95	0
3. COAL "I?," 6 in. compact, 2 ft. 4 in. semi-block	2	10	97	10
4. Fire-clay, good potter's clay	4	0	101	10
5. Sandy shale and flagstone	95	0	196	10
6. COAL "F?"	?	?	..	..
7. Fire-clay	?	?	..	..
8. Sandstone, conglomerate	70	0	266	10
9. Bituminous shale	1	0	267	10
10. COAL "A"—Coal 3 ft. 0 in., brash 6 in.	3	6	271	4
11. Fire-clay	3	0?	274	4
12. Shale	30	0	304	4
13. Lower carboniferous limestone	6	0	310	4

A generalized section along the Wagner Mill road, in Secs. 6, 7 and 18, gave the following partial section:

1466. Section 550. Section on Wagner Mill Road.—Fig. 9 of Plate XLVIII.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Fire-clay and coal? at top of hill	..	..	..	..	..	..
2. Sandstone	1	0+	..	..	1	0
3. Covered space, with some light brown and gray sandstone showing	30	0	..	..	31	0
4. COAL IIIa, in outcrop (reported)	1	10	1	10	32	10
5. Fire-clay and light brown sandy shale	15	10	..	..	47	10
6. Sandy shale or shaly sandstone	18	0	..	..	65	10
7. Covered	12	0	..	..	77	10
8. Shale	17	0	..	..	94	10
9. Sandstone with some shale	26	0	..	..	120	10
10. Dark blue sandy shale	24	0	112	0	144	10
11. COAL III or II.........3 ft. to	4	0	4	0	148	10
12. Hidden (massive sandstone) 30 ft. to	65	0	65	0	215	10
13. COAL I in outcrop (reported), 18 in. to	1	10	1	10	217	8

Mr. Kindle obtained the following additional section:

1467. Section 551. Section on Fordice Land.—N. E. ¼, Sec. 6. (E. M. K.)

	Ft.	In.
1. Surface to top of hill	75	0
2. Sandy shale	6	0
3. COAL streak (IIIb?)	..	6
4. Massive sandstone.........4 ft. to	6	0
5. Shale, blue-gray, slightly sandy.........4 ft. to	6	0
6. COAL IIIa	1	3
7. Potter's clay	..	2
8. Sandstone	?	?

1468. Section 552. Section at Sampson's Hill.—S. E. ¼ of N. E. ¼ of Sec. 6. (E. M. K., p. 336.)

	Ft.	In.
1. Upper slope, loose fragments of gray sandstone not in place	15	0
2. Dark blue potter's clay	6	0
3. Shaly impure COAL IIIa	1	0
4. Light gray sandy clay	4	6
5. Thin shelly sandstone	4	0
6. Hard, light gray, rough bedded sandstone	6	0
7. Clay, light gray, with thin strata of limonite and limonite nodules	12	0
8. Clay and sandstone	25	0
9. COAL III	3	0

Barometer readings at a number of places gave the distances between Coal I and Coal III at from 35 to 71 ft., while 1 ft. 10 in. was the greatest thickness found for Coal I. In the S. W. part of Sec. 6, 75 yds. south of Pleasant valley cross-roads, the Mansfield sandstone lies unconformably on the Kaskaskia limestone, as shown in Fig. 664. Coal I is known here as the "bench coal" and is not mined beyond a little occasional stripping.

1469. Coals III, or II, as it is not known whether it corresponds with Coal III to the north or Coal II to the south, is an excellent coal from 2 ft. 6 in. to 4 ft. 10 in. thick, but averaging not much over 3 ft. (Figs. 14 to 23). It is usually a solid bed, in some cases being mined without shooting, but in general being mined with powder. The roof varies from a fine-grained blue or black shale to a blue shaly sandstone. In "Coal Hollow" it is usually a bluish drab to blackish, shaly sandstone. The underclay runs from 0 to 7 ft., being generally about 2 ft. thick. The coal from Sampson's Hill has an excellent reputation. Mr. Cyrus Mendenhall, while superintendent of the Southern Indiana Coal and Iron Manufacturing Company, with their furnaces near Shoals, writes of this coal to Mr. Cox as follows: "The Sampson Hill coal seam is 40 in. thick; we have penetrated it with two entries about 120 yds. each, and find the coal of remarkable purity. We are also driving an entry on seam A, at the foot of the hill, near the county road, on the S. W. ¼ of Sec. 32, same township. This seam is not so thick as Sampson Hill, but of very similar character." (C. M., p 11.)

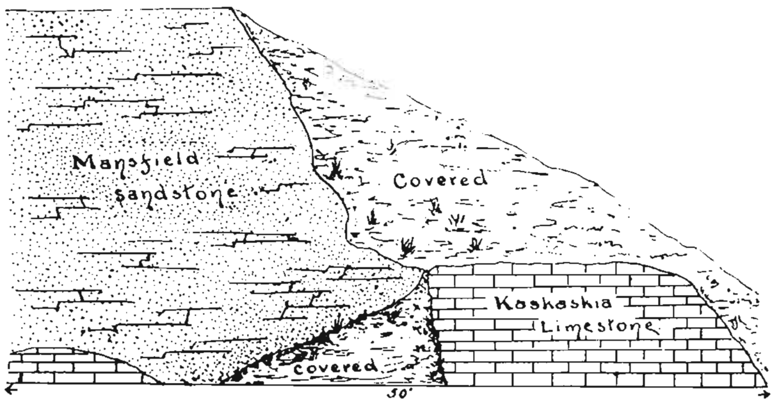


Fig. 661. Sketch of nonconformity a little south of Pleasant Valley. By E. M. Kindle.

1470. Coal IIIa, while thin, appears to have been worked a little in connection with its under and overlying clays for the clay works at Shoals. It is reported as varying from 1 ft. to nearly 2 ft. in thickness, with often a parting of 6 in. or more in the middle.

In the south part of the area there was reported to have been found a coal between Coal I and Coal III, which there are 100 ft. or more apart.

1471. Distribution and Local Details.—In T. 2 N., R. 3 W., all the coal found was in the western half of the township, and nearly all in the northwestern quarter. The workable coal, Coal III, occurs in one large irregular body with two or three other smaller bodies. Of the smaller bodies the most important is that running through Sampson's Hill, in the northern part of Secs. 4, 5 and 6. The coal is worked at the following points, beginning at the east end of the north side:

On the Fordice land an opening operated by Chas. Troutman. The coal here is from 2 ft. to 4 ft. thick, with an average of 3 ft.; it is of uniform quality, without partings, of a semi-block nature, allowing it to be mined without powder. The roof is clay shale, and scales somewhat; the floor is shale, 1 ft. thick, underlain by fire-clay. Some sulphur balls are found in it, and one roll cutting the coal down to a thickness of 1 ft., has been met. The general dip is south. About 100 yds. to the west is the Sullivan bank, where the same conditions are met with.

In the N. E. ¼ of Sec. 6 are a number of openings on the Fordice land on Coal IIIa. At one of the abandoned openings the entry was driven entirely through the hill. This coal is here 15 in. thick and is worked in connection with the clays. The section here was given above. The coal is bituminous, requiring to be shot, though in one of the old entries it was partly mined without powder. There are no clay partings, and very little sulphur. The roof is shale, full of plants, from 2 to 4 in. of bone coal between it and the good coal. The 6-in. coal streak in the section does not show at a neighboring exposure. The coal is nearly level. Other openings near this on Coal III have been made on the Fordice land, where the coal was from 2 to 4 ft. thick, but have been abandoned because of trouble with water, the entry having been driven down the dip to the south or the southwest, and on the Johnson and Chenoweth place. At the latter the coal ranges from 3 to 4 ft. thick, with an average of 3 ft. 2 in. It has no clay or sulphur partings, is a good block coal, except one or two inches at the top. The roof is a shelly sandstone.

On the south side of Sampson Hill coal has been worked at several openings just east and north of the Cross Roads, in the S. W. of N. W. of Sec. 5. At the Cross Roads No. 2 bank, which is running, Coal III is here 3 ft. thick, with 1 foot on top of bone coal. It is a black, hard, lustrous coal, showing some sulphur balls and thin sheets of sulphur. The roof is a dark blue sandy shale. The floor is dark gray potter's clay, 4 to 5 ft. thick. The dip is northeast, about 2 ft. in 100 ft.

In the east side of Sec. 5 and west side of Sec. 4 are the Stewart and Springer banks. The coal runs from 3 ft. to 3 ft. 6 in. in thickness. The roof is sandstone at the Springer bank and 8 in. of shale at the Stewart bank. The floor is fire-clay, about 2 ft. thick. Coal IIIa is said to be 22 in. thick where found near here, with a 6 in. shale parting in the middle. The lower Coal (I) is found 18 to 22 in. thick and solid.

In Sec. 9 are one or two bodies of Coal III. It has been mined at a number of places on the Way farm. The coal is said to have shown about a 4 in. parting in the middle. At one point the section was given as: 1 ft. to 1 ft. 6 in. of caking coal, 4 in. of shale, 1 ft. 6 in. of good cannel coal. At another point the coal is reported as only 2 ft. thick. The floor is sandstone. At one opening there was exposed below the opening: 20 ft. of massive sandstone, 6 ft. of black shale, place of Coal I, 12 ft. of sandstone and shale; Lower Carboniferous limestone. At an outcrop in the road near the Fairview church, the underlying sandstone is a very coarse grit. Coal I, 18 in. thick, has been mined a little by stripping near the head of Spring branch.

The main body of coal covers a large part of Secs. 7, 8 and 18, and smaller parts of Secs. 5, 6 and 17. At the divide known as Coal Hollow in the S. W. ¼ of Sec. 8 a number of banks are being worked, of which may be mentioned the Frank Felton, the Henry Stevens and the Geo. Denny, and just south the Gammin bank. The old Baker bank was just north. The coal here runs from 3 to 4 ft. and is of excellent quality. The roof is a bluish drab to black shaly sandstone. Below is from 18 in. to over 2 ft. of fire-clay. In the N. E. ¼ of Sec. 8 the Upper Kaskaskia limestone outcrops 15 ft. thick on the Joseph Williams land. It is a crystalline, pinkish crinoidal limestone or marble at this point and would appear to be very suitable for interior work. Tombstones made of it take a good polish and retain it fairly well.

In the N. E. ¼ of Sec. 7, Coal III is worked at the Cook mine, where it averages 28 to 30 in. overlain by 6 in. of bone, but runs up to 3 ft. 6 in. The roof is shale and thick. About 30 ft. above is said to be 18 in. of good coal, while 40 ft. below a 22 in. bed of good coal is reported. Below the drift being worked are heavy outcrops of sandstone. Coal has been worked from several openings on this place, also through the old Thompson drift just north. At Mr. Henry Stevens's, south of the center of Sec. 7, there are thought to be four beds of coal, of which the first below the rider is 31 in. thick. The writer was not convinced of the existence of four beds there, though there was no proof to the contrary, and the fact that at most points the first bed above Coal III is given as 30 or 40 ft. above, while here it was 88 ft. above, suggests the possibility that the rider in this hill is above the thin bed worked in Sampson Hill, in which case the 31 in. bed here would correspond to it. Coal I is reported to have been stripped back of Sycamore school house at the center of the west side of the section. A well near the road in the N. W. ¼ of Sec. 7 is reported to have gone through 3 ft. of coal. A little coal has been dug in the N. W. ¼ of Sec. 18, and more by a drift on Mr. Hampton's place in the S. W. ¼. The coal here is reported as 3 ft. or over thick and is overlain by 8 ft. or more of black shale.

South of Lost river Coal III occupies a limited area in a ridge in Secs. 31, 32 and 33, lying not far from the top of the ridge. It has been worked at the Jones and Badens banks on opposite sides of the ridge in the S. W. ¼ of Sec. 32. At the former it measured 2 ft. 3 in. thick, with a shaly sandstone roof. It appeared like a semi-block, "peacock" coal.

The part of township 1 north, range 3 west in Martin county includes only the northern two rows of sections. Coal III is limited to the high ridge in Secs. 3, 9 and 10. It is mined at two places by L. W. St. Clair. The coal measured 4 ft. 6 in. and is said to average 4 ft. 9 in. at the west bank and 3 ft. 6 in. at the eastern bank. The roof is a fine blue shale, the floor is fire-clay 2 or 3 ft. thick. The dip is south at the mouth of the west drift, but to the north is level or dips north.

Below this coal is, or has been, worked on the Willis Freeman place in the N. E. 40 of Sec. 4, where it has been stripped and drifted upon. About 18 in. were exposed overlain by shaly sandstone.

In the N. W. ¼ of Sec. 3 the coal is said to be from 2 ft. to 2 ft. 3 in. thick overlain by 1 ft. of bone. Whether these coals over Coal I lie between Coal I and Coal III was not determined. Coal I has been worked on the B. B. Meek place in Sec. 9, Wm. Harper place in N. W. ¼ of Sec. 31, and Mrs. Fanny Snider's in the S. E. ¼ of Sec. 31. At the last named place the coal measured 1 ft. thick and was being mined by a drift. It has a blue clay shale roof with massive sandstone just above. The coal at the places just named is not far above drainage.

Townships 2 and 1 (in part) North, Range 4 and 5 (in part) West.

1472. Geographic.—This area lies in the southwestern corner of Martin county and includes all of Rutherford and parts of Perry, Center, Columbia and Lost River of the civic townships. It is for the most part quite rugged. In Sec. 9 White river falls about 3 ft. and through Secs. 15, 16, 21 and 22 flows through a narrow valley, flanked on either side by perpendicular walls of Mansfield sandstone.

1473. STRATIGRAPHY.—No columnar sections of any value were obtained in this region. The area east of White river seems to contain only one coal, except over one or two very small areas. West of the river Coal I appears to be below drainage, and the coals most commonly noted are the coals worked at Alfordsville and at Patterson's mine in Daviess county, across the line. It may be well, therefore, to give sections at those points as showing the stratigraphy.

1474. SECTION AT GEO. DENSON'S MINE.—Sec. 34-2-5 (Daviess county, J. A. P.).

	Ft.	In.	Ft.	In.	Ft.	In.
Outcropping above Shaft—						
1. Limestone	..	..	..	..	..	..
2. COAL IIIc	..	..	..	..	..	..
3. Space of a few feet	..	..	..	..	..	..
Found in Shaft—						
4. Surface	6	0	..	..	6	0
5. Sandstone	2	0	..	..	8	0
6. COAL IIIb	1	2	1	2	9	2
7. Fire-clay	21	0	..	..	30	2
8. Shale	1	0	22	0	31	2
9. COAL IIIa	1	4	1	4	32	6
10. Fire-clay	2	0	..	..	34	6
11. Shale	..	8	..	..	35	2
12. Clay shale	4	0	6	8	39	2
13. COAL III	3	3	3	3	42	5

1475. SECTION 554. SECTION AT PATTERSON'S AIR SHAFT. (Sec. 11-2-5, Daviess county.)

	Ft.	In.	Ft.	In.
1. Limestone over COAL IIIc in outcrop.	..	..	..	..
2. Space to top of air shaft	10	0	10	0
3. Surface in shaft	8	0	18	0
4. Sandstone	10	0	28	0
5. COAL IIIb	2	0	..	..
6. Fire-clay and brown clay shaly rock	3	0	33	0
7. Shale	17	0	50	0
8. COAL III	3	6	53	6

1476. COAL III appears to be the principal coal west of the river. This appears to be the same as the coal called Coal II in Daviess county and to the southward. But it is doubtless the same as the coal called III at other places in this county, and as what is called III to the south is not represented by a workable coal here, this coal in this area will be called Coal III. It has a thickness here of from 2 to 4 ft. and is usually overlain by shale. Not far above is usually another bed, thinner and overlain by sandstone. This appears to be what is called Coal IIIa to the south. Coal III of Dubois county appears to be represented only in the shaft at Alfordsville. The upper coal

underlying limestone probably underlies quite an acreage in the southwestern corner of this area, but in the main appears to be too high to be caught by the hills.

1477. DISTRIBUTION EAST OF WHITE RIVER.—The area underlain by Coal I is shown on the map. It can hardly be said to reach a workable thickness at any point in this area, though at one point where coal was found after our visit 3 ft. 8 in. are reported, but this may prove to be Coal III. This was on the Peak place in Sec. 4, and was reported as found in a well at 14 ft., the elevation being such as to bring it a little below the level of the river bottoms. This would be at the level of Coal I to the north, but not be much below the level of Coal III in Sec. 8, where the latter is 36 ft. above low water almost south of this. Coal was reported as found in wells or as having been dug a little on the Wallace place just west of Peak and on the section line, at 12 ft. in well at Hill place, S. W. corner of Sec. 4, and Houghton place in Sec. 5. Coal has been worked in the S. W. ¼ of Sec. 3. and an opening was made on the Berry place by Wm. Bruner. The coal here ran from 18 in. to 2 ft., with shale roof at first, but farther in sandstone. The Mansfield sandstone makes small perpendicular bluffs at numerous points in Secs. 1, 2 and 3.

South of this Coal I outcrops in the N. E. ¼ of Sec. 22, N. W. ¼ and S. E. ¼ of Sec. 23 on Davidson place, 18 in. thick; N. W. ¼ of Sec. 26 on the Albert Kail or old Bell place and S. E. ¼ of Sec. 14 on the Abel place. It is worked a little at the Abel mine, where it shows 2 ft. of good coal overlain by 1 ft. of poor coal. Above that is shale. At the center of the west side of Sec. 12 the road descends over the bare face of the Mansfield sandstone at a high angle, descending 210 ft. (bar.) in 900 yds., though a large part of the descent is made in but a fraction of that distance. On the Brooks place in Secs. 10 and 15 coal has been found in wells only a few inches thick. Coal III occupies a small area in Secs. 22 and 23, being reported as 18 in. thick.

1478. DISTRIBUTION WEST OF WHITE RIVER.—In the S. E. ¼ of Sec. 1-2-5 is an outcrop of an 18 in. coal in the bed of Friend's creek. Much uncertainty exists as to whether this is Coal I or Coal III, but we are inclined to call it Coal I. Outcrops of a higher coal occur in the road in the N. W. ¼ of Sec. 12. Coals III and IIIb are said to outcrop in the S. W. 40 of Sec. 8-2-4 on the Clements place. In the S. E. 40 of Sec. 8 on the John Marshall or old Rollins place Coal III has been worked some. It is reported 18 in. thick and is said to have proven a sulphurous semi-block which could not be shot. It is overlain by shaly sandstone, while below the old opening appears 25 ft. of gritty cross-bedded sandstone, typical of the Mansfield sandstone around Shoals, extending down into the river. As the coal is only about 36 ft. above the river and is certainly above what is generally considered the Mansfield sandstone, it implies that the coal at Trippy's, which is at about the same elevation, is Coal III, or else there is a high south dip comes between. While much in doubt in the matter, we are inclined to assume the presence of the dip. Coal outcrops at a number of places on the Clements farm in the N. E. ¼ of Sec. 19-2-4, and at the Arvin bank in the S. W. ¼ of Sec. 24-2-5. At the latter the coal is from 2 to 3 ft. thick, with an average of 2 ft. 6 in. It is a non-caking coal, though this bed is said to be a caking coal at an opening a short distance down the creek on the Geo. Arvin place. It carries a good deal of sulphur. Over it there is exposed 7 ft. of bluish black shale. The stratigraphic position of this coal is in question, as it seems to come higher than Coal III. In Sec. 25-2-5, S. W. ¼, 3 ft. of coal is worked at the Chandler bank. It is overlain by 18 in. of black shale, then by gray and brown sandstone. It is claimed that only 6 or 8 ft. below this is a 3 to 4 ft. bed. These may be Coals III and IIIb. One of these coals, probably the upper, has been worked at the Elliot mine in Sec. 36-2-5. Though the bank was full of water it appeared as though the coal was at least 3 ft. thick. The sandstone over Coal IIIb is seen in Secs. 29 and 30-2-4, making perpendicular bluffs in places. In Sec. 29 Coal IIIb outcrops near the center of the section just above the level of Slate creek. It is here 14 to 18 in. thick, and it is said Coal III, 3 ft. to 3 ft. 4 in. thick, is found in this region about 12 ft. below IIIb, with shale between. Of the places where it has been worked in this neighborhood may be mentioned at the Arch and John Truelove bank in the eastern part of Sec. 29-2-4; Albert Truelove, Sec. 31-2-4, and John Truelove bank, in Sec. 5-1-4. Also on the Rutherford place, formerly the Asa White bank, in the S. W. ¼ of Sec. 34, where the coal is 2 ft. thick and lies about 50 ft. or more above low water. In the N. E. ¼ of Sec. 5 is the old Steele bank at the same level as the Rutherford bank. It is said that at very low water several feet of coal are exposed in the bank of the river in the S. E. ¼ of Sec. 28 and N. E. ¼ of Sec. 33. Coal reported 2 ft. 6 in. thick, with a sandstone roof, has been worked on the Mattingly place, in the south part of Sec. 5-1-4. Also coal of about the same thickness on the Parsons place in the N. E. ¼ of Sec. 1-1-5. In the S. E. ¼ of Sec. 8 Coal III is 3 ft. thick at the Emory mine. The coal has to be mined with powder, the bottom being the best. Over it is 15 ft. or more of shale, with considerable sandstone showing still above.

At the Miley bank in the N. E. ¼ of Sec. 17 the coal is reported as 2 ft. thick, with a sandstone roof, but with 2 ft. of soft material between the coal and sandstone, which comes down in mining. At the Inman stripping in the N. W. corner of Sec. 21 the coal is 2 ft. thick overlain by 3 ft. 6 in. of shale. The lower half is said to be a block coal. This is just below the level of highest high water in White river. The coal is not suitable for blacksmithing. In Sec. 18-1-4 or 13-1-5 coal reported at 3 ft. 10 in. thick has been dug by drifting and stripping on the Chatting place. Over the coal is 4 in. of shale, then sandstone.

1479. Summary of Coal.—

Divisions contained. I, II?, III and IV.
Coals contained. I. Ia?. II?. III. IIIa?. IIIb? IV?.

Round Number Estimates.

Coal I.

Worked area.....	20 acres	× av. thickness,	3 ft. ×	1,000 =	60,000 tons.
Workable area...	4 sq. mi. ×	"	3 ft. ×	500,000 =	6,000,000 tons.
Unworkable area	150 sq. mi. ×	"	1 ft. ×	1,000,000 =	150,000,000 tons.
Total area..	154 sq. mi.				156,060,000 tons.

Coal II and III.

Worked area.....	80 acres	× av. thickness,	3 ft. ×	1,000 =	240,000 tons.
Workable area...	10 sq. mi. ×	"	3 ft. ×	500,000 =	15,000,000 tons.
Unworkable area	40 sq. mi. ×	"	1½ ft. ×	1,000,000 =	60,000,000 tons.
Total area...	50 sq. mi.				75,240,000 tons.

Thin Coals.

Unworkable area 100 sq. mi. × av. thickness, 1 ft. × 1,000,000 = 100,000,000 tons.

Number of coals contained: 7?.
Greatest thickness recorded: 4 ft.
Average thickness: 1 ft. 6 in.
Area underlain by coal: 175 sq. mi.
Area underlain by workable coal: 14 sq. mi.
Contained in townships: 5-3, 2-3, 1-3, 4-4, 3-4, 2-4, 1-4.
Estimated total tonnage of coal: 330,000,000.
Estimated total tonnage of coal removed: 300,000.
Estimated total tonnage of workable coal left: 21,000,000.
Number of mines working ten men or over in operation: 1.
Number of mines working less than ten men in operation: 37.
Total number of mines in operation: 38.
Large mines abandoned: None.
Small mines not working: 100.
Strippings and outcrops: 112.
Total number of openings to coal: 250.

XXVIII. DAVIESS COUNTY.

1480. REFERENCES AND FIELD WORK.—

1862 (1859-60). Richard Owen, Rep. of Geol. Reconn., pp. 177-178. One coal analysis. (R. O.)

1862 (1859-60). Leo Lesquereux, same, pp. 317-318. (L. L.)

1871 (1870). E. T. Cox, 2d Ann. Rep. Geol. Surv. of Ind., pp. 20-80., with map, also large scale map of region around Washington. This corresponds in a way to the sketch maps given with this report. It is the only one published by the earlier survey and was made by Mr. D. H. Kennedy, C. E., at the expense of the citizens of Washington. The report also includes three cross sections, each several miles in length, with one exception, the only ones of any importance given in the earlier coal reports. There are twenty-nine columnar sections, with which an attempt at graphic representation is made by the use of leads, as in Sullivan county, in this report, a method requiring over twenty-five pages to give the twenty-nine sections, though the majority are records of less than 100 ft. There are eleven coal analyses. Altogether this is one of the best of the earlier reports. (E. T. C.)

1872 (1871-72). E. T. Cox, 3d and 4th Ann. Rep. of Geol. Surv. of Ind., pp. 25-30. One columnar section, two coal analyses.

1874 (1873). John Collett, 5th Ann. Rep. of Geol. Surv. of Ind., p. 344. Ono columnar section.

1896 (1895). W. S. Blatchley, Dept. of Geol. and Nat. Reso., 20th Ann. Rep., pp. 97-100. Discusses clays, gives two columnar sections.

1896. G. H. Ashley, field work for this report. The field work for this report was begun in this county, partly because of the character of the report made in 1871. The field work was largely carried on under the assumption that the stratigraphy given by Mr. Cox was correct. And it was not until the work was nearing completion that the writer became convinced that the original columnar section was very much in error. Just at the completion of the work a number of drilling records were obtained from several sources which in a large measure straightened out the stratigraphy, but there was not time to go over the work and adjust the data to the corrected column of coals. As far as possible that was done in the laboratory, but of necessity many errors will remain. This report was written in the winter of 1896, and time did not permit rewriting it to give it more nearly the form of the reports on the other counties.

1898. J. A. Price, notes made in trip from Dubois county to Loogootee.

1481. POSITION.—Daviess county lies about half way in a line from the center of the State to the southwestern corner. It lies south of Greene county, west of Martin, north of Dubois and Pike and east of Knox.

1482. EXTENT.—It has an extreme length from north to south of 28 miles and a width of 20 miles. It includes practically all of T. 5 N., R.'s 5 and 6 W.; T. 4 N., R. 6 W.; T. 3 N., R.'s 6 and 7 W.; T. 2 N., R.'s 6 and 7 W.; all but the eastern row of sections of T.'s 2, 3 and 4 N., R. 5 W.; most of T. 4 N., R. 7 W., and parts of T. 1 N., R.'s 5, 6 and 7 W.; T.'s 3 and 4 N., R. 8 W.; T. 5 N., R. 7 W. It has an area of 424 square miles.

1483. TOWNSHIPS.—It has ten civic townships grouped as follows:

		Elmore		Madison
Steele		Bogard		Van Buren
	Washington		Barr	
Veale		Harrison		Reeve

1484. GENERAL TOPOGRAPHY AND DRAINAGE.—In the northeastern corner of the county the surface is rather hilly, but going west, southwest and south this quickly changes to a rolling country and that in turn to a very level surface. Most of Elmore, Bogard, Steele, Washington and Barr townships are of this level character, with some rolling land. Northeast of Washington a conspicuous group of hills exist. The southern part of the county, as White river is approached, again becomes quite hilly. Many prairies exist along Smithers and Prairie creeks and their tributaries, which drain the northern central part of the county. Indian Pond and Furse creeks drain the extreme northern part, while Veale's, Aikman's Mud and Sugar creeks drain the southern part. The West fork of White river flows along the western side, the East fork along the south side.

1485. ELEVATIONS.—The county appears to range in elevation from 396 ft. above tide in the southwestern corner to over 600 ft. east of Ragglesville and just northeast of Washington. Washington is 484 ft. and low water near the same place is about 424 ft. above tide.

1486. TRANSPORTATION, ETC.—The Baltimore and Ohio Southwestern Railway crosses the county from east to west. The Evansville and Indianapolis Railway runs through the western part of the county; the Southern Indiana runs east from Elnora.

Washington, the county seat, has long been one of the most important mining centers in the State. It lies almost half way between St. Louis and Cincinnati, and with its outlets to the east, west, north, south and northeast, as well as other local advantages, ought to become a manufacturing city.

1487. STRATIGRAPHY. PLEISTOCENE.—The drift here, as to the north, consists of clays, sands and gravels. These have a thickness of from 0 to 90 ft., the latter depth occurring only where old valleys have been filled up. As a rule, the drift will average less than 20 or 25 ft. thick, yet from the level nature of most of the county is sufficiently thick to hide nearly all the natural outcrops, due principally to most of the streams following their old courses, though many score of feet above their old beds. The evidence favors the idea that the surface formerly was nearly if not quite 100 ft. above the present level.

1488. COAL MEASURES.—As suggested above, the stratigraphy as made out by Mr. Cox was found to be in error in several particulars. Thus, he correlated the lowest coal found as Coal "I" (IV), whereas now at least eleven coals are known to come below Coal IV. His Coal X, between Coals VI and V, was found to be imaginary. Coals V and IIIc, which resemble each other, were uniformly called "K" (V), etc.

Leaving out of account the records of deep drillings the strata which outcrop present the following columnar sections:

Division VII—
1. Space above Coal VII, sandstone and shale.
2. COAL VII only found near Washington.

Division VI—
3. Fire-clay, limestone, sandstone, shale.
4. COAL VI formerly worked extensively east of Washington.

Division V—
5. Fire-clay, shale, *limestone, black shale.*
6. COAL V extensively worked west and southwest of Washington, rider at Montgomery.

Division IV—
7. Fire-clay, *sandstone,* shale, sometimes a thin coal.
8. COAL IV, coal worked at Montgomery.

Division III—
9. Fire-clay, shale, *limestone, black shale.*
10. COAL IIIc very persistent to the south.
11. Fire-clay, shale, sometimes a thin coal, *sandstone.*
12. COAL IIIb, a "rider" over worked coal in eastern part of county.
13. Fire-clay, *shale,* sometimes thin coal.
14. COAL III or II, coal worked at Cannelburg and generally in eastern part of county.

Division I and II?—
15. Fire-clay, Mansfield sandstone normally, in outcrop, usually shale west of outcrop, with many small coal beds.
16. COAL I in northeastern part of county.

As noted above, at least two beds are known in outcrop, in addition to those given in the table. One of these is Coal IVa; another comes between III and IIIb and will be called IIIa. The last was only found at one or two places, but becomes more persistent to the south. From the middle of the county westward it would seem as though Division I, as developed in Martin county, was absent and its place taken by a greatly increased thickness of coal measures, including quite a number of coals. As none of these coals appear to be workable, and as correlation from deep drilling to another is generally difficult, if not impossible, they will not be given distinct names, but where necessary to refer to them the number in the columnar section in which they occur will be used. The lower coals appear to indicate quite clearly that the coal field at one time was much more limited in area than now and that in later times it spread to the east and north, overlapping its former bounds. See Plate XLIX.

TOWNSHIP 5 NORTH, RANGES 5, 6 (AND PART OF) 7 WEST.

1489. GEOGRAPHIC.—This includes all of the north end of the county, or Madison, Elmore and the north end of Steele of the civic townships.

1490. TOPOGRAPHY AND DRAINAGE.—Smithers creek, heading about Odon, flows through a prairie in the western part of 5-5. Furse creek has usually broad bottoms. The divides between the creeks are from 75 to 135 ft. above the creeks, or even higher. The western and much of the southern part of T. 5 N., R. 6 W., is prairie. One or two ridges extend in from the east, but become rapidly reduced in height.

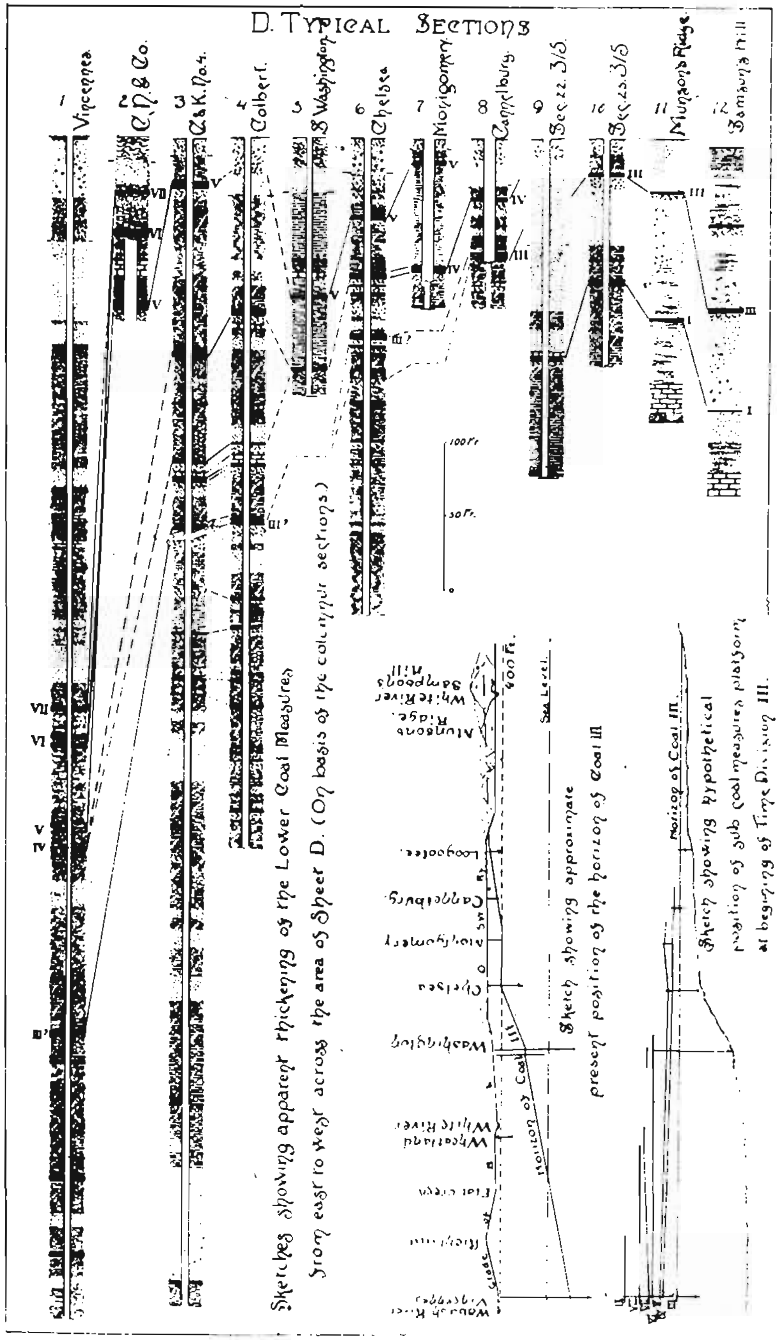


PLATE XLIX. Columnar and coal sections across Sheet D to show apparent thickening of the lower coal measures to the west, indicating overlap.

1491. TRANSPORTATION.—The Southern Indiana Railroad crosses the area from east to west; the E. & I. R. R. crosses the western end of the area.

1492. STRATIGRAPHY.—No good columnar sections were obtained in this area, and from the amount of prairie land and level uplands and the scarcity of outcrop, but little definite information could be obtained here. Coal V is the highest coal found, but it may be questioned if it occurs other than in a hill on the western border of the area. Coal I outcrops at the east. As far as discovered no workable coal exists in the area.

1493. DISTRIBUTION AND DETAILS IN T. 5 N., R. 5 W.—Coal has been dug in two places on the land of Mr. P. S. Ward in Sec. 8. East of the center is a hole from which coal has been taken (?) at about the level of Coal III. Near the southwest corner of the section is an old slope where the coal was reported as 1 ft. 6 in. thick. This would seem to be at least as high as III or IIIb.

Coal was obtained many years ago for blacksmithing purposes by stripping in a branch on the J. Shaffer place, Sec. 20 (1). Thickness unknown, but not great. Also on the place of Eli Kimmerman, same section, a thin coal has been worked. The same coal is said to have been met with in wells around Odon, being about a foot thick. It is believed to represent Coal III.

In Sec. 32 in the well of Mr. S. Callihan it is reported to be 20 ft. to coal which occurs as follows:

	Ft.	In.
COAL	1	6
Sandstone	1	6
COAL	1	0

On the Hastings place coal has been obtained by stripping and also by drifting in the low bank; the drift had fallen in, but is said to have shown 2 ft. of coal. The roof was a shelly sandstone. Probably same coal as preceding.

Coal was also reported as found on the farms of Mr. Thomas Boyd, Sec. 18, and Mr. Thomas Hand, N. W. of Sec. 16.

South of Odon a drilling put down by Capt. Z. V. Garten, N. W. of N. W. of Sec. 28, gave the following section (Sect. 555):

	Ft.
Red clay, 12 ft.; blue clay, 11 ft.; soft "stone," 4 ft.; hard "stone," 5 ft.; "dirt," 2 ft.; greenish sandstone, 23 ft.	55
Shale, level of Coal I?	11
Black clay, 5 ft.; shale, 4 ft.; fire-clay, 3 ft.; hard "rock," 3 ft.; black clay, 7 ft.; shale, 5 ft.	27

Near this drilling a well was drilled by Bedford drillers for some citizens of Odon, to a depth of 450 ft. No record of this drilling could be obtained, but Capt. Garten, who was one of the leaders in the matter, reported that 22 in. of coal were passed at the level of the shale in his well as noted above, and said that below the coal nothing but soft sandstone was met with to a depth of 450 ft. This sandstone was very soft, almost like a sand deposit, though not loose enough to run like quicksand. No explanation will be attempted. Coal III, at the Odon Coal Company's mine near Ragglesville, was estimated to be about 20 ft. below the level of the town of Odon, or about on a level with the top of these borings.

Remembering that the strike of the coal is west of north, and allowing for the dip, this would place Coal III from 25 to 30 ft. down in these wells. Hence it has been thought that the 2 ft. of "dirt" reported from the first well at 30 ft. may be in the horizon of Coal III. The 23 ft. of sandstone below may be the Mansfield sandstone. The 22 in. of coal at the level just below in the deep well may be in the horizon of Coal I.

In Sec. 15, S. W. of N. W., on Mr. Daniel Osborn's place, a drift has been opened showing 22 in. of good coal with a sandstone roof, and as outcrops close by indicate a heavy bed of sandstone overlying, this has been thought to be Coal I. This coal outcrops in the road near No. 5 school house.

Prof. Cox reported 2 ft. 6 in. of coal at Howard's mill, with the following section (Sect. 556, E. T. C., p. 71):

	Ft.	In.
Soil and clay, 8 ft.?; drift, clay and gravel, 20 ft.?; heavy bedded sandstone, 25 ft.?; buff colored sandstone in thin beds, 5 ft.	58	0
COAL I, lower 6 in. caking coal	2	6
Coal rash	..	3
Fire-clay?	..	..
Covered slope to branch	59	9
	120	6

The presence of the heavy bedded sandstone in this section would seem to make it the same coal as at Osborn's, but the coal at Howard's is reported as 60 ft. above the Buncome branch, while the outcrop near school house No. 5, half a mile north, is only from 5 to 10 ft. above the creek.

Coal I has been worked a little in Sec. 12 by Mr. Meek. Coal measured 2 ft. 7 in., and it is claimed reached 3 ft. where work was stopped. The roof is shaly sandstone. No sulphur was noticed in the coal.

Forty feet above is said to be another bed of coal 12 in. thick. This coal outcrops in Sec. 13.

Where the road south from Farlen P. O. crosses the railroad a hole has been dug through quite a thickness of shale which has been thought to correspond to the shale overlying Coal III near Ragglesville, and suggests that the horizon of Coal III is not far below the railroad at this point.

This township seems to be entirely underlain by Coal I, except in the valley of Furse creek, though doubtless absent over considerable areas. Where measured it showed a thickness of from 1 ft. 10 in. to 2 ft. 7 in. It usually has a good sandstone roof and is of good quality, but it is doubtful if the thickness will warrant extensive mining in the present state of the coal market. Coal III probably underlies most of the western part of the township and the higher ridges to the east, but nowhere was found under conditions encouraging to extensive mining.

1494. Distribution in T. 5 N., R. 6 W.—The highest coal in the township is Coal V. It is above drainage and only occurs in a low hill northwest of Elnora. A little work has been done by Mr. Osborn on the Thos. C. Day farm, Sec. 8. The coal is here about 15 ft. above the level of the prairie. At one opening the coal measured 2 ft. 3 in. at the entrance. Water prevented a measurement farther in, but it is claimed to be 3 ft. thick. However, the top half is reported as very poor coal. At one opening about 8 ft. of black or dark blue shale shows over the coal, the lower part being quite sandy. At the bottom of the hill not far from and below the level of the coal was found a large mass of dark limestone. Whether it had fallen down from a level above the coal or was lying about in its proper level below the coal could not be determined. If the limestone belongs above the coal, then the coal probably belongs in the horizon of V, but if the limestone lies below the coal, then the coal probably belongs to the horizon of IV. With present information we are inclined to the former view. A single piece of coal found outside was hard and shiny and was evidently not block coal.

On the other side of the hill on the Mitchell farm (Sec. 7) another opening has been made to this coal. This was full of water. The roof is black shale, said to be a little better than at Day's. The coal is claimed to be thicker, but to carry more sulphur.

The coal in this hill covers between a quarter and a half square mile; but even if it should prove to have sufficient thickness and satisfactory quality, the small thickness of roof will prevent extensive mining here.

In the eastern part of the township a little coal was some time ago gotten out in the bottom of a branch on the Dillon farm (Sec. 13). It was used for blacksmithing. The place where stripped later became buried beneath the refuse of a sawmill.

In Sec. 14 a coal, probably the same, has been found in a branch. The horizon of this coal is unknown, but it would seem to be either IV or III, or possibly between those.

On Mr. Hutchin's place, N. W. ¼ of 36 (1), 18 in. of coal was reported to have been found in the well at a depth of 20 ft., supposed to be either III or IIIb.

Coal was also struck in a boring on the Turner place, S. E. ¼ of Sec. 36. Mr. Cox gives the following section of the well on the Turner place (Sect. 557, E. T. C., p. 70):

	Ft.	In.
Surface, soil and clay, 10 ft.?; ferruginous shale, 6 ft.	16	..
COAL ("good caking coal")	1	6
Fire-clay ("good for fire brick")	2	..

A coal, probably IV, is said to outcrop on the Sims place, Sec. 35, in a knob which rises from the prairie.

Little of a definite nature can be said on the stratigraphy and distribution of the coals of this township. It is probably underlain by Coals III and I, which may prove workable in places. The coal was actually seen at only place.

Township 4 North, Ranges 5, 6 and 7 West. (In Daviess County.)

1495. Geographic.—This area lies just south of the preceding, and corresponds in the main with Van Buren, Bogard and Steele of the civic townships.

1496. Topography.—The general characteristics of the topography are indicated by the profiles of the sections (Figs. 665a and 672). The country, which is very level at the west, gradually rises and becomes more broken to the east, the highest point being probably in Sec. 10, where near the center of the section a hill is about 150 ft. above Prairie creek. On the north the country is more nearly level. Steele township is very level, mostly prairie, but somewhat broken by sand ridges.

The southern and western part of T. 4 N., R. 6 W., is quite level, with an extensive prairie in the southwest part along Prairie creek and another in the northern part along Smothers creek. This area

has at present (1896) no railroad facilities in the eastern part, though coal is being hauled by wagon from near Ragglesville to a switch on the S. I. R. R., two miles north. The E. & I. R. R. crosses the western part.

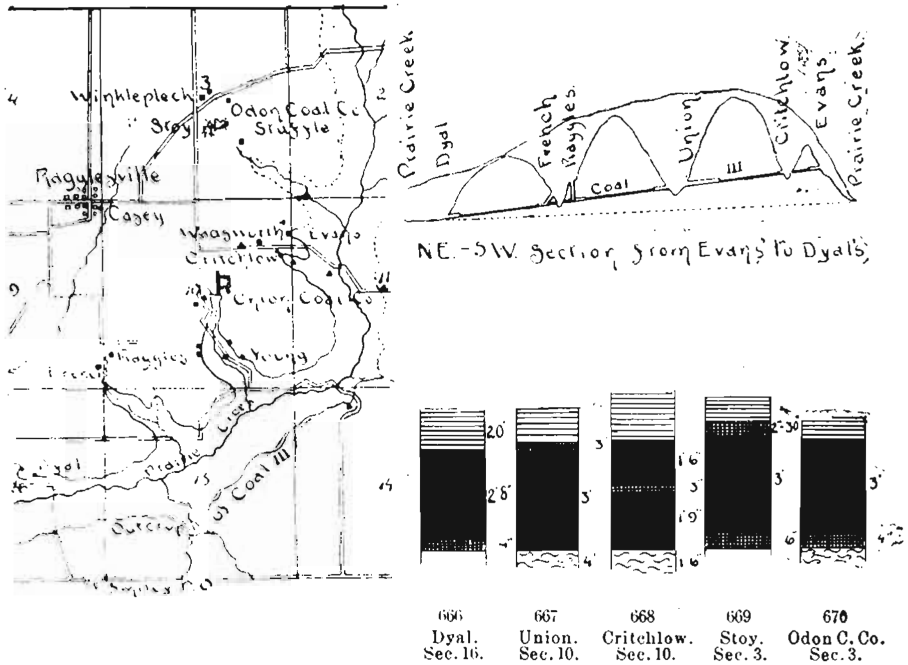


Fig. 665. Sketch map of part of Township 4 North, Range 5 West (around Ragglesville.)
Fig. 665a. N. E., S. W. Section from Evans' mine to Dyal's mine.
Figs. 666-670. Sections of coal III around Ragglesville.

1497. Stratigraphy.—The stratigraphy of the coals of this area has not been made out as accurately as could be hoped. Only a few borings have been made in the area, and no accurate record of any of these could be obtained, and none of the shafts go deeper than 43 ft. Furthermore, the region is well covered with drift, so that only a few natural outcrops were found, and these limited to the eastern part of the district.

The glacial drift is not very heavy over most of the area. It may be locally in old channels, but no information of such was obtained.

Coal V.—At only one point was a coal thought to be Coal V noted; that was at the Hardy bank, east of Epsom. There was a 9 in. coal, and just above on the hillside were pieces of white chert such as are usually found above Coal K. At the Doan and Payne banks, a mile north, a "very hard" limestone occurs over the coal, suggesting that the position of Coal V is just below.

1498. COAL IV.—This is the coal which is worked around Epsom (Figs. 673-676). It will average about 3 ft. thick, ranging from 2½ to nearly 4 ft. It generally shows a parting, as elsewhere in this county. It is below drainage north and south of Epsom and above drainage to the east of Epsom. At Hardy's bank the coal is much higher than at points due north or south, so that it has generally been considered in that region as a higher bed. As, however, the same coal apparently occurs at the lower level a mile and one-half northeast, it seems probable that the elevation here is due to faulting or folding. The eastern limit of Coal IV, as shown on the lithographed map, is drawn on the assumption that the coal worked in Sec. 7, T. 4 N., R. 5 W., is IV. Little data exists beyond the topography for its determination. In the high hill southeast of Ragglesville a 2 ft. bed of coal was reported as lying 90 ft. above the bed being worked, which probably represents Coal IV. The reports show the coal variable in quality and probably not as good as the underlying coal at Ragglesville. By discrimination in its use and in the selection of the coal it will probably prove an acceptable coal.

1499. COAL IIID?—A 10 in. coal reported by Mr. Peter Wadsworth as occurring in his well was thought from its position to represent Coal IIId?

1500. COAL IIIB.—This is the coal lying from 10 to 20 ft. above the coal worked near Ragglesville. It varies from 6 in. to 24 in. in thickness and is not known to be worked anywhere in the area, unless the coal worked at Trueblood's, near Smiley P. O., be Coal IIIb.

1501. COAL III.—In thickness this coal will average, near Ragglesville, 3 ft. (Figs. 666-670). In places shaly bands or rash coal materially reduce the thickness. Locally this rash coal may make up such a large part of the bed as to make the bed unprofitable to work. As far as the coal has been opened up it appears quite uniform in thickness, but whether it will continue so to east, south and west can only be shown by the drill.

In quality this coal is very highly spoken of, particularly at the Young and Union Coal Company's banks. It is the standard of comparison over a considerable area in northern and western Daviess county and Martin county, and "almost, if not quite, as good as the Ragglesville coal" is the acme of praise for the surrounding coals. In the fire it is said to burn up almost clean, leaving hardly any ash and no clinker, and being a very clean coal to handle. Of course, all the coal from this district will not be as good, particularly from those banks where they are not as careful as they might be about the removal of the bone coal or other poor grade coal.

1502. COAL I.—This coal was met only in drillings. Two of the drillings reported a good thickness, but as the wells were put down for water, the possibility for error was large.

STRUCTURE.—The general dip is west of south. There seems to be an anticline about at the line between Daviess and Martin counties, if our correlation of the coals is correct. Near Ragglesville the dip to the south of west is about 35 ft. to the mile. The coal in Sec. 7, T. 4 N., R. 5 W., has not been certainly correlated, as between Coal IV and Coal III. If it is Coal IV, then a sharp rise or a fault exists between there and the coal at the Hardy bank.

1503. DISTRIBUTION AND DETAILS IN T. 4 N., R. 5 W.—East of Ragglesville Coal III lies 25 to 35 ft. above Prairie creek, but dips to the west so that south of Ragglesville it outcrops just about on a level with the creek and probably is below drainage from a short distance to the west. It thus doubtless extends indefinitely to the west of the area at present worked. To the north of Ragglesville it is probable that this field is limited by the prong of Prairie creek, which flows eastward near the railroad. It may prove workable in the divide north of the railroad. To the east and south of Prairie creek this coal ought to extend in full force, at a sufficient depth under the hill to make a good roof probable. No data was obtained to show the thickness of the coal in these directions.

In Sec. 3, northeast of Ragglesville, are a group of mines from which coal is being shipped to the railway by wagon. The earliest mines opened in this area were opened in the 70's by Mr. Peter Wadsworth (now the Union Coal Company's bank) and by Mr. E. H. Evans.

Near the school house in the center of Sec. 3 are two shafts which were worked in 1895 by Messrs. Winklepleck, Wycoff and Allen. The shafts were about 40 ft. deep. Operations had been discontinued here in 1896, it being claimed that the bone coal encroached too much on the thickness of the good coal.

In 1896 this company, under the name of the Odon Coal Company, were opening a new mine a little east of the old mine. The new shaft is 37 ft. deep. The coal measured 3 ft. and runs a little higher in places (Fig. 670). There is a good shale roof and about 4 in. of bone coal below the coal. The coal shows no sulphur and is very clean. A bed of coal 20 in. thick is passed about 18 ft. down.

The Stoy mine is a short distance south of the preceding shaft. It is worked by a shaft 43 ft. deep. The coal is about 3 ft. 6 in. thick. The bone coal below the good coal, while averaging from 4 to 6 in. thick, will range from 2 in. to 2 ft. 6 in. thick (Fig. 669). In this mine the upper coal, IIIb, was reported to be from 7 to 9 ft. above the main bed and to be from 1 ft. to 1 ft. 6 in. thick. Between the two beds forming the roof of the worked bed is gray shale. Above the upper bed is principally sandstone.

The Stuffle slope is a little east of the preceding. The coal will average about 3 ft. and is about the same as in the two mines just described.

In Sec. 10 (2) 10 in. of coal was reported by Mr. Peter Wadsworth as found in his well at a depth of 12 ft.

The Critchlow drift gave the following section (Sect. 558, Fig. 668):

		Ft.	In.
1.	Shaly sandstone	10+	0
2.	COAL IIIb	..	10
3.	Hidden ("rock") ....7 ft. to	9	0
4.	Gray shale (roof) ....1 ft. 6 in. to	3	0
5.	COAL (top bench) III ....1 ft. 9 in. to	2	0
6.	Parting of bone coal	..	3
7.	COAL (bottom bench) III ....1 ft. 9 in. to	2	0
8.	Fire-clay ....6 in. to	1	6
9.	Sandstone	..	..

A 2 ft. bed of coal is said to outcrop down the branch about on a level with Prairie creek, Sec. 11 (3). A bank, not operating, a little north of Critchlow's, was supposed to be the E. H. Evans bank.

An outcrop of Coal III was noted at Sec. 11 (2) and in Sec. 14 a coal supposed from its elevation to be Coal IIIb has been dug into.

The Union Coal Company's bank, formerly the Wadsworth bank, is half a mile southwest of Critchlow's, Sec. 10 (6). The section there was as follows (Sect. 559, Fig. 667):

		Ft.	In.
1.	Shale ....about	50?	0
2.	COAL IIIb	1	4
3.	Shale (roof), gray ....12 ft. to	20	0
4.	Bone coal	..	3
5.	COAL III ....3 ft. to	3	3
6.	Fire-clay	4+	0

The coal measured 2 ft. 7 in. near the entrance and a drilling is said to show a thickness of 4 ft. a short distance beyond where they have driven the entry. A test of this coal made in Vincennes is claimed to have been very satisfactory. The coal is very highly spoken of by all users who were questioned.

The overlying 16 in. of coal is said to be very pure. It outcrops in the road north of the bank. At 90 ft. above this main coal bed is said to be a coal bed 2 ft. 2 in. thick, which is probably Coal IV, and on this basis a small area of Coal IV is shown on the lithographed map.

At Sec. 10 (8) (9) (10) and (11) are old drifts or shafts.

The J. J. Young bank is on the same coal, Sec. 10 (12). The coal here gave the same measurements in the entry. The roof is soft shale, 6 in. of fire-clay was exposed. This coal shares the high reputation of the coal from the preceding bank, forming no clinker and hardly any ash.

Just below the road between the two preceding banks a massive sandstone is exposed. This is supposed to be the Mansfield sandstone, and this is the most westerly exposure of that sandstone noted in Daviess county, if the correlation is correct. This inference is strengthened by a drilling made by Mr. Paul Hinton in the hollow south of the Union Coal Company's bank, Sec. 10 (14) (Sect. 560):

		Ft.	In.
1.	Surface	5	0
2.	Sandstone	17	0
3.	Shale	1	0
4.	COAL I	1	0
5.	Hard limestone	1	6
6.	Sandstone	12	0
7.	Shale	6	0
8.	Sandstone	16	0
9.	Shale	2	0
10.	Sandstone ....10 ft. to	20	0
11.	Shale	2	0
12.	Sandstone	27	0
13.	Shale	35	0

The 17 ft. of sandstone at the top is supposed to represent at least part of the Mansfield sandstone. The coal then becomes Coal I. The coal is about on a level with Prairie creek. The limestone below the coal then belongs to the upper Kaskaskia limestone, which has thus almost thinned out. The sandstones below are Kaskaskia sandstones.

At the Amos Raggles mine, Sec. 10 (15), the coal is 22 ft. deep at the shaft and measured 2 ft. 2 in. near the shaft. The roof is shale and the fire-clay below shows a thickness of 1 ft. 6 in.

A short distance down the branch is the French bank, Sec. 9 (2), where coal was obtained in 1895 by a slope which had caved in when visited.

In Ragglesville a well bored for Mr. Casey passed through three coal beds. The first bed, 18 in. thick, was passed through at 46 ft.; the depth and thickness of the second bed Mr. Casey could not remember. The lowest bed was 3 ft. 6 in. thick and was reached in 115 ft. The lowest coal is thought in that neighborhood to be the bed being worked to the east and south of town. According to barometer readings the coal at the Raggles bank is 52 ft. below the top of the well, the coal at the Union Coal Company's mine 55 ft. below and at Stoy's 60 ft. below. Another set of readings made later would increase the differences a few feet, but still it would indicate that Coal III should be met about from 60-80 ft. down. Coal I appears to be about 35 ft. below III to the southeast of Ragglesville. It would therefore appear more probable that the lowest bed is in the horizon of Coal I. As with the coal met with in the Byrer well, it is not possible to tell with the information obtainable how much of the thickness given is good coal and how much is bone coal or black shale, a difference not always noted in drilling with the churn drill. The effect of the correlation is to suggest that Coal III does not maintain a workable thickness under Ragglesville.

At the Dyal bank, Sec. 16 (1), Coal III has descended to the level of Prairie creek. This slope was opened in 1894. The coal measured 2 ft. 8 in., with 4 in. of bone below (Fig. 666). It will run higher in places. There is a good roof of gray shale which drillings show to be 20 ft. thick.

In Sec. 7 coal has been worked in the western part of the section.

On Mr. Wm. Kelsey's place, Sec. 7 (2) (3), are two drifts, fallen in now. The coal was reported by Mr. Kelsey as follows (Sect. 561):

	Ft.	*In.*
COAL III-IV? (top bench)	..	9
Parting	..	1
COAL III-IV (bottom bench)	1	8
Total coal	2	6

The top coal blocked out and was not of extra good quality. The bottom coal had to be shot, but was a better grade; said to be good for steam production or for blacksmithing.

A drilling made by Mr. Anderson Overton near the house passed through—coal, 12 or 18 in., at 8 ft.; coal, 29 in., at 26 or 29 ft.; and a thin bed of which the depth and thickness were not known. The 29 in. bed is the same as just described.

The Collins bank, just south of Sec. 7 (4), on Mr. Wm. Myers' land, was open, though not being operated. The coal here only measured 2 ft. without a parting. The roof was a dark drab sandy shale or shaly sandstone, which is a rather characteristic cover for Coal IV.

In the creek bed at this point many thousand bushels of coal have been obtained by stripping.

Just east Mr. Myers has put down a shaft which, as reported by Mr. Harper, at 14 ft. reached coal as follows (Sect. 562):

	Ft.	*In.*
COAL	1	6
Fire-clay	2	0
COAL	2	0
Fire-clay	2	0
To COAL	..	..
Total coal	3	6+

The correlation of these coals is in question.

In Mr. Harper's well, Sec. 7 (7), 20 in. of coal were found at 10 ft. This is doubtless the top coal at the Kelsey well. It is probably the same coal that was found in the well on the Chestnut place, Sec. 5, the coal being 1 ft. thick and 18 ft. deep, and probably the same coal that outcrops on the Hastings place just north of the sketch map, Sec. 32-5-5.

On Mr. Noah Byrer's place, Sec. 8, a well boring for water was sunk to 156 ft. Mr. Harper reported that this passed through 75 ft. of surface material and at 100 ft. passed through 4 ft. 4 in. of coal. This has been assumed to be Coal I. Too much reliance should not be placed on the thickness shown here.

The coal bed of Sec. 7 is found at a number of places in Sec. 31, also a thinner bed 20 to 30 ft. above it. The top bed has been worked a little on the land of Mr. Jacob Schwartz, Sec. 31 (1) by a drift. There was there 18 in. of good coal.

The Schwartz coal was found in a well on Mr. Peter Stoll's place at 16 ft., Sec. 31 (2).

On Mrs. Geo. Wilson's place Coal III-IV was met at a depth of 35-40 ft., the coal being 25-30 in. thick, Sec. 31 (4). On the old John Stoll place, now owned by Mr. Milton Laterfield, just over the line in Sec. 6, T. 3 N., R. 5 W., the Schwartz coal was 18 in. thick and 25 ft. deep, Coal III-IV was 25 to 30 in. thick and 50 to 55 ft. deep. As by the barometer this well is 15 ft. below Mr. Peter Stoll's, the

Schwartz coal is here 25 ft. below the same coal at Stoll's, a dip that would favor the idea that Coal III-IV of Sec. 7 was Coal III.

Coal was also reported as found in wells on Mr. Chas. Osborn's place and Mr. John Stoll's place, Sec. 31 (3) (5).

Information concerning coals in Sec. 31 given principally by Mr. Jacob Stoll.

In Sec. 29, on the Hon. A. Woodling's land, an 80-ft. well passed through 20 ft. of surface and then through 60 ft. of shale, but struck no coal.

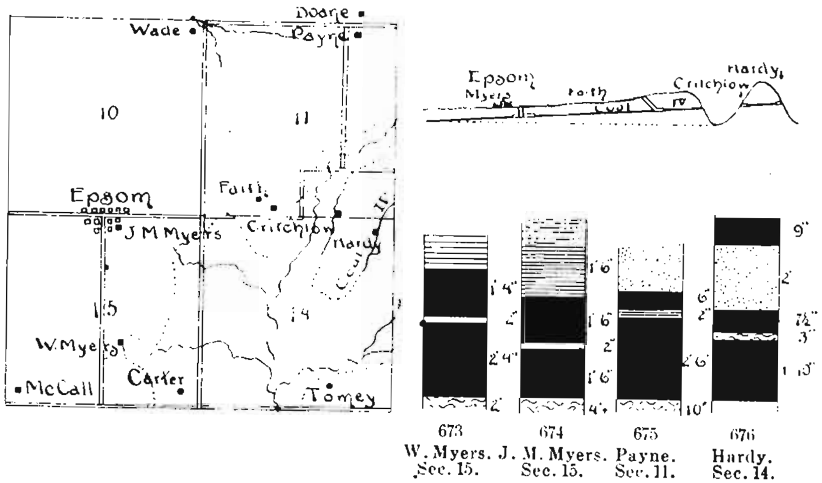


Fig. 671. Sketch map of part of T. 4 N., R. 6 W. (Around Epsom.)
Fig. 672. E.-W. section through Epsom.
Figs. 673-676. Sections of Coal IV around Epsom.

In Sec. 20 a thin bed of coal outcrops on a level with Prairie creek, on Mr. H. S. Shively's place.

Coal on the Truelove place, in Sec. 21, has been mentioned above.

In Sec. 22, Mr. Wm. Doyle has gotten out a little coal for his own use.

In Sec. 26, on Mrs. Dunn's land, some coal has been gotten out by a drift just at the creek level. In Sec. 27, 30 in. of coal is reported at the Patterson bank. In Sec. 24, coal was reported as found on the VanBuren place. The correlation of these coals is unknown.

1504. Distribution and Local Details in T. 4 N., R. 6 W.—Around Epsom, in T. 4 N., R. 6 W., coal is mined or reported as follows:

Doane's mine, Sec. 2 (1), worked by a shaft 8 ft. deep. Section of coal here, with cover, is as follows (Sect. 563, Fig. 675):

		Ft.	In.
1.	Sandstone and limestone roof	?	?
2.	COAL IV (top bench)	..	6
3.	Parting, black shale	..	2
4.	COAL IV (lower bench)	2	6
5.	Fire-clay	10	0

This coal is reported as good for steam production and not good for blacksmithing. Claimed not to clinker. The fire-clay underlying the coal is very pure and white, so much so that it is said to have been used for whitewashing in the neighborhood. A 6-18 in. coal bed is reported to lie about 50 ft. below this bed.

The Payne bank, Sec. 11 (1), on the Allen place, has a shaft 17 ft. deep, with a horse-power hoist. The coal is the same as at the Doane bank, the latter mine being on somewhat lower ground.

At the Wade place, Sec. 10, coal is said to have been struck at 22 ft.; thickness unknown. This is probably the 6-18 in. bed referred to just above.

The Critchlow bank, now all filled in, was the only point where the thickness of the coal in the area of this sketch map had been measured previously, and then it was by Mr. Cox "referred without hesitation to A" instead of Coal V, as it is now thought to be. As this coal occurs near the summit of the highest hill in the western part of this area, if this were Coal "A" or I, the inference would be justified that all of the lower surrounding country was below the coal measures and contained no coal until the higher ground near Ragglesville was reached.

The Hardy bank on the east side of this hill showed the following section of coal (Sect. 564, Fig. 676):

		Ft.	In.
1.	COAL V?	..	9
2.	Sandstone	2	0
3.	COAL IV (top bench)	..	7½
4.	Parting of clay	..	3
5.	COAL IV (bottom bench)	1	10
	Total coal	3	2½

Just over the opening of the drift the hillside shows an abundance of pieces of white chert similar to that usually occurring over Coal V; for that reason, the 9-in. coal has been called, with some hesitation, Coal V. This relation of Coals V and IV is of interest, taken in connection with their occurrence at High Rock, on the southern line of Daviess county, where the two coals are at least 90 ft. apart and separated by a massive bed of sandstone 65 ft. thick, instead of 2 ft. thick, as at this point. The coal here slopes rapidly to the west, making drainage difficult from the eastern side. No work was being done here when visited.

The Faith bank is half a mile west of the preceding. This is a slope. Only 21 in. was measured at the foot of the slope, but it is probable that it will run thicker farther in, as there was some question as to whether the whole thickness had been exposed, this being possibly but the lower bench of Coal IV. It showed no parting. The roof was a gray shale. Not operating at time of visit. Also known as the John Payne bank.

At Sec. 16 (4) is the remains of an old slope, possibly the bank which, in 1879, was being worked by Mr. M. D. Payne.

The J. M. Myers shaft is in the village of Epsom. The coal here is 15 ft. below the surface. The coal gives the following section (Sect. 565, Fig. 674):

	Ft.	*In.*
1. Shaly sandstone	?	..
2. Shale (roof)	1	6
3. COAL (upper bench) IV	1	6
4. Parting	..	2
5. COAL (lower bench) IV	1	6
6. Fire-clay	4+	0
Total coal	3	0

The Wm. Myers bank is three-quarters of a mile south. It is a slope. The coal measured as follows (Sect. 566, Fig. 673):

	Ft.	*In.*
1. Shale (roof)	?	..
2. COAL IV (upper bench)	1	4
3. Parting, black clay	..	2
4. COAL IV (lower bench)	2	4
5. Fire-clay	2	..
Total coal	3	8

The lower bench is considered the best coal.

At Mr. Andy McCall's, Sec. 15 (4), this coal is reached by a shaft 40 ft. deep. The coal is said to be the same as at the preceding bank. Not in operation at time of visit.

At Dr. Carter's, Sec. 15 (3), good coal was struck in a well at 17 ft. Coal was also found in a well at 23 ft., on Mr. Wm. A. Torney's place, Sec. 14 (2).

Outside of the area of the sketch map, coal data was obtained at only a few places in this township. In a well on Mr. Lettell's place, in Sec. 4, it is reported that two coals were passed through. The first at a depth of 40 ft., was 2 ft. thick, the top being "cannel" and the bottom block. Those are features characteristic of Coal V. The second coal was met at a depth of 80 ft., the thickness not known. The bottom coal is said to be about on a level with the prairie, and corresponds in position with Coal IV.

Coal was reported as met with in a well on Mr. Brissey's place, in Sec. 20.

In Sec. 29, Coal IV occurs a little below the level of Prairie creek. Mr. W. H. Cornett reports a number of drillings on his place, which gave the following section (Sect. 566a):

	Ft.	*In.*
1. Surface, 7 ft.; (2) sandstone, 11 ft.	18	0
3. COAL IV	2	3

The quality is reported as good and with a good sandstone roof. This place is just on the edge of Prairie creek bottom.

In Sec. 22 (2), a little mining has been done on Mr. Joseph Graber's. On Mr. Gootee's place, Sec. 25, two drifts have been opened on Coal IV (?) directly on a level with Prairie creek bottom; filled with water when visited. The coal is said to be 30 in. thick and good. In the well at Mr. Gootee's house the coal was 2 ft. thick and 28 ft. deep. In a well on the Ryan place the coal was about 20 ft. deep and 2 ft. thick.

The coal in Sec. 25 has been referred to Coal IV with much doubt. In common with the coal in Sec. 7, T. 4 N., R. 5 W., already described, and the second coal in Sec. 31 of the same township, its position is indeterminate between IV and III. Thus, at Young's, four miles up Prairie creek, Coal III is about 35 ft. above the creek level. At Dyal's, three miles up the creek, it is just about at the creek level. As the creek runs in the direction of dip, if that dip were maintained, Coal III would be 100 ft. below Prairie creek, at Gootee's, and the coal there would appear to be IV. On the other hand, Coal IV, in the general direction of strike from Gootee's, a little west of north, appears at an elevation well above the levels of the small tributaries of Prairie creek, which, of course, are much above the levels of the main creek, and it dips south of west, so that it has just passed under Prairie creek at Cornett's, five miles below Gootee's, on Prairie creek (not counting the bends), thus making the position of Coal IV at Gootee's several score of feet above Prairie creek there. As no clue could be obtained from the coal itself, the question must remain open. A syncline might bring Coal IV down to this level; an anticline might bring Coal III up to this level.

This uncertainty introduces an uncertainty in any prediction as to the position of coals in the area under consideration. If this be Coal III, then it probably underlies all of the area except stream valleys in the eastern part of the township, and at a workable depth, and Coal IV probably underlies all the higher ground in the western part of the township, being cut out by the valleys and passing above ground in the extreme eastern part of the township. If this coal is Coal IV, then Coal IV is the "surface" bed over the whole township, and Coal III lies at a good workable depth over all the township.

Coal IV in this county is usually overlain by a sandy shale or shaly sandstone and has a parting a little above the center, while Coal III is usually overlain by a clay shale, has usually no parting, but often has bone coal either at the top or bottom, which locally is pure enough to pass as cannel coal.

1505. Details in T. 4 N., R. 7 W.—In Sec. 14 a drilling was put down by Mr. Watson, of Linton, for several citizens of Plainfield, one of whom, Mr. Murphy, gave the position of the coals met with as follows (Sect. 567):

		Ft.	In.
1.	Space-surface, 13 ft.; shale, 47 ft.	60	0
2.	COAL IV? (upper bench)	1	6
3.	Fire-clay	2	0
4.	COAL IV? (lower bench)	2	0
5.	Shale, with a little limestone ... about	15	0
6.	COAL?	3	10
7.	Space, shale, etc. ... about	16	0
8.	COAL?	1	6
9.	Clay and shale to 120 ft.		

The 3 ft. 10 in. of coal was reported as good. Lack of capital has prevented further developments. If the reported thicknesses prove accurate, this ought to open up quite a coal field, lying as it does close to the railroad, with the coal at a depth of 80 ft. It is to be hoped that further investigation will be made in this area.

Mr. Cox reports the following section as found in a drilling by Mr. Clapp on the property of Mr. A. H. Doherty, in Sec. 36 (Sect. 568, E. T. C., p. 73):

Surface, 50 ft.; fire-clay, 9 ft.; "hard rock," 3 ft.; ashy shale, 8 ft.; hard sandstone, 12 ft.; soft sandstone, 17 ft. 6 in.; total, 99 ft. 6 in.

Township 3 North, Ranges 5 and 6 West. (In Daviess County.)

1506. Geography.—These townships occupy an eastern-central position in the county and correspond to the northern three-fourths of Barr and the eastern one-fourth of Washington of the civic townships.

1507. Topography.—The most of this area is very level or only slightly rolling, as shown in the cross sections on Plates L and LII. The town of Montgomery surmounts one of the highest hills, though a hill of very limited extent. A drumlin-like ridge from 75 to 100 ft. high extends from a little southwest of the center of Sec. 7, T. 3 N., R. 5 W., and runs southeast through Sec. 17.

The preglacial topography of this area was much more marked than the present topography. Evidences of several of the old channels were found. One followed the creek, running north through the western row of sections. A well at Fitzpatrick's, Sec. 7 (2), 3-6, did not reach the bottom of the old channel at 40 ft. A well on the Keith farm, Sec. 18 (1), 3-6, found the bottom at 42 ft. On the Egan farm, Sec. 7 (1), 3-6, a well started near the road passed through 9 ft. of blue mud-like quicksand beginning at a depth of 23 ft. from the surface. A preglacial channel was encountered in Sec. 27, T. 3 N., R. 6 W., in the workings of the Daviess County Coal Co. This channel ran southwest when first struck, but further west was found to turn and extend to northwest toward Black Oak. Judging from the present topography the valley of Prairie creek has been well filled. In Sec. 20, T. 3 N., R. 5 W., two drillings passed through 75 to 80 ft. of drift, indicating an old channel there. The ridge just north of this has been mentioned. Wells on this ridge, as Sec. 17 (1), 3-5, show first 25 ft. of dry sand, then quicksand down to 40 ft. Over the higher land the drift will average from 10 to 20 ft.

Drillers report a system of preglacial channels as existing between Cannelburg and Loogootee, with a depth of from 70 to 75 ft. below the present surface. One of these channels runs north of east toward Loogootee being joined on the north by one important tributary, and probably by others not discovered. It follows the B. & O. S. W. Ry. into and through Loogootee. A rounded knob rising in Secs. 26 and 27 on the county line is suggestive in form of a drumlin deposit. No examination was made.

1507a. Stratigraphy.—The stratigraphy is well shown in Plates L and LII. As many as thirteen coal beds have been penetrated in a single drilling in the western part of the field. For practical purposes not more than the upper six beds need be considered from Coal V to III?, inclusive. The Pleistocene deposits cover the area completely, ranging from 10 to 75 ft. in depth.

As most of the information in this area is in the form of drilling records, it will be convenient to briefly summarize the coal and intervening strata and to give the sections as they are reached in a discussion of the distribution of the coals.

1508. COAL V.—This coal will range from 2½ ft. down, though in several places there is what appears to be another bed IVa? a foot or two under it, the two together making at one place a total thickness of 4 ft. Some question has arisen as to whether these two beds were not the two parts of one bed. Coal V is found to split in places to the south so that the two benches are as much as 3 ft. 6 in. apart. As a rule it will average between 1 ft. and 1½ ft. It is usually overlain by a black "sheety" shale, and that, in turn, by a thin bed of limestone. In distribution this coal is probably limited to the area west of the east fork of Prairie creek. It may be caught by a few of the higher points east of that creek, though it was not noted there in this area. The quality is everywhere reported as poor, frequently having the appearance of cannel coal, due to the large proportion of shale. In places it is simply a bituminous shale. It will probably never be worked unless it be for distillation for oil.

1509. COAL IVa.—At a few places a coal bed is reported between Coals V and IV. These may or may not belong to the same horizon. In thickness it is reported from 2 ft. down, though usually being less than 1 ft. It occurs in very limited areas, not being met with at all in a majority of the borings. Nothing is known of its quality.

1510. COAL IV.—This is the most easily workable coal in the area. It lies deepest near Black Oak, 90 to 100 ft., being at a slightly shallower depth a little west and coming to the surface just east of Cannelton. It has quite a uniform thickness of from 2½ to 4 ft., with an average between 3 ft. and 3½ ft. It becomes thinner in places. It may be said to cover the whole area of T. 3 N., R. 6 W., though locally cut out by the deep channels of Prairie creek and its tributaries, and probably by Veal's creek. In quality this coal in this area does not rank as high as Coals V or VI at Washington. The coal is only worked extensively at one point in this area and the fact that the quality there is not all that can be desired doubtless has had an effect on further developments. We are inclined to believe, however, that this coal may prove of more desirable quality elsewhere in the region, judging from

the coal found at the same horizon in adjacent areas. On the whole, it will probably be found that this coal will not be suitable for all uses, as e. g., working iron; it will have a tendency to clinker but will prove a rich, oily coal. It quite characteristically has a clay parting of 1 in. thick down about 1 ft. to 1½ ft. from the top.

Mr. Cox describes Coal IV near Cannelburg as "a deep black, distinctly laminate, block coal, with charcoal partings, breaks into irregular cubes and shows pyrite in the seams. The bottom of the seam is a bright, deep black, semi-block coal with no traces of pyrite. Coal is described as a glossy, jet black, caking coal, conchoidal fracture, laminae not distinct, no pyrite visible." (E. T. C., p. 75.)

He also gives the following analyses: (A) Alva Clark's N. E. ¼ of Sec. 29; (B) J. S. Morgan, Sec. 31, (top); (C) same, (bottom).

	A.		B.		C.	
Fixed carbon	57.30		56.00		53.50	
Volatile combustible matter	34.70		32.50		36.00	
Total combustible matter		92.00		88.50		89.50
Ash	3.50		5.50		5.00	
Moisture	4.50		6.00		5.50	
Total waste		8.00		11.50		10.50

Between Coal IV and the coal worked at Cannelburg there is at least one coal bed, and there seems to be two, as shown on Plate L, and as found elsewhere. No single section was obtained showing unmistakably the four beds, and therefore the suggestion that two such beds exist can be considered only as a surmise. The plate shows well the difficulty often encountered in correlating coals. Some other data not shown in the borings given on that plate have been used in deciding on the correlation given. If there are not two coal beds between Coal IV and the Cannelburg bed, then Coal IV becomes very variable near Cannelburg, being 4 ft. thick at several places and thinning out entirely at others close by.

The Cannelburg coal bed, Coal III, is near Cannelburg from 70 to 100 ft. below the surface and becomes deeper to the west, being reported at 150 to 175 ft. in the western part of the field. It ranges in thickness from 6 ft. down, where thickest being part cannel coal and part bituminous. As a bituminous coal it appears to be of excellent quality. The cannel part of the bed is believed to be the only bed of cannel coal mined in the State (1896).

In the report for 1872 Mr. Cox gives the following analyses of the cannel coal at Cannelburg:

Proximate Analysis.

Fixed carbon	42.00	
Volatile combustible matter	48.50	
Total combustible matter		90.50
Ash	6.00	
Moisture	3.50	
Total waste		9.50

Ultimate Analysis.

Carbon	71.10	
Ash	7.65	
Hydrogen	6.06	
Nitrogen	1.45	
Oxygen	12.74	
Sulphur	1.00	
		100.00

The strata between the coals are sufficiently well shown in Plates L and LII, and do not need further discussion at this point beyond calling attention to the limestone overlying Coal V as being of assistance in determining that horizon.

A number of coals are met with below the Cannelburg bed; none of them have been reported as workable. See boring on John Hay's land beyond.

1511. STRUCTURE.—The main features of the structure are shown on the cross sections on Plates L and LII. The beds have a slight dip to the west or southwest, though it is not marked. There appears to be a slight syncline at Black Oak.

1512. DISTRIBUTION AND SECTIONS IN T. 3 N., R. 5 W.—In Sec. 6 coal in the well on the Saterfield place has already been mentioned.

In Sec. 10 of the same township coal has been dug on Mr. John Cunningham's place by a drift, now fallen in. Coal reported as 2 ft. thick at outcrop and thicker farther in. Thought to be about in the horizon of Coal III.

A short distance east in Sec. 11 coal has been opened upon on Mr. Chas. E. Dage's place by a slope. The coal is reported as 18 in. at the outcrop, but drillings showed 2 ft. 2 in. further under the hill, with several inches of bone below. Over the coal is 3 ft. of sandstone, with shale above. Coal is said to burn well and last well. Probably Coal III.

In Sec. 23, a mile west of Loogootee and 15 yds. south of the railroad it is reported that 24 to 26 in. of coal are found in a well at a depth of 20 ft. This is the surface bed at Loogootee and is probably Coal III.

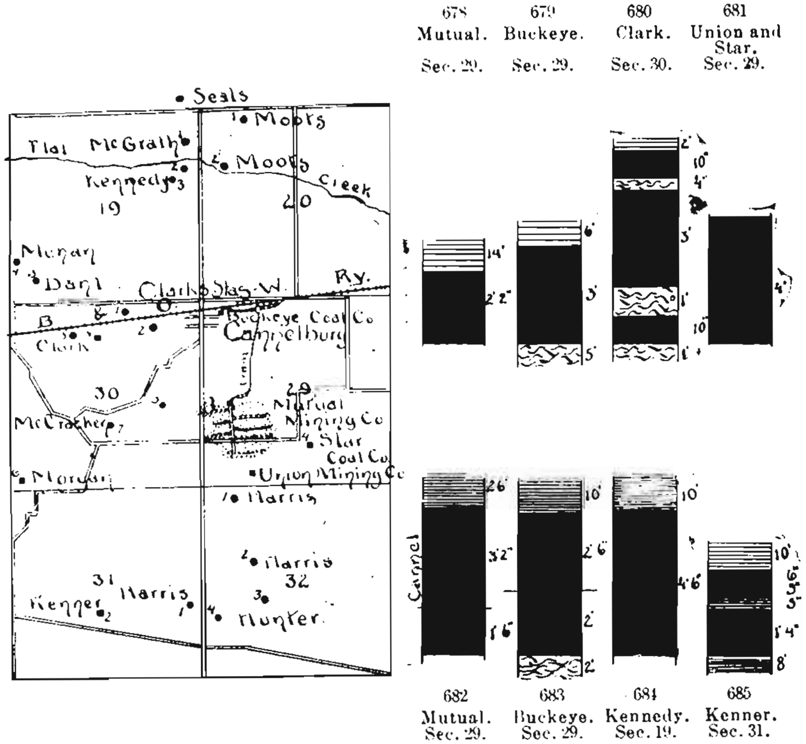


Fig. 677. Sketch map of part of T. 3 N., R. 5 W. (Around Cannelburg.)
Figs. 678-681. Sections of Coal IV around Cannelburg.
Figs. 682-685. Sections of Coal III around Cannelburg.

In Sec. 22, close to the railroad, a drilling by Mr. Paul Hinton, of Loogootee, showed the following section (Sect. 569):

		Ft.	In.
1.	Surface	15	0
2.	Quicksand	55	0
3.	Sandstone	45	0
4.	Shale	12	0
5.	Sandstone	15	0
6.	Hard limestone rock	3	0
7.	Shale	2	0
8.	COAL I?	0	6
9.	Fire-clay	6	0
10.	Gray shale	45	0
11.	Blue shale	27	0
12.	Fire-clay	?	?

This drilling evidently passed through a glacial fill. The coal, lying as it does below the heavy sandstone, is assigned to the horizon of Coal I, and is as far west as I has been recognized in a section through this part of the county. Coal III and the higher beds are cut out by the preglacial valley.

In Sec. 28, on Mr. Wm. Kennedy's land, Coal IV?, 18 to 20 in. thick, is found at 30 ft. The roof is shale, but thickness not known; probably not over 10 to 12 ft., as just south of the road a well 18 ft. deep does not reach the shale.

In Sec. 26, on the west 40 acres of Mr. Abel Padgett's place, a drilling by Mr. Hinton showed (Sect. 570):

		Ft.
1.	Surface	10
2.	Sandstone	10
3.	Shale	50
4.	Sandstone	8
5.	Shale	2
6.	Hard rock	..
	Total	80

In the area of Secs. 7 and 8, 17-20, 29-32 of T. 3 N., R. 5 W., Coal IV is the surface bed and is consequently cut out over considerable undefined territory in these sections, and has a suitable roof over a much smaller area. It reaches a thickness of 4 ft. Coal III (Cannelburg bed) is a double bed, the lower 18 to 24 in. being bituminous coal, the upper bed is cannel coal and is variable in thickness, ranging from 2 to 4 ft. As described by Mr. Paul Hinton, of Loogootee, who has done some drilling about Cannelburg, the two beds are separated to the east of Cannelburg by a "rock" parting, becoming 12 to 13 ft. apart. The suggestion is made that the "rock" parting formerly overlaid all of the bituminous bed in this vicinity; the conditions changing, a current of water swept over this area, eroding the overlying rock through a depth of at least 12 or 13 ft. and exposing or even slightly eroding the coal bed. A slight change again results in stopping the erosion, and the channel cut out begins to fill up with carbonaceous matter, possibly washed out of this underlying coal bed at some more distant point, where the stronger current still prevails. Then the sediments in the water change to a clay mud and the roofing shales are laid down.

In Sec. 7 coal has been exposed at a spring on the Sefrit place, where it is said blocks of coal used to be found. This is now covered up. This is about on a level with a 2½ ft. bed of coal reported a mile to the south and thought to be Coal IV. On that ground Coal IV would be cut out across the northern part of Secs. 7 and 8.

In Sec. 8, 2 ft. of coal was reported as found at a depth of 27 ft. in a well on the Thompson place. This would seem to be the same coal as at Sefrit's. A drilling on the Seal place, Sec. 8 (2), is reported to have passed through a good bed of coal, but the thickness and depth could not be learned.

The high ridge of sand and quicksand crossing Sec. 17 and extending into Sec. 7 has already been mentioned. In Sec. 18 on the Seal place 2½ ft. of coal was reported in a well at a depth of 40 ft.

In Sec. 19 (1) 2½ ft. of coal was reported as found in a well on the McGrath place at a depth of 23 ft. As this well was 17 ft. lower by the barometer than the seal well, this would be the same bed. Two drillings on the farm of Mr. Jas. Kennedy by Mr. Clapp, as reported by Mr. Cox, gave as follows:

1513. SECTION 571. DRILLING ON KENNEDY PLACE.—Sec. 19 (2), Plate L, Fig. 8. (E. T. C., p. 68.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	46	0	..	..	46	0
2.	Gray shale	4	0	..	..	50	0
3.	Black shale	4	0	..	..	54	0
4.	**COAL IIIb**	0	4	0	4	54	4
5.	Hard gray rock	4	0	..	..	58	4
6.	Black shale	4	0	8	0	62	4
7.	**COAL IIIa**	0	8	0	8	63	0
8.	Fire-clay	1	0	..	..	64	0
9.	Black shale	5	6	6	6	69	6
10.	**COAL III**	4	2	4	2	73	8

1514. SECTION 571. DRILLING ON KENNEDY'S PLACE.—Sec. 19 (3), Plate L., Fig. 9 and Fig. 684. (E. T. C., p. 65.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	32	0	..	..	32	0
2.	Dark gray shale	14	0	..	..	46	0
3.	Black shale	4	0	..	..	50	0
4.	**COAL**	0	2	0	2	50	2
5.	Hard gray rock	5	0	..	..	55	2
6.	Black shale	10	0	15	0	65	2
7.	**COAL III**	4	6	4	6	69	8

A short distance south of the last drilling a drill hole was put down on the land of Mr. C. H. Dant, giving the following section:

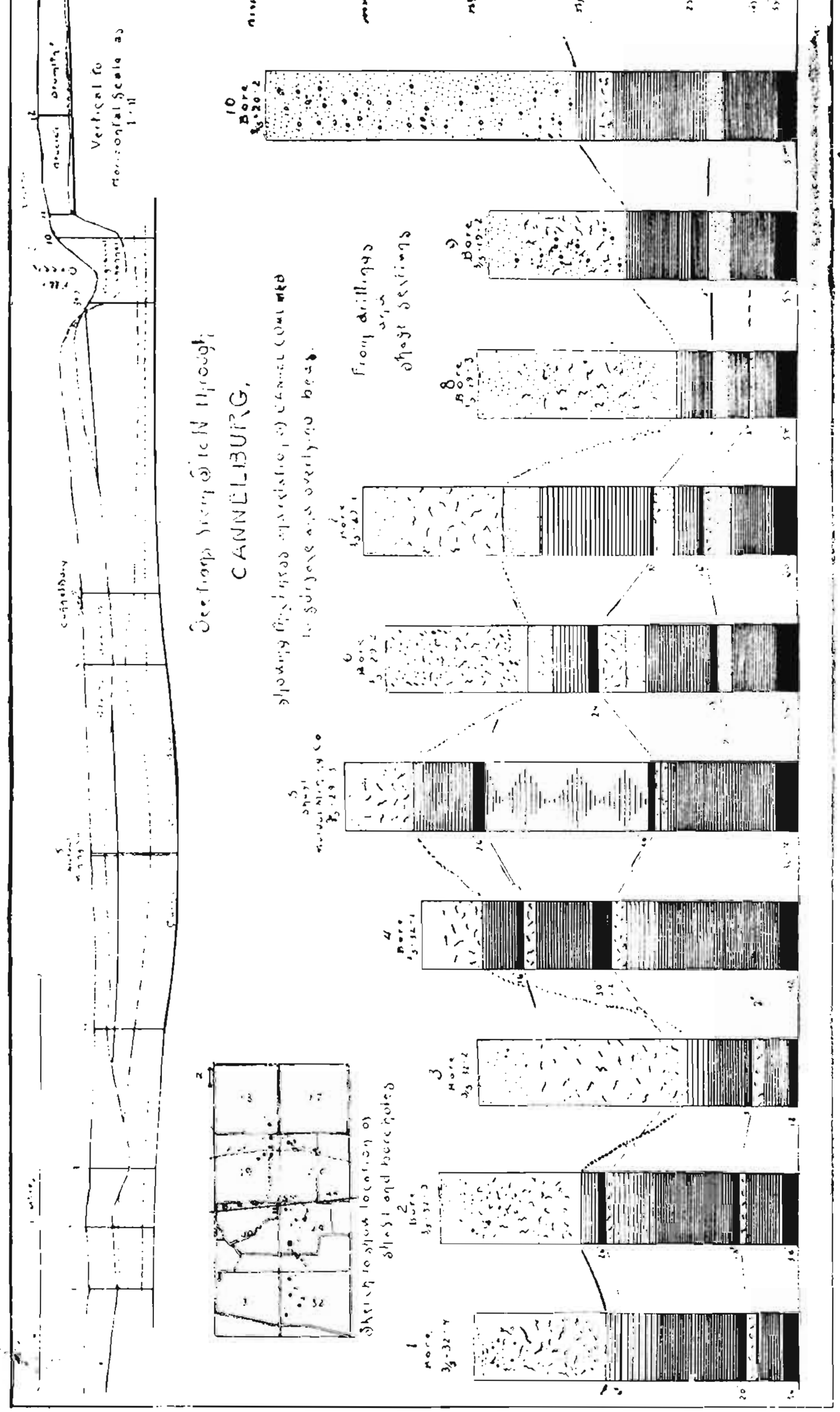


PLATE L. Sections from North to South through Cannelburg, showing thickness and relation of Cannel coal bed to surface and overlaying beds.

1515. SECTION 573. DRILLING ON C. H. DANT'S PLACE.—Sec. 19 (5). Plate LII., Fig. 8. (E. T. C., p. 64.)

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1.	Surface	30	0	..	..	30	0
2.	Fire-clay	12	0	..	..	42	0
3.	Black shale	18	0	..	..	60	0
4.	Sand rock	10	0	..	..	70	0
5.	Black shale	1	0	..	..	71	0
6.	COAL III?	2	9	2	9	73	9
7.	Shale rock	10	0	..	..	83	9
8.	Dark gray shale	10	0	..	..	93	9
9.	Black shale	6	0	..	..	99	9
10.	Shale rock	5	0	..	..	104	9
11.	Fire-clay	4	0	..	..	108	9
12.	Black shale	6	0	..	..	114	9
13.	Fire-clay	3	0	..	..	117	9
14.	Black shale	2	0	46	0	119	9
15.	COAL	0	3	0	3	120	0

Coal was also reported as found on the Mehan farm, Sec. 19.

Mr. Cox gives a section on the "Harris and Moot land, W. ½ of N. W. ¼ Sec. 29." The location would seem to be in error for this section, as the coal in this record is found at a depth of 118 ft., which is deeper than has been reported from other drillings at this point. On the map Mr. Cox places this drilling in Sec. 20 near Flat creek. The drilling shows a depth of surface material of 72 ft. and a little east of this Sec. 20 (3) Mr. Paul Hinton reported a drilling as showing 75 ft. of surface rock, so that the location on the map is probably correct, rather than the other. The record given is—

1516. SECTION 574. SECTION OF WELL ON HARRIS & MOOT (?) LAND.—Sec. 29 (?). (E. T. C., p. 60.)

		Ft.	*In.*
1.	Surface	72	0
2.	Gray shale	4	0
3.	Fire-clay	4	0
4.	Dark gray shale	22	0
5.	Sand rock	3	3
6.	Black shale	13	0
7.	COAL III	4	3
8.	Fire-clay	5	0

In Sec. 30 (4) some mining was done by a drift by Mr. Alva Clark. The coal (IV) was reported by Mr. Cox to be from 3 to 4 ft. thick and of excellent quality. The section given was (Sect. 575, E. T. C., p. 54):

	Ft.	In.
1. Surface, 10 ft.; (2) gray shale, becoming blue at bottom, 6 ft.	16	0
3. COAL IV .... 3 ft. to	4	0
Total	20	0

A section of the bluff near by gave (Sect. 575a, E. T. C., p. 54, Fig. 680):

	Ft.	In.
1. Gray and buff "argo." shale	8	0
2. Compact "argo." shale	2	0
3. Caking COAL	0	10
4. Fire-clay	..	4
5. COAL IV (block) .... 2 ft. to	3	0
6. Fire-clay	1	0
7. Caking COAL	0	10
8. Hard fire-clay, and not to the bottom	6	0
	22	0

A drilling by Mr. Chas. Bair west of Cannelburg, Sec. 30 (1), gave (Sect. 576):

	Ft.	In.
1. Surface, 34 ft.; (2) black shale, 9 ft.	43	0
3. COAL IIIb	..	6
4. Fire-clay, 1 ft. 6 in.; (5) "hard rock" (sandstone), 1 ft.	2	6
Place of Coal IIIa	..	..
6. Fire-clay, 1 ft. 6 in.; (7) "hard rock" (sandstone), 2 ft.; (8) black shale, 7 ft. 6 in.	11	0
9. COAL III	2	9
Total	59	9

Another boring by Mr. Bair just east of the last gave (Sect. 577):

	Ft.	In.
1. Surface gravel, 36 ft.; (2) fire-clay, 2 ft.; (3) gray shale, 6 ft. 6 in.	44	6
Place of Coal IIIb	..	..
4. Fire-clay, 2 ft.; (5) shale, 23 ft. 6 in.	25	6
6. COAL IIIa	..	6
Shale	10	0
Total	80	6

A boring southwest of the Mutual Mine air shaft and 25 to 30 ft. below it, Sec. 30 (3), gave (Sect. 578):

	Ft.	In.
1. Surface, 35 ft.; (2) gray shale, 15 ft.; (3) black shale, 4 ft.	54	0
4. COAL IIIa	..	2
5. Fire-clay, 2 ft.; (6) hard rock (sandstone?), 2 ft.; (7) black shale, 5 ft. 6 in.	9	6
8. COAL III	2	7
Total	66	3

Coal IV 3½ ft. thick was reported as found in an entry on the Jas. S. Morgan farm at 30 ft. down, also on the adjoining McCracken place, Sec. 30 (6) and (7).

Most of the recent mining done about Cannelburg has been done in Sec. 29.

The Buckeye Mine, Sec. 29 (1), was opened in 1870 or '71. It was operated by the Buckeye Cannel Coal Company. Operations were suspended in 1891 or '92. In 1895 there was some talk of reopening the mine, but it was not in operation in 1896. This mine has been one of the largest producers in the county, employing over 100 men several years. The section in the shaft is as follows:

1517. SECTION 579. SECTION OF BUCKEYE SHAFT.—Sec. 29, Figs. 679 and 683. (E. T. C., 1872, p. 26.)

	Ft.	In.
1. Drift clay and soil, 18 ft.; (2) quicksand, 15 ft.; (3) gray shale, 6 ft.	39	0
4. COAL IV	3	0
5. Fire-clay, 5 ft.; (6) sandstone, 4 ft.; (7) gray shale, 7 ft.	16	0
8. COAL IIIa	1	4
9. Fire-clay, 1 ft.; (10) sandstone, 4 ft.; (11) black shale, 10 ft.	15	0
12. COAL, cannel	2	6
13. COAL, caking (no parting)	2	0
14. Fire-clay	2	0
	80	10

This coal bed is more fully described under the description of the Mutual mine beyond, as that mine, being in operation, could be examined to better advantage there. The shaft of this mine was sunk close to the B. & O. S. W. Ry., giving thus unusual facilities for coal shipments.

A drilling reported by Mr. Cox and believed to have been drilled near here gave (Sect. 580, Plate L, Fig. 7, E. T. C., p. 63):

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	32	0	..	..	32	0
2.	Hard gray rock	8	0	..	..	40	0
3.	Dark gray shale	24	0	..	..	64	0
4.	COAL IV?	0	8	0	8	64	8
5.	Fire-clay	1	0	..	..	65	8
6.	Sandstone	3	0	..	..	68	8
7.	Gray shale	5	0	9	0	73	8
8.	COAL IIIa	1	4	1	4	75	0
9.	Fire-clay	2	0	..	..	77	0
10.	Sand rock	4	0	..	..	81	0
11.	Black shale	10	0	16	0	91	0
12.	COAL III	5	0	5	0	96	0

The upper coal in this section corresponds with Coal IV in the Buckeye shaft, but is here only 8 in. thick.

Another drilling near the last on the land of Harris and Moot gives, as reported by Mr. Cox (Sect. 581, Plate L, Fig. 6, E. T. C., p. 61):

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	33	2	..	..	33	2
2.	Sandstone	6	0	..	..	39	2
3.	Dark gray shale	8	0	..	..	47	2
4.	COAL IV	2	0	2	0	49	2
5.	Fire-clay	6	0	..	..	55	2
6.	White sandstone	4	0	..	..	59	2
7.	Dark gray shale	15	0	25	0	74	2
8.	COAL IIIa	1	6	1	6	75	8
9.	Sandstone	3	6	..	..	79	2
10.	Black shale	9	6	13	0	88	8
11.	COAL III	4	6	4	6	93	2

The Union Mine was opened in 1883 by the Union Coal Co. They reached Coal IV at 35 ft., the coal being 4 ft. thick (Fig. 681). The mine was shut down and abandoned March 1, 1886.

Coal has also been worked by a shaft south of the center of Sec. 29 by the Star Coal Company, the coal being reported to have been 4 ft. thick and found at a depth of 20 to 30 ft. The Mutual Mine was opened by the Union Coal Company between 1883 and 1885. From 1886 it has been operated by the Mutual Mining Company. This was in 1896, one of the largest mines in the county and the only cannel coal mine in the State. The coal is variable in thickness, an average measurement giving (Fig. 682):

	Ft.	In.
Cannel coal	3	2
Bituminous	1	6
Total	4	8

The thickest coal lies east of the shaft, where the coal becomes 6 ft. thick. The coal is thinner in the northwest, as is shown by the drillings and Plate L., and to the southeast becoming as low as 2 ft. 6 in. These differences in thickness are principally due to changes in the thickness of the cannel coal, which appears to lie in "pockets." The bituminous coal will average from 20 to 22 in. thick and is generally reported as an excellent coal. There appears to be no parting between the cannel and bituminous benches of the coal, masses of the cannel coal which have come away at the same time adhering to the blocks of bituminous coal.

A partial section at the Mutual mine, as given by Mr. Cahill, the superintendent, is as follows:

1518. SECTION 582. SECTION AT MUTUAL MINE.—Sec. 29-3-6, Plate L, Fig. 5 and Fig. 678.

		Ft.	In.
1.	Surface clay, 16 ft.; (2) soft shale, 14 ft.	30	[illegible]
3.	COAL IV	[illegible]	[illegible]
4.	Space	[illegible]	[illegible]
5.	COAL IIIa	[illegible]	[illegible]
6.	Fire-clay?; (7) [illegible] white rock [illegible] stone?); (8) shale, 26 ft.	[illegible]	0
9.	COAL III, cannel	4	0
10.	COAL III, bituminous	2	0
	Total	105	10

The shaft is 105 ft. deep. The coal is hauled from the mine to the railway, a distance of a little over a half mile, by mules on a tramway which rises to the proper height for screening and delivery to the cars. The coal dips southwest.

In Sec. [illegible] the records of four drillings made by Mr. Chas. Bair, and given by him, follow:

1519. SECTION 583. BORE NO. 1 ON HARRIS LAND.—Plate L, Fig. 4.

		Ft.	In.
1.	Surface, 14 ft.; (2) dark shale, 8 ft. 6 in.	22	6
3.	COAL IV?	1	4
4.	Fire-clay, 3 ft.; (5) dark shale, 13 ft.	16	0
6.	COAL IIIb?	2	6

	Ft.	In.
7. COAL and black shale mixed	1	0
8. Fire-clay, 3 ft. 6 in.; (9) gray shale, 6 ft.; (10) black shale, 29 ft.	38	6
11. COAL III	3	6
12. Fire-clay, 3 ft.; (13) "mud rock," 1 ft. 3 in.; (14) gray shale, 7 ft.; (15) "hard rock," 2 ft.; (16) fire-clay, 2 ft. 6 in.; (17) gray shale, 4 ft.; (18) dark shale, 7 ft.; (19) fire-clay, 1 ft.	27	9
Total	113	1

1520. Section 584. Bore No. 2 on Harris Land.—Plate L, Fig. 3.

	Ft.	In.
1. Surface, 48 ft.; (2) white shale, 3 ft.; (3) dark gray shale, 9 ft.	62	0
4. COAL IIIb	..	5
5. Fire-clay, 2 ft. 6 in.; (6) dark shale, 5 ft	7	6
7. COAL IIIa	1	8
Total	71	7

Section 585. Bore No. 3 on Hunter Land.—Plate L.

	Ft.	In.
1. [illegible] ft.; (2) dark shale, 4 ft.	36	0
3. [illegible]	2	2
4. [illegible] in.; (5) [illegible] 5 ft.; (6) [illegible]	28	6
8. COAL [illegible]	1	6
9. Fire-clay [illegible] black shale [illegible]	8	6
11. COAL III	3	0
Total	79	8

1522. Section 586. Bore No. 1 on [illegible] Fig. 1.

	Ft.	In.
1. Surface, 31 ft.; (2) gray shale, 3 ft.	[illegible]	[illegible]
3. COAL (rotten) IIIb	[illegible]	[illegible]
4. Fire-clay, 1 ft.; (5) white shale, 7 ft.; (6) dark shale, 10 ft.; (7) black shale, 8 ft.	[illegible]	[illegible]
8. COAL IIIa	[illegible]	[illegible]
9. Fire-clay, 2 ft; (10) black shale, 5 ft. 6 in.	[illegible]	[illegible]
11. COAL III	[illegible]	[illegible]
Total	[illegible]	[illegible]

The location of these borings on the map is as given by Mr. Bair himself. It is probable that the borings 2-4 should be located a quarter of a mile farther north. Mr. Bair reports that in each case Coal III was about one-third cannel coal.

In Sec. 31 another drilling on the Harris place by Mr. Bair gave (Sect. 587):

	Ft.	In.
1. Surface, 13 ft.; (2) gray shale, 6 ft.; (3) dark shale, 6 ft.	25	0
4. COAL (rotten) IV? (top bench)	1	0
5. Dark shale	3	0
6. COAL IV? (bottom bench)	2	0
7. Fire-clay, 3 ft.; (8) dark gray shale, 12 ft.	15	0
9. COAL	1	0
10. Fire-clay, 4 ft.; (11) gray shale, 8 ft.; (12) dark shale, 10 ft.	22	0
13. COAL	..	8
14. Fire-clay, 3 ft.; (15) gray shale, 7 ft.; (16) black shale, 17 ft.; (18) fire-clay, 2 ft.; (19) dark shale, 5 ft.; (20) fire-clay, 1 ft. 6 in.; (21) shale, 7 ft.	54	6
	124	2

Without having the elevation of this drilling as compared with the four just previously quoted it can not be stated whether the two top coals represent Coal IV, and III is missing or represented by one of the thin coals below, or whether the two top coals are the benches of Coal III.

Half a mile west of this boring, on the old Lewis Morgan farm, now owned by Mr. Kenner, of Washington, this upper coal is being mined by a shaft 23 ft. deep. The section here is (Sect. 588, Fig. 685):

	Ft.	In.
1. Surface, 6 ft.; (2) sandstone, 4 ft.; (3) shale, 10 ft.	20	0
4. COAL, "upper 6 in. cannel," rest bituminous, caking	..	11
5. Parting of slate	..	5
6. COAL (bottom bench) non-caking	1	4
7. Shale, hard	8+	0
Total	30	8

This coal is said to be cut out by the drain on the west and south. In 1896 it was being shipped by wagon to Washington. Two sets of barometer readings connecting this mine with adjacent points disagree to such an extent that it is not possible to decide from them whether this bed be Coal IV or Coal III.

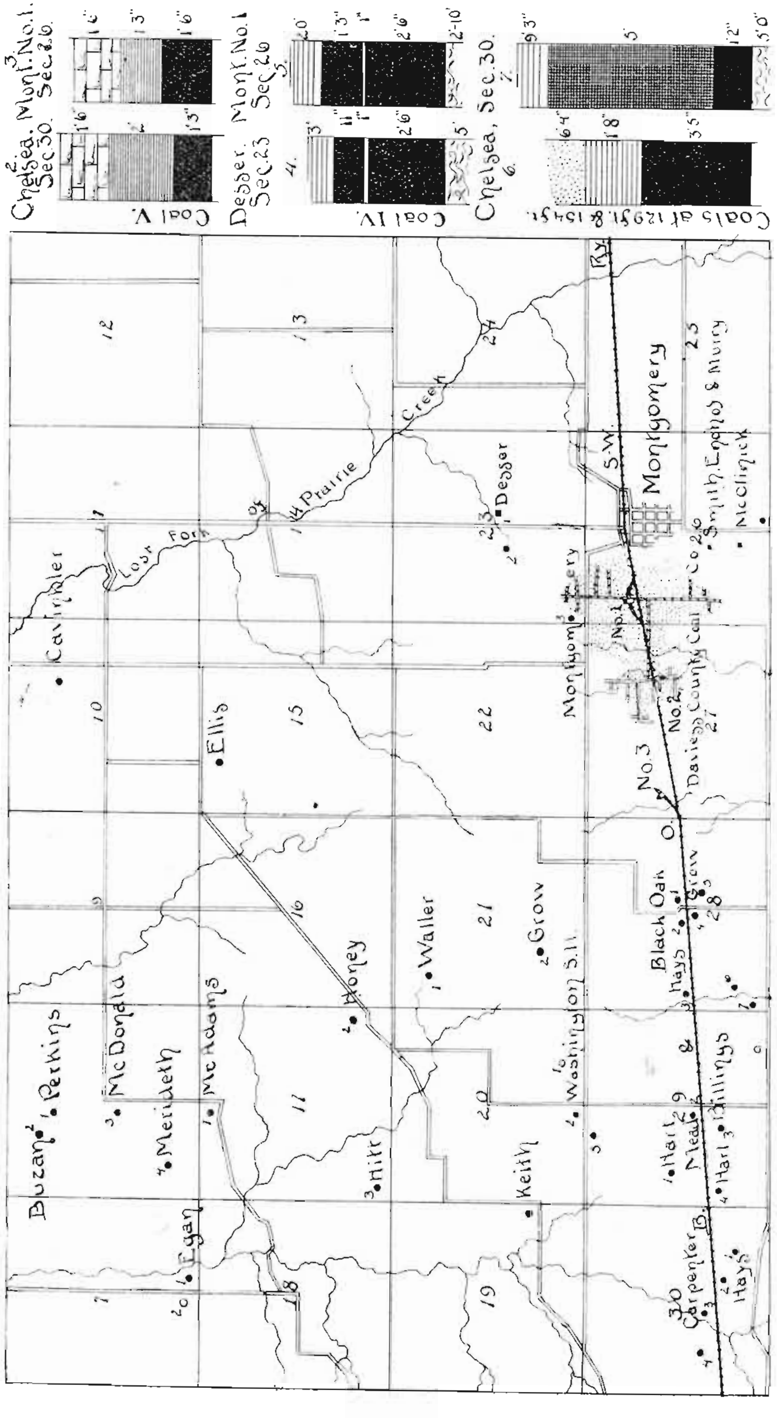


PLATE LI. Sketch map of part of Township 3 North, Range 6 West (around Montgomery) and sections of coals.

1523. DISTRIBUTION AND SECTIONS IN T. 3 N., R. 6 W.—In Sec. 1, on Mr. Hiram Lichty's place, in a well only a little above Prairie creek bottom, coal was reported at 15 ft., the coal being given as 16 in. of good coal and 8 in. of rash. This is probably the same coal as at Gootee's, a mile and a half north.

1524. T. 3 N., R. 6 W., SECS. 7-10 AND 15-22.—In Sec. 7, coal was reported by Mr. Egan as having been passed through in his well at a depth of 80 ft. Thickness given at 3½-4½ ft., given from memory, and may not be correct. Well was 100 ft. deep. Shale was passed through most of the way down, with 9 in. of "very hard rock" some 15-20 ft. above the coal. Surface material here is 30-40 ft. thick, cutting out Coal V. Coal met with was IV?

In Sec. 7, Mr. Albert Buzan, who did the drilling, reported coal as follows: In his own well, on the Joe Thompson place, well 35 ft. went through clay and blue mud, drilling 35 ft. to 3 ft. of coal. Coal IV at 70 ft. At Mr. A. Perkins's place the same coal is reached at 73 ft., the well being 35 ft. deep. The McDonald well was supposed to have stopped just above Coal V at 33 ft. At the Meridith place, Coal V, 1-1½ ft. thick, was struck at 30 ft.

In Sec. 10, coal was reported by Mr. Cox in Cavinkler's well.

In Sec. 15, 2½ ft. of coal was reported by Mr. Buzan as occurring in the well of Mr. Wm. Ellis at a depth of 51 ft. In Sec. 17, on the McAdams place, a drilling in a well to 140 ft. passed through three coal beds, the first being a thin bed, V, at about 33 ft. Mr. Buzan could not remember thickness or depth of the other two beds. On Mr. Peter Honey's place, Coal V was found at between 35 and 50 ft., with 18 in. of "hard rock" (limestone?) just above coal. The following is the record of a boring made on the J. W. Hitts farm, as reported by Mr. Cox:

1525. SECTION 589. SECTION OF A BORE ON MR. HITT'S FARM, SEC. 17. (E. T. C., p. 58.)

	Ft.	In.	Ft.	In.
1. Surface	40	0	40	0
2. Shale rock	1	0	41	0
3. Pebble rock	3	0	47	0
4. Black shale	5	0	52	0
5. Fire clay and ashy shale	8	0	60	0
6. Shale and COAL	1	0	61	0
7. Pale gray shale	13	0	74	0
8. Dark gray shale	8	0	82	0
9. Ashy gray shale	24	0	106	0
10. Black shale	56	0	162	0
11. COAL	1	5	163	5

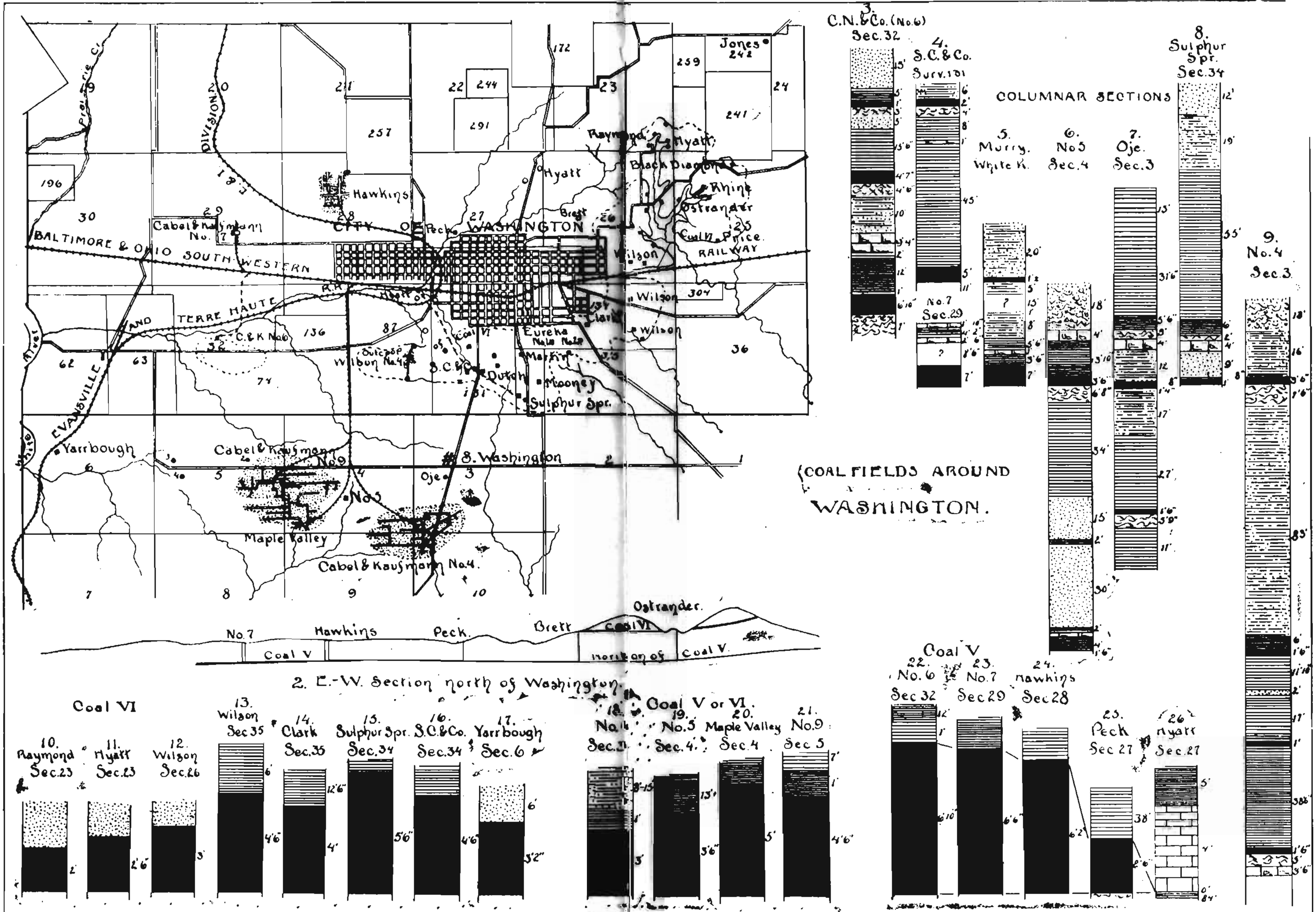

COAL FIELDS AROUND WASHINGTON.
COLUMNAR SECTIONS
CITY OF WASHINGTON
BALTIMORE & OHIO SOUTH WESTERN R.R.
EVANSVILLE AND TERRE HAUTE RAILWAY
White River
Prairie Cr.
DIVISION
Jones
Raymond
Hyatt
Black Diamond
Rhine
Ostrander
Price
Wilson
Clark
Eureka
Markin
Mooney
Dutch
Sulphur Spr.
Hawkins
Cabel & Kaufman No. 7
C. & K. No. 6
Yarrbough
Cabel & Kaufman No. 9
No. 5
Oje
S. Washington
Maple Valley
Cabel & Kaufman No. 4
2. E.-W. Section north of Washington
No. 7
Hawkins
Peck
Brett
Ostrander
Coal V
Coal VI
3. C.N. & Co. (No. 6) Sec. 32
4. S.C. & Co. Surv. 131
No. 7 Sec. 29
5. Murry. White R.
6. No. 5 Sec. 4
7. Oje. Sec. 3
8. Sulphur Spr. Sec. 34
9. No. 4 Sec. 3
Coal VI
10. Raymond Sec. 23
11. Hyatt Sec. 23
12. Wilson Sec. 26
13. Wilson Sec. 35
14. Clark Sec. 35
15. Sulphur Spr. Sec. 34
16. S.C. & Co. Sec. 34
17. Yarrbough Sec. 6
Coal V or VI.
18. No. 4 Sec. 3
19. No. 5 Sec. 4
20. Maple Valley Sec. 4
21. No. 9 Sec. 5
Coal V
22. No. 6 Sec. 32
23. No. 7 Sec. 29
24. Hawkins Sec. 28
25. Peck Sec. 27
26. Hyatt Sec. 27

PLATE LIII.

	Ft.	In.	Ft.	In.
12. Gray shale	13	0	176	5
13. COAL	1	6	177	11
14. Gray shale	12	0	189	11
15. Black shale	21	1	211	0
16. Fire-clay	1	0	212	0

The top coal in this section would appear to represent Coal IV, though nearly pinched out at this point.

In Sec. 19, in the well on the Keith place, 3 ft. of coal was reported by Mr. Keith's brother as having been passed through at 65 ft. The well was 70 ft. deep.

In Sec. 20, coal was found at 52 ft. in a boring made in the well at Washington schoolhouse by Mr. Buzan. The section as given by Mr. Buzan is (Sect. 590):

	Ft.	In.
1. Surface clay, 10 ft.; (2) sandstone and dark gray shale, 40 ft.	50	0
3. Shale ("cannel coal") V	2	0
4. Fire-clay	..	6
5. COAL V or IVa?	2	6
	55	0

At this point the upper part of the double bed found elsewhere in this neighborhood is a black, solid shale, resembling cannel coal, and generally reported as good coal.

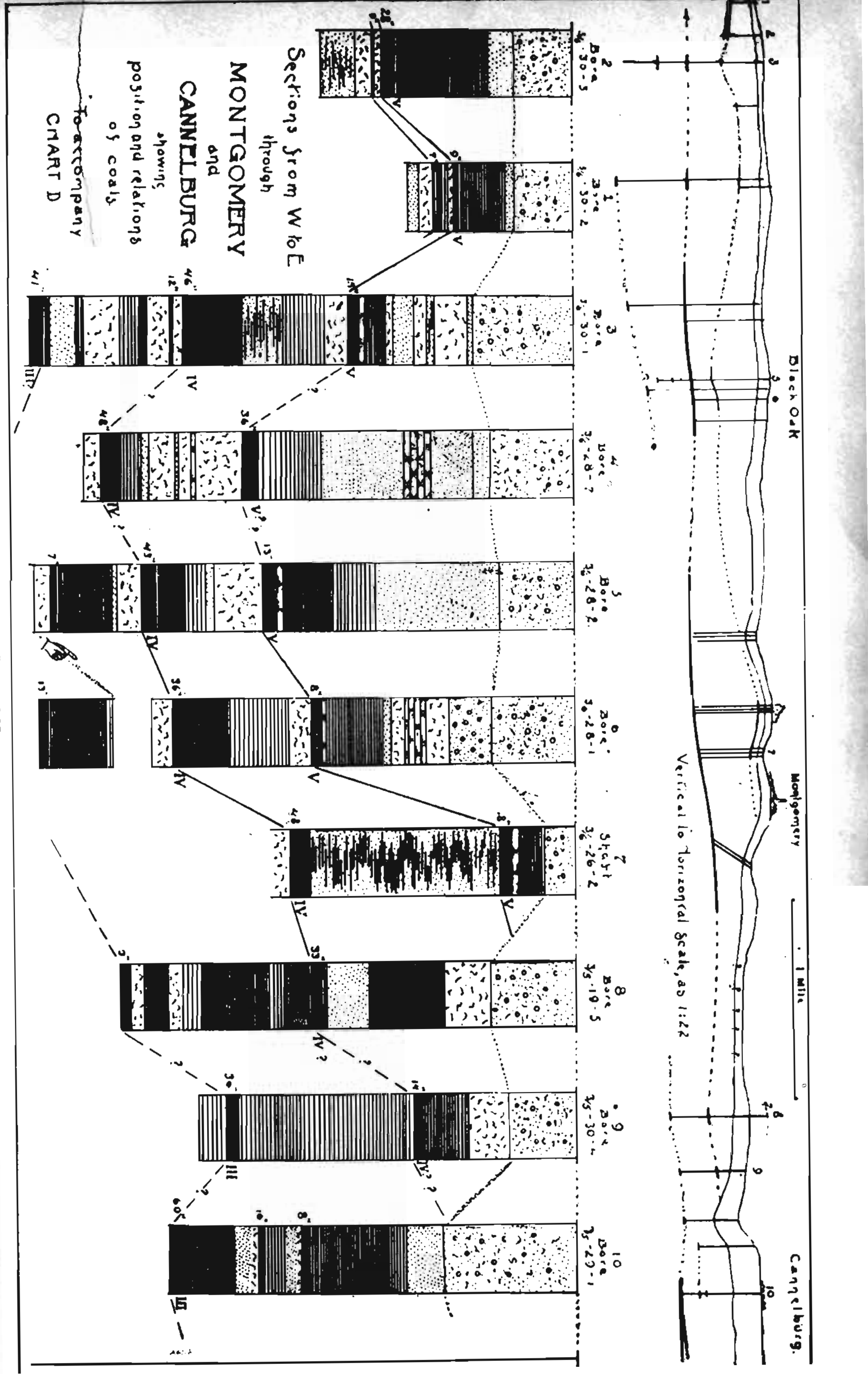
In Sec. 21, on the Grow farm, Coal V was passed through, showing 3 ft. 6 in., only 6 in. being good coal, the rest a black shale. The section at this point, from a boring by Messrs. Cabel and Kaufmann, is (Sect. 591):

	Ft.	In.
1. Surface, 28 ft.; (2) gray shale, 8 ft.; (3) sandstone, 10 ft.; (4) gray shale, 4 ft.	50	0
5. Black shale and coal (6 in.) V	3	6
6. Fire-clay, 15 ft.; (7) sandstone, 30 ft.	45	0
Total	98	6

Coal was also reported by Mr. Cox as occurring on the Waller place.

From the above, it is evident that Coal V lies about 30 ft. beneath the surface in the northwest sections, though removed from much of the area by preglacial valleys. On the higher land to the south the depth increases to about 50 ft. Coal IV is about 70 ft. deep and will

PLATE LII.



average about 3 ft. thick. The depth decreases to the east, so that Coal IV is probably cut out by Prairie creek, the coal coming nearly, if not quite, up to the level of the creek.

IN CHELSEA AND AROUND BLACK OAK.—A number of drillings were made in this area by Mr. Buzan for a company of which Mr. A. J. Hart was a member. The records were unfortunately burned when Mr. Hart's house burned, a few years ago. Mr. Hart gave the position of several of the borings with the depth and thickness of the coal as well as he could remember them, and Mr. Buzan added somewhat to that. The drillings by Messrs. Cabel and Kaufmann were diamond-drill borings.

1526. Chelsea boring, 180 ft. deep, Sec. 30 (4), passed through 2½ ft. of coal at between 60 and 80 ft. down, probably Coal IV; 30 or 40 ft. below a second bed was passed through. Drilling reported by Mr. Buzan.

Drilling on Carpenter land, Sec. 30 (3) (see, also, Plate LII, bore 2). By Messrs. Cabel and Kaufmann (Sect. 592):

	Ft.	In.
1. Yellow clay, 14 ft.; (2) sandstone, 6 ft.; (3) blue shale, 9 ft.; (4) impure limestone, 6 in.; (5) black shale, 12 ft. 6 in.; (6) limestone, 7 in.; (7) black shale, 9 in.	43	4
8. COAL V	2	4
9. Fire-clay	1	9
10. COAL V?	..	9
11. Fire-clay, 3 ft. 10 in.; (12) sandy shale	8	0
Total	56	2

Another drilling near this section, 30 (2) (bore 1, on Plate LII), by the same company and on the same farm, gave (Sect. 593):

	Ft.	In.
1. Yellow clay, 14 ft.; (2) sandstone, 2 ft.; (3) blue shale, 11 ft. 6 in.	27	6
4. COAL V	..	9
5. Fire-clay, 1 ft. 7 ft.; (6) gray shale, 2 ft.; (7) black shale, 1 ft.	4	7
8. COAL V or IVa	..	7
9. Fire-clay, 3 ft. 5 in.; (10) sandstone, 3 ft.	6	5
Total	39	10

Neither of these drillings went deep enough to strike Coal IV, which should be found at 90 ft. to 120 ft. at this point.

1527. SECTION 594. DRILLING ON JOHN HAY'S LAND IN CHELSEA.—Sec. 30 (1) [exact location in doubt] (Bore 3 on Plate L), and see, also, Plate XLIX.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Drift	5	0	..	..	5	0
2. Sandstone and gravel	19	0	..	..	24	0
3. Sandstone	1	0	..	..	25	0
4. Fire-clay	8	0	..	..	33	0
5. Sand shale	2	0	..	..	35	0
6. Fire-clay	3	0	..	..	38	0
7. Sandstone	5	0	..	..	43	0
8. Fire-clay	2	0	..	..	45	0
9. Gray shale	5	0	..	..	50	0
10. Bastard limestone	1	6	..	..	51	6
11. Black shale	2	0	..	..	53	6
12. COAL V (Plate LI, Fig. 2)	1	3	1	3	54	9
13. Fire-clay	5	3	..	..	60	0
14. Gray shale	10	0	..	..	70	0
15. Sand shale	10	0	..	..	80	0
16. Black shale	10	9	36	0	90	9
17. COAL IV	3	10	3	10	94	7
18. Fire-clay	2	11	2	11	97	6
19. COAL	1	0	1	0	98	6
20. Fire-clay	5	6	..	..	104	0
21. Black shale	2	0	..	..	106	0
22. Gray shale	5	0	..	..	111	0
23. Fire-clay	8	0	..	..	119	0
24. Gray shale	2	0	..	..	121	0
25. Sandstone	6	4	..	..	127	4
26. Gray shale	1	8	30	6	129	0
27. COAL III? (Plate LI, Fig. 6)	3	5	3	5	132	5
28. Fire-clay	4	7	4	7	137	0
29. COAL	1	2	1	2	138	2
30. Gray shale	0	10	..	..	139	0
31. Fire-clay	2	0	..	..	141	0
32. Black shale	3	0	5	10	144	0
33. COAL	0	10	0	10	144	10
34. Gray shale	9	3	9	3	154	1
35. "Black jack" (bone coal)	5	0	..	..	159	1
36. COAL (Plate LI, Fig. 7)	1	2	6	2	160	3
37. Fire-clay	5	0	..	..	165	3
38. Sand shale	10	3	15	3	175	6
39. COAL	2	1	2	1	177	7
40. Black shale	12	8	..	..	190	3
41. Gray shale	8	0	..	..	198	3
42. Blue shale	3	0	..	..	201	3
43. Black shale	1	0	..	..	202	3
44. Fire-clay	4	0	..	..	206	3
45. Gray shale	5	0	..	..	211	3
46. Boulders	0	10	..	..	212	1

		Ft.	In.	Ft.	In.	Ft.	In.
47.	Black shale	2	2	..	..	214	3
48.	Bastard limestone	2	6	30	2	216	9
49.	COAL	0	6	0	6	217	3
50.	Sandstone, shale	10	0	..	..	227	3
51.	Gray shale	3	9	13	9	231	0
52.	COAL	0	5	0	5	231	5
53.	Blue shale	6	10	..	..	238	3
54.	Bastard limestone	14	0	..	..	252	3
55.	Gray shale	5	6	..	..	257	9
56.	Black shale	1	0	27	4	258	9
57.	COAL	0	8	0	8	259	5
58.	Blue shale	0	10	..	..	260	3
59.	Sandstone	6	0	6	10	266	3
60.	COAL	0	6	0	6	266	9
61.	Sandstone	6	0	..	..	272	9
62.	Black shale	1	3	7	3	274	0
63.	COAL	0	4	0	4	274	4
64.	Gray shale	13	5	..	..	287	9
65.	Black sand shale	40	0	..	..	327	9
	Total coal, 22 ft. 2 in.						

The coals below Coal IV have not been correlated. It will be noted that there are many more coals than outcrop to the east, nor can any of the coals outcropping to the east be certainly recognized in this section below Coal IV. As shown by this section, no workable coal exists below Coal III or II, at least at this point, and to a depth of 300 ft.

1528. SECTION 29.—A boring by Mr. Clapp on Mr. A. J. Hart's place, Sec. 29 (1), reported by Prof. Cox, was as follows (Sect. 594a, E. T. C., p. 66):

		Ft.	In.	Ft.	In.
1.	Surface	12	0	12	0
2.	Shale rock	27	0	39	0
3.	Black shale	10	0	49	0
4.	Shale and COAL V	1	8	50	8
5.	Fire-clay	5	0	55	8
6.	Pale gray shale	18	0	73	8
7.	Shale rock	35	0	108	8
8.	Dark gray shale	19	0	127	8
9.	Black sand rock	2	0	129	8
10.	Black shale	1	0	130	8
11.	Black sand rock	1	0	131	8
12.	Fire-clay	5	0	136	8
13.	Pale gray shale	12	0	148	8
14.	Sand rock	1	0	149	8
15.	Black shale	15	0	164	8
16.	Fire-clay	4	0	168	8
17.	Dark gray shale	4	0	172	8
18.	Ashy shale	8	0	180	8

Three-quarters of a mile southeast, a bore, Sec. 29 (5), was put down on the place of Mr. Jesse Billings by Mr. Clapp, of which the following is a record (Sect. 595, E. T. C., p. 69):

		Ft.	In.
1.	Surface	24	0
2.	Shale rock	51	0
3.	Pale gray shale	6	0
4.	Dark gray shale	14	0
5.	Black sand rock	2	0
6.	Shale	2	0
7.	Fire-clay	2	0
8.	Ashy shale	16	0
9.	Blue sand rock	2	0
10.	Black shale	12	0
11.	Fire-clay	5	0
12.	Blue shale	10	0
13.	Black shale	10	0
14.	Gray shale	1	0

These drillings are evidence of lack of continuity of even the principal coal beds, for several borings a short distance from these and even between them report at least two workable coal beds. The last boring was evidently put down on lower ground than the other, as Coal V in the first does not appear in the second, as it evidently existed above the highest rocks exposed. Judging from diamond-drill borings near this, Coal IV is not even represented by fire-clay, the two coal horizons indicated, which agree in both sections, being probably below Coal IV.

Mr. Billings reported a boring on his land near the railroad, Sec. 29 (3), as passing through coal as follows: Coal, 10 in. at 30 ft.; coal, 36 in. at 90 ft.; coal, 48 in. at 180 ft. (See Nos. 35 and 36 of Sect. 594.)

On somewhat higher ground, close to the railroad crossing, Mr. Mead penetrated Coal V at 41 ft. to a depth of 6 in. in digging his well, Sec. 29 (2). It proved at this point to be more nearly a bituminous shale, resembling cannel coal. The section he reported was (Sect. 596):

		Ft.	In.
1.	Surface	12	0
2.	Sandstone, 6 ft.; (3) shale, 23 ft	29	0
4.	COAL V (shaly)	..	6+
		—	—
		41	6+

Coal is also said to have been struck in a well a short distance west of Washington schoolhouse at 50 ft., Sec. 29 (6). Mr. Hart reported 4 in. of coal in his well at 26 ft., Sec. 29 (4).

AROUND BLACK OAK.—Sec. 28. Mr. Albert Buzan reported that a boring made by him on the land of Mr. Geo. Hays, Sec. 28 (3), passed through 4 ft. 5 in. of coal at a depth of 160 ft. The same coal was found by him at 150 ft. in a boring on Mr. Christopher Grow's land, Sec. 28 (4). This is taken to represent the Cannelsburg coal, though it may not belong to exactly the same horizon. It is probably the same as the bone and coal Nos. 35 and 36 of Sect. 594.

Coal IV was reported by Mr. Hart as reached at 90 ft. in two drillings, Sec. 28 (5) and (6), the thickness in each case being about 3 ft. 4 in.

A drilling by Mr. Clapp on the farm of Mr. Geo. Hays, Sec. 28 (2), as reported by Mr. Cox, and location corrected by Mr. Billings, gave (Sect. 597, E. T. C., p. 56):

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Clay	10	0	..	..	10	0
2.	Sandstone	2	0	..	..	12	0
3.	Shell rock and gravel	2	0	..	..	14	0
4.	Blue clay	6	0	..	..	20	0
5.	Soft sandstone	4	0	..	..	24	0
6.	Hard sandstone	10	0	..	..	34	0
7.	Hard limestone	6	0	..	..	40	0
8.	Sandstone	10	0	..	..	50	0
9.	Hard sandstone	10	0	..	..	60	0
10.	Clay shale	15	0	..	..	75	0
11.	Black shale	0	3	..	..	75	3
12.	COAL IV	3	0	3	0	78	3
13.	Fire-clay	11	0	..	..	89	3
14.	Lime rock	1	0	..	..	90	3
15.	Fire-clay	2	0	..	..	92	3
16.	Hard rock	1	0	..	..	93	3
17.	Fire-clay	6	0	..	..	99	3
18.	Hard rock	2	0	..	..	101	3
19.	Clay shale	6	0	29	0	107	3
20.	COAL III	4	0	4	0	111	3
21.	Fire-clay	3	6	..	..	114	9
22.	Hard rock	2	0	..	..	116	9
23.	Fire-clay	4	0	..	..	120	9
24.	Hard rock	1	0	..	..	121	9
25.	Fire-clay	4	0	..	..	125	9
26.	Hard rock	1	0	..	..	126	9
27.	Hard black shale	1	0	..	..	127	9
28.	Clay shale	5	0	..	..	132	9
29.	Fire-clay	5	0	..	..	139	9

		Ft.	In.	Ft.	In.	Ft.	In.
30.	Hard rock	1	0	..	..	138	9
31.	Chalk shale	1	0	..	..	139	9
32.	Black shale	13	0	..	..	152	9
33.	Hard rock	1	0	..	..	153	9

At the railroad well at Black Oak, Sec. 28 (1), a drilling by Messrs. Cabel and Kaufmann gave (Sect. 598, Plate LII, Fig. 6):

		Ft.	In.
1.	Drift, 20 ft.; (2) sand and gravel, 10 ft.; (3) fire-clay, 6 ft.; (4) impure limestone, 5 ft.; (5) fire-clay, 3 ft.; (6) sandstone, 2 ft.; (7) gray shale, 14 ft.; (8) limestone, 1 ft.; (9) black shale, 1 ft. 6 in.	62	6
10.	COAL V	..	8
11.	Fire-clay, 5 ft. 10 in.; (12) gray shale, 14 ft.; (13) blue shale, 10 ft. 8 in.	30	6
14.	COAL IV	3	0
15.	Fire-clay	5	1
	Total	101	9

A little west of the last drilling another drilling, on the Grow farm, Sec. 28 (2), by Messrs. Cabel and Kaufmann, gave (Sect. 599, Plate LII, Fig. 5):

		Ft.	In.	Ft.	In.
1.	Drift, 18 ft.; (2) sandstone, 30 ft.; (3) gray shale, 10 ft.; (4) blue shale, 12 ft.; (5) impure limestone, 1 ft. 3 in.; (6) black shale, 2 ft. 3 in.	73	6	73	6
7.	COAL V	1	1	74	7
8.	Fire-clay, 11 ft. 5 in.; (9) sandstone, 2 ft.; (10) gray shale, 5 ft.; (11) black shale, 7 ft. 2 in.	25	7	100	2
12.	COAL IV	3	7	103	9
13.	Fire-clay, 5 ft. 3 in.; (14) sandstone, 1 ft. 1 in.; (15) blue shale, 14 ft. 3 in.	20	6	124	3
16.	COAL IIIb	..	7	124	70
17.	Fire-clay, 3 ft. 2 in.; (18) gray shale, 2 ft.; (19) blue shale, 15 ft. 2 in.	20	4	145	2
20.	COAL IIIa	1	1	146	3

The last three drillings are 4, 6 and 5, respectively, of Plate LII. In Sec. 33 (1), Mr. Buzan reports 3 ft. 6 in. at 150 ft. in a drilling. Since this region was visited, Montgomery No. 3 mine has been opened in the west side of Sec. 27, and 150 yds. north of the railroad.

COAL AROUND MONTGOMERY.—A slope was opened to Coal IV, just east of Montgomery, during the '60s, and abandoned before 1870. It is reported to have reached the coal at 40 ft., Sec. 26 (1).

In 1879-80, Rev. Mr. Pierce was mining here in a small way, operating by a shaft reported to be 60 ft. deep, and reaching coal 3 ft. 6 in. thick.

In 1880 a drift was opened and operated by Mr. Chas. M. Gough, but its exact location is not known.

In 1885 the Wilson mine was opened by the Wilson Coal Company, Sec. 26 (3). Later it became known as the Montgomery mine, and was operated by the Daviess County Coal Company. In 1895 the mine produced more than one-third of all the coal mined in the county, and taken in connection with the adjoining mine, Montgomery No. 2, Sec. 27 (1), produced nearly one-half of the coal mined in Daviess county. It has furnished coal to the locomotives on the B. & O. S.-W. Ry., except for a while in 1893. The coal is reported as not as good as could be desired. In 1896 the company was driving test entries some distance north in hopes of finding a better grade of coal, as the coal being mined at the Desser bank, one mile farther north, seemed to be of better quality. The coal is a semi-block. It seems to maintain its thickness better in a northeast and southwest direction than at right angles to that direction, as it becomes thinner to the northwest and southeast. The coal will run about 3 ft. 10 in. thick. As already mentioned, it is cut into the west by a preglacial channel or "horse-back." A clay parting similar to that usually found in this coal elsewhere in the county runs through the coal, 1 ft. to 1 ft. 6 in. from the top (Fig. 5 of Plate LI). The coal is 86 ft. deep at the shaft. The section as given by Mr. Brown, the superintendent, is (Sect. 600):

		Ft.	*In.*
1.	Clay, 10 ft.; (2) sandstone, 6 ft.	16	0
3.	COAL V (top 2 in. cannel coal)	1	6
4.	"Hard rock flint" (?), 1 ft. 3 in.; (5) blue shale, 20 ft.; (6) fire-clay, 4 ft.; (7) shale, 20 ft. (54)	68	6
8.	COAL IV (top) 1 ft. to	1	6
9.	Parting	..	1
10.	COAL IV (bottom) 2 ft. to	2	6
11.	Fire-clay 2 ft. to	10	0
	Total	100	1

Pieces of limestone supposed to be from the limestone overlying Coal V were found at the mine, and, though reported to have come from below the top coal, it is more probable that they came from over

Coal V, and that the section given as No. 7 of Plate LII, from a drilling (?) reported by Mr. Cox, is more correct, though the coal was not quite as deep. (Sect. 601, Plate LII, Fig. 7, E. T. C., p. 53):

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1.	Soil and clay	8	0	..	..	8	0
2.	Brown shale with ironstone	6	0	..	..	14	0
3.	Dark fossiliferous limestone	1	6	..	..	15	6
4.	Black bituminous sheety shale	1	3	..	..	16	9
5.	COAL V (caking)	1	6	1	6	18	3
6.	Arenaceous shale	46	0	..	..	64	3
7.	Blue argillaceous shale	1	6	47	6	65	9
8.	COAL IV (block)	4	0	4	0	69	9
9.	Fire-clay	6	0	..	..	75	9

Montgomery mine No. 2, Sec. 27 (1), was opened and operated in 1895, but was not being operated in 1896. This mine is connected with the preceding. The floor at No. 1 mine tends to be soft and uneven. In 1897 Montgomery No. 3 mine was being sunk one mile west of No. 2.

A half mile north a drilling on Mr. J. C. Montgomery's land, Sec. 23 (3), by Mr. Clapp, as reported by Mr. Cox, gave (Sect. 602, E. T. C., p. 62):

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1.	Surface	30	0	..	..	30	0
2.	Dark gray shale	25	0	..	..	55	0
3.	Sandstone	1	0	..	..	56	0
4.	Black shale	4	0	..	..	60	0
5.	COAL V	1	0	1	0	61	0
6.	Fire-clay	4	0	..	..	65	0
7.	Dark gray shale	15	0	..	..	80	0
8.	Black shale	1	4	20	4	81	4
9.	COAL IVa	1	0	1	0	82	4
10.	Fire-clay	5	0	..	..	87	4
11.	Ashy shale	7	0	..	..	94	4
12.	Dark gray shale	7	0	..	..	101	4
13.	Black shale	4	0	23	0	105	4
14.	COAL IV	2	6	2	6	107	10

Near the center of Sec. 23 is the Desser bank, Sec. 23 (1). This is a slope, the coal being about 10 ft. below the surface. The coal will run from 3 ft. to 3 ft. 8 in., with an average of 3 ft. 5 in. The usual parting, 1 in. to $1\frac{1}{2}$ in., runs about 11 in. from the top (Plate LI, Fig. 4). The coal here is claimed not to clinker and to be better than the Montgomery coal for household and blacksmithing purposes, but not to be so good for steaming purposes. The section here is as follows (Sect. 603):

		Ft.	In.
1.	Drab or brown to yellow sandy shale	3+	0
2.	COAL IV (top)	..	11
3.	Parting, 1-1½	..	1
4.	COAL IV (bottom)	2	6
5.	Fire-clay, 5 ft.; (6) shale, 3-4 in.	5	4
7.	COAL IIIb?	1	6
	Total	13	4

Should the fire-clay here prove on trial valuable for commercial purposes, the lower Coal IIIb could probably be mined at the same time, making altogether about 5 ft. of coal. The extent of Coal IIIb is not known. Coal IVa, underlying red or gray sandstone, is found a short distance up the drain from Desser's and about 15-25 ft. above, Sec. 23 (2).

Since this area was examined two banks have been opened south of Montgomery, in Sec. 26. One of these was sunk in 1898, on the John Nichols place, by Messrs. John Smith, Chas. Enchof and Mr. Murry. The other was opened in 1897 by Mr. Archibald McClintick, on the Bracken place. The coal is reported as only 20 ft. deep here, running to a crop on the east and growing thicker to the west. Coal 3 ft. 10 in. thick.

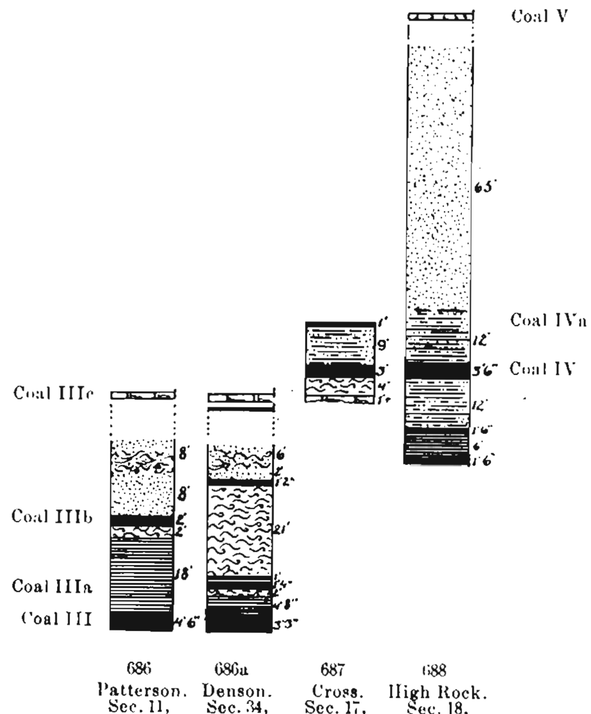
In Sec. 36 a drilling on the land of Mr. Ignatius Walker by Mr. Clapp, as reported by Mr. Cox, gave (Sect. 604, E. T. C., p. 67):

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	22	0	..	..	22	0
2.	Soft COAL V	0	10	0	10	22	10
3.	Pale gray shale	8	7	..	..	31	5
4.	Dark gray shale	7	0	..	..	38	5
5.	Black shale	3	0	18	7	41	5
6.	COAL IVa	1	0	1	0	42	5
7.	Fire-clay	2	0	..	..	44	5
8.	Ashy shale	4	0	..	..	48	5
9.	Dark gray shale	4	0	..	..	52	5
10.	Blue sandstone	10	0	20	0	62	5
11.	COAL IV	2	4	2	4	64	9
12.	Fire-clay	3	0	..	..	67	9
13.	Ashy shale	4	0	..	..	71	9
14.	Dark gray shale	15	0	22	0	86	9
15.	COAL	1	9	1	9	88	6

Prof. Cox marks Coals V and IV as occurring on the B. D. Bowman place.

TOWNSHIP 1 (IN PART) AND 2 NORTH, RANGES 5 AND 6 WEST.

1529. GEOGRAPHY.—This area lies in the southeastern part of the county and corresponds to Reeve and Harrison and the south part of Barr and the southeastern corner of Washington of the civic townships.

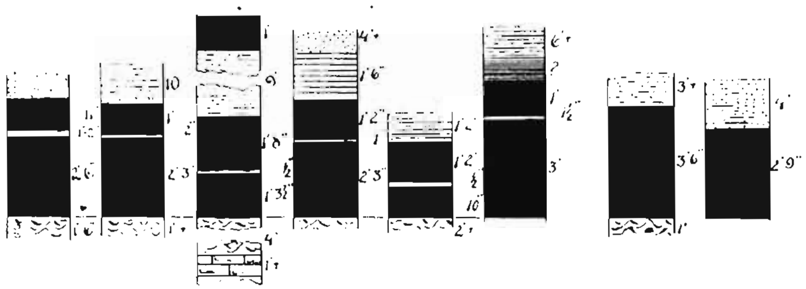


Figs. 686-688. Columnar sections from townships 1 and 2 north of ranges 5 and 6 west.

1530. TOPOGRAPHY.—At the north this area is level, but to the south becomes somewhat hilly, the hills rising 100 ft. or more above the streams.

1531. STRATIGRAPHY.—Coal V is found at a few places over the western half of this area, but is not worked. Coal IV is worked at a number of points in the western townships. It runs about 3 ft. thick, with its characteristic clay parting above the center. Its roof is either shale or sandstone and its quality much as about Montgomery.

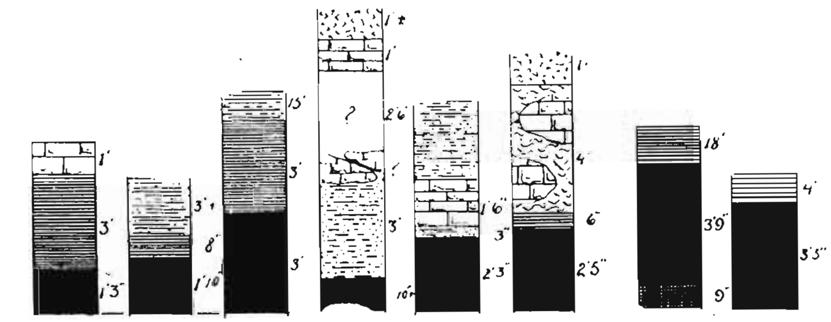
1532. Division III or III-II shows four coals at Alfordsville, of which the lowest is the one principally worked. The uppermost one is usually overlain by black shale and limestone, and, from its resemblance to Coal V, was formerly correlated with that coal. There is usually a massive sandstone over the second coal from the bottom,



689 Nolan. Sec. 7, 2, 5. — 690 Hornaday. Sec. 18, 1, 5. — 691 Cross. Sec. 17, 2, 6. — 692 Donahue. Sec. 24, 2, 6. — 693 Smoot. Sec. 22, 2, 6. — 694 Colbert. Sec. 4, 1, 6. — 695 Potts. Sec. 5, 1, 5. — 696 Scales. Sec. 9, 1, 5.

Figs. 689-694. Coal IV in townships 1 and 2 north, ranges 5 and 6 west.
Figs. 695-696. Coal ? in same area.

Coal IIIb, while Coal III is overlain by shale. The resemblance of Coals III and IIIb here to II and IIa around Cannelton, Perry county, should be noted, as it is not impossible that they are the same.



697 Aikman Cr. Sec. 14, 2, 6. — 698 Gould. Sec. 26, 2, 5. — 699 McCord. Sec. 34, 2, 5. — 700 Camp. Sec. 34, 2, 5. — 701 Allen. Sec. 3, 1, 5. — 702 Wininger. Sec. 16, 1, 5. — 703 Patterson. Sec. 11, 2, 5. — 704 Denson. Sec. 34, 2, 5.

Figs. 697-702. Coal IIIb in area of Ts. 1 and 2 N., Rs. 5 and 6 W.
Figs. 703, 704. Coal II in same area.

As before, columnar coal sections will be given under distribution.

1533. Distribution and Local Details, T. 2 N., R. 5 W.—(In Daviess county).

Sec. 6.—On the Wm. Price place, 18 in. of coal are said to have been struck in a well at 29 ft. This was thought to be Coal IIIb or IIId.

In Sec. 7 again, at Mr. Nolan's, two drifts have been driven into Coal IV on a level with the drain near its head. The coal showed the following section (Sect. 605, Fig. 689):

	Ft.	In.
Sandstone roof	..	..
COAL IV (upper bench)	..	11
Bone coal 2 in. to	..	1
COAL IV (lower bench)	2	6
Fire-clay (exposed)	1	6
Sandstone	..	..

This coal is reported to be a rich, oily coal, making some clinker, but quite satisfactory for most uses. This suggests that under the divide between Veale's and Aikman's creeks, in Barr township and extending a little into Washington township, may lie a good body of Coal IV. It is, of course, only the southern extension of the Montgomery coal field, and the coal has probably much the same character.

Sec. 11.—Coal III-II is here but a little above drainage. It is worked at the Patterson bank. The coal is here from 3 to 4 ft. thick, not including from 4 to 10 in. of bone on the bottom. This coal is said to be good, especially the lower part, which is known as blacksmith coal. Sulphur balls occur locally or in pockets. A section at the air-shaft showed (Sect. 606, Figs. 686 and 703):

	Ft.	In.
1. Surface, 8 ft.; (2) sandstone, 10 ft.	18	0
3. COAL IIIb	2	0
4. Fire-clay, "brownish gray chalk rock," 2 ft. 4 in.; shale, 16-18 ft.	20	0
5. COAL III, including bone	1	6

About 10 ft. above the mouth of the air-shaft was seen the limestone that comes above Coal IIIc. This is the farthest north that this limestone, so persistent to the south, was recognized.

Southeast of this, in the S. E. of S. W. of Sec. 11, is the Tracy bank. This coal has the same shale roof as at the Patterson bank, but is said to be not quite so thick or so good.

Sec. 17.—Coal was reported to have been found at Mr. Peter Griffin's, which, from its elevation, would seem to be in Division IV.

SEC. 19.—Coal reported to have been mined a little on the Buckley place, near the northeast corner of section.

SEC. 21.—On Mr. Peter Grannon's place, in the N. W. ¼, a 2-ft. coal is said to have been worked some by stripping.

SEC. 20.—On Mr. Jas. Shea's place, in the N. E. of N. W. of Sec. 28, a 4-ft. bed of coal was reported passed through.

SEC. 27.—A section noted by Mr. Cox, probably in the N. W. ¼ of Sec. 27, on the road to Alfordsville after crossing Sugar creek, is as follows (Sect. 607, E. T. C., p. 48):

	Ft.	In.	Ft.	In.
1. Soil and clay	10	0	10	0
2. Siliceous shale with alternating bands of iron ore	20	0	30	0
3. Gray siliceous limestone	2	0	32	0
4. Shale. Place of COAL IIIc?	4	0	36	0
5. Fire-clay	3	0	39	0
6. Flaggy limestone	1	0	40	0
7. Sandstone and shale	20	0	60	0
8. COAL	?	?	60	0
9. Fire-clay	2	0	62	0
10. Good iron ore mixed with shale	14	0	76	0
11. Siliceous shale	20	0	96	0
12. Bed of Sugar creek	0	0	96	0

SEC. 26.—On the Gould place, the S. W. of the N. W., a little coal has been mined by stripping. The section showed (Sect. 607a, Fig. 698):

	Ft.	In.
1. Brown sandy shale, 3 ft.+ (2) black shale, 8 in.	3	8
3. COAL IIIc	1	10

The same coal outcrops in the road just west. This coal has also been worked a little a quarter of a mile farther north. Mr. Cox mentions on the same quarter section (though in another place he says Sec. 25, which is more probably right) a 4-ft. bed of coal as having been passed through in Mr. Cornelius O'Brien's well.

SEC. 35.—On the east and west road, through the center of the section, a coal, possibly IIIc, outcrops in nearly every rise and fall of the road.

SEC. 34.—In the N. E. 40, Mr. J. A. McCord formerly mined coal by a drift. The section there, as given by Mr. Cox, is as follows (Sect. 608, E. T. C., p. 48):

	Ft.	In.
1. Covered space	20	0
2. Argo. siliceous shale	15	0
3. Black bituminous sheety shale	3	0
4. COAL IIIc (block coal)	2	6
5. Caking COAL	0	6
6. Fire-clay	0	0

This coal is assigned by Mr. Cox to the horizon of Coal V, as he found the limestone in the road near by. The coal is reported to have been very poor.

Just west of Alfordsville a shaft was opened in 1896 by Mr. Geo. Denson. The following section of the shaft was obtained by Mr. Price (Sect. 609, J. A. P., notes; Figs. 686a and 704):

	Ft.	In.
1. Surface, 6 ft.; (2) sandstone, 2 ft.	8	0
3. COAL IIIb	1	2
4. Fire-clay, 21 ft.; (5) shale, 1 ft.	22	0
6. COAL IIIa	1	4
7. Fire-clay, 2 ft.; (8) shale, 8 in.; (9) clay shale, 4 ft.	6	8
10. COAL III-II	3	3

A few feet above the top of the shaft, Coal IIIc and its overlying limestone outcrop, making quite a complete section. The coal contains some sulphur in balls and streaks, and is said to clinker and yield much smoke.

In the N. E. ¼ of the section two coals are exposed in the road, separated by 20 ft. of vertical space, with brown shaly sandstone showing between. The lower one was dug into, showing a thickness of over a foot, and, of course, is thicker in from the crop. It is probably Coal III or IIIa. Another coal, which, by the barometer, was 15 ft. above the upper of the two last coals, may represent Coal IIIc. On the west side of the creek about 10 ft. of dark shale is exposed on a level above Coal III, with coal above.

Mr. Cox reports 4-5 ft. of limestone as outcropping near here, "in Sugar creek." He says, "which overlies the coal."

Coal was also reported as found on Mr. Chester Camp's place, in the S. W. ¼ of this section.

In the road on the south side of this section, on the east side of Sugar creek, 30 ft. above the creek, about a foot of coal was exposed, overlain by 3 ft. of brown shaly sandstone, then large, lenticular masses of limestone, then 2½ ft. above these another line of limestone masses about a foot thick, capped with a black chert (Coal IIIc, Fig. 700).

Coal III appears to outcrop but little, if any, above Sugar creek, so that it is probable that about Alfordsville the coal but little below the level of town is Coal IIIc, and the lower one and thicker coal, from 20-30 ft. lower, will be found to be III.

It would seem probable that Coal IV underlies all of the western half of the township, except in the stream valleys, with a workable thickness in most places, and variable quality, running from very good to very poor, but showing a fair average. Coal III or IIIb may be found of workable thickness and quality, locally.

Coal III is believed to underlie the whole township, except the stream valleys in the northeastern part. This coal differs from Coal IV in being more uniform in quality, and that good, but very variable in thickness. It should be looked for at from 20 to 50 ft. below Coal IV. It should have an average thickness of between 2½ and 3 ft.

1534. Distribution and Local Details in T. 1 N., R. 5 W.—(In Daviess county.)

Sec. 3.—On Mr. Chas. Allen's place, Coal IIIc has been worked by a drift. The following section was measured at the entrance of the drift and shows the roof and coal (Sect. 610, Fig. 701):

	Ft.	In.
1. Shaly sandstone, ? ft.; (2) dark limestone, 1½ ft.; (3) sandstone, 3 in.	1	9
4. COAL IIIc	2	3+

Farther back the sandstone on the coal runs out and the limestone forms the roof.

Sec. 5.—The Potts bank, in the S. W. ¼, is in the head of a small branch of Sugar creek. Some stripping has been done, but when visited coal was being gotten out by drifting. Coal was claimed to be nearly 4 ft. thick. At the entrance there shows over the coal 3 ft.+ of brown and yellow shaly sandstone; and under the coal 1 ft.+ of fire-clay (Fig. 695). Some of the coal blocks out nicely.

Sec. 8.—Three-quarters of a mile south of the Potts bank, coal was reported to have been worked on Mr. Wm. J. Jackson's place.

Sec. 9.—Coal is being worked in the S. W. ¼ of Sec. 9, on Mr. Thomas Scales's place. The coal measured 2 ft. 7 in. at the foot of the slope and 2 in. thicker at the working face (Fig. 696). It is said that in an old shaft just south the coal showed a thickness of 3 ft. 6 in. It dips to the southwest. At the entrance there shows over the coal 4 ft.+ of dark drab shaly sandstone or sandy shale; and under the coal 1 ft. 6 in. of fire-clay. The top coal is purest and is said to be a favorite coal with blacksmiths. The coal is just about on a level with the creek. One hundred or so yards down stream is an exposure of shaly sandstone and shale, the sandstone occurring in regular layers from 3 to 6 in. thick, separated by black shale from 1 to 4 in. thick. This would appear to be but a short distance above the coal or almost overlying it. Mr. Cox reports having found the following section at this point (Sect. 611, E. T. C., p. 49):

	Ft.	In.
1. Covered space	20	0
2. Clay shale with bed of white clay and sandstone	70	0
3. Hard blue fossiliferous limestone	3	0
4. Arenaceous shale	8	0
5. Black bituminous shale	2	0
6. Semi-block, COAL IIIb?	2	0
7. Bed of Sugar creek	0	0

He also reports a 6-in. bed of very hard, bastard limestone in the bed of the creek below the mill, close to the coal bank.

Sec. 16.—A quarter of a mile southeast of the Scales bank is Mr. Bert Wininger's bank. This is about 15 ft. higher than the coal at Scales's. The section exposed here is (Sect. 612, Fig. 702):

	Ft.	In.
1. Surface, 1 ft.; (2) black chert, 1 ft.; (3) large nodular masses of light gray limestone protruding from top of (4) reddish brown decomposed sandy clay?, 4 ft.; (5) dark gray sheety shale, 6 in.	6	6
6. COAL IIIc	2	5

The top of this coal is a good blacksmith coal, "peacock coal." The coal has a good roof and good quality, though not very thick. This is Coal IIIc. Dips east.

A short distance east a ledge of black or dark-gray limestone outcrops in the road. And still farther east, near the N. E. corner of the section, considerable shale shows beside the road.

Sec. 18.—On the slope east of the church, near the N. E. corner of the section, coal outcrops about 25 ft. below the top of the hill; above it is 10-12 ft. of brown and yellow sandy shale, tending to become sandstone above. Then comes a thin bed of fire-clay, with soft, brown sandstone above, and at the top of the hill an abundance of white chert shows.

On the road that turns north a short distance west of the church coal outcrops at a greater elevation, suggesting, if it be the same coal that outcropped east of the church, a high eastward dip.

In the N. W. ¼ of the section, on the highest point of the road that turns south to High Rock, the white chert outcrops again.

At High Rock the perpendicular bluff shows the following section (Sect. 613, Fig. 688):

		Ft.	In.
1.	Slope with chert fragments, 15 ft.; (2) massive coarse-grained sandstone, 65 ft.	80	0
3.	Traces of coal in streamers and pockets	..	..
4.	Gray sandy shale	12	0
5.	COAL IV	3	6
6.	Shale, blue sandy	12	0
7.	COAL	1	6
8.	Shale, light drab	6	0
9.	COAL	2	6

A short distance north, on the east side of High Rock, Coal IV is better exposed in Mr. Jefferson Hornaday's coal bank. It there shows (Sect. 614, Fig. 690):

		Ft.	In.
1.	Dark drab shaly sandstone roof	10	0
2.	(COAL, 1 ft.; parting, 2 in.; COAL, 2 ft. 3 in.) COAL IV	3	5

The section at High Rock has been a fruitful source of error in the previous labors of the geological survey, as it has been the principal factor responsible for the error of the statement that the coals between "K" (V) and "A" (I), for the most part, did not occur in southeastern Daviess county, southwestern Martin county, eastern Pike county, etc., and for the idea that no coal occurred between Coal "I" (IV) and the top of the Mansfield sandstone in Daviess or Martin counties, etc.

The error, assuming, as it did, the nonexistence of at least five coal beds, two of them usually of workable thickness, over an area of several hundred square miles, was a serious and yet a most natural one. It arose from supposing the 65 ft. of sandstone exposed to be the Mansfield sandstone or "Millstone Grit."

The lowest bed of coal had not been discovered when the place was visited by Mr. Cox, or that alone would have saved him the error. This bed forms the bottom of the river, and, being an excellent coal, many thousand bushels have been dug up at very low water, digging often in the water. The massive sandstone shows neither grit nor cross-bedding. Large masses of it have fallen to the water's edge, but their rounded edges and corners do not suggest a suitable stone for building.

Of Coal IV, as developed at Hornaday's, the bottom coal is said to be the best.

1535. CORRELATIONS.—Of the coals mentioned, it seems to be reasonably certain that the coal at Wininger's and Allen's and certain outcrops as given above, belong to the horizon of Coal IIIc. Hornaday's coal would then be Coal IV, not "A" (I), as given by Mr. Cox. The 18-in. coal below is in Division III, as is the coal in the bottom of the river. The coal at Scales's and Potts's is in question. At Scales's no such section as given by Mr. Cox was noted, nor do we remember seeing a hill at that place high enough to give such a section. It was thought when visited that this was Coal IV and that the limestone in the creek bed was the limestone which, in many places, is found underlying Coal IV or overlying Coal IIIc. It was stated that just west of Wininger's, where Coal IIIc is clearly seen well up on the bank, that the Scale coal had been found a little below the level of Sugar creek and 15 ft. below the level of Coal IIIc at Wininger's. For these reasons it is tentatively assigned to the horizon of Coal IIIb. The Potts coal appeared, on the spot, to be Coal IV, but the barometric readings placed it about on the same level with several road outcrops that were at two places identified as Coal V.

From the foregoing it will be seen that three different beds are or have been worked, IV, IIIc? and III. Of these coals IIIc? presents the greatest thickness, and in this township seems to be of better than the average quality. Coal III, which is probably a still better coal, will probably average between 2 and 2½ ft. in thickness and underlies nearly the whole area. Coal V will probably be workable only in small areas, if at all, usually occurring near the top of the hills. It is more likely not to be of workable thickness than the other way.

It was at first assumed by the writer, as it had previously been by Mr. Cox, that the chert on top of High Rock and in Sugar creek was the same, notwithstanding such an assumption required a high dip to the east, amounting to over 130 ft. in three miles. Finally, becoming convinced of the error of this assumption, and that the limestone in Sugar creek belonged to a lower horizon, it resulted in upsetting much of the work done in the four townships being discussed. Again, the question arises as to whether the chert on top of High Rock accompanies Coal V or the upper limestone coal of Division III, Dubois county. It is considered Coal V, but with some question.

1536. DISTRIBUTION AND LOCAL DETAILS IN T. 2 N., R. 6 W.—In Sec. 2 coal was found many years ago in the well on Mr. Albert McCracken's place. Mr. McCracken reported it over 3 ft. thick, overlain by 4 ft. of shale (at outcrop, supposed to be thicker further into the hill), and with 20 ft. of surface over shale. "Rock" bottom under coal. Coal when tested said to be "as good as Pittsburg coal." Coal IV? A flow of mineral water, which has been used sixty or seventy years, comes off from the coal. In Sec. 1 of the same township, on the Hefferman place, and in Sec. 6 of the next township east, on the Price place, 18 in. of coal is reported in wells at about 30 ft. About a mile south, in Sec. 13, nearly 3 ft. of coal outcrops, about a third of it, however, being bone coal. It is just at creek level. The roof is soft sandstone, the floor fire-clay.

SEC. 17.—Drift on Mr. Cross's land. The following section was measured (Sect. 615, Figs. 687 and 691):

	Ft.	*In.*
1. COAL IVa	1+	0
2. Shale drab sandy, with thin bed of sandstone 5 ft. from bottom	9	0
3. COAL IV (upper bench)	1	8
4. Parting	..	1¼
5. COAL IV (lower bench)	1	3½
6. Fire-clay, black, with yellow streaks	1	6
Total	11	5¾

A little up stream at the road crossing, the two coals outcrop in the road at just about the same vertical distance apart. Below Coal V is about 4 ft. of fire-clay, then a hard limestone, at least a foot being exposed, and reported by Mr. Cox as 5 ft. to 10 ft. thick. Mr. Cox thought this limestone lay above the coal, and so was led to erroneously refer the coal at Cross's to "K" (V).

A little over a mile west on top of the ridge, large blocks of limestone were noticed at different places over the ground, indicating that Coal V was very near the top of the ridge and probably some distance above Coal IV.

South of the road crossing of Aikman's creek near Cross's, the sandstone over IV outcrops near the top of the hill.

SEC. 14.—Close to the road on the western side of Sec. 14, on the south side of Aikman's creek is a typical exposure of Coal IIIc? There shows (Sect. 615a, Fig. 697):

	Ft.	*In.*
1. Limestone, 1 ft.; (2) black shale, 3 ft.	4	0
3. COAL (almost bituminous shale) IIIc?	1	3

This indicates that Coal IV and accompanying strata have risen to the east from Cross's.

SEC. 24.—Donihue's bank. The section shown here was as follows (Sect. 616, Fig. 692):

	Ft.	*In.*
1. Sandstone, heavy bedded, 4 ft.+; (2) shale, brown and drab, 1 ft. 6 in.	5	6
3. COAL IV (upper bench)	1	2
4. Parting	..	1
5. COAL IV (lower bench)	2	3
6. Fire-clay	..	..
Total coal	3	5

This bank is a drift, not in operation when visited. In the entry driven the shale has broken down, leaving the sandstone as the roof. The coal is here a good workable thickness, with good roof. Of the quality we cannot speak.

In the S. W. 40 of Sec. 24 coal has been stripped in a ravine on the Riley place.

SEC. 23.—A little coal was struck in a well on Mr. Michael Kellett's place at a depth of 12 ft. There were only a few inches of shale over it.

SEC. 22.—Drift near the head of the ravine on Smoot's place and about 10 ft. above bottom. Section showed (Sect. 617, Fig. 693):

	Ft.	*In.*
1. Sandy shale, drab and yellow	..	..
2. COAL IV (upper bench)	1	2
3. Parting	..	½
4. COAL IV (lower bench)	..	10
5. Fire-clay	1+	0
Total coal	2+	0

The coal in this drift blocks out. No one at work when visited. The drift has hardly been carried far enough in to show the quality of the coal.

SEC. 27.—Coal was reported to have been worked on the Lamb place before coal had been found at Washington. This coal was not seen but was reported by Mr. Cox to have been 4 ft. thick. Mr. Cox reported finding, a short distance up the creek, the limestone and chert which is seen on Akerman (Aikman) creek at Cross's. This place was not found, but from the barometric readings at a creek crossing at what was afterward learned to be the Lamb place, it is believed that this will be found to have been Coal IV.

Coal III? is reported as found on the Conner place.

SEC. 28.—Coal has been reported as found on the Arms and Ragsdale farms. In the S. W. corner the shale overlying coal shows, and coal was reported to have been found on Mrs. Clark's place.

SEC. 29.—On the Hart place, formerly owned by Mr. John Gregory, Mr. Cox gives the following section (Sect. 618, E. T. C., p. 50):

	Ft.	In.
1. Argillaceous and siliceous shale, 40 ft.; (2) black bituminous slaty shale, containing fish remains, ? ft.	40+	0
3. COAL V or IIIc	1	3

SEC. 32.—On Mr. Alfred Lett's place, a little digging has been done, exposing mostly large slabs of the black shale overlying Coal V or IIIc, and a little coal.

On Mr. T. J. Swanigan's place considerable stripping has been done. The coal appeared to be thin, though at no place could its thickness be measured. It is overlain by about a foot of shale, then sandstone.

SEC. 33.—The coal was reported as found in wells or exposures on Mr. W. G. Smoot's land, on the Chapman place and on Mr. C. Smoot's land.

Mr. Cox reports a well dug by Dr. Mitchell at Glendale, as follows (Sect. 619, E. T. C., p. 50):

(1) Soil and drift, 8 ft.; (2) soft sandstone, 15 ft., to hard blue limestone, containing flint.

SEC. 34.—Coal was reported by Mr. Cox on the Renseler place, Mr. Michael Fagan's place, where it is said to have been 4 ft. thick in a well, and the McGee place. None of these places was found, but from the level of their approximate location it would seem probable that some of them at least represented Coal IV.

On account of the absence of most of the residents at the time of visiting the region around Glendale, not as much information as was desired could be obtained.

CORRELATIONS.—All the coals of this township were by Mr. Cox called Coal "K" (V), the error arising from an error in confusing limestone below Coal IV with the limestone common over Coal V. Coals IV? and IIIc were the only coals seen in the township except at Cross's, where the upper coal may be IVa.

Coals V and IIIc nowhere showed a thickness that would pay for working.

Coal IV, at the few places where it could be measured, showed from about 2 ft. to 3 ft. 5 in. of coal, with 4 ft. reported at two places. Where IV outcrops it is usually near the bottom of drainage, insuring a sufficient thickness of roof over most of the area, and while locally the coal may run out or be too thin to work, it seems probable that it will average 3 ft. under most of the divides. Little prospecting has been done in this field, most of the work being a little drifting in places where the coal was seen in outcrop.

1537. DISTRIBUTION AND LOCAL DETAILS IN T. 1 N., R. 6 W.—(In Daviess county.)

SEC. 3.—In the S. W. 40 a well and shaft have been dug into coal. Full of water when visited. Above water 6 ft. of gray shale shows.

SEC. 4.—On the J. B. Colbert place, across the road from the preceding, an old slope full of water shows only 5 ft. of gray arenaceous shale. The section here, as given by Mr. Colbert, is (Sect. 260, Fig. 694):

	Ft.	In.
1. Gray arenaceous shale, 6 ft.; (2) hard black shale?	6+	0
3. COAL IV (top bench)	1	0
4. Parting ....1 in. to	..	1½
5. COAL IV (bottom bench) ....2 ft. to	3	0
Total coal ....3½ ft. to	4	0

The top coal is bright but slacks readily. In general, the coal was reported to slack easily and to be very dirty.

In the N. W. ¼ of the section is the Jackson bank, at which it is claimed the coal is 2½ ft. thick, with 6 in. of bone coal over.

SEC. 5.—Across the road from the preceding is the Wratten bank where coal has been obtained by stripping and drifting at the creek level. The coal is said to be a block and to be the same as at the Jackson bank in thickness.

This coal is reported to burn very rapidly, requiring, it is said, a third more coal than the better coals to obtain a given amount of heat. There was reported to be dark limestone in the ravine below the Wratten coal bank, which we should suspect to continue down to the river at the "Rock Eddy," where, it is said, the river flows over a large shelf of hard "flinty granite" rock. The coal is mapped on the supposition that the limestone underlies the coal and that the coal is Coal IV.

In the S. E. 40 of this section, on the Gregory place, Mr. Cox found coal.

SEC. 10.—Coal was reported on the S. E. ¼ of the section on the J. W. Burton place.

SEC. 16.—It was reported that 4 ft. of coal are exposed in Mud creek at its mouth. Said not to block.

The coal at Colbert's and Wratten's was thought to be Coal IV and on that basis all the coals mentioned except the last are referred tentatively to Coal IV. The coal at the mouth of Mud creek is from its position thought to be in Division III.

Coal IV appears to present a fair thickness in this township, but as far as developed has not proven very satisfactory in quality. This may be due in part to its closeness to the surface where it has been worked.

TOWNSHIPS 1 (IN PART) 2 AND 3 NORTH. RANGE 7 WEST.

1538. LOCATION.—This area occupies the southwestern corner of Daviess county and corresponds to Veale and the western part of Washington of the civic townships.

1539. TOPOGRAPHY.—The town of Washington is situated on the low divides separating the principal forks of a small stream which flows westward to White river. It is surrounded on all sides but the west by an irregular chain of hills. These hills are highest to the northeast of town in Sec. 25-3-7, where they are about 100 ft. high. They are quite low just east of town, but rise as they cross the southeastern corner of the city, and are higher to the south and southwest. To the northwest of Washington there is only a broad elevation. A second hill rises southwest of South Washington, separated from the previously described hills by a low space. This hill runs west to the river, its southern edge being cut down by the tributaries of Veale creek. East and north of the hills about Washington the country is very level. In a general way the outcrops of Coal VI or "L," shown on the chart, will serve to outline the hills.

A topographic map of a small area close to Washington was prepared by Mr. Cox and published in the report for 1870. As practically all of the field covered by it is exhausted of coal and as it contains many inaccuracies which time did not permit correcting, it will not be republished. The following elevations obtained in its preparation, however, will prove valuable.

1540. Elevation above tide of points around Washington:

	Ft.
Depot B. & O. S. W. Ry.	484
Spink, Cabel & Co., shaft	484+
Sulphur Spring slope	467
Thompsons' bore	501
Peck's bore	496
W. Hyatt's bore	531
Hyatt s bore	558
Mooney's slope	474
Clark's slope	506
Wilson's slope	518
Price's slope	538

1541. South of Veale's creek the topography is in marked contrast with that to the north. The gentle slopes north of Veale's creek give place on the south to a comparatively high plateau-like country into which the streams have eroded deeply and broadly, leaving high ridges with short points running down between the adjacent tributaries. This topography is due to the presence of massive beds of sandstone in the coal measure series.

1542. STRATIGRAPHY.—It will doubtless be a surprise to many of those most familiar with the Washington coal field when we express our conviction that the coal now being worked is not the same bed as was formerly worked east of Washington. Mr. Cox took this as one of his type localities for Coal VI. A misinterpretation of the structure east of Washington led him to assume lack of correlation between outcrops and to consider that two workable beds existed in that region. As the upper bed had been called Coal "L" (VI) and the lower of the two beds had none of the characteristics of Coal "K" (V), he called it Coal X. It was supposed to be distinguished from Coal "L" (or VI) chiefly through having a sandstone roof. Mining has since demonstrated that the two beds are the same, the transition from the clay shale to the sandstone roof taking place at the Wilson mine.

Since Coal X was proved not to exist it was considered settled that all of the workable coal about Washington was at the horizon of Coal "L" or (VI). This view was taken in the field work by the writer, and though some questions arose, it was not until two years later, or after the field work in Pike county had been completed, that a revision of the data in the office seemed to demonstrate that in reality the coal east of Washington and that west and southwest were two separate pockets, the former at the horizon of Coal VI, the latter at the horizon of Coal V. Coal VI is distinguished by a roof of clay shale overlain by sandstone, with the sandstone frequently descending to the coal and making the roof. A typical section of the strata above Coal VI may be obtained from the section given by Mr. Cox, as found at the old Spink, Cable & Co.'s mine, just south of Washington.

1543. SECTION 621. SECTION AT SPINK & CABEL MINE AND ADJACENT HILL.—Sec. 34-3-7, Fig. 4 of Plate LIII, page 1025. (E. T. C., p. 34.)

	Ft.	In.	Ft.	In.
1. Surface, earth and drift	20	0	20	0
2. Clay, siliceous shale	6	0	26	0
3. COAL VII	2	0	28	0
4. Fire-clay	4	0	32	0
5. Clay shales	8	0	40	0
6. Pyritiferous shaly limestone	1	0	41	0
7. Arenaceous shale	14	0	55	0
8. Bluish clay shale	31	0	86	0
9. COAL VI ("Main Washington")	5	0	91	0
10. Dark and light colored fire-clay	11	0	102	0

The limestone in this section, 45 ft. above the coal, is considered the equivalent of the limestone commonly found near the top of Division VI the whole length of the coal field.

Ordinarily, Coal V is overlain by black sheety shale, and that in turn by limestone. Now, it happens, that while the coal southwest and west of Washington is generally overlain by black shale and limestone, at no point was the same observed to be sheety, and generally the limestone is over 10 ft. above the coal with some gray shale between, so that in most cases the roof appears as a black shale overlain by gray shale. The following section from a drilling at C. & K.'s No. 5 mine shows the relations.

1544. SECTION 622. SECTION OF BORING AT NO. 5 MINE.—Sec. 4-2-7, Fig. 6, Plate LIII.

	Ft.	In.
1. Drift	18	0
2. Bastard limestone	4	0
3. Black shale	7	0
4. Gray shale	6	2
5. Black shale	..	8
6. COAL V	3	6
7. Fire-clay	6	8
8. Gray shale	34	0
9. Sandstone	15	0
10. Black shale	2	0
11. Gray shale	30	0
12. Black shale	2	0
13. Black rock	1	0
14. Black bituminous shale	4	6
15. Fire-clay	1	6

Limestone is reported as 8 ft. above the coal at the No. 9 mine in Sec. 5-2-7, 15 ft. at the No. 6 mine and about the same at No. 7. We were at first misled by the lack of sheety shale and the distance from the coal to the limestone. However, in Pike county it was found that there existed a tendency for just such conditions to exist there in the roof of Coal V.

A more detailed examination of the structure, with some data not available in the first study, confirms what is suggested in the stratigraphy.

Beginning with some borings north of Washington, neither coal nor limestone is found at the horizon of Coal V, but only black shale. Thus the Brett bore, Sec. 26, started at 38 ft. above the depot and near the level of Coal VI and passed through as follows (Sect. 623, E. T. C., p. 32):

	Ft.	In.
1. Surface, earth and clay	57	0
2. Gray shale	33	0
3. Dark gray shale	4	0
4. Shale	1	0
5. Black shale	5	0
	100	0

The black shale in the bottom of the section is thought to correspond to the position of Coal V.

A boring on Mr. Hyatt's land, N. E. of N. E. of Sec. 27, commenced 74 ft. above the depot and 17 ft. below the horizon of Coal VI at Raymonds. It passed through (Sect. 624, E. T. C., p. 31):

	Ft.	In.
1. Clay and soft rock	20	0
2. Hard sandstone	40	0
3. Clay shale	40	0

A boring on W. Hyatt's place, starting at 47 ft. above the depot, N. E. of N. E. of Sec. 27, passed through (Sect. 625, E. T. C., p. 29, Fig. 26):

	Ft.	In.
1. Clay and soft rock	20	0
2. Reddish soft rock	10	0
3. Iron ore?	2	0
4. Boulder clay	8	0
5. White sandstone	6	0
6. Blue sandstone	10	0
7. Light clay shale	20	0
8. Black shale	1	0
9. "Hard rock"	2	0

	Ft.	In.
10. Hard black shale	5	0
11. "Hard rock"	4	0
"Probable place of COAL."		
12. Shale	84	0
13. Brown shale	6	0
14. COAL IV	1	0
	179	0

It would appear as though the limestone was found in the boring, placing the coal 41 ft. below the level of the depot. In the N. W. ¼ of Sec. 27, a boring on the Peck place started 12 ft. above the railroad level, and found the following (Sect. 626, E. T. C., p. 28, Fig. 25):

	Ft.	In.	Ft.	In.
1. Clay	10	0	10	0
2. Quicksand	20	0	30	0
3. Shale	38	0	68	0
4. COAL V	2	6	70	6
5. Fire-clay	..	..	..	..
6. Shale	81	0	151	6
7. Black shale	4	0	155	6
8. COAL IV	3	0	158	6
9. Fire-clay	..	..	..	..

The coal showing for the first time and at a depth of 56 ft. below the railroad. In the N. W. ¼ of Sec. 28 is the Wilson or Hawkins mine where the coal was estimated to be about 50 ft. below the railroad level at the station, the barometer making it a little less. A section of the shaft was given by Mr. Wilson to be as follows (Fig. 24):

	Ft.	In.
1. Sand and soil	14	0
2. Sand, loose red	18	0
3. White clay	5	0
4. Shale	26	0
5. COAL V	6	0
6. Fire-clay	9	0
7. "White rock"	4	0+

A drilling near here gave (Sect. 628):

	Ft.	In.
1. Surface	8	0
2. Red sand	11	0
3. Sandstone	18	0
4. Black shale	7	0
5. Blue shale	7	10
6. COAL V	6	0
7. Fire-clay	8	0
8. Sandstone	5	0
9. Blue shale	40	0

In the N. E. ¼ of Sec. 29 is C. & K. No. 7 mine where the section, as well as it could be obtained, gave (Sect. 629, Fig. 23):

	Ft.	In.
1. Surface	40	0
2. Limestone	1	10
3. Shale	4	2
4. Limestone	2	6
5. Space	8	6
6. COAL V	7	0

The coal here is probably at a little higher level, indicating a slight east dip across Secs. 29 and 28.

The testimony of the structure at this point seems to carry the coal at Wilson's and No. 7 far below Coal VI northeast of Washington. In the same way along the E. & I. R. R., just southwest of Washington, Coal VI is just at the level of the railroad, according to survey made for Mr. Cox, and rising to the northwest. South of Maysville, it outcrops and is worked only a few feet below the level of the railway and about 3 ft. thick. Half way between was the old Clark, Nutting & Co. slope, where Coal V, 6 ft. 10 in. thick, is found at a depth of 50 ft. This was certainly the same coal as at No. 7 and at No. 9. In the report for 1872 Mr. Collett gives a section made by Mr. Wilson, the working superintendent at this mine, that gives three coals.

The coals are not exposed now and the record was not found until after the completion of the field work. It was then referred to one of the best informed men in Washington, who gave it as his judgment that the record was in error, as at no point were there two coal beds known to lie above the worked bed, and on that judgment the record was cast aside, but with the accumulation of evidence that the worked coal there is Coal V, it is found to sustain such a conclusion in a remarkable manner. The section is as follows (Sect. 630, J. C., p. 344, Rep. for 1872, Figs. 3 and 22):

	Ft.	In.	Ft.	In.	Ft.	In.
1. Yellow lacustral clay	15	0	..	..	15	0
2. Brown sandstone	15	0	..	..	30	0
3. Dark pyritous shale.....2 ft. to	5	0	..	..	35	0
4. COAL VII	1	6	1	6	36	6
5. Fire-clay	3	0	..	..	39	6
6. Shaly sandstone	5	0	..	..	44	6
7. Gray shale	15	6	23	6	60	0
8. COAL VI	4	7	4	7	64	7
9. Fire-clay	4	6	..	..	69	1
10. Gray shale and sandstone	10	0	..	..	79	1
11. Gray limestone	2	4	..	..	81	5
12. Blue limestone with fossils	5	0	..	..	86	5

	Ft.	In.	Ft.	In.	Ft.	In.
13. Black limestone	2	0	..	..	88	5
14. Calcareous shale	2	0	..	..	90	5
15. Black sheety shale with fish teeth scales, etc.	12	0	..	..	102	5
16. White clay shale	1	0	38	10	103	5
17. COAL V	6	10	6	10	110	3
18. Fire-clay	7	0	..	..	117	3

It will be noticed that in this section Coal V is much nearer Coal VI than further east. Compare this section with the following from the bank of White river four or five miles south (Sect. 631, Fig. 5):

	Ft.	In.	Ft.	In.	Ft.	In.
1. Shaly sandstone	20	0	..	..	20	0
2. COAL VI exposed	1+	0	1	0	21	0
3. Drab sandy shale	5	0	..	..	26	0
4. Hidden	5	0	..	..	31	0
5. Sandstone	1	0	..	..	32	0
6. Shale	1	0	..	..	33	0
7. Sandstone ....1 in. to	..	2	..	..	33	2
8. Gray sandy shale	8	0	..	..	41	2
9. Calcareous shale, very fossiliferous	5	6	..	..	46	8
10. Limestone	1	0	..	..	47	8
11. Black sheety shale with septaria.	3	6	30	2	51	2
12. COAL V? hidden below water, 6 ft. to	7	0	7	0	58	2

Coal VI is here thin and from here to the south is only found in places, and generally close to Coal V.

Some drilling records, obtained after this report went to the printer, from Sec. 32 will show the relations of the two lower coals of the above section somewhat more fully.

Drilling No. 1—	Ft.	In.
Surface	17	0
Sandstone, 10 ft.; dark shale, 6 ft.; hard rock, 2 ft.; black slate, 2 ft.; hard rock, 2 ft.; black shale, 8 ft.	30	0
COAL V	7	10
	54	10

Drilling No. 2—	Ft.	In.
Surface	18	0
Dark shale, 20 ft.; rock, 4 ft.; black slate, 11 ft.	35	0
COAL V	7	0
	60	0

Drilling No. 3—	Ft.	In.	Ft.	In.
Surface	12	0	12	0
Sandstone, 5 ft.; dark shale, 15 ft.	20	0	32	0
COAL VI	3	0	35	0
Fire-clay, 3 ft.; hard rock, 5 ft.; rock, 10 ft.; sandstone, 4 ft.; hard rock, 3 ft.; black slate, 10 ft.	35	0	70	0
COAL V	6	2	76	2

Drilling No. 4—	Ft.	In.	Ft.	In.
Surface	12	0	12	0
Dark shale, 15 ft.	15	0	27	0
COAL VI	3	0	30	0
Fire-clay, 2 ft.; dark shale, 12 ft.; sandstone, 3 ft.; hard rock, 2 ft.; black slate, 10 ft.	29	0	59	0
COAL V	5	10	64	10

Drilling No. 5—	Ft.	In.	Ft.	In.
Surface	18	0	18	0
Dark shale, 10 ft.; rock, 1 ft.	11	0	29	0
COAL VI	2	0	31	0
Fire-clay, 2 ft.; black shale, 12 ft.; sandstone, 6 ft.; black shale, 5 ft.; hard rock, 2 ft.; black slate, 10 ft.	37	0	68	0
COAL V	7	3	75	3

Drilling No. 6—	Ft.	In.
Surface	12	0
Black shale, 6 ft.; hard rock, 2 ft.; black shale, 12 ft.	20	0
COAL V	6	4
	38	4

At shaft No. 9, 40 ft. above the worked coal is found a thin coal which is now believed is the equivalent of Coal VI in the above section.

At the old No. 4 shaft near South Washington it was said to be 84 ft. to the coal and more still on the higher ground. A drilling supposed to be at this point gave the following section (Sect. 632):

	Ft.	In.
1. Drift, 20 ft.; (2) quicksand, 15 ft.	35	0
3. Blue shale, 15 ft.; (4) gray shale, 31 ft. 6 in; (5) black bituminous shale, 5 ft. 6 in.; (6) fire-clay, 3 ft.; (7) limestone, 4 ft.	71	0
8. Sandy shale, 12 ft.; (9) COAL V? at 106 ft.	..	8
10. Black shale, 1 ft. 4 in.; (11) sandy shale, 17 ft.; (12) blue shale, 27 ft.	45	4
13. COAL	1	6
14. Fire-clay, 5 ft. 9 in.; (15) gray shale, 11 ft.	16	9

And a similar section is shown in a drilling in the S. W. ¼ of Sec. 34-3-7 (Sect. 633):

		Ft.	In.
1.	Surface	14	0
2.	Sandstone	12	0
3.	Shale, sandy	19	0
4.	Shale, gray	55	0
5.	Shale, bituminous, black	6	0
6.	Fire-clay	2	0
7.	Limestone	4	0
8.	Sandstone with shale partings	9	0
9.	Shale, blue	..	8
10.	COAL V?	1	0

The following two sections will indicate what strata and coals are found below Coal V southwest of Washington. They were made with the diamond drill.

1545. SECTION 634. SECTION OF BORING CLOSE TO NO. 4 MINE.—S. W. corner of Sec. 4-2-7, Plate LIII, Fig. 9, and Plate XLIX, Fig. 3.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and drift	13	0	..	..	13	0
2.	Gray arenaceous shale	16	0	..	..	29	0
3.	COAL V	3	6	3	6	32	6
4.	Fire-clay	7	6	..	..	40	0
5.	Gray sandy shale	12	0	..	..	52	0
6.	Blue sandy shale	13	0	..	..	65	0
7.	Gray sandy shale	22	0	..	..	87	0
8.	Blue sandy shale	36	0	..	..	123	0
9.	Dark bituminous shale	6	0	94	6	129	0
10.	COAL	1	6	1	6	130	6
11.	Blue shale	11	6	..	..	142	0
12.	Gray shale	..	4	..	..	142	4
13.	Sandstone	2	0	..	..	144	4
14.	Blue shale	17	0	30	4	161	4
15.	COAL	1	0	1	0	162	4
16.	Gray shale	38	6	38	6	200	10
17.	COAL	1	6	1	6	202	4
18.	Fire-clay	5	0	..	..	207	4
19.	Bastard limestoue	3	6	..	..	210	10
20.	Blue shale	2	6	..	..	213	4
21.	Fire-clay	3	0	..	..	216	4
22.	Sandstone	6	0	..	..	222	4
23.	Gray shale	20	0	..	..	242	4
24.	Bastard limestone	1	6	..	..	243	10
25.	Blue shale	2	6	44	0	246	4
26.	COAL	1	10	1	10	248	2
27.	Fire-clay	13	2	..	..	261	4
28.	Gray shale	26	0	..	..	287	4
29.	Fire-clay	5	0	..	..	292	4
30.	Gray shale	19	5	63	7	311	9
31.	COAL	0	7	0	7	312	4
32.	Fire-clay	3	0	..	..	315	4
33.	Gray shale	5	0	..	..	320	4
34.	Blue shale	14	0	..	..	334	4
35.	Boulder	7	0	..	..	341	4
36.	Blue shale	0	8	29	8	342	0
37.	COAL	0	8	0	8	342	8
38.	Gray shale	7	1	7	1	349	9
39.	COAL	0	10	0	10	350	7
40.	Gray shale	8	10	..	..	359	5
41.	Sandstone	7	0	..	..	366	5
42.	Gray shale	9	0	..	..	375	5
43.	Limestone	37	0	..	..	412	5
44.	Gray shale	85	0	..	..	497	5
45.	Sandstone	8	0	..	..	505	5
46.	Gray shale	6	0	..	..	511	5
47.	Sandstone	13	0	..	..	524	5
48.	Gray shale	19	0	..	..	543	5
49.	Sandstone	17	0	..	..	560	5
50.	Gray shale	68	0	277	10	628	5
51.	COAL	1	4	1	4	629	9
52.	Gray shale	42	0	..	..	671	9
53.	Sandstone	77	8	..	..	749	5
54.	Blue shale	3	4	..	..	752	9
55.	Gray shale	16	0	..	..	768	9

1546. SECTION 635. SECTION ON COLBERT FARM.—One-half mile south of Maple Valley Mine, Sec. 9, Plate XLIX, Fig. 4.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Drift	24	0	..	..	24	0
2.	Quicksand	14	0	..	..	38	0
3.	Sand shale	42	0	..	..	80	0
4.	Sandstone	7	0	..	..	87	0
5.	Sand shale	6	0	..	..	93	0
6.	Sandstone	4	0	..	..	97	0
7.	Gray shale	16	0	..	..	113	0
8.	Black bituminous shale	5	0	..	..	118	0
9.	Fire-clay	4	0	..	..	122	0
10.	Limestone	3	0	..	..	125	0
11.	Gray shale	4	0	..	..	129	0
12.	Sandstone	9	0	..	..	138	0
13.	Gray shale	34	0	..	..	172	0
14.	Blue shale	14	0	..	..	186	0
15.	Gray shale	5	0	..	..	191	0
16.	Sandstone	11	0	..	..	202	0

		Ft.	In.	Ft.	In.	Ft.	In.
17.	COAL	0	10	0	10	202	10
18.	Fire-clay	6	2	..	..	209	0
19.	Bastard limestone	5	0	..	..	214	0
20.	Black shale	2	6	..	..	216	6
21.	Fire-clay	4	6	..	..	221	0
22.	Gray shale	27	0	..	..	248	0
23.	Bastard limestone	1	6	..	..	249	6
24.	Black shale	2	0	51	8	251	6
25.	COAL	1	6	1	6	253	0
26.	Fire-clay	7	0	..	..	260	0
27.	Sandstone	5	0	..	..	265	0
28.	Gray shale	5	0	..	..	270	0
29.	Sandstone	15	0	..	..	285	0
30.	Gray shale	16	0	..	..	301	0
31.	Black shale	2	0	50	0	303	0
32.	COAL	0	6	0	6	303	6
33.	Fire-clay	1	6	..	..	305	0
34.	Black shale	17	0	..	..	322	0
35.	Black shale	1	0	..	..	323	0
36.	Fire-clay	4	0	..	..	327	0
37.	Gray shale	19	0	..	..	346	0
38.	Boulder	6	0	..	..	352	0
39.	Black shale	3	0	..	..	355	0
40.	Gray shale	2	0	53	6	357	0
41.	COAL	0	10	0	10	357	10
42.	Gray shale	16	2	16	2	374	0
43.	COAL	1	6	1	6	375	6
44.	Black shale	1	0	..	..	376	6
45.	Gray shale	29	0	..	..	405	6
46.	Bastard limestone	3	0	..	..	408	6
47.	Gray shale	3	0	..	..	411	6
48.	Sandstone	2	0	..	..	413	6
49.	Blue shale	1	0	..	..	414	6
50.	Fire-clay	5	0	..	..	419	6
51.	Gray shale	6	0	..	..	425	6
52.	Bastard limestone	4	0	..	..	429	6
53.	Sandstone	6	0	60	0	435	6
54.	COAL	0	10	0	10	436	4
55.	Fire-clay	2	2	..	..	438	6
56.	Black shale	7	0	..	..	445	6
57.	Black shale	2	0	11	2	447	6
58.	COAL	0	7	0	7	448	1
59.	Fire-clay	5	0	..	..	453	1
60.	Gray shale	15	0	..	..	468	1

No attempt will be made toward correlating the coals found in these sections with those found further east. It is interesting to note the correspondence in the coals and strata of the two sections. Thus the 1 ft. 6 in. coal of the first (No. 10) is represented only by black shale

(No. 8) of the second, and the same with the second (No. 15 of the 1st and No. 14 of the 2d). Strata Nos. 17-27 of the first record correspond very closely with Nos. 17-26 of the second record. Coals Nos. 31, 37 and 41 would seem to correspond quite well to Nos. 32, 41 and 43 of the second record. Below that the correspondence is more obscure, but indicates a total of twelve coals below Coal V at this point.

1547. Coal VII? is exposed over a small area south of Washington. It runs from 1 to 2 ft. thick and is reported as yielding a good quality of caking coal with red ash. A mile south of Washington Coal VI is exposed with about 20 ft. of light brown shale overlying. This in turn is overlain by about 15 ft. of Pleistocene clay.

1548. Coal VI. This is the coal bed formerly worked east of Washington. Its thickness is shown to vary from 2 ft. up to over 5 ft., with an average of almost 4 ft. In quality it probably stands as high as any caking coal in the State, though where it becomes thicker the quality is not apt to be so good. It is a caking coal of a dull black color with irregular and cubical fracture, often being mined in as large blocks as convenient to handle, shows but little calcite in partings and generally but little sulphur. Its composition is shown by the following analyses by Mr. Cox. (E. T. C., pp. 39-41.)

NAME.	Location.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Aikman	Sec. 34-3-7	56.50	35.50	92.00	3.00	5.00	8.00
Dutch Bank	Sec. 34-3-7	61.50	34.50	96.00	2.00	2.00	4.00
Spink, Cabel & Co.	Sec. 34-3-7	60.00	30.00	90.00	4.50	5.50	10.00
Sulphur Springs Bank	Sec. 34-3-7	58.30	31.20	89.50	6.00	4.50	10.50
Wilson's	Sec. 26-3-7	59.20	34.90	94.10	2.50	3.40	5.90
Raymond	Sec. 23-3-7	50.75	46.50	97.25	1.75	1.00	2.75

These show a coal unusually high in fixed carbon. The roof is either a shale overlain by sandstone or a shaly micaceous sandstone. The floor is fire-clay.

1549. Coal V—is often thin or absent in this area, but over a considerable area attains a thickness approaching what it has just south in Pike county. It appears to be a good grade of coal near Washington, but is reported very poor further south. The following analysis by Mr. Noyes shows the composition at C. & K. No. 9 mine:

Fixed carbon	49.16	
Volatile combustible matter	37.99	
Total combustible matter		87.15
Ash	6.35	
Moisture	6.50	
Sulphur	1.85	
Total waste		14.70

The quality is generally reported as following an inverse ratio with the thickness. The roof does not usually show the sheety shale commonly found over Coal V, and in some cases not even black shale, though usually there is black shale and limestone some 8 ft. or more above. In a few cases the roof is typical black sheety shale, full of sulphur concretions, overlain immediately by limestone.

There appears to be no workable coal below the coal now being worked.

In discussing the distribution of the coal it will be convenient to treat first the area of the sketch map, then the rest of the area north of Veale's creek, then the area south of Veale's creek.

1550. Distribution and Local Details of Coal in Area of Sketch Map.—Coal VI occupies an isolated area under the high hill in Secs. 23, 24 and 25. It has been opened up and worked as follows:

Raymond Bank, T. 3 N., R. 7 W., Sec. 23 (2), consists of a number of abandoned slopes in the head of a small stream. The mine was abandoned before the coal was all worked out. So in the fall of 1896 a drift had been opened and a little coal was being taken out by Mr. Price, of Washington. At this drift the coal measured 2 ft., overlain by soft, yellow sandstone (Fig. 10). How much coal remains could not be ascertained. On the north side of the ridge north of these openings a drilling showed 3 ft. of coal under a thick bed of sandstone. A short distance south of Raymonds, near a well beside the road, Coal V was found at 90 ft. Just to the east, up a small prong, are the old Hyatt or Jackson slopes, now abandoned. At one of these slopes the roof showed the same soft, yellow sandstone as at Raymonds. Thirty in. of coal reported (Fig. 11). Further south at the Bedford road are the two old drifts, one on either side of the road. Southeast of these in the head of a small fork are three drifts, the old Ostrander and Rhine banks.

The Ostrander bank was opened in the '60's and for a time shipped coal extensively, using a tramway to haul the coal to the railway. The Rhine bank, operated by Sefrit and Braun, was opened in 1880, and also had a tramway to the railroad. At the Ostrander bank the coal was claimed to be 4 ft. thick, and at the Rhine 2½ ft. thick. In the short distance between the two banks the coal rises at least 25 ft., and this rise, continuing into the hill, led to the abandonment of the mine.

The Price drift was opened in the '60's. In 1880 Mr. Price opened a new slope, known as the Black Diamond mine, which was working ten men in 1883. How much coal is left at the southern end of this area could not be ascertained. A little coal for local use was gotten out during the winter of 1885-6.

The high west dip in this hill carries the coal up so that the eastern outcrop is well up the hillside.

Mr. Zack Jones, Sec. 24 (1), reported that a drill hole of 7 ft. deep in the bottom of his well, which was 37 ft. deep, passed through 4 ft. of coal. This is possibly the double bed, Coal V, which is met with in wells just east.

A second district of workable coal runs from a little south of the Raymond drift to the Sulphur Spring mine. This district is nearly divided into two at the B. & O. S. W. R. R. In the northern half the Wilsons opened slopes, Sec. 26 (6) and (7), soon after opening the first mine, just south of the railroad. The coal is here nearly on a level with the railway. Only the southern portion has been worked out, the coal having been nearly 5 ft. thick (Fig. 13), with a shale roof, but becomes thinner to the north, with sandstone roof (Fig. 12). The bed was 3 ft. thick where operations were suspended, but a drilling still further north showed only 2 ft. At the eastern extremity of the district a fault with a downthrow of about 4 ft. has cut off a few acres of 4-ft. coal close to the railroad. North of Wilson's some fifteen openings have been made to the coal, from some of which coal has been taken out. There is probably quite a body of coal in the northwestern part of this district, though possibly not thick enough to work commercially. South of the railroad the coal is probably all worked out. The following mines have been operated in that area.

Wilson's, Sec. 35 (2-4) -3-7, opened in 1858 and worked extensively during the '60's. Coal was reached at 27 ft., with the following section (Sect. 635a):

	Ft.
1. Drift clay, 11 ft.; (2) clay shale, 10 ft.; (3) shale, 6 ft.	27
4. COAL VI	4 ft. to 5

At the southern end of this mine, at Sec. 35 (4), the coal bed was found to rise at a high angle to the south. A drilling here showed Coal V at 90 ft., as only a bed of bituminous shale, and at 307 ft. 27 in. of good coal was passed through. It is said that at the lower level 11 ft. of good cannel coal were found. A shaft was started, but after going over 200 ft., was abandoned on account of the water which flowed in in unmanageable streams.

On the rise east of the mine, Mr. Cross sunk a "6-in. well to between 1,200 and 1,400 ft. It is said that at between 350 and 550 ft. they passed through a bed of coal so thick that a barrel full came up from the 6-in. hole."

Clark & Co. had a slope in the edge of Washington, Sec. 35 (5), which was worked in the '60's. The section was (Sect. 636, Fig. 14):

	Ft.
1. Drift clay, 15 ft.; (2) clay shale, 12 ft.; (3) shale, 6 ft.	33
4. COAL VI	+4

Eureka No. 1 and No. 2, Sec. 35 (6) and (7). Eureka No. 1 was opened in the '70's. Eureka No. 2 was opened in 1880 by Cabel, Wilson & Co. It was worked out and abandoned in 1887. Depth to coal, 60 ft.; thickness of coal, 3 ft. to 3 ft. 8 in.

Mooney slope, Sec. 34 (12). Small slope worked in the '60's. Coal dips west. Section at slope (Sect. 637):

	Ft.
1. Drift clay, 10 ft.; (2) shale, 10 ft.	20
3. COAL VI	?

Sulphur Spring, Sec. 34 (11). This mine was opened in 1866, abandoned in 1889. Operated by Cabel, Wilson & Co., and later by Cabel & Kaufmann. In the early '80's this mine comprised the largest worked territory of any mine in the State. The coal is reported as 4 ft. 10 in. and up to 5 ft. 10 in. thick, and the depth variously given at from 33 to 60 ft. (Fig. 15). The roof was thin, giving much trouble from water.

South Branch mine. This mine was opened in 1866, was operated extensively in the '70's and '80's and abandoned in 1886. Originally opened by Spink, Cabel & Co., it was later operated by Cabel, Wilson & Co. It was worked by a slope, the coal having a thickness of 4 ft. 6 in. The section at this point is given as (Sect. 638, Fig. 16):

	Ft.	In.
1. Drift clay, 20 ft.; (2) shale, 7 ft.; (3) clay shale, 13 ft.; (4) shale, 4 ft.; (5) clay shale, 12 ft.	56	..
6. COAL VI	4	6

At this mine the coal dipped 1° southeast.

This district is entirely worked out, unless it be at the western end. Since this area was examined, Wilson No. 4 mine has been opened west

of the earlier workings. An entry has been driven entirely through the hill. The coal is here 3 ft. 6 in. thick and of excellent quality. The roof is shale and good. The bottom is fire-clay.

A third district extends from Cabel & Kaufmann's shaft No. 4 to White river, Coal V? being worked.

C. & K. shaft No. 4, Sec. 3 (4). The original shaft, No. 4, was just east of the present shaft. The present shaft is 44 ft. deep. The coal ranges from $2\frac{1}{2}$ to $4\frac{1}{2}$ ft. thick, with an average of 3 ft. (Fig. 18). Section of coal (Sect. 639):

	Ft.	In.
1. Shale, gray, arenaceous ....8 to	15	0
2. Fire-clay or shale ....10 in. to	4	0
3. COAL V ....2½ to	4	6
4. Fire-clay ....10 in. to	3	0

Coal VI? lies from 9 to 15 ft. above this coal. A set of "horse backs," or preglacial cut outs, cut into the coal a few hundred yards southeast of the shaft. In cutting through one of these a large, rounded mass of coal was encountered with a piece of a small tree several feet long leaning up against it. The coal from this mine has the reputation of being the best in the county and equal to any in the State.

C. & K. shaft No. 5, Sec. 4 (1). The section at this mine above the coal was given above. See Figs. 6 and 19.

Maple Valley, Sec. 4 (2). This shaft was opened in 1880 by Wilson, Kaufmann & Co. In 1885 it was being operated by Cabel, Wilson & Co. In 1886 by Cabel & Kaufmann. Operations were suspended in 1895 and in 1896 the shaft was being used as a water hoist for shaft No. 9. The coal is reported as 66 ft. deep. The drainage is from this shaft to No. 5. The coal is reported to average 5 ft. thick (Fig. 20).

C. & K. No. 9, Sec. 5 (1). This shaft was opened in 1893 by Cabel & Kaufmann in the northern part of the workings of the Maple Valley mine, and in 1896 was one of the largest mines in the county. The shaft is 86 ft. deep. The coal is 5 ft. thick near the shaft, but becomes less than 4 ft. in places. Section of coal (Sect. 640, Fig. 21).

	Ft.	In.
1. Limestone, bottom bench	4	0
2. Light colored tough shale	7	0
3. Shale, black ....6 in. to	1	0
4. COAL V? ....4 ft. to	5	0
5. Shale or (fire-clay under "low" coal)	..	..

The coal here has a good roof of tough shale. The coal has a dip of about 2° to the south. Where the coal is thickest it is underlain by shale, but where thinner is underlain by fire-clay.

As shown on the map, several borings made to the west show this coal to lie from 55 ft. to 60 ft. below the surface. This coal would seem to underlie large portions of Secs. 5 and 6, as shown on the map. Judging from the topography, it should be overlain over much of that area by a good thickness of roof, but the sandy nature of the higher land leads to the suspicion that a poor roof might be expected.

Alex. Yarrbough slope, Sec. 6 (1). This slope is on the E. & I. R. R. about a mile south of Maysville. It is an old slope which shipped coal to some extent on the old Wabash and Erie canal, whose site is now occupied by the railway. The coal lies about 15 to 18 ft. below the level of the railway. The section is (Sect. 641, Fig. 17):

	Ft.	*In.*
1. Covered slope	..	..
2. Sandstone, soft shaly	7	0
3. Sandstone, soft gray, micaceous	6	0
4. COAL VI .....2 ft. 4 in. to	4	0
5. Black shale	6	0
6. Fire-clay	..	..

The coal only gave 3 ft. of thickness when measured and seems to have carried a good deal of sulphur in the form of pyrite. This occurs in sheets and it may have been possible to pick this out. The dip is east at the mouth, but in general is southeast and southwest.

The extent of Coal VI to the southwest could not be determined, though a coal was reported as occurring in the higher land just north of Thomas switch on the E. & T. Ry.

C. & K. No. 6, Sec. 32 (2). This is a small isolated area covering a few acres and now worked out. The coal was reported as 6 ft. 6 in. thick (Fig. 22), and as lying 49 ft. below the surface. The coal underlies a small hill.

A fifth district comprises a limited area of Coal V northwest of Washington. The extent of workable coal is not nearly as large in some directions as indicated on account of the poor roof. Poor roof and thick coal characterize all the district.

Cabel & Co.'s shaft No. 7, Sec. 29 (1). Shaft 64 ft. deep and coal 6-7 ft. thick (Fig. 23), coal dips to north. Southeast of shaft the rise is so rapid as to make haulage difficult. This coal has a very poor roof, it being thin and uneven with quicksand above, which is said to occasionally make its way into the mine in great quantities, making the work dangerous. A great many drippers are reported in the roof. The coal is said to be not as good in quality as that found at shafts Nos. 4 and 9, "burning very fast, yielding much bitumen and clinker." It is said that the pumping in this mine dried all the wells for a quarter of a mile around.

Wilson's No. 2, or Hawkins's, Sec. 28 (1). This mine was opened in 1887 by the Wilson Coal Co., now the Washington Coal Co. It is 69 ft. to the coal, which runs from 6 to 7 ft. thick (Fig. 24). The section at the shaft was given above.

This mine, like No. 7, has a poor roof and is very wet. Though the coal extends half a mile north of the shaft it cannot be worked safely more than a quarter of a mile. The coal is reported of good quality. This mine is nearly worked out, and in 1895 they had begun to draw the pillars on nearly all the entries. The coal is blocked out here.

Indefinite information was obtained of other banks worked in this area without the location being obtained, as banks worked by Mr. H. Mattingly and Mr. Wm. Martin and many old drifts were noted, but no information obtained as to by whom they were worked.

Of Coal IV there still remains a small amount in the eastern part of the first district, running from 2 to 4 ft. in thickness. In the second district there remains a few acres north of the railroad and east of Wilson's of good workable thickness, and a larger area north of Wilson's in which the thickness will not, probably, average much over 2 ft.

In the third district, there is a considerable body of Coal V? in Secs. 5 and 6, and probably also in Secs. 7 and 8 of T. 2 N., R. 7 W. This is probably of workable thickness, but is likely to have a poor roof over some of it. In the fifth district, a limited district, a limited quantity of coal remains adjacent to C. & K. shaft No. 7.

1551. Outside of the area of the sketch map, coal is found north of Veale's creek, as follows:

Coal occurs on the West Fork of White river at Appaw's ford, Sec. 14-3-8. The coal was not seen on account of the height of the water, but it is reported as 4 ft. thick. A few inches of black shale which probably immediately overlies the coal was exposed at the water's edge; above that were at least 15 ft. of shaly sandstone, tending to shale in places.

In Sec. 14, T. 3 N., R. 7 W., two drillings were made on the Keith place; one 110 ft. deep passed through 3 ft. of coal, depth not known. This drilling started about 8 ft. above the level to the east. The other drilling on higher ground a little southwest, went 170 ft. It also passed through a bed of coal above the 3-ft. bed. These would appear to be Coals V and IV.

In the southwest corner of Sec. 12-2-7, a well was reported to have gone 68 ft. without striking "rock."

In the southeast corner of the same section a well passed through (Sect. 641a):

	Ft.
1. Surface, 10 ft.; (2) sandstone, 28 ft.	38

About 80 rods north there is a little coal just under this sandstone; 150 yds. west of this corner wells show 34 ft. of quicksand.

In Sec. 7-2-6 coal was reported to have been found in the drains at a number of places not much above the level of Veale's creek. It is overlain by the sandstone.

1552. South of Veale's creek coal is met with at only a few points. A section was given above of the rocks at the point where the railroad runs close to White river in Sec. 24-2-8. This section differs very materially from that given by Mr. Cox, but was made with some care and is given with confidence. He made the distance between the two coals 15 ft. 6 in. as against 30 ft. 5 in. in the section as given above.

At the northern end of the outcrop the layers have a south or southwest dip of 7 ft. 4 in. in one hundred. The average dip for the whole exposure is probably not over 2 ft. in 100.

Between a quarter and a half mile northeast up the railway is the Rogers, or Murry mine, as it was opened by Messrs. Murry & Baily. The shaft is 42 ft. deep and the coal runs from 6 ft. to 6 ft. 4 in. Our levels would make this from 10 to 15 ft. below the river, indicating that the strata have dipped north, and showing anticlinal structure between this point and the exposure in the river bed.

The mine was full of water at the time of visit. In the mine there is 4 ft. of shale between the coal and the limestone. The top coal is said to be hard and firm, the lower softer, with tendency to slack, but said by Mr. Rogers to be the best coal. Some of the coal shows calcite in the seams. Judging from the reports of those who have used the coal the quality is not good, it tending somewhat toward a bony coal without very great shrinkage in burning. It would appear to be rather a local pocket, as a drilling a quarter of a mile south showed a thickness of 7 ft. 3 in., while a drilling a half mile east found only black shale.

The first of these drillings showed (Sect. 642):

	Ft.	In.
1. Surface	35	0
2. Sandstone	3	0
3. Shale, black	6	0
4. COAL V	7	3

The second drilling showed (Sect. 643):

	Ft.	In.
1. Surface	20	0
2. Sandstone	3	0
3. Shale, black	5	0
4. Limestone	2	0
5. Shale, black	8	0
6. Fire-clay	4	0
7. Sandstone	2	0
8. Fire-clay	4	0

Drillings and records given by Mr. Paul Hinton, of Loogootee.

In Sec. 30, between Jacobs' and Veale's switches, a shaft has been sunk for coal. Mr. Hinton reports the section at this place to be as follows (Sect. 644):

	Ft.	In.
1. Sandstone	25	0
2. Clay	9	0
3. Gravel	3	0
4. Sandstone	38	0
5. Shaly clay shale	25	0
6. Black shale	7	0
7. Fire-clay and sandstone	18	0

If the first item is correctly given as sandstone, it would indicate that the preglacial channels of White river had undercut its bank at this point as the Wabash has been found to do at Vincennes. In that case it would seem that Coal IV came about at the level of the clay or gravel and the horizon of Coal V was passed through near the bottom. This is, however, largely conjectural.

The sandstone exposed on Veale's creek, supposed to overlie Coal VI is nonferruginous, resembling a fine-grained saccaroidal sandstone cross-bedded in places, showing a thickness of 20 ft. in one or two places, and at several places extending out over the creek several feet, at one place about 20 ft.

SEC. 21.—On Mr. John Davis's place a great thickness of sandstone is passed through. The record is roughly (Sec. 645):

	Ft.
1. Clay, 10 ft.; (2) sandstone, shelly, 100 ft.; (3) hard white rock, ?; (4) black shale, 5 ft.; (5) hard rock (sandstone?), 3 ft.; depth of well	125

This well is on the highest point on the ridge. The shale probably occurs at the horizon of one of the coals.

SEC. 28.—On Mr. Davis's place in Sec. 28, coal was met in a well in the head of a branch (VI or V?).

SEC. 23.—Well on Franklin place. The record was given from memory and Mr. Franklin was much in doubt about the order of some of the strata (Sect. 646):

		Ft.	In.
1.	Clay, 8 ft.; (2) sandstone, hard, 77 ft.; (3) flint, 2 ft.; (4) fire-clay, 3 ft.; (5) shale, ?	90	0
6.	COAL (IV?)	3	0
7.	Sandstone, etc.	6	0
8.	COAL ....1 to	1	6
9.	Sandstone	2	0
10.	COAL ....1 to	1	2
11.	Sandstone to bottom	42	..
	Total	145	8

This well is probably 70 ft. above Veale's or Aikman's creek. A short distance south and a little below this level at a depth of 5 ft. in a well was found 1 ft. of coal (V?).

SEC. 13.—On Mr. Allen's place, on top of the divide, Coal V was found, 7-8 in. thick, in a well a few feet from the top. Over it and exposed beside the well is a black sheety shale, and some limestone was also thrown out of the well. This is some 40 ft. below the house. One-half mile farther east, in the head of a drain, is an exposure of massive shelly sandstone. This lies above (?) the coal.

IN SEC. 24.—A little south of the above exposure, 18 in. of coal was dug into. Chert occurs on top of the ground a half mile east, suggesting that this is V.

In addition to what was said above: The top coal at south of Franklin's and the coals at Allen's, from their associated strata, can be assigned to V. The 3-ft. bed in the Franklin well is probably IV, as IV outcrops over 3 ft. thick and on about the same level 2½ mi. east.

Too little data is at hand to determine the horizon of coal on Mr. Davis's land.

COAL PROSPECTS IN THIS TOWNSHIP SOUTH OF VEALE'S CREEK.—The Rodgers coal is very thick, but not of extra quality, and of unknown extent. It is possible that it will be found at a short distance to, in large part, grade into black shale. While it might do no harm to prospect in that region, the outlook for workable coal is not great. Nor can it be said that any of the area offers much inducement to even prospecting. Coal IV may be found to have a workable thickness locally in the eastern part, but we should expect negative results rather than positive.

1553. DISTRIBUTION IN T. 1 N., R. 7 W. IN SEC. 3.—In the bend of White river, in Secs. 3 and 4, the river is said to flow over rock, several feet below which is coal. This may be Coal V, but is much below the level of Coal V at the nearest known points in Pike county.

SEC. 12.—On Mrs. Gregory's land, coal or coal-like shale is reported to have been struck in the bottom of drains.

SEC. 1.—On Mr. Osborn's place, in the southwest corner, a well and drilling was reported as follows (Sect. 647):

		Ft.
1.	Surface, 17 ft.; (2) sandstone, 5 ft. (bottom of well)	22
3.	Sandstone, 30 ft.; (4) shale, 44 ft.; (5) hard rock (limestone?), 5 in. to 6 in.; shale	75
	Bottom of well	97

On Mr. Daton's place, near the center of the section, a well and drilling yielded the following section, as given by Mrs. Daton (Sect. 648):

		Ft.
1.	Clay, 11 ft.; (2) sandstone, 39 ft.; (3) "flint rock" ("nigger head"), ?; (4) shale, about 20 ft.; fire-clay, 2 ft.+; bottom of ell	92

1554. SUMMARY OF COAL FOR DAVIESS COUNTY.—

Divisions contained, VII, VI, V, IV, III, II, I.

Coals contained, VII, VI, V, IVa, IV, IIIb, IIIa, III (several in Div. II), I.

ROUND NUMBER ESTIMATES.

Coal VII.

Worked area......	2 acres × av. thickness,	3 ft. ×	1,000 =	6,000 tons.
Workable area....	20 acres × "	3 ft. ×	1,000 =	60,000 tons.
Unworkable area	80 acres × "	1 ft. ×	1,500 =	120,000 tons.
Total area.....	100 acres			186,000 tons.

Coal VI.

Worked area......	1 sq. mi. × av. thickness,	4 ft. ×	500,000 =	2,000,000 tons.
Workable area...	⅓ sq. mi. × "	3 ft. ×	500,000 =	500,000 tons.
Unworkable area.	4 sq. mi. × "	1 ft. ×	1,000,000 =	4,000,000 tons.
Total area....	5 sq. mi.			6,500,000 tons.

Coal V.

Worked area......	1 sq. mi. × av. thickness,	4 ft. ×	500,000 =	2,000,000 tons.
Workable area ...	10 sq. mi. × "	4 ft. ×	500,000 =	20,000,000 tons.
Unworkable area.	100 sq. mi. × "	1½ ft. ×	1,000,000 =	150,000,000 tons.
Total area....	110 sq. mi.			172,000,000 tons.

Coal IV.

Worked area......	½ sq. mi. × av. thickness,	3 ft. ×	500,000 =	750,000 tons.
Workable area...	100 sq. mi. × "	3 ft. ×	500,000 =	150,000,000 tons.
Unworkable area.	150 sq. mi. × "	1 ft. ×	1,000,000 =	150,000,000 tons.
Total area....	250 sq. mi			300,750,000 tons.

Coal III.

Worked area......	¼ sq. mi. × av. thickness,	4 ft. ×	500,000 =	500,000 tons.
Workable area...	100 sq. mi. × "	3 ft. ×	500,000 =	150,000,000 tons.
Unworkable area.	200 sq. mi. × "	1 ft. ×	1,000,000 =	200,000,000 tons.
Total area....	300 sq. mi			400,000,000 tons.

Coals Not Already Given.

Unworkable area 300 sq. mi. × av. thickness, 5 ft. × 1,000,000 = 1,500,000,000 tons.

Number of coals contained: 15.
Greatest thickness recorded: 7 ft. 10 in. Coal V.
Area underlain by coal: 400 sq. mi.
Area underlain by workable coal: 150 to 200 sq. mi.
Estimated total tonnage of coal: 2,378,000,000.
Estimated total tonnage of coal removed: 5,250,000.
Estimated total tonnage of workable coal left: 320,000,000.
Number of mines working ten men or over in operation: 10.
Number of mines working less than ten men in operation: 26.
Total number of mines in operation: 36.
Large mines not in work: 25.
Small mines not in work: 30.
Strippings, outcrops, etc.: 209.
Total number of openings to coal: 300.

XXIX. KNOX COUNTY.

1555. References and Field Work.—

1862 (1859-60). Richard Owen, Rep. of a Geol. Reconn. of Ind., pp. 178, 179. (R. O.)

1862 (1859-60). Leo. Lesquereux, same, p. 340. (L. L.)

1871 (1870). E. T. Cox, 2d Ann. Rep. of Geol. Surv. of Ind., pp. 42 and 46. Two columnar sections. (E. T. C.)

1874 (1873). John Collett, 5th Ann. Rep. of Geol. Surv. of Ind., pp. 315-382. Map, detailed description, twenty-five columnar sections, twenty-one coal analyses. Over most of this county but little can be added to Mr. Collett's report, and it is therefore largely drawn upon for data. (J. C.)

1896. G. H. Ashley, field work for this report. It might be remarked that this county was worked up at a time when almost daily political meetings drew many people from their homes, rendering it difficult to get locations or find many of the outcrops or other datum points of which more or less unreliable reports were obtained.

1556. Position.—Lying just west of Daviess county, Knox county is next to the western State line, and lies south of Sullivan and Greene and north of Pike and Gibson counties.

Section 1. Geographic.

1557. Extent and Townships.—The civic townships are arranged about as follows:

	Busseron.		Widner.	Vigo.
		Washington.		
		Palmyra.	Steen.	
	Vincennes.	Johnson.		Harrison.
Decker.				

It occupies all of Ts. 2, 3, 4 and 5 N. of R. 9 W.; T. 5 N., R. 8 W.; T. 2 N., R. 10 W.; most of T. 5 N., R. 7 W.; Ts. 2, 3 and 4 N. of R. 8 W.; T. 1 N. of R. 11 W.; and parts of T. 5 N., R. 6 W.; T. 1 S. of Rs. 11 and 12 W.; T. 1 N. of Rs. 8, 9, 10, 11 and 12 W.; T. 2 N. of R. 11 W.; Ts. 3, 4 and 5 N. of R. 10 W. It has an extreme reach from north to south of 34 mi., and from east to west of 36 mi., with an area of 540 sq. mi.

1558. ELEVATIONS.—The elevation of this county ranges from about 375 to probably something over 600 ft. The elevation of the following points is known:

	Ft. A. T.
Sanborn, I. & V. R. R.	472
Westphalia, I. & V. R. R.	456
Edwardsport, I. & V. R. R.	460
Bicknell, I. & V. R. R.	about 475
Bruceville, I. & V. R. R.	515
Vincennes (Court House), I. & V. R. R.	435
Vincennes, C. & V. R. R.	417?
Vincennes, E., L. & H. R. R.	463
Wheatland	about 505
Summit between White and Wabash rivers, B. & O. S. W. R. R.	573
Low water junction E. & W., forks of White river	396
Decker's, E. & T. H. R. R.	427.8
Purcell's, E. & T. H. R.	421.3
Vincennes, E. & T. H. R. R.	412.6
Jno. Smith's, E. & T. H. R. R.	416.2
Emison's, E. & T. H. R. R.	469.7
Busseron, E. & T. H. R. R.	455.5
Oaktown, E. & T. H. R. R.	479.8

Elevations on E. & T. H. R. R. on basis of Evansville=378 ft. above tide.

1559. GENERAL TOPOGRAPHY.—Around three sides of the county extends a belt of fertile bottom lands from 1 to 3 mi. wide. Through the center of the county extends the divide between White and Wabash rivers, giving the major part of the county a fairly level or gently rolling topography. Several old streams now filled up to make marshes cut into this divide, their banks often being quite steep and up to 75 ft. high.

1560. TRANSPORTATION, ETC.—The B. & O. S.-W. Ry. crosses from east to west, the E. & T. H. R. R. from north to south, the I. & V. Ry. and Cairo & Vincennes cross from northeast to southwest. Vincennes, the oldest town in the State, is well situated as regards transportation, and ought to become a manufacturing center of some importance.

Section 2. Stratigraphy.

1561. PLEISTOCENE.—The county is practically all covered with Pleistocene deposits. In the valleys these may run up to 100 ft. in thickness, and in some of the old valleys which have not been cleared out may exceed that. On the uplands the drift and surface will seldom exceed 30 ft., and will generally run between 10 and 20 ft.

1562. COAL MEASURES.—At the top of the coal measures in the county is the Merom sandstone. At Vincennes this appears to be 70 ft. thick. The lower part of the coal measures are best known from the deep drillings at Vincennes. The stratigraphy is represented in the following table:

Division IX—
1. Merom sandstone.

Division VIII—
2. Shale, black shale.
3. COAL, local.
4. Sandstone and shale.
5. COAL, local.
6. Clay, shale, limestone, shale.
7. COAL VIII, thin, not worked.

Division VII—
8. Clay, sandstone, shale.
9. COAL VII, worked at Vincennes and along east end of county.

Division VI—
10. Clay, sandstone and shale.
11. COAL VI, worked at Edwardsport and Bicknell.

Division V—
12. Clay, sandstone, shale, *limestone, black shale.*
13. COAL V, worked a little at Edwardsport and around Sanborn.

From Vincennes Well.

Division IV?—
14. Clay, shale.
15. COAL IV, struck around Sanborn.

Division III?—
16. Clay, shale, sandstone, shale, limestone.
17. COAL III, struck at Edwardsport and Sanborn.
18. Clay and shale.
19. COAL in drilling at Vincennes.
20. Shale.
21. COAL.
22. Shale.
23. COAL.
24. Shale.
25. COAL.
26. Shale.
27. COAL.
28. Shale.
29. COAL.
30. Shale.
31. Shale and sandstone.
32. COAL.

Township 5 North, Range 7 West (in part.)

1563. Geography.—This partial township occupies the northeastern corner of the county, corresponding with the northeastern part of Vigo of the civic townships.

The most of this township is quite level, with much prairie, though with some higher rolling land in the northwestern part. Sand hills rise in places. It is evident that White river has formerly flowed through channels much west of its present channel.

1564. Stratigraphy.—The coals here run from Coal VII? down. Coals VII? and VI? were only found in Sec. 7, where the following partial section was obtained:

1565. Section 648a. Section of Shaft on Wm. Dye Place.—Sec. 7-5-7.

		Ft.	In.
1.	Surface	13	0
2.	COAL VII? ....1 ft. 10 in. to	3	0
3.	Space	?	?
4.	COAL VI? (1 ft. in drilling) ....5 in. to	0	6
5.	Space	?	?
6.	Clay shale	..	..
7.	Black shaly limestone ....1 ft. 6 in. to	2	6
8.	Soft shale	1	0
9.	Gray limestone	1	0
10.	Black shale	1	6
11.	COAL V (5 ft. in drill hole)	4	0
12.	Fire-clay	2	6

Coal V appears to be the principal coal.

A drilling on a hill in the N. E. of the S. W. of Sec. 2 gave:

1566. Section 649. Section of Drilling on C. E. Crane's Place.—Sec. 2. (J. C., p. 352.)

		Ft.	In.
1.	Soil and sand	14	0
2.	Yellow shale	7	0
3.	Soft sandstone	10	0
4.	Compact sandstone	5	0
5.	Clay shale (calcareous shale?)	4	6
6.	Black sheety shale	6	4
7.	COAL IV, part block	3	0
8.	Fire-clay	3	0
		52	10

A drilling made near the railroad track, in the N. E. of N. W. of Sec. 3, appears to have missed Coal V, but shows the presence of coals, which may be Coals IV, III and IIIa (?).

1567. Section 650. Section of Drilling on Russel, Crane & Co.'s.—Sec. 3 (J. C., p. 353).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil, sand and muck	42	0	..	..	42	0
2.	Sandstone	12	0	..	..	54	0
3.	Bone COAL	3	2	3	2	57	2
4.	Clay shale parting	5	0	5	0	62	2
5.	COAL IV	1	6	1	6	63	8
6.	Hard sandstone	6	0	..	..	69	8
7.	Shale and iron balls	16	0	..	..	85	8
8.	Black shale	9	4	31	4	95	0
9.	Shaly cannel	3	0	..	..	98	0
10.	COAL, part block	3	0	6	0	101	0
11.	Fire-clay	1	0	..	..	102	0

A drilling made at Sanborn by Mr. Atkinson, of Edwardsport, is said to have shown 1 ft. of coal at 75 ft., and at 150 ft., 18 in. of coal, then 6 in. of fire-clay, 6 in. of coal, and below, 6 ft. of fire-clay.

1568. Distribution and Local Details of Coal.—Very little coal has been mined in this township, and it may be doubted if there is much desirable coal there. Coal V gives the greatest promise. This coal lies about at drainage level in the northeastern part of the township. It is reported as 2 ft. thick there, having formerly been mined a little, and is overlain by black sheety shale, as in the Crane boring. At Sanborn it appears to be cut out. Attempts have been made there to mine the coal, supposed to be about 50 ft. deep, a shaft having at one time been sunk to that bed. But it proved to be only 1 ft. or 18 in. thick, and the enterprise was abandoned.

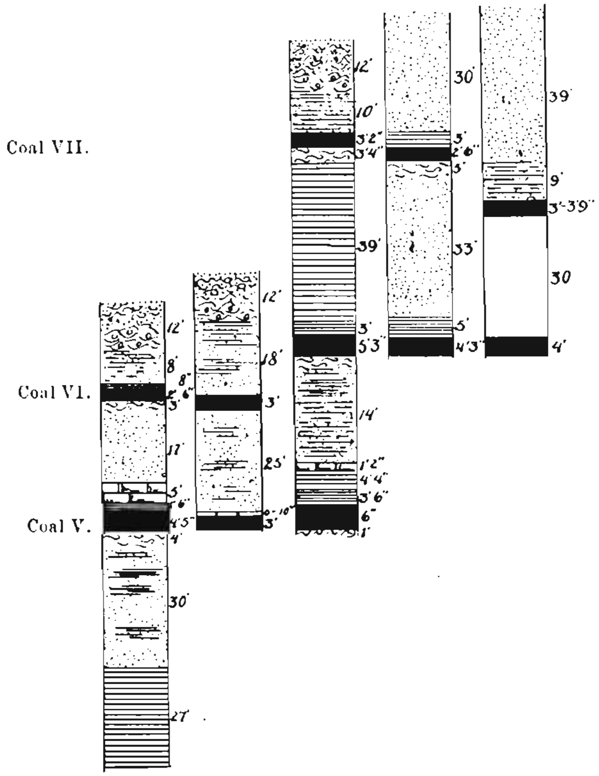
In the N. E. corner of Sec. 7, shallow wells, as on the Zeb. Brison place, are reported to strike Coal V at a depth of but a few feet. It is reported 5 ft. thick, overlain by 5 ft. of dark shaly limestone.

Coal V is also met with on the Wm. Dye place, in the S. W. part of the section. The coal is 49 ft. deep and 4 to 5 ft. thick, with a roof as given in the section above. A little to the southeast, and starting 16 ft. below, a drilling is said to have struck 3 ft. of coal at 18 ft., with only the drift for a cover. Nearly a mile south a drilling went 185 ft. and passed through a 2-ft. bed of coal at about 100 ft. As the drilling went through 40 ft. of quicksand, Coal V was doubtless cut out. About 20 yds. northeast of this hole, another hole went 80 ft. through gravel ("size of partridge eggs") without striking rock. About 200 yds. west of the shaft a drilling at a little lower level struck 3 ft. of coal at a depth of 18 ft.

Taking these figures, it is evident that Coal V is the only workable coal yet found, and that covers only a limited area, and with a poor roof over much of it.

Townships 4 and 5 North, Range 8 West.

1569. Geography.—This area is in the northeastern part of the county, and includes the western part of Vigo and the eastern part of Widner and Washington of the civic townships. The northern and



705 Keith. Sec. 12, 4-8. 706 Brickyard. Sec. 12, 4-8. 707 E. C. & M. Co. Sec. 36, 5-8. 708 Bicknell. Sec 21, 4-8. 709 Swicks. Don. 242.

Figs. 705-709. Columnar sections from townships 4 and 5 north, range 8 west.

western part of the area is rolling, with a long tongue of upland extending down to Edwardsport from the northwest. With that exception, and south of Indian creek, the eastern part of the area tends to be a level, characteristic of a filling of the preglacial valleys. Sand ridges are abundant in parts of this area and to some extent relieve the flatness.

This has always been the most important mining region of the county, mining having been carried on at Edwardsport from an early date. The I. & V. R. R. crosses the area from northeast to southwest.

1570. Stratigraphy.—Divisions VIII down are found in this area. Coal VIII was not seen, though it was reported, and its position relative to the others was not determined.

The following section, given by Mr. Collett, shows the upper part of the columnar section of this area:

1571. Section 650a. Section at Cox's Hill.—Sec. 8-4-8 (J. C., p. 355).

		Ft.	In.
1.	Shale soil	5	0
2.	Laminated ~~Merom~~ sandstone	5	0
3.	Thick bedded ~~Merom~~ sandstone	10	0
4.	Soft, friable, white sandstone	15	0
5.	Sandy limestone, conglomeritic	3	0
6.	Shale parting ....1 in. to	..	4
7.	Dark limestone, containing crinoid stems, corals...	4	0
8.	Place of rash COAL	0	0
9.	Fire-clay, potters' clay	1	6

The following section shows the strata immediately overlying Coal VII:

1572. Section 651. Section at Kelty's and Swick's Banks.—Don. 242-4-8 (J. C., p. 347, Fig. 709).

		Ft.	In.	Ft.	In.
1.	Slope	20	0	20	0
2.	Shelly sandstone	6	0	26	0
3.	Laminated sandstone	15	0	41	0
4.	Quarry sandstone	14	0	55	0
5.	Laminated sandstone	4	0	59	0
6.	Sandy shale with iron nodules	9	0	68	0
7.	COAL VII........3 ft. to	3	9	71	9
8.	Bore reported by Dr. Keith with limestone at base	30	0	101	9
9.	Coal VI	4	0	105	9

The following boring shows the relative position of Coals VII and VI:

1573. SECTION 652. SECTION OF BORING IN HILL NEAR THE HOFFMAN OR EDWARDSPORT COAL AND MINING CO.'S MINE.—Sec. 36-5-8 (W. S. B., p. 96, Fig. 707).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and drift	12	0	..	..	12	0
2.	Blue sandy shale	10	0	..	..	22	0
3.	COAL VIII	3	2	3	2	25	2
4.	Fire-clay	3	4	..	..	28	6
5.	Blue clay shale	39	0	..	..	67	6
6.	Dark bituminous shale	3	0	45	4	70	6
7.	COAL VI	5	3	5	3	75	9
8.	Fire-clay	2	0	..	..	77	9

Another boring on the old Simonson place commenced at the fire-clay of Coal VI and shows the stratigraphy of Coal V:

1574. SECTION 653. SECTION OF SIMONSON BORE.—S. E. ¼ of Sec. 35-5-8 (J. C., p. 349, Fig. 707).

		Ft.	In.
1.	Clay at level of coal	12	0
2.	Clay and shale	12	0
3.	Sandy shale	14	0
4.	Limestone	1	2
5.	Calcareous shale	4	4
6.	Black shale	3	6
7.	COAL V	6	0
8.	Fire-clay	1	0

The section at the shaft of the Bicknell Coal Company is somewhat as follows:

1575. SECTION 653A. SECTION AT BICKNELL SHAFT.—Sec. 16-4-8, Fig. 708.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	14	0	..	..	14	0
2.	Sandstone	30	0	..	..	44	0
3.	Shale	3	0	..	..	47	0
4.	COAL VII	2	6	2	6	49	6
5.	Fire-clay	5	0	..	..	54	6
6.	Sandstone	33	0	..	..	87	6
7.	Shale	5	0	43	0	92	6
8.	COAL VI	4	3+	4	3+	96	3

A somewhat more comprehensive section than Sect. 653 is given by Mr. Collett, as obtained south of Edwardsport, in the N. E. ¼ of the N. W. ¼ of Sec. 12-4-8.

1576. SECTION 654. SECTION AT KEITH MINE.—Sec. 12-4-8 (J. C., p. 349, Fig. 705).

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and loess	12	0	..	..	12	0
2.	Shaly sandstone	8	0	..	..	20	0
3.	Clay shale	0	8	..	..	20	8
4.	COAL VI	2	6	2	6	23	2
5.	Fire-clay	3	0	..	..	26	2
6.	Sandstone, laminated	3	0	..	..	29	2
7.	Sandstone, laminated	14	0	..	..	43	2
8.	Bituminous limestone	5	0	..	..	48	2
9.	Black sheety shale.......6 in. to	1	6	26	6	49	8
10.	COAL V	4	5	4	5	54	1
11.	Fire-clay (in bore)	4	0	..	..	59	1
12.	White sandstone and shale	30	0	..	..	89	1
13.	Clay shale, becoming darker	27	4	..	..	116	5

At the brickyard bank in the N. W. corner of Sec. 12 occurs the following section:

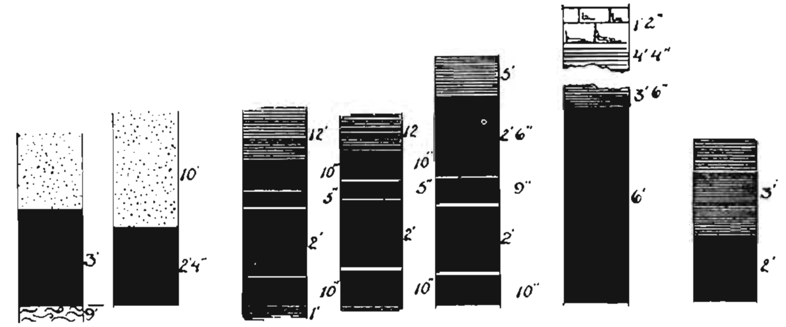
1577. SECTION 655. SECTION AT BRICKYARD MINE.—Sec. 12-4-8, Fig. 706.

		Ft.	In.
1.	Surface	12	0
2.	Sandstone and shale	18	0
3.	COAL VI, including 10 in. of bone at bottom	3	0
4.	Sandstone, etc.	25	0
5.	Limestone .... trace to	..	10
6.	COAL V	3	0

These sections show principally massive sandstone above Coal VII in Division VII.

1578. COAL VII is everywhere a solid coal and shows thickness and roof as follows (Figs. 711, 712, Figs. 6-8 of Plate LIV):

NAME.	Sandstone.		Shale.		Coal VII.		Fire-clay.	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Freelandsville	?	?	0	0	3	0	9	0
Purdy	30	0	0	0	3	2	......	......
C. & C. Co. (bore)	......	......	10	0	3	2	3	4
E. C. & M. Co. (drift)	10	0+	0	0	2	4	......	......
Bicknell	30	0	3	0	2	6	5	0
Swick	39	0	9	0	3	0	......	......
Slinkard	22		0	0	3	0	6	0+



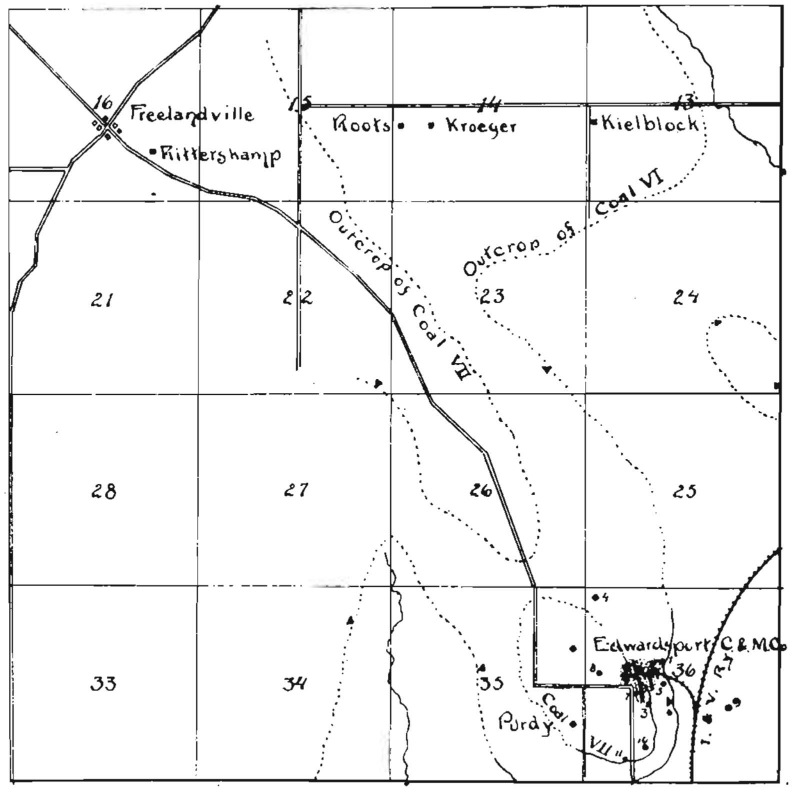


Fig. 710. Sketch map of part of T. 5 N., R. 8 W.
Figs. 711, 712. Coal VII in same area.
Figs. 713–715. Coal VI in same area.
Fig. 716. Coal V in same area.
Fig. 717. Coal III? in same area.

This coal may be said to average 3 ft. in thickness in this area. It is generally spoken of as a soft coal, but a good coal. It is not mined extensively. The following analysis will show its composition at the Swick bank, Don. 242-4-8:

Fixed carbon	46	
Volatile combustible matter	45.50	
Total combustible matter		91.50
Ash	5.50	
Moisture	3.00	
Total waste		8.50

It is described as a "glossy, brownish-black caking coal, with conchoidal fracture."

1579. Coal VI lies about 30 ft. below Coal VII. It is the principal coal mined here. The following additional sections may be given to show its roof and thickness:

1580. Section 656. Section at Roots and Bensing's Mine.—Sec. 14-5-8.

	Ft.	In.
1. Surface clay	13	0
2. Sandstone	10	0
3. Black shale	12	0
4. COAL VI ....4 ft. 6 in. to	4	10
5. "Hard black flint-like shale"	..	1
6. Clay shale	..	2

1581. Section 657. Section at Freelandsville.—(From Coals VII to VI) Sec. 16-5-8.

	Ft.	In.
1. "Blue sandy rock"	..	..
2. COAL VII at 60 ft., 2 ft. 6 in. to 3 ft. 6 in.	3	0
3. Fire-clay	9	0
4. "Very hard rock"	10	0
5. Shale	20	0
6. COAL VI	4	0

1582. Section 658. Section of Edwardsport Coal and Mining Company's Shaft.—Sec. 36 (2)-5-8.

	Ft.	In.
1. Surface	18	0
2. Clay shale	9	0
3. Yellow sandstone	7	0
4. Black shale	5	0
5. COAL VI	6	0

1583. SECTION 659. SECTION AT OLD CURRY MINE.—Sec. 1-4-8.
NE NE NE Bicknell Quad.

		Ft.	In.
1.	Clay	12	0
2.	Shelly sandstone	18	0
3.	Shaly sandstone	1	6
4.	Clay shale	0	8
5.	COAL VI	5	2
6.	Fire-clay	3	0

1584. SECTION 660. SECTION AT HARRINGTON COAL COMPANY'S SHAFT.—Sec. 2-4-8. NE NE SE Bicknell Quad.

		Ft.	In.
1.	Surface	15	0
2.	Shale	6	0
3.	COAL VI	6	2
4.	Hard black shale	1	6
5.	Fire-clay	2	6

1585. SECTION 661. SECTION AT THURSTON'S SHAFT.—Sec. 2 (2)-4-8. NE NE SE Bicknell

		Ft.	In.
1.	Surface clay	6	0
2.	Sandstone	10	0
3.	Clay shale	8	0
4.	COAL VI	5	6
5.	Fire-clay	1	0
6.	Black shale	3	0
7.	Hard gray shale	14	0+

In the figures just given of Coal VI the bottom bench is included. This is part of the basin that runs through Sullivan county, as shown by the following table, showing the thickness of the various benches (Figs. 713-715 and Figs. 2-5 of Plate LIV):

NAME.	Location.	BENCHES.							Total.	
		Upper.		Mining.	Lower.		Bottom.			
		Ft.	In.	In.	Ft.	In.	Ft.	In	Ft.	In.
Freelandsville	Sec. 16-5-8	?	?	?	?	?	1	0	4	0
Roots and Bensing	Sec. 14-5-8	....	10	5	2	0	...	10	4	10
Kroeger	Sec. 14-5-8	....	10	5	2	0	....	10	4	10
Edwardsport C. & M. Co.	Sec. 36-5-8	2	6	9	2	0	....	10	6	3
Curry (J. C., p. 348)	Sec. 1-4-8	1	8	6	2	0	....	10	5	2
Harrington C. Co	Sec. 2-4 8	2	4	9	2	1	1	2	6	6
Thurston	Sec. 2 (2)-4-8.	1	6	6	2	4	1	2	5	6
Brickyard	Sec. 12 (4)-4-8.	?	?	?	?	?	....	10	3	0

This shows a total average of over 5 ft., but, omitting the bottom bench, which is bony and not marketable, and never worked in this area, there is left between 4 and 5 ft. of workable coal. The maximum thickness seems to be found close to Edwardsport, and to the north and, to a still greater extent, to the south the coal becomes thinner. The benches are separated by clay partings, as in Sullivan county, which will average about 1 in. thick. This coal has always had an excellent reputation, inquiry at Indianapolis coal dealers indicating that it is an acceptable coal. The following analyses are by Mr. Noyes:

	A.	B.	
Fixed carbon	36.00	35.22	
Volatile combustible matter	46.03	48.54	
Total combustible matter		82.03	83.76
Ash	9.22	8.63	
Moisture	8.75	7.61	
Sulphur	3.08	1.67	
Total waste		21.05	17.91

These analyses are made—A from Edwardsport and B from Bicknell. They indicate a coal below the average in quality.

Analyses of coal around Edwardsport gave Mr. Cox as follows:

NAME.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Curry	57.00	34.50	91.50	4.50	4.00	8.00
Shepard & Hazlett	49.00	39.00	88.00	6.50	5.50	12.00
Simonson, upper part	47.00	47.00	94.00	2.50	3.50	6.00
Simonson, middle part	45.50	47.50	93.00	3.50	3.50	7.00
Simonson, lower part	48.50	45.50	94.00	3.00	3.00	6.00

As in the previous analyses, the proportion of gas is unusually large. Much of this coal is mined without powder by first mining out the middle bench, or bench-mining, after which the top bench settles down so as to easily be taken off, after which the bottom bench is wedged up. Coal VI usually appears to have a good roof.

1586. COAL V lies from 25 to 80 ft. below Coal VI. The space between is largely sandstone or shale, but over the coal usually comes the characteristic black sheety shale and limestone. The following table will show the variation in the coal and roof (Fig. 716, Figs. 9-12 of Plate LIV):

NAME.	Location.	Sandstone.		Shale.		Limestone.		Shale.		Coal.	
		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Simonson	Sec. 35-5-8	....	....	26	0	1	2	7	10	6	0
South of station	Sec. 1-4-8	....	....	26	0	1	6	1	0	1	0+
Keith	Sec. 12-4-8	17	0	0	0	5	3	2	4	3	4
Brickyard	Sec. 12-4-8	25	0	0	0	0	10	0	0	3	0

These indicate a thickness of from 3 to 6 ft. In the case of the Keith bank, the limestone measured as follows:

	Ft.	*In.*
Light colored limestone	1	3
Yellowish shale	2	0
Light colored lenticular limestone	2	0

At the Brickyard bank there is a parting running from a trace to 1 in. in thickness, 1 ft. from the top of the coal. Mr. Collett gives the following section of Coal V where formerly worked on the Keith place:

	Ft.	*In.*
Laminated coal	1	6
Pyrite parting and smut	..	½
Compact coal, part black	1	4
Smut parting	..	½
Blacksmith fat coal	1	6
	4	5

Where at present mined, it is solid, though not so thick. The black shale at this mine runs from 2 in. to 4 ft. in thickness and is wanting at the Brickyard mine. It commonly carries pyrite concretions. This coal does not share the good reputation of Coal VI here, being generally reputed as bony and making too much ash. Mr. Cox gives the following analyses of this coal:

NAME.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Keith, upper part	49.50	39.50	89.00	5.00	6.00	11.00
Keith, middle part	49.00	39.00	88.00	6.00	6.00	12.00
Keith, lower part	49.00	39.00	88.00	6.50	5.50	12.00
Simonson & Hulan, upper part	45.50	45.50	91.00	5.00	4.00	9.0
Simonson & Hulan, middle part	49.00	43.00	92.00	3.50	4.50	8.00
Simonson & Hulan, lower part	52.00	37.50	89.50	7.00	3.50	10.50

1587. DIVISIONS IV AND III have been but little explored here. A drilling by Mr. Atkinson was made just east of where the switch turns off to the E. C. & M. Co.'s mine, and at 125 ft. is said to have pierced 3 ft. of cannel or bone and 2 ft. of bituminous. This would perhaps correspond to Coal III, Coal IV being missed by the boring.

1588. DISTRIBUTION OF COAL.—Coal VII occupies an area limited to the western and higher parts of the ridges, though south of Indian creek it approaches nearer to drainage. There is a small basin in the hill northwest of Edwardsport. The Freelandsville shaft, sunk by Mr. Ritterskamp, which started about 60 ft. below the level of town, reached Coal VII at 60 ft. At Bicknell it is 47 ft. to this coal.

Coal VI underlies all but the flat country in the eastern part of the area. It is reported as 35 ft. deep at the old John Keilblock shaft, in Sec. 13-5-8; the same at the Roots & Bensing shaft, in Sec. 14-5-8, and but 2 ft. deeper at the Fred Kroeger bank, just east of the last.

Coal V is said to be 90 ft. from the surface here. A drilling on the section line, west side of Sec. 10, is said to have found this coal 4 ft. thick at a depth of 30 ft. At Ritterskamp shaft, this coal was 4 ft. thick and 100 ft. deep. This shaft encountered a flow of water from above Coal VII, which led to its abandonment. In Sec. 36-5-8, Coal VI outcrops about at the level of the railroad, with Coal VII about 30 ft. above it. It is extensively worked by the Edwardsport Coal and Mining Company. At the top of the hill, near this, a well on the Purdy place found Coal VII at about 40 ft. Coal VI has been pretty well worked out close around Edwardsport, in Sec. 1-4-8, through the old Curry slopes north and southwest of town. Near the station, Coal V lies about level with the railroad track, but dips rapidly to the south, so that it passes under the river just above the ferry near the Keith mine. The Harrington and Thurston mines are working out

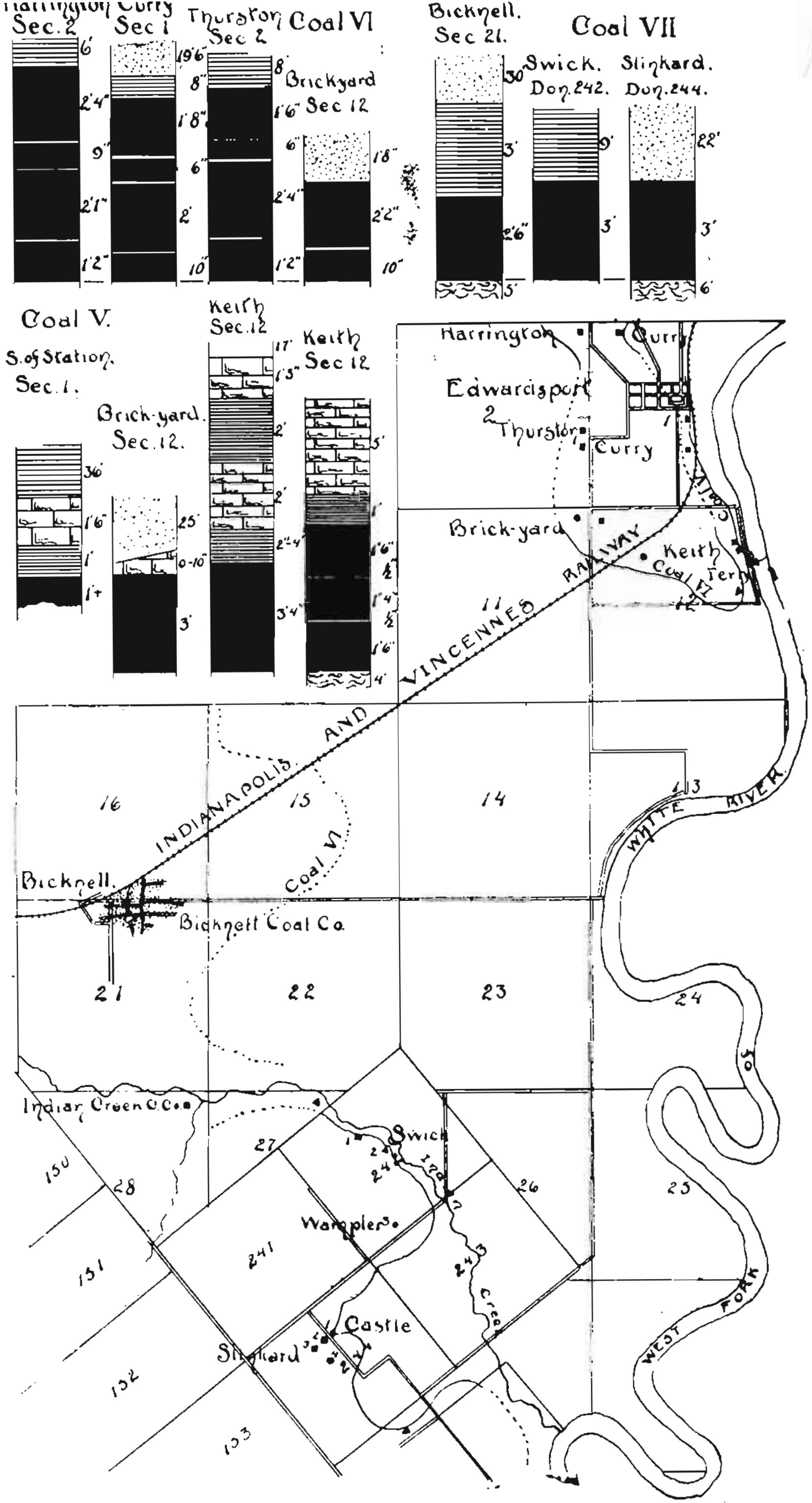


PLATE LIV. Sketch map and coal sections, T. 4 N., R. 8 W.

small areas, remnants left by previous mining operations. Coal VI appears to be cut out over a large filled area, west and southwest of Edwardsport. Coal V is being worked at the Keith bank by R. C. Vance, and at the Brickyard bank, both in Sec. 12. At the Bicknell Coal Company's shaft, Coal VI is 92 ft. deep. Coal VII, while of a uniform grade, varies greatly in thickness. Drillings show at least two beds of coal below the worked bed.

The coal dips to the south and was formerly mined extensively at the Indian Creek Coal Company's shaft, a mile south of Bicknell. The shaft, starting 15 to 18 ft. above the creek, reached the coal 4 ft. to 5 ft. 6 in. thick at about 80 ft. From here the dip was southwest.

Since the report and maps went to the printer a number of drillings and other data have been obtained in the region of the old Indian Creek mines which throw some light on conditions at that point. The drillings are accompanied by a sketch map, which shows the shaft to be in the N. W. 40 of Sec. 27, instead of in Sec. 28, as given on the maps. Of the borings, Nos. 1, 2 and 3 are in Don. 241; No. 1 being a little northwest of the N. E. ½ of the donation, No. 2 in the W. ½ and No. 3 in the S. ½ of the donation. No. 4 is in the N. W. ½ of Don. 242, near the N. W. line and close to Indian creek; it started below the outcrop of Coal VII. No. 5 is a little northeast of the shaft. At the mine the coal is roofed with from 5 to 12 ft. of black shale, with 4 to 5 ft. of black shale with boulders for a floor, with a small thickness of fire-clay between the coal and shale.

Below are records of the drillings mentioned:

Drilling No. 1—	Ft.	In.	Ft.	In.
Surface	20	0	20	0
Soft sandstone, 2 ft.; blue sandstone, 52 ft. 6 in.; gray shale, 1 ft. 6 in.	56	0	76	0
COAL VII	2	9	78	9
Fire-clay, 4 ft. 7 in.; gray shale, 6 ft.; shale, 13 ft.; gray shale, 4 ft.; shale, 3 ft.; dark shale, 9 ft. 6 in.	40	1	118	10
COAL VI	4	11	123	9
Dark shale	..	..	..	..
Drilling No. 2—	Ft.	In.	Ft.	In.
Surface	27	0	27	0
Soft sandstone, 8 ft.; blue sandstone, 29 ft. 2 in.; shale, 1 ft.	37	2	64	2
COAL VII	2	6	66	8
Fire-clay, 6 ft. 4 in.; "fire-clay rock," 4 ft.; shale, 12 ft. 6 in.; gray shale, 6 ft.; shale, 2 ft.; black shale, 1 ft.; dark shale, 9 ft. 10 in.	41	8	108	4
COAL VI	4	10	113	2
Dark shale.				

Drilling No. 3—

	Ft.	In.	Ft.	In.
Surface	21	0	21	0
Blue sandstone, 41 ft. 6 in.; dark shale, 3 ft. 10 in.	45	4	66	4
COAL VII	2	9	69	1
Fire-clay, 5 ft. 6 in.; "fire-clay rock," 7 ft. 5 in.; gray shale, 1 ft. 9 in.; shale, 7 ft. 3 in.; dark shale, 12 ft. 4 in.	34	3	103	4
COAL VI	5	4	108	8
Dark shale.				

Drilling No. 4—

	Ft.	In.
Surface	18	9
Shale	10	3
COAL VI	4	4
Dark shale.		

Drilling No. 5—

	Ft.	In.
Surface	41	0
Shale	17	0
Dark shale	5	6
COAL VI	4	4
Dark Shale.		

South of Indian creek, Coal VII has been worked at Geo. W. Swick's by a drift. It is here 2 ft. 6 in. to 3 ft. thick, overlain by 15 ft. of blue sandstone, which becomes red at the bottom. Coal VI is reported to be 32 ft. below. A drilling on the Wampler place, Don. 242, according to one report, passed through 2 to 3 ft. of coal at 39 ft., 5 ft. of coal at 70 ft., and 2 to 3 ft. of poor coal at 120 ft. According to Mr. J. T. Whitaker, who drilled this hole, only two beds of coal were struck, the upper being 18 in. thick and the lower 4 ft.

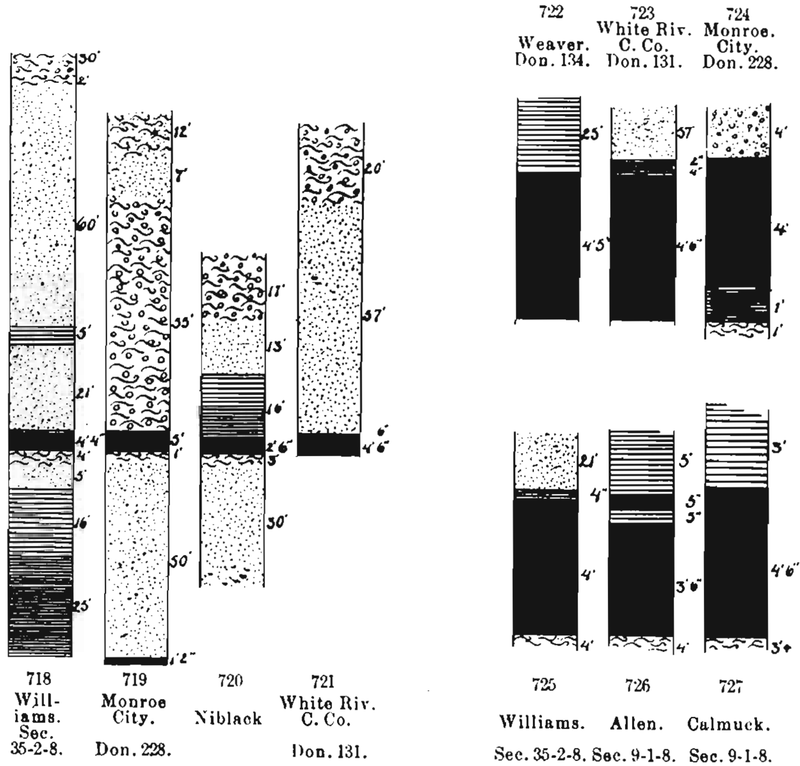
Some coal has been dug in Don. 244, on the Castle place and the Slinkard place. Coal VII is here 3 ft. thick, including 6 in. of poor coal in the middle, and is overlain by white friable sandstone. Coal VI is said to be 30 ft. below and to be 4 ft. 6 in. thick. On top of the hill a drilling showed 49 ft. of sandstone over the coal.

Townships 1 (in part), 2 and 3 North, Range 8 West.

1589. Geography.—This area lies in the southeastern part of the county and corresponds approximately with Steen and the western part of Harrison of the civic townships. The topography divides itself into the upland, which ranges from flat to rolling, and the bottoms, along White river and Pond creek. The bottoms along White river are often several miles broad; the flat strip along Pond creek is narrow, but

bordered by sharp bluffs. The B. & O. S. W. Ry. crosses the area from east to west, and the proposed "Black Diamond" railroad is surveyed to cross the southwestern corner of this strip.

1590. Stratigraphy.—The stratigraphy of this area is not as clear as might be, due principally to uncertainties in regard to Coal VI. To the north Coal VI is the principal coal, while to the south it is found to have run out. At the old Weaver drifts, Mr. Collett obtained the following section:



Figs. 718-721. Columnar sections in T's 1, 2 and 3 N., R. 8 W.
Figs. 722-727. Coal sections in same area.

1591. Section 662. Section at Weaver Drift.—In bluff of river, Don. 134 (J. C., p. 346).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Slope.						
2. Quarry sandstone, soft part	15	0	..	..	15	0
3. Gray shale, pyritous.......4 ft. to	2	0	..	..	17	0
4. COAL VII ....6 in. to	3	4	3	4	20	4

	Ft.	In.	Ft.	In.	Ft.	In.
5. Fire-clay	3	6	..	..	23	10
6. Clay shale, with ironstone nodules, 16 ft. to	25	0	..	..	48	10
7. Shale	0	4	28	10	49	2
8. COAL VI	4	5	4	5	53	7
9. Fire-clay	3	0	..	..	56	7

A section at the White River Coal Company's shaft showed:

1592. SECTION 663. SECTION AT WHITE RIVER COAL COMPANY'S SHAFT.—Don. 131, Fig. 721.

	Ft.	In.
1. Drift	20	0
2. Hard sandstone	41	0
3. Fine-grained sandstone	16	0
4. Gray shale	0	2
5. Black shale	0	4
6. COAL VII	4	6
	82	0

Some question exists as to whether this is Coal VII or VI. The sandstone makes it look like VII. Its thickness and the presence of a bottom bench of poor coal, with a parting 10 in. from the bottom, suggest Coal VI. If it is Coal VII, the suggestion comes that some or all of the coal called Coal VI around Washington may be called Coal VII. A boring put down by Mr. S. L. Niblack near Wheatland gave as follows:

1593. SECTION 664. SECTION IN NIBLACK'S BORE.—Don. ? (J. C., p. 343, Fig. 720.)

	Ft.	In.
1. Drift	17	0
2. Red sandstone	7	0
3. White sandstone	6	0
4. Dark clay shale	16	0
5. COAL VII	2	6
6. Fire-clay	3	0
7. "Dark coarse rock"	20	0
8. White sandstone	10	0
9. Blue "hard rock"	8	0
10. Dark "hard rock"	4	0
11. White fine rock, shaly sandstone	4	0

The following section is as near as could be obtained of the old Monroe City Coal Company's shaft, in Don. 228.

1594. SECTION 665. SECTION OF MONROE CITY COAL COMPANY'S SHAFT.—Don. 228, Fig. 719.

	Ft.	In.	Ft.	In.
1. Surface clay	12	0	12	0
2. Quicksand	7	0	19	0
3. Blue clay	55	0	74	0
4. "Concrete rock"	4	0	78	0
5. COAL	4	0	82	0
6. Bone coal	1	0	83	0
7. Fire-clay	1	0	84	0
8. Sandstone	50	0	134	0
9. COAL	1	2?	135	2

This coal, like the last, is either VII or VI, but with the data on hand it is still a question which. The underlying bench of bone coal makes it look like Coal VI.

At the Calmuck coal mine, in Sec. 9-1-8, the following section was obtained (Sect. 666, Fig. 727):

	Ft.	In.
1. Surface clay	18	0
2. Sandstone	7	0
3. Clay shale	3	0
4. COAL VII	4	6
5. Fire-clay	3	0+

From its position a comparison with the coals across in Pike county in this same township would indicate that this is Coal VII. Another section near here gave:

1595. SECTION 667. SECTION AT ALLEN'S AND FOULK'S BANK.—N. E. ¼ of Sec. 9-1-8. (J. C., p. 340, Fig. 726.)

	Ft.	In.
1. Slope.		
2. Laminated sandstone	3	0
3. Clay shale	5	0
4. Bituminous parting .4 in. to	0	5
5. Clay shale, fern bed .2 in. to	0	5
6. COAL VII .1 ft. 6 in. to	3	6
7. Fire-clay	4	0

Mr. Collett gives the following section of the strata in outcrop and in a boring on the old Gov. Williams farm, in Sec. 35-2-8:

1596. SECTION 668. SECTION ON J. D. WILLIAMS'S PLACE.—Sec. 35-2-8. (J. C., p. 341, Figs. 718 and 725.)

	Ft.	In.
1. Red clay soil slope .20 ft. to	30	0
2. Fire-clay—Coal?	2	0
3. Shaly sandstone	8	0

		Ft.	In.
4.	Compact sandstone	3	0
5.	Shaly sandstone	12	0
6.	Shaly, soft sandstone	10	0
7.	Massive quarry sandstone	15	0
8.	Heavy-bedded sandstone	10	0
	(Top of bore.)		
9.	Sandstone	2	0
10.	Shale	5	0
11.	Solid blue sandstone	21	0
12.	Black shale	..	4
13.	COAL VII?	4	0
14.	Fire-clay	4	0
15.	Sandstone	5	0
16.	Gray shale	4	0
17.	Blue clay shale	5	0
18.	Gray shale	7	0
19.	Black shale	25	0

The only coal at present worked in this area is supposed to be Coal VII. It appears to vary in thickness from 4 ft. 6 in. down, and overlain by first a little shale, then a considerable thickness of sandstone, up to 60 or 80 ft. Analyses by Mr. Cox of this coal shows as follows:

NAME.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Weaver Coal Company, Don. 134	52.00	38.50	90.50	4.50	5.00	9.50
Weaver Coal Company, boring (top)	59.00	34.00	93.00	3.50	3.50	7.00
Weaver Coal Company, boring (bottom)	59.50	33.00	92.50	4.00	3.50	7.50
J. D. Williams, boring	54.00	38.50	92.50	4.00	5.50	7.50

These analyses indicate a good quality of coal.

1597. Distribution and Local Details.—The outcrop at Appaw ford, Don. 157, has been mentioned under Daviess county. The coal is there in the bed of the river, with the dip to the south. In Don. 135 it rises so as to outcrop again in the bed of the river and rises to the south so that in 300 or 400 yds. it is 10 or 12 ft. above the river, where it was formerly mined on the Weaver place by five slopes or drifts. From there it dips to the southwest, and is estimated to be 20 ft. lower at the shaft of the White River Coal Company. At this

point the coal is 80 ft. deep. Mr. Collett mentions that seven borings have been put down on this property, then controlled by the Weaver Coal Company. These he reports found Coal V in the extreme northern corner at 37 ft., doubtless an error; three bores found Coal VII at a depth of from 47 to 78 ft., while the third and probably the fifth bore passed Coal VII as a mere parting of shale and found Coal VI at 67, then 108 ft. Notwithstanding the section given in the river bank by Mr. Collett, which was not seen, I am far from convinced of the existence of two workable beds of coal in this region corresponding to Coals VII and VI. Coal VII appears to be the surface bed here, cropping out at some of the lower levels near drainage, as on the Nicholson place, in a branch just west of Wheatland, and at other points near town.

Since the report went to the printer, the borings, sketch map and accompanying letter, referred to above, have been found, and as they may prove of help in the future working out of the stratigraphy of this region, the records of the boring will be given below. The new evidence strengthens our suspicions that the coals of Sect. 662 are based on two outcrops of the same coal. The old drift at the river bank, according to Mr. E. N. Wild, of the company, was 20 ft. above low water. This coal had a thick sandstone roof. Below this, and starting at the water's edge, hole No. 1 was put down 13 ft or 33 ft. below the outcropping bed, and found nothing but gray shale. In the bottom land a half mile (?) north of the drift mine bore No. 4 was put down. It started about 15 ft. above low water:

Drilling No. 4—	Ft.	In.
Soil, sand, clay and gravel	28	0
Soft gray shale, 4 ft.; "black chip slate, almost coal," 2 ft. 6 in.; hard gray shale, 1 ft. 6 in.; hard black shale, 1 ft.	9	0
COAL and shale mixed	2	6
Bluish soft shale	1	6

Presumably this is below the worked coal, but that is not certain. The other borings start from high rolling ground.

Drilling No. 2 (starting 70.30 ft. above low water in river)—	Ft.	In.
Surface	14	0
Gray sandstone	33	0
COAL VII	3	0
Gray shale, 15 ft.; sandstone, 1 ft. 6 in.; shale, 3 ft. 5 in.	19	11
	69	11

Drilling No. 3 (starting 64.20 ft. above low water in river)—

	Ft.	In.
Surface	12	0
Red sandstone	14	0
Shale	23	0
Black shale	trace	..
Gray shale	18	0
COAL	5	3
Shale.		
	72	3

Drilling No. 5 (starting 88.70 ft. above low water in river)—

	Ft.	In.
Surface	20	0
Gray shale, 6 ft.; gray sandstone, 82 ft.	88	0
COAL and shale	0	6
Coal VII	3	6
Black shale.		
	112	0

Drilling No. 6 (starting 80 ft. above low water in river)—

	Ft.	In.
Surface	16	0
Gray sandstone, 5 ft.; red sandstone, 9 ft.; shale, 30 ft.; black shale, 1 ft. 6 in.	45	6
COAL	3	10
Black shale.		
	65	4

Drilling No. 7 (a little over 70 ft. above the river)—

	Ft.	In.
Surface	20	0
Yellow sandstone, 12 ft.; gray sandstone, 30 ft.; gray shale, 15 ft.; shale, 1 ft.	58	0
COAL	4	2
	82	2

In general this coal strongly resembles the upper bed along Indian creek, considered to be Coal VII; on the other hand, it has a strong resemblance to the coal formerly extensively worked around Washington, in Daviess county, and called Coal VI. This is one of the problems to be solved in the future.

Just east of Wheatland a boring made many years ago is said to have found 2 ft. of coal at 38 ft., and 5 ft. of coal at 135 ft. It is thought that the lower coal is Coal V, worked west of Washington. It was reported that 7 ft. of coal was struck at 58 ft. on the John Dunn farm, 2 mi. southeast of Wheatland. Though not found, this well was reported as being on the edge of the bottom and as passing through only soft material until the coal was struck.

Southwest of Monroe City, in Don. 228, a shaft was sunk by the Monroe City Coal Company, striking 4 ft. of good coal at a depth of 78 ft., with a foot of bone coal below. The roof, however, proved too poor to work, as, while in places it consisted of a few feet of a conglomeritic-like rock, according to the description, this tends to thin out, leaving only the drift clay for a roof. The coal is said to have been good. The dip was strongly to the northeast.

A large number of deep wells sunk for water were reported as having found coal, but little definite information could be obtained concerning them. At Mr. Geo. Like's well, in Sec. 18-2-8, it is said to have been 105 ft. to the rock, 165 ft. to a 2 ft. bed of coal, and 185 ft. to a 2 ft. 6 in. bed of coal, the well being 206 ft. deep. The surface around Monroe City appears to be quite a deep filling. Coal was also reported found in the well of Mr. Elijah Cooper, in Sec. 19-2-8, and at the Elmer Davidson place, in Sec. 33. At the John Like place, in the S. E. ¼ of Sec. 32, it was reported to be 160 ft. to sandstone, 2 or 3 ft. thick; then 1 ft. of coal and shale was passed through, with below 15 to 20 ft. of clay shale and clay and coarse sandstone to 220 ft., the depth of the well.

In Sec. 5-1-8 coal has been found on the Warner place, and was reported as 3 ft. thick, but poor, and on the Snider place, a little south. At the Calmuck mine, in the S. W. ¼ of Sec. 9-1-8, Coal VII is being worked by a shaft at a depth of 28 ft. This makes the coal just about at high water mark. It is 4 ft. 6 in. thick, ranging from 4 to 5 ft. It is reported that a shaft and boring ½ mi. southwest of this, starting 18 to 20 ft. above high water, passed through 26 ft. of clay, 36 ft. of sandstone, with 7 ft. of very hard rock 7 ft. from the top of the sandstone, and went into 2 ft. 6 in. of cannel coal.

In the northwestern part of this section a drilling on Mrs. Tyron's place is said to have found 5 ft. of coal at 60 ft.

The data suggest that Coal VII will be found of workable thickness over much of this area, but indicates that preglacial erosion has removed much of it, and rendered much more of it unworkable through lack of roof. Coal V may prove workable in places. Coal VI appears to be thin.

Knox County, West of Range 8 West.

1598. Geography.—This includes about the western two-thirds of the county. In this area the workable coals are deeply buried, and the few outcrops are principally in Divisions VIII and IX. Most of this area is bottom land, or approaching the level drift topography further north.

As coal is worked at only one point, the data consist almost entirely of wells and outcrop sections, and may be discussed geographically.

1599. DETAILED GEOLOGY.—Section at Oaktown. (Obtained after report went to printer.)

	Ft.	In.
Surface	30	0
Sandstone	17	4
COAL	0	4
Fire-clay, 2 ft. 6 in.; limestone, 3 ft. 4 in.; fire-clay, 10 ft. 6 in.; shale and iron ore, 13 ft. 10 in.	30	2
Black shale and COAL	6	0
Clay shale, 7 ft. 8 in.; gray limestone, 10 ft.; clay shale, 3 ft. 7 in.; fire-clay, 5 ft.; sandstone, 6 ft. 6 in.; gray shale, 2 ft.; limestone, 12 ft.; gray limestone, 4 ft.; sandstone and gravel, 4 ft. 2 in.; sandstone, 2 ft. 4 in.; limestone, 1 ft. 5 in.; gray limestone, 7 ft.; limestone, 1 ft. 5 in.; shale and iron ore, 6 ft. 7 in.; limestone, 1 ft. 8 in.; clay shale, 9 ft. 8 in.; iron ore, 1 ft. 2 in.; clay shale, 1 ft. 8 in.; blue limestone, 6 ft.; clay shale, 8 ft. 6 in.; gray limestone, 12 ft. 8 in.; gray shale, 5 ft. 6 in.; limestone, 9 ft.; gray shale, 23 ft.	152	6
	236	4

The limestones and some of the other strata in this section are doubtless in error. It should have been continued at least 50 ft. further to have found Coal VI.

The following sections are given by Mr. Collett:

1600. SECTION 669. SECTION AT FORT KNOX HILL.—Surveys 51 and 52, from borings by Mr. T. A. Kirkoff. (J. C., p. 333.)

	Ft.	In.
1. Soil and sand	16	0
2. Sandstone	45	0
3. Crevice	0	6
4. Clay shale	58	0
5. Sandstone	0	11

The following bore by Mr. Beard commences near the bottom of the above on the north side of Marie creek east of the E. & T. H. R. R.:

1601. SECTION 670. SECTION AT MARIE CREEK.—Sec. 24-4-10. (J. C., p. 333.)

	Ft.	In.
1. COAL VIII? or VIIIa and black shale	1	6
2. Clay shale	20	0
3. Black shale	9	0
4. Gray shale	8	0
5. Sandstone, laminated	42	0
6. Clay shale and clay	16	0

A boring a mile south of Vincennes showed the following:

1602. SECTION 671. SECTION IN DR. PATTON'S WELL.—1 mi. south of Vincennes. (J. C., p. 334.)

	Ft.	In.
1. Surface soil	7	0
2. Soft sandstone	40	0
3. COAL VIII or VIIIa	1	0
4. Fire-clay	3	0
5. Hard stone (limestone?)	3	0

A well on Mr. Fay's place, near Sugar-loaf mound, gave:

1603. SECTION 672. SECTION IN FAY'S WELL.—S. E. of Vincennes. (J. C., p. 335.)

	Ft.	In.
1. Sand	10	0
2. Soft sandstone	65	0
3. Gray shale	9	0
4. Blue limestone	8	0

A section of a well on Dr. Mantel's place, east of Vincennes, on upper prairie survey No. 10, gave as follows:

1604. SECTION 673. SECTION IN DR. MANTEL'S WELL.—(J. C., p. 335.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface soil, Vincennes plain	3	0	..	..	3	0
2. Merom rock, sandstone	45	0	..	..	48	0
3. COAL VIIIb?	0	3	0	3	48	3
4. Sandstone	2	6	..	..	50	9
5. Soft clay shale	14	8	17	2	65	5
6. COAL VIIIa	0	2	0	2	65	7
7. Clay shale	15	0	..	..	80	7
9. Sandstone	10	0	..	..	90	7
10. Soft stone	..	10	..	..	91	5
11. Hard limestone	10	5	..	..	101	10
12. Black shale	5	0	..	..	106	10
13. Soft stone	18	0	..	..	124	10
14. Sandstone	50	5	..	..	175	3
15. Sandstone, soft	10	3	119	11	185	6
16. COAL VIII?	0	8	0	8	186	2
17. Fire-clay	2	10	..	..	189	0

The following section gives the strata outcropping at Bunker Hill, in Secs. 28 and 32-3-10, and found in a neighboring shaft and boring, as given by Mr. Thomas Carr:

1605. SECTION 674. SECTION AT BUNKER HILL.—Sec. 28-3-10. (J. C., p. 336.)

		Ft.	In.	Ft.	In.
1.	Slope	30	0	30	0
2.	Red sandstone, Merom rock	22	0	52	0
3.	Sandy ironstones in shale	3	0	55	0
4.	Black sheety shale	5	0	60	0
5.	Gray clay shale	2	0	62	0
6.	Dark bituminous shale	4	0	66	0
	Top of shaft 4 ft. above water.				
7.	Soft sandstone	7	0	78	0
9.	Dark shale	4	0	82	0
10.	Soft dark limestone	2	0	84	0
11.	Fire-clay	0	6	84	6
12.	Flaggy limestone or siliceous shale	11	0	95	6
13.	Sandy shale	6	0	101	6
14.	Dark shale	5	0	106	6
15.	Gray limestone	2	0	108	6
16.	Calcareous shale	1	6	110	0
17.	COAL	..	11	110	11
18.	Fire-clay	3	6	114	5
19.	Sand rock, compact	7	0	121	5
20.	Gray shale	8	0	129	5
21.	Sandstone	3	0	132	5
22.	Dark soft limestone	1	6	133	11
23.	Sandstone	5	0	138	11
24.	Soft gray limestone	8	0	146	11
25.	Dark gray shale	10	0	156	11
26.	Clay shale	..	6	157	5
27.	COAL parting	..	1	157	6
28.	Clay shale	1	6	159	0
29.	Hard limestone	2	0	160	0
30.	Sandstone	8	0	169	0

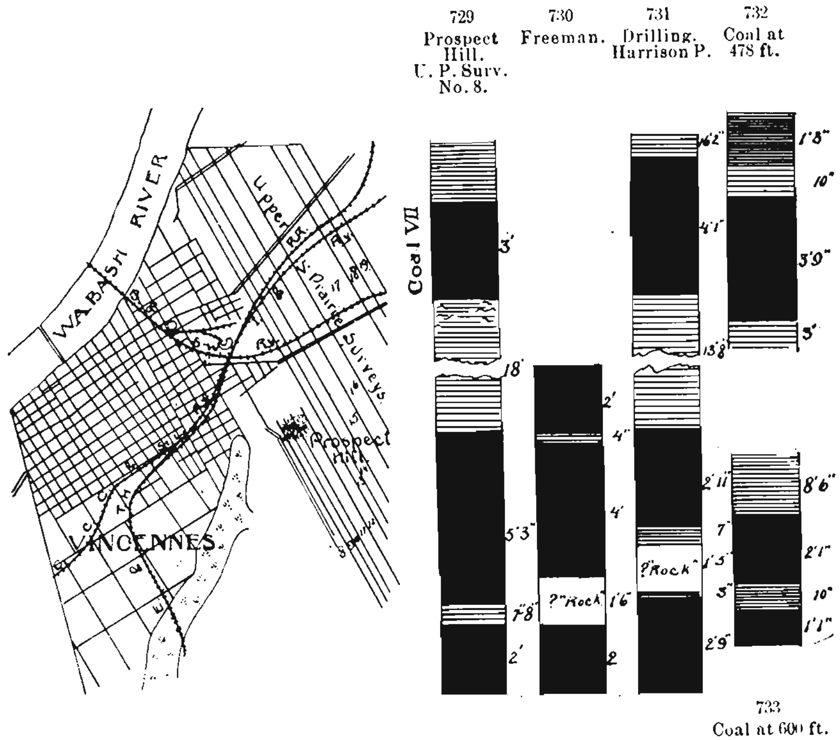
1606. SECTION 675. SECTION AT EARLE'S MILL.—3 mi. south of east of Purcell station. (J. C., p. 339.)

		Ft.	In.
1.	Red sandstone	4	0
2.	Shelly sandstone	8	0
3.	Black shale	2	6
4.	COAL, rash	..	3
5.	Fire-clay	3	0
6.	Sandstone and covered to creek	30	0

1607. In Part 1, p. 35, is given the record of a deep well at Harrison's park in Vincennes. It need not be repeated here. It showed in part (Fig. 1, Plate XLIX):

	Ft.	In.		Ft.	In.
COAL	0	7	at	238	0
COAL	0	9	at	317	11
COAL VII	4	1	at	382	10
COAL VI?	2	11	at	400	7
COAL VI or V	2	9	at	405	9
COAL	1	9	at	467	1
COAL. (Fig. 732)	3	9	at	478	2
Etc.					

The third coal is the one worked, and is judged to be Coal VII. It is a solid coal of very irregular thickness, varying from 1 ft. 6 in. to 3 ft. 6 in., with an average of about 3 ft. or a little less. (Fig. 729.)



Figs. 728-733. Sketch map and coals about Vincennes. (See also Fig. 1 of Plate XLIX.)

The coal is said to make a good deal of ash, but not to clinker. From 13 to 18 ft. below is a much thicker coal, but so broken up and with such a soft roof as not to be workable. At the Prospect Hill mine this lower bed is reported as follows (Fig. 729):

	Ft.	In.
COAL	5	3
Parting ....7 in. to	..	8
COAL	2	0

At the abandoned shaft the section of this coal was reported as follows (Fig. 730):

	Ft.	In.
COAL	2	0
Shale	..	4
COAL, sulphury	4	0
"Rock" ....14 in. to	1	6
COAL, good	2	0

In the Harrison park drilling this coal shows (Fig. 231):

	Ft.	In.
COAL	2	11
Clay shale	..	7
Hard stone	1	5
Dark shale	..	3
COAL	2	9

If the worked coal is VII, this would naturally be Coal VI. Some question has arisen as to whether this may not be both Coals VI and V, bearing to each other a relation similar to that common in Pike county. If so, the "hardstone" in the Harrison park drilling would represent the limestone commonly overlying Coal V. The space between the double bed and the worked bed was found to consist almost entirely of fire-clay or very soft clay shale, and this was intersected by joints that rendered it almost impossible to keep it up.

Near Emison Mill a bony coal outcrops, overlain by bituminous shale. The Merom sandstone shows in the Wolf hills west of Emison, at Ft. Knox, and at the railroad bridge across Marie creek. It is a massive, coarse-grained sandstone, sometimes white, though often discolored with iron, and frequently cross-bedded. A well at Bruceville went 50 ft. into the Merom sandstone. A boring by Messrs. Witherspoon and Emison, in the valley south of town, gave as follows:

1608. SECTION 676. SECTION AT BRUCEVILLE BORE.—(J. C., p. 356).

	Ft.	In.
1. Soil and drift	20	0
2. Soft red Merom rock	20	0
3. Sandy shale	2	0
4. Hard, ferruginous, sandy, conglomeritic limestone.	2	0
5. Black shale, COAL VIIIa (?)	0	2
6. Fire-clay	1	0
7. Clay shale and sandy shale	20	0
8. Coarse sandstone	8	0
9. Bituminous clay shale	4	0
10. Hard rock (limestone in layers, with partings of shale)	42	10

The coals in Division VIII have been found around Bruceville generally overlain by a cannel-like bituminous shale. One of the coals is reported to reach a thickness of 2 ft. 6 in. east of town and to have formerly been worked a little on the old Denny place, Don. 143, and Willis place, Don. 123; also at the S. Hoffman place, on Don. 183, a mile southwest of Bruceville. The section there, as given by Mr. Collett, is as follows:

SECTION 676*a*. SECTION AT HOFFMAN BANK.—Don. 183. (J. C., p. 357.)

	Ft.	In.
1. Slope	30	0
2. Red and white Merom rock, 18 ft.; (3) sandy shale and iron nodules, 3 ft.; (4) flaggy sandstone, 4 ft.; (5) sandy shale and shaly sandstone, 25 ft.; (6) conglomeritic sandstone, 2 ft. 4 in.; (7) pyritous clay shale, 8 in.	53	0
8. Coal, 8 in.; (9) "cannel slate," 2 ft. 2 in.; (10) coal, caking, 2 in.	3	0
11. Fire-clay	3	0
	89	0

In conclusion, it will be evident that the first workable coal in this area will be Coal VII and that this will be found generally above high water in the White river on the east side of the county or from 400 to 500 ft. above tide, and along the western side of the county will be found at about 400 ft. lower level. Below that will probably be found two workable coal horizons. While in places two, or possibly all three of these coals will be found workable, it seems probable that on the whole there will hardly average one workable coal over the area, if indeed it will do as well as that.

1609. SUMMARY OF COAL OF KNOX COUNTY.—

Divisions contained: IX down.
Coals contained: VIII, VIIIa, VIIIb?, VII, VI, V, etc.

ROUND NUMBER ESTIMATES.

Coal VII.

Worked area	40 acres × av. thickness,	3 ft. ×	1,000 =	120,000 tons.
Workable area ...	100 sq. mi. × "	3 ft. ×	500,000 =	150,000,000 tons.
Unworkable area	400 sq. mi. × "	1½ ft. ×	1,000,000 =	600,000,000 tons.
Total area ...	500 sq. mi.			750,120,000 tons.

Coal VI.

Worked area	160 acres × av. thickness,	4 ft. ×	1,000 =	620,000 tons.
Workable area	200 sq. mi. × "	4 ft. ×	1,500,000 =	400,000,000 tons.
Unworkable area	300 sq. mi. × "	2 ft. ×	1,000,000 =	600,000,000 tons.
Total area	500 sq. mi.			1,000,620,000 tons.

Coal V.

Worked area	5 acres × av. thickness,	4 ft. ×	1,000 =	20,000 tons.
Workable area	100 sq. mi. × "	4 ft. ×	500,000 =	200,000,000 tons.
Unworkable area	400 sq. mi. × "	1½ ft. ×	1,000,000 =	600,000,000 tons.
Total area	500 sq. mi.			800,020,000 tons.

Coals Below Coal V.

Workable area	100 sq. mi. × av. thickness,	4 ft. ×	500,000 =	200,000,000 tons.
Unworkable area	440 sq. mi. × "	10 ft. ×	1,000,000 =	4,400,000,000 tons.
Total area	540 sq. mi.			4,600,000,000 tons.

Number of coals contained: 15.
Greatest thickness recorded: 6 ft.+ Coal VI at Edwardsport.
Area underlain by coal: 540 sq. mi.
Area underlain by workable coal: 300-400 sq. mi.
Estimated total tonnage of coal: 7,000,000,000+.
Estimated total tonnage of coal removed: 760,000.
Estimated total tonnage of workable coal left: 950,000,000+.
Number of mines working ten men or over in operation: 3.
Number of mines working less than ten men in operation: 9.
Total number of mines in operation: 12.
Large mines not in work: 5.
Small mines not in work: 14.
Strippings and outcrops: 66.
Total number of openings to coal: 97.

XXX. ORANGE COUNTY.

1610. References and Field Work.—

1862 (1860). R. Owen, Rep. of Geol. Reconn. Ind., pp. 140-146. No sections showing coal. (R. O.)

1876 (1875). M. N. Elrod, E. S. McIntire, 7th Ann. Rep. Geol. Surv. of Ind., pp. 203-239. Four sections containing coal. (M. N. E. and E. S. M.)

1896 (1895). E. M. Kindle, Dept. of Geol. and Nat. Resa., 20th Ann. Rep., pp. 329-368. Map and numerous sections. Discusses whetstone. (E. M. K.)

1898. E. M. Kindle. Fieldwork for this report. (E. M. K.)

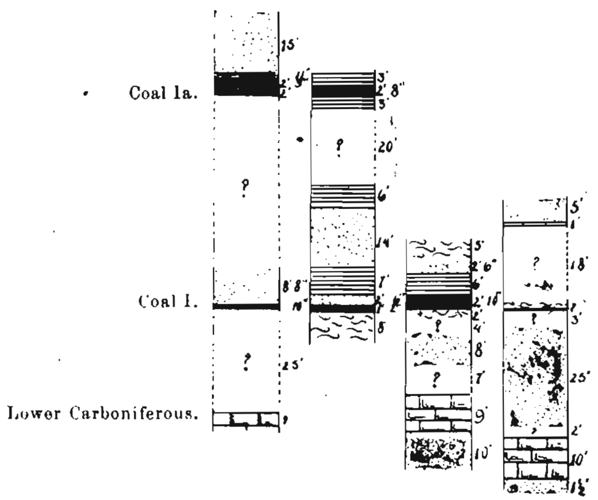
Note.—This report is in large part taken directly from a summary report on the county prepared by Mr. Kindle, and should therefore be considered in the main as his work.

1611. Position, Topography, Drainage and Transportation.—Orange county occupies a place in the second tier of counties north of the Ohio, about seventy-five miles southwest of Indianapolis. Lawrence county forms its northern and Crawford its southern boundary. Washington and Crawford bound it on the east and Martin and Dubois on the west. All of the coal measure rocks of this county lie in the western part of the county, west of range line 1 west, comprising portions of Orangeville, Northwest, French Lick and Jackson townships.

The western part of Orange is very rugged and broken. High and steep ridges, with narrow, winding valleys, are the prevailing surface features. Mt. Arie, near West Baden, and Burtin Hill, southwest of French Lick, are two of the highest points in this region. Two streams, the Patoka river and Lost river, with their tributaries, drain the county.

A branch if the C., I. & L. Ry. terminates at French Lick. Three or four trains per day are running during the summer season between French Lick and the main line, for the accommodation of the many visitors at West Baden and French Lick Springs.

1612. Stratigraphy.—The lower carboniferous limestone forms the bottoms of the valleys throughout the western tier of townships in Orange county and runs well up toward the tops of the ridges over a part of this area. The Mansfield sandstone division, or Division I, with Coals I and Ia, and their accompanying shales and sandstones, comprise the upper portion of most of the ridges. One and sometimes both of these coals frequently appear to be wanting. The following sections taken in the vicinity of Osborn's whetstone quarry, T. 2 N., R. 2 W., Sec. 32, S. W. ¼, shows the relations of these coals:



734 Osborn. Sec. 32, 2 N.-2 W. 735 Braxton. Sec. 31, 2 N.-2 W. 736 Nation. Sec. 29, 3 N.-2 W. 737 Sec. 7, 1 S.-2 W.

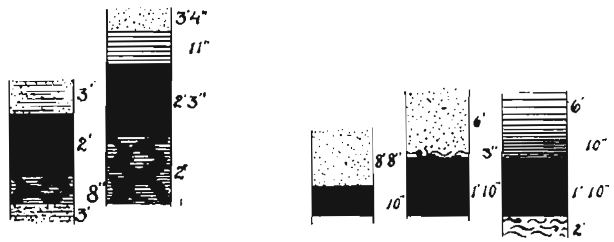
Figs. 734-737. Columnar sections in Orange county.

1613. Section 678. Section Near Osborn's Quarry.—S. W. ¼ Sec. 32, 2 N., 2 W. (E. M. K., Fig. 734):

		Ft.	In.
1.	Massive sandstone	15	0
2.	Bluish-gray sandy shale	..	11
3.	COAL Ia	2	3
4.	Bone COAL Ia ....18 in. to	2	0
5.	Shale and fire-clay	..	..
6.	Whetstone "grit," heavy-bedded ....3 ft. to	6	0
7.	Whetstone "grit," thin-bedded ....6 in. to	1	2
8.	Whetstone "grit," heavy-bedded	1	6
9.	COAL I ....6 in. to	..	10
10.	Covered	25	0
11.	Kaskaskia limestone.		

1614. Section 679. Section (Connected) at Braxton's Quarry.—S. E. ¼ Sec. 31-2 N., 2 W. E. M. K., Fig. 735.)

		Ft.	In.
1.	Covered	20	0
2.	Bluish-gray sandy shale, with sandstone	3	0
3.	COAL Ia—Coal, 2 ft. 0 in.; bone, 8 in.	2	8
4.	Sandy shale	3	0
5.	Covered	20	0
6.	Soft gray clay shale	6	0
7.	Whetstone strata	14	0
8.	Shale	7	0
9.	Whetstone	2	6
10.	COAL I ....1 ft. to	1	2
11.	Fire-clay ....7 ft. to	8	0



738 Lynch. 739 Nelson. 740 Osborn. 741 Pruitt. Sec. 23, 3 N.-2 E. 742 Nation. Sec. 29, 3 N.-2 W.

Figs. 738-739. Sections of Coal Ia, Orange county.
Figs. 740-742. Sections of Coal I, Orange county.

Coal Ia seems to be entirely absent in township 2 N. 2 W., from the whetstone quarries to Scarlet Chapel. Coal I, which lies at the base of the whetstone horizon, is generally present in this township, and is of workable thickness at a few localities. It has been traced along the ridge from the quarries nearly to New Antioch. The coal is more persistent than the whetstone beds; the latter are generally represented west of Bonds P. O. by sandy shale. Nation's coal bank shows the greatest thickness of this coal that has been observed.

1615. Section 680. Section at Nation's Coal Mine.—N. W. ¼, Sec. 29-3 N., 2 W. (E. M. K., Figs. 736, 742.)

		Ft.	In.
1.	Surface clay	5	0
2.	Massive hard sandstone	2	6
3.	Drab-colored shale, full of ferns and lepidodendra.	6	0

		Ft.	In.
4.	Bone COAL I	..	10
5.	Block Coal I	1	10
6.	Fire-clay	2+	0
7.	Covered	4	0
8.	Massive buff, coarse sandstone	8	0
9.	Covered	7	0
10.	Kaskaskia limestone	9	0
11.	Kaskaskia sandstone	10	0

Neither Coal I nor Coal Ia occurs east of French Lick creek. The different members of the Kaskaskia group, as they are generally developed in this region, are shown in the following section from Foot's spring, T. 1 N., R. 2 W., Sec. 11, S. W. ¼:

1616. SECTION 681. SECTION AT FOOT'S SPRING.—S. W. ¼, Sec. 11-1 N., 2 W.

		Ft.
1.	Slope, with Mansfield sandstone fragments	18
2.	Limestone	15
3.	Sandstone	35
4.	Limestone	16
5.	Sandstone	30
6.	Limestone	6
7.	Blue shale	3
8.	Limestone	5

One or two thin beds of coal occur near drainage level at many localities in this region. Considerable labor and money have been expended in attempting to develop this coal. This coal where noted belongs near the middle of the Kaskaskia. It is usually 2 or 3 in. thick, seldom if ever exceeding six inches, and is nowhere of workable thickness. It has been noticed outcropping at the following localities: One-half mile southeast of Scarlet Chapel, 3 N., 2 W., in the bed of branch; on the north bank of Lost river, on Geo. Pierce's land, Sec. 17, 2 N., 2 W.; below Young's Creek P. O., on Young's creek; in the bed of the branch at French Lick, just above Claxton's hotel. At the last locality the section exposed is as follows:

1617. SECTION 682. SECTION AT FRENCH LICK.—150 yds. above Claxton's hotel, Sec. 3-1 N., 2 W. (E. M. K.)

		Ft.	In.
1.	Sandstone (Lower Kaskaskia)	10	0
2.	Limestone	7	0
3.	Dark-gray shale, with plant fossils	..	8
4.	Covered	1	0
5.	Buff, shelly sandstone and shale	1	6

		Ft.	In.
6.	Greenish sandstone	..	2
7.	COAL	..	1½
8.	Bone COAL	..	3
9.	Dark-blue soft shale	..	3
10.	Dark bluish-gray hard sandstone.		

1618. DISTRIBUTION AND DETAILS OF COAL.—Coal has been dug for local use at a number of localities in Northwest township (3 N., 2 W., and 2 N., 2 W.). Coal I is found from 10 to 40 ft. below the summit of the ridge, which extends from near the eastern edge of this township to the Martin county line, and thence south to Lost river. It is nearly everywhere too thin to work, except in a small way by stripping. Only one bank is in operation at present in the county north of Lost river. This is the Samuel Nation bank, Sec. 29, of T. 3 N., 2 W.

The section at this point was given above. (See ¶ 1615, Sect. 680.) The coal shows a thickness of 1 ft. 10 in., overlain by 10 in. of bone coal. The roof is a drab colored shale, 6 ft. thick, and is not good, having to be planked as far as the entry is driven. The under clay is at least 2 ft. thick. The coal is said to be good, burning to a white ash. It is here only 20-25 ft. below the top of the ridge, which is about 180 yds. wide at the level of the coal. The Kaskaskia limestone outcrops about 25 ft. below.

An entry has been started on Wm. Tulliver's land, three-quarters of a mile northeast of Nation's bank, 3 N., 2 W., Sec. 21, but no coal has been taken out yet.

The coal has barely been exposed. The roof is a gray sandy shale, evidently poor. The section here shows as follows:

1619. SECTION 683. SECTION AT WM. TULLIVER'S BANK.—S. E. ¼ Sec. 21-3-2. (E. M. K.)

		Ft.	In.
1.	Surface to top of hill	20	0
2.	Gray sandy shale	3	0
3.	COAL I	?	?
4.	Fire-clay	2	0
5.	Covered	2	0
6.	Coarse sandstone	1	0
7.	Covered	3	0
8.	Massive sandstone	6	0
9.	Kaskaskia limestone	5	0

The coal here lies 40 to 50 ft. below the highest part of the ridge.

An entry was being driven at the time of my visit at C. J. Pruitt's old whetstone quarry, T. 3 N., R. 2 E., Sec. 23. The coal here, including the brash, is 22 in. thick. The section here shows as follows:

1620. SECTION 684. SECTION AT C. J. PRUITT'S QUARRY AND MINE.—S. E. ½ of Sec. 23-3-2. (E. M. K., Fig. 741.)

		Ft.	In.
1.	Surface.		
2.	Whetstone, worked	4	0
3.	Whetstone in 6-in. to 1-ft. layers, not worked	2	0
4.	Gray fire-clay ..2 in. to	..	3
5.	COAL I	1	10
6.	Gray fire-clay	..	4+

This is said to be a good blacksmith coal, but is too thin to work.

A small amount of coal has been dug at Dr. Ritter's whetstone quarry, T. 3 N., R. 2 W., S. W. ¼ Sec. 32.

South of Lost river, Coal I has never been found thick enough to work. Two miles northwest of French Lick, Coal Ia was opened by an entry at Lynch's about a year ago. The entry has been driven but a few feet, and it will probably not be continued, owing to the thinness of the good coal.

The section here shows (Sect. 685, E. M. K., Fig. 738):

		Ft.	In.
1.	Surface clay	8	0
2.	Blue-gray sandy shale, with occasional strata of coarse sandstone	3	0
3.	COAL Ia—Coal, 2 ft. 0 in.; bone, 8 in	2	8
4.	Sandy gray shale	3	0+

The coal is a semi-caking coal, making some clinker. There is a streak of sulphur 4 in. from the top. The coal lies 20 ft. below the top of the hill.

At I. V. Nelson's the same bed has been stripped and a few hundred bushels taken out. Coal here is 27 in. thick.

The section here shows (Sect. 686, E. M. K., Fig. 739):

		Ft.	In.
1.	Surface clay ..4 ft. to	6	0
2.	Sandstone, buff, soft	3	4
3.	Bluish-gray sandy shale	..	11
4.	COAL Ia—Coal, 2 ft. 3 in.; bone, 1 ft. 6 in. to 2 ft. 0 in.	4	0
5.	Fire-clay ..8 ft. to	10	0

The coal is said to cake some and to clinker some and to be a good house coal, but not a good blacksmith coal. It carries a good deal of sulphur in seams ¼ in. or less in thickness. The coal can probably be stripped here for several hundred yards to the north.

On Mr. Dillard's land, one mile west of Obi, a drift has been opened to the coal and a hundred bushels taken out.

A few inches of coal are noticed in the N. W. ¼ of Sec. 7-1 S., 2 W., 60 or 70 ft. below the top of the hill. A connected section near this gave as follows (Sect. 687, E. M. K.):

		Ft.
1.	Surface	20
2.	Massive sandstone, false bedded and soft	5
3.	Blue shale	1+
4.	Covered	18
5.	Fire-clay	1+
6.	COAL I	?
7.	Covered	3
8.	Massive sandstone	25
9.	Covered	2
10.	Kaskaskia limestone	10
11.	Soft gray shelly sandstone	1½

1621. SUMMARY OF COAL OF ORANGE COUNTY, BY E. M. KINDLE.—

Divisions contained, I.
Coals contained, I and Ia.

ROUND NUMBER ESTIMATES.

Coal I.

Worked area	$\frac{1}{10}$ acre ×	av. thickness,	2 ft. × 1,000 =	200 tons.
Workable area	50 acres ×	"	2 ft. × 1,000 =	100,000 tons.
Unworkable area	300 acres ×	"	10 in. × 100 =	300,000 tons.
Total area	350 acres			400,000 tons.

Coal Ia.

Workable area	50 acres ×	av. thickness,	2 ft. × 1,000 =	100,000 tons.
Unworkable area	400 acres ×	"	11 in. × 100 =	440,000 tons.
Total	400 acres			440,000 tons.

Number of coals contained, 2.
Greatest thickness recorded, 2 ft. 8 in. Coal I (including bone) at Nation's.
Area underlain by coal, 1 sq. mi.
Area underlain by workable coal, 80 acres.

Estimated total tonnage of coal, 840,000.
Estimated total tonnage of coal removed, 200.
Estimated total tonnage of workable coal left, 200,000.
Number of mines working ten men or over in operation, 0.
Number of mines working less than ten men in operation, 1.
Total number of mines in operation, 1.
Large mines not in work, 0.
Small mines not in work, 2.
Strippings and outcrops, 13.
Total number of openings to coal, 16.

XXXI. CRAWFORD COUNTY.

1622. REFERENCES AND FIELD WORK.—

1862 (1860). R. Owen, Rep. of Geol. Reconn. Ind., pp. 149-159. Notes Kaskaskia coal. (R. O.)

1872 (1872). E. T. Cox, 3d and 4th Ann. Rep. Geol. Surv. of Ind., pp. 145-156. Does not treat of coal measure area.

1879 (1876-78). John Collett, 8th, 9th and 10th Ann. Reps. Geol. Surv. of Ind., pp. 423-522. Detailed description, map and numerous sections; only a few show coal, and the coal measures but briefly treated. (J. C.)

1898. E. M. Kindle, field work for this report. (E. M. K.)

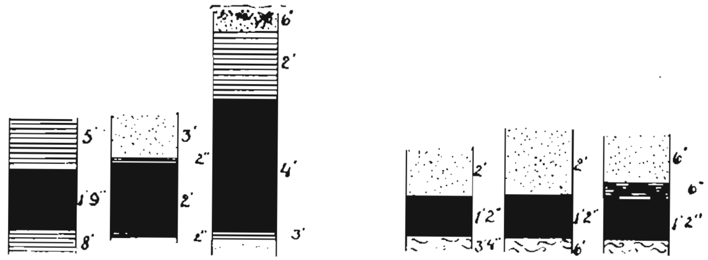
NOTE.—This report has been largely prepared directly from Mr. Kindle's summary report on the county.

1623. POSITION, TOPOGRAPHY, DRAINAGE AND TRANSPORTATION.—Crawford county is bounded on the north by Orange and Washington counties and on the east by Blue river, which separates it from Harrison; on the south by the Ohio river and Perry county, and on the west by Dubois and Perry counties. The coal measure rocks are confined to the western portion of the county; no trace of Coals I, Ia or II occurs east of the second principal meridian which crosses the Air Line R. R. just east of English. Only that portion of the county lying west of this meridian will therefore be considered in discussing the coal. This includes T.'s 2 S., 1 W.; 2. S., 2 W.; 3 S., 1 W., and the northern third of 3 S., 2 W., and the south tier of sections of T.'s 1 S., 1 W., and 1 S., 2 W. These comprise the civil townships of Patoka, Johnson, Union and a portion of Stirling.

The topography of this region is similar to that of western Orange. Hills and ridges, with occasional table-lands of limited extent, reach an elevation of from 300 to 450 ft. above the Ohio. According to Collett, Chestnut Oak ridge, east of Marietta, in Secs. 22 and 27, has an elevation of 570 ft. above the Ohio. At the Dubois county line the railroad is 397 ft. above low water in the Ohio.

A high table-land, with many dependent ridges and a rather broken surface, extends from near English to the county line, separating the drainage system of the Patoka on the north from that of the Little Blue and Anderson rivers to the south. These streams have narrow, deep valleys, and carry the drainage of the region to the Wabash and to the Ohio rivers.

The Air Line Railroad crosses the county from east to west, affording excellent transportation facilities for the northern part of the county. The Ohio forms about 18 miles of the southern boundary and affords means of transportation for those parts of the county not convenient to the railroad.



743 Tunnel. Sec. 21-2-1. 744 Smith. Sec. 31-2-1. 745 Laswell. Sec. 31-3-1. 746 Sec. 16-2-2. 747 Graham's. Sec. 31-2-1. 748 Nelson's. Sec. 9-2-2.

Figs. 743-745. Sections of Coal II, Crawford county.
Figs. 746-748. Sections of Coal Ia, Crawford county.

1624. STRATIGRAPHY.—The Kaskaskia limestone and shales occur in nearly all the valleys, and toward the east constitute the major portion of the hills. The Kaskaskia is much more shaly as a rule in this county than further north. The upper 20 to 40 ft. is usually mainly laminated blue clay shale, with one or more thin beds of limestone toward the top. The Mansfield sandstone and the shales and sandstones associated with the horizons of Coals Ia and II comprise most of the rocks above drainage level in the western part of the area. The following is a representative section taken in the S. E. $\frac{1}{4}$ of Sec. 16-2 S., 2 W.:

1625. SECTION 688. SECTION IN S. E. ¼, SEC. 16-2-2. (E. M. K., Fig. 746):

		Ft.	In.
1.	Slope to top of hill covered	25	0
2.	Black shale (in spring) level of coal II?	?	0
3.	Covered	20	0
4.	Shelly gray sandstone, with plants	2	0
5.	COAL Ia	1	2
6.	Hard sandy fire-clay	3	4
7.	Blue shale	1	8
8.	Massive sandstone	20	0
9.	Blue clay shale (and Coal I not seen)	30	0
10.	Massive sandstone	15	0
11.	Clay shale	6?	0
12.	Kaskaskia limestone	1	0
	Level of creek.		

At the tunnel two miles east of Taswell, the section would indicate that either Coal II has two parts at this place or that Ia and II have approached very close together. The section is as follows:

1626. SECTION 689. SECTION AT RAILROAD TUNNEL.—Sec. 21-2-1. (E. M. K., Fig. 743.)

		Ft.	In.
1.	Surface clay	6	0
2.	Blue clay shale	5	0
3.	COAL II?	1	9
4.	Blue clay shale	8	0
5.	COAL Ia?	1	6
6.	Blue clay and shale....3 ft. to	5	0
7.	Massive sandstone....2 ft. to	6	0
8.	Blue clay shale	13	0

At Smith's bank, N. W. ¼ Sec. 31-2 S., 1 W., Coal II is mined. The following section is exposed (Sect. 690, E. M. K., Fig. 744):

		Ft.	In.
1.	Surface clay	6	0
2.	Sandstone thin bedded	3	0
3.	Shale	..	2
4.	COAL II....1 ft. 6 in. to	2	2

The coal here runs out to the northwest in a short distance. About 100 yds. northwest the fire-clay underlying the coal at the bank is overlain by a massive sandstone 20 ft. thick, with no trace of the coal between.

Coal Ia has been worked a little a half mile southeast of Wickliffe in Sec. 9. The following section is exposed (Sect. 691, E. M. K., Fig. 748):

		Ft.	In.
1.	Massive sandstone	10	0
2.	Gray sandy shale and sandstone	6	0
3.	COAL Ia—Bone coal, 6 in.; coal, 1 ft. 3 in	1	9
	Hard fire-clay	?	?

Coal I has not been certainly recognized in this region. A bed which is said to be sometimes exposed under the sandstone in the bed of the branch north of Eckerty in Sec. 22, may belong to this horizon.

The Mansfield sandstone outcrops in conspicuous ledges at many localities in this region. The cliffs are especially prominent in Sec. 1-2-2. Bold cliffs 25 to 35 ft. high wall the valleys at frequent intervals. The sandstone here frequently has irregular bedding, and thin, wavy bands of iron often give a variegated appearance to the face of the cliffs. Southeast of Eckerty good ledges of the Mansfield occur along many of the streams. The following section is taken in the S. W. ¼ of Sec. 34-2-2, near the head of one branch of Anderson river (Sect. 692, E. M. K.):

		Ft.	In.
1.	Massive sandstone	20	0
2.	Covered	30	0
3.	Greenish-blue shale	10+	0
4.	Gray crystalline limestone	5	6
5.	Blue shale	..	10+

The following section from the roadside in the S. W. ¼ of Sec. 3-2-2 will indicate the shaly character of the upper Kaskaskia as generally seen in this county (Sect. 693, E. M. K.):

		Ft.	In.
1.	Blue clay shale	15+	0
2.	Hard blue Kaskaskia limestone	..	8
3.	Blue clay shale	2	0
4.	Shelly limestone	..	10
5.	Blue clay shale	4	0
6.	Hard blue limestone	4	0
7.	Shelly sandstone	5	0
8.	Blue clay shale (fossiliferous)	6	0
9.	Limestone.		
	Drainage level.		

One or more thin coal beds are found at several localities at a horizon somewhat lower than the base of the above section. The Kaskaskia coal outcrops in the bed of the creek a half mile above English, also below English, near the railroad cut. The coal indicated on Collett's map of Crawford county, southwest of Magnolia, belongs at this horizon.

1627. DISTRIBUTION AND DETAILS OF COAL.—Only a few localities are known in Crawford county, where the coal is sufficiently thick to be worked profitably. These all occur in the hills southeast of Eckerty from one to three miles. Coal II, which here lies near the summits of the hills, is in places thick enough to justify mining for local use. As shown on the map, Coal II is confined to the top of the dividing ridge along which the Air Line runs, and to the principal spurs which project from that ridge.

1628. DISTRIBUTION IN T. 2 S., R. 2 W.—As shown on the map, the coal measures are confined to the west side of Little Blue river. Division II caps the ridge which runs from Taswell almost to English and some projecting points from the ridges north and south of Taswell. Division I is found just below in this ridge and its spurs, and caps the higher ridges over the rest of the area west of Little Blue river.

At Smith's bank, N. W. $\frac{1}{4}$ Sec. 31, 2 S., 1 W., the coal averages 2 ft. thick. It ranges from 22 to 26 in. in thickness. It is the semi-block, with a 3 in. band of harder caking coal in the center, which tends to break up into small pieces. The roof is sandstone, with 1 to 2 in. of draw slate. There are 2 in. of black shale at the bottom. Sulphur in coal occurs in nodules, generally small. Some rolls were met with. The section here was given above, ¶1626. The coal lies only about 15 ft. below the general level of the top of the ridge. As stated above, 100 yds. northwest the coal has disappeared and the overlying sandstone, here 20 ft. thick, lies directly on the fire-clay.

Two years ago three or four thousand bushels were taken from this bank and hauled to Eckerty.

On Martha Mock's land, $\frac{1}{2}$ mi. south of Taswell, coal 2 ft. thick was struck in deepening a spring.

The section at the tunnel in Sec. 21 was given above. The top of the section as given is 107 ft. from the railway track. The upper of the two coals there (thought to be Coal II) is a block coal, of which the top 6 in. is shaly and the rest good. Half a mile west of the tunnel there shows in a railway cut an interesting section showing the relation not infrequently found between sandstones and shales in the coal measures. (See Fig. 749.)

Coal is reported in a well on the McDonald place, in Sec. 5. Kaskaskia coals were found about English as follows: Half a mile north-west, 2 in. thick, accompanied by a very fossiliferous shale, and southeast of English, in Sec. 30, 2 S., 1 E., 3 or 4 in. thick; on the Millard Shield place, and about the same on the Thos. Cunningham farm.

1629. DISTRIBUTION IN T. 3 S., R. 1 W.—Division I is found capping narrow ridges in Secs. 15, 16, 17, 22, 27 and 28. Coal is reported in the area only at one point, and that in a well in the N. E. of S. E. of Sec. 17, on Mrs. Nash's farm. Division I appears again in the ridges west of the West Fork of the Little Blue river, along the edge of the township, being overlain there by Division II.

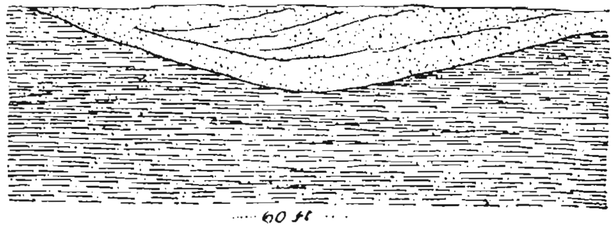


Fig. 749. Section in railroad cut 1½ mi. east of Taswell. From sketch by E. M. Kindle.

1630. At John Laswell's bank, S. E. of S. E., Sec. 31, 3 S., 1 W., the coal is said to run from $2\frac{1}{2}$ ft. to 4 ft. in thickness. The coal has not been worked recently here, and the bank has caved, concealing the coal at the time of visit. The top of the coal for about 6 in. is soft. Over the coal is 2 ft. of blue clay shale, then 6 ft. of shelly sandstone and shale. Under the coal is 3 in. of shale, then sandstone (Fig. 745). The area of coal is very limited, as it lies within 10 to 15 ft. of average height of top of ridge.

1631. DISTRIBUTION IN T. 2 S., R. 2 W., AND T. 3 S., R. 2 W. (PART IN CRAWFORD COUNTY).—Coal II underlies a narrow strip along the ridge, which is followed in the main by the railroad, and still narrower strips out some of the ridges which project from the main ridge; also along the ridge in the north part of T. 3 S., R. 2 W.

Coal was formerly dug from Coal Ia at a number of localities where the bed showed 12 to 14 in. of good coal for the use of blacksmiths. Since the building of the Air Line road, good coal can be more cheaply obtained from mines outside the county, and stripping this vein has been abandoned. At Cyrus Gresham's, two miles southeast of Eckerty, considerable coal was formerly dug for blacksmithing. The section there is as follows (Sect. 694, E. M. K., Fig. 747):

		Ft.	In.
1.	Surface	2	0
2.	Hard yellowish-brown sandstone	1	0
3.	Gray shelly sandstone and thin carbonaceous streaks	2	0
4.	COAL Ia? ....10 in. to	1	2
5.	Blue fire-clay	6	0
6.	COAL I?	..	8
7.	Fire-clay	..	8

The coal is 50-60 ft. below the tops of the ridges.

Coal has also been dug at two or three places on the Joseph Adkins land, on the east side of Sec. 16, 2 S., 2 W. The coal is reported 14 in. thick, overlain by 2 ft. of shelly sandstone and underlain by 18 in. of hard sandy fire-clay. The coal lies about 60 ft. below the highest part of ridge and 10 ft. above the creek valley. A section down the ravine here showed (Sect. 695, E. M. K.):

		Ft.	In.
1.	Shaly sandstone with plants	2	0
2.	COAL Ia	1	2
3.	Sandy fire-clay	3	4
4.	Blue shale	1	8
5.	Massive sandstone	20	0
6.	Clay shale and Coal I (not seen)	30	0
7.	Massive sandstone	15	0
8.	Clay shale	6	0
9.	Kaskaskia limestone	1	0
	Bed of creek.		

Three feet of coal are reported to have been struck in Dr. Hazlewood's well at Eckerty.

North of the water tank at Eckerty, 2½ in. of coal is exposed, overlain by 5 ft. of shelly gray sandstone and underlain by 4 ft. of sandy fire-clay. Coal is also reported as struck at Mr. W. H. Ott's, south of Eckerty, about 3 ft. thick, at a depth of 75 ft., and a similar thickness at Mr. Schnell's, in Eckerty. A mile east of Eckerty, it is said coal was formerly mined on the Harrison Farmer place, now Morgan, the coal being 10 to 14 in. thick, overlain by 3 ft. of hard blue shale, and to have been of good quality.

Coal was also struck in a well at Riceville, put down by Benton Reed. Both of these wells probably encountered Coal Ia.

Small amounts of coal have been dug at the following localities: On Wesley King's land, ½ mi. south of Riceville; on Peter Newton's land, ½ mi. south of Boston, and in the N. E. of N. W. ¼ of Sec. 9, 2 S., 2 W., on Lewis Nelson's. The section here showed (Sect. 696, E. M. K., Fig. 748):

		Ft.	In.
1.	Massive sandstone	10	0
2.	Gray sandy shale and sandstone	6	0
3.	COAL Ia—Bone, 0 ft. 6 in.; coal, 1 ft. 2 in	1	8
4.	Hard fire-clay.		

The coal appears to be of fair quality, with block slips 10 to 20 in. apart. It lies about 80 ft. above drainage.

1632. SUMMARY.—Two divisions of the coal measures are represented in Crawford county, the Mansfield sandstone, with Coals I and Ia, and Division II, with Coal II.

No coal has been mined in the county during the last year. Neither of the seams is of workable thickness except over very limited areas. It is not likely that the total area containing coal that can ever be profitably mined will exceed five hundred acres. There are probably 7,000 acres underlain by coal from 5 to 15 in. thick.

The greatest thickness of coal there is in Crawford county, so far as known, is 4 ft., which is reported at John Laswell's bank, Sec. 6, 3 S., 1 W. It probably does not average more than 14 in. The greatest thickness which has been noted for Coal Ia is at Nelson's, ½ mi. southeast of Wickliffe, where it measures 20 in., including 6 in. of brash.

This bed will probably not average more than 10 in.

1633. SUMMARY OF COAL FOR CRAWFORD COUNTY, BY MR. KINDLE.—

Divisions contained, I and II.
Coals contained, I, Ia and II.

ROUND NUMBER ESTIMATES.

Coals I, Ia and II.

Workable area	200 acres	× av. thickness, 2 ft.	× 1,000 =	400,000 tons.
Unworkable area	11 sq. mi. ×	" 10 in.	× 80,000 =	8,800,000 tons.
Total area	11 sq. mi			9,200,000 tons.

Number of coals contained, 3.
Greatest thickness recorded, 4 ft.
Average of township averages, 10 in.
Area underlain by coal, 12 sq. mi.
Area underlain by workable coal, 200 acres.
Estimated total tonnage of coal, 9,200,000.
Estimated total tonnage of coal removed, none ?
Estimated total tonnage of workable coal left, 400,000.

Number of mines working ten men or over in operation, 0.
Number of mines working less than ten men in operation, 0.
Total number of mines in operation, 0.
Large mines not in work, 0.
Small mines not in work, 0.
Strippings and outcrops, 14.
Total number of openings to coal, 14.

XXXII. DUBOIS COUNTY.

By J. A. Price.*

1634. REFERENCES AND FIELD WORK.—

1862 (1859-60). Richard Owen, Rep. of Geol. Reconn. of Ind., pp. 179-180. Three analyses.

1862 (1859-60). Leo Lesquereux, same, pp. 313-315.

1871 (1870). E. T. Cox, 2d Geol. Rep. of Ind., pp. 141-143. One columnar section.

1872 (1871-72). John Collett, 3d and 4th Ann. Reps. Geol. Surv. of Ind., pp. 192-237. Detailed report, map, fifteen columnar sections, twenty-four coal analyses by Mr. Cox, pp. 38-46.

1896 (1895). W. S. Blatchley, Ind. Dep. Geol. and Nat. Reso., 20th Ann. Rep., pp. 106-110. One columnar section; discusses clay and shales, pp. 312-314, sandstones.

1896 (1895). T. C. Hopkins, same, pp. 312-314.

1898, April, May. J. A. Price, field work for this report.

1898, May. E. M. Kindle, field work in T. 1 N., R. 3 W.

Section 1. Geography.

1635. LOCATION.—Dubois county is located in the southwest part of the State, and is bounded on the north by Daviess and Martin counties, on the east by Orange, Crawford and Perry counties, on the south by Perry, Spencer and Warrick counties, and on the west by Warrick and Pike counties.

1636. EXTENT.—The county has an area of about 426 sq. mi., having a length from north to south of 22 mi. and from east to west of 21 mi. With the exception of the south half of township 3 south

* Field work and report by Mr. Price; see Introduction.

of 3 west, which is included in Perry county, and the part of townships 1 north of 4, 5 and 6 west, north of White river, the county is 22 mi. long and 21 mi. wide. The center of the county is about 2 mi. southeast of Jasper, the county seat. It includes all of townships 1 and 2 south of 3, 4 and 5 west; 3 south of 4 and 5 west; the southern half of 3 south of 3 west; the eastern half of 1, 2 and 3 south of 6 west, and the southern half of 1 north of 3, 4, 5 and 6 west.

1637. ELEVATIONS.—The following elevations along the line of the proposed Vincennes and Ohio Valley Railroad, which crosses the county from east to west, were given by Geo. R. Wilson, of Jasper, Ind.:

	Ft.
County line east of Otwell	479
Bethel	470
Ireland	470
Mill street in front of Kastner's hotel at Jasper	460
Water in Patoka river below mill at Jasper	450
Valley of Bailey creek south of Knoxville	480
Orange county line on the bank of Dillon creek	523

Probably the highest points in the county are in and around Birdseye and Ferdinand.

Elevations along the line of the Louisville, Evansville and St. Louis Consolidated Railroad are as follows:

	Ft.
Birdseye	745
Mentor	751
Kyana	537
Bretzville	563
St. Anthony	521
Huntingburg	496
Duff	501
Jasper	501
Jasper (high water)	459
Ferdinand	563
Ferdinand Station	534

1638. GENERAL TOPOGRAPHY.—In general this county is very rough, especially in the eastern half, where the hills rise from 75 to 200 ft. above the creek and river valleys. To the southwest, along the Patoka river, and west of Huntingburg, the hills are not so high and precipitous, running from 50 to 150 ft. in height, usually with rather gentle slopes. With the exception of some few hills along Birch creek and Mill creek, the northwestern part is comparatively level. This level territory is included in Boone and the northern half of Madison townships, and is referred to as "the garden spot" of the county. Quite a lot of level land is found along White river. Patoka river and many of the streams running into it have broad bottoms. In general, the topography runs from high hills and broken ridges in the east to rather low rolling lands in the southwest and comparatively level plains in the northwest.

1639. Drainage.—The northern part of the county is drained by White river. The Patoka river, a slow, sluggish, meandering stream, crosses the county from the northeast to the southwest, draining the central part of it. The southern part is drained by Hunley creek, Straight creek and their tributaries. Pigeon creek rises in the southwest corner of the county, and the southeast corner is crossed by Anderson river.

1640. Transportation Facilities.—The Louisville, Evansville and St. Louis Consolidated Railway crosses the southern half of the county from east to west, and the Evansville division of this road crosses the southern half from north to south, coming as far north as Jasper.

Section 2. Stratigraphy.

1641. Surface Geology.—Nearly all of the exposed strata of this county belong in the coal measures; but in the eastern and northern part, the upper members of the Kaskaskia group are exposed near the bottom of the hills. The lower carboniferous rocks are most readily recognized from the presence of a rather heavy bed of limestone. This limestone was observed at a number of places along Lick Fork creek and the Patoka river, where it rises from a few feet to 30 or 40 ft. above the adjacent bottom lands. In Secs. 10 and 15, T. 2 S., R. 3 W., and west of where the limestone passes under the coal measures, it comes to the surface along a small stream, forming a rather steep cliff some 15 ft. high, and following down the branch one-quarter of a mile or more, where it disappears under a heavy ledge of sandstone. One mile and a half farther west along Hall creek the outcropping strata belong to the lower members of the coal measures.

The northwestern part of the county is covered with drift and alluvium. A line drawn north from Jasper to White river and west from Jasper to the Pike county line would include almost all of the covered area. This included territory would also contain a small amount of uplands, the largest body of which lies just north of Jasper, in Secs. 14, 15, 21, 22, 23, 25, 26, 27 and 28, T. 1 S., R. 5 W., and another in

Secs. 25, 26, 35 and 36, T. 1 N., R. 6 W. Cooper hill, a high, irregular hill rising some 60 ft. above the surrounding plain, is located in Secs. 11 and 12, T. 1 S., R. 6 W., and a very small knoll of upland is found in Sec. 29, T. 1 S., R. 5 W., rising 8 or 10 ft. above the surrounding level lands. In Sec. 10, T. 1 S., R. 5 W., chert and shale were observed.

The line marking the eastern and southern limits of this level area, which will be called the Patoka Lake plain, with the two embayments of Upper Patoka plain on the east, and middle Patoka or Straight and Hunley creek plain on the southeast, leaves the present valley of White river in Sec. 27, T. 1 N., R. 5 W., and passes south through Sec. 35, T. 1 N., R. 5 W.; thence south through Secs. 2, 12 and the N. E. corner of Sec. 13, T. 1 S., R. 5 W.; thence south across Sec. 18 and into 19 to the present bottom of Patoka river. From this point the Patoka river marks the boundary as far south as Frog island, where the line turns northwest through Sec. 25, crossing the S. W. corner of Sec. 24, thence north across Sec. 23 and the S. W. corner of Sec. 14, leaving this section at the center of the west side, here turning west and south across sections 13, 21 and 28, and thence south and east through Secs. 34 and 35, T. 1 S., R. 5 W., to Patoka river at Jasper. From this point the Patoka river becomes the boundary as far west as Sec. 10, T. 2 S., R. 5 W., where the line turns north and west across the section and Sec. 4, thence west, south of the northern boundary of Secs. 5 and 6, T. 2 S., R. 5 W., where it again strikes the Patoka river, following it to the mouth of Flat creek, where it turns north along this stream to the Pike county line.

Upper Patoka plain includes Secs. 11 to 14, inclusive, T. 1 S., R. 5 W., and part of Secs. 24 and 25, T. 1 S., R. 5 W., and the S. W. corner of Sec. 18 and the N. W. part of Sec. 19, T. 1 S., R. 4 W. Straight and Hunley creek plain includes Secs. 32 and 33 and part of 24, T. 1 S., R. 5 W., and Sec. 3 and part of Secs. 2, 11, 10, 4 and 5, T. 2 S., R. 4 W. The rest of Patoka Lake plain in this county comprises the east half of T. 1 S., R. 6 W., and part of T. 1 S., R. 5 W., T. 1 N., R. 5 W., and T. 1 N., R. 6 W. See accompanying map.

The names Upper and Middle Patoka are suggested by Mr. Frank Leavett as designating the preglacial drainage basins of the Patoka. It is evident that in preglacial times the part of the drainage basin above the gorge near Jasper drained northwest across Upper Patoka plain to White river. The name Upper Patoka river is given to the stream draining that area at that time. West of this basin, and between the gorges near Jasper and near Velpen, Pike county, was another drainage basin known as the basin of the Middle Patoka river of preglacial times. Straight and Hunley creeks are part of the Middle Patoka river drainage. According to Mr. Leavett, the main stream flowed northwest to White river, passing close to Otwell. Most of the Patoka basin in Pike county belongs to what Mr. Leavett calls the Lower Patoka basin, which drained northwest into White river in western Pike or eastern Gibson county. The outlet of Patoka lake during glacial times appears to have been the low ground near Francisco, in Gibson county, where the old Wabash and Erie canal crossed the divide between the Ohio and Patoka rivers.

The drift and alluvial deposits of these plains vary in thickness from a few feet to 26 ft. plus, it being impossible to get the maximum thickness, as the wells of this territory are all driven, going down to only the water bearing strata which lie above the country rock.

The following well sections taken from these plains will give some idea of the thickness of the deposit:

WELLS IN TOWNSHIP 1 SOUTH, RANGE 5 WEST.

		Ft.		Ft.
1.	S. E. of S. E. Sec. 32	soil, 12;	quicksand,	1+
2.	S. E. of S. W. Sec. 33	soil, 20;	quicksand,	3+
3.	S. E. of S. E. Sec. 33	soil, 20;	quicksand,	2+
4.	S. E. of S. W. Sec. 34	soil, 16;	quicksand,	1+
5.	S. E. of S. W. Sec. 34	soil, 20;	quicksand,	2+
6.	350 yds. west of center of Sec. 15	soil, 18;	quicksand,	1+
7.	S. W. of S. W. Sec. 10	soil, 20;	quicksand,	1+
8	S. W. of S. W. Sec. 11	soil, 20;	quicksand,	4+
9.	S. E. of S. W. Sec. 11	soil, 21;	quicksand,	4+
10.	N. W. of N. W. Sec. 11	soil, 20;	quicksand,	2+
11.	S. E. of N. W. Sec. 14	soil, 25;	quicksand,	3+
12.	S. E. of S. W. Sec. 14. This well is south of the boundary of the plain in the uplands.	soil and sandstone, 40		
13.	S. W. of S. E. Sec. 2. This well is south of the boundary of the plain in the uplands.	soil and sandstone, 40		
14.	N. W. of N. W. Sec. 3	soil, 25;	quicksand,	3+
15.	S. E. of N. E. Sec. 4	soil, 26;	quicksand,	1+
16.	S. E. of N. E. Sec. 6	soil, 22;	quicksand,	8+
17.	N. E. of N. W. Sec. 6	soil, 20;	quicksand,	3+

18. Section of well at Mr. Cave's in S. E. of N. E. Sec. 2:

	Ft.	In.
Surface	10	0
Sand	12	0
Shaly sandstone	3	0
Coal	2	6
Fire-clay and clay	15	0

WELLS IN TOWNSHIP 1 NORTH, RANGE 5 WEST.

		Ft.		Ft.
1.	S. W. of N. W. Sec. 26	soil, 16;	quicksand,	3+
2.	S. W. of S. E. Sec. 23	soil, 13;	quicksand,	3+
3.	S. E. of S. W. Sec. 23	soil, 19;	quicksand,	3+
4.	N. W. of S. E. Sec. 23	soil, 16;	quicksand,	3+
5.	N. W. of N. E. Sec. 23	soil, 16;	quicksand,	2+
6.	S. W. of N. E. Sec. 15	soil, 18;	quicksand,	1+

Wells in Township 1 North: Soil, 18 ft.; quicksand, 1 ft. plus.

Wells in Secs. 35, 36, 25 and 26 show sandstone and shale; these sections lie outside of the alluvial plain.

As stated above, it is quite probable that during preglacial times the Patoka river turned northwest above Frog island and flowed through what is now known as Buffalo pond to the headwaters of Mill creek, and followed down the present valley of Mill creek and discharged near the present mouth of that stream, and that Hunley creek and Straight creek followed northwest along what has been described as Straight and Hunley creek plain, and then probably turned west and northwest across Patoka lake basin, past Otwell, to the present valley of Beech creek. This change in the location of these streams was doubtless brought about by the advancement of the ice sheet during the latter (?) part of the glacial period, when the ice probably pushed as far south as Portersville and the uplands in Secs. 25, 26, 35 and 36, T. 1 N., R. 6 W., damming the streams and forming Patoka lake. During this period, and previous to the recession of the ice sheet, the drift and alluvial sands and clay were deposited over this part of the county.

Also during this period, and probably when Patoka lake reached its greatest extension, the Patoka river broke across the narrow divide one mile north of Jasper, flowing southwest and entering Straight creek valley south of town. The preglacial gorge through this divide is very narrow, with rather steep and abrupt banks. Below are given some of its dimensions, together with a description of its topography and exposed strata.

The gorge sets in on the north, just south of the line running east and west through the center of Sec. 25, and some 300 yds. west of the center of the section, and extends south to Jasper with a width of about 190 yds. at the mouth and 350 yds. near the center and 200 yds. at the south end. The banks rise from 20 to 50 ft., with rather steep slopes, exposing heavy ledges of sandstone at a number of places. The best exposures are at Jasper and east of Frog island at the northern end of the gorge.

The top of the preglacial divide was probably three or four hundred yards north of Frog island. The small streams emptying into the river from the east flow to the northwest, while those farther down the river flow to the southwest. See topographic map of the gorge on Fig. 758.

The high hills north and northeast of Jasper, west of the river, and the hills east of the river at this place were once continuous, forming the preglacial divide.

1642. COAL MEASURES.—The accompanying section will show the divisions and coals occurring in this county.

Division IV—
1. Space above coal IV, sandstone, shale, sandstone predominating.
2. Coal IV. Found in northwestern part of county and at "Buffalo Wallow," or the headwaters of Pigeon creek.

Division III—
3. Shale, sandstone, limestone and slate, shales predominating.
4. Coal IIIb. Found about Jasper, Portersville and a number of other places.
5. Clay, shale and sandstone, sandstone predominating.
6. Coal IIIa. Main coal used about Jasper.
7. Fire-clay, shaly sandstone, shale and limestone, shales predominating.
8. Coal III.

Division II—
9. Sandstone and shale.
10. Coal II. Mined west of Mentor and at other points along the L. E. & St. L. C. R. R.

Division I—
11. Sandstone, massive, and shale.
12. Coal Ia. Not persistent. Outcrops in northeastern part of county.
13. Sandstone and shale.
14. Coal I. But few outcrops; not persistent.
15. Shale and sandstone.
Lower Carboniferous rocks.

TOWNSHIP 1 NORTH, RANGE 3 WEST (IN PART).*

1643. GEOGRAPHY.—This partial township lies in the northeastern corner of the county. It shares the rugged, hilly topography common to the eastern edge of the county. The drainage is principally by Davis, Dillon and Cane creeks to the Patoka river.

*Field work by E. M. Kindle and report by G. H. Ashley.

1644. STRATIGRAPHY.—Over most of the area Coal I is the only coal found. The following section shows its position relative to the Lower Carboniferous and the Mansfield sandstone.

1645. SECTION 696. SECTION AT ST. CLAIR COAL MINE.—S. W. ¼ Sec. 28, 1 N., 3 W. (E. M. K.)

		Ft.	In.
1.	Surface to top of hill ....30 to	35	0
2.	Massive sandstone with irregular bedding in places	55	0
3.	Covered	10	0
4.	Drab colored shales	5	0
5.	COAL I ....18 in. to	1	8
6.	Covered	10	0
7.	Lower Carboniferous limestone	..	..

At the Line bank, in Sec. 15, there are reported to be four coals. The uppermost bed, Coal II (?), is 3 ft. to 4 ft. or over thick. About 50 or 70 ft. below is said to be a thin bed separated by 16 in. of fire-clay from a 5 or 6 in. bed. Near the bottom of the hill is a 19 in. bed, Coal I, which lies between two sandstones. It would appear that the two intermediate coals correspond to Coal Ia of Orange and Crawford counties. Coal I at this point is reported a good blacksmith coal. Coal II appears to be workable along the divide northwest of Davis creek.

1646. DISTRIBUTION OF COALS AND LOCAL DETAILS.—As shown on the map, the coals are cut out along much of the valleys of Davis, Dillon and Cane creeks. Kaskaskia limestone is well exposed in these valleys, with Coal I found locally but a few feet above. Coal II occupies a very limited area along the summit of the divide in Secs. 15-20. At the W. A. and W. M. Line mine, in the N. W. ¼ of Sec. 15, the coal measures 2 ft. 10 in. in one entry. The section here was (Sect. 697, E. M. K.):

		Ft.	In.
1.	Surface	..	..
2.	Gray, rather soft shale	3	0
3.	COAL II ....2 ft. 10 in. to	3	4
4.	Dark gray clay	10+	..

The coal is mostly block, rather soft, with the luster and appearance to the touch of charcoal, and seems to be quite free from sulphur. About 6 in. of the top is bony and is rejected. The shale makes a good roof. The coal lies about 35 ft. above the bed of the branch below it. This bed outcrops in the road in the S. E. corner of Sec. 18, where it is about 22 ft. below the top of the hill.

Coal I has been dug a little in the S. W. ¼ of Sec. 15, being about 7 ft. above the bed of the branch and 100 ft. below the top of the ridge. This coal has been dug a little on Dr. Line's land, Sec. 15, and David Morgan's land, N. E. ¼ of Sec. 19.

Coal I outcrops in the S. E. ¼ of Sec. 20, on the Wm. Combs place. The section here gave (Sect. 698, E. M. K.):

		Ft.	In.
1.	Covered	..	..
2.	Sandstone, massive buff	5	0
3.	Drab colored shale	3	0
4.	COAL I, block ..8 in. to	..	10
5.	Hard blue-gray sandy clay	..	10
6.	Covered	9	0
7.	Sandstone with irregular bedded thin coal seams and charcoal plant remains	1	3

A little coal has been dug here. Some 60 yds. up the ravine the coal masses in the bottom sandstone occur in irregular, more or less lenticular pockets, up to 1 in. thick, lying irregularly in the sandstone and shales.

Coal I outcrops in the N. W. ¼ of Sec. 21, opposite Mr. Hall's house, where the following section was observed (Sect. 699, E. M. K.):

		Ft.	In.
1.	Surface	..	..
2.	Shale, soft brownish-gray with Lingula	5	0
3.	Soft black carbonaceous shale	1	0
4.	COAL I	1	8
5.	Light gray sandy clay	3	0
6.	Sandy shale	1	0
	Bed of creek.		

The coal has been mined a little.

In the S. E. ¼ of Sec. 21, Coal I is worked some on the Jeremiah Sanders place. The coal is reported at from 18 to 24 inches thick, though only 1 ft. is said to be good coal. It is said to be a non-caking block coal, burning to a white ash. The roof is shale, the floor a hard gray clay. The coal is just at drainage and has been stripped before being mined by drifting.

The coal outcrops at several places in Sec. 22. It was formerly drifted upon in the N. E. ¼ on the Mary Nichols place. It is there 3 or 4 ft. above the adjacent ravine and 75 ft. below the top of the ridge.

At an outcrop in the S. E. ¼ on Wm. A. Winninger's place the following section shows (Sect. 700, E. M. K.):

		Ft.	In.
1.	Gray shale	2	6
2.	COAL I	..	10
3.	Drab colored clay	..	8

The coal lies about 8 ft. above the branch.

Coal is worked on Harrison Treadwell's place, in the S. E. ¼ of Sec. 27. The coal is a block or semi-block, with several inches of bone, but the worked part appears to be good. The roof is clay shale. The coal lies just at drainage.

In the N. W. ¼ of Sec. 34 are the two mines of Ansley Sutton. The coal is 2 ft. or 2 ft. 6 in. thick. It is a block coal with distinct seams, requiring no powder in mining at No. 1 mine. It burns to a white ash and does not show the bone coal so usually found about here in Coal I. The roof is a bluish black shale 18 in. thick, overlain by 6 ft. of gray sandy shale. The floor is light gray clay 9 ft. thick. The coal lies at drainage level. At the No. 2 mine the block slips are not distinct and the coal is a caking coal. At this mine there are 3 or 4 in. of soft bone under the coal. The roof and floor are much the same as at No. 1. A third of a mile southeast of Crystal is the St. Clair bank, where was taken the section given above. (See Sect. 696.) In the S. W. ¼ of Sec. 28 is the A. C. Harbison mine. The coal is here reported to be 18 in. thick on the average, and is said to be a good caking coal, burning to a white ash. The roof is made by 20 in. of hard black shale, with streaks of coal all through it. The coal lies 75 ft. below the top of the hill and 40 ft. above Davis creek. In the S. E. ¼ of Sec. 29 Coal I is about 10 ft. above Davis creek, on Mary Elkins's land. It is overlain by 6 ft. of bluish-gray sandy shale.

Partial Townships 1 North, Ranges 4, 5 and 6 West.

1647. Geography.—These partial townships lie in the northern part of the county along White river, in the civil townships of Boone and Harbison, and are bounded on the south by the base line. White river on the north serves as a drainage for these partial townships, with the exception of the south half of township 4 west, which is drained by affluents of the Patoka river.

1648. The topography runs from high, irregular hills in the east to a level plain in the west—the basin of Patoka lake. The highest hills are about Kellersville, which rise probably 250 ft. or more above White river. Haysville, in township 5 west, is surrounded by high and broad hills. Portersville, the old county seat, is located on

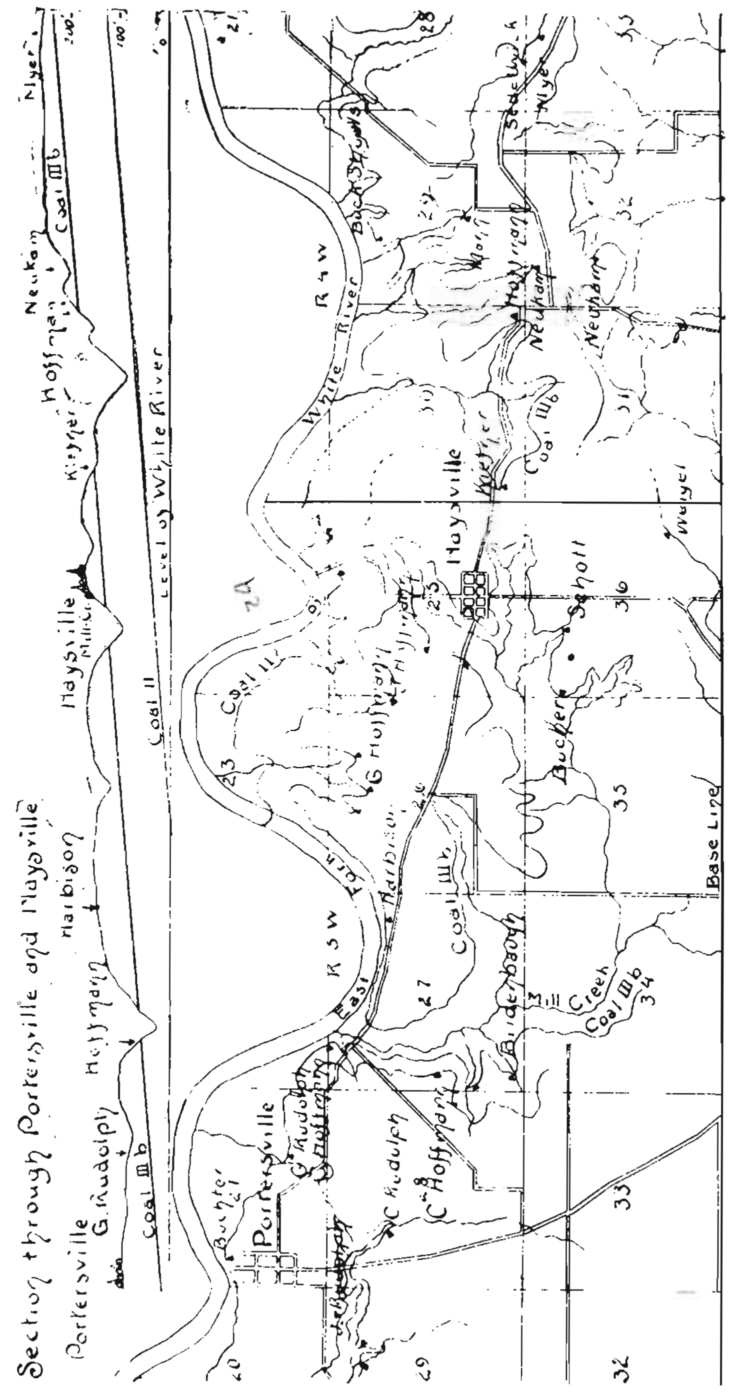


PLATE LIVa. Sketch map and cross-section of part of T. 1 N., Rs. 4 and 5 W.

White river, in township 5 west, and is surrounded by "sand hills." These sand hills are most noticeable east of the town and west of Mill creek. Farther west, along Birch creek, in township 6 west, occur a number of hills, especially west of the creek, in Secs. 25, 26, 35 and 36, is this true. Surrounding these hills is quite a stretch of level land—a part of Patoka Lake basin.

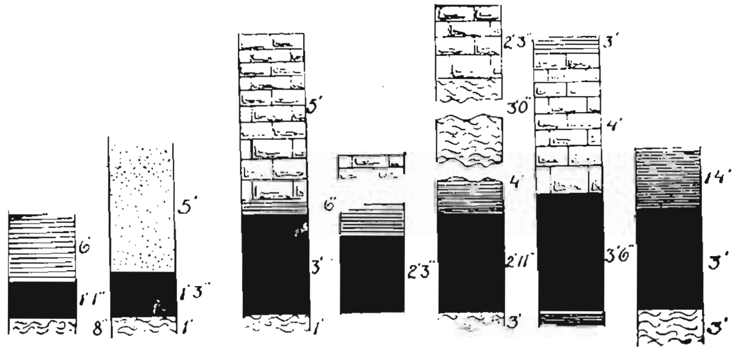


Fig. 750. Section of Coal Ib in T. 1 N., R. 4 W.
Fig. 751. Section of Coal II in T. 1 N., R. 4 W.
Figs. 752–756. Section of Coal IIIb in T. 1 N., Rs. 4 and 5 W.

1649. STRATIGRAPHY.—The outcropping strata of these partial townships belong in Divisions I, II, III and IV, with six coals exposed—Coal Ib(?), II, III, IIIa, IIIb and IV?. These coals are now worked, or have been worked, Coals III and IIIb having been worked the most. The Mansfield sandstone is exposed in the eastern part of township 4 west, but soon disappears under the overlying strata. The lines of outcrop of Coals II, III and IIIb are shown on the map. By a glance at the map it is seen that but few outcrops were found in township 4 west, and for this reason the correlation of the coals through this township is very unsatisfactory. This is not only true of township 4 west, but of parts of all these partial townships. Where exposures were wanting, the correlation was made from what was found across the river in Martin and Daviess counties.

One coal was observed and one reported in Sec. 13, township 4 west. Both of these coals belong in Division I, the upper one some 40 ft. below Coal II. This coal was observed under the Raven rock in the S. E. ¼ of the N. E. ¼ of Sec. 13. The coal measured 13 in.

1650. SECTION 701. SECTION OF THE BLUFF AT THE RAVEN ROCK.—(Fig. 750.)

		Ft.	In.
1.	Solid sandstone	45	0
2.	Light sandy shale	6	0
3.	Coal Ib (?)	1	1
		52	1

Besides calling this Coal Ib and the coal 40 ft. higher Coal II, it seems quite as accurate to call the lower coal Coal II and the upper coal Coal IIb, as the heavy sandstone forming the projecting rock seems to be the Mansfield.

The correlation given seems to be the better one in correlating from the base of the coal measures from the east. The heavy shelving rock seems to be a thickening of one of the lower strata of the Mansfield. This rock forms a waterfall about 60 ft. high and projects over an area of 100 yds. long and 50 ft. deep. The coal that was reported lies some 40 ft. below the base of the Raven rock, and was reported as being a few feet below the bed of the branch in the N. E. ¼ of Sec. 13, township 4 west, on the William Radcliff farm. No exposures of this coal were observed in this section.

What was considered as Coal II was reported on John Bauer's farm, in the S. E. ¼ of the N. E. ¼ of Sec. 22, township 4 west. Some little coal has been taken out at this crop by a stripping and was reported 18 in. thick. At the time of the examination the exposure of the coal was covered. Above the coal is an exposure of sandstone 8 ft. thick, which forms a small waterfall. The coal as reported is about 2 ft. above drainage and a fair quality of coal.

Another outcrop of this coal was reported on the Gollar place, along White river, in the N. E. ¼ of Sec. 21, township 4 west. Coal 18 in. thick, covered with sandstone and with a fire-clay and shale floor. About 40 ft. above the river. The same coal was reported as having outcropped at Buck Shoals's, in the N. W. ¼ of Sec. 29, township 4 west, but at the time of examination was obscured.

On the J. W. Neukam place, in the N. E. ¼ of the S. E. ¼ of Sec. 35, township 4 west, some little coal has been worked by stripping. Coal varies in thickness from 32 in. to 2 in., with an average of 20 in. Dips to the south. Reported a good coal for smiths' use. Roof of shale. Floor of fire-clay. Mr. Neukam is of the opinion that this coal is not persistent, as his neighbors have drilled for the coal and found none. He considers it as a basin found only in the one hill. This is probably true, as no outcroppings were found in adjoining hills. The coal belongs in Division I.

A thin coal was reported on Tom Neukam's farm, in the S. E. ¼ of the S. E. ¼ of Sec. 27, township 4 west, 8 to 2 in. thick, with an average of 5 in. Exposures covered. Roof reported to be shale. But very little coal taken out at the stripping. Was correlated as Coal III, but the correlation is very unsatisfactory.

The horizon of Coal IIIb occurs near the top of the high hills to the southeast of Kellersville, as indicated by the outcrop of cherty limestone. This cherty limestone is near the top of the hill and is found in only the highest ones as isolated bodies. Farther west, in Secs. 28 and 33, Coal IIIb outcrops on the August Myer farm. Reported 18 in. thick, with a shale and sandstone roof. A thin coal was reported in Peter Sedelwick's well, in the N. W. ¼ of the N. E. ¼ of Sec. 33, township 4 west. Coal IIIb has been worked by a drift on Henry Mann's farm, in the N. E. ¼ of the S. W. ¼ of Sec. 29, township 4 west. The drift has been abandoned for years and all exposures of the coal covered. From position and overlying strata, this coal was correlated as given above.

At the time of examination, Coal IIIb was mined at the William Neukam mine, in the N. E. ¼ of the N. W. ¼ of Sec. 32, township 4 west. The following report was obtained: Maximum and minimum thickness of the coal, 3 ft. and 2½ ft., respectively, with an average of 2½ ft. Number of sulphur balls near the center of the coal. No faults, but few small rolls. Blacksmiths use the coal and report that which comes from the top of the coal a very good coal. Dip to the north and south, dipping each way from the main entry. The coal is picked and wedged down, it being a block to semi-block.

Section at entrance of the drift (Sect. 702, Fig. 752):

		Ft.	In.
1.	Soil	3	0
2.	Limestone	5	0
3.	Shale	0	6
4.	COAL IIIb	3	0
5.	Fire-clay	1+	0
		12	6

This coal outcrops on Philip Hoffman's place, in the S. E. ¼ of the S. E. ¼ of Sec. 30, township 4 west, and on the John Kiefner place, in the S. W. ¼ of the S. W. ¼ of the same section.

In township 5 west, Coal II was observed on the Baecher farm, in the N. W. of N. E. of Sec. 25. Below is given the section obtained at the entrance of the old drift (Sect. 703, Fig. 751):

		Ft.	In.
1.	Soil and drift	2	0
2.	Massive sandstone	5	0
3.	COAL II	1	3
4.	Clay	1+	0
		9	3

But very little coal has been used at this place. Quality reported fairly good.

Coal IIIb was observed or reported at the following places in township 5 west, viz.: Jno. Hoffmann's, in the S. E. ¼ of the N. E. ¼ of Sec. 26; Geo. Hoffmann's, in the N. E. ¼ of the N. W. ¼ of Sec. 26; Jas. Harbison's, in the N. E. ¼ of Sec. 27; Christ Hoffmann's, in the N. W. ¼ and S. W. ¼ of Sec. 27; Jno. Bridenbaugh, in the S. W. ¼ of Sec. 27, where the following report was obtained: Coal 3 ft. to 6 in. thick, with an average of 2 ft. 3 in. Semi-block, with some sulphur scattered through near the bottom of the coal. Good smith coal. Roof of shale and limestone. (Fig. 753.)

At Geo. Rudolph's, in the S. W. ¼ of the S. E. ¼ of Sec. 21, Coal IIIb is worked by a slope. The following report was given by the owner:

Thickness of the coal, from 32 to 36 in., with an average of 35 in. Has a few sulphur balls near the top and bottom; burns to a white ash, but does not char well.

Some 8 in. of peacock coal is found at the top of the coal. This is the best part of the coal, and serves well for shop use. Roof is a hard, sheety bituminous shale, that holds up well, the rooms being 15 ft. wide without any props. Below is the reported section (Sect. 704, Fig. 754):

		Ft.	In.
1.	Soil	10	11
2.	Limestone	2	3
3.	Red clay	3	0
4.	Shale, sheety	4	0
5.	COAL IIIb	2	11
6.	Fire-clay	3	0
		26	1

At J. J. Rudolph's, near the center of the N. E. ¼ of Sec. 29, the same coal is worked by a slope. The thickness of the coal here runs from 3 ft. 10 in. to 3 ft. 6 in., with an average of 3 ft. 6 in.

Practically free from sulphur balls and clay bands, but occasionally a light sulphur streak is found. No faults, but a few rolls. Coal burns to an ash, leaving but very few clinkers. Block to semi-block.

A bench of peacock coal 6 to 8 in. on top of the coal. Section below reported by Mr. Rudolph (Sect. 705, Fig. 755):

		Ft.	In.
1.	Slate	3	0
2.	Limestone	3-4	0
3.	COAL IIIb	3	6
4.	Shale and sandstone	?	..
		10?	6

At time of examination, the slope was filled with water, and only the crop of the coal was examined. Judging from the crop and some little coal which was found about the entrance, this coal seems to be above the average of Coal IIIb.

A crop of this coal was reported on C. H. Rudolph's farm, in the N. W. ¼ of Sec. 28. Coal IIIb has been worked at a few places in township 6 west, more probably at Brittian's, in the S. E. ¼ of the S. E. ¼ of Sec. 36, than any other one place. The coal was reported 32 to 35 in. thick, with an average of 33 in. The following section was reported by Mr. Brittian (Sect. 706, Fig. 756):

		Ft.	In.
1.	Soil	18	0
2.	Shale	2	0
3.	Hard sheety shale	14	0
4.	COAL IIIb	3	0
5.	Fire-clay	3+	0
		40	0

The above strata were passed through in sinking the shaft. The coal is divided into two benches by a clay band 1 in. thick. Above this band is 14 in. of bituminous coal, which is very sulphurous; below the bench is 20 in. thick, and is a good semi-block with but very little sulphur.

The coal dips to the east and is 7 ft. below the level of Birch creek, which is probably 200 yds. east of the shaft. The water gives a great deal of trouble and is a source of heavy expense, for which reason the mine has been abandoned.

Coal was reported at the following places in this township, viz.: Conrad Dike's, in the N. E. ¼ of the S. E. ¼ of Sec. 36; L. Jager and Frank Duley's, in the N. E. ¼ of Sec. 36; near the bridge across Birch creek, in the N. E. ¼ of Sec. 25; Mrs. Farris's, in the N. W. of N. W. of Sec. 25. But little coal has been used at the above place, it being thin and of poor quality.

TOWNSHIP 1 SOUTH, RANGE 3 WEST.

1651. GEOGRAPHY.—This township is located in the east part of the county, and comprises the north half of Hall township and north to the base line in Columbia township. Ellsworth, a small village, is located one mile northeast of the center of the township. Celestine is located one mile southeast of the center of the west side of the township. Patoka river flows northwest across the northeastern corner of the township, draining that part of it. The east side is crossed by Lick Fork creek and the southwest corner is touched by Hall creek. Barley creek drains the northwest part. The topography runs from low river and creek bottoms to high, irregular, broken hills, rising from 150 to 200 ft. above the bottom lands, with rather steep slopes. In general, the hills in the east and south parts are higher and more precipitous than those in the west and south parts, where they rise from 100 to 175 ft. above the adjacent lowlands. The nearest railroad is the L. E. & St. L. C. R. R., which crosses the county five miles south of this township.

1652. STRATIGRAPHY.—The outcropping strata of this township belong in Divisions I and II, with two coals exposed, Coals I and II.

The following sections will show the relation of the coals and accompanying strata.

Section along a hill in wagon road near the center of the east side of Sec. 24 (Sect. 707):

		Ft.	In.	Ft.	In.
1.	Surface	10	0	10	0
2.	Massive sandstone	12	0	22	0
3.	Shale and sandstone	15	0	37	0
4.	Shale	10	0	47	0
5.	Black streak of clay	?	..	..	..
6.	Shale and clay	5	0	52	0
7.	Obscured	3	0	55	0
8.	Limestone and clay	15	0	70	0
9.	Shale and clay	2	0	72	0
10.	Shale and sandstone	1	6	73	6
11.	Drab shale	10	0	83	6

Section reported by Mr. Isaac Pinnick as exposed on his farm in the S. W. ¼ of the N. W. ¼ of Sec. 35 (Sect. 708):

		Ft.	In.
1.	Surface	6	0
2.	Blue shale (?)	0	3
3.	COAL II	1	9
		8	0

Section along the hill west of the branch west of Celestine (Sect. 709):

		Ft.	In.
1.	Surface	10	0
2.	Rather hard massive sandstone	8	0
3.	Light sandy fire-clay	2	6
4.	Shale with cross seams of ferruginous sandstone	30	0
5.	Sandstone	10	0
		60	6

In the northeast part of the township the Kaskaskia limestone is exposed, varying in thickness from a few feet to 20 ft. or more. Springs are quite numerous at this horizon, the limestone forming small cliffs above the springs. The line of parting between the Kaskaskia limestone and the coal measures is shown on the map; also the line of outcrop of Coal II. This coal has been drifted upon on Dr. Cobbe's farm, in the S. W. ¼ of Sec. 35. The following section was obtained at the mine (Sect. 710):

		Ft.	In.
1.	Massive sandstone	12	0
2.	Blue to drab shale	3	0
3.	COAL II	1	11
		16	11

No mining has been done at this mine for years, and the entrance to the mine was so closed by debris that satisfactory investigation was impossible. The coal was reported to have been a good steam coal, and also a very good coal for shop use.

The same coal has been mined on the Isaac Pinnick place, in the S. W. ¼ of the N. W. ¼ of Sec. 35. (See above section.) This coal was struck in Mr. Pinnick's well, who reported it a good coal. This same coal is found on the B. Scherers place, near the center of the N. W. ¼ of Sec. 34; also on the H. Humbert place, in the N. W. ¼ of the N. W. ¼ of Sec. 34, and on the M. Anges place and the A. Beckert place, in the S. E. ¼ of Sec. 33. Very little coal has been mined at the last four mentioned places, and the mining that has been done was done years ago, making the correlation very uncertain. Mr. Jno. Steigel reports the same coal on his place in the N. W. ¼ of the S. E. ¼ of Sec. 29. The following report was given by the owner (Sect. 711):

		Ft.	In.
1.	Dark blue shale	4	0
2.	COAL II	2	0
3.	Slaty coal or shale	0	6
		6	6

Four inches of the top of the coal contain much sulphur, but the other 20 in. contain but very little. Coal blocks well, some pieces containing 2 or 3 bushels; good coal for shop work; leaves some few clinkers in burning and does not char well.

Coal which is probably Coal II was reported on the Heichelbech place, in the S. W. ¼ of the N. W. ¼ of Sec. 28, and on the Joe Stein place, near the center of the S. E. ¼ of Sec. 29. Farther south, in the N. W. ¼ of the N. E. ¼ of Sec. 32, on the Joseph Hurst place, the same coal was reported.

Coal II is only found in the south half of the township, occurring high in the ridges. Southwest of Celestine, in the S. E. ¼ of the S. W. ¼ of Sec. 31, occurs a lower coal, probably Coal I. This coal has been worked some on Geo. Haseman's farm. An examination at an old stripping gave the following strata (Sect. 712):

		Ft.	In.
1.	Shale and shaly sandstone	10	0
2.	COAL I	1	6.8
3.	Shale	2	0
4.	Sandstone	1+	0
		14	.8

This coal has quite a lot of sulphur at this outcrop, and seems to be a poor quality of coal. Blacksmiths claim that it is a poor coal for their use. The same coal was reported on the Clements place, in the N. E. ¼ of the N. E. ¼ of Sec. 13; in the S. E. ¼ of the N. E. ¼ of Sec. 15, and in the N. W. ¼ of the S. W. ¼ of Sec. 18, on the Joe Seger farm. Very little coal is found in this township, especially in the central and northern portions. Coal I is very thin and is probably not persistent. Coal II, in the south part of the township, is thicker, but the thickness is subjected to great variations, at some places thinning down to only a few inches or being entirely cut out.

Township 2 South, Range 3 West.

1653. Geography.—This township lies in the east part of the county, south of the center of the east side, and extends one mile south of Birdseye, including the southern part of Hall and the northern half of Jefferson townships, extending one mile west into Jackson township. Hall creek rises one-quarter of a mile west of Mentor, in Sec. 27, and flows northwest across the township, draining that part of it. Lick Fork creek rises just north of Birdseye and flows north along the east side of the township, leaving it in the N. E. ¼ of Sec. 1. The south part of the township is drained by the head waters of Flat creek, which rises in Sec. 34 and flows west along the L., E. & St. L. C. R. R. The southeastern corner of the township is crossed by Anderson river. The topography runs from high and crooked continuous ridges to low and narrow creek valleys. Probably the highest point in the township is in and about Birdseye, this being the dividing point between Lick Fork creek on the north, Hall creek on the northwest and Anderson river on the south. The hills rise from 100 to 200 ft.; the lower half rather steep, with sandstone cliffs at intervals. These cliffs and shelving rocks are most numerous southeast of Mentor and south of Birdseye, along the branches that flow south and southeast into Anderson river. The upper half of the hills is not so steep and abrupt, but with gentle slopes running back to the long ridges. The L., E. & St. L. C. R. R. crosses the south half of the township from east to west.

1654. Stratigraphy.—The prevailing exposures of this township are massive and shaly sandstone and shale. The massive sandstone is rather soft, crumbling into fine sand, forming a sandy soil at its outcrop. This is seen in the wagon road one-quarter of a mile northwest of Mentor, around the headwaters of Hall creek. This same ledge of sandstone outcrops along the L., E. & St. L. C. R. R., one mile southwest of Mentor. It is also found above the shale which overlies the coal at B. B. Able's mine, in the N. E. ¼ of Sec. 34, and at Chanley's and Whaley's mines, in the south half of Sec. 33. Quite an exposure of limestone was observed in the S. W. ¼ of the S. E. ¼ of Sec. 10 and the N. W. ¼ of the N. E. ¼ of Sec. 15. (See description of the outcrop under ¶1641.)

The general stratigraphy of the township is shown in the following sections:

1655. Section 713. Section Along the North Side of a Small Branch.—In the N. E. ¼ of the N. W. ¼ of Sec. 15.

	Ft.	In.	Ft.	In.
1. Obscured	30	0	30	0
2. Shale	2	0	32	0
3. Irregular coarse, many layers of broken sandstone	2	0	34	0
4. Hard, blue, impure flinty limestone	0	5	34	5
5. Fine, light drab shale	5	0	39	5
6. Dark shale streaked with thin layers of hard sandstone	2	0	41	5
7. Irregular hard ferruginous sandstone	4	0	45	5
8. Hard calcareous sandstone	0	2	45	7
9. Shale	1	2	46	9
10. Hard calcareous sandstone	0	3-4	47	1
11. Shale	0	5	47	6
12. Hard, blue, impure and flinty limestone	0	2	47	8
13. Blue shale	0	6	48	2
14. Hard, impure, flinty limestone	0	2	48	4
15. Blue to drab shale	3	0	51	4
16. Obscured	35	0	86	4
17. Soft sandstone	5	0	91	4
18. Obscured to bed of branch	3	0	94	4

The limestone and calcareous sandstone reported in this section are very impure. The limestone containing no small amount of sand, while carbonate of lime forms one of the principal ingredients of the sandstone. In each case the rocks are very hard and not persistent. Coal was reported as outcropping at this place on Henry Prechtel's farm, but a careful observation failed to verify the report.

This section is probably one-half mile west of the exposed Kaskaskia limestone referred to above, the limestone in the section, however, coming at higher horizons and in no way connected with the Kaskaskia limestone.

1656. SECTION 714. SECTION ALONG WAGON ROAD GOING EAST FROM SCHNELLVILLE.—In the N. E. ¼ of the S. E. ¼ of Sec. 16.

	Ft.	In.	Ft.	In.
1. Surface	20	0	20	0
2. Sandstone and shales	4	0	24	0
3. Drab shale and sandstone	3	0	27	0
4. Sandstone	0	8	27	8
5. Sandstone mixed with thin layers of shale	12	0	39	8
6. Shale	0	4	40	0
7. Coal dirt	0	1	40	1
8. Drab to blue shale	3	6	43	7
9. Drab shale with cross seams	10	0	53	7
10. Hard chalk white sandstone with fine grit	1	6	55	1
11. Sandy shale	0	6	55	7
12. Sandstone	5	0	60	7
13. Shaly sandstone	4	6	65	1
14. Shale and shaly sandstone	30	0	95	1

The outcropping strata of this township belong in Divisions I and II, with two coals exposed—Coal II and Coal IIa.

The lowest rocks are exposed in Secs. 10 and 15. With the exception of this one place, the horizon of Coal I is below the surface. At Ublhor's, in the S. W. ¼ of the S. E. ¼ of Sec. 10, coal was reported to have been worked years ago, but an examination found no signs of the same, but did find a streak of coal dirt and shale, coming some 20 ft. above the Kaskaskia limestone, judging from its position 400 yds. down the branch.

Coal II is very thin and has been mined only at a few places.

The line of outcrop of Coal II is shown on the map. At the King mine, northeast of Birdseye, in the N. W. ¼ of the N. E. ¼ of Sec. 24, this coal is mined by a slope. The coal was reported as having a maximum thickness of 2 ft. and a minimum thickness of 1 ft. 6 in., averaging about 20 in. Six inches from the top of the coal occurs a sulphur streak. The upper bench contains a number of sulphur balls, but the lower one is almost entirely free from these balls, but has some few sulphur threads. The roof runs from sandstone to shale; holds up fairly well. Rooms usually 12 ft. wide and 50 or 75 ft. long, with two rows of props two or three feet apart. Free from rolls and is a shooting coal. Blacksmiths use this coal and pronounce it a very good coal for part of their work. Some peacock coal was reported by the miners. This same coal has been mined on Joseph Blume's place, in the S. E. ¼ of the N. W. ¼ of Sec. 3. Here the maximum thickness is 2 ft., with an average of 1 ft. 9 in. The coal is divided into two benches by a broken band of sulphur balls running from 0 to 2 in. in thickness. The upper bench at the entrance is 6½ in. thick and a poor quality of coal. The lower bench is 16½ in. thick and is a better quality of coal—a good steam coal, but poor for shop use. The sulphur band at the entrance is 1 in. thick, making a total thickness of 2 ft. The roof is a hard shale, with cross seams 8 or 12 ft. apart. Floor is composed of a hard sandy fire-clay. Section as exposed along the branch near the mine. Below the horizon of the coal in the branch is an exposure of sandstone, which seems to come immediately under the floor of fire-clay. Farther down the branch, and what seems to be a continuation of this ledge of sandstone, is an exposure of sandstone forming a shelving rock. Above the horizon of the coal is some 12 or 15 ft. of light drab shale. Overlying this shale is 10 or 12 ft. of hard massive sandstone. Some coal has been obtained from an old stripping on Louis Hoffman's place, in the N. E. ¼ of the N. E. ¼ of Sec. 4, where the coal was reported to have been 2 ft. thick, with a hard shale roof. This same coal is found in the S. W. ¼ of the N. E. ¼ of Sec. 4, on Chas. Miller's farm. Probably this same coal is found on David King's place, in the S. W. ¼ of the N. E. ¼ of Sec. 27. Mr. King reports the coal to be 18 in. thick, with a very soft sandstone roof. On Joseph Mann's place, in the S. E. ¼ of the S. E. ¼ of Sec. 21, this coal has been drifted upon. Some 20 ft. below the horizon of this coal is an outcrop of coal 5 in. thick in the road some 300 yds. northwest of a schoolhouse, in the N. W. ¼ of the S. E. ¼ of Sec. 21. The coal is overlain by 2 ft.+ of drab shale, with 2 in. of shale as floor, which rests upon 1 ft. 6 in. of hard chalk-white sandstone. This is probably the same coal as reported being found on J. C. Striegel's farm, in the N. W. ¼ of the N. E. ¼ of Sec. 21. Years ago Coal II was mined on the McCarty farm, now Mrs. Grass's place, near Schnellville, in the N. E. ¼ of the S. W. ¼ of Sec. 16. This coal outcrops on August Blume's farm, in the S. E. ¼ of the N. E. ¼ of Sec. 18. Coal reported 11 or 12 in. thick. Below is given the section of Mr. Blume's well as reported by Mrs. Blume (Sect. 715):

		Ft.	In.
1.	Soil	6	0
2.	Solid sandstone	21	0

The coal that outcrops in the same quarter section seems to be about 12 ft. below the bottom of the well. Coal II has been mined at a number of places southwest of Mentor, along the L., E. & St. L. C. R. R.—at B. B. Able's, in the N. E. ¼ of the N. W. ¼ of Sec. 34; Theo. Whaley's and Jno. Chanley's, in the S. W. ¼ of the N. E. ¼ of Sec. 33; Dan Taylor's, in the N. E. ¼ of the N. W. ¼ of Sec. 33; at Enoch Able's, in the N. W. ¼ of the N. W. ¼ of Sec. 33, and at Mary A. Tebben's and Mary Baron's, in the N. W. ¼ of Sec. 29. This coal was examined at a number of the above places with practically the same result. Below is given the result of the examination made at the Whaley mine, in the S. W. ¼ of the N. E. ¼ of Sec. 33: At the entrance of the drift the coal measured 32 in. and was divided into the following benches from top to bottom: Six in. of hard lustrous coal; 3 in. of semi-block coal, with now and then a discontinuous streak of fine rotten shaly

coal. The coal is overlain with 52 in. of blue to drab shale, which is overlain with 2 ft.+ of soft red sandstone. Floor is of shale and sandstone. Parts of this coal are good for shop use. Burns well, leaving few clinkers, but does not char well.

Other outcrops were noted at A. T. Whaley's, in the S. E. ¼ of the S. E. ¼ of Sec. 27; B. Ott's, in the N. W. ¼ of the S. W. ¼ of Sec. 26, and at Irvin Whaley's, in the S. E. ¼ of the S. W. ¼ of Sec. 33.

Township 3 South, Range 3 West, North Half.

1657. Geography.—This partial township is located in the southeastern corner of the county, including the southern half of the civil township of Jefferson. Anderson river crosses the eastern half of the township. The western half is drained by Hurricane creek, which flows southwest across the township. The topography runs from high broken hills to narrow valleys, the valley of Anderson river being the widest, ranging in width from 300 to 500 yds. The hills along this river rise from 100 to 200 ft., with the lower half of the slope very steep. A jutting ledge of sandstone some 10 or 15 ft. thick is exposed along the western bank of the river only a few feet above the water's edge. Higher on the hill, 100 ft. or more, is another exposure of sandstone, rather massive, which is probably the Mansfield. Typical exposures of the Mansfield sandstone occur along the small branch flowing southeast, south of the center of Sec. 11. These exposures form cliffs 20 or 30 ft. high, with perpendicular walls filled with deep irregular pockets. The nearest railroad is the L., E. & St. L. C. R. R., one to two miles north of the township.

1658. Stratigraphy.—The prevailing outcrop is sandstone, quite soft and massive to hard flaggy exposures. It is quite possible that the Anderson river has cut down to some of the upper members of the Kaskaskia group, the sandstone exposed just above the river probably belonging in this group.

The exposed strata of this township, including the upper members of the Kaskaskia group, belong in Divisions I and II, with two coals exposed—Coals Ia and II, both unworkable. The line of outcrop of Coal II, as shown on the map, occurs high in the ridge west of Anderson river, following the meandering of the side streams of that river, and runs south into Perry county, returning, however, along Hurricane creek, following north around the head waters of this stream, and thence south to Perry county, crossing the county line near the S. E. corner of Sec. 18. An exposure of this coal was observed on S. E. Newton's place, in the S. E. ¼ of the S. E. ¼ of Sec. 10. Coal measures 12 in. and was covered with loose sandstone and shale. This coal is probably 100 ft. above Anderson river. What seems to be the same coal was reported outcropping on Irving Whaley's farm, in the S. E. ¼ of the N. E. ¼ of Sec. 8. A lower coal, probably Coal Ia, was reported outcropping in the bed of a small branch on H. Keorner's place, in the N. E. ¼ of the S. E. ¼ of Sec. 17. The same coal occurs on Isaac Hobbs's farm, in the S. E. ¼ of the S. E. ¼ of this section. This lower coal is very thin, 12 in. being the greatest thickness reported, and seems to be very "pockety." Coal II is also very thin, its greatest thickness not exceeding 12 in. Owing to the covered condition of the few exposures of this half township, the correlation is very unsatisfactory.

Township 1 South, Range 4 West.

1659. Geography.—This township lies near the northeastern quarter of the county, and is included in the civil townships of Harbison, Bainbridge and Marion, the greatest part lying in the last mentioned township. Patoka river crosses the township in a meandering course from the northeastern to the southwestern corner, receiving a number of tributaries, the largest of which are Bailey creek, Teder creek, Beckman creek and Beaver creek. Teder and Beckman creeks drain the southeastern quarter of the township. The south half of the township is rough, the hills rising from 50 to 150 ft. above the branch bottoms. The north half is not so rough, including the bottom lands of the Patoka river.

1660. Stratigraphy.—The outcropping strata of this township belong in Divisions I, II and III. Very little coal has been mined in this township, and but few exposures observed, due to which the correlation is very unsatisfactory. All coals of this township have been classed in Divisions I and II. Division III is found in the northwestern part of the township, and the horizon of Coal III is located by the loose chert in the southeastern part of the township, in the S. W. ¼ of Sec. 35. At only this one place was this chert observed, where it was confined to the top of one hill and was exposed in the road. No trace of Coal III was found. It was said that years ago Coal II was worked on Felix Schneider's place, near the center of Sec. 35, and on Jno. Schneider's farm, in the N. W. ¼ of the N. W. ¼ of the same section. Five or six years ago Coal II was worked by a stripping on Geo. Humbert's farm, in the N. W. ¼ of the N. W. ¼ of Sec. 36. Coal said to be 25 or 30 in. thick, but not a good quality. Ten or twelve years ago some coal was mined by a stripping on Joe Stein's farm, in the S. W. ¼ of S. E. ¼ of Sec. 23. No exposures at this place at the time of examination. Coal seems to be below the horizon of Coal II. In the S. E. ¼ of Sec. 32, Coal II outcrops on L. Bicklein's farm, on Jno. Bicklein's farm and on L. Pfau's place.

In the S. W. ¼ of Sec. 29, on Jno. Kreilein's farm, Coal II was said to outcrop, with a thickness of 24 to 27 in.

Coal 27 in. thick is found under the sandstone that is quarried on Ben Shroater's farm, in the S. E. ¼ of the S. W. ¼ of Sec. 20. Reported by a miner who mined the coal.

A lower coal than Coal II was worked by a stripping on a small scale years ago, on Joe Friedmann's place, in the S. E. ¼ of Sec. 20, and on Conrad Sitz's place, near the center of the N. E. ¼ of Sec. 20. Coal covered at time of examination. Coal in Division I was reported on J. L. Neukam's place, in the S. W. ¼ of Sec. 11, and the N. E. ¼ of Sec. 12, on the Poleson place. No coal mined at either of the last two mentioned places for years. At present the coal is covered.

Township 2 South, Range 4 West.

1661. Geography.—This township lies in the central part of the county, including all of Jackson township except the extreme eastern part, the southern part of Marion township and the southeastern corner of Bainbridge township. Hall creek crosses the northern part of the township and drains that part of it. Flat creek crosses the township from the southeastern corner to the northwestern part, joining Hall creek north of Maltersville, forming Straight creek. The topography of this township runs from narrow, level creek valleys to irregular, broken hills, running from 50 to 100 ft. in height.

1662. Stratigraphy.—The outcropping strata of this township belong in Divisions I and II (?), with two coals exposed, Coal II and Coal IIa, Coal IIa occurring only in the southwestern corner of the township as a very thin and discontinuous coal. Coal II probably underlies one-half of the township and has a workable thickness at a number of its croppings.

This coal is mined most extensively at the St. Anthony mine, where the following report was obtained: Maximum thickness of the coal, 4 ft.; minimum thickness, 3 ft. 4 in., with an average of 3 ft. 9 in.

The quality and physical details of the coal were not constant. Below are given the different divisions of the coal from top to bottom (Sect. 716):

		Ft.	In.
1.	Hard lustrous coal with sulphur balls	0	11
2.	Block coal free from sulphur balls	0	10
3.	Streak of hard slate	0	3
4.	Block coal	1	4
		3	4

The coal rests upon a soft shale, below which is a bed of fire-clay. The last division of the coal is a good coal for blacksmithing purposes, as reported by the smiths in St. Anthony.

The line marking the outcrop of this coal is shown on the map as running around the headwaters of Flat creek and Hall creek. It was reported that coal was mined five years ago on the Andy Buechler place, in the N. W. ¼ of the N. E. ¼ of Sec. 21, but at time of examination the entrance was closed so that an examination of this coal was impossible. From the outcropping strata up the branch from the old mine this coal was correlated as Coal II. In the same quarter section an outcrop of what was considered to be the same coal was noted. The exposure occurs in the road on the south side of a small branch running west into Flat creek. The following section was obtained at the crop (Sect. 717):

		Ft.	In.
1.	Hard sandstone	1	0
2.	Shale	10	0
3.	Hard sandstone	2	0
4.	COAL II	0	4
5.	Fire-clay	0	6
6.	Soft shale and sandstone	5	0
7.	Shale	8	0
		26	10

Following the line of outcrop northwest, the next crop was noted in the road in the N. W. ¼ of the N. W. ¼ of Sec. 16. At this point the line of outcrop turns east and southeast around the headwaters of Grassy Fork, a small branch in Secs. 13, 14 and 11 emptying into Hall creek in the S. E. ¼ of Sec. 10. This coal was drifted upon some twelve years ago on the Adam Buechler farm, in the S. E. ¼ of Sec. 9. Coal was reported to be a block coal, averaging 2 ft. in thickness and some 12 or 15 ft. above Hall creek and 40 or 50 ft. below the top of the hill. On the Bernard Knust place, in the S. E. ¼ of the N. E. ¼ of Sec.

23, some coal was mined by a drift three or four years ago. Entrance closed at time of examination, with no strata exposed. Above the coal in the branch is an exposure of shale, and below the coal in the branch is an exposure of 2 ft. of hard drab to red fire-clay. No massive sandstone is found in the branch near the old mine. The coal is about 40 ft. below the hilltop. One hundred yards east of the cross roads, in the N. W. ¼ of the N. W. ¼ of Sec. 13, is an exposure of coal 8 in. thick, with 5 ft.+ of bright bluish shale as a roof. Below the coal is 2 ft.+ of fire-clay. The coal outcrops some 20 ft. below the top of the hill, and is 6 ft. above adjacent drainage. The same coal outcrops in the same quarter section 350 yds. south of the cross roads. From this point the line of outcrop follows east, south of Hall creek, until it leaves the township. North of Hall creek there are no exposures, but the proper sandstones are exposed to locate the horizon of the coal.

In th southwestern quarter of the township this coal is exposed at the following places: On the Joe Buechler place, in the S. W. ¼ of the N. W. ¼ of Sec. 20; on the Jones place, in the N. E. ¼ of the S. W. ¼ of Sec. 29; at the railroad cut under the wagon bridge, north of Bretzville, near the center of the N. E. ¼ of Sec. 23; and on the Wm. Bretz place, near Bretzville, in the S. W. ¼ of Sec. 32. In the cut north of Bretzville the coal measured 32 to 34 in., with 2 to 4 in. of discontinuous shale above it, 6 to 8 in. of light reddish shale to shaly sandstone

Fig. 757. Sketch of rock exposures in railroad cut north of Bretzville from sketch by Mr. Price.

(a) Coal II.
(b) Shale and shaly sandstone.
(c) Sandstone and thin beds of coal.
(d) Limestone boulders.

above the shale, 2 to 3 ft. of shaly sandstone resting on the shale and shaly sandstone, and above this last mentioned shaly sandstone occurs 6 to 8 ft. of shale. The coal has a decided dip to the west at this point, dipping probably 4 or 5 ft. in 50 or 60 yds. At the west end of the cut the strata are somewhat distorted. Coal II has dipped beneath the surface, and 7 ft. above the railroad track is an exposure of a broken ledge of whitish sandstone 12 or 15 in. thick. In this sandstone ledge occur streaks of coal sometimes 2 in. thick. This coal outcrop is seen best along the south side of the cut, where it is exposed for 40 ft. or more, with a decided dip to the east, 3 ft. or more in 15 ft. Above the coal at one place is a broken ledge of whitish sandstone 1 to 3 ft. thick and 20 ft. long. Below the coal is an outcrop of 6 ft. of shale to shaly sandstone. Just east of the center of the cut the rocks form a trough, as seen on the south side, and on the west side of the trough, near the top of the cut, are two large impure limestone boulders.

1891

Seven or eight years ago, Coal II was mined quite extensively on Wm. Bretz's farm, west of Bretzville. The entrances are now closed Mr. Bretz gave the following report: Minimum thickness of the coal, 42 in.; average, 41½ in.; coal blocked out and was good coal; roof of slate and soft sandstone (roof was exposed); coal 1 ft. above adjacent drainage.

Township 3 South, Range 4 West.

1663. Geography.—This township lies in the southeastern part of the county and is included in the civil township of Ferdinand, with the exception of one tier of sections along the north side, which is included in the civil township of Jackson. Ferdinand lies near the center of the south half of the township and is the only village included in this township. The drainage of the township is into Indian creek on the north and Hunley creek on the west. Some parts of the township are very broken, with high hills and irregular, broken ridges. The hills rise from 100 to 200 ft., usually with steep slopes and occasional cliffs, especially in the southeastern part.

The nearest railroad is the Evansville division of the L., E. & St. L. C. R. R., which lies from 1½ to 3 mi. west of the township.

1664. Stratigraphy.—The outcropping strata for this township belong in Divisions I, II and III, with three coals exposed. The stratigraphy in part is shown by the following sections:

1665. Section 718. Section of a Well in Ferdinand, on Lot 237.—

	Ft.	In.	Ft.	In.
1. Soil	18	0	18	0
2. Sandstone	4	0	22	0
3. Blue shale	33	0	55	0
4. COAL II (?)	0	6	55	6
5. Blue shale	25	0	80	6
6. Rather soft white sandstone	59	0	139	6

1666. Section 719. Section of a Well on a Hill at the Sisters' Monastery in Ferdinand.—

	Ft.	In.
1. Soil	2	0
2. Soft massive sandstone	10	0
3. COAL III (?)	1	8
4. Fire-clay	2	0
5. Shale	14	0
	29	8

1667. Section 720. Section of a Well on the Hill.—200 yds. southeast of the center of Sec. 28.

	Ft.	In.
1. Soil	5	0
2. Shale	14	0
3. COAL	0	0
	19	0

When the coal was struck, digging stopped. What seems to be the same coal outcrops on the side of the hill and is said to be 18 in. thick.

The line of outcrop of Coals III and II are shown on the map. As is indicated on the map, Coal III only occurs in the highest hills in the east half of the township, and is usually accompanied with more or less of cherty limestone. This cherty limestone, which marks the horizon of the coal, was observed in position at a number of places in Secs. 2, 11, 12, 13, 14, 23 and 24, although coal was noted at but one place in these sections, viz., in the road along the south side of the S. W. ¼ of the N. W. ¼ of Sec. 13, where the following section was obtained:

1668. Section 721. Section in Road.—Sec. 13.

	Ft.	In.	Ft.	In.
1. Surface	5	0	5	0
2. Shaly sandstone	2	0	7	0
3. Fire-clay (?)	1	6	8	6
4. Red tough clay	4	0	12	6
5. Red and fire-clay	4	6	17	0
6. Drab shale	2	0	19	0
7. COAL III (?)	0	5	19	5
8. Fire-clay	1	6	20	11
9. Sandy shale	10	0	30	11
10. Fire-clay and shale (?)	2	6	33	5
11. Shale	7	0	40	5
12. Covered	3	0	43	5

The cherty limestone was not exposed along the road where the foregoing section was run, but one-fourth of a mile north in the road along the east side of Sec. 13, and apparently at a higher horizon, a heavy crop of limestone was noted. The horizon of the limestone was estimated some 20 ft. above the horizon of the coal. The coal has been drifted upon at Ben Beyke's, in the S. E. ¼ of the N. E. ¼ of Sec. 26, where, by an examination, the following data were gathered: Coal ranges in thickness from 3 ft. to 2 ft. 6 in., with a probable average of 2 ft. 9 in.; is very shaly; slacks quickly; is a very poor quality of coal, leaving many ashes in burning, and can only be burned when used with wood. This coal is reported to be a cannel coal, but a better name for it would be "oily shale."

1669. SECTION 722. SECTION OBTAINED AT THE ENTRANCE OF THE DRIFT.—

	Ft.	In.
1. Surface	10	0
2. Limestone	4	0
3. Cherty limestone	3	0
4. Fire-clay (?)	2	0
5. Bituminous shale	5	0
6. COAL III	3	0
7. Shale	2+	0
	29	0

The limestone is not persistent, but lies in very large boulders. The disintegration of some of the cherty limestone has formed quite a lot of "tripoli," which lies near the top of the upper bed of limestone. The same coal outcrops near the forks of the road near the N. W. corner of the N. E. ¼ of the N. E. ¼ of Sec. 26. This coal is said to outcrop on the hill near the Sisters' Monastery in Ferdinand, and was found at some three or four places along the road through the N. ½ of Sec. 29. At the outcrop in the N. E. ¼ of the N. E. ¼ of this section the following section was made (Sect. 723):

	Ft.	In.
1. Surface	1	0
2. Cherty limestone	2	0
3. Clay and light shale	3	6
4. COAL III	0	3
5. Fire-clay	1	0
6. Clay, light shale and ferruginous sandstone	4	0
7. Shaly sandstone	20	0
	31	9

At the outcrop in the N. W. ¼ of the N. W. ¼ of Sec. 29, the coal is divided into two benches, with 6 ft. of intervening clay and shale.

One mile west of Ferdinand the following sections were obtained: Section of exposed strata in the road along the south side of the S. W. ¼ of the S. E. ¼ of Sec. 31 (Sect. 724):

	Ft.	In.
1. Shale and sandstone	4	6
2. Thin bedded sandstone	10	0
3. Shaly sandstone	5	0
4. Obscured	2	0
5. Massive sandstone	6	0
6. Soft massive sandstone	4	0
7. Obscured	20	0
	51	6

Section of the hill along the road on the north side of the N. E. ¼ of the N. E. ¼ of Sec. 31 (Sect. 725):

	Ft.	In.	Ft.	In.
1. Soil and shale	2	0	2	0
2. Shaly sandstone	2	0	4	0
3. Massive to thin bedded sandstone	10	0	14	0
4. Ferruginous sandstone	0	8	14	8
5. COAL III (?)	0	2	14	10
6. Shale (?)	1	0	15	10
7. Fire-clay	4	0	19	10
8. Covered	2	0	21	10
9. Cherty limestone	0	5	22	3
10. Fire-clay	2	6	24	9
11. Fire-clay and red clay	6	0	30	9
12. Limestone	0	8	31	5
13. Covered	7	0	38	5

It is more than probable that the limestone in the above section was not in position. If so, there seems to be two distinct strata of limestone, neither one accompanied with coal.

Section of the hill at the N. E. corner of Sec. 31 (Sect. 726):

	Ft.	In.
1. Surface	10	0
2. Red tough clay	8	0
3. Red bluish clay	2	0
4. Fire-clay	4	0
5. Drab shale	3	0
6. Impure sandy limestone	0	6
7. Tough red clay	15	0
	42	6

Section along the hill near the center of the north side of the N. W. ¼ of the N. W. ¼ of Sec. 32 (Sect. 727):

	Ft.	In.
1. Surface	2	0
2. **Flinty limestone**	2	9
3. Hard bluish limestone	1	0
4. Fire-clay	2	0
5. Shale	2	6
6. Hard, bluish limestone	1	7
7. Obscured	30	0
	41	10

Apparently the lower limestone is in position, making two strata of limestone in the hill. It is possible that this lower limestone stratum corresponds with the lower bed of limestone found farther south as rather a persistent bed through Spencer county. If this be true, the other bed of limestone marks the horizon of Coal IIIb. These two beds of limestone do not both extend north, but, as far as investigation showed, only one extends north. The presence here of the lower limestone may be an irregularity or a slip, although it seems "in situ."

Coal II outcrops along Hunley creek and is worked by a drift at Oeding's, in the N. W. ¼ of the S. W. ¼ of Sec. 30, where the following report was obtained:

Maximum thickness of the coal was 3 ft., with a minimum thickness of 2 ft. 4 in., and a general average of 2 ft. 6 in. The coal is divided into two benches by a rather persistent sulphur streak, or "sulphur blossom," as reported by the miner. Sulphur balls are found in all of the coal except 6 in. at the top, which was reported good coal for smiths' use. The lower bench is not suitable for shop use. Has few rolls and a marked dip to the northeast. Massive shale roof, which holds up fairly well. Rooms are from 12 to 14 ft. wide, with three rows of props. Floor formed of shale and fire-clay. The miner is of the opinion that there is only a basin of coal at this place, probably some five or six acres in all. He reports that efforts have been made to strike this coal not more than ½ mi. away and that in each case no coal was found. As far as personal examination went, no coal was found outcropping on the west side of Hunley creek in the neighborhood of the Oeding mine; but it is more than probable that the coal is persistent and that the exposures were obscured, as what seems to be the same coal is worked at the Miller mine on the east side of the creek, in the S. E. ¼ of the S. E. ¼ of Sec. 19. Below is given the section of the air-shaft at the Oeding mine as reported by the miner:

1670. SECTION 728. SECTION OF OEDING SHAFT.—

	Ft.	In.	Ft.	In.
1. Soil	7	0	7	0
2. Soft yellow sandstone	27	0	34	0
3. **COAL IIb**	0	1	34	1
4. Hard "iron rock"	2	0	36	1
5. COAL IIa	1	6	37	7
6. Fire-clay	8	0	45	7
7. Massive shale	10	0	55	7
8. COAL II	2	10	58	5

Coals IIa and IIb are not persistent and were reported only at this one place.

At first examination it was thought that the coal worked at the Miller mine, in Sec. 19, corresponded to Coal IIa in the foregoing section, and was so correlated. But after a more thorough examination it was concluded that the coal worked at the Oeding mine was the same coal as mined at Miller's. The following report was obtained at the Miller mine:

Thickness of the coal varies from 2 ft. 8 in. to 2 ft. 1 in., with an average of 30 in., and is divided into three parts, viz., 4 in. of hard coal, or bone coal on top; 18 in. of block to semi-block, and 8 in. of soft bituminous coal. Free from sulphur balls and streaks. Roof of shaly sandstone to soft shale, which holds up well. Rooms 20 by 20 ft., with two rows of props. Floor of fire-clay, 2 ft. thick. Few small rolls and horsebacks were reported, but no faults. Coal reported to be very good for steam and house use. Burns to a white ash, leaving very few clinkers. The coal is about 30 or 40 ft. below the flinty limestone found on the hill, and some 25 ft. above Hunley creek. The Oeding mine is some 20 ft. above the creek.

An outcrop of Coal II was noted in the S. E. ¼ of the S. W. ¼ of Sec. 9, when the following section was obtained (Sect. 729):

	Ft.	In.
1. Surface	2	0
2. Shaly sandstone	2	6
3. COAL II (?)	0	2
	4	8

What seems to be the same coal, as given in the foregoing section, has been worked at Meyer's, in the S. W. ¼ of the S. W. ¼ of Sec. 9. The following report was given by Mr. Meyer: Coal ranges from 3 ft. to 0 in thickness, averaging probably 3 ft.; free from sulphur balls and clay bands, with quite a number of small rolls and irregularities in the dip. Coal was not shot, but wedged down. Block to semi-block.

Section of coal (Sect. 730):

		Ft.	*In.*
1.	Soil	6	0
2.	Red to white sandstone	10	0
3.	Hard sandstone	2	0
4.	Shale	1	8
5.	COAL II	2	6
		22	2

Below the coal occurs a hard shaly coal, or a "hard shaly stone," which makes a splendid floor. Coal dips to the west, and is below drainage, due to which fact the mine was abandoned some eight years ago. It was reported that this same coal outcrops on the Hopperyians farm, in the N. E. ¼ of the S. E. ¼ of Sec. 8.

TOWNSHIP 1 SOUTH, RANGE 5 WEST.

1671. GEOGRAPHY.—Jasper, the county seat of Dubois county, is located in the southeastern part of this township. It extends one mile west of Ireland and north to the base line, including the northwestern part of Bainbridge, northeastern part of Madison, southeastern part of Boone, and northeastern corner of Harbison townships. The Patoka river crosses the southeastern corner of the township, draining that part of it. The southwestern part is drained by Crooked creek and Alder creek. Crooked creek rises near the center of the township, flows southwest and empties into Patoka river. Alder creek rises north of Ireland, flows south and empties into the Patoka river. The northern part of the township is drained by Mill creek. The southeastern part of the township is somewhat hilly, the hills rising from 40 to 50 ft., but with gentle slopes. The western and northwestern part is included in the alluvial plain of Straight creek and Hunley creek, and is comparatively level, with slope enough, however, to give good drainage. A few low rolling hills are found in the northern part, west of Mill creek, between Patoka lake plain and the alluvial plain of Patoka river, which crosses the northeastern part of the township from Buffalo pond to Mill creek. A branch of the L., E. & St. L. C. R. R. comes into Jasper from the south.

1672. STRATIGRAPHY.—The outcropping strata of this township belong in Divisions II, III and IV, with three coals exposed. A drilling in Jasper pierces the underlying strata, going through one coal.

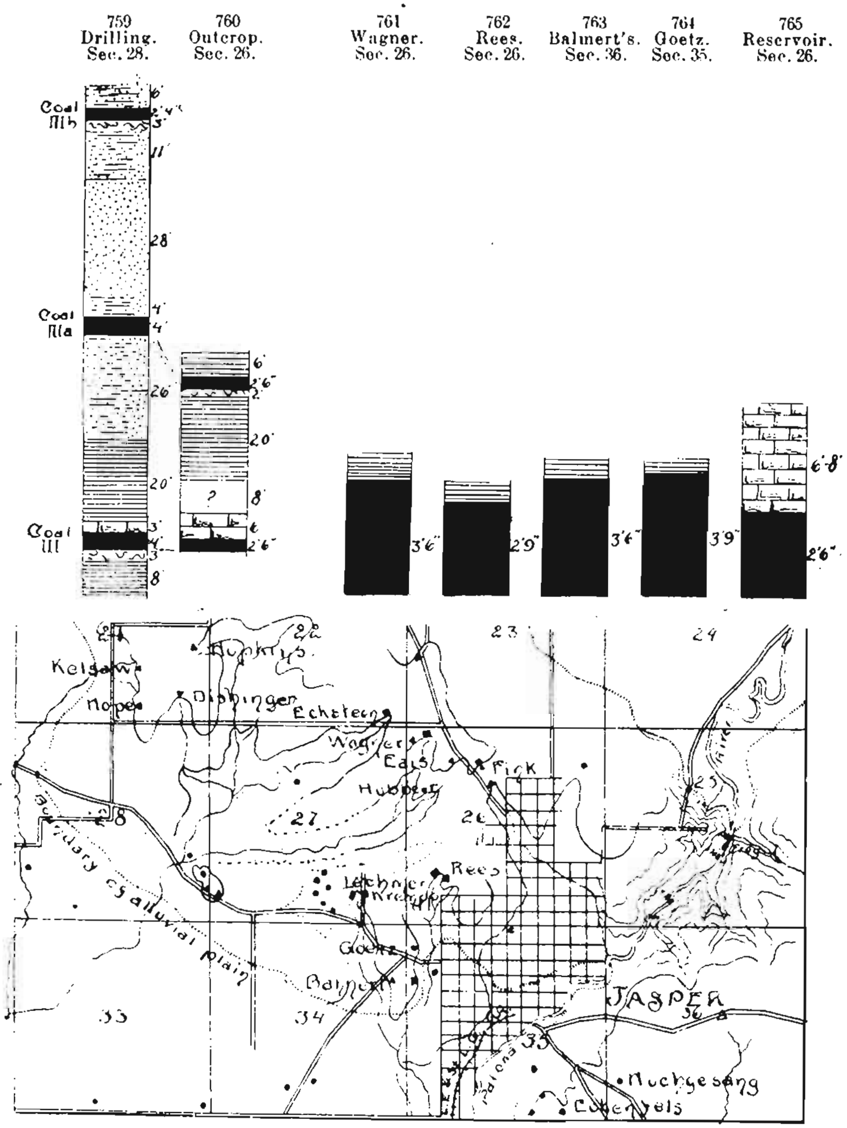


Fig. 758. Sketch map of part of T. 1 S., R. 5 W. In Sec. 25 the postglacial gorge is shown by the use of 20 ft. of contours.
Figs. 759-760. Columnar sections, same area.
Fig. 761. Coal IIIb, same area.
Figs. 762-764. Coal IIIa, same area.
Fig. 765. Coal III, same area.

As far as known, no record has been kept of this well, and the section given below was given by Dr. Salb, of Jasper, from memory:

1673. SECTION 731. SECTION OF "GAS WELL."—In Patoka river bottoms, eastern part of Jasper, N. E. ¼, Sec. 35.

		Ft.	In.	Ft.	In.
1.	Soil	32	0	32	0
2.	Sandstone	16	0	48	0
3.	Shale	40	0	88	0
4.	COAL	1	0	89	0
5.	Fire-clay	3	0	92	0
6.	Shale with nigger-heads	170	0	262	0
7.	White sandstone	9	0	271	0
8.	Blue shale	120	0	391	0
9.	Limestone	8	0	399	0
10.	Blackish slate. (thickness forgotten)	..	..	..	..
11.	Limestone	4	0	403	0
12.	Sandy limestone (thickness forgotten)	..	..	..	..

West of Jasper, in the N. E. ¼ of Sec. 35, a drilling was made 308 ft. deep, passing through the same strata as in the "gas well."

A bed of coal was pierced which was 4 ft. higher than what seemed to be the same coal in the "gas well." (Line of levels run by Geo. Wilson.)

A bed of coal 1 ft. thick was struck in a well at the brewery on Main street, four blocks north of public square.

The coals exposed in this township are Coals III, IIIa, IIIb, all workable.

The following sections will give their relative position and accompanying strata:

1674. SECTION 732. SECTION OF DRILLED WELL ON TOP OF HILL.—In S. E. ¼ of S. E. ¼ of Sec. 28, Fig. 759.

		Ft.	In.	Ft.	In.
1.	Soil	16	0	16	0
2.	Shaly sandstone	6	0	22	0
3.	COAL IIIb	2	4	24	4
4.	Fire-clay	3	0	27	4
5.	Hard reddish dirt	11	0	38	4
6.	White sandstone	28	0	66	4
7.	Shaly sandstone	4	0	70	4
8.	COAL IIIa	4	0	74	4
9.	Reddish gray dirt	26	0	100	4
10.	Blue shale	20	0	120	4
11.	Flinty limestone	3	0	123	4
12.	COAL III	4	0	127	4
13.	Fire-clay	3	0	130	4
14.	Shale	8	0	138	4

1675. SECTION 733. SECTION OF THE HILL NORTH OF JASPER RUNNING PAST THE RESERVOIR.—In N. W. ¼, Sec. 26, Fig. 760.

		Ft.	In.	Ft.	In.
1.	Shaly sandstone	5	0	5	0
2.	Light shale	6	0	11	0
3.	COAL IIIb	2	6	13	6
4.	Fire-clay	2	6	16	0
5.	Shale	20	0	36	0
6.	Obscured	8	0	44	0
7.	Limestone	6	0	50	0
8.	COAL III	2	6	52	6
9.	Fire-clay	1+	0	53	6

Coal IIIa has run out at this place or is obscured.

The lines of outcrop of Coals III and IIIb are shown on the map. Coal III has been worked on F. Eckenfels's farm, in the S. E. ¼ of Sec. 35, and years ago was worked on what is now the Fink land, in the S. E. ¼ of the N. W. ¼ of Sec. 36, and in the northwestern part of Jasper, some 150 ft. southeast of the reservoir. Above the coal is an exposure of some 6 or 8 ft. of limestone, a splendid stone for macadamizing purposes, which could be used to a great advantage on the streets of Jasper. Few exposures of this coal were observed, although it underlies the greater part of the township. Coal IIIb is found only high in the hill northwest of Jasper, and has been worked at some three or four places in the neighborhood of Cedar Garden, in the N. W. ¼ of the N. W. ¼ of Sec. 26. It has been drifted upon on Mary Wagner's farm, in the N. W. ¼ of the N. W. ¼ of Sec. 26. Coal reported 3 ft. 6 in. thick, free from sulphur balls and streaks, and has shale roof, which holds up well. The upper part of the coal is rather soft, while the lower part, especially the last 8 in., is hard and lustrous, and is a good coal for smith's use (Fig. 761). Same coal is worked on Mat. Eais's farm, in the same quarter section. Outcrops were noted in the road on the reservoir hill northeast of Jasper and in the N. E. ¼ of the S. W. ¼ of Sec. 23. The top of the high hill in the S. W. ¼ of the S. W. ¼ of Sec. 27 and the S. E. ¼ of the S. E. ¼ of Sec. 28 is underlain by Coal IIIb. Two exposures were seen in the road at this place, one in Sec. 27 and the other in Sec. 28.

Coal IIIa is the most important coal of this township, or at least it has been developed the most. This coal is mined at quite a number of places near Jasper and largely supplies the town with coal. The greatest number of openings lie to the west and northwest of town. In general the coal is of a fair quality and is a very good steam coal. Usually it is too sulphurous for shop use.

The roof in most places consists of soft shale, 1 to 5 ft. thick, over which lies a soft and rather massive sandstone.

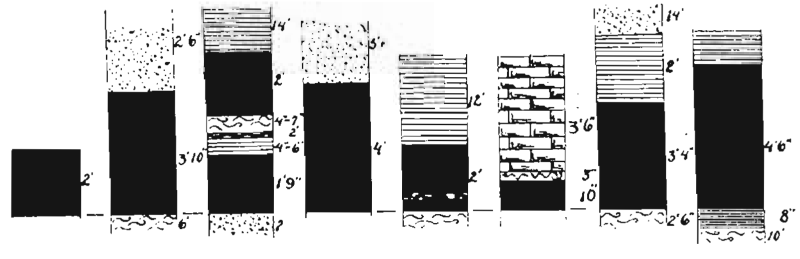
At the Goetz or Hoffman mine, west of Jasper and near the center of the N. W. ¼ of Sec. 35, the coal measured 3 ft. 9 in. at its greater thickness and 3 ft. 8 in. at its narrowest place, with an average of 3 ft. 8½ in. Coal rather sulphurous, but free from clay bands (Fig. 764). Near the entrance of the drift a small anticlinal fold was observed. The same coal has been drifted upon on the opposite side of the hill, on Anthony Bahnert's place, in the N. E. ¼ of Sec. 36. Here the coal was reported 3 ft. 10 in. to 3 ft. 4 in. in thickness, with an average of 3 ft. 6 in. (Fig. 763). Has no sulphur band or clay band, but has sulphur balls near the bottom. Bituminous to semi-block coal. Number of rolls ranging from 6 to 8 in. in the mine. Coal has a decided dip to the southwest, dipping 12 ft. in 200 ft. The same coal is drifted upon at three or four places in the S. E. ¼ of Sec. 27, on Andrew Krempp's and Joe Lechmer's farms, and worked by a slope on the Rees farm, in the S. W. ¼ of Sec. 26. The coal is not quite as thick here as at the Bahnert mine, ranging from 2 ft. 6 in. to 3 ft., with an average of 2 ft. 9 in. (Fig. 762). Coal fairly good; has some sulphur, with few cross seams; no faults, but few rolls. The roof is of shale and sandstone; the sandstone is soft and laminated. In the S. E. ¼ of Sec. 21, Coal IIIa has been worked by a drift at the following mines: Frank Hopkins's, Geo. Dishinger's, south of Hopkins's; Andy Hope's, southwest of Dishinger's, and L. M. Kelsaw's, north of Hope's. At each of these mines the coal and roof are in general the same as at the Rees mine. An abundance of coal is found in the hill northwest of Jasper for all local use.

Township 2 South, Range 5 West.

1676. Geography.—This township lies in the south-central part of the county, principally in Patoka and Bainbridge townships, comprising the section of country between Jasper and Huntingburg. Patoka river enters the northeastern part of the township, in Sec. 2, and flows southwest to near the central part, and then turns to the northwest, leaving the township in Sec. 6, draining the north half of the township. The southeastern part is drained by Hunley creek, which enters Sec. 36 and flows to the northwest, emptying into Patoka river in Sec. 16.

1677. Topography.—With the exception of some few low and gentle hills east of Patoka river, the north half is comparatively level,

including a part of the level plain of Straight creek and Hunley creek. The south half is somewhat hilly, the hills rising from 30 to 50 ft., but with usually gentle slopes. No continuous ridges, the streams having broken them into short, irregular ones. The L., E. & St. L. C. R. R. crosses the township from north to south, passing through the center of the east half.



766 Cox. Sec. 18. 767 Stenftnezal. Sec. 5. 768 Rosebank. Sec. 14. 769 Vogler. Sec. 14. 770 Bretz. Sec. 27. 771 Echenfels. Sec. 2. 772 Haskins. Sec. 20. 773 Huntingburg. Sec. 34.

Figs. 766-773. Sections of worked coals in T. 2 S., R. 5 W. Fig. 766, Coal IIIb. Figs. 767-768, Coal IIIa. Figs. 769-772, Coal III. Fig. 773, Coal II.

1678. Stratigraphy.—The outcropping strata of this township belong in Divisions III and II, with three coals exposed--Coals III, IIIa and IIIb. The outcropping strata vary a great deal over the township, running from a hard massive sandstone to shale. This is seen in the following typical section:

1679. Section 734. Section Along Road Running West Across the L., E. & St. L. R. R.—S. E. ¼ of the S. E. ¼ of Sec. 23.

		Ft.	In.
1.	Soil and shale	5	0
2.	Hard sandstone	1	0
3.	COAL IIIa (?)	0	2
4.	Fire-clay	1	6
5.	Shale	12	0
		19	8

Along the same road, 300 yds. northeast, in the S. E. ¼ of the S. E. ¼ of Sec. 23, the following strata are exposed:

1680. Section 735. Section in Sec. 23.—

		Ft.	In.
1.	Surface	5	0
2.	Shale	15	0
3.	Sandstone, massive	12	0
		32	0

1681. SECTION 736. SECTION OF BORING IN N. E., N. W. ¼ SEC. 14.—

		Ft.	In.
1.	Yellow clay	9	0
2.	Reddish sandstone	7	0
3.	Fire-clay	1	0
4.	Sandstone	5	0
5.	Gray sandstone	7	0
6.	Slate	9	0
7.	Slate, gravel and coal	3	0
8.	Hard gray sandstone	22	0
		46	0

Some little coal was found scattered through the hard gray sandstone, No. 8. Coal was reported outcropping in the bed of the Patoka river, N. E. ¼ of Sec. 14. This outcrop is only 24 ft. below the top of boring as determined by a line of levels run by Geo. Wilson, of Jasper. If this coal is the same as pierced in the well, there is a dip of 14 ft. to the west in 300 yds.

1682. DISTRIBUTION AND LOCAL DETAILS.—The map shows the territory underlain by Coals III and IIIb. The line of outcrop of Coal III enters the township in Sec. 2 on each side of the Patoka river, and follows the meanderings of this stream and its affluents probably as far west as Sec. 17. Very few exposures of this coal were observed along the river, and the line of its outcrop was located with reference to outcrops of sandstone and shale, which are subject to such great variations that it makes the location of this line very uncertain and unsatisfactory.

The coal has been worked on Frederick Echenfel's farm, in the N. E. ¼ of Sec. 2, where the coal measured 10 in., with a roof of red clay and hard bluish limestone, the clay measuring 3 in. and the limestone from 2 ft. to 3 ft. 6 in. thick. (Fig. 771.) The coal is hard and lustrous and contains but little sulphur. West of this exposure some 300 yds. is an old drift or slope with entrance closed and no strata exposed. In another stream, 300 yds. to the north, are four or five old openings with entrances closed. Very little coal has been mined here, and, due to the fact that all outcrops were obscured, the correlation of this coal is uncertain. If it is Coal III, there is a decided dip to the north and west from the old stripping in the field to the south; if it is a lower coal, it is the only place in this township where this coal has been worked. There are no exposures of any coal in this township, or in township 1 S., 5 W., lower than Coal III. It is quite

probable that all of these openings reach the same coal, the different elevations being due to irregularities in the lay of the coal. Some eight years ago, what is probably the same coal, was worked on John Vogler's place, in the N. W. ¼ of the N. E. ¼ of Sec. 14. Coal was said to be 4 ft. thick, free from sulphur balls and partings, with a hard sandstone roof 4 or 5 ft. thick. (Fig. 769). Coal said to block well and free from rolls. Coal III has been worked by a drift on Conrad Hoffman's farm, in the N. E. ¼ of the N. E. ¼ of Sec. 20. Coal was reported 18 to 20 in. thick, with a slate and limestone roof. This drift is along Patoka river and is about 2 ft. above the water's edge.

Outcrop reported near the center of the N. E. ¼ of Sec. 21. Coal said to be 18 in. thick and 4 or 5 ft. above drainage.

At the Bretz mine, in the N. W. ¼ of the N. E. ¼ of Sec. 27, Coal III is worked by a shaft, where the following report was obtained from Mr. Bretz: Coal runs from 2 ft. 11 in. to 1 ft. 6 in. in thickness, with an average of 2 ft. Four or five inches from the bottom is a 3 in. streak of soft bone coal, under which is 1 to 2 in. of cannel (?) coal. Roof said to be shale (?), 12 to 13 ft. thick. Floor is a light blue fire-clay, with here and there patches of gray shale and sandstone with stigmaria. (Fig. 770.) The coal dips to the southeast, falling 5 or 6 ft. in 140 yds. Mr. Bretz is of the opinion that the coal is not persistent, but merely a small basin. His neighbors have drilled for the coal and found none. Probably one-quarter acre has been worked out.

An outcrop was observed in the wagon road 300 yds. west of the center of Sec. 35 and east of Huntingburg. Below is given a section of exposed strata as seen in the road on the east side of the hill (Sect. 737):

		Ft.	In.	Ft.	In.
1.	Surface soil	5	0	5	0
2.	Soft massive sandstone	6	0	11	0
3.	Rather hard sandstone	1	0	12	0
4.	Fire-clay	2	6	14	6
5.	Shale	5	0	19	6
6.	Hard, flinty, disintegrating limestone	1	0	20	6
7.	Fire-clay with coal streak	3	0	23	6
8.	Shale	12	0	35	6

It is quite probable the fire-clay, No. 4, marks the horizon of Coal IIIa, as the overlying sandstone has all of the characteristics of the sandstone roof of this coal. The fire-clay, with the coal streak and underlying this limestone were obscured at the time of the examination. stone bed outcrops in the street near the foot of the hill some 300 yds. west of the public school building and 150 yds. southwest of Bucking Brothers' clay bank, in the west part of Huntingburg. The strata underlying this limestone were obscured at the time of the examination, but the coal exposed in the clay bank to the northwest, 150 yds., is probably Coal III, although there is an exposure of coal in the street above the limestone which might correspond to the coal in the clay bank. In this case the coal in the bank, which measures from 8 to 18 in. in thickness, with a number of small rolls, would be Coal IIIa. Below is given a section of the hill 200 yds. northeast of the standpipe in the N. W. ¼ of the S. W. ¼ of Sec. 34. The section starts some 15 or 20 ft. below the top of the hill.

1683. SECTION 738. SECTION AT STANDPIPE HILL.—Huntingburg, Sec. 34.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface of red clay and shale	5	6	..	..	5	6
2. COAL	1	5	1	5	6	11
3. Fire-clay	3	6	..	..	10	5
4. Clayish shale	1	0	4	6	11	5
5. COAL	0	5	0	5	11	10
6. Bluish shale	4	6	..	..	16	4
7. Drab shale and shaly sandstone	15	0	..	..	31	4

Farther east in the road, or street, running east on the center section line, is another exposure of coal, which seems to lie about 12 ft. below the lower coal given in the foregoing section. This seems to correspond with the coal in the Bucking Brothers' clay bank. In the street below this exposure is the exposure of limestone referred to above. This outcrop of limestone consisted of a number of rather large boulders, and at no point did the exposure show a continuous stratum. It is quite possible that there has been a slip at this place and that this limestone is not "in situ." Slips aside, there seem to be three veins of coal in this hill, all dipping to the northeast. Cherty limestone is found loose in the top of the ridge and along the sides.

Coal III was pierced in Henry Neihan's well, in the N. E. ¼ of the N. E. ¼ of Sec. 32. Below is the section reported (Sect. 739):

	Ft.	In.
1. Soil	12	0
2. Hard flinty stone	14	0
3. COAL III	0	1
4. Fire-clay	4	0
5. Sandstone	12+	0
	42	1

Limestone was reported outcropping in the railroad cut in the S. E. ¼ of the N. W. ¼ of Sec. 29. The outcrop found in the road in the S. E. ¼ of the N. W. ¼ of Sec. 20 was correlated as IIIa. The following section was obtained (Sect. 740):

	Ft.	In.
1. Soil	2	0
2. Shaly sandstone	4	0
3. Thin bedded sandstone	4	6
4. COAL IIIa	0	5
	10	11

Mr. N. Haskin reported the following section of a boring made in the N. W. ¼ of the S. E. ¼ of Sec. 30 (Sect. 741, Fig. 772):

	Ft.	In.
1. Soil	13	0
2. Hard gravel	2	0
3. Red sandstone	14	0
4. Hard slate	2	0
5. COAL III	3	4
6. Fire-clay	2	6
	26	10

This boring is in the valley of Patoka river and locates Coal III 26 ft. and 10 in. below the bottom lands.

Section of the hill west of the bridge across Patoka river in the N. E. ¼ of Sec. 18 (Sect. 742):

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	4	6	..	..	4	6
2. Fossiliferous limestone	2	4	..	..	6	10
3. Shale	2	0	..	..	8	10
Place of Coal IIIb	0	0	0	0	8	10
4. Fire-clay	2	0	..	..	10	10
5. Obscured	6	0	..	..	16	10
6. Shale	4	6	..	..	21	4
7. Shale and clay	4	0	14	6	25	4
8. COAL IIIa	0	2	0	2	25	6
9. Obscured	0	8	..	..	26	2
10. Fire-clay	1	6	..	..	27	8
11. Shale and sandstone	16	0	..	..	43	8
12. Bedded to massive sandstone	20	0	..	..	63	8
13. Obscured to Patoka river	3	0	..	..	66	8

The limestone, No. 2, marks the horizon of Coal IIIb. Coal IIIa is found rather high on the hill, as compared with its location as found some 300 yds. to the southeast. Owing to a number of slips when this section was run, the relation of the outcropping strata is somewhat uncertain. Below the bridge some 40 rods is a fine exposure of the bedded to massive sandstone, and some 40 ft. higher on the hill is an exposure of coal and limestone boulders. It is quite probable that this is a slip of Coal IIIb and its overlying limestone, as it occurs lower in the hill at this point than in the road west of the bridge, and is twisted and tilted about a good deal.

Coal IIIa has been worked some on the John Stenftnegel farm, in the N. W. ¼ of Sec. 8, when the coal was reported to be 3 ft. 6 in. thick, with a hard sandstone overlying it. The same coal has been drifted upon on Leo Stenftnegel's place, in the N. W. ¼ of the S. E. ¼ of Sec. 5. The coal was reported having an average of 3 ft. 10 in., free from sulphur balls or clay bands. Coal bituminous, burning to a fine ash, with but little soot, roofed with 2 ft. 6 in. of hard sandstone and underlain by 6 ft. of fire-clay. (Fig. 767.) Similar conditions were found at the Ell mine, in the N. E. ¼ of the S. E. ¼ of Sec. 5, and at the Mundy mine, in the S. E. ¼ of the N. W. ¼ of Sec. 4. The coal at the Ell mine, as reported, has a considerable amount of sulphur scattered through it, while at the Mundy mine it is practically free from sulphur and clay bands.

What seems to be Coal IIIa was mined years ago at the old Rosebank mine, north of the center of Sec. 14. Entrances were all closed, making a personal examination of this coal, with its accompanying strata, impossible. The following report was obtained from Mr. S. Pursinger, of Buffaloville, Spencer county, who worked in the mine for three years and operated it for two years (Sect. 743, Fig. 768):

	Ft.	In.
1. Shale, hard	14	0
2. BLOCK COAL	2	0
3. Fire-clay	0	4-7
4. BONE COAL	0	2
5. Slate	0	4-6
6. COAL	1	9
7. Hard white sandstone	2+	0
	21	0

Mr. John Vogel, who now owns the mine, gave the following report: Average thickness of the coal, 4 ft. 6 in.; shale and sandstone roof; floor of fire-clay, sandstone and slate. This report is not considered reliable.

Section of the coal (Sect. 744):

	Ft.	In.
1. BLOCK COAL	1	6
2. Slate	0	6
3. BLOCK COAL	2	0
4. Slate	0	3
5. Fire-clay	1	6
6. Hard shale	1+	0
	6	9

The block coal, No. 3, is the best part of the bed, the only part suitable for shop use. Probably the same coal has been drifted upon on the Geo. Blessinger place, in the S. E. ¼ of the S. E. ¼ of Sec. 13. Coal reported 3 ft. thick, with a sandstone roof 2 ft. 6 in. thick. No coal has been taken from this mine in the last six years.

Section of a hill in the S. E. ¼ of the S. E. ¼ of Sec. 23, as obtained from exposed strata seen in the wagon road (Sect. 745):

	Ft.	In.
1. Soil and shale	5	0
2. Hard ferruginous sandstone	1	0
3. COAL IIIa	0	2
4. Fire-clay	1	6
5. Shale	12	0
	19	8

On a hill 300 yds. to the northeast of where the above section was obtained, and at what seems to be the same horizon, the following section was obtained (Sect. 746):

	Ft.	In.
1. Soil	5	0
2. Light to blue shale	15	0
3. Massive sandstone	12	0
	32	0

Coal IIIb underlies a portion of the southwest corner and the west part of this township, coming almost as far east as Huntingburg. As noted above, the horizon of this coal is marked by the appearance of loose chert on the Standpipe hill. To the southwest one-half mile or more, and in T. 3 S., R. 5 W., occurs a rather thick bed of solid limestone, marking the horizon of the coal, but at no point was the coal observed. The line marking the horizon of the coal is shown on the map following Patoka river north, leaving the township in Sec. 6. On the Cox farm, in the N. W. ¼ of Sec. 18, the coal has been drifted upon and reported to have been 2 ft. thick. (Fig. 766). Some 20 years ago the same coal was worked by a stripping on the Baker farm, in the S. W. ¼ of Sec. 7. Coal reported 2 ft. thick. Near the center of Sec. 6, on Martin Nahler's farm, the coal outcrops with probably the same thickness, overlain with shale (?) and limestone.

The lowest coal worked in this township is the coal in the Huntingburg mine, which corresponds to Coal II. It is quite possible, however, that the coal is not continuous with the coal to the southeast correlated as Coal II. The operator of the mine is of the opinion that there is a basin located at this place running off to the northeast one mile or more. Beyond this limit borings have been made, but no coal was found. Also, borings have been made west of Huntingburg without piercing this coal. The following report was obtained through the kindness of the operator:

Maximum thickness of the coal, 5 ft.; minimum thickness, 3 ft., with 4 ft. 6 in. as an average. Coal is bituminous to semi-block, free from sulphur balls or streaks and clay bands, with 8 in. of black shale under it. (Fig. 773.) Coal dips to the northwest, dipping 7 ft. in 100 yds. No faults and but few averaged sized "horsebacks." Coal burns well, leaving but few clinkers. The engines on the L., E. & St. L. C. R. R. are coaled at the mine. Shale roof, that holds up fairly well. Fire-clay floor, 10 ft. thick. Some of this clay has been utilized for pottery use, with fairly good results. The coal lies 40 ft. below the surface and is worked by a shaft.

Township 3 South, Range 5 West. (See Plate LV.)

1684. Geography.—This township lies in the southwestern part of the county and includes the east half of the civil township of Cass, the south part of Patoka township and the western tier of sections in Ferdinand township.

Wibking creek rises in the southeastern part of the township, one mile west of St. Henry, and flows north across the eastern half, draining that part of it. Short creek crosses the township from west to east, draining the north part of it. The southwest corner of the township is drained by the head waters of Pigeon creek. The surface of the southwestern part of the township is very broken, the hills rising from 50 to 150 ft. above the creek bottoms. A large per cent. of the hills in this portion of the township have rather steep and abrupt slopes. Farther to the north and northeast the surface is not so broken.

The hills are not so high and the slopes are more gentle. The Evansville Division of the L., E. & St. L. C. R. R. crosses the eastern half of the township.

1685. Stratigraphy.—The outcropping strata of this township belong in Divisions II, III and IV, with three coals exposed—Coals III, IIIa and IIIb. Coal IIIb has been worked most and attains the greatest thickness of any of the exposed coals.

As is indicated on the map, Coal III underlies nearly all of the township, while Coals IIIa and IIIb are found only in the southwestern part of the township. North and northwest of St. Henry, one mile or more, occurs quite a lot of hard cherty limestone, which was taken as marking the horizon of Coal III. At quite a number of places exposures of limestone were found, but no exposures of coal were observed. The coal is probably not persistent. One-half mile north of St. Henry, and west of the road running south into St. Henry, is a small sandstone quarry, where a fair quality of fine grit grindstones are quarried.

Coal IIIa has been worked at the following places in the southwestern part of the township:

At Ed. Stone's, in the S. E. ¼ of Sec. 31; J. Kemp's, in the N. W. ¼ of Sec. 32, where the coal is said to be 18 in. thick; Geo. Schmitts, in the N. E. ¼ of Sec. 31, and at David Cooper's, in the S. W. ¼ of Sec. 31. The exposures were not observed at the four last mentioned places, the correlation being based upon reports. Exposures were observed in the road along the west side of the N. W. ¼ of Sec. 30, 350 yds. west of the center of Sec. 30, which were, with some little hesitation, correlated as Coal IIIa. Coal IIIb underlies the highest parts of the western and southwestern parts, as indicated by the line of the outcrop on accompanying map. In the southwestern part of this township this coal has been mined quite extensively for local use, and from reports seems to be a fairly good coal, but quite sulphurous at places. At the Cooper mine, in the S. E. ¼ of the N. W. ¼ of Sec. 32, the following data were obtained: Average thickness of the coal, 2 ft. 8 in., with a maximum and minimum thickness of 3 ft. and 2 ft. 4 in., respectively. Contains few sulphur balls near the bottom and is overlain with 3 to 6 in. of shale, upon which rests a stratum of hard bluish limestone 2 ft thick. (See Plate LV.) This roof of slate and limestone holds up well. The coal is free from faults and rolls, with a few clay seams. Reported to be a poor coal for smiths' use, but a good steam coal. West of this mine, in the N. W. ¼ of the S. W. ¼ of the same section, the following section was obtained (Sect. 747):

	Ft.	In.
1. Surface	5	6
2. Shale	3	0
3. Impure fossiliferous limestone	..	6
4. COAL IIIb	0	7
5. Obscured	2	6
	12	1

This coal has been worked or outcrops at the following places, where the physical details, quality, quantity of the coal, roofing, floors, etc., are similar to that found at the Cooper mine:

Whitten's, Jas., in the N. E. ¼ of the S. W. ¼ of Sec. 33; Kemp's, G. A., in the S. W. ¼ of the S. E. ¼ of Sec. 32; Wood's, Sarah, in the S. E. ¼ of Sec. 32; Cooper's, in the N. E. ¼ of the S. W. ¼ of Sec. 32; Cooper's, Geo., on the S. E. ¼ of the N. W. ¼ of Sec. 32; Kemp's, Jno., in the N. E. ¼ of the N. W. ¼ of Sec. 32.

Two exposures were noted in the road along the north side of the S. E. ¼ of Sec. 32; Simmons's, Jefferson, in the S. E. ¼ of the S. W. ¼ of Sec. 29; Kemp's, William, in the S. E. ¼ of Sec. 29; Griffith's, John, in the N. W. ¼ of the N. W. ¼ of Sec. 29, and in the S. W. ¼ of the S. W. ¼ of Sec. 20.

The above outcrops and mines and their location were reported by Mr. J. Kemp. Quite a basin of limestone is found in Secs. 29 and 32, where much lime was burned years ago. Mr. Kemp states that no well in these sections goes through limestone, but at places as much as 7 ft. of limestone has been removed. Plenty of stone can be obtained here, and of good quality, too, to build the much needed macadamized roads in this and adjoining townships.

The coal has been drifted upon at the Frick mine, in the N. E. ¼ of S. W. ¼ of Sec. 19. Reported thickness ranges from 2 ft. to 14 in., with an average of 20 to 22 in. Coal not persistent and runs from a bituminous to a semi-block. Above the coal is a thin layer of gravel overlain with 4 or 5 ft. of limestone. Mr. Frick is quite positive, from investigations made, that the coal does not extend more than 300 yds. north from this mine. Reports his neighbor, living one-quarter mile south of his mine, as having dug for the coal, but found none.

It is quite possible that there are local cut-outs in the coal, but on the whole this coal is rather a persistent one through this township. It was observed north and northeast of Frick's, proving conclusively that Mr. Frick's idea is an erroneous one.

An outcrop was observed in the road 300 yds. west of the southeast corner of Sec. 18, where the following section was obtained (Sect. 748):

	Ft.	In.	Ft.	In.	Ft.	In.
1. Shale (?)	25	0	..	..	25	0
2. COAL IIIb	0	6	0	6	25	6
3. Fire-clay	2	0	..	..	27	6
4. Yellow clay and sandstone	0	8	2	6	28	2
5. COAL IIIa (?)	0	1	0	1	28	3
6. Fire-clay	3	0	..	..	31	3
7. Clay	5	0	..	..	36	3

Two limestone boulders were observed just above the upper coal.

East Half of Township 1 South, Range 6 West.

1686. Geography.—This township lies in the northwestern part of the county, in the southwestern part of Boone township and in the northwestern part of Madison township. Birch creek and its western tributaries drain the northeastern part of the township. Little Flat creek flows south along the west side of the township, draining that part of it. Big Flat creek crosses the southwestern corner, crossing the township line at the S. W. corner of Sec. 35. The topography runs from a level to somewhat hilly, the hills rising from 30 to 50 ft. along Birch creek, in the northeastern corner of the township, and from 20 to 30 ft. along Big Flat creek, in the southwestern corner of the township. The central part of the township is level, this part being crossed by the alluvial plain of Straight and Hunley creek. The nearest railroad is the L., E. & St. L. C. R. R., 1½ mi. south.

1687. Stratigraphy.—Very few exposures are found in this township, the greater part of it being covered with drift and alluvium. Shales and sandstone are exposed in Secs. 11 and 12. A glacial boulder 3 by 4 in. was found in the N. W. ¼ of Sec. 1. The outcropping strata of the partial township belong in Divisions III and IV, Division III occurring in the southern part. Only one outcrop of coal was reported in the southern part, which, as reported, is near the center of the north side of the N. W. ¼ of Sec. 34, on G. P. Wagner's farm. From the report given this coal was correlated as Coal IIIb.

Two outcrops were reported in Secs. 1 and 12, but from report correlation was impossible, and, as the coal was very thin and probably covered, personal examinations were considered unnecessary. The coal, however, belongs in Division IV.

A thin coal was reported in L. L. Cooper's well, in the N. E. ¼ of Sec. 11, which lies probably 10 ft. below the level of the alluvial plain of Patoka lake. The same coal was reported in a number of other wells in this neighborhood, which is probably the same coal which outcrops along Brushy branch, in the N. W. ¼ of Sec. 1.

East Half of Township 2 South, Range 6 West.

1688. Geography.—This half township lies in the western half of the county, in Madison and Patoka townships, the north half in Madison and the south half in Patoka. Patoka river crosses the north half of the township from northeast to southwest, draining that part of it. The south half is drained by small branches that rise near the center and flow to the north and northeast into Patoka river. The southwest corner is drained by small branches flowing west into Pike county. The topography runs from high, irregular, broken hills, rising from 50 to 100 ft. in the southwest to lower ones with gentle slopes in the north and central parts. The bottom lands of Patoka river run from one-quarter mile to one mile in width. The L., E. & St. L. C. R. R. crosses the central part of the township, running from east to west.

1689. Stratigraphy.—The outcropping strata of this township belong in Divisions III and IV, with two coals exposed. No drillings, so far as known, have pierced the underlying member. The section of a drilled well 300 yds. north of the center of Sec. 25, on Isaac Coto's farm, gives the lowest strata (Sect. 749):

	Ft.	In.
1. Surface	19	0
2. Limestone, blue flinty	3	0
3. COAL IIIb	3	4
4. Sandstone	60	0
5. Black slate	1	0
	86	4

Sandstone No. 4 was solid. Probably Coal IIIa lies immediately under the black slate.

The distance between Coals IIIb and IV varies greatly, as well as the intermediate strata. This is shown in the following sections:

1690. Section 750. Section Along Wagon Road.—Near the center of the S. ½ of Sec. 12.

	Ft.	In.	Ft.	In.
1. Shaly sandstone	1+	..	1+	..
2. COAL IV	1	3	2	3
3. Fire-clay	2	0	4	3
4. Shale	0	8	4	11
5. Clay and fragments of impure limestone	1	0	5	11
6. Clay, reddish	0	3	6	2
7. COAL IIIb	0	9	6	11
8. Fire-clay	0	3	7	2
9. Shaly sandstone	2	3	9	5

Section along branch running west into Pike county, in N. W. ¼ Sec. 27, on Thos. Stillwell's farm.

1691. Section 751. Section on T. Stillwell Farm.—Sec. 27.

	Ft.	In.	Ft.	In.
1. Surface	19	6	19	6
2. Shaly sandstone	2	0	21	6
3. COAL IV	0	10	22	4
4. Drab shale	1	2	23	6
5. COAL IIIb	1	3	24	9
6. Fire-clay	3	0	27	9
7. Shaly sandstone	6	0	33	9
8. Hard massive sandstone	6	0	39	9
9. Soft massive sandstone	10	0	49	9
10. Hard massive sandstone	15	0	64	9
11. Hard sandstone and shale	5	0	69	9
12. Hard massive sandstone	5	0	74	9
13. Shaly sandstone	3	6	78	3
14. Chert and impure limestone	1	8	79	11
15. COAL III	0	1	80	0
16. Shale	3	0	83	0

The shaly sandstone, No. 13, contains small pockets of coal from 1 to 1½ in. thick.

Coal III is scattered through the chert and impure disintegrating limestone, showing three small veins. Rocks have a decided dip to the north.

The line of outcrop of Coal IIIb is shown on the map, running high on the hills, underlying probably one-third of this partial township. It outcrops on the Sundemann place, in the S. W. ¼ of the N. W. ¼ of Sec. 36, and in the wagon road 300 yds. east of the center of Sec. 35, where the following section was obtained (Sect. 752):

	Ft.	In.
1. Fire-clay	1	0
2. Shale	20	0
3. Limestone	1	1

		Ft.	In.
4.	Shale	0	9
5.	COAL III	1	0
6.	Fire-clay	1+	0
		24	10

Fire-clay, No. 1, probably marks the horizon of Coal IV.

Outcrops of Coal IIIb were noted at the following places: In the wagon road along the south side of the S. W. ¼ of the S. W. ¼ of Sec. 1; in the wagon road, near the center of the east side of the S. E. ¼ of the S. W. ¼ of Sec. 12; 250 yds. north of the center of Sec. 13; on the H. Fenerman farm, in the S. W. ¼ of the S. W. ¼ of Sec. 13; on J. G. Geebe's farm, in the S. W. ¼ of the S. E. ¼ of Sec. 23, and on the Kater farm, near the center of the N. E. ¼ of Sec. 27, where the following section was obtained (Sect. 753):

		Ft.	In.
1.	COAL IIIb	1	2
2.	Fire-clay	1+	0
		2	2

Above the coal was a thin exposure of the shale. The coal has been drifted upon at Mrs. Stoncamp's, in the S. E. ¼ of Sec. 22, where it is 3 ft. 4 in. thick, overlain by shale and impure flinty limestone 10 to 20 in. thick. The coal is a fair quality of coal, with the exception of the top part, in which quite a number of sulphur balls are found. Some coal has been mined on the Payne place, in the S. E. ¼ of the N. E. ¼ of Sec. 10, where the coal is 10 to 13 in. thick, overlain with sheety bituminous shale. Below is the section exposed at the old stripping (Sect. 754):

		Ft.	In.
1.	Limestone, hard and flinty	0	6
2.	Hard sheety shale	1	2
3.	Soft shale to shale	1	0
4.	Hard bituminous shale	0	2
5.	COAL IIIb	1	1
6.	Shale	0	2+
		4	1

High in the hill, in the Stillwell farm, in the S. W. ¼ of the N. W. ¼ of Sec. 27, Coals IIIb and IV are exposed. See section under stratigraphy of the county. Outcrop reported on James Songer's place, in the S. W. ¼ of the S. E. ¼ of Sec. 27. Coal reported 20 in. thick, with a hard sheety shale 6 in.+ and 6 ft. above adjacent drainage.

1692. SECTION 755. WELL SECTION NEAR THE CENTER OF SEC. 35.—

		Ft.	In.
1.	Soil	4	0
2.	Limestone	1	0
3.	Sheety shale	1	6
4.	COAL IIIb	1	0
		7	6

Coal IIIb is rather persistent in this township, with a workable thickness at quite a number of outcrops. In general, the coal is fairly good, with streaks of sulphur and sulphur balls scattered through it, coming usually near the top. The limestone and sheety bituminous shale that forms the roof is persistent and oftimes marks the horizon of the coal, where no coal is exposed. The shale and limestone make a good, strong roof, very seldom breaking down.

Coal IV is found in the highest hills, at places very close to Coal IIIb, while at other places the intervening space between these two coals may increase to many feet. The relation of these two coals with accompanying strata is shown by the sections under the stratigraphy of the township. Coal IV is very irregular and not at all persistent. The same irregularity and variation is observed in accompanying strata. In the wagon road 300 yds. east of the center of Sec. 35, and some 22 ft. above the outcrop of Coal IIIb, is an outcrop of fire-clay with a coal streak, which marks the horizon of Coal IV. As stated above, Coal IV outcrops on the Stillwell farm, in the S. W. ¼ of the N. W. ¼ of Sec. 27. Coal IV outcrops in the road 300 yds. west of the center of Sec. 22, and in the road along the west side of the S. W. ¼ of the S. E. ¼ of Sec. 12, where the following section was obtained (Sect. 756):

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Shaly sandstone	1	0	..	..	1	0
2.	COAL IV	1	3	1	3	2	3
3.	Fire-clay	2	0	..	..	4	3
4.	Shale	0	8	..	..	4	11
5.	Clay and fragments of disintegrating limestone	1	0	..	..	5	11
6.	Impure limestone	0	7	..	..	6	6
7.	Red clay	0	3	4	6	6	9
8.	COAL IIIb	0	9	0	9	7	6
9.	Fire-clay	0	3	..	..	7	9
10.	Shaly sandstone	2	3	..	..	10	0
11.	Thin bedded sandstone	2	0	..	..	12	0

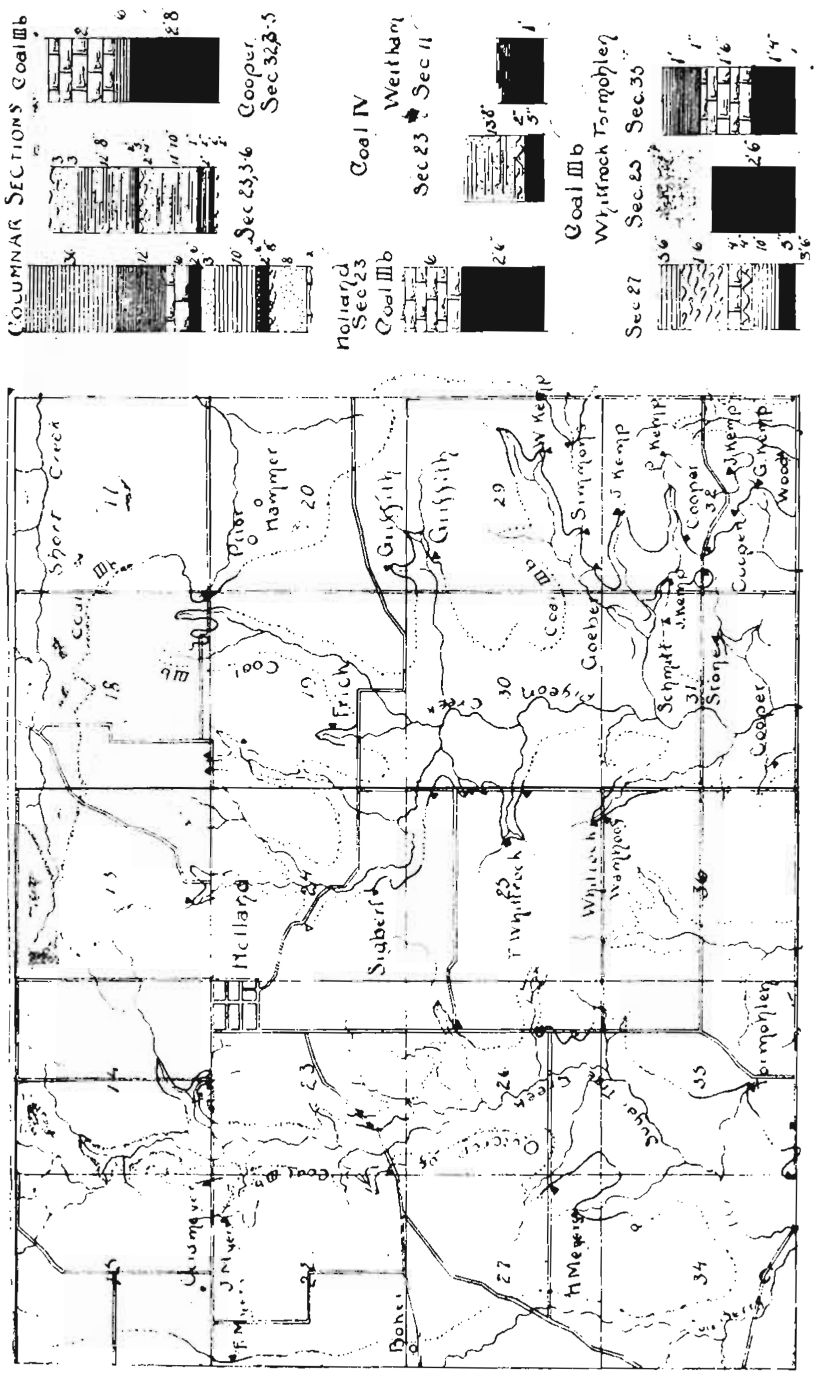


PLATE LV. Sketch map of parts of T. 3 S., Rs. 5 and 6 W., and coal and columnar sections.

EAST HALF TOWNSHIP 3 SOUTH, RANGE 6 WEST.

1693. GEOGRAPHY.—This half township lies in the southwestern corner of the county, in Cass township. Holland lies one-quarter of a mile east of its center. Sugar creek rises in the northwestern part and flows south through the township, draining the west part of it. Elk and Short creeks rise in the northeast part and Pigeon creek in the east central part. The topography runs from low, narrow creek valleys to high, irregular, broken ridges. Probably the highest part in the township is about the head waters of Sugar, Elk and Short creeks. The western part is hilly, the hills rising from 50 to 80 ft., with the lower half of the slope rather steep, but the upper half long and very gentle. The nearest railroad is the Evansville Division of the L., E. & St. L. C. R. R., which is from 3½ to 4 mi. east.

1694. STRATIGRAPHY.—The outcropping strata of this township belong in Divisions III and IV, with three coals exposed—Coals III, IIIb and IV, probably both workable.

A drilling in Holland pierced Coal IIIa (?) and accompanying strata. The following sections will show the variations in the coals and their accompanying strata:

1695. SECTION 757. SECTION OF WELL 108 FT. DEEP IN HOLLAND.—In the N. E. ¼ of the N. E. ¼ of Sec. 23.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	16	0	..	..	16	0
2.	White sandy shale	30	0	..	..	46	0
3.	Hard black slate	12	0	..	..	58	0
4.	Limestone	6	0	..	..	64	0
5.	COAL IIIb	2	6	2	6	66	6
6.	Hard sandstone	3	0	..	..	69	6
7.	Gray slate	10	0	..	..	79	6
8.	Copperas rock	0	6	13	6	80	0
9.	COAL IIIa	2	0	2	0	82	0
10.	Fire-clay	0	8	..	..	82	8
11.	Coarse soft sandstone	8	0	..	..	90	8
12.	Hard flint rock	0	2	..	..	90	10

1696. SECTION 758. SECTION ALONG WAGON ROAD ON THE HILL EAST OF SUGAR CREEK.—In S. W. ¼ of Sec. 23.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	3	6	..	..	3	6
2.	Shaly sandstone	2	0	..	..	5	6
3.	Solid sandstone	1	0	..	..	6	6

	Ft.	In.	Ft.	In.	Ft.	In.
4. Shale to shaly sandstone	10	0	..	..	16	6
5. Shale mixed with sandstone	2	8	..	..	19	2
6. Blue clay	0	2	..	..	19	4
7. COAL IV	0	5	0	5	19	9
8. Fire-clay	2	4	..	..	22	1
9. Sandstone	0	8	..	..	22	9
10. Shale	1	6	..	..	24	3
11. Sandstone	0	6	..	..	24	9
12. Drab shale	6	6	..	..	31	3
13. Soft blue shale	0	4	11	10	31	7
14. COAL IIIb	0	1	0	1	31	8
15. Shale	0	2	..	..	31	10
16. Shale	0	4	..	..	32	2
17. Shale	0	2	..	..	32	4
18. Shale	1	6	2	2	34	10
19. COAL IIIa	0	2	0	2	35	0
20. Fire-clay	0	2+	..	..	35	2

Fire-clay, No. 20, is about 4 ft. above Sugar creek bottoms.

Shale to shaly sandstone, No. 10, contained cross seams and concretions. Drab shale, No. 12, contained a large number of irony, shelly concretions running in two sizes, viz., 2 by 3 and 5 by 9 in.

1697. SECTION 759. SECTION ALONG WAGON ROAD, ON THE HILL.—Near the center of S. E. ¼, Sec. 27.

	Ft.	In.	Ft.	In.
1. Surface	9	0	9	0
2. Drab shale	5	6	14	6
3. Fire-clay	1	6	16	0
4. Brick, red, impure, shaly limestone	0	4	16	4
5. Clay	0	4	16	8
6. Shale	0	10	17	6
7. COAL IIIb	0	5	17	11
8. Fire-clay	3	6	21	5
9. (Obscured)	4	0	25	5
10. Shale	2	0	27	5
11. Limestone	4	0	31	5

Section along road on the hill west of Sugar creek, in the S. W. ¼ of the S. W. ¼ of Sec. 23 (Sect. 760):

	Ft.	In.
1. Surface	3	6
2. Shaly sandstone	9	0
3. Shale	4	6
4. COAL IV	0	4
5. Fire-clay	1	0
6. Blue to drab shale	1	6
7. Sandstone	1	0
8. Drab shale	8	0
9. Obscured	7	0
	35	10

If Coal IIIb occurs in this hill it comes near the bottom and is obscured.

Section along the hill near the center of the S. E. ¼ of Sec. 26 (Sect. 761):

	Ft.	In.
1. Surface	5	6
2. Hard blue limestone	2	6
3. Fire-clay	3	6
4. Light shale	4	0
	15	6

Coal IIIb does not occur here at what seems to be its horizon.

Section along road 100 yds. north of the center of N. E. ¼ of Sec. 26 (Sect. 762):

	Ft.	In.
1. Surface soil and shale	15	0
2. Limestone	1+	0
3. COAL IIIb	0	6
4. Fire-clay	2+	0
	18	6

Section of hill along road running east and west at center of east side of Sec. 10 (Sect. 763):

	Ft.	In.
1. Surface	4	6
2. Massive sandstone	7	0
3. Shaly sandstone	5	0
	16	6

In general, the strata run from shale to shaly sandstone in the south part of the township to more or less massive sandstone in the northwest part. Here the sandstone is quite massive and is quarried at a place or two.

The line of outcrop of Coal IIIb is shown on the map. The coal underlies nearly all of the half township, being cut out only by Pigeon creek and Sugar Tree fork. The coal has been worked by a stripping on the Whittrock place, in the S. E. ¼ of the S. E. ¼ of Sec. 25. Reported thickness ranges from 3 to 2 ft., with an average of 2 ft. 6 in. The coal is divided into two benches; the upper one is 2 ft. thick and the lower one is 1 ft. thick. The lower bench is the better coal for smiths' use. The coal is not free from sulphur balls, but has a few scattered through it. West of the stripping is an outcrop of limestone which seems to overlie the coal.

The same coal has been mined by a slope on Fred Whittrock's farm, in the N. E. ¼ of the S. E. ¼ of Sec. 25. The report given concerning the coal at this slope corresponds in general to the report given above of the Whittrock stripping. Outcrops of the coal were noted in the following places: In the road along the east side of the N. E. ¼ of the S. E. ¼ of Sec. 25; in the road along the east side of the N. E. ¼ of the N. E. ¼ of the same section; in the S. E. ¼ of the S. W. ¼ of Sec. 24, and 150 yds. north of the road, along the south side of the S. W. ¼ of Sec. 13, occurs an outcrop of black bituminous sheety shale and impure coal. This outcrop marks the horizon of Coal IIIb. Farther west, along Sugar Tree fork, the coal outcrops at a number of places. At two places was the outcrop observed in the road along the south side of the S. W. ¼ of Sec. 35. West of the road 100 yds., on Geo. Tormohlen's place, in the S. E. ¼ of Sec. 35, occurs an outcrop. Some coal was mined here years ago. Reported quality fairly good. Above the coal is shale and limestone. Below is an imperfect section obtained at this place (Sect. 764):

		Ft.	*In.*
1.	Shale, sheety	1	0
2.	COAL IIIb	0	1
3.	Limestone, hard and bluish	1	6
4.	COAL IIIb	1	4
		3	11

Somewhat of an irregularity occurs in the relation of the coal and accompanying strata at this place. It is an unusual thing for this coal to split into two benches, as it apparently has done at this place, and the limestone is usually above the shale, which rests upon the coal. Outcrops were noted at the following places:

In the road near the center of the S. E. ¼ of Sec. 26; near the center of the N. E. ¼ of Sec. 26; in the road just west of the forks of the road one-quarter of a mile west of Holland; on the hillside, in the S. E. ¼ of the S. W. ¼ of Sec. 14; in the road west of the S. E. corner of Sec. 15; in the road on both sides of Sugar Tree fork, in the S. W. ¼ of the S. W. ¼ of Sec. 23, and in the S. E. ¼ of Sec. 27. At a number of other places the sheety shale and limestone were observed—one of the best exposures in the bed of the branch, in the S. W. ¼ of Sec. 14.

Coal IV was observed at the following places:

In the N. E. ¼ of the N. E. ¼ of Sec. 25, and in the N. W. ¼ of the N. W. ¼ of Sec. 11. This coal is very thin through this half township, as indicated by the foregoing outcrops. Some coal has been mined by a stripping at the last mentioned place, on August Weitkam's farm. The coal is high in the hill and was reported 1 ft. thick. Reported roof of rotten coal and dirt. Below the stripping along the branch occurs a number of crops of massive sandstone.

1698. SUMMARY OF COALS OF DUBOIS COUNTY.—

Divisions contained: I, II, III and IV.
Coals contained: I, Ia, II, IIa, IIb, III, IIIa, IIIb and IV.

ROUND NUMBER ESTIMATES.

Coal IIIb.

Worked area	5 acres ×	av. thickness,	3 ft. ×	1,000 =	15,000 tons.
Workable area ...	5 sq. mi. ×	"	3 ft. ×	500,000 =	7,500,000 tons.
Unworkable area.	40 sq. mi. ×	"	2 ft. ×	1,000,000 =	80,000,000 tons.
Total area	45 sq. mi				87,515,000 tons.

Coal IIIa.

Worked area	8 acres ×	av. thickness,	3 ft. ×	1,000 =	24,000 tons.
Workable area ...	5 sq. mi. ×	"	3 ft. ×	500,000 =	7,500,000 tons.
Unworkable area.	50 sq. mi. ×	"	1½ ft. ×	1,000,000 =	75,000,000 tons.
Total area	55 sq. mi				82,524,000 tons.

Coal III.

Worked area	8 acres ×	av. thickness,	3 ft. ×	1,000 =	24,000 tons.
Workable area ...	25 sq. mi. ×	"	3 ft. ×	500,000 =	22,500,000 tons.
Unworkable area.	100 sq. mi. ×	"	1½ ft. ×	1,000,000 =	150,000,000 tons.
Total area	125 sq. mi				172,524,000 tons.

Coal II.

Worked area	8 acres ×	av. thickness,	3 ft. ×	1,000 =	24,000 tons.
Workable area ...	10 sq. mi. ×	"	3 ft. ×	500,000 =	15,000,000 tons.
Unworkable area.	200 sq. mi. ×	"	2 ft. ×	1,000,000 =	400,000,000 tons.
Total area	210 sq. mi				415,024,000 tons.

Coal IV.

Unworkable area. 10 sq. mi. × av. thickness, 1½ ft. × 1,000,000 = 15,000,000 tons.

Coal IIa.

Unworkable area. 50 sq. mi. × av. thickness, 1½ ft. × 1,000,000 = 75,000,000 tons.

Coal I and Ia.

Unworkable area. 50 sq. mi. × av. thickness, 2 ft. × 1,000,000 = 100,000,000 tons.

Number of coals contained: 9.
Greatest thickness recorded: 5 ft.
Average of township averages: I, 1[illegible] in.; Ia, 12 in.; II 27 in.; IIa, 18 in.; IIb, 1 in.; III, 24 in.; IIIa, 26 in.; IIIb, 28 in., and IV, 11 in.
Area underlain by coal: 300 sq. mi.
Area underlain by workable coal: 40 sq. mi.
Estimated total tonnage of coal: 947,000,000.
Estimated total tonnage of coal removed: 87,000.
Estimated total tonnage of workable coal left: 52,500,000.
Number of mines working ten men or over in operation: 1.
Number of mines working less than ten men in operation: 35.
Total number of mines in operation: 36.
Large mines not in work: 3.
Small mines not in work: 39.
Strippings and outcrops: 194.
Total number of openings to coal: 233.

XXXIII. PIKE COUNTY.

1699. REFERENCES AND FIELD WORK.—

1862 (1859-60). Richard Owen, Rep. of Geol. Reconn. of Ind., pp. 180-181. Two coal analyses. (R. O.)

1862 (1859-60). Leo Lesquereux, same, pp. 315-317. (L. L.)

1871 (1870). E. T. Cox, 2d Rep. of Geol. Surv. of Ind., pp. 143-144. Three columnar sections. (E. T. C.)

1872 (1871). John Collett, 3d and 4th Ann. Rep. of Geol. Surv. of Ind., pp. 239-287. Detailed report, map, twenty-six columnar sections; thirty-nine coal analyses (by E. T. C., pp. 46-59.)

1896 (1895). W. S. Blatchley, Ind. Dept. of Geol. and Nat. Reso., pp. 110-113. Discusses clays; gives four columnar sections.

1897. Geo. H. Ashley, part of field work for this report. The last of the field season was spent in this county, visiting the localities where small mines would be found working then, that would be closed when visited in the spring.

1898, April. G. H. Ashley, completion of field work.

Section 1. Geography.

1700. POSITION.—This county is in the southwestern part of the State, lying south of Daviess and Knox counties, west of Dubois, north of Warrick and Gibson and east of Gibson county.

1701. EXTENT AND TOWNSHIPS.—The county has an extreme length from north to south of 22 mi., and a width from east to west of 21 mi., comprising 338 sq. mi. The county includes all of T.'s 1 and 2 S. of R. 7 W., and T. 1 S., R. 8 W.; the western half of T. 1 N (in part), 1, 2 and 3 (in part) S., R. 6 W.; the part of T. 1 N. south of White river, in R.'s 7, 8 and 9 W., and the eastern part of T. 1 S., R. 9 W.; T. 2 S., R. 8 W., and the northeastern part of T. 3 S., R. 8 W. The civic townships are arranged as follows:

Clay.	Madison.	Washington.	Jefferson.
	Logan.	Patoka.	Marion.
		Monroe.	Lockhart.

1702. ELEVATIONS.—In elevation the county ranges from about 390 ft. A. T. to nearly 700 ft. A. T. The following are some of the known altitudes:

	Authority.	*Ft. A. T.*
Velpen	L., E. & St. L. C. R. R.	509
Winslow	L., E. & St. L. C. R. R.	467
Ayrshire	L., E. & St. L. C. R. R.	457
Divide between Patoka and White river	Canal survey	469
Same, surface of canal in deep cut	Canal survey	444
Patoka river at Dongola	Canal survey	410
Same, surface of canal	Canal survey	436
Petersburg, foot of Main street	Prelim. railroad survey (V. & N. A. R.R.)	432
Upland at Algiers	Prelim. railroad survey (V. & N. A. R. R.)	507
Upland at Otwell	Prelim. railroad survey (V. & N. A. R. R.)	485
Upland at county line	Prelim. railroad survey (V. & N. A. R. R.)	479
Township line between Washington and Jefferson townships	Prelim. railroad survey (V. & N. A. R. R.)	459

1703. TOPOGRAPHY.—The northwestern part of the county is generally level or rolling. From Petersburg eastward the divide between Patoka and White river is level. To the north the drainage cuts the surface up somewhat as White river is approached. To the south the old lake filling and prairies drained by Flat creek are found. South of this the surface becomes more hilly; then come the slopes and broad bottoms of Patoka river. South of Patoka river the topography shows high, irregular divides, with usually broad stream basins, the high land culminating in the divide between Patoka river and the Ohio, which often rises in the form of conical knobs 150 to 175 ft. above the neighboring drainage. White river flows along the northern bound of the county, with broad bottoms. The Patoka river, a sluggish, muddy stream, flows from east to west across the center of the county. Its main tributaries from the north are Flat creek, Stone Coal creek and Sugar creek; from the south, Rock creek, Cup creek, Barren creek and South Patoka river, with its many tributaries.

Section 2. Stratigraphy.

1704. Pleistocene.—The drift appears to have covered only the northern part of the county, not extending much, if any, south of the base line until it has passed south of Petersburg, when the limit swings off to the southwest. Over this area the drift tends to have a variable depth, depending largely on the preglacial topography, so that in places it becomes quite deep. The prairies along Flat creek appear to be the filling of a lake that resulted from the front of the glacier having dammed up the streams which drained from this region to White river. Subsequently the drainage found a new outlet, and by overflowing the divide near Velpen, drained to the south and west over the present course of the Patoka. It will be recalled that Patoka river represents several preglacial basins which formerly emptied into White river in Dubois and Pike counties, but which were compelled by the glacier to seek new outlets. See under Dubois county. In these old lake fillings wells go 40 to 50 ft. through soft stratified deposits, often encountering fragments of trees, etc.

1705. Coal Measures.—Coal V is pre-eminently the coal bed of this county. It runs from 5 to 11 ft. thick and has a long dendritic line of outcrop, making it easy of access over a broad belt of country. Probably no county in the State except Warrick can show more than a fraction the number of small mines working coal over 5 ft. thick that can be found in this county. Coal VII is workable over the western edge of the county. Coals in Division VIII are caught in the northwestern and southwestern corners of the county. Coal VI is nowhere workable, unless it be in connection with Coal V. Coal IV and Coals III, IIIa and IIIb outcrop in the eastern part of the county and contain some workable coal. Drillings indicate the presence of still deeper coals of workable thickness.

Division IX—
1. Massive sandstone (only in northwestern corner).

Division VIII—
2. Shale, limestone, black shale.
3. COAL VIIIa?, not workable.
4. Fire-clay, shale, limestone, black shale.
5. COAL VIII?, not workable.

Division VII—
6. No connected section; toward bottom principally sandstone.
7. COAL VII, workable west of E. & I. R. R.

Division VI—
8. Fire-clay, shale, limestone, shale.
9. COAL VIb, not workable, not persistent.
10. Fire-clay, sandstone and shale.
11. COAL VI, not workable, generally absent, rider at Hartwell.

Division V—
12. Fire-clay, shale, limestone, black shale.
13. COAL V, main coal all over western half or more of county.

Division IV—
14. Fire-clay, sandstone, massive sandstone at Winslow, Survant, High Rock, Daviess county, etc.
15. COAL IV, semi-block.

Division III—
16. Fire-clay, shale, limestone, black shale.
17. COAL IIIb, "18 in. vein," like a thin edition of Coal V, all over eastern edge of county, and formerly thought to be Coal V.
18. Fire-clay, sandstone, massive sandstone on Rock creek southeast of Velpen and to the east.
19. COAL IIIa, not workable, Lockhart township.
20. Fire-clay.
21. COAL III, thin, seen only in Rock creek, workable in Dubois and Spencer counties.

For additional coals, see the drillings at Petersburg. These indicate a coal between Coal V and Coal IV, and coals in Division II probably underlie all of this area. The stratigraphy in the earlier report made what are now recognized as Coals V, IIIb and III all of the same horizon. The massive sandstones over Coals IV and IIIa were in every case thought to be at the horizon of the Mansfield sandstone, and accordingly Coal IV or Coal IIIa were usually called Coal "A" (I), the stratigraphic column recognizing no coal between Coal "K" (V) and "A" (I). Coal VI is made the most important coal of the county, being given as a 10 ft. 9 in. coal. These errors naturally throw all previous correlations into confusion.

In the recent field work it was not until the county was practically all worked up that the exact relation of Coals V, IIIb and III were completely worked out.

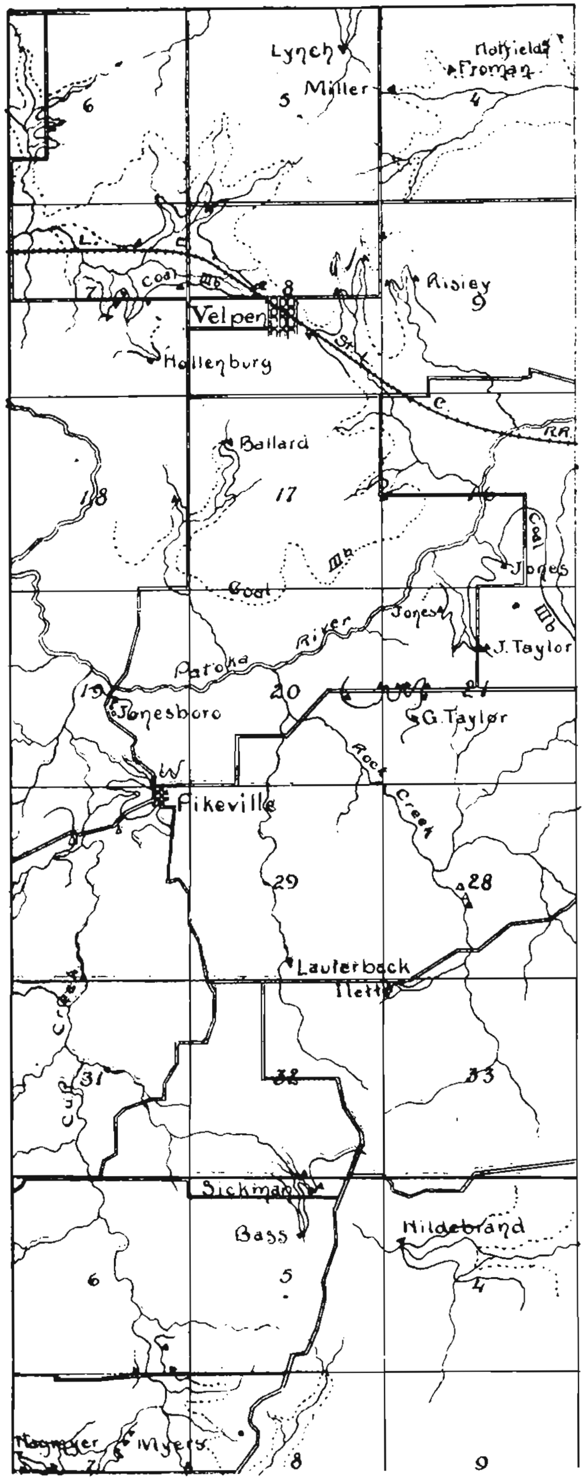
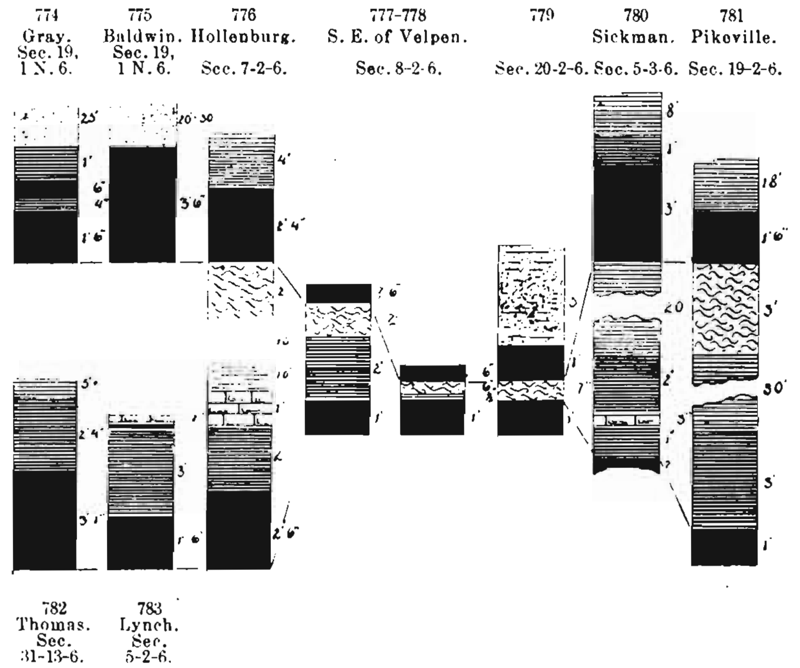


PLATE LVI. Sketch map of parts of Ts. 2 and 3 S., R. 6 W.

TOWNSHIPS 1 NORTH, 1, 2 AND 3 SOUTH, OF RANGE 6 WEST.
(PART IN PIKE COUNTY.)

1706. GEOGRAPHY.—This area includes the western half of the township south of White river, except Secs. 29-32 of T. 3 S., R. 6 W. It includes the eastern part of Jefferson, Marion and Lockhart of the civic townships. T. 1 N., R. 6 W., is level to rolling in the southern part, becoming rougher toward White river, which has the usual broad bottoms, except where the river changes to a western course from a northern. T. 1 S., R. 6 W., is level in the northern part, but becomes somewhat hilly in the southern part. Flat creek has rather broad bottoms. The topography of T.'s 2 and 3 S., R. 6 W., is rather broken, the divides rising about 150 ft. or more above the larger streams, with less broken surface as Patoka river is approached. Cup and Rock creeks are the principal tributaries from the south. The Air Line Railroad crosses near the center of the area.



Figs. 774-783. Sections of Coals IV and IIIb in Ts. 1 N., 1, 2 and 3 S., of R. 6 W.

1707. STRATIGRAPHY AND COALS.—Divisions IV to III, inclusive, outcrop here, with one coal in Division IV and three coals in Division III. The following sections from this area assist in displaying the stratigraphy:

1708. SECTION 765. SECTION AT SICKMAN'S—Sec. 5-3-6, Fig. 780.

	Ft.	In.	Ft.	In.
1. Sandstone	..	..	..	..
2. Gray clay shale	8	0	8	0
3. Tough blue to black shale	1	0	9	0
4. COAL IV (rep.)	3	0	12	0
5. Fire-clay	4	0	16	0
6. Hard clay shale with occasional bands of sandstone about	20	0	36	0
7. Dark blue shale	2	0	38	0
8. Yellow limestone	..	3	38	3
9. Black sheety shale	1	0	39	3
10. COAL IIIb (not exposed)	..	..	..	..

In several cases Coal IV has the massive sandstone immediately over it.

1709. SECTION 766. SECTION ON SPENCER GRAY FARM.—N. E. ¼, Sec. 19-1 N.-6, Fig. 774.

	Ft.	In.
1. Sandstone	25	0
2. "Copperas rock"	1	0
3. COAL IV—Coal, 6 in.; clay shale, 4 in.; coal, 1 ft. 6 in.	2	4
4. Fire-clay	..	..

At the Hollenburg mine the roof of Coal IV is shale, as shown in the following section:

1710. SECTION 767. SECTION ON HOLLENBURG PLACE.—S. E. of S. E. of Sec. 7-2 S.-6, Fig. 776.

	Ft.	In.
1. Coarse-grained sandstone	12	0
2. Hidden	15	0
3. Clay shale	3	0
4. COAL IV	2	4
5. Fire-clay	1	6+

Farther down the branch, and at a level 20 ft. lower, Coal IIIb has been dug. The section is as follows:

1711. SECTION 768. SECTION CLOSE TO RAILROAD.—N. E. ¼, Sec. 7-2 S.-6, Fig. 776.

	Ft.	In.
1. Gray sandy shale	10	0
2. Very impure limestone	1	0
3. Black sheety shale	2	0
4. COAL IIIb (exposed)	2	6+

A similar section is seen a little southeast, on the south side of the creek, near the north and south road. Just east of Velpen, at a slight cut beside the railroad, this coal and the Hollenburg come together. Where first noticed, Coal IIIb is 1 ft. thick, overlain by 2 ft. of black sheety shale, and that overlain by clay shale. Tracing them 20 ft. to the east, the black shale can be seen to thin down to ½ in. and the clay shale and clay to 6 in., while on the latter rests 6 in. of coal, believed to represent the upper coal.

The space between Coals IV and IIIb varies greatly, ranging from the space given in Sects. 767, 768, to a few inches, as in the section just quoted. Thus, beside the road, in the center of the west side of Sec. 21-2-6, the section shows:

1712. SECTION 769. SECTION IN SEC. 21-2-6.—Fig. 779.

	Ft.	In.
1. Massive sandstone exposed in road	..	..
2. Light brown shaly sandstone	5	0
3. COAL IV	1	0
4. Gray fire-clay	..	7
5. COAL IIIb	1	0
6. Gray fire-clay	2	0+

A few other scattered sections of the strata surrounding Coal IIIb may be given:

1713. SECTION 770. SECTION AT WHITE RIVER FERRY.—North of Long Branch P. O., S. W. of S. E. of Sec. 7-1 N., 6.

	Ft.	In.
1. Gray fire-clay	3	0
2. Brown sandy fire-clay	3	0
3. Gray fossiliferous limestone 0 to	1	0
4. Drab to blue shale, in places black and sheety with some iron nodules	4	0
5. COAL IIIb?	..	3
6. Drab fire-clay	3	0

1714. SECTION 771. SECTION AT THOMAS'S MILL.—S. E. ¼ Sec. 31-1S-6, Fig. 782. (J. C., p. 264.)

	Ft.	In.
1. Slope, covered	..	..
2. Soft laminated sandstone	8	0
3. Sandy and clay shale	4	10
4. Blue clay shale	0	6
5. Dark shale with fragments of petrodus occidentalis and discina	1	6
6. Black bituminous sheety shale	0	10
7. Cannel COAL IIIb	1	1
8. Hard COAL, some sulphur	2	0
9. Fire-clay to branch	5	3
	24	1

1715. SECTION 772. SECTION AT PATOKA BRIDGE, JONESVILLE. —Sec. 19-2-6.

	Ft.	In.
1. Slope of hill	10	0
2. Gray to drab clay shale	+25	0
3. Black sheety shale	1	0
4. COAL IIIb ....about	1	0
5. Dark drab fire-clay	1	0
6. Light drab fire-clay	4	0
7. Shaly sandstone	12	0
8. Massive sandstone	10	0
9. Gray shaly sandstone	15+	0

Coal IIIa cannot be far below the bottom of this.

1716. SECTION 773. SECTION AT PIKESVILLE.—Secs. 30 and 19-2-6, Fig. 781. (J. C., p. 276.)

	Ft.	In.	Ft.	In.
1. Soil and loess loam	20	0	20	0
2. Sandy shale and clay shale	18	0	38	0
3. COAL IV	1	6	39	6
4. Fire-clay	3	0	42	6
5. Sandy clay shale	30	0	72	6
6. Ochre and black shale	3	0	75	6
7. COAL IIIb ......1 ft. to	3	0	78	6
8. Laminated sandstone	20	0	98	6
9. Massive sandstone ......10 ft. to	40	0	138	6
10. Clay shale in Patoka river, estimated ......10 to	30	0	168	6

The following section by Mr. Price, made just over the Dubois county line, in the N. W. ¼ of Sec. 27-2-6, shows the relation of Coals IV, IIIb, IIIa and III at that point. Coal IV here is close to Coal

IIIb, and Coal IIIa is close to III and represented only by streaks and pockets of coal.

1717. SECTION 774. SECTION IN N. W. ¼ SEC. 27-2-6.—(J. C. Price, notes.)

	Ft.	In.	Ft.	In.
1. Surface	19	6	19	6
2. Shaly sandstone	2	0	21	6
3. COAL IV	0	10	22	4
4. Drab shale	1	2	23	6
5. COAL IIIb	1	3	24	9
6. Fire-clay	3	0	27	9
7. Shaly sandstone	6	0	33	9
8. Hard massive sandstone	6	0	39	9
9. Soft massive sandstone	10	0	49	9
10. Hard massive sandstone	15	0	64	9
11. Hard sandstone and shale	5	0	69	9
12. Hard massive sandstone	5	0	74	9
13. Shaly sandstone with coal in pockets	3	6	78	3
14. Chert and impure limestone	1	8	79	11
15. COAL III	0	1	80	0
16. Shale	3	0	83	0

In this case it would appear that Coal IIIa had been eroded and the pockets of coal represent not part of the original bed in places but pieces caught as they were being carried away.

Coal IIIa is well exposed on the Henry Ilert place on the west side of the creek, in the N. W. corner of Sec. 33, as follows (Sect. 774a):

	Ft.	In.
Massive brown sandstone	6	0
Shale ......1 in. to	..	3
COAL IIIa—Coal, 1 ft. 0 in.; clay, 1 in. to 4 in.; coal, 2 in. to 3 in.	1	7

Two sections on Rock creek by Mr. Collett gave:

1718. SECTION 775. SECTION AT J. CASE'S LAND.—N. W. ¼ Sec. 28. (J. C., p. 271.)

	Ft.	In.
1. Slope	..	..
2. Massive sandstone	60	0
3. Clay shale "rock houses"	8	0
4. Clay shale	3	0
5. Limestone	0	8
6. Black shale	2	0
7. COAL III—		
Compact splinty cannel	1	1
Block coal	0	5
8. Fire-clay to Rock creek	3	6

1719. SECTION 776. SECTION AT DETAR'S BANK.—S. E. ¼ Sec. 28-2-6. (J. C., p. 272.)

	Ft.	In.
1. Loess	25	0
2. Slope covered	50	0
3. Massive sandstone	15	0
4. Clay shale with iron nodules	16	0
5. Ferruginous limestone	1	1
6. Ochre	0	10
7. Black cannel-like shale	2	10
8. COAL III—		
Choice cannel coal	0	8
Bright compact splinty cannel	1	1
Block coal	0	6
9. Fire-clay to rocky run	2	6

Going south into T. 3 S., R. 6 W., it would appear that the massive sandstone between Coals IIIb and IIIa thins out and in places the two coals come close together, as shown by a section just across the county line.

1720. SECTION 777. SECTION AT BEARDSLEY'S BANK.—Warrick county, Sec. 29-3-6. (J. C., p. 274.)

	Ft.	In.	Ft.	In.
1. Thin bedded sandstone	10	0	10	0
2. Ferruginous limestone	1	0	11	0
3. Clay shale	4	0	15	0
4. Dark shale	1	8	16	8
5. Black shale with fish remains	0	6	17	2
6. Black shale filled with large boulders	..	10	18	0
7. COAL IIIb caking	1	8	19	8
8. Fire-clay	4	0	23	8
9. Clay shale with iron nodules	4	2	27	10
10. COAL IIIa pyritous	2	2	30	0
11. Fire-clay	3	0	33	0

Coal IIIa on Cup creek is frequently broken up, as shown by the following two sections:

1721. SECTION 778. SECTION ON MRS. ELIZA MYERS' PLACE.—In bluff. S. W. of N. E. of Sec. 7-3-6.

	Ft.	In.	Ft.	In.
1. Light brown shaly sandstone and sandy shale	6	0+	6	0
2. Blue shale	..	6	6	6
3. COAL	..	6	7	0
4. Blue and drab shale	..	9	7	9
5. Light brown shaly sandstone	4	0	11	9
6. Drab shale	1	0	12	9
7. COAL	..	2	12	11

1722. SECTION 779. SECTION 50 YDS. FROM PRECEDING.—

	Ft.	In.
1. Brown shale with iron nodules	3	0
2. Drab clay shale	1	6
3. COAL	0	8
4. Drab clay shale	0	6
5. Black shale (bone coal)	0	3
6. Drab shale, sandy	1	0
7. Sandstone	0	6
8. Drab sandy shale	2	6
9. COAL	0	6
10. Gray fire-clay	1	0

1723. DISTRIBUTION AND LOCAL DETAILS OF COAL, T. 1 N., R. 6 W.—The only outcrops seen in this area were north of Long Branch P. O. Two coals are exposed, supposed to be Coals IIIb and IV. Coal IIIb was only seen in the river bank at the ferry, where is exposed the section given above. Nearer Long Branch are a number of partial exposures of the upper Coal IV. Where a small branch crosses the road on the G. E. Eubanks place, in the south part of Sec. 18, about 15 ft. of brown sandstone are exposed over the coal. A section was given above of the strata and coal on Mr. Spencer Gray's farm, in the N. W. of N. E. of Sec. 19. On the Baldwin place, in the N. E. of N. W. of Sec. 19 the coal is reported to have had a thickness of up to 3 ft. 6 in. (Fig. 775). It is overlain by 20-30 ft. of massive sandstone. Some years ago a test shaft was sunk 30 or 40 ft. on the Gray farm, N. E. ¼ of Sec. 32. Only drift was passed through, and a drilling made at a slightly lower level passed through 50 ft. of drift without striking rock. This indicates how much of the coal is probably cut out. The sandstone mentioned above is considered to be the same as the sandstone so well exposed at High Rock across the river in Daviess county.

1724. T. 1 S., R. 6 W.—The northern part of this township is like the preceding, buried in drift, or perhaps more properly lake deposits accompanying the glacier as given above. Thus a section of Mr. Davenport's well in Sec. 20, by Mr. Collett, gave (Sect. 780, J. C., p. 262):

	Ft.	In.	Ft.	In.
Soil and modified loess	5	0	5	0
Yellow and red clay	6	0	11	0
Blue clay with layers of sand	30	0	41	0
Blue clay inclosing driftwood	2	0	43	0
Blue mud and sticks	7	0	50	0

Coal is reported as found in a well on Mr. W. E. Hays place, in the N. W. corner of Sec. 8.

South of Flat creek the topography changes and becomes hilly, the hills rising from 50 to 150 ft. above drainage. Coal outcrops were noted and reported at several places on the southern side of the creek, in Secs. 28 and 29, and coal is said to have been worked on Mrs. Campbell's place, in the N. W. ¼ of Sec. 28. No good exposures were seen, but as far as observed the roof appeared to resemble that common to Coal IV, sandstone predominating. The coal is reported as running from 1 ft. to 2 ft. 6 in. or even up to 4 ft. just across the county line. This coal outcrops above the level of the bottoms. The coal appears to rise to the south so that in the S. W. ¼ of Sec. 28 and S. E. ¼ of Sec. 29 it outcrops well up the hill. It has been reported that at one opening on the Jas. Dillon farm, in the S. W. ¼ of Sec. 28, the coal was 5 ft. thick. As drilling has determined this coal to be 70 ft. above Coal IIIb, it is suggested on that basis alone that the coal in this high ridge at the corner of Sec. 28 is Coal V rather than Coal IV. If it is Coal V, as seems quite possible, there should be a small body of good workable coal in the top of this hill. Lacking more definite information we will take the conservative view by assuming Coal IV as the highest coal yet found here, but suggest that this point may pay for investigating.

Coal IIIb outcrops in the bottom of Flat creek across in Dubois county, but rising to the south it is slightly above drainage, in Secs. 32 and 33, along Sulphur Springs branch. At the White Sulphur Springs the water flows out of the crevices in the limestone over IIIb, and the coal is reported to have a thickness of 2 ft. 6 in. where it has been worked on this farm. On the M. V. Hays place, in the S. E. ¼ of Sec. 32, Coal IIIb has been worked a little and found to be 18 in. thick, overlain by 3 ft. of black shale and 2 in. of limestone. A section from the G. W. Thomas place, in the S. E. ¼ of Sec. 31 (?), was given above (Fig. 782).

1725. T. 2 S., R. 6 W.—Going southward the coal continues to rise to the south until in the southern part of this township Coal IIIb is found well up toward the top of the divides and Coals IIIa and III are exposed in Rock creek. All through this township along its eastern side Coals IV and IIIb seem to tend to come together, the evidence that this apparently double coal is in reality the two coals in close proximity is well shown just east of Velpen as described above. In Sec. 4 coals have been worked at several points. On the Hatfield place, in the N. E. ¼, are a number of drifts on a coal, reported as 2 ft. 6 in. thick, overlain by clay shale, Coal IV(?). The stripping and drift on the Froman place, in the S. E. of N. E. of Sec. 4, is reported to have shown:

	Ft.	In.
Clay shale roof	..	..
COAL IV	1	8
Clay	1	6
COAL IIIb	2	0

Coal IIIb has also been stripped on the Miller place, in the S. W. of S. E. of Sec. 4. In Sec. 5 Coal IIIb has been extensively stripped on the Lynch place. It is reported as 22 in. thick. It is overlain by black sheety shale. Coal IV outcrops beside the road in the N. W. ¼ of Sec. 5 and S. W. ¼ of Sec. 6, where it is overlain by 8 ft. of brown sandy shale, and underlain by gray fire-clay.

In Secs. 7, 8 and 9 are numerous outcrops of Coal IIIb and several of Coal IV. The section at a small stripping close to the railroad, in the N. E. ¼ of Sec. 7, was given above (Sect. 768). The same coal has been stripped at several points south of the railroad just about at a level with the bottoms. In the S. E. ¼ of Sec. 7, Coal IV is worked by a drift on the Hollenburg place. The coal is here about 28 in. thick, with often a sulphur band of up to 3 in. about 6 in. from the top. The upper half of the coal carries a good deal of sulphur. All of the coal is tender. The roof is clay shale and only fair. The fire-clay below is very hard. The coal here is about 20 ft. above Coal IIIb near the railroad. Where the coal has been stripped close to the road, in the N. E. of S. E. of Sec. 7, it is a good looking, peacock-colored coal, with some of the features of a semi-block. There is over it 3 ft.+ of black sheety shale, 1 ft. of limestone and still above drab shale. Coal IIIb has been stripped in the N. W. 40 of Sec. 8 and in the S. E. of N. E. of Sec. 8, on the Jackson Risley place. Southwest of this Coal IIIb is exposed beside the road with its black shale and limestone, and only a few feet above is an outcrop of massive sandstone, suggesting that the horizon of Coal IV is but a few feet above Coal IIIb. A little further east, in the S. W. of N. W. of Sec. 9, Coal IIIb has been stripped at numerous points in a ravine on the Jackson Risley place, with the black sheety shale from 1 ft. to 6 ft. thick, and the limestone 1 ft. thick. Here what was taken to be an outcrop of Coal IV was found at least 15 to 20 ft. above Coal IIIb. It is overlain by 10 ft. and over of gray clay shale.

In Sec. 16 Coal IIIb is found well up toward the summit of the upland, while below it along Patoka river are many outcrops of the massive sandstone overlying Coal IIIa, though that coal is still below drainage. In the S. W. of S. E. of Sec. 16, Coal IIIb is 18 in. thick on the Jones place. In the N. E. of S. E. of Sec. 17, an outcrop in the road showed 5 ft. drab sandy shale, 8 in. coal, 1 ft. clay, 8 in. coal. Coal IIIb has been stripped on the Sarah Ballard place. The black sheety shale is here quite fossiliferous.

The section observed at the bridge over Patoka at Jonesboro was given above (Sect. 772), as was a section obtained in the road in the S. W. of N. W. of Sec. 21. Coal also is found on the Louis Jones place, N. E. of N. W. of Sec. 21; John Taylor place, S. W. of N. E. of Sec. 21; Geo. Taylor place, N. W. of S. W. of Sec. 21.

In Secs. 28 and 29, 32 and 33, Coal IIIb is largely cut out, and there are found numerous outcrops of the massive sandstone between Coal IIIb and Coal IIIa, while Coals IIIa and III are exposed in the bed and banks of Rock creek. The stratigraphy here was well exhibited in Sects. 774 to 776. Coal III is exposed in the bed of the creek, in the N. E. of S. W. of Sec. 28, where it is overlain by 2 ft. of black sheety shale and 1 ft. of yellow limestone. Coal IIIa seems to be cut out at this point, as massive beds of sandstone outcrop only a few feet above. Coal IIIa outcrops in the N. W. of N. W. of Sec. 33, on the Henry Hert place (see Sect. 774a). It is reported as having been found on the Lauterbach place, in the south part of Sec. 28, the roof being sandstone. At Pikeville Coal IIIb is but little below the summit of the ridge and has been dug a little at a number of points.

It ranges from 6 to 12 in. in thickness. From here, as at Velpen, the westward dip quickly carries it below drainage.

1726. T. 3 S., R. 6 W.—The high divides in this area catch Coal IV, and Coal IIIa is found at drainage level along Cup creek, in Secs. 6 and 7. A section at the Sickman bank, in the N. W. of N. E. of Sec. 5, has already been given (Sect. 765). Coal IV is there not far below the top of the ridge. It is 3 ft. thick, overlain by shale, dark and tough at the bottom. This coal is reported to show a similar thickness on the R. G. Bass place, in the S. W. of S. E. of Sec. 3. and on the H. H. Hildebrand place, in the S. W. of N. W. of Sec. 4. Coal IIIa outcrops at creek level on Mrs. Eliza Myers's place, in the S. W. of N. E. of Sec. 7, the sections at this point being as given above. Coal IIIb is 1 ft. thick where dug on Mr. Hagmyer, Jr.'s place, in the S. W. of N. W. of Sec. 7. It has black shale over with sulphur nodules. Coals have also been dug on the following places, which were not seen, though a number of points were visited. J. W. Lukes, S. E. ¼ of Sec. 7, 1 ft. thick; John Hulsmyer, south of center of Sec. 7; H. H. Sakel,

Sec. 8; Wellmyer, Sec. 9; two places in the S. E. ¼ of Sec. 6; coal reported 10 to 20 in.; Sodkamp, N. W. Sec. 17; H. Christopher, N. E. of Sec. 18; J. T. Gray, N. E. of N. W. of Sec. 19, extensive stripping, only roof of clay shale exposed; Prudence Call, N. E. ¼ of Sec. 19; J. H. Dotker, F. Dotker and Christopher, in Sec. 21. In the S. W. ¼ of Sec. 16, Coals IIIb and IIIa outcrop on the Ben Myers farm, being at this point about 30 ft. apart; sandstone in the creek bed indicates the presence of that rock above and below Coal IIIa. Coal IIIb occurs in a small knob in the N. E. ¼ of Sec. 21, on the Fred Myers place.

In review, it will be evident that these partial townships contain little if any workable coal, certainly not in the presence of Coal V so close to the west. After that is worked out it is possible some of this coal will prove of some commercial importance.

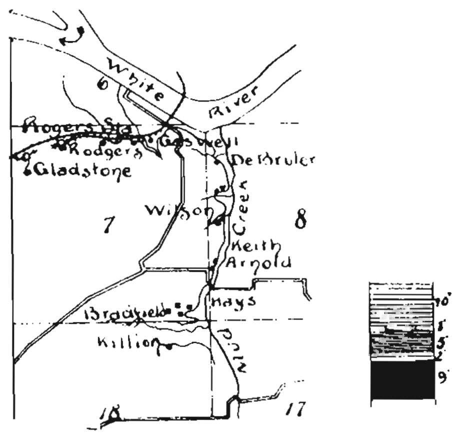


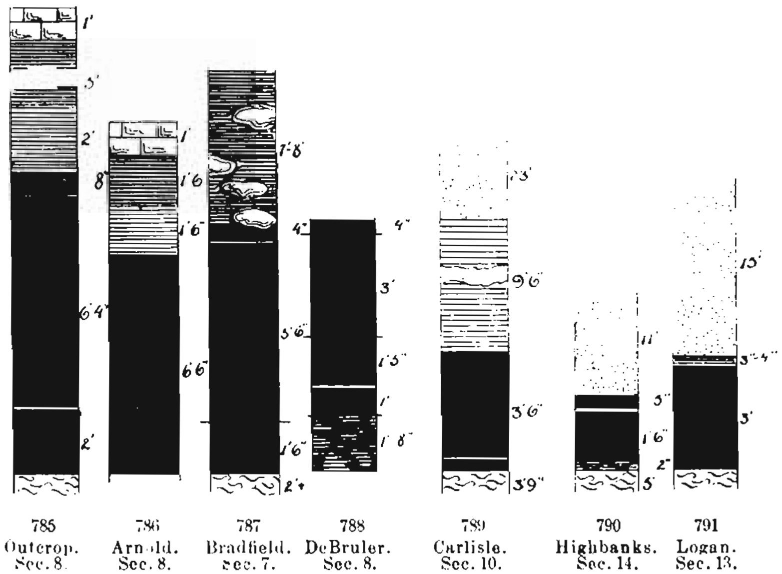
Fig. 784. Sketch map of part of Township 1 north, Range 7 west.

Township 1 North, Range 7 West.

1727. Geography.—Only the part of this township south of White river is in Pike county. It covers the northwestern part of Jefferson and northeastern part of Washington of the civic townships.

The drainage is principally to White river, through Mud, Pond and Beech creeks, while a small area in the south drains to Flat creek. From Algiers eastward the surface is flat. The rest of the township, except the northwestern corner and close to the principal streams, is rolling, with but very few rock outcrops. The E. & I. R. R. crosses the northwestern corner.

1728. STRATIGRAPHY.—Divisions VI to VII, inclusive, outcrop in this area. Coal VI was not seen, but reports indicated the presence of a thin coal locally above Coal V in what was judged to be the horizon of Coal VI. Coal V has only been exposed in the northwestern corner of the township. The following sections of that coal and of the strata above were obtained.



Figs. 785-788. Sections of Coal V, T. 1 N., R. 7 W.
Fig. 789. Section of Coal ?, T. 1 N., R. 7 W.
Figs. 790-791. Sections of Coal IV, T. 1 N., R. 7 W.

The best exposure seen, and one of the best in the State, was in the west bank of Mud creek, in the N. W. ¼ of Sec. 8.

1729. SECTION 781. SECTION ON MUD CREEK.—Sec. 8, Fig. 785.

		Ft.	In.
1.	Gray to brown shale....8 ft. to	10	0
2.	Limestone	1	0
3.	Drab sheety shale	5	0
4.	Soft fissile shale	2	0
5.	COAL V—Coal, jointed, 8 in.; sulphur parting, —; coal, 6 ft. 4 in.; sulphur parting, —; coal, 2 ft.	9	0

Mr. Collett gives the following section of the coal at the old DeBruler bank, which was not far from the above outcrop.

1730. SECTION 782. SECTION OF DE BRULER'S COAL.—N .W. of N. W. of Sec. 8, Fig. 788. (J. C., p. 259.)

		Ft.	In.
1.	Fat cannel-like COAL	0	4
2.	Steam COAL	3	0
3.	Sulphur parting	0	0
4.	Good bituminous COAL	1	5
5.	Parting	..	..
6.	Choice bituminous COAL	1	0
7.	Rash COAL	1	8
		7	5

1731. SECTION 783. SECTION AT ARNOLD MINE.—N. W. of S. W. of Sec. 8, Fig. 786.

		Ft.	In.
1.	Limestone	1	0
2.	Dark sheety shale	1	6
3.	Dark drab shale	1	6
4.	COAL V....6 ft. to 7 ft. 6 in.	6	6

1732. SECTION 784. SECTION AT JOHN BRADFIELD'S MINE.—S. E. of S. E. of Sec. 7, Fig. 787.

		Ft.	In.
1.	Boulder clay in air shaft	?	?
2.	COAL VI? in shaft (not seen)	1	6
3.	Space	5	0
	At drift.		
4.	Black sheety shale, full of sulphur concretions..... 7 ft. to	8	0
5.	COAL V—Coal, blocks, 4 in.; sulphur parting, ⅛ in.; coal, 5 ft. 6 in.; coal, blocks out, 1 ft. 6 in.	7	4

1733. SECTION 785. SECTION AT OLD RODGERS SLOPE.—N. E. of N. W. of Sec. 7.

		Ft.	In.
1.	Surface	10	0+
2.	Limestone	1	6
3.	Dark calcareous shale	5	0
4.	Limestone	1	0
5.	Black sheety shale	5	0
6.	COAL exposed	5+	0

As showing the absence of this coal further south the following drilling is of interest. It starts from the level of the upland.

1734. SECTION 786. SECTION OF DRILLING AT WILLIAM JACKSON'S.—N. W. of S. W. of Sec. 28.

		Ft.	In.
1.	Old well	27	0
2.	Yellow shale	10	0
3.	Blue muck	12	0
4.	"Changeable rock" (sandstone and shale)	70	0
5.	Shale	9	6
	Stopped on shale.		
		128	6

In Sec. 10 is a coal which with some question is referred to the horizon of Coal IV. It is described as an excellent grade of semi-block coal. A section made here by Mr. Collett gave as follows:

1735. SECTION 787. SECTION AT CROW'S.—(Carlisle) N. E. ¼ of Sec. 10, Fig. 789. (J. C., p. 260.)

		Ft.	In.	Ft.	In
1.	Slope	..	..	..	..
2.	Sandstone, soft and coarse	11	0	11	0
3.	Sandstone, thin bedded	12	0	23	0
4.	Clay shale	9	0	32	0
5.	COAL IV?	3	6	35	6
6.	Fire-clay	3	9	39	3
7.	Covered	50	0	89	3
8.	Hard sandstone	1	6	90	9
9.	Clay shale with iron nodules containing zinc blend	5	0	95	9
10.	Flagstones and ferruginous limestone	12	0	107	9
11.	COAL IIIb in White river	?	?	..	..

1736. SECTION 788. SECTION BESIDE ROAD.—West bank of Pond creek, S. W. ¼ Sec. 14.

		Ft.	In.
1.	Brown shaly sandstone	6 ft. to 20?	0
2.	Light drab clay shale	8	0
3.	Brown shaly sandstone	3?	0
4.	Gray clay shale	10	0
5.	Black shale sheety	?	?
6.	COAL?	?	?
7.	Fire-clay	?	?
8.	Massive sandstone	20+	0

At this exposure the coal and adjacent strata appeared to be in large pieces indiscriminately mixed up, but as some fallen timber prevented close examination that part of the section is given with much hesitation.

In Sec. 13, Coal IV has been worked at several places. A section given by Mr. Collett is as follows:

1737. SECTION 789. SECTION AT DAILY'S FARM.—"S. W. of N. E. of Sec. 13," Fig. 790. (J. C., p. 261.)

		Ft.	In.
1.	White fluviatile sand with shells	33	0
2.	Red clay "modified drift"	8	0
3.	Blue potter's clay, glacial drift with fossil plants	10	0
4.	Soft sandstone	11	0
5.	COAL, bone, IV	0	5
6.	Clay parting	0	1
7.	COAL, good	1	6
8.	COAL, bone	0	2
9.	Stigmarial clay	5	2

These sections show Coal V to be a coal from 6 to 9 ft. thick, overlain by black shale, in part sheety and full of pyrite concretions, and above that limestone. The coal is apt to contain irregular sulphur bands and probably a larger percentage of ash than most of the thinner coals.

Coal IV appears to be a good grade of coal, with often the same clay band that was so generally present in Daviess county. Its thickness is generally given as about 3 ft., but it will probably average much less. Its roof is sandstone, or shale overlain by sandstone.

Coal IIIb has been reported in the banks or bottom of White river 3 ft. thick, and said to be 6 ft. in one place but under conditions that render measurements unreliable.

No data was obtained of the underlying coals, but they may be counted on as present, and possibly workable in places.

1738. DISTRIBUTION AND LOCAL DETAILS.—Coal IIIb is just about at drainage level in White river, in Secs. 12, 13 and 14, and below in Secs. 11 and 10. It is said to outcrop in the bed of the river in Sec. 12, large fragments being washed out on to the sandbars in the river. At High Banks it is said to be 3 ft. thick on the Logan place, in the N. E. of S. E., and to be overlain by 3 ft. of black shale (Fig. 791). This is in the river bluff. In Sec. 10 only the overlying limestone is exposed.

Coal IV has been worked in Sec. 13, on the Hargraves place, in the S. E. ¼. The coal is not exposed but is overlain by massive brown sandstone. It occurs well up in the bluff. It is probably this coal that has been worked in Sec. 10. The only recent work has been on the Carlisle place, where the coal is reported to average 3 ft. 6 in., with a 1-in. sulphur band 3 in. from the bottom. It is here about 75 ft. above the river (see Sect. 787).

The horizon of these two coals probably underlies all of this area except as it has been cut out by preglacial erosion.

Coal V is just about at the level of Mud creek at the Arnold and Keith mines, in the S. W. ¼ of Sec. 8, but rises to the north and south. To the south it is worked at the John Bradfield or old Hays mine, where it averages 7 ft. thick. The roof here is "knobby" with the pyrite and lime concretions extending down into the coal. These are often several feet in diameter and extend 1 ft. 6 in. into the coal. The dip here is north. It has also been worked on the Alexander Killion place, formerly the Holloway place, in the N. E. ¼ of Sec. 18.

At Rodgers station the coal is just about level with the railroad track, or about 30 ft. above low water in White river. It has been stripped here and appears to have been 6 or 7 ft. thick (see Fig. 801).

A little further west, at the old Rodgers' slope, the coal is about 6 ft. below the railroad. A little further and the dip has brought the coal 40 ft. or more below the track, so that it is reached by a shaft. The coal here is said to have run from 4 to 8 ft. thick and rather soft. It was mined by shooting on the solid. The roof was a clay shale from 1 to 18 in. thick, which here comes between the coal and the regular black shale roof. It required very close timbering. In the N. W. of N. W. of Sec. 7 is the Gladstone or Alexander mine, formerly the Rhodes mine. Coal was shipped from this point to New Harmony and elsewhere as early as 1835, according to Mr. Owen. (R. O., p. 180.) The coal has risen to this point so that it is only 10 to 12 ft. below the railroad. (Railroad runs on old towpath of E. & W. canal and therefore keeps about level.) Whether this early mining was by stripping or by drift or slope was not learned. If by the latter, this would appear to be one of the first if not the first of the mines in the State to go under the ground.

The distribution of Coal V to the south was not learned. As indicated by the Jackson well section in Sec. 28, it is wanting there, but it seems probable that it will be found along the western edge of the township.

Township 1 South, Range 7 West.

1739. Geography.—This township corresponds to the southwestern corner of Jefferson, southeastern corner of Washington, northeastern corner of Patoka and northwestern corner of Marion of the civic townships. A fairly high ridge crosses the township from Sec. 18 to Sec. 25, south of which the drainage is to the Patoka and the topography much broken. North of this the drainage is to Flat creek

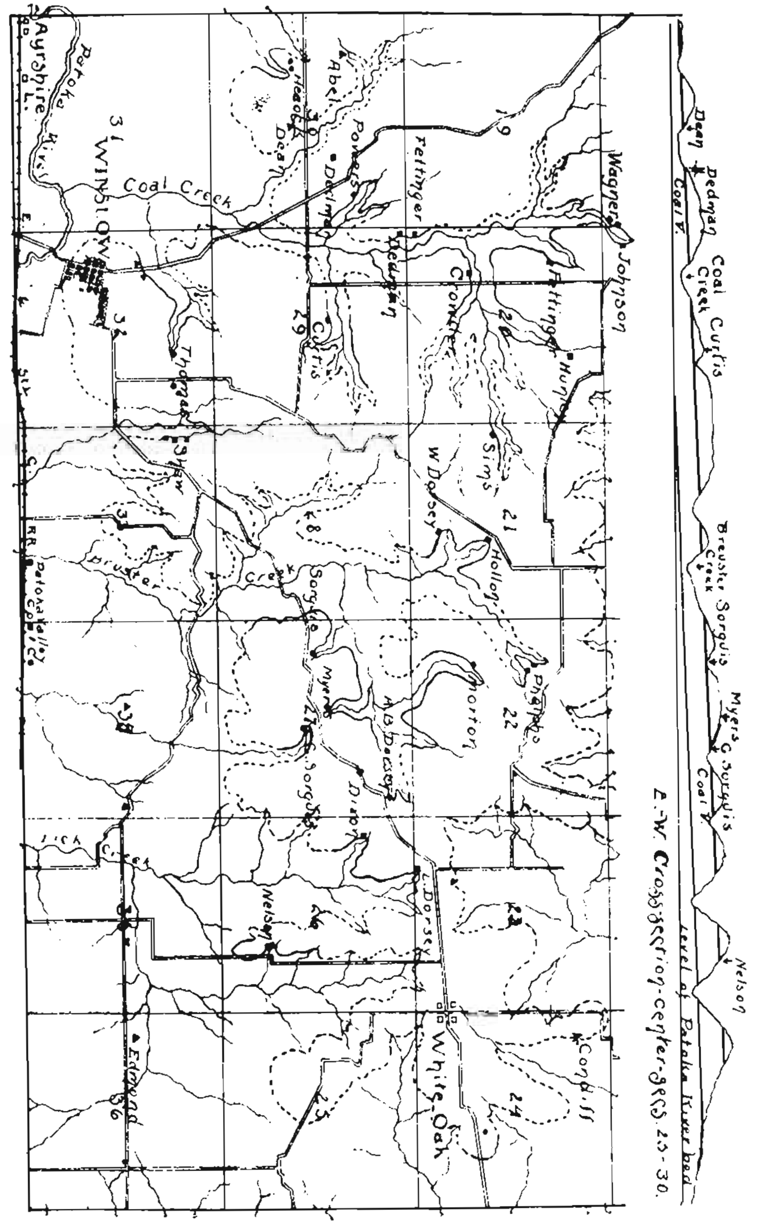
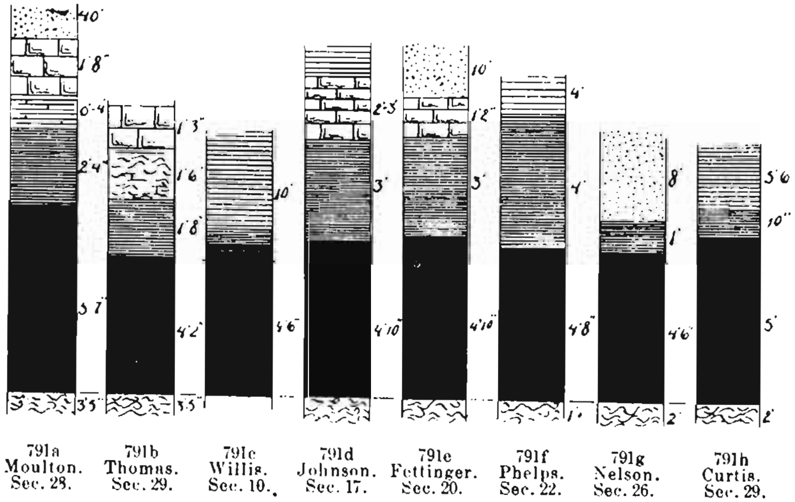


Plate LVII. Sketch map and cross-section of part of Township 1 south, Range 7 west.

and the topography is rolling, with a large area of high, flat land just north of and extending northwest of the center of the township. This flat country appears to have been a lake, probably caused by the damming up of its outlet by the ice of the glacial period. It is suspected that the drainage was in preglacial times down Mud creek, but our investigations were not sufficiently detailed to prove it. The Air Line railroad skirts the southern edge of the township.



Figs. 791a-791h. Sections of Coal V in T. 1 S., R. 7 W.

1740. STRATIGRAPHY AND COALS.—Coal V becomes important in this township and while some of the lower coals were reported or observed, no detailed sections were obtained showing their stratigraphic relations to Coal V. Two sections showing the strata overlying Coal V, as seen by Mr. Collett, will be given here. Others are given farther along.

1741. SECTION 790. SECTION AT MOULTON BANK.—Sec. 28, Fig. 791a. (J. C., p. 266.)

		Ft.	In.
1.	Slope, thin to heavy sandstone	40	0
2.	Limestone	1	8
3.	Calcareous shale .4 ft. to	0	0
4.	Black sheety shale with iron stones	2	4
5.	COAL V—Good blacksmith coal, 1 ft. 0 in.; steam coal, pyritous parts, 3 ft. 7 in.; good blacksmith coal 1 ft. 0 in.	5	7
6.	Fire-clay	3	5

1742. SECTION 791. SECTION AT THOMAS'S BANK.—Sec. 29, Fig. 791b. (J. C., p. 266.)

		Ft.	In.
1.	Slope	0	0
2.	Limestone with productus and spirifer	1	3
3.	Calcareous clay	1	6
4.	Black bituminous sheety shale	1	8
5.	COAL V—Good smith's coal, 1 ft. 2 in.; steam coal, 1 ft. 6 in.; caking coal, 1 ft. 6 in.	4	2
6.	Fire-clay	3	5

Coal V yields a small basin of workable coal in the northeast quarter and a very fine basin in the southern half of the township. In the latter area an abundance of exposures show the coal to maintain a good workable thickness over the whole basin. In thickness it ranges from 4 ft. to 5 ft. 4 in. or even more in places. There is a top coal 6 to 8 in. thick, sometimes laminated, sometimes very hard and blocky; below it is a smooth parting, with sulphur sometimes. There is usually from a few inches to a foot of hard coal; then the rest is about uniform and softer. There is usually a sulphur band about the middle. This coal, though containing the bands mentioned and occasionally thin bands not persistent, appears to be otherwise quite free from sulphur. The roof is usually the characteristic black sheety shale with sulphur nodules, and sometimes a few inches of draw slate, otherwise excellent when it has sufficient cover over it. Above occurs the limestone as usual, though not thick and not entirely persistent. In places neither the black shale nor limestone appear, the roof being made of clay shale. This roof appears to be fairly good as far as observed, but would probably soften if wet and might prove unsatisfactory. Fire-clay underlies the coal.

Little is known of the underlying coals. Coal IV is said to have been 3 ft. and an inch or two, and Coal III 4 ft. thick in the shaft and drilling of the Patoka Valley Coal Company.

1743. DISTRIBUTION AND LOCAL DETAILS.—Workable coal, as far as developed, appears to be confined to two basins, one extending from Winslow to White Oak, the other occupying low hills in Secs. 2, 3, 10 and 11. The latter would seem to be an outlier from the first area rather than a separate basin, having formerly been connected with the larger area in a southwesterly direction. This connection was largely cut off by the erosion, which latter when filled up produced the broad prairie in the central part of the township. The connection seems to be maintained through the ridge between Secs. 14 and 15, 22 and 23. Whether a workable thickness exists through this ridge was not ascertained. At the north area, Coal V has been worked at the Arthur Hutchins and Thomas Whitehead places, and in 1898 was being worked at the T. M. Willis place. A description of the coal at this place will serve for this area. The coal here averages 4 ft. 6 in. thick, not varying 2 in. either way. There is a thin sulphur band about 2 in. from the top and a smooth parting 6 in. from the top (Fig. 791c). The upper 1 ft. is harder than the rest of the coal, the 6 in. above the smooth parting is the hardest coal and has a tendency to block out. The roof is a brown to drab clay shale, of which 10 ft. are exposed, about 2 to 6 in. tending to come down; appears to be solid above. The floor is fire-clay. At the Schlockner bank, just west, the roof is the characteristic black sheety shale.

In Sec. 24, 6 in. of coal, overlain by black shale and limestone, outcrops on the L. Condiff place. In the N. W. of S. E. of Sec. 24, there is reported to have been about 2 ft. of coal struck in a well at a depth of about 25 ft. It is said to have had 5 ft. of black shale over it, with limestone above that. These data would indicate a thinning out of the coal east and north of White Oak.

The coal in the southern half of the township shows a general dip to the southwest, so that it runs up the streams without passing under until near their heads. Along Stone Coal branch it is just above drainage, but keeps above drainage almost to the heads of the branches. Going east, it becomes higher until at the Nelson bank, in the S. E. ¼ of Sec. 26, it is almost up to the top of the ridge.

1744. Sec. 17.—The Geo. Johnson coal bank is located in the S. W. 40 acres. The coal averages 4 ft. 10 in. thick (see Fig. 791d). The roof is black shale, 3 ft. thick, about 5 in. coming down; otherwise good. Above is 2 to 3 ft. of blue limestone, with clay shale and sandstone still above. The floor is fire-clay. Just across, in Sec. 18, some test drifts on the Samuel Wagner place showed 5 ft. 4 in. of coal, with a black shale roof.

1745. Sec. 20.—In the N. E. ¼ of this section is the Hunley slope, 3 ft. of coal being exposed, with a roof of black sheety shale containing sulphur nodules. In the N. W. ¼ is the John R. Fettinger bank. The coal here measured 4 ft. 10 in.; the section showing (Sect. 792, Fig. 791e):

	Ft.	In.
1. Sandstone	10	0
2. Dark blue, impure limestone, fossiliferous	1	2
3. Black sheety shale	3	0
4. COAL V	4	10
5. Fire-clay	..	..

The coal appears to be solid. The roof is good, though having 4 in. of draw slate. It contains some pyrite nodules, but they do not extend far into the coal. In the N. E. of the S. W. ¼ is the J. M. Crowder bank. The coal here measured 4 ft. on the average, with a black shale roof and fire-clay floor. A bank was formerly run on Mrs. Fettinger's place, in the S. W. 40 acres of this section.

1746. Sec. 21.—In the S. W. ¼ the coal measured 4 ft. 3 in. at the Simms bank, showing a smooth parting 6 to 9 in. from the top. The roof is black sheety shale 9 in. thick, overlain by 4 ft. of gray to drab clay shale. Near the center of the section, in the Edward Hollen mine, the coal measures 4 ft. 4 in. in thickness, with a thin sulphur band 9 in. from the top. The roof is black shale, 1 ft. 3 in. thick, with sandstone over. At the J. W. Dorsey bank the coal measured 4 ft. 6 in. The top 2 ft. is the hardest and blocks out best. Near the center is a sulphur band 1 to 3 in. thick. The roof is black sheety shale 6 ft. thick, with some sulphur nodules. Above it is sandstone. The floor is fire-clay, 12 ft. thick; still below, massive sandstone is exposed down the creek.

1747. Sec. 22.—In the N. W. ¼ of this section the coal measured 4 ft. 5 in. at the W. E. Phelps bank, ranging up to 5 ft. The top coal is 6 in. thick, with a sulphur band below. The section here is (Sect. 793, Fig. 791f):

	Ft.	In.
1. Surface	8	0
2. Soft sandstone	8	0
3. Gray shale	4	0
4. Black shale with sulphur nodules	4	0
5. COAL V	4	8
6. Hard fire-clay	1	0+

Six inches of the roof come down. The coal is well up toward the top of the ridge, being 8 to 10 ft. above adjacent drainage. In the S. W. ¼ the coal is much the same at the Washington Morton bank. It here averages 4 ft. 8 in., ranging up to 5 ft. 1 in. It has a sulphur band in the middle from 0 to 2 in. thick, and a smooth parting 8 in. from the bottom. The roof is black shale, 3 ft. thick, 8 in. coming down; above is sandstone. The floor is fire-clay, 2 ft.+ thick.

1748. Sec. 23.—At the Lee Dorsey bank, in the S. W. corner, the coal is 4 ft. 6 in. thick and solid, the top 22 in. being the hardest and best. The roof is black shale, with the peculiar nodules inclosing soft clay, the draw slate not running over an inch or two. Above the black shale is 3 ft. of gray shale, then 1 ft. of dark blue limestone, fossiliferous, with 18 ft. and more of sandstone over that. The floor is generally fire-clay, though at times sandstone.

1749. SEC. 26.—In this section the coal is very near the top of the divides. At the Nelson bank the section exposed is (Sect. 794, Fig. 791g):

		Ft.	In.
1.	Surface	12	0
2.	Soft yellow sandstone	8	0
3.	Black sheety shale ......6 in. to	1	0
4.	COAL V	4	6
5.	Fire-clay	2	0
6.	Massive yellow coarse-grained sandstone	20	0+

In the N. W. ¼ the coal is worked at the Geo. Dixon bank. At these banks the closeness of the coal to the top of the ridges is apt to render the roof soft and poor.

1750. SEC. 27.—In this section the coal is worked at the Christopher Myers, William Sorgius, Geo. Sorgius and R. B. Dorsey banks, the coal ranging from 4 ft. or 4 ft. 6 in. to an average of 5 ft. 3 in. in Myers's bank. All have the usual black shale roof, usually 3 ft. thick, usually with sulphur nodules, which, in the Dorsey bank, have the centers soft. At the Dorsey bank there is above the black shale 2 ft. of soft gray clay, then 1 ft. of black limestone, with clay shale and clay above. In the Myers bank there is 30 ft.+ of sandstone above the black shale. The draw slate ranges from 0 to 6 in.; otherwise the roof is generally excellent. The floor is soft fire-clay at the Dorsey bank, while at the Myers and Geo. Sorgius banks it is hard and sandy.

1751. SEC. 29.—At the Samuel Curtis mine the section is (Sect. 795, Fig. 791h:

		Ft.	In.
1.	Surface	3	0
2.	Brown shale	4	0
3.	Drab shale	1	6
4.	Black sheety shale	..	10
5.	**COAL V**	5	0
6.	Fire-clay	2	0+

The coal shows a sulphur streak 4 in. from the top and many irregular streaks about 2 ft. from the top. Coal has also been dug in the N. W. corner, on the Dedman place.

1752. SEC. 30.—At the James Powers bank the coal measured 5 ft. 2 in., with a sulphur band noted 2 ft. 3 in. from the top. The roof is here clay shale, full of plant remains for a thickness of 6 in., 8 or 10 ft. being exposed.

The coal has also been worked on Mrs. Dedman's place by shaft 15 ft. deep and at a small stripping near the center of the section.

1753. SEC. 32.—Drillings near the center of the N. E. ¼ are reported to show 4 ft. 6 in. of coal. Coal was formerly worked on the Thomas place.

1754. SEC. 33.—Near the N. W. corner this coal measures 5 ft., at the Shaw bank, the top coal being 6 to 8 in. thick and laminated, with usually a ¼ in. sulphur band below. About 2 ft. from the top is usually a dirt streak. The roof is black shale, with many sulphur nodules extending down into the coal and tending to come down. As usual, the coal tends to stick tightly to these and loses its regular cleat below them. The limestone appears to have decayed, leaving 2 to 6 ft. of hard blue clay over the black sheety shale. Above still is 1 to 4 ft. of clay shale, with sandstone above. The fire-clay appears to be quite thick.

In the S. W. of S. E. of this section a drilling by the Patoka Valley Coal Company is reported to have found 4 ft. of coal at a depth of 135 ft. Its depth below Coal V would probably be somewhat more than that. A shaft was started and is said to have passed through a 3 ft. 3 in. bed at a depth not learned, but it was abandoned before reaching the 4 ft. bed. An examination of the material brought up from the shaft shows principally a flaky micaceous sandstone, a little blue shale, a very small amount of black sheety shale and quite a little coal.

SECS. 34, 35 AND 36.—Several outcrops of coal were noted in these sections, usually only a few inches thick, overlain by the usually black sheety shale, limestone and sandstone that occur over IIIb. From the Nelson bank, in Sec. 26, to an outcrop of Coal IIIb beside the road, near the center of Sec. 35, there appears to be a difference of level of about 50 ft.

These data indicate a fine basin of coal in this half township. It appears to crop out along the north side of the ridge running from Secs. 18 to 24. It probably runs under the highland west of the large flat stretch in the center of the township. It is cut out across the bottom land of the Patoka valley. Coal VI appears to be entirely lacking in this area, its position evidently being below the massive sandstone met with near the top of all the hills here. The massive sandstone below the coal shows well at the Patoka bridge south of Winslow and in the valley south of White Oak.

Coals II, III, IIIa, IIIb and IV are supposed to run under all of this township and are credited with a working thickness at least in places. They may prove of considerable value later.

Township 2 South, Range 7 West.

1755. Geography.—This area is south of the center of the county and corresponds to the southwestern part of Marion, the southeastern part of Patoka, the northeastern part of Monroe and the northwestern part of Lockhart of the civic townships. There is a little flat land along the stream bottoms; otherwise the area is quite broken and hilly. The northern half of the area drains to Patoka river, the southeastern corner to Cup creek, the southern or southwestern part to South Patoka. The Air Line Railroad crosses the northern edge of the area and sends a branch to Hartwell, well into the center of the township.

1756. Stratigraphy.—Though Coal VII was not seen, the limestone occurring near the top of Division VI was noted as far east as Hartwell, indicating the probable presence of Coal VII in some of the higher hills of the western part of the township. As usual, Coal V is the most important coal, though at Hartwell and Augusta Coal VI reaches a good thickness. Coal IV about reaches a workable thickness, and a coal still below is reported at one point as reaching a thickness of 6 ft.

The following sections will show the relations of the coals:

1757. Section 796. Section at White's Bank.—N. ½ of S. E. ¼ of Sec. 16. (J. C., p. 269.)

		Ft.	In.
1.	Clay shale ....10 to	15	0
2.	Black sheety shale....................	1	10
3.	COAL V—		
	Splinty coal with clay and shale partings........	3	4
	Good splinty cannel....................	1	3
4.	Fire-clay	5	0
		26	5

1758. Section 797. Section at Corn's.—S. W. ¼ of S. E. ¼ of Sec. 16, Fig. 1, Pl. LVIII. (J. C., p. 269.)

		Ft.	In.
1.	Slope	0	0
2.	Coarse, soft sandstone ....10 to	30	0
3.	Massive sandstone with rock houses..............	50	0
4.	Clay shale ....10 to	15	0
5.	Black sheety shale....................	2	0
6.	COAL V....................	4	6
		101	6

This section gives a great thickness to the sandstone of Division VI, and I am inclined to think was overestimated. In the northwestern corner of the township the usual black shale roof is often separated some distance from the coal by intervening clay shale, as shown in the following section in the road near Robling's mine, south of Winslow:

1759. Section 798. Section in Road.—N. E. ¼ of Sec. 6, Pl. LVIII, Fig. 2.

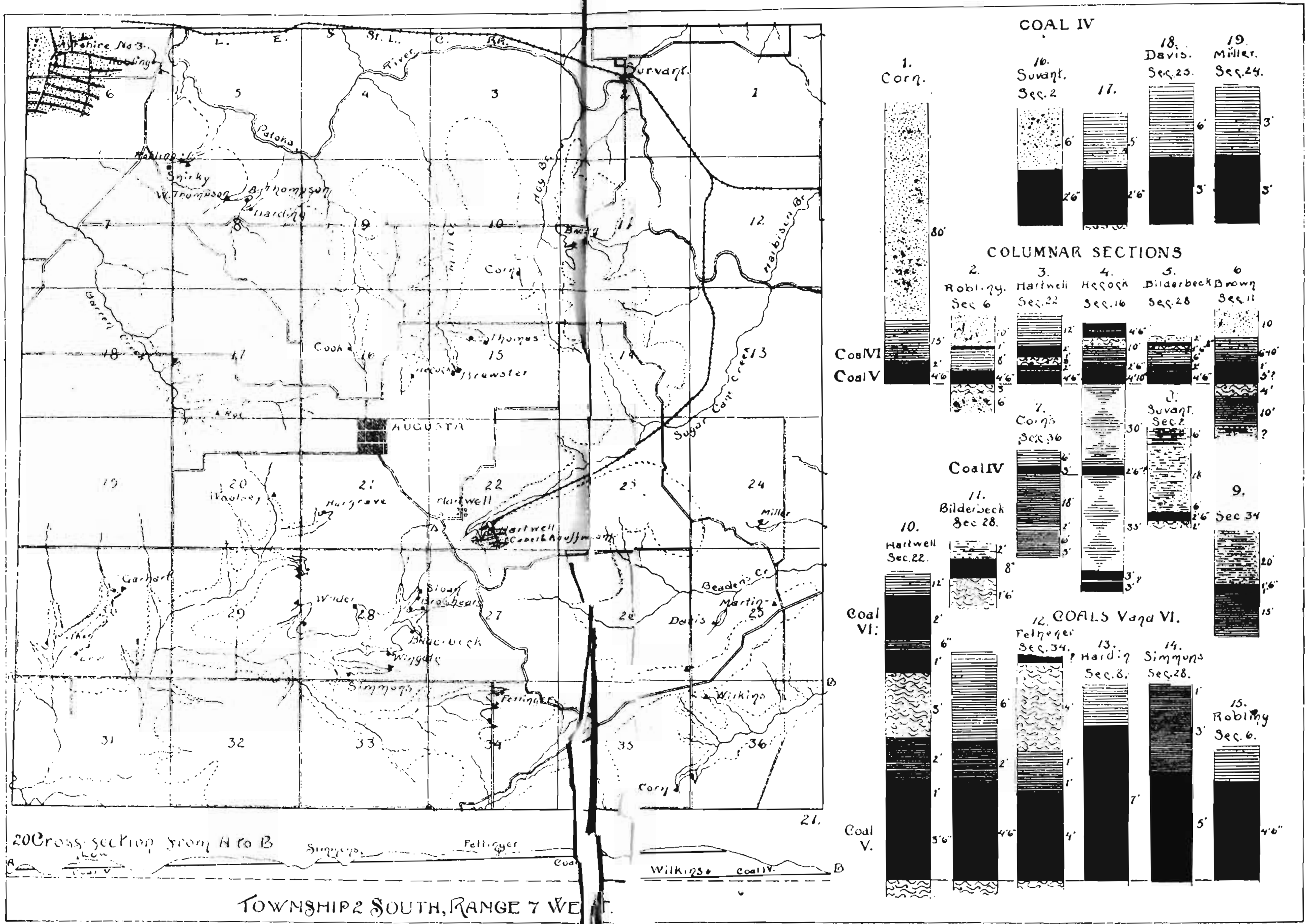
		Ft.	In.
1.	Yellow sandstone	10	0+
2.	Blue to black shale, a little sheety................	1	0
3.	Light brown clay shale....................	8	0
4.	COAL V....................	4	6
5.	Fire-clay and shale....................	3	0
6.	Massive yellow to brown sandstone...............	6	0

The best exposure observed of Coal VI was at Hartwell, where the following section shows above the Hartwell drift:

1760. Section 799. Section at Hartwell.—Sec. 22, Pl. LVIII, Figs. 3 and 10.

		Ft.	In.
1.	Light drab shale....................	12	0
2.	COAL VI—Coal, 1 ft. 6 in. to 2 ft. 0 in.; gray shale, 4 in. to 6 in.; coal, 1 ft. 0 in.?..................	3	6
3.	Fire-clay	3	0?
4.	Black sheety shale with sulphur concretions.......	2	0
5.	COAL V ....1 ft. to 5 ft.	4	6
6.	Fire-clay	..	..

At the Perry Hecock mine, near Augusta, Coal VI is reported as ranging from 4 ft. to 4 ft. 6 in. thick, with a band which in places is as much as 20 in. thick. The section here principally reported is as follows:


L. E. & St. L. C. RR.
Patoka River
Robling
Suvant
AUGUSTA
Hartwell
Sugar Cane Creek
Halbison Br.
Barren Creek
Beadens Cr.
COAL IV
COLUMNAR SECTIONS
COALS V and VI.
Coal VI
Coal V
Coal IV
1. Corn.
16. Suvant. Sec. 2
17.
18. Davis. Sec. 25.
19. Miller. Sec. 24.
2. Robling. Sec. 6
3. Hartwell Sec. 22
4. Hecock Sec. 16
5. Bilderbeck Sec. 28
6. Brown Sec. 11
7. Corn Sec. 36
8. Suvant. Sec. 2
9. Sec. 34
10. Hartwell Sec. 22.
11. Bilderbeck Sec. 28.
12. Fettinger Sec. 34.
13. Harding Sec. 8.
14. Simmons Sec. 28.
15. Robling Sec. 6.
21.
20 Cross-section from A to B
Simmons
Fettinger
Wilkins
Coal IV.
Coal V
TOWNSHIP 2 SOUTH, RANGE 7 WEST.

re LVIII.

1761. SECTION 800. SECTION AT HECOCK MINE.—Sec. 16, Pl. LVIII, Fig. 4.

	Ft.	In.
1. COAL VI	4	6
2. Fire-clay and gray shale.....8 ft. to	10	0
3. Black sheety shale	2	6
4. COAL V	4	10
5. Space, fire-clay, sandstone, etc., gray shale	30	0
6. COAL IV	2	6
7. Space	35	0
8. COAL with 6 in. to 1 ft. dirt in center	7	0

As showing the way Coal VI is frequently found in this area the following section is interesting:

1762. SECTION 801. SECTION ON FRANK BILDERBECK PLACE.—N. E. of S. E., Sec. 28, Pl. LVIII, Figs. 5 and 11.

	Ft.	In.
1. Gray shaly sandstone	2	0
2. COAL VI	..	8
3. Gray fire-clay	1	6
4. Gray shale	6	0
5. Black sheety shale	2	0
6. COAL V	+4	6

At a majority of places Coal VI is not seen, and the sandstones overlying it lie directly upon the roof shales of Coal V as follows:

1763. SECTION 802. SECTION AT TAYLOR & HARNET'S (OLD BROWN PLACE).—Sec. 11, Pl. LVIII, Fig. 6.

	Ft.	In.
1. Brown sandstone	10	0+
2. Gray to brown shale, sandy in places.....6 ft. to	10	0
3. Massive blue shale to black sheety shale.....6 in. to	1	0
4. COAL V (reported)	5	0
5. Gray to brown fire-clay	4	0
6. Light brown shale	10	0
7. Sandstone and sandy shale	..	..

In the eastern part of the township Coals IV and IIIb are exposed.

1764. SECTION 803. SECTION UNDER RIVER BRIDGE AT SURVANT.—Sec. 2, Pl. LVIII, Fig. 8.

	Ft.	In.
1. Brown sandy shale	6	0
2. Light brown shaly sandstone	18	0
3. Brown massive sandstone	6	0
4. COAL IV	2	6
5. Drab fire-clay and shale to water in river	2	0

1765. SECTION 804. SECTION ON ROAD, FRED CORN'S PLACE.—S. W. ¼ Sec. 31, Pl. LVIII, Fig. 7.

	Ft.	In.
1. Gray clay shale	6	0
2. COAL IV	3	0
3. Gray clay shale	18	0
4. Drab shale inclined to be sheety	2	0
5. Black fissile shale	6	0
6. Brown ironstone	..	6
7. Shale to creek bed	3	0

1766. COAL VI ranges from 4 ft. to 6 in. in thickness in this area, though usually less than 1 ft. or absent. Where thick, it has a parting which is apt to render it unworkable. As it has not been worked here, nothing is known of its quality. It usually has a roof of shale, overlain by a considerable thickness of sandstone. It is generally found from 5 to 10 ft. above Coal V.

1767. COAL V is from 7 ft. thick down, averaging probably over 4 ft. It usually has the characteristic black sheety shale roof, though without the limestone, but in the northwestern corner this black shale is underlain in many places by up to several feet of clay shale. In places this black shale roof is so irregular with pyrite concretions as to render mining very difficult. General opinion appears to indicate that Coal V is of a little better grade in this area than through most of the county. As the coal is somewhat thinner here than in most of the townships, it would not be surprising if the quality proved to be above the average.

1768. COAL IV runs from 2 ft. 6 in. to 3 ft. in thickness, with sometimes a sandstone roof, but often a light cream-colored clay shale that suggests suitable material for clay products, paving brick, etc. As the coal appears to be a dry, semi-block coal of some purity, it may prove of value if mined in connection with the overlying shale.

1769. COAL IIIb was not seen in this township, but was observed above or at drainage within a half mile of the township line to the north, east and south. It appeared to be thin at all of these points. It is probable that not less than five or six coals underlie Coal V, some of which may prove workable, at least locally.

1770. DISTRIBUTION OF COAL AND LOCAL DETAILS.—Coal V is cut out over nearly all of Secs. 1 to 5. Much of these sections is river bottom. Coal IV outcrops at river level at Survant and the sandstone overlying that coal outcrops abundantly in Sec. 1. In Sec. 6

Coal V is extensively worked at Ayrshire No. 3 shaft. The coal is only about 14 ft. deep at the shaft and outcrops to the north and east, where it is a few feet above the level of the river bottoms. The coal will average 5 ft. thick, without bands or parting. The roof is black sheety shale, overlain by 40 ft. or more of sandstone. The black shale varies in thickness from 0 to 18 in. It is free from pyrite balls, and holds well if closely timbered, though the general practice here is to leave large pillars. The coal is free from sulphur. It runs about 60 per cent. lump. Much of the fine coal is utilized by screening, washing and coking. The coal is mined on bottom and at rib or is shot on the solid. The underclay is rather soft.

Local trade is served from the Robling drift, in the N. E. of N. E. of Sec. 6. The coal here measured 4 ft. 6 in., with a gray to drab clay shale roof. (Fig. 15.) The coal is here 10 to 15 ft. above the bottoms. At the corners of Secs. 5, 6, 7 and 8 coal is mined on the Peter Shirky and Robling places. At the Shirky slope the coal is 4 ft. 8 in. thick, the roof clay shale, overlain by 5 ft. of black shale, and that in turn by 20 ft. or more of massive sandstone. North of the center of Sec. 8, Coal V is worked at the Wm. Thompson, formerly the Russ bank, Alfred Thompson and Albert Hardin banks. At the two latter mines the coal is reported to run up to 7 ft. in thickness, with a clay shale roof. At the Wm. Thompson bank the coal ranges from 4 ft. 6 in. to 5 ft. in thickness, with an average of 4 ft. 9 in. The roof is clay shale, with a thickness of 10 ft. or more, overlain by black shale. Below is fire-clay. The coal is about at drainage level.

Going east, the coal rises until on the Thomas Brown place, in Sec. 11, it is nearly at the top of the ridge and estimated to be 75 ft. above Coal IV at Survant. The coal is here reported to be 5 ft. thick, and has been drifted upon on both sides of the ridge. The section was given above. A section was given above on the Jackson Corn land, in the S. W. ¼ of Sec. 16. Mr. Collett describes a natural bridge here 30 ft. long, 10 ft. wide, with a cord of 20 ft. This place was not visited, and some question which has arisen in regard to the stratigraphic position of the section given by Mr. Collett cannot be answered. It is possible the coal in the section is Coal IIIb, in which case its thickness is probably overstated. Some coal was dug in 1897 on the James Corn place, in Sec. 10.

In the row of sections from Sec. 13 to Sec. 18, Coal V has been worked at the Sherman Thomas and Clark Brewster banks, formerly the Beech and Corn banks, in Sec. 15; the Perry Hecock and John Cook banks, in Sec. 16, and at the Wm. Roe, formerly the Bee bank, in Sec. 17. The coal at these places runs from 4 to 5 ft. thick. The roof is black sheety shale, with clay shale below in places, and ranges from fair to good. At the Hecock bank the coal is just at creek level. Above here 10 or 12 ft. is Coal VI, reported to be 4 ft. to 4 ft. 6 in. thick, with a band which in places runs up to 20 in. in thickness. See section given above.

Coal V has been mined some on the G. T. Woolsey place, in Sec. 20, stripped on the Hargraves place, in Sec. 21, and mined extensively at Hartwell, in Sec. 22. At the Hartwell mine of Messrs. Cabel & Kaufmann the coal runs from 4 to 5 ft., with an average of 4 ft. 6 in., but in places runs down to 18 in. The top 6 or 8 in. of the coal blocks well and is the best coal. A sulphur band occurs about 1 ft. from the top. Most of the sulphur in the coal occurs about the middle of the coal. The roof is poor toward the crop, but good under the hill. Some trouble is had with the pyrite concretions which occur in parts of the mine, not as individual concretions, but in such numbers that they partly coalesce, giving the roof a strongly botryoidal appearance. Parts of the mine are entirely free from this roof. The bed of coal does not lie evenly, so that some steep grades are encountered, and the haulage is up-grade to the mouth of the drift from most parts of the mine. A few faults of from 2 to 3 ft. downthrow have been met with.

Except in the top of one or two ridges, Coal V is cut out in Secs. 12, 13, 24, 25 and 36. Coal IV outcrops in these sections as follows: In Sec. 24 it is stripped on the Miller place, where it is 3 ft. thick, overlain by white to cream-colored clay shale; in Sec. 25 is the Hutchinson stripping on the Philip Davis place, where it is a semi-block, with mud slip 3 ft. thick, and overlain by 6 ft. of gray shale, as at Miller's; in Sec. 36, on the Wm. Wilkie place, Coal IV is 2 ft. 6 in. thick, and seems to have a thin dirt band 1 ft. from the top. The white mud slips tend to run N. 65°-70° E., but whether regular or not, could not be determined. The roof is gray clay shale, 5 ft. thick, and the floor of soft dark drab fire-clay. On the Fred Corn place, in Sec. 35, the coal runs from 2 to 3 ft. in thickness, and occurs well up toward the top of the ridge.

Coal V appears to underlie the top of the ridge in Sec. 25, and has been worked a little back of the church, on Mrs. Martin's place.

Coal V is present under much of the upland of Secs. 27 and 26. In Sec. 28 it is worked at a number of points. On the A. Sloan place, in the N. E. of N. E. of section, and Walker Brashear's, just across the fence to the south, the coal measured 4 ft. 10 in., including 6 in. of bony coal at the top. One foot from the top a thin sulphur band was noted. The coal is a rich, shiny black, with some of the characters of a semi-block. The roof is black sheety shale. A section at the Frank Bilderbeck mine, N. E. of S. E. of Sec. 28, was given above. (Sect. 801.) At a drift on the J. Wingate place, in the N. W. of S. E. of Sec. 28, the coal measured 4 ft. 7 in. plus, with the black sheety shale roof and fire-clay floor. Massive sandstone outcrops up the hill from it. It has been stripped here and on the Simmons place, in the S. W. of S. W. of Sec. 26, and drifted upon at the Simmons bank, in the S. E. of S. W. of Sec. 28. It here measured 5 ft., overlain by 3 ft. of gray to black pyritiferous shale, and that in turn by 1 ft. plus of black sheety shale, in which the fossils are replaced by pyrite. The coal is 6 or 8 ft. above the creek level. Coal has also been worked on the Wilder place, in the N. W. ¼. On the road along the western side of the section are several exposures of Coals VI and V. Two of these gave as follows (Sects. 805 and 806):

	Ft.	In.	Ft.	In.
Streak or crop of COAL VI	..	..	..	..
White fire-clay	2	0	2	0
Gray clay shale	6	0	2	0
Black shale	1	6	2	0
COAL V, mostly hidden	1	0+	1	0+

In Sec. 30, Coal V has been worked on the W. D. Garhart, Margaret A. Low and Walker farms. In Sec. 31 it is largely cut out across the bottoms of South Patoka. In Sec. 34 it is worked at the S. A. Fethener bank. The section here showed (Sect. 807, Fig. 12):

	Ft.	In.
1. COAL VI crop	..	..
2. Drab and brown fire-clay	4	0
3. Drab shale	1	0
4. Black sheety shale	1	0
5. COAL V	4	0

Township 3 South, Range 7 West (in Pike County.)

1771. Geography.—The northern two-thirds of this township is in Pike county. It corresponds with the southwestern part of Lockhart and southeastern part of Monroe of the civic townships. It is drained by South Patoka creek, which has broad bottoms. Receding from the South Patoka and Log creeks, the topography becomes quite broken, with the divides rising 150 ft. or more above the main drainage. The nearest railway communication is at the Hartwell switch in the township just north.

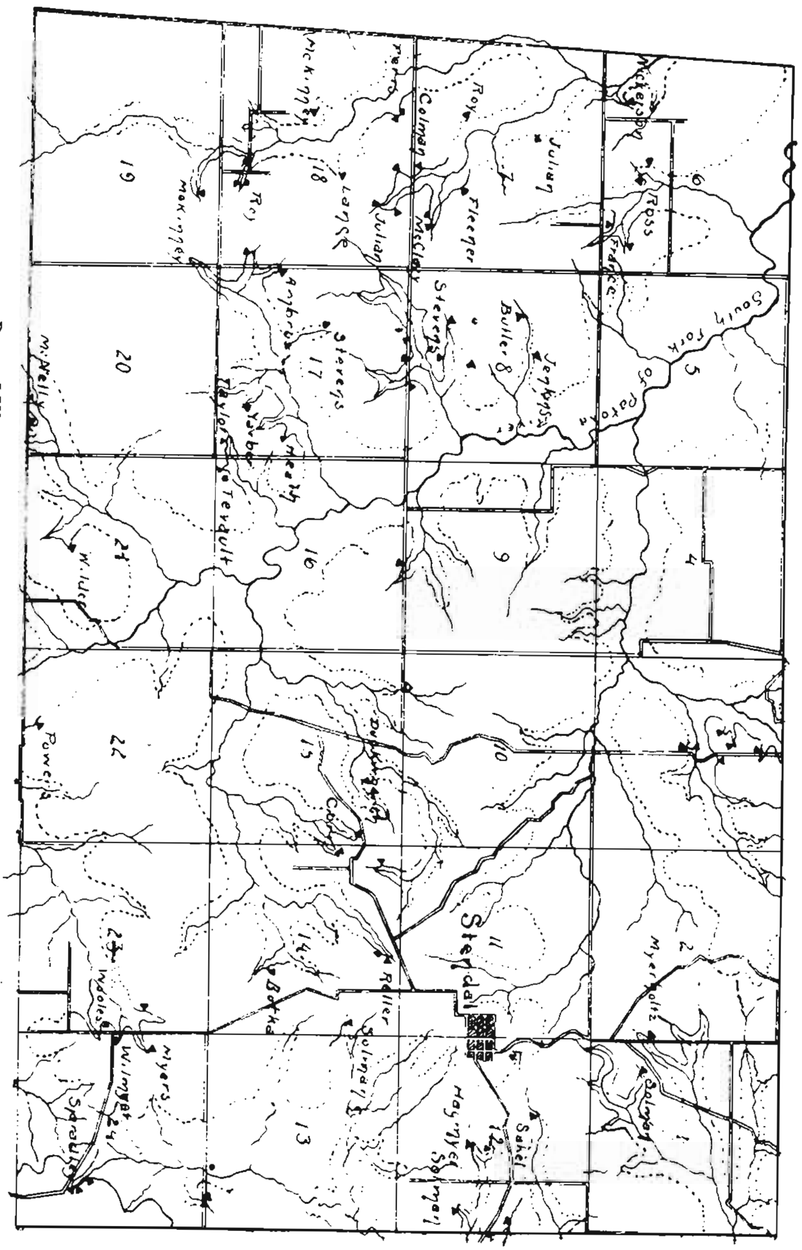
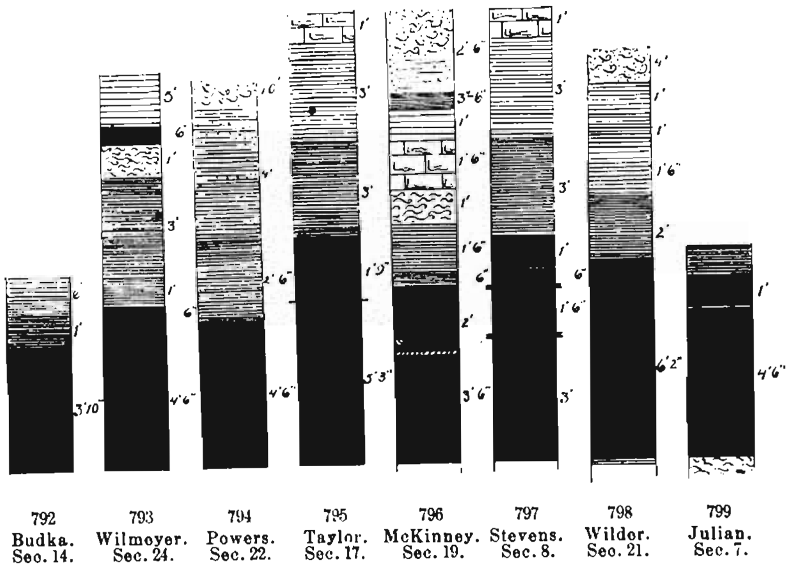


Plate LIX. Sketch map of part of Township 3 south, Range 7 west.

1772. STRATIGRAPHY AND COALS.—Nearly all the coal observed in this township was at the horizon of Coal V. Coal VI, where seen, was represented by a few inches of coal only a few feet above Coal V, and nowhere workable. Coal IV outcrops along the eastern edge of the township.



Figs. 792-799. Sections of Coal V in T. 3 S., R. 7 W. (in Pike county).

Coal V in this area shows a good workable thickness over probably all of it, as indicated in the figures. It will be noted that there is a pretty constant sulphur band about 1 ft. from the top. It shows a thickness of from 4 to 7 ft., with an average of probably over 5 ft. The following series of sections will show pretty completely the way the coal and its roof runs (see Figs. 792 to 799):

1773. SECTION 808. SECTION ON RUDOLPH BUDKA'S PLACE.—S. E. ¼ Sec. 14, Fig. 792.

	Ft.	In.
1. Brown to drab shale	5	0
2. Jointed black sheety shale	1	0
3. COAL V	3	10

1774. SECTION 809. SECTION ON CHAS. MEYER'S PLACE.—N. W. ¼ Sec. 34.

	Ft.	In.
1. Surface	2	0
2. Light drab sandy and clay shale	3	0
3. COAL VI	0	3
4. Light drab sandy shale or fire-clay	4	0
5. Drab and black sheety shale with sulphur balls	1	6
6. COAL V	3	11
7. Drab fire-clay	..	..

1775. SECTION 810. SECTION ON JNO. WILMEYER'S PLACE.—N. W. ¼ Sec. 24, Fig. 793.

	Ft.	In.
1. Surface	5	0
2. Gray clay shale	5	0
3. COAL VI ....0 to	0	6
4. Gray and drab fire-clay	1	0
5. Black sheety shale with hard heads	3	0
6. "Copperas rock" (black shale full of pyritized fossils) ....3 in. to	1	6
7. COAL V	4	6
8. Fire-clay	..	..

1776. SECTION 811. SECTION ON HANS SPRADLEY FARM.—S. E. ¼ Sec. 24.

	Ft.	In.
1. Surface	4	0
2. Gray shale	2	0
3. COAL VI	0	6
4. Gray to drab fire-clay and shale	2	6
5. Black sheety shale	1	0
6. COAL V ....4 ft. to	5	0
7. Fire-clay	..	..

1777. SECTION 812. SECTION ON GEO. POWERS.—S. W. ¼ Sec. 22, Fig. 794.

	Ft.	In.
1. Surface	10	0
2. Shaly sandstone and shale	4	0
3. Black sheety shale	2	6
4. COAL V	4	6

1778. SECTION 813. SECTION ON WILDER PLACE.—Sec. 21, Fig. 798.

	Ft.	In.
1. Surface and shale	4	0
2. Hard calcareous shale to shaly limestone...1 ft. to	1	6
3. Light drab shale	1	0
4. Dark drab shale	1	6

		Ft.	In.
5.	Black sheety shale with fossils and large sulphur balls	2	0
6.	COAL V	6	2
7.	Bone coal	..	2
8.	Hard fire-clay	..	..

1779. SECTION 814. SECTION ON H. W. TEVAULT'S.—S. W. of S. W., Sec. 16.

		Ft.	In.
1.	Magnesian limestone, solid	2	0
2.	Shelly fossiliferous limestone	4	0
3.	Black sheety shale, with limestone concretions	3	0
4.	COAL V (reported) ....4 ft. to	7	0
5.	Sandy shale	5	4
6.	Shaly sandstone	10	0

1780. SECTION 815. SECTION ON ALFRED TAYLOR'S FARM.—S. E. of S. E. Sec. 17, Fig. 795.

		Ft.	In.
1.	Surface	6	0
2.	Limestone	1	0+
3.	Shale	3	0
4.	Black sheety shale, with "hard heads"	3	0
5.	COAL V, upper 1 ft. 9 in. soft	7	0
6.	Fire-clay	..	..

1781. SECTION 816. SECTION ON MRS. ELIZA HEATH'S PLACE.—N. E. of S. E. of Sec. 17.

		Ft.	In.
1.	Surface and shale	6	0
2.	Black sheety shale	0	6
3.	Soft black shale	2	0
4.	COAL V	5	0

1782. SECTION 817. SECTION ON WM. YARBER'S.—S. W. of S. E. of Sec. 17.

		Ft.	In.
1.	Surface	2	0
2.	Limestone, impure	1	6
3.	Gray shale	1	0
4.	Black sheety shale	1	0
5.	COAL V (exposed) ....4 ft. 6 in.	5	6
6.	Fire-clay	..	..

1783. SECTION 818. SECTION ON JOSEPH MCKINNEY FARM.—Sec. 19, Fig. 796.

		Ft.	In.
1.	Surface and shale	2	6
2.	Black shale ....3 in. to	0	6
3.	Soft gray shale	1	0
4.	Light drab limestone	1	6
5.	Light drab clay	1	0
6.	Dark drab shale	1	6
7.	Black sheety shale with hard heads	0	6
8.	COAL V	5	6

1784. SECTION 819. SECTION AT FERRIS MINE AND IN ROAD.—Sec. 18.

		Ft.	In.
1.	Gray clay shale	10	0+
2.	Black shale or bony coal (VI?)	0	3
3.	Light drab shale	1	0?
4.	Shaly limestone	1	0?
5.	Soft gray sandy shale	1	0
6.	Drab shale	1	0
7.	Black sheety shale, with large hard heads	5	0
8.	COAL V (exposed)	4	0+

1785. SECTION 820. SECTION AT WM. STEVENS'S.—Sec. 8, Fig. 797.

		Ft.	In.
1.	Surface	5	0
2.	Limestone, very impure	1	0
3.	Drab and gray shale	3	0
4.	Black sheety shale	3	0
5.	COAL V	7	0

1786. SECTION 821. SECTION ON PLES. CORN FARM.—N. E. $\frac{1}{4}$ Sec. 15.

		Ft.	In.
1.	Surface	2	0
2.	Soft friable yellow sandstone	10	0
3.	Light drab clay shale ....3 ft. to	4	0
4.	Black sheety shale	2	0
5.	COAL V ....3 ft. 4 in. to	4	0

These sections, taken together with the data obtained at numerous other points, indicate that Coal V originally occupied this area as a nearly, if not quite, continuous sheet, seldom running below 4 ft. It is everywhere overlain by black sheety shale, usually full of pyrite concretions, but above that the strata vary in detail at almost every point. Limestone only occurs over the coal locally and mostly to the west. Coal VI, from 4 to 6 in. thick, and shaly, appears to the east and possibly to the west. Generally most of the strata exposed above the coal are shales, but in the last section sandstone predominates. Reports indicate that the general grade of this coal in this area is not quite up to the best of the same coal to the north.

Coal IV runs from 2 ft 6 in. to 3 ft. thick as far as exposed, overlain by light colored clay shale, while Coal IIIb is about 1 ft. thick.

1787. Distribution and Local Details.—In Secs. 1 and 2 Coal IV has been worked a little on Fred. Solman's place, S. W. ¼ of Sec. 1, and John Myerholtz's farm, S. E. ¼ of Sec. 2. At one outcrop in the road 10 to 12 ft. of gray clay shale shows in the road above the coal. In Sec. 3 a number of outcrops of the coal were noted overlain with from 1 ft. to 1 ft. 6 in. of black sheety shale and then by 15 to 20 ft. of clay and sandy shale, and underlain by 15 ft. of gray and drab shale. The thickness of the coal was not seen. It is referred with doubt to Coal V.

A good deal of Coal V is cut out in Secs. 4, 5 and 6. In Sec. 6 Coal V has a good thickness. On the Vincent France place, in the S. E. ¼, the coal is 6 ft. thick, overlain by 2 to 3 ft. of black shale and that by 6 ft. plus of brown sandy shale. Coal stripped on the Frank Ross place is reported as from 3 to 4 ft. thick. On the J. M. Nickerson farm, in the S. W. of S. W., the coal is 5 to 6 ft. thick, overlain by 2 ft. of black sheety shale. The coal is above drainage at all of these points. In Sec. 7 it is worked at the John Julian bank, in the N. W. ¼, where it is 4 ft. to 5 ft. thick, or 6 ft. a little east of the present workings; at the W. G. Roy bank, in the S. W. ¼, and on the M. and W. L. Fleener, John McClary and Coleman farms, in the S. E. part of the section.

In Sec. 8 it is or has been worked on the N. Jenkins, Butler and Wm. Stevens places. At the last the coal is up to 7 ft. thick. The lower half of the coal is said to contain many seams, quite often open, and in two sets like block coal, the main cleat being about east and west. It mines out in big blocks and is the richest coal. About 1 ft. down is a sulphur band, and 6 in. lower a slight parting of "mother coal." This top coal is laminated. The middle part of the coal is the hardest and contains the most sulphur. The section here was given above (Sect. 820).

In Secs. 9, 10 and 11, Coal V rises, its position being indicated by exposures of coal or black shale, until at Stendal it is almost at the top of the divide. An outcrop of a few inches of coal reported at a small pond just north of the village was judged to be Coal VI, and if so, Coal V ought to be found a short distance below.

In Sec. 13, Coal IV? has been stripped on the Wm. Saakel place, formerly the old Brunt farm. It is reported as 2 ft. 6 in. thick. The same coal has been stripped on the F. W. Hagmyer or old McKeen place. The coal is said to be 2 ft. 6 in. thick, and has a gray to drab clay shale roof, or in places gravel, with a hard, white, shaly clay below. It is said to be a caking coal, containing some sulphur and making a hot fire. The bottom coal is the best.

On the Geo. W. Solman place, in the S. E. ¼ of Sec. 12, the coal is reported as 3 ft. thick, with black shale below; over it 1 ft. of black shale, then 5 ft. of gray clay shale. There is some question as to whether this is Coal IV or IIIb.

In the S. E. of S. E. of Sec. 13 is an outcrop of Coal IIIb, showing a roof of 2 to 3 ft. of black sheety shale and fragments of yellow shaly limestone. Coal IIIa is said to have been met in a well in the creek bottoms in the same 40 acres. Coal is reported as found at points on the Solman farm, in the N. W. ¼ of Sec. 13.

In Sec. 14 Coal has been stripped at Rudolph Budka's, S. E. ¼, 3 ft. 10 in. thick (see Sect. 808), and on Henry Solman's, in N. E. ¼, where it measured 3 ft. 6 in., overlain by black shale and underlain by gray fire-clay. It is here a "peacock coal," with gray mud slips, and shows a sulphur band 1 ft. from the top. It has also been mined on the C. F. Reller place, N. W. of N. E. of Sec. 14; Eilert place, N. W. of N. W., and Jas. Terry place, N. W. ¼ of Sec. 14.

A section was given of the coal at the Ples. Corn stripping, in the N. E. of N. E. of Sec. 15, the coal here being from 3 to 4 ft. thick and not more than 30 ft. below the top of the ridge. It has also been mined on the John Duckworth place, in the N. E. ¼ of this section.

In Sec. 16 Coal V is still well above the main drainage. It has been worked in the S. W. corner on the H. W. Tevault place, where it is reported 7 ft. thick. (See Sect. 814.) Just across the road west, on Alfred Taylor's place, formerly the Powers place, in the S. E. of S. E. of Sec. 17, the coal is 7 ft. thick, but where examined the top 1 ft. 9 in. is soft. It may prove better under a greater amount of cover. (See Sect. 815.) Sect. 816 gives the section at Mrs. Elizabeth Heath's, N. E. of S. E. of Sec. 17, where the coal is 5 ft. thick. On the Wm. Yarber farm, near this, 4 ft. 6 in. to 5 ft. 6 in. of coal is exposed. (See Sect. 817.) On the Wm. Ambrose place, in the western part of the section, the coal is said to have been 6 ft. thick where they started and to have run up to almost 7 ft., with 1 ft. of hard black shale over. Coal has also been worked on Wm. Stevens's place, in the N. W. ¼ of Sec. 19.

In Sec. 18 coal is or has been worked at the Jas. Julian, Ferris, S. Lance, D. J. McKinney, Washington Roy and Whitman Dickon banks. At the Julian mine the coal runs from 4 ft. 6 in. to 6 ft. in thickness, with a sulphur band 1 ft. from the top, a smooth parting 18 in. from the top and another 18 in. from the bottom. The bottom coal is the best. (Fig. 799.) See Sect. 819 for section at Ferris mine. The coal is said to be 5 ft. 6 in. at Roy and Dickon banks, and is overlain by black shale, which at the latter place is full of pyritized fossils. In Sec. 19 Coal V is stripped on the Joseph McKinney place, of which a section was given in Sect. 818. It has been worked on the McNelly place, in the S. E. of S. E. of Sec. 20, and on the Wilder place, in Sec. 21, where, as given in Sect. 813, it measured 6 ft. 2 in. in thickness. In Sec. 22 it measured 4 ft. 2 in., at the Geo. Powers bank, with slips running N. 80° E. (See Sect. 812.) In Sec. 23 it has been worked a little on the Wools place and elsewhere.

In Sec. 24 Coal V is worked at the Chas. Meyers, John Wilmyers and Hans Spradley banks. (See Sects. 809 to 811.) The coal at these places varies from about 4 ft. to 5 ft. It appears to have a pretty regular sulphur band 1 ft. from the top, and the lower part of the coal comes out in large blocks. The cleat at the Spradley mine gave N. 50° E. The coal at these points is nearly at the top of the divides. The coal at Spradley's has been cut off from the main body.

Township 1 North, Ranges 8 and 9 West (in Pike County).

1788. Geography.—The part of these townships in this county lies south of White river and occupies part of Washington and most of Madison and Clay of the civic townships. The principal tributaries of White river in this area are Lick creek, in the northeastern corner, and Pride creek, in the center of T. 1 N., R. 8 W.; Conger's and Harbin's creeks, in T. 1 N., R. 9 W. The surface is pleasantly diversified, ranging from the bottoms and second bottoms of White river to hilly parts in places. Much of it is rolling. It is crossed by the E. & I. R. R. and by the proposed Black Diamond Railroad.

1789. Stratigraphy and Coals.—Division IX is found in the extreme northwestern corner of this area. Division VII covers most of it. Division VI and V, with Coal V, underlie practically all of it. Several other coals of importance have been found below. Coal V in this area reaches a greater thickness than coal anywhere else in the State as far as observed. The section at the Gibson county line, in Sec. 7-1-9, as obtained by Mr. Collett, gave as follows:

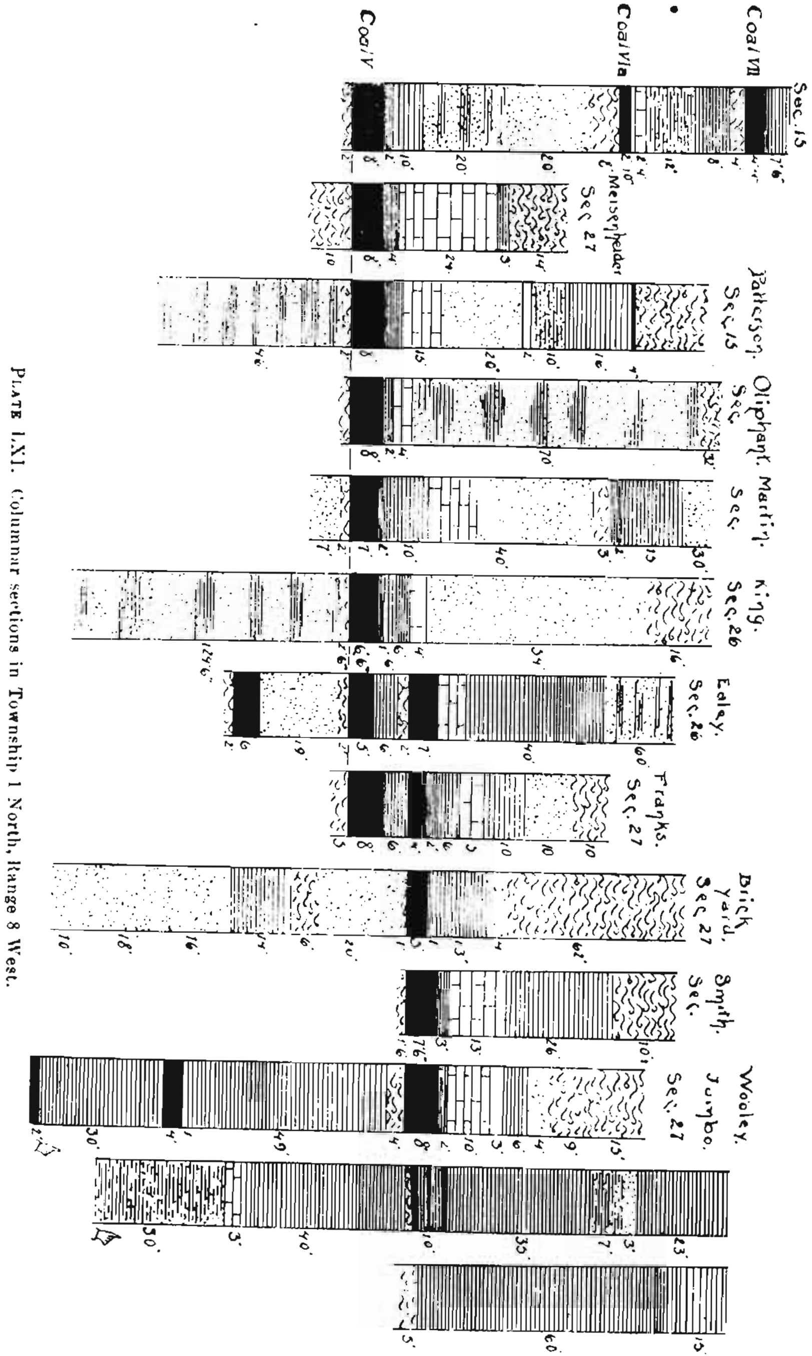


Plate LXI. Columnar sections in Township 1 North, Range 8 West.

1790. Section 822. Section at Gibson County Line.—Sec. 7-1-9. (J. C., p. 251.)

	Ft.	In.	Ft.	In.
1. Loess and river sand	20	0	20	0
2. Pebbly fluviated drift	8	0	28	0
Division IX—				
3. Soft white and yellow sandstone	30	0	58	0
4. Soft laminated sandstone	22	0	80	0
5. Quarry sandstone "Meron rock"	18	0	98	0
Division VIII—				
6. Calcareous and argillaceous shales and limestone 10 ft. to	3	0	101	0
7. Black bituminous shale	1	4	102	4
8. Rash COAL VIIIa (?) 8 in. to	0	2	102	6
9. Fire-clay	2	6	105	0
10. Clay shales 6 ft. to	15	0	120	0
11. Limestone, with crinoid stems 2 ft. to	4	0	124	0
12. Clay shale 2 ft. to	5	0	129	0
13. Black shale 3 ft. to	1	0	130	0
14. Rash COAL VIII (?) (reported)	2	0	132	0

1791. Section 823. Section at Sand Hill.—Sec. 22-1-8, Pl. LXI, Fig. 1. (J. C., p. 255.)

	Ft.	In.	Ft.	In.
1. Ancient river sand 10 ft. to	20	0	20	0
Division VII—				
2. Sandy shale	7	0	27	0
3. Clay shale	0	6	27	6
4. COAL VII 3 ft. to	4	4	31	10
Division VI—				
5. Fire-clay 2 ft. to	4	0	35	10
6. Clay shale	8	0	43	10
7. Sandy shale 2 ft. to	12	0	55	10
8. Ferruginous limestone	2	4	58	2
9. Calcareous and pyritous clay, 3 ft. to	1	0	59	2
10. COAL VIb—				
Shale and coal	0	6	59	8
Pyritous and bituminous clay	0	8	60	4
Caking coal	1	8	62	0
11. Fire-clay	8	0	70	0
12. Sandstone 5 ft. to	20	0	90	0
13. Covered siliceous flags and shales (low water in White river)	20	0	110	0
Division V—				
14. Clay shale	10	0	120	0
15. COAL V (reported)	8	0	128	0

1792. Section 824. Section in Petersburg Near Woolen Mill.—Sec. 27. (J. C., p. 256.)

	Ft.	In.	Ft.	In.
1. Clay and soil	28	0	28	0
2. Shelly stone	10	0	38	0
3. Shale and boulders	2	0	40	0
4. COAL V	10	0	50	0
5. Fire-clay to bottom	2	0	52	0

1793. Section 825. Section at Meisenhelder Shaft.—N. E. ¼ Sec. 27, Pl. LXI, Fig. 2. (W. S. B., p. 111.)

	Ft.	In.
1. Surface soil and blue mucky clay	16	0
2. Blue clay shale	6	8
3. Blue limestone, fossiliferous	10	4
4. Black sheety shale, with "kidneys" of iron ore	3	10
5. COAL V, 7 ft. 6 in. to 9 ft.	7	1

1794. Section 826. Section at Dr. Posey's Mine.—Sec. 13-1-8. (J. C., p. 257.)

	Ft.	In.
1. Sandstone 5 ft. to	20	0
2. Magnesian limestone	4	0
3. Ferruginous limestone 3 ft. to	1	4
4. Dark pyritous clay shale, with fossils 2 ft. to	0	0
5. Black sheety shale with pyritous ironstone boulders from 1 to 5 ft. in diameter	5	0
6. COAL V— Thin bedded, often cannel, 0 ft. 6 in.; steam coal, 1 ft. 10 in.; parting of black sulphur, 0 ft. 1 in.; good steam coal, 2 ft. 4 in.; parting (pyritous), 0 ft. 2 in.; smiths' coal, 1½ ft. to 2 ft. 4 in.; grate coal (pyritous), 1 ft.	8	3
7. Stigmarial fire-clay	5	5
	44	0

1795. Section 827. Section of Drilling on John Patterson's.—Six miles west of Petersburg, Pl. LXI, Fig. 3.

	Ft.	In.	Ft.	In.
1. Yellow shale	15	0	15	0
2. Yellow sand	20	0	35	0
3. Quicksand	11	0	46	0
4. Blue mud	20	0	66	0
5. Clay shale	15	0	81	0
6. Blue muck	32	0	113	0
7. Shale and COAL VII	4	0	117	0

		Ft.	In.	Ft.	In.
8.	Clay shale	16	0	133	0
9.	Dark gray rock, hard (limestone)	10	0	143	0
10.	COAL VIb	2	0	145	0
11.	White sandstone	26	0	171	0
12.	Dark rock, hard (limestone)	15	0	186	0
13.	COAL V	8	0	194	0
14.	Fire-clay	2	6	196	6
15.	"Changeable rock," mostly white sandstone	46	0	242	6

1796. SECTION 828. SECTION ON PRENTIS MARTIN'S, IN PETERSBURG.—Pl. LXI, Fig. 5.

		Ft.	In.	Ft.	In.
1.	In old well	28	0	28	0
2.	Sandstone	30	0	58	0
3.	Clay shale	15	0	73	0
4.	Shale and COAL VII?	2	0	75	0
5.	Fire-clay	3	0	78	0
6.	Sandstone and limestone	40	0	118	0
7.	Clay shale	10	0	128	0
8.	Shale	2	0	130	0
9.	COAL V	7	0	137	0
10.	Fire-clay	2	0	139	0
11.	Sandstone	7	0	146	0

1797. SECTION 829. SECTION OF DRILLING ON GEO. KING'S.—East part of Petersburg, Pl. LXI, Fig. 6.

		Ft.	In.
1.	Yellow shale	16	0
2.	Yellow sandstone	54	0
3.	Limestone	4	0
4.	Clay shale	6	0
5.	Shale	1	6
6.	COAL V	6	6
7.	Fire-clay	2	6
8.	"Changeable rock," mostly white sandstone	124	6

1798. SECTION 830. SECTION OF DRILLING ON E. A. EALEY'S LAND.—Near King's, N. W. of Sec. 26-1-8, Pl. LXI, Fig. 7; Pl. LX, Fig. 2.

		Ft.	In.	Ft.	In.
1.	Surface shale	21	0	21	0
2.	Changeable rock and small vein of COAL	60	0	81	0
3.	Rock, some limestone	40	0	121	0
4.	COAL V top bench?	7	0	128	0
5.	Fire-clay	2	0	130	0
6.	Clay shale	6	0	136	0

		Ft.	In.	Ft.	In.
7.	COAL V bottom bench	5	0	141	0
8.	Fire-clay	2	0	143	0
9.	White sandstone	19	0	162	0
10.	COAL (?) very hard (hard coal)	6	0	168	0
11.	Fire-clay	2	0	170	0

1799. SECTION 831. SECTION OF DRILLING AT FRANK'S MILL.—Petersburg, Sec. 27, Pl. LXI, Fig. 8; Pl. LX, Fig. 3.

		Ft.	In.	Ft.	In.
1.	Shale	6	0	6	0
2.	Blue shale	4	0	10	0
3.	Yellow sandstone	10	0	20	0
4.	Blue shale	10	0	30	0
5.	Flint, blue	5	0	35	0
6.	Dark shale	6	0	41	0
7.	Shale	2	0	43	0
8.	COAL V, upper bench?	3	0	46	0
9.	Hard blue shale	6	0	52	0
10.	COAL V, lower bench, and shale	8	0	60	0
11.	Shale ....4 ft. to	6	0	66	0

1800. SECTION 832. SECTION OF DRILLING AT BRICK YARD.—Petersburg, Sec. 27, Pl. LXI, Fig. 9.

		Ft.	In.
1.	Blue shale	6	0
2.	Gray sand	4	0
3.	Blue sandy shale	13	0
4.	Shale	1	0
5.	COAL V	5	0
6.	Fire-clay	1	0
7.	Sandstone	5	0
8.	Fire-clay	6	0
9.	Dark shale	14	0
10.	Sandstone	16	0
11.	White sandstone	18	0
12.	Blue sandstone	10	0

1801. SECTION 833. SECTION OF DRILLING ON O. O. SMITH'S LAND.—1½ mi. southwest of Petersburg, Pl. LXI, Fig. 10.

		Ft.	In.
1.	Old well	24	0
2.	Blue shale	60	0
3.	Sand, dark shale	10	0
4.	Clay shale	26	0
5.	White sandstone (limestone?)	13	0
6.	Shale	3	0
7.	COAL V	7	6
8.	Fire-clay	1	2

1802. SECTION 834. SECTION OF DRILLING ON LAND OF JAMES McCOY.—One mile west of Petersburg, N. E. ¼ Sec. 28.

		Ft.	In.
1.	Yellow shale	30	0
2.	Quicksand	30	0
3.	Blue mud	16	0
4.	Quicksand	10	0
5.	Clay shale, fire-clay and trace of COAL	14	0
6.	Fire-clay	1	0

1803. SECTION 835. SECTION OF DRILLING ON LAND OF LESS LAMB.—N. W. of S. E. of Sec. 22-1-8.

		Ft.	In.
1.	Surface shale	19	0
2.	Sandstone	20	0
3.	Shale	2	0
4.	COAL V?	7	0
5.	Fire-clay	2	6
6.	Clay shale	12	6
7.	White sandstone	15	0

1804. SECTION 836. SECTION OF DRILLING ON LAND OF SAM STUKEY.—S. W. of N. E. of Sec. 22.

		Ft.	In.
1.	Yellow shale, little sandy	17	0
2.	Quicksand	40	0
3.	Yellow sandstone	20	0
4.	Changeable sandstone	60	0
5.	Gray sandstone	10	0
6.	Limestone	3	0

Coal V appears to be cut out at this point.

1805. SECTION 837. SECTION OF SHAFT AT WOOLEY COAL BANK.—S. W. of S. E. of Sec. 27, Pl. LXI, top of Fig. 11.

		Ft.	In.
1.	Yellow shale	15	0
2.	Blue shale	9	0
3.	Yellow sand	4	0
4.	Dark shale	6	0
5.	Sandstone	3	0
6.	Hard sandstone (limestone?)	10	0
7.	Shale	2	0
8.	COAL V	8	0

Coal occurs in two benches as follows, making 9 ft. of coal in places. (Pl. LX, Fig. 4):

		Ft.	In.
Upper bench	2 ft. 6 in. to	3	6
Drab clay, usually with thin parting of coal	2 in. to	..	6
Lower bench	2 ft. 6 in. to	6	0

1806. SECTION 838. SECTION OF "JUMBO" GAS WELL DRILL.—Close to Wooley coal mine.

		Ft.	Ft.
1.	Clay, sand and clay	37	37
2.	Blue and yellow limestone	11	48
3.	Shale and COAL V	13	61
4.	Shale	49	110
5.	Hard rock	1	111
6.	COAL IV	4	115
7.	Shale	30	145
8.	COAL IIIb (?)	2	147
9.	Shale	23	170
10.	Hard sandstone	3	173
11.	Sandy shale	7	180
12.	Common shale	35	215
13.	Cannel coal or shale with streaks of fire-clay	10	225
14.	Shale	40	265
15.	Limestone	3	268
16.	Hard sandy shale	32	300
17.	Streaks of limestone and shale	15	315
18.	Shale	60	375
19.	Rock and coal	5	380
20.	Dark and light shale	44	424
21.	Streaks of limestone	202	626
22.	Sandy limestone	51	677
23.	White sandstone	31	708
24.	Shale	8	716
25.	White sandstone	45	761
26.	Black shale	24	785
27.	White shale	20	805
28.	Black shale	17	822
29.	Hard limestone	4	826
30.	Blue limestone	14	840
31.	Dark shale	18	858
32.	Light shale	8	866
33.	Limestone and shale	24	890
34.	Limestone	30	920
35.	Shale	7	927
36.	Hard sandstone	7	934
	At this depth a strong flow of Blue Lick water was struck.		
37.	Shale	2	936
38.	Hard sandstone	9	945

	Ft.	Ft.
39. Limestone	35	980
40. Shale	5	985
41. Limestone	7	992
42. Red marl and shale	23	1,015
43. Streaks of limestone and shale	18	1,033
44. Limestone	19	1,052
45. Drab shale	13	1,065
46. Red marl	6	1,071
47. Shale	20	1,091
48. Streaks of limestone and shale	21	1,112
49. Limestone	24	1,136
50. Black shale	7	1,143
51. Hard sandy rock	1	1,144
52. Black shale	17	1,161

1807. The No. 2 well found one important coal missed by the section just given. Sample bottles taken every 5 ft. showed coal as follows:

At 55 ft., 7 ft. of coal, Coal V.
At 160 ft., a little coal and sand.
At 170 ft., a little coal and sand.
At 220 and 225 ft., some coal.
At 250 ft. coal and coarse sand.
At 260 ft., coal (?) and coarse sand.
At 280-290 ft., cannel (?) coal (reported by drillers at 9 ft.).
At 310-315 ft., coal, fragments show bright, good coal (reported 10 ft.).
At 350 ft., coal and sand.

1808. SECTION 839. SECTION AT SMITH MINE.—Sec. 13-1-8, Pl. LX, Fig. 6.

	Ft.	In.
1. Surface	8	0
2. Shaly sandstone, micaceous	10	0
3. Blue shale	14	0
4. COAL V—Coal, hard, 10 in.; coal, poor to good, 5 ft. 3 in.; coal, breaks up, 2 ft. 6 in.; black shale parting; coal, fair (not mined), 1 ft. 3 in.	9	10
5. Fire-clay	2	0

This was the thickest coal measured in the State.

1809. SECTION 840. SECTION AT WHITLOCK MINE, ON STUKEY PLACE.—N. E. ¼ Sec. 22.

	Ft.	In.
1. Surface clay	9	0
2. Sandstone	15	0
3. Clay shale .... 2 ft. 6 in. to	4	0
4. COAL VII	4	0
5. Fire-clay	4	0

1810. SECTION 841. SECTION AT BLACKBURN MINE OF S. W. LITTLE COAL CO.—N. W. 40 of Sec. 13, Pl. LX, Fig. 7.

	Ft.	In.
1. Surface	20	0
2. Gray shale, gets darker towards bottom, where it contains many inch layers of limestone	15	0
3. Hard, gritty limestone	1	0
4. Hard, impure limestone, up to 4 ft	3	0
5. Yellow limestone, "hardest"	1	0
6. Black bituminous sheety shale, full of "hard heads"	5	0
7. COAL V (measured), averages 7 ft.—coal, hard, fragile, fair, 8 in.; coal, soft, sulphury, poorest, 2 ft. 6 in.; coal, harder, best, 3 ft. 6 in.	6	8
8. Sandy fire-clay	6	0+

The sections serve to show the stratigraphy of the different divisions. Divisions VIII and IX are given in the first of the sections. Division VII shows one coal which appears to be workable locally, if not generally. It is usually a solid bed about 4 ft. thick; does not appear to be such a rich coal as Coal V, but, on the other hand, does not burn up so quickly. It also appears to be freer from sulphur than Coal V. The roof is usually clay shale overlain by sandstone, and is of a fair grade.

1811. DIVISION VI is supposed to contain two thin coals in this area, though neither of them was certainly identified. Coal VI was reported as found in the south part of Sec. 13, where it was reported as from 1 ft. 6 in. to 4 ft. thick. The very thick coal at the Smith mine in some respects resembles Coal VI, and its correlation was for a time in much doubt, but the evidence seems strong that it is Coal V. Coal VI is reported as found in a well in Sec. 13. Coal VIb occurs near the top of the division and close under the limestone. This seems to occupy exactly the position of Coal VIb of Vermillion, Parke and Vigo counties. It is 2 ft. 6 in. thick, including an 8 in. parting, north of Petersburg.

1811*a*. DIVISION V.—The evidence suggests that while there is only one coal in this division, it splits under Petersburg. That the coal is split at the Petersburg (Woolley) mine is beyond question, though the separation is only up to 8 in. But the fact is used to explain the appearance of two thick coals in several of the drillings made in Petersburg. Notably in the Ealey and Frank wells, these benches are separated by from 6 to 8 ft. Yet at the Meisenhelder shaft, only a little to one side of a line connecting those wells, not a trace of a parting is reported. In northern Warrick county, Coal V splits into two benches, separated by 3 ft. 6 in. of strata, so that the case is not without parallel. Yet until a shaft or core drilling is sunk through the two beds, there will remain some doubt as to the facts. The same is true of the third thick bed in the Ealey drilling. Coal V here, omitting the drillings just mentioned, which give a total of 12 ft. of coal, runs from 4 or 5 ft. up to a reported thickness of

Fig. 800. Sketch of iron and lime concretion depending from roof in Blackburn mine.

11 ft. Measurements in the Smith mine gave 9 ft. 10 in. and 10 ft. 2 in., which is the greatest measured thickness of coal in Indiana. Most of the mines will not show over 9 ft. of coal as the highest, and between 7 and 8 ft. as an average. In its details the coal varies greatly, perhaps the most persistent feature being a top bench of less than 1 ft. of laminated coal.

The roof is generally the black sheety shale, which here makes one of the best roofs in the State. Thus in the Blackburn mine some of the rooms have stood 12 years without posts, and seem perfectly solid yet. The main difficulty lies in the presence of iron or lime concretions. In places these are very large, measuring up to 7 ft. long, and, projecting down into the coal, offer obstruction to easy mining. Fig. 800 was sketched in the Blackburn mine. In that case the concretion projected 3 ft. 10 in. into the coal, or to within 3 ft. 5 in. of the floor. They seem to contain a large proportion of lime, and often brachiopods or other fossils are found in them. Their faces are usually slickened as though to some extent they had been forced down into the coal, yet as a rule the coal below does not appear much disturbed. In no case were feelers of coal found to rise over them. In some of the mines these concretions consist of a hard but thin shell filled with mud, so that a blow with the pick will break them open, allowing the mud to run out. In places the roof is a gray clay shale, which might

lead to the supposition that another bed was being examined, were it not that some of the large mines contain both roofs. Thus, in the Blackburn mine, two basins were crossed where the roof was a clay shale. These appear to be broad rolls of the type of Figs. 8 and 9 of Part I. This light colored shale measured up to 4 ft. at this mine but gradually thins out at the edges, and at the edge it is seen that the regular black shale roof rises over the light shale, while, as in the figures referred to, feelers of coal also run out over the light shale. This light clay shale is full of shells and has many plant remains. It does not make a strong roof and is generally taken down. These rolls or basins of light shale roof are often quite extensive, so that some of the small mines have that roof entirely. Above the black shale is limestone, which appears to be unusually thick about Petersburg, running as high as 10 or 15 ft. In places this limestone is very sandy and sometimes grades insensibly into sandstone. The coal lies very irregularly, and in places shows a tendency to thicken in the "swamps" and to thin in the rise. The floor of this coal is usually here a sandy fire-clay, and as far as learned, gives no trouble.

Mr. Cox gives the following analyses of Coal V in this area:

NAME.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Posey, upper part	48.00	40.00	88.00	5.50	6.50	12.00
Posey, middle part	48.00	41.00	89.00	4.00	7.00	11.00
Posey, lower part	50.50	38.00	88.00	6.00	5.50	11.50
Shandy, upper part	51.50	37.00	88.50	5.00	6.50	11.50
Shandy, lower part	49.00	41.50	90.50	3.50	6.00	9.50

This would indicate a good coal for steam or gas. It is said to have been used for gas at the Evansville gas works in the days of the old E. & W. canal.

Coal IV, at No. 1, or Jumbo well, and in a core drilling, was 4 ft. thick. It may be expected to be of a better grade than Coal V. About 30 ft. below was found a 2 ft. coal, and 68 ft. below was 10 ft. of cannel (?), shale and fire-clay, which in a core drilling was found not to contain a workable quantity of coal. Below that, in No. 2, was reported a 10 ft. bed; in the well at the railroad crossing of Main street this bed was only 2 ft. thick.

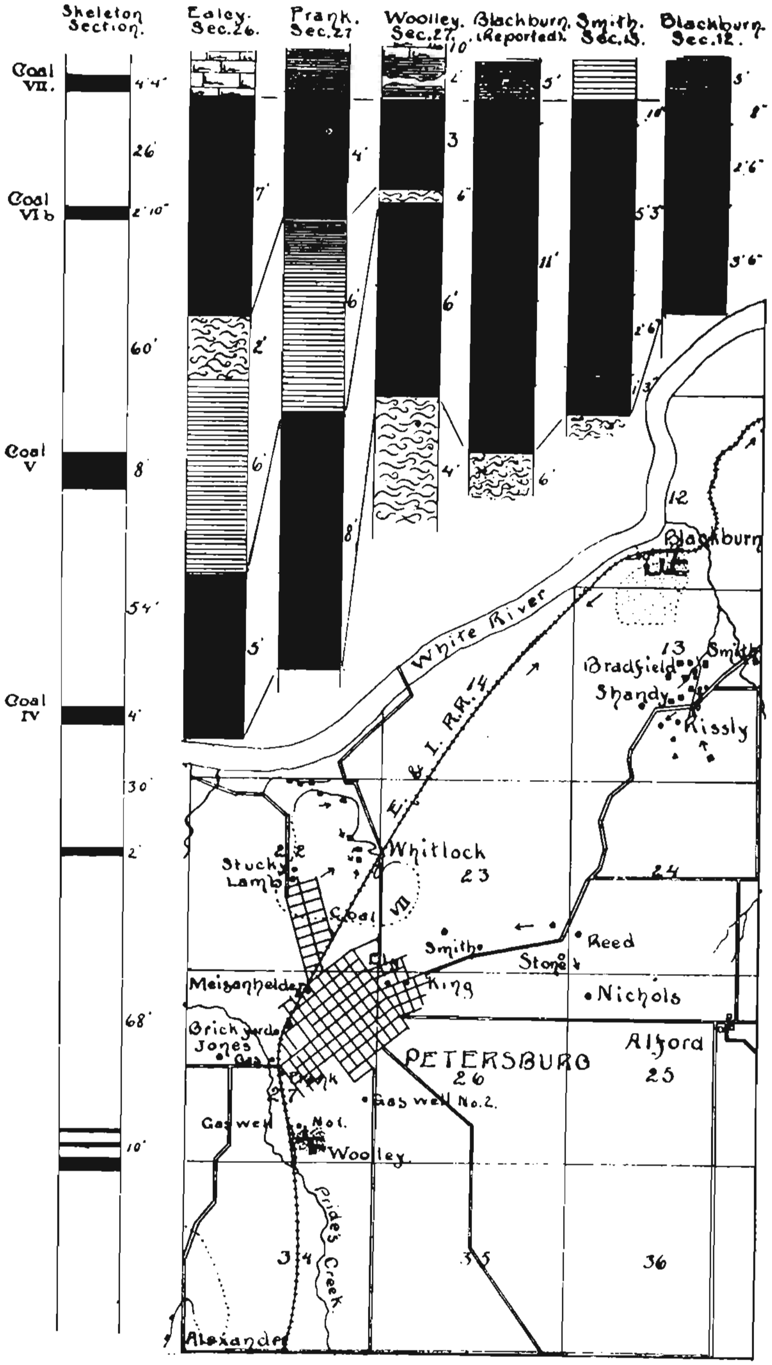


PLATE LX. Sketch map and coals, part of T. 1 N., R. 8 W.

1812. DISTRIBUTION AND LOCAL DETAILS.—In Fig. 801 is given a cross section along the line of the old E. & W. canal. At the Gladstone mine, just across the township line, the coal appeared to be dipping to the east or northeast. There appears to be evidence of a fault along Lick creek, the coal on the west side being 15 to 20 ft. higher than to the east. This has been traced for a mile to the south. Where

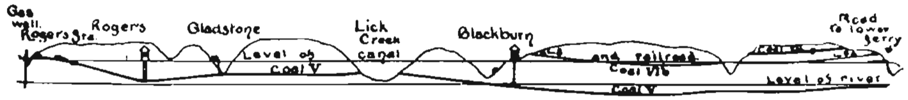


Fig. 801. Cross-section along line of old E. & W. canal, north of Petersburg.

the canal crossed the line between the S. E. and S. W. ¼s of Sec. 12 was the old Posey slope and shaft, and a short distance southwest of it is the present Blackburn mine of the S. W. Little Coal Company. The coal is reached by a slope 400 ft. long. The coal averages about 7 ft., running up to 9 ft., or a reported thickness of 11 ft. (see Figs. 5 and 7 of Plate LX). The coal here lies very irregularly, necessitating some deep cuts for haulage, but has a general dip to the southwest. The coal is generally mined by shooting on the solid, two sets of drillings being necessary. The first breaks down the lower part of the coal and then the upper part is shot down. Rooms 28 ft. and pillars 10 ft., not to be drawn. A little southwest of Blackburn the limestone over Coal VIb shows a few feet above the level of the canal or present railroad. It can be traced for some distance and then the sandstone below it shows prominently in the bank. Where the railroad leaves the canal the strata are lost sight of, and when first seen again, at Sand Hill, north of Petersburg, the limestone is about level with the bed of the canal. A little beyond, and 15 to 20 ft. above, near the top of the hill, are traces of the old openings on Coal VII. They probably comprised the old Hawthorn and Glason mines. Going southwest along the canal, the strata rise so as to expose Coal VIb and also 8 or 10 ft. of massive sandstone below it. At the road to the lower ferry, Coal V can not be far below the level of the river.

At the Whitlock mine, on the Stukey place, Coal VII is 28 ft. deep and 4 ft. thick. The lower half of the coal is the best, being harder and cleaner than the top and not slacking so readily. The coal for the most part is mined without shooting, being mined on slips that in places approach regularity. In places these are mud slips, in places they are filled with calcite. They run a little west of north. The roof is clay shale, some of which needs very close timbering. The coal is said to lie irregularly, more so than Coal V, there being a marked local anticline just north of the shaft. The coal rises to a crop to the south. Several sandstone and shale rolls have been met with, cutting the coal down, but not out. The largest of these was about 30 ft. across at the top, and ran to an edge at the bottom, its direction being northwest and southeast. A 4-ft. fault occurs under one of these rolls. Sect. 840 gives the section here. Coal VIb, 30 in. thick, is reported to lie about 15 to 25 ft. below the bed worked here.

At an opening a short distance north, Coal VII measured 3 ft. 7 in., with a sandstone roof. At the Stukey well, at the center of the section, the coal measures have been removed to a depth of 57 ft., so that Coal VII was not struck, and probably Coal V was also removed. At Mr. Lamb's well, just south, the coal measures are met at 20 ft.—Coal VIb, 18 in. thick, at 25 ft., and Coal V, 7 ft. thick, at 41 ft. These wells are about 30 ft. above the Whitlock shaft, indicating a rise of at least 40 or 50 ft. in Coal VII from the shaft to the well.

Another interesting section is obtained along the Washington-Petersburg road, in Secs. 13, 24, 23, 26 and 27. The structure here is being worked out with great care by Mr. Wooley, he having had lines of levels run to datum points and having encouraged in every way possible the digging of wells, etc., to enlarge the amount of data known. I am, therefore, largely indebted to him for the structure given there.

Just about on the township line is the Smith mine, on the Alexander Killion place, S. E. of N. E. of Sec. 13. This is the mine before referred to as having the thickest coal measured in the State. The coal differs quite materially from Coal V at other points in the neighborhood, so much so as to raise some question if it were not a local pocket of Coal VI. It is claimed to be a dryer coal than Coal V at most of the mines, not catching fire so quickly, but holding fire well and burning steadily, being freer of sulphur and giving little or no clinker. The roof is a clay shale, and no black shale was found in the air shaft. It is divided into four benches, as given in Sect. 839, the lower one of 15 in. not being mined. The roof is good. The coal lies just above the creek level. Just south of this less than a quarter of a mile, on the road to the south, is an exposure of gray and yellow sandstone 20 ft. thick. There is some question as to whether this comes above or below the Smith coal, but the finding of black shale below the sandstone suggests that the coal passes below the sandstone and would therefore at this point be 10 or 15 ft. below the creek bed here. To the west from this point the strata appear to rise rapidly, so that the sandstone is struck at a slight depth in a well at Mr. C. W. Bradfield's barn. Just west of this is a 17-ft. fault, with downthrow to the east. A hundred or two feet west of the barn was a shaft on Coal V, but in mining toward the barn the coal ended suddenly against a bed of gravel. A well dug between the shaft and the barn well found the coal 17 ft. below its level in the mine, according to Mr. Bradfield. It may be that continuing down the ravine to Lick creek and down the creek to the river this descent takes the form of a sharp flexure instead of a distinct break, as suggested above. Coal V has been and is mined from numerous openings in the S. W. ¼ of N. E. ¼ of Sec. 13. At Sec. 13 (3) the coal measured 8 ft. 6 in. The roof here is that characteristic of Coal V, the concretions being of the variety having soft centers. This is just at creek level and about on a level with the coal at the Smith mine. West of this are the old Posey mines. Mr. C. W. Bradfield is running a shaft there in which the coal is 8 ft. 6 in. thick and 24 ft. deep. From Bradfield's the rise continues to Bert Shandy's, so that Coal V outcrops at Sec. 13 (9), but dips down again so rapidly that at the C. V. Shandy shaft, Sec. 13 (10), the coal is 43 ft. deep. It is here 5 ft. 6 in. thick, overlain by 9 ft. plus of black shale. From here it crops out to the south, and has been worked by a drift at Sec. 13 (18). From the Shandy shaft the dip is very rapid to the northwest, Coal V just coming to an outcrop in the ravine, Sec. 13 (8). At the old Posey mine, Sec. 13 (16), the coal has been on fire for some years, having been started by the dropping into the mine of the burning timbers of the tipple that had been set on fire. Thin columns of smoke rise from several places where the roof has settled in.

From the Shandy mine the anticline divides, the north prong being at first very sharp, but as it goes westward it flattens out, becoming at the same time much lower. The divided anticline, of course, loses height, giving the effect of an N.-S. syncline crossing the anticline at right angles. As this depression is not shown by the topography, some of the higher coals are found south and southwest of the center of Sec. 13. Coal VIb (?) starts in near the Shandy store, and at the Risley place, old Vauhn place, is 14 ft. deep and 1 ft. 6 in. thick. At a well on the Shandy place, Sec. 13 (13), it is 18 ft. deep. At Sec. 13 (12) a new well being dug on the Risley place appeared to have just touched the edge of Coal VII, which it found as a coal streak. Below it passed through fire-clay and drab material into limestone, apparently the limestone near the top of Division VI. Then, through drab clay or shale into Coal VIb, 1 in. thick. Below that was fire-clay, then sandstone. At a level some 15 or 20 ft. below the limestone coal has been dug down the ravine to the south, Sec. 13 (17). This coal was variously reported to have been from 2 ft. 6 in. to 4 ft. thick. It seems to occupy the position of Coal VI, but I am not yet convinced that it is not Coal V. The anticline which diverges to the west or northwest from Shandy's spreads out so as to become lost in a general slope toward the river and northwest. In the S. E. corner of the N. E. of S. E. of Sec. 23 is an outcrop of limestone on the north side of the road and about 15 ft. below. Near this a well reaches 2 ft. of coal at 21 ft., making it 25 or 28 ft. below the limestone. This appears to be too thin for Coal V and too far below the limestone for Coal VIb. Its position, therefore, suggests that it is Coal VI. It would seem to have the same relative position to the limestone as the coal formerly worked on the Risley place. On the south side of the road, and 34 ft. below, a well on the Stone place strikes a sandy limestone or calcareous sandstone at a depth of 3 ft. The well shows: Surface, 3 ft.; calcareous sandstone, 1 ft.; sandstone, 5 ft.; drab shale, 2 ft. A little farther south, and at a lower level, on the Nichols place, the limestone outcrops massive and hard, and coal is reported in a well close by. The limestone south of the road is 22 ft. below the limestone north of the road, and may be not the same, but the limestone over Coal V, rather than the limestone over Coal VIb, and the coal north of the road, may be Coal V. The question is still open, but I am inclined to the theory that the limestone at Nichols is the lower limestone. Going to the west, we find limestone struck in the Smith well, Sec. 23 (1), at 8 ft. This is 40 ft. below the limestone just described as north of the road. If it is the same limestone, there must be a dip of 40 ft. in the half mile. At Sec. 23 (2), 6 ft. of coal is reported at a depth of 46 ft., probably Coal V. When this area was gone over with Mr. Wooley the disappearance of Coal VI and the reappearance of Coal VIb had not been clearly worked out, and many questions arose that might have been readily answered with the clearer knowledge of the stratigraphy subsequently gained. At the King and Ealey wells, on the opposite side of Main street, in the east and highest part of town, it is 81 ft. 6 in. and 121 ft., respectively, to Coal V.

At Mr. Wooley's mine the dip is sharply in all directions. To the east it spreads out into a broad basin. The dip to the north from the mine can not continue far, as at the old mine and at Meisenhelder's Coal V is about on a level with the same coal at the Wooley mine. It then dips east of north toward Blackburn. To the west of the Wooley mine the dip was so sharp that mining was abandoned in that direction. At Mr. Jones's, west of Petersburg, they report 5 ft. of coal at 50 ft., and 6 ft. at 100 ft. The top of this well was judged to be 15 ft. above the railroad, which would give a dip to the west of 35 ft. in the half mile, on the supposition that Coal V was the lower of the two coals. At the John Meisenhelder mine the coal is reported to run from 7 ft. 6 in. to 9 ft., with an average of 8 ft. At the Petersburg mine of the J. Wooley, Jr., Coal Company, the coal runs from 6 to 9 ft. Reference has already been made to a drab clay parting usually showing a little above the middle of the coal. It runs from 2 to 8 in. thick. The bottom of the upper bench of coal is bony for several inches. As the lower bench of coal is the best, it being bright, solid coal, tending to a semi-block, it alone is being worked at present.

In township 1 north, range 9 west, Coal VII has been worked at Union P. O., Sec. 32, at the Alexander Oliphant mine, where it is 80 ft.? to the coal, and at the Fredericks mine, where the coal is 60 ft.? deep. The coal is reported to be 4 ft. thick, with two fairly persistent sulphur bands 8 in. apart in the middle. The roof is a white clay shale and the floor fire-clay.

In the drilling given above from the John Patterson place, in Sec. 15, it is there 113 ft. to Coal VII, 143 ft. to Coal VIb, and 180 ft. to Coal V, 8 ft. thick. This indicates an abundance of workable coal in this area.

Township 1 South, Ranges 8 and 9 (in part) West.

1813. Geography.—This area includes the southwestern part of Washington, the southern part of Madison and Clay, the northwestern part of Patoka and all of Logan of the civic townships. The area is for the most part rather hilly, with some bottoms along Patoka river. The E. & I. R. R. crosses the center of T. 1 S., R. 8 W. The Air Line touches the southeastern corner of the same township.

1814. Stratigraphy.—No sections connecting the coals together were obtained in this area, but in general the stratigraphy may be assumed to be similar to that of the last township. Coals VII and V are worked here and are quite similar to the same coals in the last township.

Coal VII usually shows a parting of a few inches, as shown in the following sections:

1815. Section 842. Section at Hosea Alexander's Shaft.—N. E. of N. E. of Sec. 4, Plate LXII, Fig. 1.

	Ft.	In.
1. Surface	14	0
2. Sandstone, hard, fine-grained, blue..40 ft. in hill to	4	0
3. Gray shale .4 ft. to	2	6
4. COAL VII—Coal, seams tight and irregular, 2 ft. 0 in.; smooth parting; coal, regular seams, 2 ft. 8 in.	4	8
5. Fire-clay	3	0
6. Hard sandstone	..	..

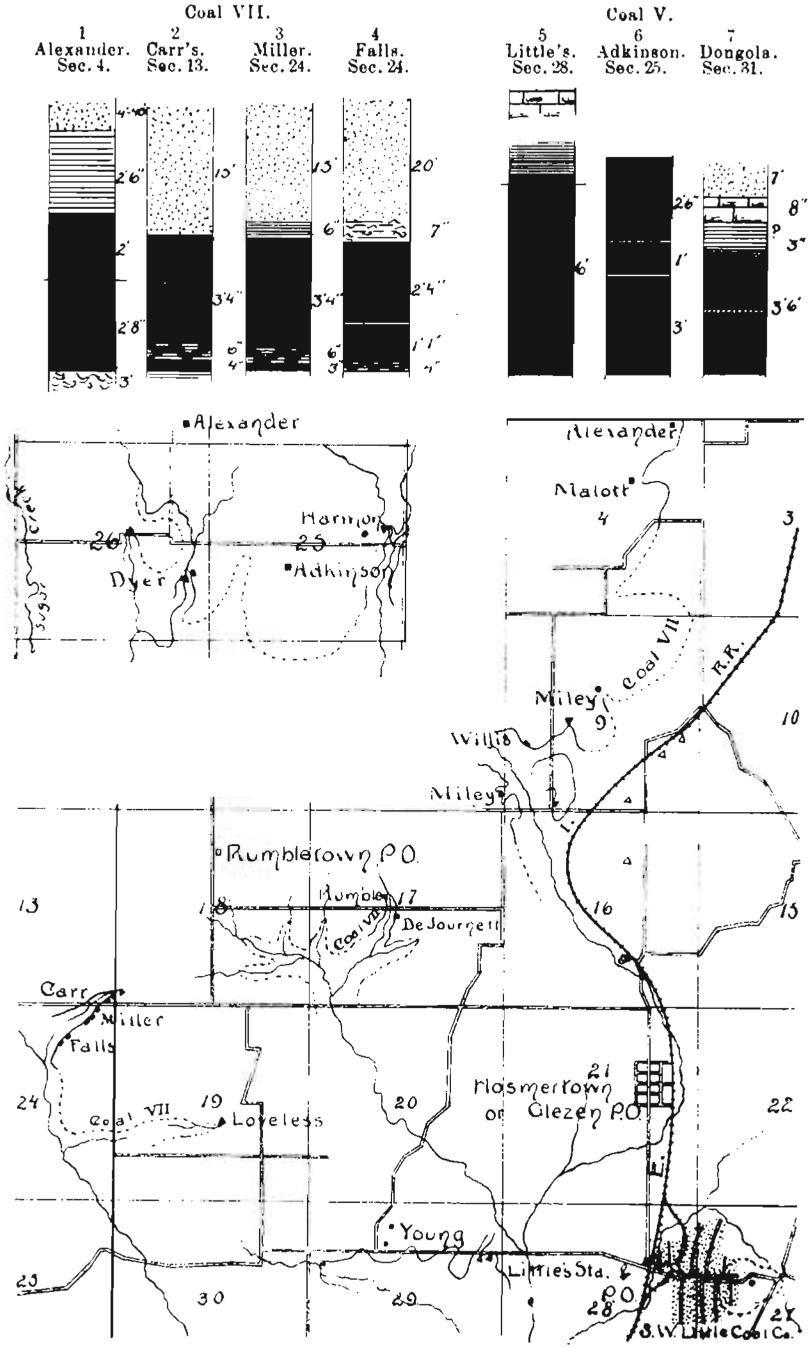


PLATE LXII. Sketch map of part of T. 1 S., R. 8 W.

1816. SECTION 843. SECTION AT WM. CARR'S MINE.—S. E. of S. E. of Sec. 13-1-9, Fig. 2.

	Ft.	In.
1. Sandstone, jointed	15	0
2. COAL VII—Coal, solid, 3 ft. 4 in.; bone coal, 6 in.; coal, blocks out, 4 in.	4	1
3. Gray shale	..	..

1817. SECTION 844. SECTION AT MILLER BROS.'—N. E. of N. E. of Sec. 24-1-9, Fig. 3.

	Ft.	In.
1. Gray to yellow, shaly sandstone, jointed	15	0
2. Gray shale with coal "feelers" .0 to	..	6
3. COAL VII—Coal, solid, 3 ft. to 3 ft. 4 in.; bone coal, 6 in.; coal, 3 in.	4	1

1818. SECTION 845. SECTION AT FALL'S BANK.—Sec. 24-1-9, Fig. 4 (J. C., p. 252).

	Ft.	In.	Ft.	In.
1. Heavy bedded sandstone.....10 ft. to	20	0	20	0
2. Calcareous and argillaceous clod 14 ft. to	..	7	20	7
3. COAL VII—				
Shaly coal	2	4	22	11
Pyritous partings .....3 in. to	0	1	23	0
Choice caking coal	1	1	24	1
Shaly pyritous coal	0	4	24	5
4. Fire-clay to water	3	0	27	5

These sections show Coal VII to have a thickness of from 3 to nearly 5 ft., with often a few inches of waste at some horizon in the coal. The lower part of the bed tends to have regular slips. At the Alexander bank these are from 1 to 3 ft. apart, the principal slip being east and west, with others less regular north and south. The roof is sandstone, with often some shale between it and the coal. The coal is apt to be rich and glossy, burning freely with much flame and leaving little ash.

Mr. Cox gives the following analyses of this coal here:

NAME.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Alexander, Sec. 4 1-8	49.50	41.50	91.00	3.00	6.00	9.00
Alexander, another sample	52.00	36.00	88.00	4.00	8.00	12.00
Turner Smith, Sec. 4 1-8	53.50	38.50	92.00	2.50	5.50	8.00
Barr, Sec. 15-1 8	57.00	32.50	89.50	3.50	7.00	10.50
Falls, Sec. 24 1-9, upper part	47.00	42.50	89.50	5.00	5.50	10.50
Falls, lower part	51.50	37.00	88.50	4.00	7.50	11.50

Coal V varies in thickness from 4 ft. to 7 ft. At Little's mine the coal is solid and uniform, except 3 or 4 in. of the top, which is harder and separated from the rest by a smooth parting. At the Adkinson or Crow mine the coal is described as having a parting 3 ft. from the bottom and another 1 ft. above, the coal between being harder and dryer than the rest. The coal here is 5 ft. 6 in. to 7 ft. thick, the bottom 3 ft. being the purest and best. At Dongola the coal is not so thick and has a sulphur band through the middle.

The roof at Little's is excellent, black sheety shale, with pyrite concretions only in places. Rooms 40 ft. wide that have stood six or seven years without a post have only lost a few inches of the roof. At Dongola the roof is similar, though not perhaps so good. At Adkinson's the black shale is wanting (?), the roof being clay shale with ferns, with 7 in. of "mother coal" or "draw slate" between, which may represent the black shale. Roof fairly good. The floor is usually hard, at Little's, sometimes showing a little fire-clay, but usually either black shale (bone coal) or "rock."

Coals VIb and VI outcrop at a few places, but thin.

1819. Distribution and Local Details.—The limestone near the top of Division VI occurs near the level of the old canal grade from Dongola north to Sec. 10. In Secs. 9 and 16 it was cut through in digging the deep cut necessary in crossing the divide, and Coal VIa is reported to have been exposed in and near the canal bed at several points, but usually thin. As Coal V underlies this by from 50 to 100 ft., it is evident that Coal V will underlie all of this area except as it may be cut out along the bottoms of Patoka creek, in the southeastern corner. Coal VII will be above drainage along the canal and found only in the hills east of the railroad. West of the railroad it descends to drainage as the county line is approached, beyond which it is probably entirely below drainage. The outcrop of Coal VII was not traced east of the railroad, as little data could be obtained on it. It was reported to have been found 4 ft. thick in the S. E. ¼ of Sec. 23, on the Alexander place, at an elevation of about 100 ft. above Coal V.

Coal V has been stripped and sunk to in Sec. 25, on the Logan Harmon place, and at the G. Adkinson or old Crow shaft. At the latter the coal averages 6 ft. thick and is found at a depth of 16 ft. In Sec. 26 it has been stripped at the Isaac Dyer place, in the S. E. ¼. Near the center of the section outcrops of what was thought to be Coal VI were observed in the road.

At Little's mine, Coal V is 82 ft. deep. On the southeast side of the shaft the dip is to the southeast. Coal V appears to pass below drainage in Patoka river, in Sec. 33.

West of the railroad, Coal VII is well up on the flank of the hill, in Sec. 4. It is mined at the H. W. Alexander mine, close to the base line, and at the Malott shaft, in the S. W. of N. E. of Sec. 4. The coal here was described above. The roof shows the same kind of rolls as farther north—those in which the regular roof is not cut out but passes over the roll material, in this case clay shale, accompanied by feelers of coal. These run north and south at Alexander's, and in some cases nearly cut the coal out. In the Malott shaft they run northeast and southwest. The shale between the coal and sandstone tends to come down when thin. It is observed to get thicker in the "swamps." The general dip is to the north or northwest. This coal was 4 ft. thick where formerly stripped on the J. D. Miley place, in the S. E. of N. W. of Sec. 9. It outcrops on the Miley place, in the N. E. of S. W. of Sec. 9, and beside the road in the S. E. of S. W. of Sec. 9. It has been worked on the Turner Willis place, N. W. of S. W., where it is 4 ft. or more thick, with a poor roof of clay shale, and on the J. D. Miley place, in the S. E. of S. E. of Sec. 8. At the last place the coal is 4 ft. 2 in. thick, overlain by 5 ft. of clay shale, and that in turn by shaly sandstone.

In Sec. 17, Coal VII has been worked at the Poke Rumble bank, in the S. E. of N. W., and at Mrs. Jane DeJournett's bank, in the N. E. of S. W. of the section. The coal is reported to be 3 ft. thick at these points and appears to have a sandstone roof.

This coal has been worked by stripping and drifts in the S. W. 40 of Sec. 18 and S. E. 40 of Sec. 13-1-9, on the Wm. Carr place. The section here was given above. In Sec. 24-1-9 it outcrops just above drainage, and has been worked at numerous points on the Miller Bros., Richard Fall, and Joseph Miller places. The two sections given above show how the coal runs here. The sandstone roof is jointed and tends to come down readily.

In Sec. 19-1-8, Coal VII has been stripped at the Loveless bank, near the center of the section. In Sec. 29 it is 3 ft. thick at 30 ft. in a well on Mr. Noah Young's, N. E. of N. W. of section. At Dongola it is 10 to 15 ft. above Patoka and too badly split up to be workable. The lower coals may be expected to underlie Coal V at depths and with much the same thickness as found in the township north.

Townships 2 and 3 South, Range 8 West. Part in Pike County.

1820. Geography.—This area includes the southwestern part of Patoka and western part of Monroe of the civic townships, and forms the southwestern corner of the county. The topography of most of

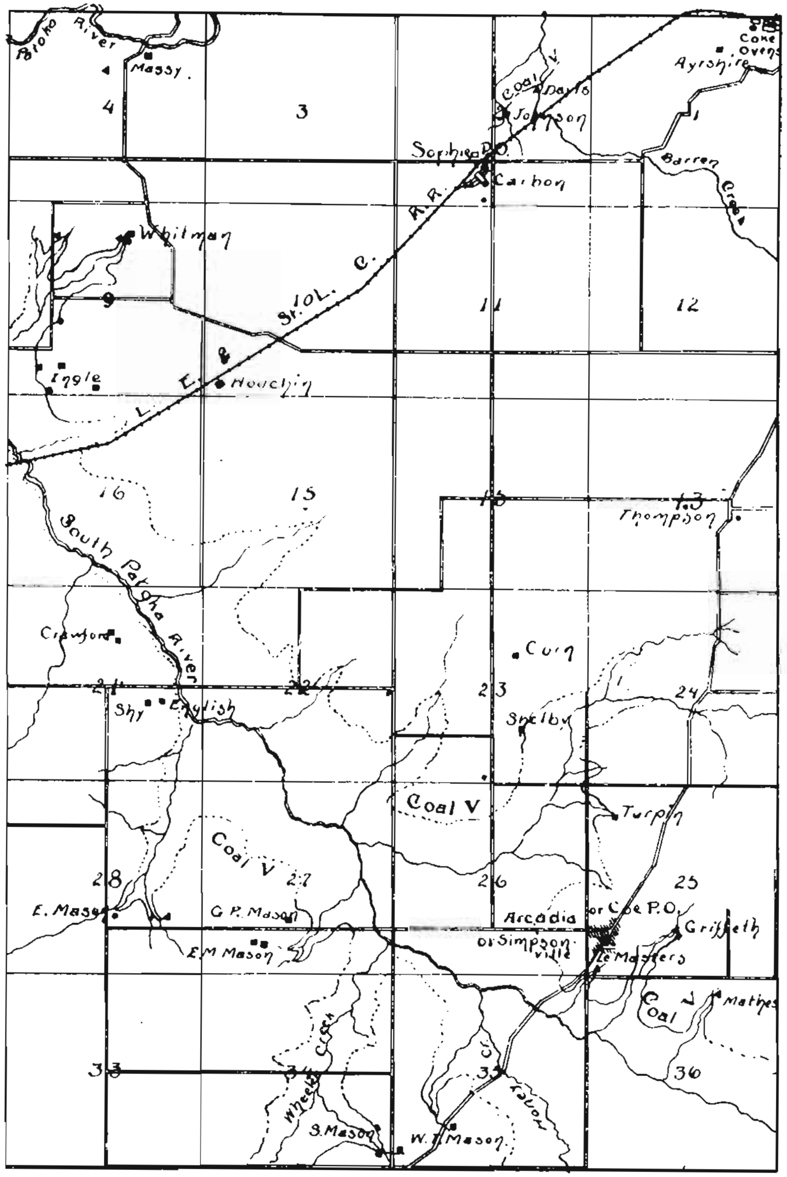
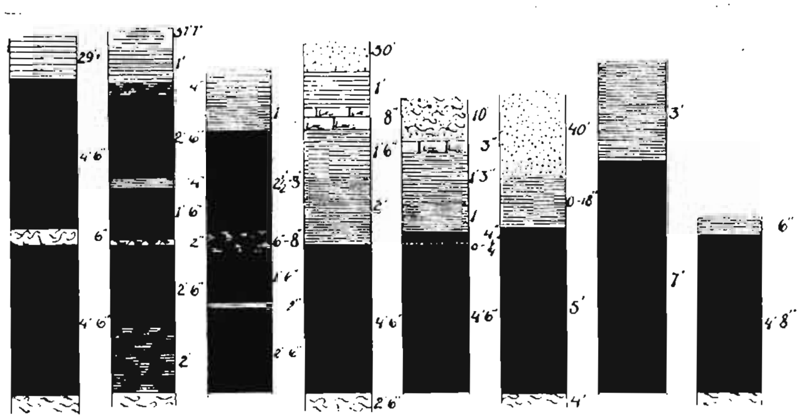


PLATE LXIII. Sketch map of part of T. 2 S., R. 8 W.

the area is rolling, with broad bottoms along the south Patoka river, but at the south end included part of the watershed between the Ohio and Patoka rivers, with the usual irregular ridge and high knobs that characterize that divide. Some hilly country is met with in T. 2 S., R. 8 W. The Air Line railroad crosses the northern part of the area.



Figs. 802-809. Sections of Coal V in T. 2 S., R. 8 W. (In Pike County.)

1821. STRATIGRAPHY.—In the main the stratigraphy is similar to the townships just north, as shown in the following sections:

1822. SECTION 846. SECTION AT M'GREGOR'S HILL.—Sec. 9-3-8, Fig. 2, Plate LXIV (J. C., p. 279).

		Ft.	In.
1.	Soil and clay	5	0
2.	Limestone, argillaceous, clinky	6	0
3.	Space covered, place of upper rash coal (Coal VIIIa?)	6	0
4.	Limestone, compact clinky	3	0
5.	Clay shale and nodules	4	0
6.	Place of lower rash coal? (Coal VIII?)	?	?
7.	Fire-clay, buff	2	4
8.	Sandstone, coarse red	8	0
9.	Sandy shale with carbonaceous partings	16	6
10.	Clay shale with pyritious partings	8	0
11.	"Black clod"	2	0
21.	COAL VIII? choice white ash, gas coal	1	0
13.	Fire-clay	3	0
14.	Sandy shale and thin-bedded sandstone	20	6

1823. SECTION 847. SECTION AT TYRING'S BANK.—N. E. ¼, Sec. 23-3-8, Fig. 3, Plate LXIV. (J. C., p. 278, in the main.)

		Ft.	In.
1.	Surface and soil	15	0
2.	Loose soft sandstone	8	0
3.	Quarry sandstone, coarse, ferruginous	7	0
4.	COAL VII ..2 ft. 4 in. to	3	0
5.	Fire-clay	3	0
6.	Covered	27	0
7.	Limestone, roof of V	2	0
8.	Covered	5	0
9.	Black sheety shale of V in creek	?	?
10.	COAL V at Matthew Parker's	5	0

1824. SECTION 848. SECTION AT CARBON MINE OF WM. A. JACKSON.—S. E. of S. W. of Sec. 2-2-8, Fig. 805.

		Ft.	In
1.	Sandstone .10 ft. to	50	0
2.	Gray shale .0 ft. to	1	0
3.	Limestone .0 ft. to	..	8
4.	Gray shale .0 ft. to	1	6
5.	Black sheety shale .0 ft. to	2	0
6.	COAL V—Good coal, 1 ft. 0 in.; sulphury coal, 1 ft. 0 in.; good coal, 2 ft. 6 in.	4	6
7.	White fire-clay	2	6
8.	Hard white sandstone	..	..

In parts of the mine the sandstone comes down so as to cut out the regular roof.

1825. SECTION 849. SECTION AT E. G. DAVIS'S MINE.—S. W. of N. E. of Sec. 2, Fig. 806.

		Ft.	In.
1.	Surface	10	0
2.	Gray shaly limestone	..	3
3.	Dark drab shale	1	3
4.	Black sheety shale with pyritous concretions	1	0
5.	COAL V—Coal, hard, 4 in.; sulphur band, 0 to ¼ in.; coal, soft, some sulphur, 3 ft. 0 in.; coal, hard, best, 1 ft. 2 in. to 1 ft. 6 in.	4	10
6.	Fire-clay	2	0+

1826. SECTION 850. SECTION AT AYRSHIRE MINES OF DAVID INGLE.—Sec. 1-2-8, Fig. 807.

		Ft.	In.
1.	Sandstone, up to	40	0
2.	Black sheety shale .0 ft. to	1	6
3.	COAL V	5	0
4.	Fire-clay, rather soft	4	0

1827. SECTION 851. SECTION AT OLD WELLS AND WHITMAN BANK.—Sec. 1-2-8. (J. C., p. 268.)

		Ft.	In.	Ft.	In.
1.	Sandy shales with carbonaceous and clay partings	12	0	12	0
2.	Clay shale, fern bed, with neuropteris, etc.	..	8	12	8
3.	COAL V—Shaly coal, 4 in.; pure laminated, 6 in.; cubic gas coal, 1 ft. 2 in.; choice angular bright, 2 ft. 8 in.	4	8	17	4
4.	Fire-clay, dark, bituminous	0	9	18	1
5.	Fire-clay, white, stigmarial	4	3	22	3
6.	Clay shale with calcareous balls and bands	2	3	24	6
7.	Clay shale and sandy shales	12	0	36	6

Mr. Cox, in describing the mine a year or two previously, gave the following section (Sect. 852, E. T. C., p. 144):

		Ft.	In.
1.	Covered slope	10	0
2.	Gray sandy shale, with bands of flagstone	8	0
3.	Bituminous shale	1	0
4.	COAL V	4	6
5.	Fire-clay	..	..

In Secs. 4 and 9 of T. 2 S., R. 8 W., Coal V thickens up to 9 or 10 ft., and shows a parting as at Petersburg, though in this case the roof is so much like the roof of Coal VI that the suggestion is made that the upper bench of coal here is Coal VI and the lower bench Coal V. Taking the conditions around Hartwell and Augusta, it will be readily seen that if the pinching out of the strata between Coals VI and V is carried a little further, we should have just what is shown in the following sections. The fact that Coal V all around this small area shows a thickness of from only 4 to 5 ft. lends strength to that view. It must be acknowledged, though, that this suggestion has yet to be proven, and so for the present we will continue calling the coal all Coal V.

1828. SECTION 853. SECTION AT GEO. W. MASSEY'S.—N. E. ¼ of Sec. 4, Fig. 802. (E. T. C., p. 144.)

		Ft.	In.
1.	Clay shale with false bedding	25	0
2.	Tough bluish clay shale with plants	4	0
3.	COAL V—coal, 4 ft. 6 in.; clay parting, 6 in.; coal, 4 ft. 6 in.	9	9
4.	Fire-clay	..	..

As described by Mr. Massey, the coal runs from 9 to 10 ft. in thickness, including a 6 or 7 in. dirt band, which comes 6 ft. 6 in. to 7 ft. from the top. The top coal for 18 or 20 in. was not so good, and was usually left in mining.

1829. SECTION 854. SECTION AT THOS. MARTIN'S BANK.—Now Whitman, N. E. ¼ Sec. 9-2-8, Fig. 803. (J. C., p. 282.)

		Ft.	*In.*
1.	Soil, clay, etc.	18	0
2.	Black shale	1	0
3.	"Soft shale (rotten coal ?)"	1	6
4.	COAL VII ..... 1 ft. 1 in.	2	7
5.	Fire-clay	4	6
6.	Sandy shale and clay shale, covered (bar.)	57	7
7.	Clay shale, with ferns ..... 4 ft. to	1	0
8.	COAL V—shaly coal, 4 in.; laminated coal, 2 ft. 6 in.; soft black shale, 4 in.; good smith coal, 1 ft. 6 in.; good smith coal, white clay and soft coal, 2 in.; good smith coal, 2 ft. 6 in.; bony pyritous coal (not seen), 2 ft. 0 in.	9	1
9.	Fire-clay	..	..

1830. SECTION 855. SECTION AT INGLESIDE MINE.—S. E. of S. W. of Sec. 9, Fig. 804, as given by one of the men who formerly worked in the mine.

		Ft.	*In.*
1.	Clay shale	..	..
2.	Drab shale	1	0
3.	COAL V—Coal, 2 ft. 6 in. to 3 ft. 0 in.; bone coal, 0 ft. 6 in. to 0 ft. 8 in.; coal, 1 ft. 0 in. to 1 ft. 6 in.; shale, 0 ft. 2 in.; coal, 2 ft. 0 in. to 2 ft. 6 in.	7	10

From these sections and other data it appears that Coal VII is workable over only a small area if at all, being either too poor or too thin.

Coal V appears to be from 4 to 9 or 10 ft. thick, thicker coal including much unworkable coal and clay, while the thinner coal appears to be equal or better than the average of this bed elsewhere. While the normal roof of black shale, and sometimes a thin limestone, is commonly found, this is replaced in many places by sandstone, which appears to have cut out the regular roof, or by clay shale with plant remains. The possibility that in the latter case the coal bed is a combination of Coals VI and V was spoken of above.

Mr. Cox gives the following analyses of this coal:

MINE.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Wells and Whitman, top	52.50	37.00	89.50	2.50	8.00	10.50
Wells and Whitman, middle	50.50	41.50	92.00	2.00	6.00	8.00
Wells and Whitman, bottom	50.50	42.00	92.50	2.50	5.00	7.50
G. W. Massey, upper part	53.50	34.50	88.00	3.50	8.50	12.00
G. W. Massey, lower part	55.00	36.50	91.50	1.50	7.00	8.50
Thos. Martin, upper part	52.00	37.00	89.00	3.50	7.50	11.00
Thos. Martin, middle part	57.00	33.50	90.50	3.00	6.50	9.50
Thos. Martin, lower part	55.00	35.00	90.00	2.50	7.50	10.00

These analyses indicate more than the average amount of fixed carbon, which is a desirable thing in a coal. Nothing was found out about the underlying coals, but a gas well at Oakland indicated the existence of several workable coals beneath Coal V. These data would need proving with a core drill before acceptance.

1831. DISTRIBUTION AND LOCAL DETAILS.—Coal V outcrops about at the level of the bottoms of Patoka river, in Secs. 1 and 2. It is extensively worked in the N. E. ¼ of Sec. 1, at the Ayrshire mines, being worked by a slope at the north section line. Near the slope is a coking plant. About 60 per cent. of the coal is lump, the screening and slack being washed and coked.

In the N. E. ¼ of Sec. 2 Coal V has been stripped on the Thos. A. Johnson and E. G. Davis places. The coal is 10 or 15 ft. below the level of the bottoms. (See Sect. 849.) In the S. E. of S. W. of Sec. 2 it is worked extensively at the Carbon mine of Wm. A. Jackson by a slope. (See Sect. 818 for section here.) The coal averages 4 ft. 6 in. As stated above, the normal black shale and limestone roof has in parts of the mine been removed and replaced by sandstone. The coal shows faces running 14° N. of E. The top of the coal is about 12 ft. below the railroad level at the slope. The roofing is good under sandstone; the rest has to be timbered closely. One fault, with a downthrow of 2 ft., has been encountered here, and sandstone veins and "white sand pots" in the roof occur here. A well in the top of the hill to the south is reported to have found 14 in. of coal at a depth of 17 ft. (Coal VII or VIb.) Coal VII probably underlies a large hill on high divide in Secs. 3 and 10. In the N. E. ¼ of Sec. 4, Coal V is just at the water level in the Patoka river on the G. W. Massey place, lying under the river but rising to the south so as to just about outcrop at low water in the south bank. The coal is 9 ft. to 10 ft. thick all told, including a parting of 6 or 7 in. (See Sect. 853.) A shaft 22 ft. deep reaches the coal from the upland and was just being opened up when visited, by Mr. S. A. Day. Only about 5 ft. of the coal is usually worked. Coal VII or VIb is reported to be 2 ft. 6 in. thick, at an elevation of 60 or 70 ft., to the southwest of the shaft.

Coal V is worked by drifting in the N. E. ¼ of Sec. 9, at the Whitman mine, formerly the Thos. Martin. (See Sect. 851.) It was mined extensively in the S. W. ¼, at the Ingleside mine of Mr. David Ingle. A number of openings have been made in this quarter section. (See Sect. 853.) The coal is here about at the level of the South Patoka bottoms. In the S. W. 40 of Sec. 9 the coal is reached by a 35 ft. shaft on the C. D. Houchin place, formerly the Whitman mine. The coal runs from 4 ft. to 4 ft. 6 in. in thickness, with a sandstone roof (?). Gray and black sheety shale overlies the coal, judging from the material on the dump. Lenticular masses of limestone also show there. The dip is rapid to the southwest.

The higher points east of this catch Coal VII. Thus, at Arthur a well on Mr. Thompson's place, in the S. E. ¼ of Sec. 13, found 3 ft. of coal at 15 ft., overlain by clay shale and underlain by fire-clay and that by limestone. A drilling in a hollow near the center of the section, on Mr. John Thompson's east line, found 5 ft. 4 in. of coal at 40 ft.

Coal V is below the creek level at the Crawford shafts, in the N. E. ¼ of Sec. 21. Quite a thickness of yellow sandstone showed above the water in the shaft. In the S. W. ¼ of Sec. 21 it is worked on the Wm. English and Wm. Sly places by slopes. The coal is here probably a little below the level of the bottoms. The coal is reported as 4 ft. thick, and was seen to be overlain by black sheety shale.

A coal reported to be 18 in. thick has been worked a little on the Mansfield Corn place, in the N. E. ¼ of Sec. 23. Coal V is reported to have been 7 ft. thick where formerly worked on the Oliver Selby place. It was overlain by black shale, but was under too low a hill and did not find a satisfactory roof. While Coal V is doubtless cut out over much of the bottom land long the South Patoka creek, it will probably be found that almost as large an additional area to the northeast will not be workable on account of poor roof. In the N. W. of the N. W. of Sec. 25 Coal V is just at drainage at Jonathan Turpin's slope. The coal runs from 5 ft. 2 in. to 5 ft. 6 in., the bottom foot being a little the best. The roof is in places clay shale; in others, black shale with a little limestone in places. Overlying these is sandstone. The coal is cut out across much of Secs. 26 and 27. It has been worked a little on Mrs. G. R. Mason's, in the N. E. of S. W. of Sec. 27, where it is 4 ft. 6 in. thick, overlain by 20 in. of black shale, and that by dirt, and by a shaft on the E. M. Mason place, in the S. E. of S. W. of Sec. 27. At the shaft the coal is 17 ft. deep, but it crops out just east. The coal is given as 4 ft. 8 in. thick, and though clay shale was said to make the roof, at the old slope 6 in. of black sheety shale is seen lying on the coal. The floor is gray fire-clay. (Fig. 809.)

In Sec. 28 4 ft. of coal is said to have been stripped in the N. E. of S. W. ¼, and 4 ft. 4 in. to have been found in a well at 6 ft., beside the creek, in the N. W. of S. E. of Sec. 28, on the E. M. Mason land. At the well the coal had 1 ft. 6 in. of black shale over it. Coal V is worked in the S. E. 40 of Sec. 34 and S. W. 40 of Sec. 35, on the Simeon Mason and W. T. Mason farms. It runs here 4 ft. 6 in. thick, with black shale roof over 1 ft. 6 in. to 2 ft. thick, overlain by clay shale. As elsewhere through here, the top 1 ft. is not as good as the rest.

On the Mary LeMasters place, in the S. W. 40 of Sec. 25, Coal V is reported to be 7 ft. thick, overlain by 3 ft. of black sheety shale. (Fig. 808.) This is a little above the level of the bottoms. It has also been worked on the Geo. Griffiths place, in the S. E. ¼ of Sec. 25, by drifting and stripping. The coal runs about 4 ft. 6 in., overlain by 2 ft. of black shale, with 2 ft. plus of fire-clay below. The same coal runs 4 or 5 ft. thick on the Wm. Mathes place, formerly the Geo. Ashby place, in the N. W. of N. E. of Sec. 36, where it has been stripped. It has a black sheety shale roof. The coal is cut out over much of Secs. 35 and 36.

1831*a*. T. 3 S., R. 8 W.—Coal V is said to have had a thickness of 7 or 8 ft. in a mine on the John Ross place, in the N. E. ¼ of Sec. 1. It was overlain by 1 ft. of black shale, and had a fire-clay floor. (Fig. 8.) It has been worked a long time on the R. C. Hamilton place, in the N. W. ¼ of Sec. 1. The coal runs about 4 ft. 4 in., but in places reaches nearly 6 ft., with a black sheety shale roof 3 ft. thick. (Fig. 7.) This coal was well spoken of in the surrounding country. The same coal is worked a little on Mrs. Coleman's place, formerly the Louisa Faries farm. It is reported 4 ft. thick, with a black shale roof. Coal V is worked on the farms of David Mason, N. W. ¼ of Sec. 4; Ben Mason, in S. W. ¼ of Sec. 4, and John Mason, in the N. E. ¼ of Sec. 4. At the Chas. McCully mine, on the David Mason place, the coal is 12 ft. deep and from 4 ft. to 4 ft. 6 in. thick. The roof is black shale, 8 in. of which comes down. (Fig. 6.) The coal contains some

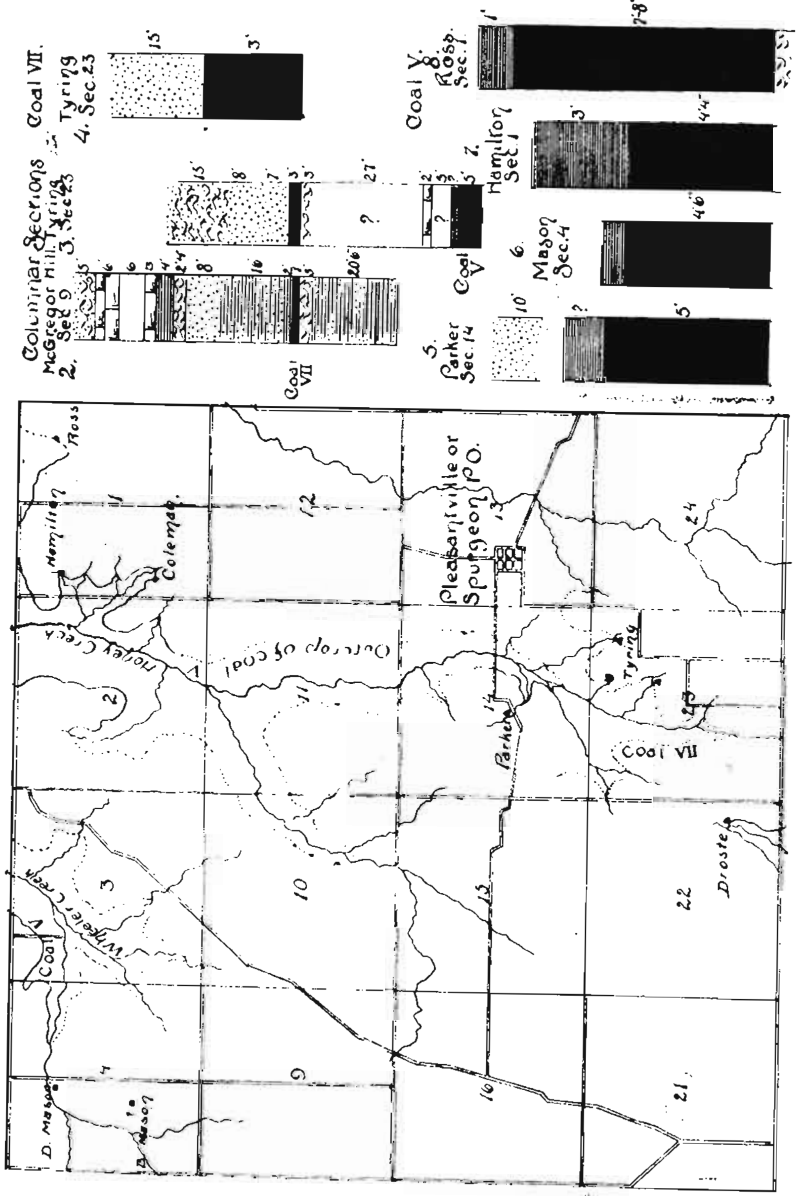


PLATE LXIV. Sketch map of part of T. 3 S., R. 8 W., with columnar and coal sections.

sulphur, but not in regular bands. Coal is shown on the county atlas on the E. H. Yager place, N. E. 40 of Sec. 4; J. Skinner place, N. E. ¼ of Sec. 3; W. A. LeMaster, S. W. ¼ of Sec. 14, and Thos. H. Beatty place, in S. W. of S. E. of Sec. 9. No data were gained about these places. From the topography it would seem probable that the last was Coal VII. Coal V measures 5 ft. on the Matthew Parker place, in the N. E. of S. W. of Sec. 14. It is overlain by black shale and that by 10 ft. plus of massive sandstone. (Fig. 5.)

At Pleasantville, or Sturgeon P. O., it is said wells show a 2 ft. bed (Coal VIb?) at 25 ft. and a 5 ft. bed at 40 ft.

In Secs. 22 and 23 Coal VII outcrops and has been mined at the Tyring bank, where it runs from 2 to 3 ft. thick, with a sandstone roof. (Fig. 4.) Reports conflict as to its quality. Coal VII probably underlies the most of Secs. 21 to 24.

1832. SUMMARY OF COAL FOR PIKE COUNTY.—

Divisions contained: IX, VIII, VII, VI, V, IV, III, etc.
Coals contained: VIIIa, VIII, VII, VIb, VI, V, IV, IIIb, IIIa, III, etc.

ROUND NUMBER ESTIMATES.

Coal VII.

Worked area	10 acres ×	av. thickness,	4 ft. ×	1,000 =	40,000 tons.
Workable area	20 sq. mi. ×	"	3 ft. ×	500,000 =	30,000,000 tons.
Unworkable area ..	30 sq. mi. ×	"	2 ft. ×	1,000,000 =	60,000,000 tons.
Total area	50 sq. mi.				90,000,000 tons.

Coal V.

Worked area	½ sq. mi. ×	av. thickness,	5 ft. ×	500,000 =	1,250,000 tons.
Workable area	180 sq. mi. ×	"	5 ft. ×	500,000 =	450,000,000 tons.
Unworkable area ..	20 sq. mi. ×	"	1 ft. ×	1,000,000 =	20,000,000 tons.
Total area	200 sq. mi. ×				471,250,000 tons.

Coal IV.

Worked area	1 acre ×	av. thickness,	3 ft. ×	1,000 =	3,000 tons.
Workable area ...	50 sq. mi. ×	"	3 ft. ×	500,000 =	75,000,000 tons.
Unworkable area .	250 sq. mi. ×	"	½ ft. ×	1,000,000 =	125,000,000 tons.
Total area	300 sq. mi				200,000,000 tons.

Other Coals.

Workable area	50 sq. mi. ×	av. thickness.	3 ft. ×	500,000 =	75,000,000 tons.
Unworkable area .	250 sq. mi. ×	"	4 ft. ×	1,000,000 =	1,000,000,000 tons.
Total area	300 sq. mi.				1,075,000,000 tons.

Number of coals contained: 10+.
Greatest thickness recorded: 10 ft. 2 in.; 11 ft. reported.
Area underlain by coal: 338 sq. mi.
Area underlain by workable coal: 200 sq. mi.
Estimated total tonnage of coal: 1,836,000,000 tons.
Estimated total tonnage of coal removed: 1,293,000 tons.
Estimated total tonnage of coal left: 630,000,000 tons.
Number of mines working ten men or over in operation: 6.
Number of mines working less than ten men in operation: 125.
Total number of mines in operation: 131.
Large mines not in work: 3.
Small mines not in work: About 150.
Strippings and outcrops: 267.
Total number of openings to coal: 450.

XXXIV. GIBSON COUNTY.

1833. REFERENCES AND FIELD WORK.—

1862 (1859-60). Richard Owen, Rep. of Geol. Reconn. of Indiana, p. 181. One columnar section.

1862 (1859-60). Leo Lesquereux, same, p. 340.

1874 (1873). John Collett, 5th Ann. Rep. of Geol. Surv. of Ind., pp. 383-422. Detailed report, map, twenty-one columnar sections, four coal analyses. This report forms the basis of a large part of the present report.

1896 (1895). W. S. Blatchley, Ind. Dept. of Geol. and Nat. Resources, 20th Ann. Rep., pp. 113-116. One columnar section (without coal); discusses clays.

1898. E. M. Kindle, field work for this report.

Section 1. Geography.

1834. POSITION.—Gibson county is in the western row of counties and in the second tier from the south. It lies west of Pike and part of Warrick, north of Warrick, Vanderburgh and Posey, south of Knox, and is separated from Illinois on the west by the Wabash river.

1835. EXTENT AND TOWNSHIPS.—It has an extreme length from east to west of 36 mi. and width from north to south of 25 mi., with an area of about 487 sq. mi. It occupies all of T.'s 2 and 3 S., R.'s 9 to 12 W., and T. 1 S., R. 10 W.; parts of T. 1 N., R.'s 10 and 11 W.;

T. 1 S., R.'s 9, 11 and 12 W.; T. 2 S., R.'s 8 and 13 W.; T. 3 S., R.'s 8, 13 and 14 W.; T. 4 S., R.'s 10 and 11 W. Its civil townships and their relative positions are as follows:

	White River.	Washington.		
	Patoka.	Center.		Columbia.
Wabash.	Montgomery.		Barton.	
	Johnson.			

1836. ELEVATIONS.—The following elevations are known:

	Ft. A. T.
Oakland City, L. E. & St. L. C. R. R.	488
Francisco, L. E. & St. L. C. R. R.	464
Princeton, L. E. & St. L. C. R. R.	483
White river, low water, at E. & T. H. bridge	388.82
Wabash river, low water, mouth of White river	376.55
Patoka river at Dougola	410
Canal survey, lowest point of ridge near Francisco	469
St. James, E. & T. H. R. R.	471.5
Haubstadt, E. & T. H. R. R.	466.9
Fort Branch, E. & T. H. R. R.	442.6
Princeton, E. & T. H. R. R.	475.1
Patoka, E. & T. H. R. R.	429.9
Miller's, E. & T. H. R. R.	487.1
Hazelton, E. & T. H. R. R.	417.5

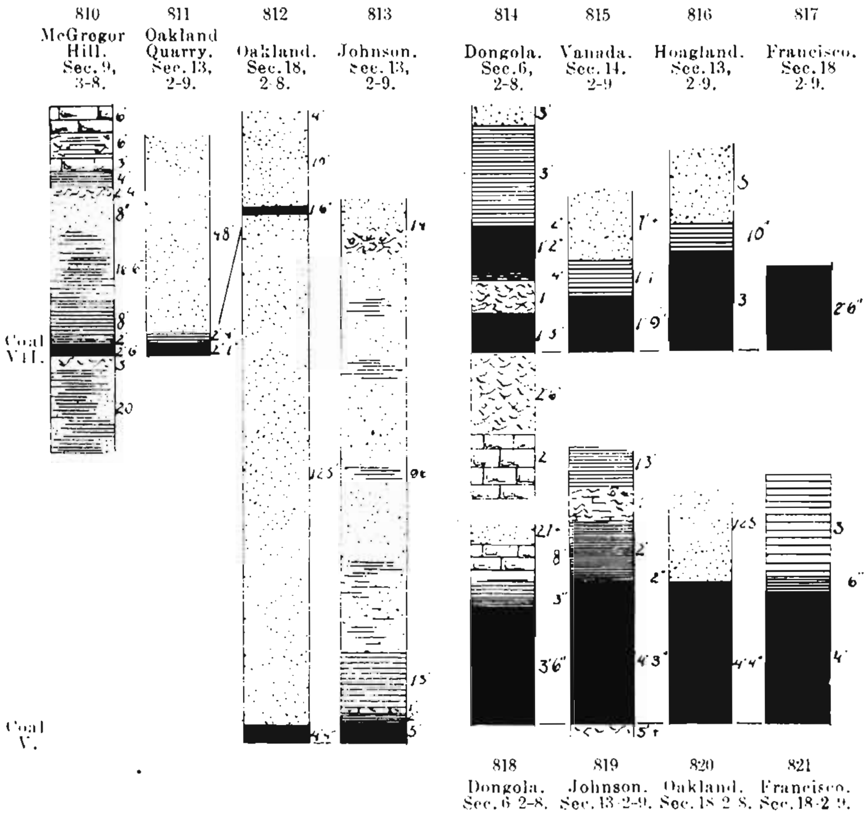
Elevation along E. & T. H. R. R. on basis of Evansville being 378 ft. A. T.

1837. GENERAL TOPOGRAPHY.—The eastern part is elevated and rolling, or in places plateau-like, with deeply cutting ravines. A few knob-like hills are found in this part of the county. The western half is generally level or slightly undulating, with a large area of bottom land. This part of the county is very fertile.

1838. GENERAL DRAINAGE.—White river flows along part of its northern border, while the Wabash forms the rest of the northern border, the two together also forming the western border. Patoka river flows across the northern part of the county with a sluggish current. The southeastern quarter of the county drains to Pigeon creek and the southwestern into swamps along the Wabash or into Black river.

Section 2. Stratigraphy.

1839. The workable coals barely reach the surface along the eastern edge of the county, and in the center of the county are to be found from 350 ft. deep and deeper. It is therefore readily understood why there are but few mines in the county, and that most of the data consist of columnar sections, especially those obtained by borings. For that reason, the columnar sections will be given in the discussion of the distribution of the coals.



Figs. 810-813. Columnar sections in eastern Gibson county.
Figs. 814-817. Sections of Coal VII in same area.
Figs. 818-821. Sections of Coal V in same area.

1840. Distribution and Details, Part of County in Ranges 8 and 9 West.—Coal V appears to be below drainage under all of this area. Coal VII is at drainage in the Patoka river valley. Coal VIII appears to outcrop in the higher parts of the upland, while a few knobs catch still higher strata. Only two coals are mined in this area, and those at only a few localities.

At Dongola, Coal VII lies about 15 or 20 ft. above the level of the river. It is so divided up as to be of no value, as shown in the following section:

1841. Section 856. Section at Dongola Clay and Coal Bank.—Sec. 6-2 S., 8, Fig. 814. (E. M. K., Nos. 8, 9 and 10, from J. C., p. 389.)

	Ft.	In.
1. Soft sandstone	3	0
2. Yellowish brown shale	3	0
3. Bone coal and dirt ....1 in. to	0	2
4. COAL VII, upper bench ....10 in. to	1	2
5. Bone COAL	0	4
6. Blue plastic, fossiliferous fire-clay, lower 6 in. shaly	1	8
7. COAL VII, lower bench ....1 ft. to	1	3
8. Fire-clay	2	6
9. Impure limestone	2	0
10. Flaggy sandstone	10	0

An entry was driven on this seam in hopes of finding better coal.

Starting only a few feet below Coal VII, a shaft has recently been sunk to Coal V by Mr. Fred Auch. The coal is 54 ft. 6 in. deep and 3 ft. 6 in. thick. This makes the coal nearly 50 ft. below the level of Patoka river. The shaft gave the following section:

1842. Section 857. Section of Auch Shaft.—Dongola, Sec. 6-2 S., 8 W., Fig. 818. (E. M. K.)

	Ft.	In.
1. Surface	5	0
2. Gray sandstone and sandy clay	7	0
3. Shelly sandstone	20	0
4. Limestone	0	8
5. Gray shale	?	?
6. Black carbonaceous shale	0	3
7. COAL V	3	6
8. Very hard drab colored clay	3	0

The coal shows a sulphur band near the middle, appears to carry a good deal of sulphur and gives a red ash with much clinker. The roof shows the pyrite concretions usually found over Coal V.

At Oakland both Coals VII and V are found. A well on Main street is reported to have given as follows:

1843. Section 858. Section of Well.—Oakland, Sec. 18, 2 S., 8 W. (E. M. K., Figs. 812, 820.)

	Ft.	In.
1. Surface	4	0
2. Sandstone	19	0
3. COAL VII	1	6
4. Sandstone	125	0
5. COAL V	4	4

Coal VII is from 2 ft. 6 in to 3 ft. thick northwest and west of town. It is missed by wells in the southwestern part of town. On the southwestern edge of town is the J. D. Johnson shaft.

1844. SECTION 859. SECTION OF J. D. JOHNSON SHAFT.—Sec. 13, 2 S., 9 W., Figs. 813, 819.

		Ft.	*In.*
1.	Surface	14	0
2.	Sandstone with some shale	96	6
3.	Black or gray shale	13	0
4.	"Soft fossiliferous material" (bleached limestone?)	1	0
5.	Black shale with pyrite concretions........7 in. to	2	0
6.	COAL V	5	0
7.	Fire-clay	..	..

In its best development the coal is solid, a hard bright coal of good quality. Locally it tends to be cut up with sulphur streaks. Mr. Kindle gives the following section of the coal at one point (Sect. 859*a*, E. M. K.):

	Ft.	*In.*
Black fossiliferous shale	7	0
Black sheety shale ....6 in. to	0	10
Sulphur and dirt band	0	1
COAL	0	7
Sulphur band	0	⅛
COAL	0	5
Soft coal and sulphur streaks	0	½
COAL	0	8½
Sulphur streaks	0	½
COAL	1	7
Hard fire-clay ....3 ft. to	4	0

At workings in 1898 the coal ran from 4 ft. to 4 ft. 4 in., and generally showed a sulphur band near the middle. There is usually 2 in. of bone at the top, with a few inches of laminated coal below, then a smooth parting. The roof stands fairly well, being good as long as kept dry. The floor is very hard and gives no trouble. The pyrite concretions in the roof occur in "nests." Very little trouble with rolls.

At the Oakland gas well, coals were reported as follows:

	Ft.
Coal, 3 ft., at	180
Coal, 6 ft., at	450
Coal, 7 ft., at	650
Coal, 20 in., at about	1,000

A mile and a half west of Oakland Coal VII is worked some at Stumpsburg, along a branch of the Patoka. It occurs just above the branch. Mr. Collett gives the following sections of the coals here:

1845. SECTION 860. SECTION AT OAKLAND QUARRY.—Sec. 13, 2 S., 9 W., Fig. 811. (J. C., p. 400.)

		Ft.	*In.*
1.	Soft sandstone	10	0
2.	Laminated sandstone	8	0
3.	Heavy bedded quarry sandstone	30	0
4.	Pyritous shale	2	0
5.	Black shale	0	4
6.	COAL VII	2	1
7.	Fire clay, to brook	4	0
		56	5

1846. SECTION 861. SECTION AT VANADA'S.—Sec. 14, 2 S., 9 W., Fig. 815. (J. C., p. 400.)

		Ft.	*In.*
1.	Soft yellow sandstone	7	0
2.	Pyritous shale	1	1
3.	COAL VII	1	9

At Mr. Thos. Hoagland's bank, N. W. of S. W. of Sec. 13, 2 S., 9 W., is the following section (Sect. 862, E. M. K., Fig. 816):

		Ft.	*In.*
1.	Surface clay	1	0
2.	Soft yellowish sandstone	5	0
3.	Dark gray shale.............5 in. to	0	10
4.	COAL VII............2 ft. 4 in. to	3	0
5.	Blue fire-clay	..	..

The coal has no regular clay or sulphur band, and, though occasionally streaks of dirt occur which thicken up to 2 in., as a rule it is a fairly clean coal. The roof is good after taking down 6 in. of shale. The floor is rather soft. The coal lies about 2 ft. above the adjacent drainage. At the John Cotterill bank, in the N. E. of S. E. of Sec. 14, 2 S., 9 W., Coal VII is from 2 to 3 ft. thick. It is overlain by 4 in. of gray shale, then by 6 ft. of soft yellow sandstone. The coal in this mine thins out at the entrance, and is said to do the same all around the southeastern side of the hill, as shown in Fig. 822. Where the coal runs out, the sandstone is conglomeritic.

At the Chas. Worth bank, just north of Stumpsburg, the coal is from 26 to 30 in. thick, with a massive hard sandstone roof 5 ft. plus thick. Below the coal is first 2 or 3 ft. of blue and rather soft fire-clay, then 2 ft. plus of hard blue sandstone. The hill at Stumpsburg has been pretty well worked out. To the west the coal is said to be too thin to work.

Fig. 822. Figure showing thinning out of Coal VII in Cotterill mine (from sketch by Mr. Kindle).

In the S. E. ¼ of Sec. 9, 2 S., 9 W., 9 in. of coal is reported in a well on the hill at a depth of 35 ft.

Just northwest of Francisco is the G. W. Bird shaft. Coal VII, at 90 ft., is 2 ft. 6 in. thick here (Fig. 817), and Coal V (?), at 140 ft., 3 ft. 6 in. to 4 ft. A section in the mine gave (Sect. 863, E. M. K., Fig. 821):

	Ft.	In.
1. Tough dark gray shale with plants	..	..
2. Dark gray shale, rather soft, with plants....2 ft. to	3	6
3. Hard dark shale....5 in. to	0	8
4. COAL V (?)....3 ft. 4 in. to	4	0
5. Fire-clay, plant fragments	3	0

The coal shows a sulphur band of from ½ to 3 in. in the middle. The roof comes down for from 8 to 11 in.; is more solid above. The floor tends to creep a little. The roof of this coal is so unlike the normal roof of Coal V as to raise some question of their identity. Coals were reported to have been found at a number of wells south of Oakland. An outcrop of Coal VIII? was noted beside the road in the N. W. ¼ of Sec. 6-3-8.

The limestone of Division VIII is found in knobs east of Somerville. Mr. Collett gives the following section of two of these knobs:

1847. Section 864. Section at Kennedy Knob.—Sec. 35, 2 S., 9 W. (J. C., p. 401.)

	Ft.	In.	Ft.	In.
1. Sand and loess	30	0	30	0
2. Hard shaly limestone	5	0	35	0
3. Place of upper rash COAL?	..	..	..	..
4. Blue fossiliferous limestone	10	0	45	0
5. Place of second rash COAL?	..	..	..	..
6. Covered, sandy shale	35	0	80	0
7. COAL?	0	?	80	0
8. Slope to valley plain	70	0	150	0

1848. Section 865. Section at McGregor Hill.—Sec. 9-3-8. (J. C., p. 402, Fig. 810.)

	Ft.	In.	Ft.	In.
1. Limestone, shaly and clinky	6	0	6	0
2. Clay and shale, place of first rash COAL....4 in. to	6	0	12	0
3. Limestone, compact	3	0	15	0
4. Shale, with ironstone nodules	4	0	19	0
5. Place of lower rash COAL	..	..	..	..
6. Fire-clay	2	4	21	4
7. Coarse sandstone	8	0	29	4
8. Sandy shale, bituminous partings	16	6	45	10
9. Clay shale	8	0	53	10
10. Black clod, soft shale	2	0	55	10
11. COAL VII?, white ash, gaseous	2	6	58	4
12. Fire-clay	3	0	61	4
13. Sandy shale and flaggy sandstone	20	0	81	4

At Somerville drillings report 6 ft. of coal at 92 ft.

Princeton Field.

1849. With the exception of at Princeton, the workable coals have not been reached in this part of the county in ranges 10 to 14 west, and nearly all data obtained away from that point refer only to the non-workable coals of Divisions VIII and IX. It will therefore be convenient to consider the area about Princeton first, as the information obtained there will be of service in interpreting the rest of this area.

At some time previous to 1873 a drilling was made, under the supervision of Mr. Kurtz, at or near Princeton, to a depth of 325 ft. It failed to reach workable coal, but gives the most complete record of that part of the rock section we have.

1850. Section 866. Princeton Bore.—(J. C., p. 408), Fig. 1, of Plate LXV.

	Ft.	In.	Ft.	In.
1. "Lacustral (or Erie) muck"	36	0	36	0
2. Sandrock	2	0	38	0
3. Sandy shale	17	0	55	0
4. Shale and rash COAL VIIIb?	1	0	56	0
5. Fire-clay	4	0	60	0
6. Limestone in bands	15	0	75	0
7. Clay shale	8	0	83	0
8. Gray limestone	2	6	85	6
9. Carbonaceous parting, COAL VIIIa?	0	2	85	8
10. Fire-clay	14	0	99	8

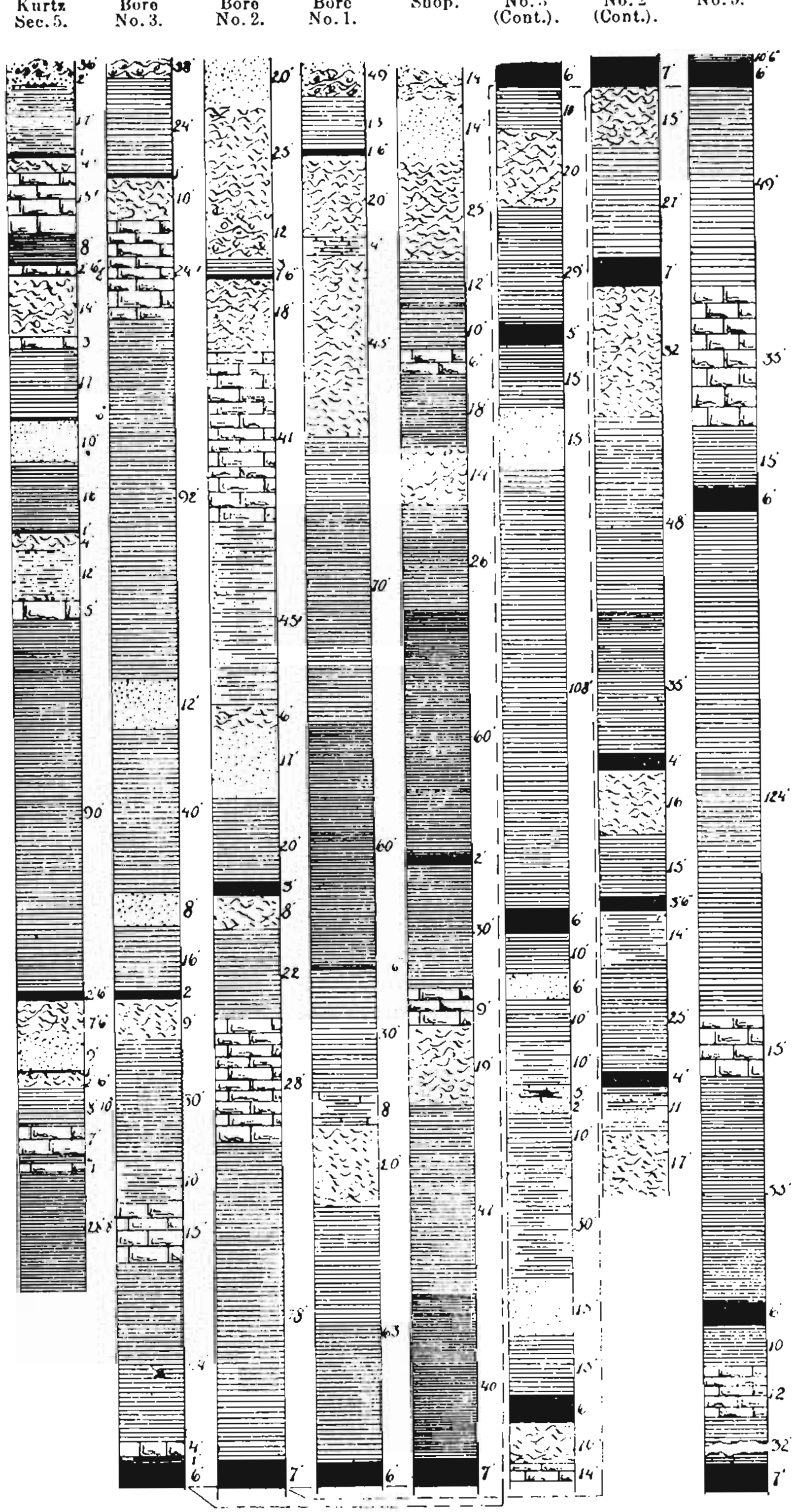


PLATE LXV. Columnar sections of drillings at Princeton.

		Ft.	In.	Ft.	In.
11.	Gray limestone	3	0	102	8
12.	Clay shale	17	0	119	8
13.	Limestone	0	6	120	2
14.	Quarry sandstone	10	0	130	2
15.	Clay shale and gray shale	16	0	146	2
16.	COAL VIII?	1	0	147	2
17.	Fire-clay	4	0	151	2
18.	Shaly sandstone	12	0	163	2
19.	Limestone	5	0	168	2
20.	Blue shale	55	0	223	2
21.	Blue shale	3	0	226	2
22.	Blue shale	32	0	258	2
23.	COAL VII?	2	6	260	8
24.	Fire-clay	7	6	268	2
25.	Sandrock	9	0	277	2
26.	Carbonaceous clod coal?	1	0	278	2
27.	Fire-clay	2	6	280	8
28.	Shale	8	10	289	6
29.	Limestone	7	0	296	6
30.	Shale	2	0	298	6
31.	Black limestone	1	0	299	6
32.	Black shale	28	8	328	2

The discovery of natural gas in Indiana led in 1887 to the drilling of a gas well at Princeton which went 544 ft. and found two 6 ft. beds of coal. This led to the drilling of more wells which, going to greater depths, reported up to five coal beds of workable thickness, some of the wells reporting over 20 ft. of workable coal, one well reaching 28 ft. of coal in five workable beds, all below the bottom of the first well drilled by Mr. Kurtz. Below is given the record of some of these wells:

1851. SECTION 867. SECTION OF WELL ON L. E. & ST. L. C. RY. SHOP GROUNDS.—Princeton, by S. C. Churchill, Fig. 5.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil	14	0	..	..	14	0
2.	Quicksand	14	0	..	..	28	0
3.	Fireclay	25	0	..	..	53	0
4.	Black shale	12	0	..	..	65	0
5.	Red shale	10	0	..	..	75	0
6.	Rotten limestone	6	0	..	..	81	0
7.	Clay shale	18	0	..	..	99	0
8.	Fire-clay	14	0	..	..	113	0
9.	Clay shale	26	0	..	..	139	0
10.	Black shale	60	0	..	..	199	0
11.	COAL VII?	2	0	2	0	201	0

		Ft.	In.	Ft.	In.	Ft.	In.
12.	White shale	30	0	..	..	231	0
13.	Limestone	9	0	..	..	240	0
14.	Fire-clay	19	0	..	..	259	0
15.	Shale	47	0	..	..	306	0
16.	Black shale	40	0	152	0	346	0
17.	COAL V?	7	0	7	0	353	0
18.	Fire-clay	28	0	..	..	381	0
19.	Sandy shale	10	0	..	..	391	0
20.	"Glass sand"	60	0	98	0	451	0
21.	COAL	2	0	2	0	453	0
22.	Brown shale	28	0	..	..	481	0
23.	Limestone	35	0	..	..	516	0
24.	Black shale	5	0	..	..	521	0
25.	Limestone	3	0	..	..	524	0
26.	Black shale	8	0	..	..	532	0
27.	Limestone?	20	0	..	..	552	0
28.	Gray? shale	5	0	..	..	557	0
29.	Gray? sandstone	15	0	..	..	572	0
30.	Fire-clay	13	0	..	..	585	0

1852. SECTION 868. SECTION OF GAS WELL No. 5.—On J. B. Hall's place, Princeton. J. W. Churchill, driller, Fig. 8.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Clay	8	0	..	..	8	0
2.	Clay, gravel, water	28	0	..	..	36	0
3.	Shale	102	0	..	..	138	0
4.	Limestone	15	0	..	..	153	0
5.	Shale	96	0	..	..	249	0
6.	Limestone shells	10	0	..	..	259	0
7.	Shale	106	0	..	..	365	0
8.	COAL V?	6	0	6	0	371	0
9.	Shale	49	0	..	..	420	0
10.	Limestone	35	0	..	..	455	0
11.	Shale	15	0	99	0	470	0
12.	COAL	6	0	6	0	476	0
13.	Shale	124	0	..	..	600	0
14.	Limestone	15	0	..	..	615	0
15.	Shale	55	0	194	0	670	0
16.	COAL	6	0	6	0	676	0
17.	Shale	10	0	..	..	686	0
18.	Limestone	12	0	..	..	698	0
19.	Shale	32	0	54	0	730	0
20.	COAL	7	0	7	0	737	0
21.	Limestone	112	0	..	..	849	0
22.	Shale	41	0	..	..	890	0
23.	Limestone	30	0	..	..	920	0
24.	Sandstone	40	0	..	..	960	0

		Ft.	In.	Ft.	In.	Ft.	In.
25.	Shale	18	0	..	..	978	0
26.	Sandstone	40	0	..	..	1,018	0
27.	Shale	2	0	238	0	1,020	0
28.	COAL	3	0	3	0	1,023	0
29.	White sandstone	221	0	..	..	1,244	0
30.	Blue limestone	30	0	..	..	1,274	0

1853. SECTION 869. SECTION OF GAS WELL No. 1.—On Evans Broadway, Princeton, Fig. 4.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil	6	0	..	..	6	0
2.	Quicksand	22	0	..	..	28	0
3.	Blue clay	21	0	..	..	49	0
4.	Clay shale	13	0	..	..	62	0
5.	COAL VIII?	1	6	1	6	63	6
6.	Fire-clay	20	0	..	..	83	6
7.	Lime shale	4	0	..	..	87	6
8.	Clay shale	18	0	..	..	105	6
9.	Fire-clay	45	0	..	..	150	6
10.	Clay shale	70	0	..	..	220	6
11.	Black shale	60	0	173	0	280	6
12.	COAL VII?	0	6	..	6	281	0
13.	Shale	30	0	..	..	311	0
14.	Lime shale	8	0	..	..	319	0
15.	Fire-clay	20	0	..	..	339	0
16.	Shale	50	0	..	..	389	0
17.	Hard shale	3	0	..	..	392	0
18.	Shale	10	0	121	0	402	0
19.	COAL V?	6	0	6	0	408	0
20.	Fire-clay	20	0	..	..	428	0
21.	Sandy shale	40	0	..	..	468	0
22.	Shale	40	0	100	0	508	0
23.	COAL	6	0	6	0	514	0
24.	Sandy shale	35	0	..	..	549	0

1854. SECTION 870. SECTION OF WELL No. 2.—Figs. 3 and 7.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and clay	20	0	..	..	20	0
2.	Quicksand	20	0	..	..	40	0
3.	Blue mud	25	0	..	..	65	0
4.	Yellow gravel and mud	12	0	..	..	77	0
5.	Shale	3	0	..	..	80	0
6.	COAL VIII?	1	6	1	6	81	6
7.	Fire-clay	18	0	..	..	99	6
8.	Limestone	12	0	..	..	111	6
9.	Soft limestone	29	0	..	..	140	6
10.	Sandy shale	4? or 45?	0	..	..	185	6

		Ft.	In.	Ft.	In.	Ft.	In.
11.	Fire-clay	6	0	..	..	245	6
12.	"White stone"	17	0	..	..	262	6
13.	Shale	20	0	201	0	282	6
14.	COAL VII?	3	0	3	0	285	6
15.	Fire-clay	8	0	..	..	293	6
16.	Shale	22	0	..	..	315	6
17.	Limestone	28	0	..	..	343	6
18.	Shale	78	0	..	..	421	6
19.	COAL V?	7	0	7	0	428	6
20.	Fire-clay	15	0	..	..	443	6
21.	Shale	27	0	..	..	470	6
22.	COAL	7	0	7	0	477	6
23.	Fire-clay	32	0	..	..	509	6
24.	Shale	48	0	..	..	557	6
25.	Shale	35	0	..	..	592	6
26.	COAL	4	0	4	0	596	6
27.	Fire-clay	16	0	..	..	612	6
28.	Shale	15	0	..	..	627	6
29.	COAL	3	6	3	6	631	0
30.	Sandy shale	14	0	..	..	645	0
31.	Shale	25	0	..	..	670	0
32.	COAL	4	0	4	0	674	0
33.	"Shell or gas stone"	1	0	..	..	675	0
34.	Shale and sandstone	10	0	..	..	685	0
35.	Fire-clay	17	0	..	..	702	0

1855. SECTION 871. SECTION OF WELL No. 3.—On Tompkins's land, Princeton, Figs. 2 and 6.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and clay	20	0	..	..	20	0
2.	Quicksand	2	0	..	..	22	0
3.	Clay and gravel	36	0	..	..	58	0
4.	Shale	24	0	..	..	82	0
5.	COAL VIII?	1	0	1	0	83	0
6.	Fire-clay	10	0	..	..	93	0
7.	Limestone, soft	24	0	..	..	113	0
8.	Shale	92	0	..	..	205	0
9.	Sandstone	12	0	..	..	217	0
10.	Shale	40	0	..	..	257	0
11.	Sandstone	8	0	..	..	265	0
12.	Shale	16	0	..	..	281	0
13.	COAL VII?	2	0	2	0	283	0
14.	Fire-clay	9	0	..	..	292	0
15.	Shale	30	0	..	..	322	0
16.	Sandy shale	10	0	..	..	332	0
17.	Limestone	15	0	..	..	347	0
18.	Shale	44	0	..	..	391	0
19.	"Lime shell"	4	0	..	..	395	0
20.	Shale	1	6	..	..	396	6

		Ft.	In.	Ft.	In.	Ft.	In.
21.	COAL V?	6	0	6	0	402	6
22.	Shale	10	0	..	..	412	6
23.	Fire-clay	20	0	..	..	432	6
24.	Shale	29	0	59	0	461	6
25.	COAL	5	0	5	0	466	6
26.	Shale	15	0	..	..	481	6
27.	White sandstone	15	0	..	..	496	6
28.	Shale	35	0	..	..	531	6
29.	Shale	30	0	..	..	561	6
30.	Shale	20	0	..	..	581	6
31.	Shale	23	0	138	0	604	6
32.	COAL	6	0	6	0	610	6
33.	Shale	10	0	..	..	620	6
34.	Sandstone	6	0	..	..	626	6
35.	Shale	10	0	..	..	636	6
36.	Sandy shale	10	0	..	..	646	6
37.	Sandstone and coal parting	5	0	..	..	651	6
38.	Sandstone	2	0	..	..	653	6
39.	Blue shale	10	0	..	..	663	6
40.	Sandy shale	20	0	..	..	683	6
41.	Sandy shale	10	0	..	..	693	6
42.	Soft sandstone, salt water	15	0	..	..	708	6
43.	Shale	15	0	113	0	723	6
44.	COAL	6	0	6	0	729	6
45.	Fire-clay	10	0	..	..	739	6
46.	Gray limestone	14	0	..	..	753	6
47.	Sandy shale	30	0	..	..	783	6

The result of this drilling finally led, in 1895, to the sinking of a shaft west of town by the Maule Coal Company, the coal being reached at 430 ft. In the mine the coal is found to run from 6 ft. to 7 ft. 7 in., with an average of 6 ft. 6 in. The coal contains no regular sulphur or clay bands, though in places sulphur is abundant. At first 4 to 6 in. of the bottom of the coal was left, but as it gave trouble by heaving, the whole thickness of the coal is now mined. It is a hard, bright coal, with a good deal of sulphur in thin bands, which tend to yield considerable slack. The following analyses have been made of the coal:

Analysis of Coal from Boring, by Mr. G. M. Levette.

Fixed carbon	59.70	
Volatile combustible matter	23.90	
Total combustible matter		83.60
Coke slightly swollen, bright.		
Ash, light gray	7.80	
Moisture	8.60	
Total waste		16.40

Analysis of Coal from Mine, by Regis Chanvenet & Bro., St. Louis.

Fixed carbon	51.18	
Volatile combustible matter	22.71	
Total combustible matter		83.89
Ash, gray	11.02	
Moisture	5.09	
Total waste		16.11
Sulphur, separately determined		1.38
Per cent. of coke		62.20

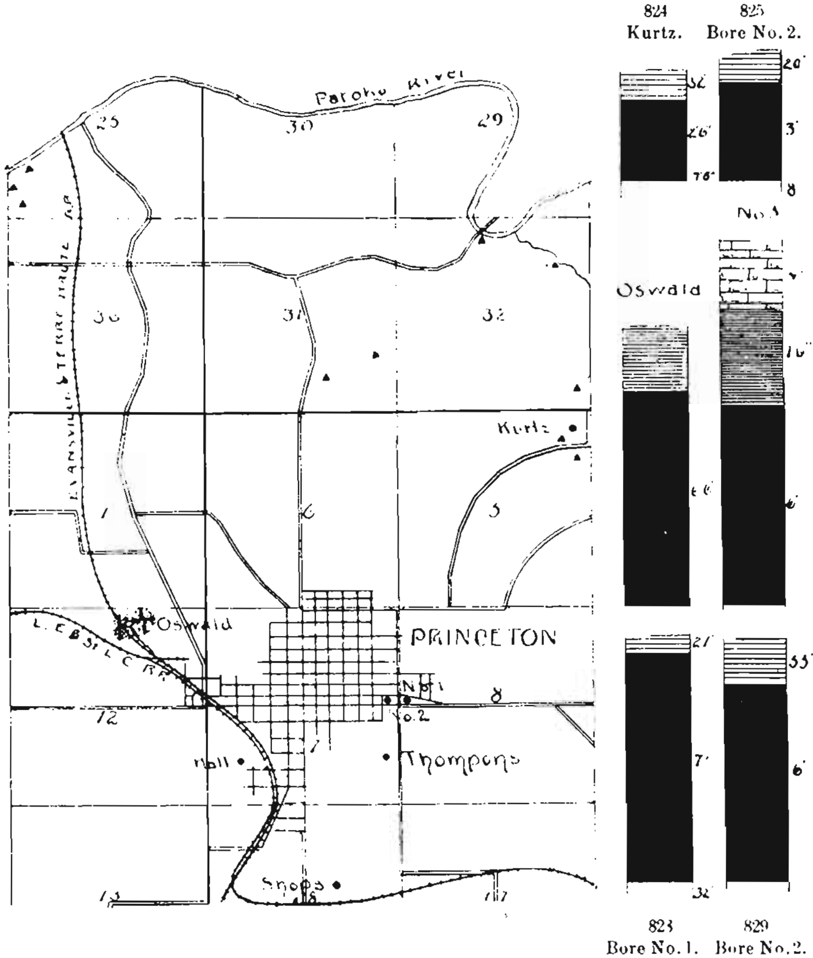


Fig. 823. Sketch map of area about Princeton.
Figs 824-825. Sections of Coal VII (?), same area.
Figs. 826-829. Sections of Coal V (?), same area.

Analysis of Commercial Coal, Sampled by Mr. Epperson and Analyzed by W. A. Noyes.

Fixed carbon	45.30	
Volatile combustible matter	37.72	
Total combustible matter		83.02
Ash	9.10	
Moisture	7.88	
Sulphur	2.71	
Total waste		19.69

An analysis of coke made from selected coal from this mine gave as follows:

Fixed carbon	88.14	
Volatile combustible matter	.20	
Total combustible matter		88.34
Ash	11.52	
Moisture	.14	
Sulphur	1.89	
Total waste		13.55

The coke is bright, silvery and fine-celled. These analyses indicate a good quality of coal, which, taken in connection with its thickness and the extent of the field, as far as revealed by drillings, indicates a very valuable deposit of coal. The roof as shown by the drillings is a shale or "slate," in many cases thin and overlain by limestone. In other cases the limestone is not reported and the shale is of considerable thickness. In the mine the roof shows about 4 in. of draw slate in places, with none in other places. The roof is stronger in cold than in warm weather. A few "inverted pot" like rolls occur in the roof. The floor is dark gray shale or fire-clay, very hard and difficult to pick. From some of the boulders in the roof a black oil exudes, accompanied by gas. Some serious trouble has been experienced with gas in mining this bed in the past, but largely disappears with better methods of ventilation.

The full extent of this bed is somewhat conjectural. We have correlated it with Coal V. If that is correct, it would seem reasonable to assume that it is only the western extension of that bed which is a thick workable bed all along the eastern edge of the county. At first we were disposed to think this bed too deep for Coal V, but more careful study of the data tends to confirm the opinion that it is Coal V.

In the first place, the drillings give evidence of a rather rapid dip to the west; next, the exposures along White river indicate a rapid westerly dip; then the dip across Knox county to the north of this is high to the west; and again, taking elevations above sea level, the coal here is just about at the mean level between Coal V at Evansville and at Vincennes; finally, the roof and coal have a good deal of resemblance to Coal V. Furthermore, the coal at 277 ft. agrees very well with Coal VII. The shale overlying it, of blue color, is very similar to that over Coal VII at Vincennes. This bed is 3 ft. 7 in. thick in the shaft, overlain by 22 ft. of blue clay shale, and that by 18 ft. of gray sandy shale. If this correlation is correct, we are inclined to expect that the coal being worked underlies no small share of the county, though it is hardly probable that it maintains that thickness over any considerable area, and it may be unworkable in many areas.

As to the coals below the worked coal, we are inclined to await further developments before passing judgment. They show such an unusual amount of coal in thick beds, as compared with examinations at Washington, Vincennes, Evansville and other surrounding points, that were it not that the correctness of the thickness of the first bed had been amply demonstrated, we should have been inclined to doubt the correctness of the records. The first part having been found correct, it argues for the correctness of it all. However, an examination of the sections as drawn (Plate LXV) indicates that these lower coals in one drilling do not correspond with those of another, and suggests that while coals may occur at these levels, the thicknesses are probably greatly exaggerated.

1856. PART OF THE COUNTY IN RANGES 10 TO 14 WEST.—This includes the major part of the county, but of its commercial coal resources little is known except as drawn by inference from what has been found at Princeton. As stated above, no workable coals outcrop in this area, and except at Princeton and a few other points, only coals of Division VIII have been found. The following columnar sections and accompanying notes sum up the known data:

1857. SECTION 872. "BIG TREE" SECTION.—In northeastern corner of county. (J. C., p. 396.) Section begins 235 ft. above White river.

	Ft.	In.	Ft.	In.
1. River sand	20	0	20	0
2. Fluviated drift	8	0	28	0
3. Soft white and yellow sandstone	30	0	58	0
4. Soft laminated sandstone	22	0	80	0
5. Quarry sandstone, "Merom rock"	18	0	98	0
6. Calcareous shale and limestone, 10 in. to	3	0	101	0
7. Black bituminous clod	1	4	102	1
8. COAL VIIIb?.............8 in. to	0	2	102	6
9. Fire-clay	2	6	105	0
10. Clay shales.................6 ft. to	15	0	120	0
11. Limestone, crinoidal.........2 ft. to	4	0	124	0
12. Clay shale	5	0	129	0
13. Black shale...............3 ft. to	1	0	130	0
14. COAL VIIIa? in bank (reported)	2	0	132	0

In the geology of Pike county, Mr. Collett says: "This section is interesting from the fact that the coarse loose sandstone near the top may be traced almost continuously to the 'Wabash' (White) river in the vicinity of Hazelton. This shows the abruptness of the local dip in that direction and the great depth at which the lower coals must be there sought."

The lower of the two coals of the above section is said to outcrop in the bed of White river just below Hazelton, where a little coal has been dug from it. This would seem to place it about at the level of the coal at 81 ft. at Princeton. At Princeton it was about 200 ft. below it to Coal VII and 360 ft. below to Coal V. A boring near Hazelton is reported to have shown a workable coal about 240 ft. below the coal in the river bed, with a thickness of 3 ft. 6 in. to 4 ft. Its exact correlation is in question. If it is Coal VII, or corresponds to the coal at 280 ft. at Princeton, as seems most probable, then still thicker coal should be looked for lower down. The sections of the boring and of the outcropping strata which overlay it follow:

1858. SECTION 873. HAZELTON SECTION.—Don. 101. (J. C., p. 394.)

	Ft.	In.	Ft.	In.
1. Soil and slope	..	..	..	..
2. Shaly sandstone and flagstones	10	0	10	0
3. Yellow sandstone	20	0	30	0
4. COAL VIIIb	0	11	30	11
5. Fire-clay	2	2	33	1
6. Shaly limestone	9	0	42	1
7. COAL VIIIa	0	11	43	0
8. Flaggy sandstone, to bore	22	0	65	0

The bore mentioned begins at the bottom of the preceding section and is as follows:

1859. SECTION 874. HAZELTON BORE.—Thorn place, Don. 101. (J. C., p. 394.)

	Ft.	In.	Ft.	In.
1. Soil	4	0	4	0
2. Sandstone	40	0	44	0
3. COAL VIII?	1	0	45	0
4. Space, sandstone	60	0	105	0
5. COAL	1	0	106	0
6. Space, shaly sandstone	115	0	221	0
7. COAL VII? or V? ....3 ft. 6 in.	4	0	225	0
8. Sandstone	55	0	280	0

The following bore is reported to have been put down on the high land east of Hazelton:

1860. SECTION 875. EAST HAZELTON BORE.—(J. C., p. 395.)

	Ft.	In.	Ft.	In.
1. Drift and clay	25	0	25	0
2. Hard sandstone (limestone?)	4	0	29	0
3. Bituminous shale	6	0	35	0
4. Sandy shale	25	0	60	0
5. Soft clay shale	10	0	70	0
6. Sandstone	40	0	110	0
7. Bituminous shale	6	0	116	0
8. COAL VIIIb?	0	6	116	6
9. Fire-clay	6	0	122	6
10. Sandstone	14	0	136	6
11. Clay shale	20	0	156	6
12. Bituminous and sandy shale	15	0	171	6
13. COAL VIII?	1	6	173	0
14. Fire-clay and strong water vein, which caused the well to cave	4	0	177	0
15. Clay shale	20	0	197	0
16. Sandstone	70	0	267	0
17. Clay shale	40	0	307	0

1861. SECTION 876. SECTION AT PATOKA.—In outcrop below the mill. (J. C., p. 414.)

	Ft.	In.	Ft.	In.
1. Loess, ash gray	15	0	15	0
2. Loess, reddish	5	0	20	0
3. Covered Merom sandstone....5 ft. to	10	0	30	0
4. Shaly COAL VIIIb..........5 in. to	1	2	31	2
5. Gray shale and flaggy sandstone	40	0	71	2
6. Bituminous limestone or clod. 2 in. to	0	8	71	10
7. Shale with fossils	2	0	73	10
8. Black shale..................2 ft. to	4	0	77	10
9. Blue shale..................3 ft. to	4	6	82	4
10. COAL VIIIa	0	7	82	11
11. Fire-clay	3	0	85	11

	Ft.	In.	Ft.	In.
12. Hard sandy limestone, changing to buff sandy shale..........2 ft. to	4	0	89	11
13. Fire-clay, place of COAL VIII?	2	6	92	5
14. Clay shale with iron nodules	5	0	97	5
15. Laminated sandstone to river	1	0	98	5

On the C. Myers place, adjoining Bald Hill, a lofty knob in Sec. 31, 1 S., 10 W., rising 130 ft. above the level of Princeton, is the following section:

1862. SECTION 877. MYERS HILL SECTION.—Sec. 31, 1 S., 10 W. (J. C., p. 411.)

	Ft.	In.
1. Slope, covered	70	0
2. Merom sandstone	29	0
3. Black sheety shale	1	4
4. Pyritous clod	0	9
5. COAL (irregular)	0	7
6. Fire-clay..........5 ft. to	3	6

The following section commences at the top of the hill at Townsend's quarry:

1863. SECTION 878. TOWNSEND'S QUARRY SECTION.—Sec. 28, 1 S., 10 W. (J. C., p. 411.)

	Ft.	In.	Ft.	In.
1. Soil..........10 ft. to	14	0	14	0
2. Heavy sandstone	5	0	19	0
3. COAL and shale	0	8	19	8
4. Fire-clay	1	2	20	10
5. Heavy bedded and flaggy sandstone	30	0	50	10
6. Shaly sandstone	10	0	60	10
7. Gray shale	31	0	91	10
8. Nodular iron ore..........2 in. to	0	6	92	4
9. Bituminous limestone	1	0	93	4
10. Calcareous shale, sandy	1	4	94	8
11. Black sheety shale..........3 in. to	0	6	95	2
12. COAL	0	6	95	8
13. Fire-clay to Patoka	9	0	104	8

In Secs. 4 and 5, 2 S., 10 W., this section is continued as follows:

1864. SECTION 879. SECTION NORTHEAST OF TAFFTOWN.—Secs. 4 and 5, 2 S., 10 W. (J. C., p. 412.)

	Ft.	In.	Ft.	In.
1. Bituminous limestone	1	6	1	6
2. Calcaro-argilite with some fossils	1	2	2	8
3. Black sheety shale	3	0	5	8

		Ft.	In.	Ft.	In.
4.	Pyritous clod	0	10	6	6
5.	COAL	1	0	7	6
6.	Fire-clay	4	0	11	6
7.	Fire-clay with ironstone nodules	6	0	17	6
8.	Gray shale	5	0	22	6
9.	Hard sandy limestone ....3 ft. to	8	0	30	6
10.	Fire-clay, place of COAL	5	0	35	6
11.	Gray shale	10	0	45	6

This coal has been worked a little, affording a bright, lustrous coking coal, with much pyrite.

In the S. E of N. W. of Sec. 24-2-10, Mr. W. A. Smith struck 3 ft. 7 in. of coal (Coal VII) at 65 ft. In Sec. 9 the following section is exposed (Sect. 880, E. M. K.):

		Ft.	In.
1.	Blue shale	7	6
2.	Soft black shale	..	10
3.	Dark sheety shale	..	7
4.	COAL	..	9
5.	Blue fire-clay	1	3

In the S. W. ¼ of Sec. 8, 1 ft. of coal was struck in a well at 55 ft., on the N. Gerauld place. On the E. E. Wilkinson place, in S. W. ¼ of Sec. 9, a well is reported to have struck 8 in. of coal at 18 ft. and 3 ft. 9 in. of coal at 205 ft. (Coal VII).

On the W. Stormout place, in the S. E. ½ of the N. E. ¼ of Sec. 17, a well struck 2 ft. 1 in. of black shale and coal at 66 ft.

A bore by Mr. Kurtz, in the S. E. of N. E. of Sec. 5-2-10, gave as follows:

1865. SECTION 881. SECTION OF KURTZ BORE.—Sec. 5-2-10. (J. C., p. 409.)

		Ft.	In.	Ft.	In.
1.	Sandy shale and clay shale	30	0	30	0
2.	Sandstone and shales	20	0	50	0
3.	COAL .... trace	..	..	..	..
4.	Sandy shales	40	0	90	0
5.	COAL—Coal, laminated, 1 ft. 0 in.; clay parting, 1 ft 6 in.; cubic coal, 2 ft. 0 in.; rotten coal, 6 in.	4	6	94	6
6.	Fire-clay	2	6	97	0

About 900 ft. northeast of the deep bore made by Mr. Kurtz at Princeton 1 ft. 6 in. of coal was struck in a well on the S. S. Shannon place at a depth of 76 ft.

No rocks outcrop from Princeton South to Haubstadt. At Fort Branch two deep wells have been drilled. The first was drilled for coal by Mr. Peter Hoffmann.

1866. SECTION 882. SECTION OF WELL DRILLED BY PETER HOFFMANN.—At Fort Branch (E. M. K.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil	2	0	..	..	2	0
2.	Red and blue clay	20	0	..	..	22	0
3.	Sand	2	0	..	..	24	0
4.	Blue clay	18	0	..	..	42	0
5.	Clay shale	12	0	..	..	54	0
6.	Shale	1	6	..	..	55	6
7.	COAL	1	0	1	0	56	6
8.	Fire-clay	4	6	..	..	61	0
9.	Sandstone	3	0	..	..	64	0
10.	Gray sandstone	2	3	..	..	66	3
11.	Clay shale	9	9	..	..	76	0
12.	Sandstone	1	6	..	..	77	6
13.	Limestone	7	11	..	..	85	5
14.	Clay shale and fire-clay	18	3	..	..	103	8
15.	Limestone	8	0	..	..	111	8
16.	Clay shale	7	0	..	..	118	8
17.	Black "smut" and clay	4	0	..	..	122	8
18.	Limestone	0	4	66	6	123	0
19.	Fire-clay	3	0	..	..	126	0
20.	Clay shale	4	0	..	..	130	0
21.	Sandstone	25	0	..	..	155	0
22.	Gray clay shale	23	0	55	0	178	0
23.	Fire-clay and COAL	5	0	5	0	183	0
24.	Sandstone	13	0	..	..	196	0
25.	Gray shale	20	0	..	..	216	0
26.	Limestone	6	6	..	..	222	6
27.	Shale with coal	28	9	67	9	250	3
28.	COAL VII?	3	6	3	6	253	9

1867. SECTION 883. SECTION OF WELL AT GROVE MILL, FORT BRANCH.—By John M. Spear; drilled in 1887 for water. (E. M. K.)

		Ft.	In.
1.	Depth of dug well	18	0
2.	Sand	35	0
3.	Sandstone	24	7
4.	Clay shale	10	3
5.	Impure limestone	4	6½
6.	Sandstone	73	0
7.	Shale	28	0
8.	Sandstone; (9) shale; (10) shale, "slate," 3 in.	95	0
11.	COAL VIII, at 300 ft. 8 in.	5	4
12.	Space	..	..
13.	COAL V reported at 408 ft.	7	0

At Haubstadt a well at the flouring mill went 75 ft. without striking coal.

A well 3 mi. west of Haubstadt, in Sec. 3-3-11, is reported to have struck coal as follows:

2 ft. of coal at 60 ft.
4 ft. of coal at 80 ft. to 100 ft.

The lower bed is said to have had a sandstone roof. A half mile north a well is said to have gone 186 ft. without striking coal.

The following sections are reported by Mr. Collett from range 12 west:

1868. SECTION 884. SECTION OF DRILLING AT OWENSVILLE.—By Jas. Montgomery (J. C., p. 405).

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface, clay	8	0	..	..	8	0
2. Sandstone	2	0	..	..	10	0
3. COAL	0	2	0	2	10	2
4. Clay parting	0	10	..	..	11	0
5. Black shale	2	6	..	..	13	6
6. Gray shale	8	6	..	..	22	0
7. Gray limestone	3	0	..	..	25	0
8. Clay shale	3	0	..	..	28	0
9. White limestone	47	0	..	..	75	0
10. Gray shale	29	6	..	..	104	6
11. Black shale	0	6	95	0	105	0
12. Soft rotten coal	2	10	2	10	107	10
13. Shaly fire-clay	4	0	..	..	111	10
14. Gray limestone	30	0	..	..	141	10
15. Gray shale	21	0	..	..	162	10
16. Fire-clay	20	0	..	..	182	10
17. Gray limestone	3	0	78	10	185	10
18. COAL	0	6	0	6	186	4
19. Colored clay	2	0	..	..	188	4
20. Hard flinty limestone, with partings	10	0	..	..	198	4
21. Soft red sandstone	4	0	..	..	202	4
22. Black shale	4	0	..	..	206	4
23. Fire-clay and gray shale	10	10	..	..	217	2

1869. SECTION 885. SECTION AT DRIPPING SPRING.—On W. A. Walter's land, N. E. ¼, Sec. 33-2-12 (J. C., p. 406).

	Ft.	In.
1. Covered Merom sandstone?	60	0
2. Sandy shale	11	0
3. Fire-clay	4	0
4. Shaly limestone containing crinoid stems	3	0
5. Calcareous clod	2	0
6. Shales covered to bottom	30	0

1870. SECTION 886. SECTION AT SYLVESTER BENSON'S.—S. E. ¼, Sec. 26-2-12.

	Ft.	In.	Ft.	In.
1. Soil and sand in well	25	0	25	0
2. Sandstone in well	15	0	40	0
In outcrop.				
3. Sandstone	15	0	55	0
4. Irregular COAL	0	3	55	3
5. Clay	2	0	57	3
6. Clay shale	14	0	71	3
7. Bituminous limestone, highly shaly	3	0	74	3
8. Calcareous	1	3	75	6
9. Black bituminous shale, rash COAL?	1	6	77	0
10. Fire-clay	2	0	79	0

1871. SECTION 887. SKELTON'S CLIFF SECTION.—On L. Skelton's land, S. W. ¼, Sec. 35-2-12.

	Ft.	In.
1. Soft and fluviated sand	70	0
2. Soft yellow sandstone	10	0
3. Massive red and yellow sandstone	12	0
4. Brown ferruginous sandstone	8	0

1872. SECTION 888. SECTION OF A DRILLING AT MT. CARMEL, ILL.—By Mr. J. Zimmerman. The boring is said to have commenced 30 ft. below the base of the Merom sandstone. (J. C., p. 409.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Shelly sandstone	2	0	..	..	2	0
2. Sand rock	2	0	..	..	4	0
3. Clay shale	4	0	..	..	8	0
4. Sandstone	35	10	..	..	43	10
5. Hard shale	4	0	..	..	47	10
6. Clay shale	1	0	..	..	48	10
7. Black shale, COAL	0	7	0	7	49	5
8. Fire-clay	9	0	..	..	58	5
9. Sandstone	2	0	..	..	60	5
10. Blue shale	1	4	..	..	61	9
11. Fire-clay	3	10	..	..	65	7
12. Limestone	23	0	..	..	88	7
13. Sandstone	1	0	..	..	89	7
14. Limestone	28	0	..	..	117	7
15. Blue shale	5	6	..	..	123	1
16. Clay shale	13	0	..	..	136	1
17. Gray shale	4	0	92	11	140	1
18. COAL	0	7	0	7	140	8
19. Fire-clay	3	0	..	..	143	8
20. Limestone	13	8	..	..	157	4
21. Fire-clay	2	0	..	..	159	4
22. Cherty limestone with shale partings	10	0	..	..	169	4

The data given above are suggestive of considerable workable coal in central and western Gibson county, but it is also evident that it must be sought at greater depths than most of the earlier drillings went to. It would seem probable that from the E. & T. H. R. R. westward test drillings should go at least 500 ft., and possibly more. Coal VII, as we have correlated it, is of workable thickness at several points.

1873. Summary of Coals of Gibson County.—

Divisions contained: IX down.

Coals contained: VIIIb, VIIIa, VIII, VII, V and numerous coals below.

Round Number Estimates.

Coal VII.

Worked area......	2 acres	× av. thickness,	3 ft. ×	1,000 =	6,000 tons.
Workable area...	50 sq. mi. ×	"	3 ft. ×	500,000 =	75,000,000 tons.
Unworkable area	350 sq. mi. ×	"	2 ft. ×	1,000,000 =	700,000,000 tons.
Total area....	400 sq. mi.				775,006,000 tons.

Coal V.

Worked area......	10 acres	× av. thickness,	6 ft. ×	1,000	60,000 tons.
Workable area....	250 sq. mi. ×	"	1 ft. ×	500,000 =	500,000,000 tons.
Unworkable area	200 sq. mi. ×	"	2 ft. ×	1,000,000	400,000,000 tons.
Total area....	450 sq. mi.				900,060,000 tons.

Coals Below Coal V.

Workable area...	400 sq. mi. ×	av. thickness,	3 ft. ×	500,000 =	600,000,000 tons.
Unworkable area	400 sq. mi. ×	"	10 ft. ×	1,000,000 =	4,000,000,000 tons.
					4,600,000,000 tons.

Coals Above Coal VII.

Unworkable area	400 sq. mi. ×	av. thickness,	1 ft. ×	1,000,000 =	400,000,000 tons.

Number of coals contained: About 10+.
Greatest thickness recorded: 7 ft. 7 in., at Princeton.
Area underlain by coal: 450 sq. mi.+
Area underlain by workable coal: 400 sq. mi.+
Estimated total tonnage of coal: 6,675,000,000 tons.
Estimated total tonnage of coal removed: 66,000 tons.
Estimated total tonnage of workable coal left: 1,175,000,000 tons.
Number of mines working ten men or over in operation: 1.
Number of mines working less than ten men in operation: 5+.
Total number of mines in operation: 6.
Large mines not in work: 0.
Small mines not in work: 4+.
Strippings, outcrops, etc.: 38.
Total number of openings to coal: 48.

XXXV. PERRY COUNTY.

1874. References and Field Work.—

1857. Hamilton Smith, Indiana Agricultural Rep., pp. 512 to 544, "Coal Mining in Indiana." Eight figures or plates and much data of interest and value. (H. S.)

1862 (1859-60). Richard Owen, Rep. of Geol. Reconn., pp. 181-186. One coal analysis. (R. O.)

1862 (1859-60). Leo. Lesquereux, same, pp. 343-345. (L. L.)

1862 (1859-60). J. P. Lesley, same, pp. 343-345. One columnar section. (J. P. L.)

1872 (1871-72). E. T. Cox, 3d and 4th Ann. Rep. Geol. Surv. of Ind., pp. 61-143. Several coal measures and numerous analyses, map, extracts and figures from paper by Hamilton Smith. (E. T. C.)

1896 (1895). W. S. Blatchley, Dept. of Geol., etc., 20th Ann. Rep., pp. 123-127. Two columnar sections. (W. S. B.)

1896 (1895). T. C. Hopkins, same, pp. 314, 315. (T. C. H.)

1898. E. M. Kindle, field work for this report. Mr. Kindle's generalizations of the geology of the county were of great help in the preparation of this report, and, being incorporated in fragmentary form, comprise about one-half of the report, for which he should be given credit.

1875. Location.—Perry county lies a little west of a meridian of the State, on its southern border. It lies south of Dubois and Crawford counties, west of Crawford county, northwest and north and northeast of Kentucky, from which it is separated by the Ohio river, east of Spencer county.

1876. Extent.—It has an extreme length from north to south of about 28 mi., and width from east to west of about 25 mi., with an area of about 380 sq. mi. It includes all of T. 4 S., R. 1 W.; Ts. 4, 5 and 6 S., R. 2 W.; T. 4 S., R. 3 W.; the major part of T. 5 S., R. 1 W.; Ts. 3 and 7 S., R. 2 W.; Ts. 5 and 6 S., R. 3 W., and parts of T. 5 S., R. 1 E.; Ts. 6 and 7 S., R. 1 W.; Ts. 3 and 7 W., R. 3 W.; Ts. 4 and 6 S., R. 4 W.

1877. Topography.—As a rule the surface of this county is very broken, the hills rising from 250 to 400 ft. above the main valleys, and often showing bluffs of sandstone or limestone. Some flat country occurs along the Ohio and the larger streams in the form of bottoms.

1878. DRAINAGE.—All the drainage is to the Ohio, which bounds the county for about 50 mi. Anderson river or creek bounds much of the western side of the county, its main tributaries being Hurricane fork from the north, Middle fork from the northeast, and Brushy fork from the east.

Going eastward around the county, we observe Windy creek, Deer and Little creeks, then flowing somewhat easterly Poison and Little Poison creeks and Oil creek. Little Blue river just touches the northeastern corner.

1879. STRATIGRAPHY.—The rocks outcropping in this county belong in Divisions I, II and III, and the limestones, etc., of the Lower Carboniferous. Division III occupies but a very limited area near Troy. As the stratigraphy is rather irregular and is quite fully discussed under the first two townships taken up, the reader is referred to those sections of the report. Suffice it to say that the county contains but one workable coal, Coal II, and that that lies in basins of usually limited extent, and that it is only in a small part of the area that the coal, even in these basins, is workable.

1880. CULTURE AND TRANSPORTATION.—This county was fortunate in being chosen at a very early day as the site of a colony of very energetic, industrious and thrifty people, so that for a long time it has ranked as one of the important manufacturing counties. The Ohio river affords transportation of an exceptional character. The Cannelton branch of the L., E. & St. L. C. R. R. is the only railroad transportation yet in the county.

TOWNSHIPS 7 S., R. 3 W., AND 7 S., R. 2 W.

1881. NOTE.—In order to get a clearer idea of the geology of this county, the plan is adopted of starting in the southwestern corner, where the stratigraphy is seen to the best advantage, and working to the northeast.

1882. POSITION.—These two townships include the southernmost land in the county, embracing parts of the civil townships of Tobin and Troy. The greater portion of township 7 S., 2 W., lies in what is known as the "pocket," a big bend which the Ohio makes to the south.

1883. TOPOGRAPHY.—The surface is quite rugged and hilly, the hills rising from 250 to 320 ft. above high water. Bold cliffs of sand-

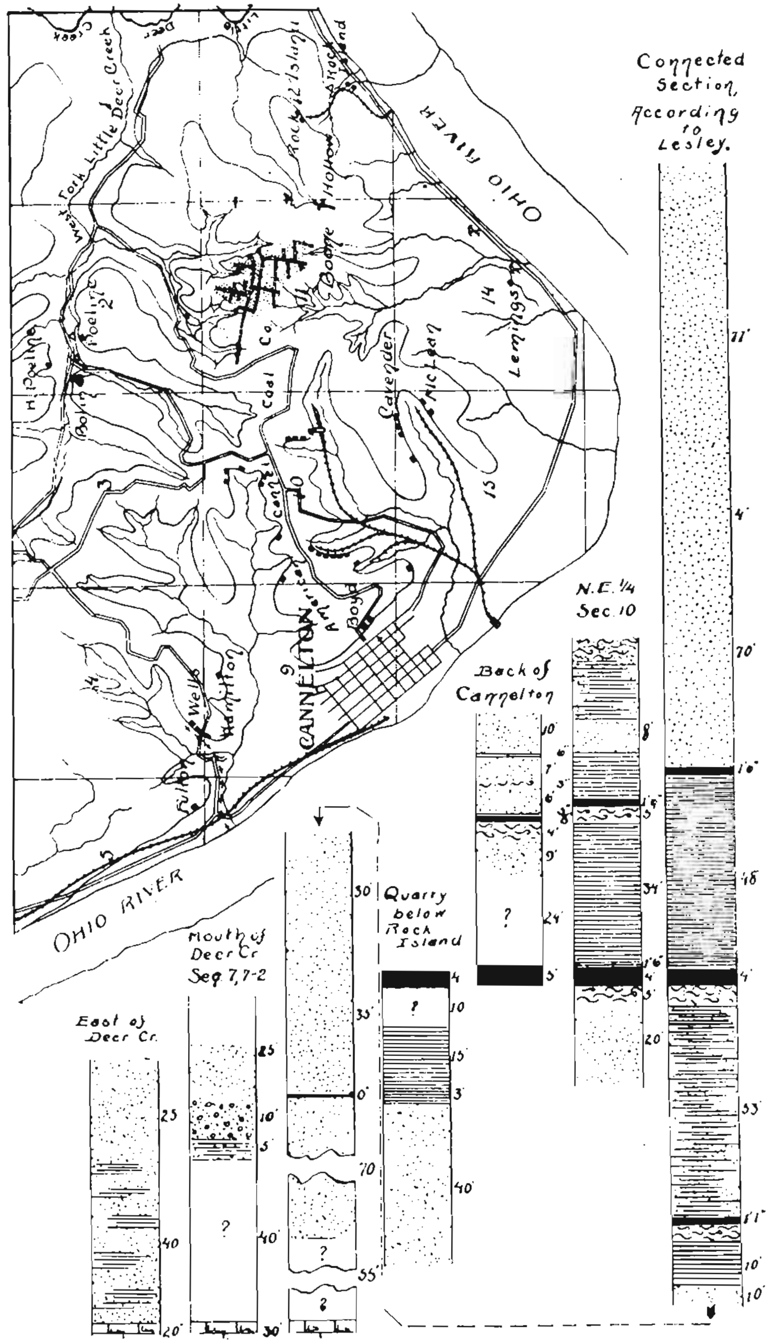


PLATE LXVI. Sketch map and columnar sections, T. 7 S., R. 3 W.

stone face the river in many places. In some of the valleys joining the Ohio the cliffs have broken up into "rock houses," adding much to their picturesqueness.

1884. Drainage.—Big and Little Deer creeks, together with a number of small streams, carry the rainfall of this district directly to the Ohio. The winding course of the Ohio keeps it within the confines of these townships for nearly 22 mi.

1885. Transportation.—Besides the cheap and convenient means of transportation afforded by the river, the Cannelton branch of the Air Line gives railway connection with the main line. The Texas railroad (L. & St. L.) skirts the river bank on the Kentucky side of the river, affording direct communication by rail with Louisville.

1886. Stratigraphy.—The rocks occurring in this part of the county include the Kaskaskia and Divisions I and II of the coal measures.

The following sections will show the stratigraphy of the coal measure rocks of the area:

1887. Section 889. General Section by J. P. Lesley.—Plate LXVI. (J. P. L., p. 343.)

		Ft.	In.	Ft.	In.
1.	Thin bedded sandstone, shaly toward upper part	77	0	77	0
2.	Band of highly ferruginous sandstone	4	0	81	0
3.	The so-called "top rock," being a thick bedded, homogeneous, fine-grained, cream-colored sandstone, extensively quarried for building purposes; it is easily worked, but hardens by exposure	70	0	151	0
4.	COAL IIa, "top coal vein"	1	6	152	6
5.	Gray shales, containing thin bands of nodular iron ore	48	0	200	6
6.	COAL II, "Main Cannelton coal vein"	4	0	204	6
7.	Fire-clay	5	0	209	6
8.	Shales and schistose sandstone, containing a heavy band of kidney iron ore 35 ft. below the main coal vein	53	0	262	6
9.	COAL Ia, "Lower Cannelton coal vein"	1	1	263	7
10.	Fire-clay	4	0	267	7
11.	Shales	10	0	277	7
12.	The so-called "bottom rock;" thick-bedded sandstone, sometimes quarried for building and tombstones	40	0	317	7
13.	Thin-bedded sandstone	35	0	352	7
14.	COAL I, "coal streak"	..	..	..	..
15.	Massive sandstone and conglomerate	70	0	422	7
16.	Covered space, probably sandstone	55	0	477	7
17.	"Top of the sub-carboniferous limestone at the mouth of Deer creek"	..	..	..	..

1888. Section 890. Section on S. E. ¼ of N. E. ¼ of Sec. 10-7-3. Plate LXVI. (W. S. B., p. 126.)

		Ft.	In.	Ft.	In.
1.	Soil and yellow clay	6	0	6	0
2.	Gray sandy shale	14	0	20	0
3.	Sandstone	8	0	28	0
4.	Blue sandy shale	11	0	39	0
5.	COAL IIa ....1 ft. to	1	6	40	6
6.	Potter's clay ....4 ft. to	6	0	46	6
7.	Blue clay shale	34	0	80	6
8.	Black bituminous shale	1	6	82	0
9.	COAL II	4	0	86	0
10.	Fire-clay	5	0	91	0
11.	Sandstone	20	0	111	0

1889. Section 891. Section (Connected) of Hill Back of Cannelton.—Upper part to Coal IIa taken from just southwest of the cemetery, the rest from section back of the church. Plate LXVI. (E. M. K.)

		Ft.	In.	Ft.	In.
1.	Sandstone with shaly partings	10	0	10	0
2.	Gray sandy shale ....1 in. to	..	6	10	6
3.	Massive sandstone	7	0	17	6
4.	Shelly iron ore ....3 in. to	..	1	17	7
5.	Sandstone	6	0	23	7
6.	Gray shale	..	5	24	0
7.	COAL IIa	..	8	24	8
8.	Sandy shale and fire-clay	4	0	28	8
9.	Sandstone	9	0	57	8
10.	Covered	24	0	61	8
11.	COAL II	5	0	66	8

1890. Section 892. Section at Sandstone Quarries Below Rock Island.—Plate LXVI. (E. M. K.)

		Ft.	In.
1.	Slope, covered	40	0
2.	COAL II	4	0
3.	Covered	10	0
4.	Gray sandy shale	15	0
5.	Blue shale	3	0
6.	Massive buff sandstone	40	0

The following section occurs in the S. W. ¼ of Sec. 8, 7 S., 2 W., near the river bank:

1891. SECTION 893. SECTION IN SEC. 8, 7 S., 2 W.—Plate LXVI. (E. M. K.)

		Ft.
1.	Massive shaly sandstone	25
2.	Massive conglomerate, with alternate cross and horizontal bedding, containing many quartz pebbles the size of hazelnuts	10
3.	Gray sandy shale	5+
4.	Covered	40
5.	Kaskaskia limestone and shale	30
6.	Covered to low water	35

1892. SECTION 894. SECTION IN SEC. 5-7-2.—Just east of bridge. Plate LXVI. (E. M. K.)

		Ft.
1.	Massive sandstone	25
2.	Sandstone and sandy shale	40
3.	Kaskaskia limestone and blue shale	20
4.	Covered to creek level	18

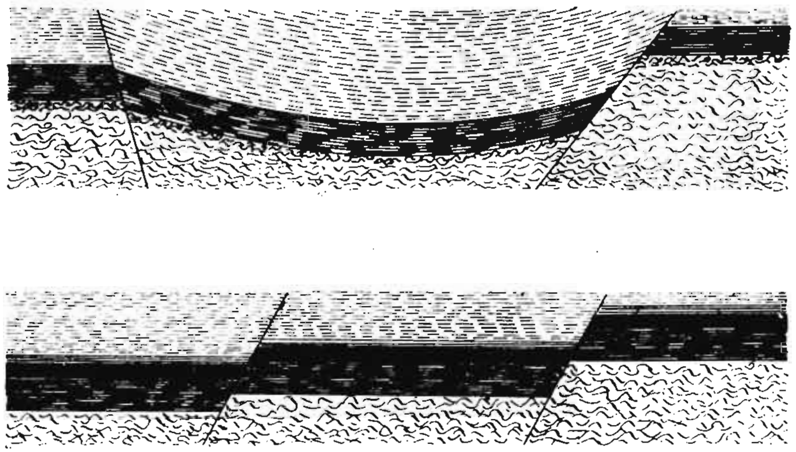
1893. DISTRIBUTION AND RELATION OF THE KASKASKIA TO COAL MEASURES.—This is described by Mr. Kindle as follows:

East of Deer creek the Kaskaskia comprises as much as two-thirds of the hills on the west side of T. 7 S., R. 2 W., while toward Rome it reaches the summits of the hills.

West of Deer creek, owing to dip and to unconformity of the superior beds with the Kaskaskia, its upper limit shows considerable variation in elevation above drainage. In following the Kaskaskia down the river, the last outcrop seen occurs a quarter of a mile above Rock island, in the bed of the branch near the base of the old incline to the Rock island mines. The limestone here is not more than 15 or 20 ft. above high water. Only a few square feet of the limestone are exposed, but the exposure shows the shale of Division I resting on the worn and sloping surface of the limestone. At the river, less than a quarter of a mile below this outcrop, the Mansfield sandstone is well exposed in Rock island and reaches below low water level. The difference in level of the partings of the two formations between the limestone outcrop and the river bank is therefore not less than 35 or 40 ft. The coal at the old Rock island mines lies 147 ft. above high water, according to Mr. Minto, which gives Coal II an elevation of about 125 ft. above the Kaskaskia at this point. About a mile northwest, at the A. C. C. Company's mines, the coal has about the same absolute elevation, but its position with reference to the limestone has changed so that the outcrops of the latter a few hundred yards below the mines are only about 35 ft. below the level of Coal II. This makes the difference in the level of the top of the Kaskaskia at these two points about 90 ft. Three-quarters of a mile north of the company's mines, in the N. W. ¼ of Sec. 2, Coal II, at Poeline's bank, is not more than 10 or 15 ft. above the level of the Kaskaskia, which outcrops in a 10 ft. ledge about 60 yds. east of the bank. The exposure here shows the sandstone resting unconformably on the limestone. (See Plate VIII, p. 93, in Part II.) This locality and Rock island are, with reference to each other, about in the general direction of the strike of the rocks of the region. At a rough estimate, the difference in level of the top of the Kaskaskia at the two points, which are less than two miles apart, is somewhat more than 100 ft. This surprising variation in the elevation of the coal above the limestone leads Mr. Lesley to suppose the existence of faults in the vicinity. The discovery of the unconformity mentioned above, however, together with the fact that the extensive beds of shale which generally characterize the upper part of the Kaskaskia in this part of the State are absent at the localities mentioned above, indicate that a considerable amount of erosion of the Kaskaskia occurred here previous to the deposition of the coal measures. Mr. Cox, in describing this county, rejected the fault theory, and ascribed the variations found to "the waves of the strata."

The writer is inclined to take an intermediate ground between the conclusions of Mr. Lesley and those of Mr. Kindle. That a non-conformity exists is beyond question, as evidenced by the figure referred to above, and by many of the facts given above, as for example, Coal II being but 10 to 15 ft. above Kaskaskia limestone at Poeline's mine, while at the stone quarries below Rock island 60 ft. or more of sandstone and shale are exposed below Coal II, and at many places in the county one or two beds are exposed below Coal II. If the assumption that the shales, sandstones and coals belong in the coal measures is correct, there seems little doubt of the Kaskaskia having suffered considerable pre-coal measure erosion. It may, however, be questioned if faulting has not much to do with the irregular distribution and placing of the rocks and coal beds. Evidence of such faulting is readily found. Small double faults are noticed in the tunnel of the A. C. C. Company's mine, as shown below. (Figs. 830, 831.)

In the bluff back of the church at Cannelton, Mr. Kindle noticed a fault with a downthrow of about 35 ft., and the same fault was encountered in mining the coal below. Mr. Cox mentions that there is a "difference of 65 ft. in the level of Coal F (II) at Frabue's mine and the mine a few yards from it in the east edge of Hawsville" (Ky.). Mr. Minto, of the A. C. C. Company, mentions what was supposed to be a 120 ft. north and south fault in their old Hancock mines 4 mi. southeast of Hawsville. At this point the coal came squarely against a face of Lower Carboniferous limestone, only 4 or 5 in. of "mud" separating the coal from the limestone. He also describes the case mentioned by Mr. Cox, which he says proved to be a fault of up to 60 ft. downthrow. The fault line ran north and south, and while at the north end the downthrow was to the west, at the south end the downthrow was to the east.



Figs. 830, 831. Small faults in American Cannel Coal Co.'s tunnel. (Sketches by Mr. E. M. Kindle.)

Turning to the stratigraphy of the coal measures, there will be noted first the preponderance of massive sandstone. The members of the present survey failed to find, either here or elsewhere, but a small part of the sandstone reported by Mr. Lesley. It would seem probable that he had made errors in correlating his strata from one part of the area to another. The attempt to determine what part of these sandstones corresponds with the Mansfield sandstone further north has met with only slight success. On the face of it the conglomeritic facies of the lowest sandstone seems to suggest exact correlation as far as that part of the sandstone is concerned. How far up should the line at the top of Division I be drawn? Extreme views would exclude all but the gritty sandstone at the bottom, or include all the sandstone in this region. As a compromise, we shall assume the main Cannelton coal

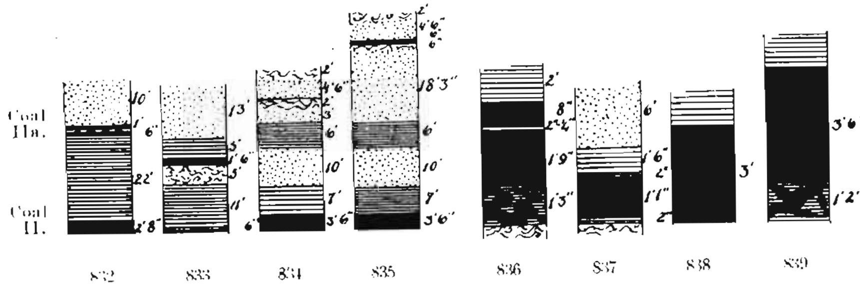
bed as coming above Division I, calling it Coal II, with the suggestion that it possibly correlated with coal mined at Huntington, Dubois county, and possibly with that mined at Sampson's hill, in Martin county.

1894. Division I.—Mr. Lesley noted two coal beds or coal horizons in this division, neither of the coals being workable, and the lower one showing nothing more than a streak. Separating these coal beds, and above and below them, he places three massive beds of sandstone, from 50 to over 70 ft. thick, with some shale. Mr. Kindle's sections and figures indicate that at least one of these sandstone horizons is superfluous. None of Mr. Kindle's sections show more than one massive sandstone in this division, but, on the other hand, none of his sections cover more than half of the estimated maximum thickness of the division, so that, judging from his sections, the massive sandstone around the mouth of Deer creek might be the same as the sandstone quarried below Rock island, or, what seems more probable, it is below the latter.

Concerning the conglomeritic facies of the Mansfield, Mr. Kindle says: "East of Deer creek the Mansfield outcrops in massive ledges, which are in many places full of small quartz pebbles.

"The Mansfield preserves its conglomerate character throughout the greater part of the high ridge running north and south through Secs. 10, 15, 22 and 27 of 7 S., 2 W., and in places the conglomerate is 25 ft. or more in thickness. Elsewhere in the county outside of this township the Mansfield contains no pebbles as far as observed."

No coal has been noted below this gritty sandstone. A coal is noted in places in T. 7 S., R. 2 W., above the top of the massive sandstone near the mouth of Deer creek, and supposed to come below the sandstone quarried below Rock island.



Figs. 832–834. Sections at Cannelton. Fig. 835. Section at Rock Island mine.
Figs. 836–839. Sections of Coal II. (836) Average around Cannelton. (839) Maxima around Cannelton. (837) At Bolin's, Sec. 2. (838) At Poeline's, Sec. 2.

1895. DIVISION II.—This division in this area contains two coal beds, the upper of which is not workable. In addition to the sections given above, the following sections may be given as showing more in detail the stratigraphy of this division in this interesting region (see Figs. 832 to 839):

1896. SECTION 895. SECTION No. XII.—At Cannelton, Fig. 832.

		Ft.	In.
1.	Sandstone	10	0
2.	COAL IIa	1	0
3.	Fire-clay	..	6
4.	Good shale	22	0
5.	COAL II	2	8
	(Coal 173 ft. above low water.)		
		36	2

1897. SECTION 896. SECTION No. XIII.—At Cannelton, Fig. 833.

		Ft.	In.
1.	Sandstone	13	0
2.	Shale	5	0
3.	COAL IIa	1	6
4.	Sandy clay	5	0
5.	Shale	11	0
6.	COAL II	..	6
7.	Fire-clay	1	0
	(Coal 176 ft. above low water.)		
		37	0

1898. SECTION 897. SECTION No. XVII.—At Cannelton, Fig. 834.

		Ft.	In.
1.	Clay	2	0
2.	Sandstone	4	6
3.	Shale	..	..
4.	COAL IIa	..	..
5.	Fire-clay	2	0
6.	Sandstone	3	0
7.	Black shale	6	0
8.	Sandstone	10	0
9.	Blue shale	7	0
10.	COAL II	3	6
	(Coal 176 ft. 4 in. above low water.)		
		38	0

1899. SECTION 898. SECTION No. XVI.—At Cannelton.

		Ft.	In.
1.	Shale	29	0
2.	COAL II	3	11
	(Coal 163 ft. 3 in. above low water.)		
		32	11

1900. SECTION 899. SECTION No. XX.—At Cannelton.

		Ft.	In.
1.	Clay	6	0
2.	Sandstone	3	0
3.	Shelly sandstone	6	0
4.	Shale	3	0
5.	COAL II	2	10
	(Coal 182 ft. above low water.)		
		20	10

1901. SECTION 900. SECTION No. XI.—At Cannelton.

		Ft.	In.
1.	Sandstone	6	0
2.	Shale	21	6
3.	COAL II	1	6
4.	Fire-clay	1	0
	(Coal 188 ft. above low water.)		
		30	0

1902. SECTION 901. SECTION No. XXII.—At Rock Island mines.

		Ft.	In.
1.	Clay	4	3
2.	Sandstone	3	6
3.	Sandstone	12	10
4.	Black shale	3	6
5.	COAL IIa	..	2
6.	Blue sandstone	8	4
7.	Shale	8	0
8.	COAL II	..	6
9.	Sandstone	1	7
	(Coal 162 ft. above low water.)		
		42	8

1903. SECTION 902. SECTION No. XIX.—At Rock Island mines.

		Ft.	In.
1.	Clay	4	0
2.	Sandstone	9	6
3.	Shale	6	0
4.	COAL IIa	1	10
5.	Fire-clay	..	2
	(Coal 189 ft. above low water.)		
		21	6

1904. SECTION 903. SECTION AT ROCK ISLAND MINES.—

		Ft.	In.
1.	Clay	2	0
2.	Sandstone	4	6
3.	COAL IIa	..	6
4.	Fire-clay	..	6
5.	Sandstone	2	0
6.	Sandstone	16	3
7.	Black shale	6	0
8.	Sandstone	10	0
9.	Black shale	7	0
10.	COAL II	3	6
		52	3

1905. SECTION 904. SECTION NO. XV.—At Rock Island mines.

		Ft.	In.
1.	Sandstone	14	0
2.	COAL IIa	1	6
3.	Sandstone	16	0
4.	Black shale	22	6
	(Top coal 209 ft. 6 in. above low water.)		
		54	0

1906. SECTION 905. SECTION NO. XIV.—At Rock Island mines.

		Ft.	In.
1.	Clay	6	0
2.	COAL IIa	1	0
3.	Sandstone	13	0
4.	Black shale	10	0
	(Top coal 189 ft. above low water.)		
		30	0

1907. SECTION 906. SECTION AT HANCOCK MINES, KY.—

		Ft.	In.
1.	Soil	5	0
2.	Sandstone	6	0
3.	Blue shale	6	0
4.	Black shale	17	0
5.	COAL II	3	0
6.	Bottom shale	..	6
7.	Fire-clay	1	0
	(Coal 152 ft. 3 in. above low water.)		
		38	6

1908. SECTION 907. SECTION AT HANCOCK MINES, KY.—

		Ft.	In.
1.	Soil	2	0
2.	Gravel and clay	5	..
3.	Good shale	22	0
4.	COAL II	3	6
5.	Fire-clay	1	0
	(Coal 154 ft. above low water.)		
		33	6

1909. SECTION 908. SECTION AT HANCOCK MINES, KY.—

		Ft.	In.
1.	Soil	4	0
2.	Clay shale	3	0
3.	Sandstone	3	0
4.	Black shale	25	0
5.	COAL II	2	10
6.	Bottom shale	1	0
7.	Fire-clay	1	0
	(Coal 162 ft. 6 in. above low water.)		
		39	10

1910. SECTION 909. SECTION AT HANCOCK MINES, KY.—

		Ft.	In.
1.	Soil	4	0
2.	Gravel and clay	7	6
3.	Black shale	8	3
4.	COAL II	3	0
5.	Shale and fire-clay	2	0
	(Coal 147 ft. above low water.)		
		24	9

1911. SECTION 910. SECTION AT HANCOCK MINES, KY.—

		Ft.	In.
1.	Soil	11	0
2.	Shale	5	0
3.	COAL II	3	2
4.	Bone coal	1	0
5.	Fire-clay	2	0
	(Coal 149 ft. above low water.)		
		22	2

The exact location of these drillings by the American Cannel Coal Company can not be given. They, with the others, show Coal II to run from 5 ft. to 0, and Coal IIa from 1 ft. 10 in. to 0. The strata between are principally shales, often black, with frequently a massive sandstone making up part of the space. Above Coal IIa comes the massive sandstone which makes such prominent bluffs in the hills about Cannelton.

1912. COAL II.—Coal II here runs from 0 to 5 ft. in thickness, including the bone coal at the bottom, which is 12 to 14 in. thick. The good coal is about 3 ft. 6 in. at the best and averages about 2 ft. 10 in. The following is about an average section of the coal (Sect. 911):

		Ft.	*In.*
1.	Gray shale ....6 in. to	2	0
2.	Thinly laminated coal	..	8
3.	Sulphur and charcoal band ....2 in. to	..	¼
4.	Hard, close-textured coal, breaking with conchoidal fracture	1	9
5.	Bone coal	1	3½
6.	Fire-clay	..	..

The second bench, No. 4 of the above section, contains the best grade of coal. The best part of this is a hard coal, showing scarcely a trace of lamination or structure and breaking readily in any direction with conchoidal fracture. It makes an excellent steam and heating fuel and makes only a moderate amount of clinker. The top bench makes a considerable amount of white ash, and necessitates frequent cleaning of furnaces using it. The coal is a non-caking black coal. The face and butt slips are generally regular, 18 in. to 2 ft. apart, the face slips running nearly north and south. No faults are known in the present works. Three or four were seen in the first tunnel. A few small rolls have been noticed in the mine. In places the coal thins out entirely and is absent over considerable areas, where the floor rises above the general level of the bottom of the mine. In tunnel No. 1 the vein thins gradually toward the south end and disappears entirely before reaching it. The second tunnel was driven 400 yds. through coal too thin to work.

The roof is generally a dark bluish shale, varying greatly in thickness. At the A. C. C. Company's air shaft it was found to be about 24 ft. thick. It has very little tendency to slack in the air and makes a good roof. In places the roof is sandstone.

The floor is a hard fire-clay, and seldom gives any trouble by heaving.

The following analyses by Mr. Cox may give some idea of the composition of the various parts of the bed:

MINE.	Part of Coal Bed.	Fixed Carbon.	Volatile Combustible Matter.	Total Combustible Matter.	Ash.	Moisture.	Total Waste.
Rock Island	Upper 12 in................	52.50	41.00	93.50	2.00	4.50	6.50
Rock Island	Sulphurous coal parting..	58.00	27.50	85.50	11.00	3.00	14.00
Rock Island	Lower bench...............	50.00	37.00	87.00	8.50	4.50	13.00
Rock Island	Bony coal at bottom.......	49.50	34.00	83.50	12.50	4.00	16.50
Rock Island	So-called "Cannel Coal"..	45.50	42.00	87.50	6.00	6.50	12.50
Cannelton	Upper part................	51.50	41.00	92.50	4.00	3.50	7.50
Cannelton	Middle part...............	48.50	43.00	91.50	2.00	6.50	8.50
Cannelton	Bottom part	45.50	46.00	91.50	3.50	5.00	8.50
Clark Bros., at Cannelton.	Upper part................	48.50	42.50	91.00	2.00	7.00	9.00
Clark Bros., at Cannelton.	Middle part...............	49.50	40.50	90.00	3.50	6.50	10.00
Clark Bros., at Cannelten.	Bottom part	48.50	41.00	89.50	4.00	6.50	10.50
Hancock, Ky...............	Upper part................	49.50	40.50	90.00	3.50	6.50	10.00
Hancock, Ky...............	Middle part...............	45.50	45.00	90.50	4.00	5.50	9.50
Hancock, Ky...............	Bottom part	40.00	41.50	81.50	12.00	6.50	18.50
Hancock, Ky...............	Bony coal beneath........	36.50	31.00	67.50	24.00	8.50	32.50
Heck, near Cannelton.....	Top of seam	49.50	40.00	89.50	6.00	4.50	10.50
Heck, near Cannelton.....	Bottom part of seam	45.00	43.00	88.00	8.00	3.50	12.00
McMahan..................	Upper part................	48.50	41.50	90.00	4.00	6.00	10.00
McMahan..................	Lower part................	50.50	39.50	90.00	5.50	4.50	10.00

These analyses indicate from a fair to a good coal. The amount of water is unusually large as compared with most of the analyses by Mr. Cox.

"An ultimate analysis was made of a specimen from the Rock island coal taken from above the parting, and another, of a mixture of equal parts of Nos. 1, 2 and 3 of the proximate analysis."

Tests by Mr. Cox of its value in the manufacture of gas gave the following (E. T. C., p. 118):

	Coke.	Tar and Ammoniacal Liquor.	Water.	Carbonic Acid and Sulph. Hyd.	Illuminating Gas by Difference.	Cu. ft. of Gas per lb. of Coal.
No. 1, top of seam..........................	62.5	15.00	.25	.50	21.75	3.41
No. 2, middle, exclusive of the sulphur band	72.5	2.50	....	.25	24.75	3.50
No. 3, bottom of seam.......................	62.5	15.00	....	....	22.50	2.62
Nos. 1, 2, 3, average of seam	62.0	12.00	.25	.50	21.75	3.08
No. 4, bone coal, below......................	62.5	....	5.00	....	32.50	3.41

1913. DISTRIBUTION.—Coal II is confined to the western part of these two partial townships. In Sec. 12 it appears in the hills about 147 ft. above high water. From there the dip to the west is rapid. Back of the Catholic church at Cannelton it is about 80 ft. above high water; at the old Fulton mine it is just about at high water. As this point is about 3½ mi. west of the old Rock Island mines, there is a dip of 147 ft. in that distance.

Mr. Lesley describes the manner of occurrence of the bed as follows: "This dip is not regular, but in long low waves, and these last are crossed at right angles by similar waves. These waves cause the leading peculiarity of this portion of the coal fields and also have been the cause of much perplexity and pecuniary loss to those who have undertaken to develop the resources of this district, for the main coal vein has always been found to become thin and sometimes even to disappear upon the crests of these waves, thus reducing very much the area of workable coal and throwing it, so to speak, into pockets which are difficult to strike, without a previous careful geological and topographical survey," etc.

This thinning is well shown in No. 1 tunnel east of Cannelton. At the south end of the tunnel the coal is entirely lacking. A short distance in it begins to show as a thin streak of bone coal. A section here would show (Sect. 912, E. M. K.):

	Ft.	In.
1. Gray shale	2	0+
2. Black carbonaceous shale	..	6
3. BONE COAL II	..	2
4. Fire-clay	3	6
5. Sandstone	6	0

It thickens to the north until at the first of the faults figured above, about 80 yds. in the tunnel, the section is as follows (Sect. 913, E. M. K.):

	Ft.	In.
1. Bluish gray shale	4	2
2. Bone COAL	..	9
3. Black clay	..	3
4. Sandy fire-clay	5	6

At the second double fault, 40 ft. further north, the section has thickened up to (Sect. 914, E. M. K.):

	Ft.	In.
1. Dark gray shale	..	3+
2. COAL II	..	5
3. Bone COAL	1	0
4. Sandy fire-clay	..	..

At the north end of the tunnel the normal thickness of the coal has been reached.

It may not be out of place to repeat what Mr. Lesley had to say in regard to the faults in this area, even though it now appears, according to Mr. Kindle, that much of the irregularity he ascribed to faults was due to unconformity. He says: "Besides these waves, there is a fault running along the south side of the valley of Caney fork of Deer creek, and in a direction parallel to that of the general dip of the strata. At right angles to this fault, and running into it, is another, not so long, and showing itself on the east side of the valley of "Hayden Meadow." These faults are occasioned by an upthrow of the strata of the Sub-Carboniferous limestones, which, along Caney fork of Deer creek, form the bluffs along that stream, and dip into the hills at an angle of 60° in a south-southwesterly direction."

With the exception of a few small areas along the west fork of Little Deer creek, all of the workable coal land in these townships is owned by the American Cannel Coal Company. The larger part of this area has been worked out and abandoned. The coal is everywhere above drainage, and has been worked exclusively by drift mining. All of the territory immediately adjacent to the river has been worked out. The Rock Island mines, which are the easternmost in the region, were abandoned many years ago. The coal there lies about 145 ft. above high water. A railway was used to transfer the coal to the river. The coal is said to have been thicker in the hill just back of Cannelton than at any other place where it has been worked, the bed reaching a thickness there of 5 ft. plus. The coal has been worked out in the ridge running northeast from Cannelton for a mile and a half. The mines in operation at present are located in the N. W. ¼ of Sec. 11. A dummy engine is used to transport the coal to the river over a railroad which terminates at the mouth of tunnel No. 1. The mine cars are hauled from the works through two tunnels to the tip house, where they are dumped into cars of two tons capacity, and these are then drawn to the river by the dummy. The east entry is back nearly a mile. The coal is pretty well worked out, most of the mining at present being on pillars. The coal can be mined without powder, but powder is sometimes used.

At the old Fulton bank the coal has a sandstone roof, with no intervening shale. The coal here was worked out a number of years ago. Between the Fulton bank and Tell City the drill indicates a barren zone at the level of Coal II, where drillings have been made.

Just above Tell City the coal outcrops in the bank of the river nearly at low water level. In the N. W. ¼ of Sec. 2, 7 S., 3 W., Coal ~~III~~ has
II

been opened on John S. Poeline's land. Only a small amount has been taken out, and the bank has caved in. The coal was 3 ft. thick here, with a shale roof and 25 ft. above drainage. (Fig. 838.) It is only 60 yds. east of this, and at a level 10 or 15 ft. lower, to where the Kaskaskia limestone outcrops in a ledge 10 ft. thick. The limestone and sandstone are unconformable here, as shown in Plate VIII, p. 93. No limestone could be found under or closer to the entry. A short distance west of the coal bank the limestone outcrops beside the road and 15 ft. above drainage.

A small amount of coal has been mined for home use at Mr. Anderson Bolins's bank, in S. W. of N. W. of Sec. 2. A section of the coal here shows (Sect. 915, E. M. K., Fig. 837):

	Ft.	*In.*
1. Massive sandstone	6	0
2. Gray shale ....1 ft. 6 in. to	1	8
3. Bone coal	..	2
4. Laminated block coal bright and glassy	1	1
5. Black carbonaceous shale	..	2
6. Fire-clay	..	..

The coal lies 25 to 30 ft. above the stream and 10 or 12 feet above the limestone, which outcrops across the branch.

On the north side of the branch (where, according to Mr. Lesley's fault, it ought to be 200 ft. above drainage) Coal II is 15 to 18 ft. above drainage, and has been worked some by Mr. Hiram Poeline. The section here shows (Sect. 916, E. M. K.):

	Ft.	*In.*
1. Surface	1	6
2. Sandstone	3	0
3. Gray fire-clay	1	0
4. COAL II (reported)	3	0
5. Fire-clay (reported)	1	0
6. Sandstone (reported)	9	0
7. Limestone	10	0

There seems to be no coal sufficiently thick to mine in township 7 S., 2 W. Some prospecting has been done on F. M. Wilkinson's land, in the S. E. $\frac{1}{4}$ of Sec. 5.

The section here shows (Sect. 917, E. M. K.):

	Ft.	*In.*
1. Surface	..	..
2. Dark blue clay shale	8	0
3. COAL Ia (?)	0	6
4. Dark blue fire-clay	1	0
5. Sandstone	1	0
6. Gray sand shale	5	0+

The coal appears to be rather bony, but is said to burn well. It lies here about 30 ft. below the top of the ridge. At another entry, a few yards away, the coal is $7\frac{1}{2}$ in. thick; the upper 2 in. are a finely laminated bone coal, and the rest is a hard, compact coal, nearly identical in appearance with the best coal around Cannelton.

In the S. E. of Sec. 3 this coal outcrops within 15 to 20 ft. of the top of the ridge.

Township 6 South, Range 3 West.

1914. Position.—This township embraces the northern portion of Troy and the southern part of Anderson townships.

1915. Topography.—This township is somewhat hilly, but the slopes are less abrupt and angular than they usually are in this county. The proportion of rolling and level land to broken is greater than in any other township in the county.

1916. Drainage.—The township is drained principally by three small creeks, Little Deer, Windy creek and Brushy fork.

1917. Transportation.—The Cannelton branch of the Air Line passes through the western margin of the township. The Ohio forms a portion of the western boundary and affords convenient river transportation facilities.

1918. Stratigraphy.—Nearly all of the surface rocks of this township belong to the coal measures. The Lower Carboniferous limestone occurs only in the southwestern corner of the township and in Sec. 13. The relation of the limestone and the Mansfield sandstone indicates unconformity.

Following the branch from Sec. 12 to the S. W. $\frac{1}{4}$ of Sec. 13, the section exposed is as follows:

1919. Section 918. Section in Secs. 12 and 13.—Fig. 8, Plate LXVII, p. 1280. (E. M. K.)

	Ft.	*In.*	*Ft.*	*In.*
1. Covered to top of hill	25	0	25	0
2. COAL II (at outcrop)	0	6	25	6
3. Dark gray fire-clay	0	6	26	0
4. Covered	30	0	56	0
5. Tough blue shale	2+	0	58	0
6. COAL Ia ....1 ft. 1 in. to	1	6	59	6
7. Hard sandy blue shale	10	0	60	4
8. Shelly sandstone	3	0	63	4

		Ft.	In.	Ft.	In.
9.	Hard sandy shale	4	0	67	4
10.	Blue fire-clay	1	8	69	0
11.	COAL I.....1 in. to	0	2	69	2
12.	Sandy blue fire-clay	2	0	71	2
13.	Shelly sandstone	4	0	75	2
14.	Shale	1	0	76	2
15.	Iron ore and clay shale	1	10	78	0
16.	Dark blue clay shale	0	8	78	8
17.	Covered	4	0	82	8
18.	Kaskaskia limestone	5	0	87	8

The following section is based on the outcrops in the hill at Bergenroths and the record of a bore made by Mr. Geo. Minto at the old Troy shaft:

1920. SECTION 919. SECTION AT TROY.—By Mr. Kindle, Fig. 2.

		Ft.	In.	Ft.	In.
1.	Covered to top of hill	15	0	15	0
2.	Brown to grayish calcareous, fossiliferous sandstone	14	0	29	0
3.	Covered	4	0	33	0
4.	COAL (streak) III?	..	..	..	..
5.	Sandy shale	16	0	49	0
6.	COAL streak	0	1	49	1
7.	Shaly sandstone	5	0	54	1
8.	Sandstone, shaly to massive	4	0	58	1
9.	COAL	0	2	58	3
10.	Fire-clay	1	0	59	3
11.	Shale to shaly sandstone	4	0	63	3
12.	Sandy limestone	1	0	64	3
13.	Light-blue shaly sandstone	12	0	76	3
14.	Massive sandstone	2	0	78	3
15.	Shaly sandstone	3	0	81	3
16.	Massive sandstone	5	0	86	3
17.	Black clay shale	4	0	90	3
18.	COAL IIa	0	6	90	9
19.	Bluish-gray fire-clay	6	0	96	9
20.	Sandstone and sandy shale	23	0	119	9
21.	Trace of COAL	..	..	..	..
22.	Sandstone	15	0	134	9
23.	COAL II	3	4	138	1
24.	Fire-clay	2	0	140	1
25.	White sandstone	3	0	143	1
26.	Blue sandstone	13	0	156	1
27.	Blue shale	11	0	167	1
28.	COAL Ia	0	4	167	5
29.	White sandstone	9	0	176	5
30.	Blue shale	28	0	204	5
31.	COAL I	0	2	204	7
32.	Limestone	1	6	206	1

It is interesting to compare this section with the one made by Mr. Cox in 1871 or 1872:

1921. SECTION 920. SECTION AT TROY.—By Mr. Cox, Fig. 3. (E. T. C., p. 101.)

		Ft.	In.	Ft.	In.
1.	Soil and clay	5	0	5	0
2.	Loess?	10	0	15	0
3.	Covered and shale	27	0	42	0
4.	Sandy limestone and limestone	15	0	57	0
5.	COAL III? ("K")	1	0	58	0
6.	Fire-clay	..	..	..	..
7.	Sandy shale	50	0	108	0
8.	COAL ("I"), thin	..	..	..	..
9.	Fire-clay	..	..	..	..
10.	Sandy shale and heavy-bedded sandstone	30	0	138	0
11.	COAL ("H")	2	0	140	0
12.	Shistose, massive and shaly sandstone	90	0	230	0
13.	COAL IIa ("G")	1	6	231	6
14.	Fire-clay used at pottery	5	0	236	6
15.	Shale	10	0	246	6
16.	Sandstone	30	0	276	6
17.	COAL II ("F")	3	0	279	6
18.	Fire-clay	4	0	283	6
	Low water in Ohio river.				

According to Mr. Cox's section, it is 220 ft. from the limestone near the top of the hill to Coal II, while Mr. Kindle makes them 101 ft. apart. As corroborating Mr. Kindle's section, may be given one made independently by Mr. Price. The lower part of this corresponds very clearly with a section made here by Mr. Blatchley in 1896:

1922. SECTION 921. SECTION AT TROY.—By Mr. Price, Fig. 5.

		Ft.	In.	Ft.	In.
1.	Surface	15	0	15	0
2.	Brown to grayish shaly, fossiliferous limestone	12	0	27	0
3.	Ferruginous sandstone	2	0	29	0
4.	Shaly sandstone	18	0	47	0
5.	COAL streak	..	1	47	1
6.	Shaly sandstone	5	0	52	1
7.	Sandstone, shaly to massive	4	0	56	1
8.	COAL	..	2	56	3
9.	Fire-clay	1	0	57	3
10.	Shale to shaly sandstone	4	0	61	3
11.	Impure sandy limestone	1	0	62	3

		Ft.	In.	Ft.	In.
12.	Light-blue shaly sandstone	12	0	74	3
13.	Massive sandstone	2	0	76	3
14.	Shaly sandstone	3	0	79	3
15.	Massive sandstone	5	0	84	3
16.	Shale, slacking readily	4	0	88	3
17.	COAL IIa	..	6	88	9
18.	Fire-clay	6	0	94	9
19.	Massive sandstone	33	0	127	9
20.	COAL II	3	0	130	9

By this section the limestone is 100 ft. above Coal II, being within a foot of the distance as determined by Mr. Kindle.

Mr. Cox made a section of these same strata across the river in Kentucky at Haw's mine. This is doubtless subject to the same general tendency as his section at Troy.

1923. SECTION 922. SECTION AT HAW'S MINE, KY.—Fig. 4. (E. T. C., p. 98.)

		Ft.	In.	Ft.	In.
1.	Slope, sandstone and sandy shale	..	..	..	..
2.	Limestone	6	0	6	0
3.	COAL III? ("K"), with 1 ft. clay parting	2	6	8	6
4.	Sandstone and shale	60	0	68	6
5.	COAL ("I")	..	..	..	..
6.	Sandstone and shale	80	0	148	6
7.	COAL ("H")	1	6	150	0
8.	Sandstone	30	0	180	0
9.	COAL IIa	1	0	181	0
10.	Hard bluish shale	25	0	206	0
11.	Black bituminous shale	15	0	221	0
12.	COAL II ("F")	4	0	225	0
13.	Fire-clay	..	..	..	..

A deep boring was put down in 1889 at Tell City for gas. Samples of rock passed through were carefully preserved by Dr. Aug. Schreiber. The following section is based on an examination of those samples:

1924. SECTION 923. SECTION OF A DEEP WELL AT TELL CITY.—(E. M. K.)

		Ft.	Ft.
0.	Light clay shale	25 to	25
1.	Soft sandstone	15 to	40
2.	Soft sandstone	40 to	80
3.	Light blue gray clay shale (Kaskaskia?)	80 to	160
4.	Hard gray limestone, probably some shale	30 to	190
5.	Black or dark bluish shale, slightly sandy	40 to	230
6.	Gray limestone	5 to	235
7.	Gray shale	45 to	280
8.	Blue limestone	30 to	310
9.	Gray sandy shale	41 to	351
10.	Sandstone	6 to	357
11.	Dark blue shale and sandstone	43 to	400
12.	White sandstone	15 to	415
13.	Dark blue sandy shale	40 to	455
14.	Limestone	41 to	496
15.	Brown shale	35 to	531
16.	Limestone	33 to	564
17.	Black shale	36 to	600
18.	Sandstone	20 to	620
19.	Black shale	3 to	623
20.	Limestone	17 to	640
21.	Brown shale	13 to	653
22.	Limestone	27 to	680
23.	Brown shale	5 to	685
24.	Sandstone	62 to	747
25.	Blue shale	10 to	757
26.	Limestone	168 to	925
	Strong flow of salt water at 825 ft.		
27.	Limestone	5 to	930
28.	Limestone	245 to	1,175
29.	Dark limestone	83 to	1,258
30.	Gray limestone	12 to	1,270
31.	Dark blue limestone	44 to	1,314
32.	White limestone (oolitic?)	50 to	1,425
34.	Dark blue limestone	75 to	1,500
35.	Limestone, gray	75 to	1,575
36.	Limestone, gray	70 to	1,645
37.	Limestone, light gray	85 to	1,730
38.	Limestone, light gray	70 to	1,800
39.	Limestone, light gray	50 to	1,850
40.	Limestone, light gray	35 to	1,885

Coal II was wanting where this section was put down. The usual belt of black shale indicating the top of the Devonian does not appear in this section. It would be the writer's judgment that its position is about at the 10 ft. of blue shale No. (25).

The following section was obtained in the S. W. of S. E. of Sec. 20:

1925. SECTION 924. SECTION IN SEC. 20.—Fig. 6. (E. M. K.)

		Ft.	In.
1.	Sandstone with shaly partings	15	0
2.	Covered	5	0
3.	Sandstone, thin and thick bedded	6	0
4.	Hard sandy shale	5	0
6.	Sandstone	0 to 1	0

		Ft.	In.
7.	Dark blue soft shale	3	0
8.	Hard gray sandy shale	3	0
9.	COAL IIa ....1 ft. 6 in. to	1	10
10.	Light gray sandy fire-clay	2	0
11.	Gray sandy shale	4	0
12.	Black shale	1	6
13.	Covered	15	0
14.	COAL II	..	..

1926. SECTION 925. SECTION AT REED MINE.—N. E. ¼ of Sec. 26, Fig. 7. (E. M. K.)

		Ft.	In.
1.	Surface	..	...
2.	Massive cross-bedded sandstone	16	0
3.	COAL II—Coal. 1 ft. 2 in.; clay, 5½ in.; Coal, 1 ft. 4 in.; "sulphur," 1 in.	3	0
4.	Gray fire-clay and covered	6	0
5.	Massive sandstone ....25 ft. to	30	0
6.	Covered	8	0
7.	Kaskaskia limestone, outcrop ½ mile below	5	0
8.	Shale, sandstone and limestone	20	0

This section put Coal II 44 ft. above the Kaskaskia limestone. The section in Secs. 12 and 13 made it 66 ft. above, while the drilling at Troy made it 64 ft. These figures may then be taken as fairly representative of the thickness of Division I in this area. There appear to be two coals in this division here, neither of which is workable, and the lower coal seems to be usually limited to a few inches, or is wanting entirely.

1927. DIVISION II.—This division appears to run about 100 ft. thick, assuming the coal under the limestone to be Coal III. The two limestones found in Dubois county, in what was there called Division III, are more persistent in Spencer county, yet not enough so as to render certain the position of a limestone when found alone, and much doubt has existed as to whether the limestone found at places along the eastern edge of Spencer county and at this point is the upper or lower limestone. Mr. Price has reached the conclusion that it is the lower limestone, and has so mapped it. The writer was inclined to the view that it was the upper, and that the lower was at this point represented by the 1 ft. of shaly limestone reported by both Mr. Price and Mr. Kindle. With the data at hand, however, Mr. Price's conclusion will have to stand, and the stratigraphy will be discussed accordingly.

Division II, under that understanding, contains at least four coal horizons, only the lower of which contains a workable coal. The division is largely sandstone, though not so much as in the last township.

1928. COAL II.—As indicated by the figures, this coal in this township will not average as thick as the last, and is generally split by a clay band, which has a thickness of up to 1 ft., interfering seriously with the coal being minable. The lower bench varies from about 1 ft. to nearly 3 ft. in thickness, while the upper tends to be about 1 ft. thick. At Bergenroth's there are two thin clay partings. In many places the upper bench is only bone coal. The roof is either shale or sandstone, in about equal proportions, the floor generally fire-clay, though in a few instances it is black shale. Its quality is variable and will be discussed under distribution and details.

1929. DIVISION III.—This division, as limited above, is only found in the top of the hills, and is most conspicuous for the presence of the limestone noted in the sections. As a rule, Coal III is wanting here. Mr. Cox reported, on the authority of Mr. Minto, that it had been found and worked on Windy creek, where it showed two 8 in. benches separated by 6 in. of clay. The resemblance of this to the section of Coal II in Sec. 20, on Windy creek, leads to the suspicion that the two were confused.

1930. DISTRIBUTION AND DETAILS OF COAL.—In taking up the details of the coal it will be convenient to follow the creek valleys along which the mines are all located, beginning with the valley of Little Deer creek.

In the S. W. ¼ of Sec. 12, Coal Ia has been worked on Theodore Hanna's land. Coal Ia is here a good hard coal about 15 in. thick. In its hard, compact structure it resembles the best of the Cannelton coal, and the roof is also similar to that at Cannelton, being a blue shale. The coal is here about 5 ft. above the branch. Some 35 ft. higher is an outcrop of Coal II. (See section given above.)

On the opposite side of the branch Coal II was found to be too thin to work, showing only 6 or 8 in. of coal, where prospecting was done. In Secs. 24 and 25 Coal II is seen outcropping occasionally from 30 to 40 ft. below the summits of the ridges. Coal II has been worked a little on Powell Smith's land, S. E. ¼ of Sec. 25. Coal here is reported to have been about 3 ft. thick, with a good deal of bone in it.

At Reed's bank, N. E. ¼ of Sec. 26, Coal II has a massive sandstone roof and 5-6 in. clay band. Coal is here 80 or 90 ft. above drainage and within 20 ft. of the top of the ridge. (See Fig. 7 and Sect. 925, as given above.) The quality of the coal is not very good, and the bank has not been operated during the last year. Coal II outcrops in the S. W. ¼ of Sec. 24, 6 in. thick, and bony. It is also found in two springs on Mr. Josiah Turner's, in the N. E. ¼ of Sec. 23.

At Geo. Leesner's bank, in the N. E. ¼ of Sec. 27, Coal II shows no clay band, but is so slaty that it will probably be abandoned.

The good coal is 19 in. thick, overlain by 4 in. of bone, and that in turn by 8 in. of "black coaly shale." The roof is gray fossiliferous shale, the floor light gray potter's clay. The coal is 25 or 30 ft. above the branch. A short distance above this bank Coal Ia has been struck in the bed of the branch about 30 ft. below the level of Coal I. It is said to be a good coal here. It lies 3 ft. below the bed of the branch and was covered by 6 in. or more of blue sandy shale, slightly fossiliferous. The coal is 17 in. thick. A 6 in. bed shows in the branch a few feet higher.

About ¼ mi. southwest of Leesner's bank, Coal II is mined at John Powell's. The coal is solid here and averages about 2 ft. thick. A section in entry shows (Sect. 926, E. M. K.):

		Ft.	In.
1.	Tough blue gray shale	1	3
2.	Tough black shale	0	2
3.	Bone coal	0	6
4.	COAL II	2	0+

The roof is good. The coal has regular slips, and is said to burn to a white ash, with but little clinker. A 4 or 6 in. fault was found in the old entry. In the S. E. ¼ of Sec. 27 Coal II is mined at Ephraim Powell's bank and at Jno. Ringer's bank. Just across the road from Ringer's the same vein is worked.

In Ringer's bank the coal has a clay parting of about 2 in., while just across the road, at Poeline's, the clay runs 2 ft. thick in part of the mine. In Powell's bank the clay parting runs about 10 to 12 in. thick. A bluish gray shale full of plant fossils forms the roof at each of these banks. In this bank the upper bench is 10-12 in. thick and the lower bench 1 ft. 3 in., with 6 ft. of hard fire-clay below. The coal is partly pick mined and partly gotten with powder, the shooting being done in the base of the clay band. The slips are quite regular in the lower bench, the face running north and south and the butts east and west. The upper bench tends to break in small pieces in mining. Both benches have frequent streaks of charcoal "mother coal," which largely increases the amount of slack. The clay band shows frequent little slips or "cat faces," which interfere with its shooting. They do

not extend into the coal. The coal is 8 or 10 ft. above drainage and about 45 ft. below the top of the hill. Only about three acres of the 40 have been taken out.

At the John Poeline mine the coal shows the following section (Sect. 927, E. M. K.):

		Ft.	In.
1.	Dark fossiliferous shale	..	..
2.	COAL II, top	0	11
3.	Gray fire-clay	0	9
4.	Dark fire-clay	0	3
5.	COAL II, bottom (block)	1	4
6.	Sulphur band	0	1
7.	Fire-clay	..	..

At another section here the upper bench is 11 in., the lower 15 in., and the clay band 9 in. There is much charcoal in the coal, and the lower bench in places carries a sulphur band in its upper third. The coal is all laminated and much of it soft. It is mined both with pick and with powder. In places there are streaks of coal in the clay band. The under clay is very hard and sandy. The coal lies irregularly, but with a general dip to the west. The drift is 10 ft. above the branch.

At Mr. Ringer's mine the upper bench is about 1 ft. thick and the lower 1 ft. 4 in., there not being much variation from that. The clay band varies from 1½ in. to 4 in. and is not usually much over 2 in. In one section obtained the upper bench showed 2¾ in. of coal, then ½ in. of charcoal, then 1 ft. of coal. (Fig. 13.) No powder is used in mining. The coal is laminated and inclined to be soft. It lies level; about two-thirds worked out.

In the N. E. of S. W. of Sec. 34, Coal II has been worked a little on John Litherland's place. It is about 2 ft. thick, without clay parting, and with a shaly sandstone roof. At the outcrop the dip is sharply to the southeast.

A short distance southwest, on Mrs. Ryan's place, the section shows (Sect. 928, E. M .K.):

		Ft.
1.	Coarse sandstone	4
2.	Sandy gray fossiliferous shale	7
3.	Covered	3
4.	COAL II	2

The coal is here about 1 ft. above the branch and 7 ft. below the last mentioned bank. The dip made drainage difficult and prevented working of coal.

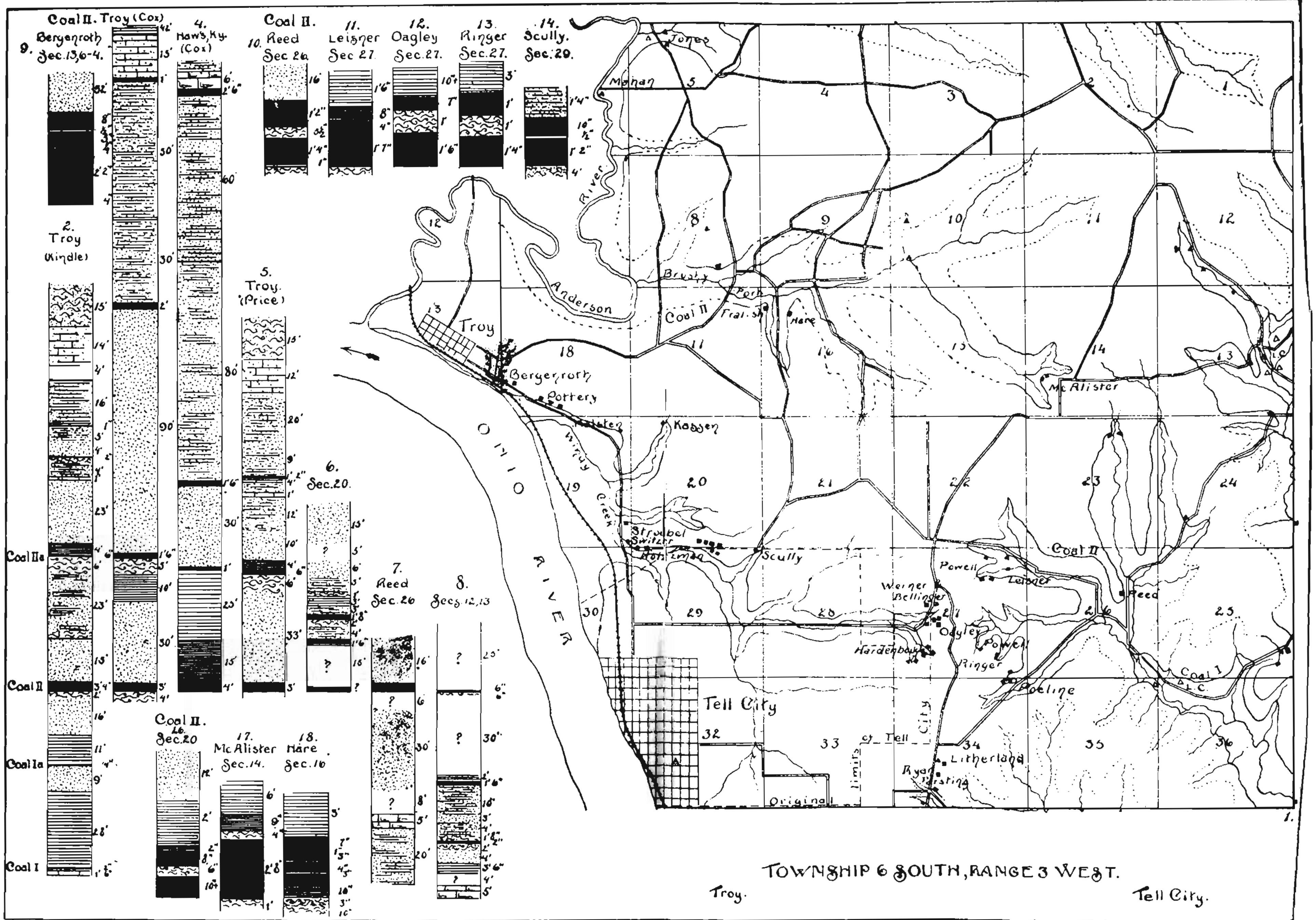


PLATE LXVII.

pg 1284

The same coal has been worked in the S. W. of S. W. of Sec. 34, on Mr. B. Fursting's place. There is here a floor of sandy fire-clay 2 ft. plus thick.

WINDY CREEK.—In the S. W. ¼ of Sec. 27 several coal banks are located on the head ravines of one branch of Windy creek. Only two of these have been operated during the past year.

At the Benedict Oagley bank Coal II is mined by slope. The section of the coal shows (Sect. 929, Fig. 12, E. M. K.):

	Ft.	In.
1. Gray fossiliferous shale	1	8
2. COAL II, upper bench	..	7
3. Clay ....6 in. to	1	8
4. COAL II, lower bench....1 ft. 5 in. to	1	7
5. Hard light gray fire-clay	1	0+

The slips run fairly regular in both benches. In places a ½ in. dirt or charcoal or clay streak shows near the middle of each bench. In places there are 2 to 4 in. of interstratified coal and shale at the top of the upper bench. The 1 in. sulphur band at the bottom is frequently found, and it is often necessary to reject about 4 in. of the top of the coal. Some rolls are met with. The dip is to the west.

The Werner and Bellinger mine lies about 300 yds. northwest of the Oagley bank. At this mine the clay band disappears in parts of the mine and in other parts is replaced by a ¼ to ½ in. band of sulphur. The section here is as follows (Sect. 930, E. M. K.):

	Ft.	In.
1. Dark blue gray shale	3	0+
2. Bone coal	0	6
3. COAL II, upper bench	0	10
4. Clay band	0	1
5. COAL II, lower bench	1	0
6. Sulphur	0	½
7. Fire-clay	..	..

The coal is about 2 ft. above the branch.

Coal II has been worked from a shaft 18 ft. deep, a little east of this, on Moses Powell's place.

Coal II is worked some on John Hardenbaugh's place, in the S. E. of S. W. of Sec. 27. The coal shows the following section (Sect. 931, E. M. K.):

	Ft.	In.
Bone coal and shale	0	4
COAL	0	5
Clay	1	6
COAL	1	4
Sulphur band	0	½
Hard sandy fire-clay, nearly a sandstone	..	..

The upper bench is poor, while the lower is fair, hard, and blocks, with much sulphur in thin, irregular bands.

A mile and a half west of the Oagley bank, Coal II is worked at the Jos. Scully bank, N. W. ¼ Sec. 29. The coal here has only a trace of the clay parting. The bed is about 2 ft. thick here and lies 10 or 12 ft. above high water. The dip is quite irregular and causes much difficulty in draining. The upper bench is 10 in. thick and the lower 1 ft. 2 in. (Fig. 14.) In places it runs up to 33 or 34 in. The top 3 or 4 in. are bony, also just above and below the dirt band. The roof is a blue sandy shale, the floor a sandy fire-clay. The coal clinkers some and contains sulphur in small balls. A 9 in. fault was met here. The coal is 5 or 6 ft. above the branch and has been nearly worked out.

Northwest of Scully's bank, in the S. W. of S. E. of Sec. 20, Coal IIa was formerly worked on the south side of the hill. (See section as given above.) The bed here was 16 to 22 in. thick, with a clay parting from 6 to 0 in. in thickness. Coal II was worked from a slope at this point.

At Clay Switzer's bank, a mile west of Scully's, Coal II lies a little below high water level. The middle bench here shows some of the characteristics of cannel coal. The coal here is in three benches; the upper, 5 in. thick, breaks into small pieces; the middle bench is hard, black, cannel-like coal, 20 in. thick; the lower bench, which is left at present workings to avoid water, is 10 to 12 in. thick. The face slips, which are quite regular and of some length, run east and west; the butt slips, which are irregular, run north and south. A 35 ft. ledge of sandstone outcrops above the bank. The roof is sandstone over most of the mine. The coal dips to the north. About 300 yds east of this bank is the Holtzman drift. At Frank Stroebel's, in the S. E. of S. E. of Sec. 19, the coal is similar to that at Switzer's. The coal is here about 3 ft. above the branch and 28 ft. above low water in the river. Coal II is reported by Mr. Minto as found on Mrs. Kasson's, in the N. E. of N. W. of Sec. 20, and C. H. Halsten's, N. E. of N. E. of Sec. 19.

East of the old pottery works, in the S. W. ¼ of Sec. 18, Coal II lies a few feet above high water and was formerly mined by two or three drifts.

In approaching Troy the bed dips rapidly, and at the Troy shaft lies 40 ft. below the surface and about at low water level. Coal IIa here lies about 45 ft. above Coal II and is about 6 in. thick.

Coal II has long been mined at Troy, at first by Chas. Heck, in 1871, but at present through a more recent shaft by the Bergenroth Bros. The shaft starts about 20 ft. above high water, and is 50 ft. deep to the coal. The coal ranges from 2 ft. 6 in. or less to 3 ft. 8 in., with an average of about 3 ft. The coal lies generally in three benches, as follows (Sect. 932, Fig. 9, E. M. K.):

		Ft.	In.
1.	Massive gray sandstone	32	0
2.	COAL, first bench	0	8
3.	Charcoal and sulphur streak	0	¼
4.	COAL, middle bench	0	5
5.	COAL, "glossy cannel"	2	2
6.	Black shale	0	4
7.	Fire-clay	0	6
8.	Hard gray sandstone	6	0

The lowest bench is the best coal, the top the next best. The face slips run north and south, and are longer and more regular than the butt slips, which run east and west. The coal is said to clinker but little, most of the sulphur occurring where the floor rises and thins the coal.

The roof is sandstone, with sometimes a little shale between it and the coal. It is of an excellent character, requiring no timbering. In places the sandstone arches up and the space above the coal will be filled with gray shale, often 1 or 2 ft. thick, and sometimes as much as 8 ft. The under clay never heaves, except sometimes in drawing pillars. At present the coal is all mined with powder.

The section obtained in the hill near here and a drilling made in the shaft were both given above, combined with the shaft section.

Bushy Fork.—Coal III has been worked at a number of places along the ravines entering Bushy fork from the south. The coal appears to be generally rather slaty along this stream. The coal lies from 12 to 25 ft. above the bed of the creek.

At John Hare's bank, N. W. ¼ of Sec. 16, clay veins from 1 to 3 in. thick occur in the coal.

The following section of the coal was made in the mine (Sect. 833, Fig. 18, E. M. K.):

		Ft.	In.
1.	Tough bluish gray shale	3	0
2.	COAL	..	7
3.	Clay	..	1
4.	COAL	..	3
5.	Clay	..	1
6.	COAL	..	4
7.	Dirt streak	..	..
8.	COAL	..	3
9.	Soft bone coal	..	10
10.	Black clay	..	3
11.	Gray fire-clay	..	10

There is no regular clay band, but irregular dirt streaks, as in the above sections, which only run a short distance, but sections could be made showing none. The good coal averages about 2 ft. The roof is fair, and the upper part of bed seems to be good coal. The dip is strongly to the east, rendering mining difficult on that side of the mine. A peculiarity of the coal here is the clay veins 1 to 3 in. wide, which cut the coal at frequent intervals, often at distances apart of 8 or 10 ft., and extend up into the shale roof. The coal is about 15 ft. above drainage.

At McAlister's bank, in the S. W. ¼ of Sec. 14, the coal is decidedly bony. A 4 in. clay band runs through the coal here. A section of the mine shows (Sect. 934, Fig. 17, E. M. K.):

		Ft.	In.
1.	Massive sandstone	8	0
2.	Hard blue gray shale	6	0
3.	Black shale and bone	0	9
4.	COAL II	2	8
5.	Fire-clay	1	0+
6.	Gray sandy shale	15	0
	To creek level.		

An outcrop of coal was noted in the S. W. ¼ of Sec. 10, overlain by 3 ft. of shale and that by 5 ft. of thin-bedded sandstone, and underlain by 6 ft. of shale. A 15 to 20 ft. ledge of sandstone outcrops across the creek from this and above it.

On John Kress's place, in the S. E. ¼ of Sec. 8, two beds of coal are found, the lower of which was 16 in. thick.

North of Brushy fork the coal appears to be generally too thin to work in this township. At Jones's mill two flatboat loads of coal are said to have been taken out of the bed of the stream many years ago. The bed, which is now covered by the mill pond, is probably Coal Ia. The section at the mill shows (Sect. 935, E. M. K.):

		Ft.	In.
1.	Gray shale and plant fossils	5	0
2.	COAL II	..	8
3.	Gray shale and plant fossils	4	0
4.	Covered	25	0
5.	COAL Ia	..	..
6.	Thin-bedded sandstone	5	0

Below the mill 80 yds. the sandstone outcrops 15 ft. thick, and the coal occurring above the dam has apparently run out there.

A section in the ravine running east from the mill gave as follows (Sect. 936, E. M. K.):

		Ft.	In.
1.	Micaceous shelly sandstone	5	0
2.	Covered	10	0
3.	Sandy shale	5	0
4.	Fire-clay	3	0
5.	Sandy shale	6	0
6.	Fire-clay	0	6+
7.	Covered	1	6
8.	Sandstone	5	0
9.	Covered	6	0
10.	Sandstone	3	0
11.	Thin-bedded sandstone and shale	1	4
12.	Sandy blue shale	5	6
13.	Covered	7	0
14.	COAL Ia, under water	..	..
15.	Shelly sandstone and shale	5	0

In the N. E. of S. E. of Sec. 6, 6 or 8 in. of coal outcrop 15 ft. above drainage.

Townships 3 (in part), 4 and 5 South, of Range 3 West.

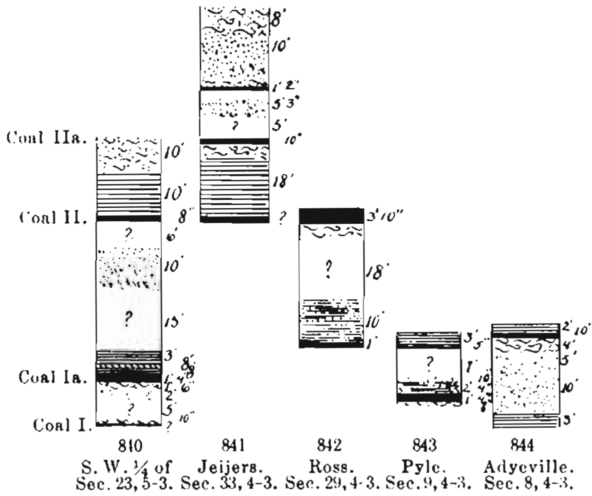
1931. Geography.—These townships comprise the western part of the civic townships of Clark and Anderson. The Anderson river and its branches drain the area. The streams have cut deeply into the coal measure rocks, and the region is quite hilly, with vertical cliffs of Mansfield sandstone in many places.

1932. Stratigraphy and Coals.—The Lower Carboniferous limestone and shale appear in the bottoms of the valleys over much of the eastern half of this tier of townships toward the south. In the northern part they reach the county line. Coals I, Ia and II outcrop in the hills over much of the area. Coal II appears to be the most persistent coal, but it is too thin to work over a considerable area. The following sections will indicate the relation of these coals:

1933. Section 937. Section in S. W. ¼ of Sec. 23-5-3.—Fig. 840. (E. M. K.)

		Ft.	In.	Ft.	In.
1.	Surface to top of hill	10	0	10	0
2.	Gray clay shale	10	0	20	0
3.	COAL II (on opposite side of hill)	..	8	20	8
4.	Covered	6	0	26	8
5.	Shelly sandstone	10	0	36	8
6.	Covered	15	0	51	8

		Ft.	In.	Ft.	In.
7.	Blue shale	3	0	54	8
8.	Concretionary iron ore	..	8	55	4
9.	Blue shale	0	8	56	0
10.	COAL Ia ....10 in. to	1	4	57	4
11.	Gray fire-clay, sandy	1	6	58	10
12.	Shelly sandstone	2	0	60	10
13.	Covered	5	0	65	10
14.	Fire-clay	0	10	66	8
15.	COAL I outcrop	..	..	..	..



Figs. 840-844. Columnar sections in Ts. 3, 4 and 5 S., R. 3 W.

1934. Section 938. Section of Hill at John Jeijer's.—S. W. ¼ of Sec. 33-4-3, Fig. 841. (E. M. K.)

		Ft.	In.	Ft.	In.
1.	Surface to top of hill	8	0	8	0
2.	Soft yellowish sandstone	10	0	18	0
3.	Gray sandy fire-clay	1	2	19	2
4.	Dark blue micaceous shale	0	8+	19	10
5.	Covered	1	2	21	0
6.	Hard sandstone	4	0	25	0
7.	Shelly sandstone	1	3	26	3
8.	Covered	5	0	31	3
9.	COAL IIa, shaly, outcrop	0	10	32	1
10.	Fire-clay and shale	18	0	50	1
11.	COAL II	..	..	..	..
12.	Fire-clay and hidden to creek	14	0	64	1

1935. SECTION 939. SECTION AT M. A. ROSS'S MINE.—N. E. of S. W. of Sec. 29-4-3, Fig. 842. (E. M. K.)

	Ft.	In.
1. COAL II—Bony coal, 8 in.; coal, 2 ft. 8 in.; soft coal and bone, 3 in.	3	7
2. Fire-clay and covered	18	0
3. Sandy hard gray shale	10	0
4. COAL Ia	1	0

1936. SECTION 940. SECTION AT COAL STRIPPING.—W. H. Pyle's land, N. E. ¼ Sec. 9-4-3, Fig. 843. (E. M. K.)

	Ft.	In.
1. Clay shale	3	0
2. COAL Ia	0	5
3. Covered	7	0
4. Sandstone	0	10
5. Dark blue sandy shale	2	4
6. COAL I. ... 1 ft. to	1	4
7. Fire-clay	0	8

The above section lies about 35 or 40 ft. below Coal II, which has been worked a quarter of a mile west in the same section, where it is 2 ft. thick. The relations of the Mansfield sandstone and coal measure shales just east of Adyeville indicate nonconformity.

The following section reaches to the Kaskaskia:

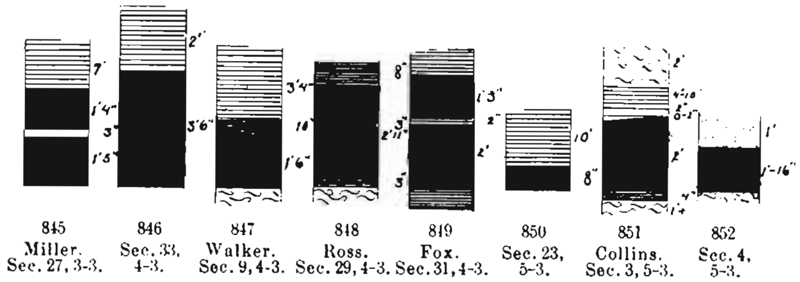
1937. SECTION 941. SECTION SOUTH OF ADYEVILLE.—Sec. 8-4-3, Fig. 844. (E. M. K.)

	Ft.	In.
1. Greenish shale	2	0
2. Sandstone, hard gray	0	10
3. Hard blue fire-clay and traces of plants	4	0
4. Massive to shelly sandstone	5	0
5. Shelly sandstone	10	0
6. Blue Kaskaskia shale with fossils	3	0

A small anticline is nicely exposed in the bed of Anderson creek, in the S. E. ¼ of Sec. 26-3-3, near the school house. The anticline is about 150 across, the axis running about S. 50° E. The arch rises about 5 ft. On the west side of the arch is a displacement of 8 in., hading toward the west.

1938. DIVISION I.—This division appears to have a thickness of 50 ft. or under, with two coal horizons, but containing no workable coal. The Mansfield sandstone or its equivalent does not seem to be very thick or prominent.

1939. DIVISION II.—The whole thickness of this division is probably nowhere exposed in this area. Coal IIa will be found at a few places, but not workable. Coal II is the only coal reaching a workable thickness, and, as shown by Figs. 845 to 852, it is workable only locally. It ranges up to 3 ft. 6 in. or 4 ft. at the best, and, while often without a parting, in many cases it shows a clay parting of several inches, as in the last township. The roof is usually shale, though sandstone in some cases. The floor is generally clay, though in some cases shale. In many cases the top of the coal is of a bony nature.



Figs. 845-852. Sections of Coal II in Ts. 3, 4 and 5 S., R. 3 W.

1940. DISTRIBUTION AND DETAILS OF COAL. TOWNSHIP 3 SOUTH, 3 WEST.—Coal II runs through the hills in this township from 40 to 50 ft. above drainage. It is probably too thin to work in most places. The only mine at present in operation is the Geo. Miller bank, S. E. of Siberia ½ mi. The coal here is 2 ft. 6 in. to 3 ft. thick, with a 2 to 4 in. clay parting. The upper bench, 1 ft. 4 in. thick, blocks imperfectly or not at all, and has much poor coal, with thin dirt streaks. The lower bench is fair block coal. The roof is good, requiring no timbering in entry. (Fig. 845.)

West of Siberia three-quarters of a mile Coal II is reported by Mr. A. L. Conrad to be only about 12 to 15 in. and the two coal beds below it each about 3 ft. thick. Coal is reported on Michael Scritchfield's land, N. W. ¼ of Sec. 24-3-3.

1941. TOWNSHIP 4 SOUTH, 3 WEST.—Coal II runs through the hills of the western part of this township with some persistence. It is of workable thickness only over a small part of it.

At Clive Maine's, Sec. 2, the bed has been opened and a little coal dug. The coal here is only 18 in. thick. It is a bright, glossy black coal, apparently of good quality. The roof is black shale, with small mica flakes, overlain by 4 ft. of shelly sandstone.

Southeast of Adyeville 1½ mi., in Sec. 9, a drift has been started on Coal II. It is here a solid coal 2 ft. thick, the upper 6 in. being bony. This is on the John Walker place. The coal appears to be of fair quality, of a dull lustre, and may be mined by blocking. The roof is a soft gray shale 3 ft. 4 in. thick. (Fig. 847.) It lies about 40 ft. below the top of the hill and 40 ft. above Coal Ia and adjacent drainage.

At the Weasel bank, Sec. 30, the coal is 3 ft. 4 in. thick, with 6 or 8 in. of bone at the top and no clay parting. Generally the lower 6 in. is also somewhat bony. The roof is a dark blue shale that stands well. The coal is about 35 ft. above the creek bed. The coal here has numerous vertical clay veins from 1 to 6 in. thick.

At the M. A. Ross mine, in the N. E. of S. W. of Sec. 29, Coal II is worked. It shows a thickness of about 3 ft. 10 in. The coal shows at the top 8 in. of bone coal, then 2 ft. 6 in. of good coal, then at the bottom 3 in. of soft coal and bone. (Fig. 848.) Coal Ia lies 28 ft. below. Small clay veins 1 or 2 in. thick are common. Except the upper 8 or 10 in., the coal blocks out fairly well. There is about 3 in. of shale in the middle of the bed. The dip is to the southwest. Three rolls, cutting the coal down from 1 to 3 ft., were met with within 30 ft. of each other, about 250 ft. in. The coal lies about half way up the hill, which is about 60 ft. high.

Coal II averages about 2 ft. 3 in. thick at the John Fox mine, in the N. W. of S. E. of Sec. 31. It has a few thin clay veins. A sulphur or dirt band 1 to 3 in. thick generally runs 12 to 16 in. below the top. (Fig. 849.) The upper bench is a semi-block, the slip often being absent entirely. The lower bench blocks regularly. It is a hard coal of fair quality. The slips run approximately north and south and east and west. These slips occasionally become veins filled with clay. The roof is of rather hard gray shale, which stands up well. Below the coal is 6 or 8 in. of black carbonaceous shale. The entry lies about 30 ft. above Anderson creek, but a little below the level of the branch at its mouth.

In the N. W. ¼ of Sec. 33 a bank has been opened on Coal II. The bed here is solid and runs from 3 ft. 2 in. to 3 ft. 8 in. in thickness. (Fig. 846.) The coal here contains a good deal of sulphur in thin streaks and some soft coal. The bank has not been worked this season. The roof is a blue micaceous shale.

About a quarter of a mile southwest of the last named mine the same bed was formerly worked. The entry is now caved in and abandoned. Coal IIa outcrops in the road above the old drift at this point. (See section given above.) About one mile southwest of Bristow, in Sec. 34, Coal Ia outcrops at the roadside. It has been followed back about 15 ft. from the outcrop, but shows about 2 ft. of black carbonaceous shale and no coal. The same bed outcrops in the road about ½ mi. southwest of Bristow, while the Kaskaskia shale outcrops on the opposite side of a small ravine at about the same level. Apparently the relations of the two are unconformable here.

1942. Township 5 South, Range 3 West.—Coal II seems to be too thin to work over nearly all of this township. The greatest thickness which has been seen in the township is at Collins's bank, in the S. E. ¼ of Sec. 3, where the coal is 2 ft. 2 in. thick. The section here shows as follows (Sect. 942, Fig. 851, E. M. K.):

	Ft.	In.
1. Sandy shale	1	0
2. Sandstone	3	0
3. Hard gray sandy fire-clay	2	0
4. Soft dark blue shale .... 4 in. to	..	10
5. COAL II—Bone coal, 2 in.; dirt band, 2 in.; coal, 2 ft. 0 in. to	2	4
6. Dark blue shale	..	4
7. Sandy micaceous fire-clay	1	0+

The dirt band runs out in the mine so that there is generally a solid bed 2 ft. 2 in. thick. The coal is hard, bright, a semi-block, with much sulphur in nodules and thin sheets. The roof stands well. The entry is about 35 ft. below the top of the ridge and 40 ft. above the branch.

On the opposite side of the valley from the Collins bank, in the S. W. ¼ of Sec. 4, the bed shows a thickness of from 12 to 14 in. where it has been opened, with a sandstone above and hard sandy shale below. (Fig. 832.) The coal here lies about 40 ft. above drainage.

A massive ledge of Mansfield sandstone outcrops at frequent intervals along the west side of Middle fork and the south side of Sulphur fork. In places the cliffs are 35 to 40 ft. high. The following section shows the relation of this sandstone to the Kaskaskia:

1943. Section 943. Section in S. W. ¼ of Sec. 15 at Road Side.—(E. M. K.)

	Ft.	Ft.
1. Massive sandstone	20	20
2. Covered	5	25
3. Blue shale	1	26
4. Yellow sandy limestone	1	27
5. Blue shale	2	29

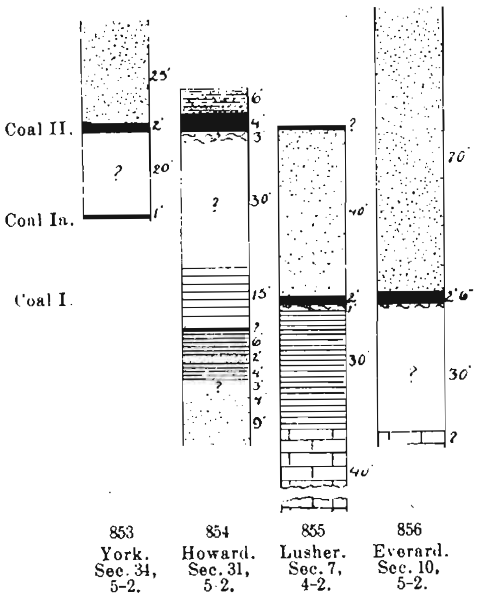
South of Sulphur fork Coal II is found at a number of places, but it appears to be everywhere too thin to work, even for local use. In the S. W. ¼ of Sec. 12 it is said to be about 14 in. thick where opened.

In the N. W. ¼ of Sec. 23, on Herman Tice's place, a drift has been driven on Coal Ia. The coal here is said to be 3 ft. thick. It is rather slaty and lies about 5 or 6 ft. above drainage. It will probably not be worked again, owing to the difficulty of draining and the inferior quality of the coal.

In the S. W. ¼ of Sec. 23 this vein is about 16 in. thick. (See section given above.) Near the Butler mill, in the S. E. ¼ of Sec. 31, coal is said to have been mined formerly.

Townships 3, 4, 5 and 6 South of Range 2 West.

1944. Geography.—This series of townships runs through the center of the county from north to south. They include portions of each of the civic townships in the county. The region is very hilly, the hills running from 250 to 400 ft. above drainage. The streams which drain this area are Oil creek and Poison creek, flowing east and southeast, and Deer and Anderson creeks, flowing south and southwest.



Figs. 853-856. Columnar sections in Ts. 3, 4, 5 and 6 S., R. 2 W.

1945. Stratigraphy.—Divisions I and II of the coal measures and the Kaskaskia compose the surface rocks of this area. The Kaskaskia sandstone outcrops in vertical cliffs 30 to 50 ft. high at many points, as in the vicinity of Branchville, along the valley of Deer creek, in township 6-2, and the south part of Sec 36-6-2. The Mansfield, where it is present, does not appear to be a massive sandstone generally.

The following sections will indicate the relations of the coal in these townships:

1946. Section 944. Section on York Farm.—S. E. of S. E. of Sec. 34-5-2, Fig. 853. (E. M. K.)

		Ft.
1.	Covered to top of hill	50
2.	Massive sandstone	25
3.	COAL II (not seen)	2
4.	Covered	20
5.	COAL Ia	1

1947. Section 945. Section from Dr. Howard's Mine, Eastward.—S. W. ¼ Sec. 31-5-2, Fig. 854. (E. M. K.)

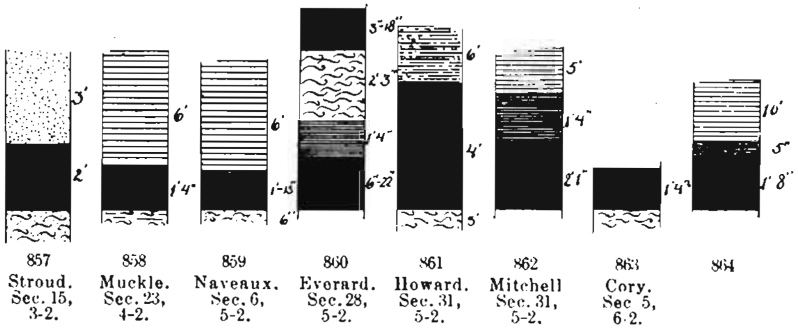
		Ft.
1.	Covered to top of hill	16
2.	Gray sandy shale	6
3.	COAL II	4
4.	Fire-clay	3+
5.	Covered	30+
6.	Gray clay shale	15
7.	COAL Ia	?
8.	Shale	6
9.	Sandstone	2
10.	Blue-gray clay and sandy shale	4
11.	Covered	3
12.	Sandy shale	3
13.	Thin-bedded sandstone	4
14.	Massive sandstone	9

1948. Section 946. Section at Abraham Lusher's.—Sec. 7-4-2, Fig. 855. (E. T. C., p. 90.)

		Ft.
1.	Space covered, mostly sandstone and shale	200
2.	COAL?, thin	..
3.	Massive sandstone	40
4.	COAL	2?
5.	Fire-clay	1
6.	Gray shales	30
7.	Archimedes limestone (Kaskaskia)	40
		313

1949. SECTION 947. SECTION AT GODFRIED EVERARD'S.—Secs. 10 and 11-5-2, Fig. 856. (E. T. C., p. 87.)

		Ft.	In.
1.	Covered	30	0
2.	Flags and massive conglomerate sandstone with pebbles	70	0
3.	Bituminous brown shale	1	0
4.	COAL I or Ia	2	6
5.	Fire-clay	1	0
6.	Covered	30	0
7.	Kaskaskia limestone	..	..



Figs. 857-864. Sections of coals in Ts. 3, 4, 5 and 6 S., R. 2 W.

1950. COAL II AND IA.—The figures given indicate a workable thickness for these coals at only one place The seams are usually solid, though at the Everard bank there are two benches separated by 2 ft. 3 in. of clay and 1 ft. 4 in. of black shale. The roof is generally shale, often black, though sandstone reaches the coal in a few instances. The floor is usually fire-clay, often sandy.

1951. DISTRIBUTION AND DETAILS OF COAL.—Beginning in the north, Coal II is everywhere too thin to work, so far as known, except at Henry Stroud's, in the N. W. ¼ of Sec. 15-3-2, where it is said to be 2 ft. thick. The coal here has a sandstone roof and a sandstone or hard sandy clay floor. (Fig. 857.) The bed lies about 30 ft. below the top of the ridge.

In the S. W. ¼ of Sec. 15, Coal II is reported as 18 in. or less in thickness, on the Humphrey place.

A little coal has been dug on Dr. Cannelman's land, in the N. E. ¼ of Sec. 3, from Coal II. The bed here is thin. The bank is caved in and the coal is not exposed at present. It lies about 20 ft. below the top of the ridge. In the S. W. ¼ of Sec. 23-4-2 coal has been dug from

the outcrop on Ann Muckle's land. The coal here is a bright black of very good quality, but only about 16 in. thick. The roof is dark gray shale 6 ft. plus thick, and the floor black shale. A sulphur band occurs 2 in. from the top. (Fig. 858.) The coal lies within 25 ft. of the top of the ridge. A small quantity of coal has been dug on the land of Louis Fleming, in the N. E. ¼ of Sec. 22, and on Thomas Quinlan's land, in the N. E. ¼ of Sec. 27, the same seam has been worked in a small way for local use. Coal Ia has been opened on John Lannan's land, in the S. E. ¼ of Sec. 31-4-2. The coal is said to be of poor quality here. Coal Ia has been opened on Jos. Naveaux's land, in the N. W. ¼ of Sec. 6-5-2. It is from 12 to 15 in. thick at this place. (Fig. 859.) The coal is block, of a fair quality, with a gray clay shale roof and a hard sandy fire-clay floor. A few 1 in. clay veins run through the coal here from the roof. It lies about 30 ft. above the Kaskaskia limestone, which in turn lies from 25 to 60 ft. above drainage.

Over the south part of township 5-2 the coal reaches a workable (?) thickness at many places. At Badger's bank, S. W. ¼ of Sec. 26, it runs from 20 to 24 in. A section here shows (Sect. 948, E. M. K.):

		Ft.	In.
1.	Sandstone, soft brownish	18	0
2.	Blue gray shale ....6 in. to	..	0
3.	Black carbonaceous shale ....1 in. to	0	2
4.	COAL II, block ....1 ft. 8 in. to	2	0
5.	Fire-clay	1	6+

The lower 3 or 4 in. of the seam is somewhat bony. It is a fairly hard coal, without parting or sulphur bands. It mines in blocks 10 to 20 in. square, and is rather a coarse-structured coal, with plenty of sulphur in thin sheets. It is said to clinker but little. It is about 35 ft. below the top of the ridge.

At Thos. Snider's, in the N. E. ¼ of Sec. 21-5-2, the coal was formerly worked by a drift, but the mine has been abandoned for two or three years. Coal here is about 50 ft. above drainage. It had 6 or 8 in. of bone and black shale at the top and a dove gray fire-clay roof, which caved badly.

Along the high ridge in the southwestern corner of township 5 S., 2 W., the seam reaches a thickness of from 3 to 4 ft. The clay parting runs from 4 ft. at Everard's mine to 0 at Dr. Howard's.

At Mr. John B. Everard's, in the N. W. or S. W. of Sec. 28-5-2, the coal shows the following section (Sect. 949, Fig. 860, E. M. K.):

		Ft.	In.
1.	COAL ....18 in. to	1	1
2.	Gray fire-clay	2	3
3.	Black shale	1	4
4.	COAL ....1 ft. 10 in. to	1	4
5.	Sulphur band	0	1
6.	Fire-clay ....6 ft. to	0	8
7.	Sandstone	..	..

In the upper bench the slips are irregular or wanting, and in the lower bench they are not as regular as is usual with this bench. The roof stands fairly well; some rolls are met with, and it is weakened by "breakers" (joints?) in places, so that it tends to come down. Coal Ia outcrops 30 or 40 ft. below, and was formerly mined a little.

On John Mitchell's land the coal is 2 ft. 1 in. thick, overlain by 16 in. of carbonaceous shale, and that by 5 ft. of dove gray shale, and underlain by fire-clay.

At the Reason Howe bank the coal shows this section (Sect. 950, E. M. K.):

		Ft.	In.
1.	Blue gray shale	..	..
2.	COAL	1	6
3.	Clay band	..	4
4.	COAL	1	9
5.	Fire-clay, very hard	..	..

Some of the coal is a bright, glossy, rich-looking coal, while in other places it is of a dull lustre. It contains a good deal of sulphur in thin sheets. Blocks quite regularly. Located about half way up the hill, which is about 50 ft. high.

Dr. W. C. Howard's bank is just south of this. The coal runs from 3 ft. 9 in. to 4 ft. 2 in., with an average of about 4 ft. There is no dirt streak in the coal here nor other irregularity. The roof is a sandy gray shale, 6 ft. thick, and the floor fire-clay, 3 ft. thick. See above for a section running down the ravine into Sec. 5-6-2 from this bank. (Figs. 854, 861.)

A little coal has been dug from the outcrop on Mr. York's land, in the S. E. ¼ of Sec. 34-5-2. (See section given above.)

East of Don Juan ½ mi., Coal II was mined several years ago. The coal has 25 ft. of massive cross-bedded sandstone over it here.

In the N. E. ¼ of Sec. 5-4-2, Coal Ia has been dug from the outcrop for home use, on the Mariam Covy place. The section here shows (Sect. 951, E. M. K., Fig. 863):

		Ft.	In.
1.	Shelly sandstone	..	..
2.	Covered	..	..
3.	COAL Ia	1	4
4.	Fire-clay	2	?
5.	Covered	4	0
6.	Blue soft shale	1	2
7.	COAL I	..	7
8.	Fire-clay	1	0+

Coal Ia lies about 25 ft. above the branch and is said to be very good. This seam has been worked a little from the outcrop at the following points: In the N. W. ¼ of Sec. 19-4-2; on the farms of Curtis Smith and Wm. Schroeder, N. W. ¼ of Sec. 20-4-2. The stratigraphical position of the coal in Sec. 19 is not clear, as this is below the level of a 15 ft. ledge of Kaskaskia limestone that outcrops a quarter of a mile up the creek. The coal is said to have been 2 ft. thick, and is probably Coal I or Ia. At Mr. Smith's, Coal Ia is about 18 in. thick. Apparently it belongs under the massive sandstone, 20 ft. thick, which here lies just above the Kaskaskia shale, a relation brought about by the unconformity.

At Mr. Schroeder's, coal has been dug from two beds, the upper of which is 9 in. thick and the lower 10 in., but the lower one runs out or is cut off by a fault. They are about 35 ft. apart. About 300 yds. below this the Kaskaskia sandstone outcrops as a massive ledge 25 or 30 ft. thick. A section on hill east of the Schroeder bank showed (Sect. 952, E. M. K.):

		Ft.	In.
1.	Sandy shale to top of hill	6	0
2.	COAL II, not seen	0	9
3.	Covered	3	0
4.	Thin-bedded sandstone	4	0
5.	Green clay shale and sandy shale	20	0
6.	COAL Ia	0	10
7.	Fire-clay and shale	1	3
8.	Sandstone and sandy shale	4	0
9.	Covered	15	0
10.	Sandstone, thin-bedded	3	0

The massive Kaskaskia sandstone comes at about a level between the two coal beds, indicating again the unconformity.

A small amount of coal was dug on German ridge, in the S. E. ¼ of the N. W. ¼ of Sec. 25-6-2, about thirty-five years ago, from Coal Ia. The bed is only a few inches thick at this point.

1952. SUMMARY OF COAL FOR PERRY COUNTY.—By Mr. E. M. Kindle.

Divisions contained: I, II, III?.
Coals contained: I, Ia, II, IIa, IIb+.

ROUND NUMBER ESTIMATES.

Coal II.

Worked area......	800 acres	× av. thickness,	3 ft. ×	1,000 =	2,400,000 tons.
Worked area......	400 acres	× "	2½ ft. ×	1,000 =	1,000,000 tons.
Workable area ...	3,500 acres	× "	2½ ft. ×	1,000 =	8,750,000 tons.
Unworkable area	10,000 acres	× "	15 in. ×	100 =	15,000,000 tons.
Total area....					26,150,000 tons.

Other Coals.

Unworkable area 13,000 acres × av. thickness 8 in. × 100 = 10,400,000 tons.

Number of coals contained: 7 (about).
Greatest thickness recorded: 5 ft., Coal II. at Cannelton.
Area underlain by coal: 30 sq. mi.
Area underlain by workable coal: 6 sq. mi.
Estimated total tonnage of coal: 36,500,000.
Estimated total tonnage of coal removed: 3,400,000.
Estimated total tonnage of workable coal left: 8,750,000.
Number of mines working ten men or over in operation: 2.
Number of mines working less than ten men in operation: 38.
Total number of mines in operation: 40.
Mines not in work: 67.
Strippings, outcrops, etc.: 56.
Total number of openings to coal: 163.

XXXVI. SPENCER COUNTY.

(BY J. A. PRICE.)

1953. REFERENCES AND FIELD WORK.—

1862 (1859-60). Richard Owen, Rep. of Geol. Reconn. of Ind., p. 186. One analysis. (R. O.)

1862 (1859-60). Leo Lesquereux, same, pp. 308-311. One columnar section. (L. L.)

1871 (1870). E. T. Cox, 2d Rep. Geol. Surv. of Ind., pp. 145-155. Two columnar sections, eleven coal analyses. (E. T. C.)

1896 (1895). W. S. Blatchley, Ind. Dept. of Geol. and Nat. Reso., 20th Ann. Rep., pp. 121-122. (W. S. B.)

1898, May-July. J. A. Price, field work for this report.

Section. 1. Geography.

1954. LOCATION.—Spencer county is an irregularly elongated county, situated in the southwestern part of the State on the Ohio river. On the north it is bordered by Dubois and Warrick counties, on the west by Warrick county and on the east by Perry county.

1955. EXTENT.—This county has an area of about 389 sq. mi., with a maximum width from east to west of 21 mi. and a length of 34½ mi. from the northeastern corner to the Warrick county line at the southwestern corner. The county is divided into nine civil townships and includes all or part of the following congressional townships: 4 S., 4 and 5 W.; 5 S., 3, 4, 5 and 6 W.; 6 S., 3, 4, 5, 6 and 7 W.; 7 S., 5, 6, 7 and 8 W., and 8 S., 6 and 7 W.

1956. GENERAL TOPOGRAPHY.—The eastern part of the county is very rough, the surface broken into high hills and sharp ridges, with narrow intervening valleys. The hills rise from 50 to 240 ft. or more, with precipitous walls and overhanging cliffs. Farther west the hills are lower, with gentle slopes running off into broad valleys. To the west and south along Pigeon creek and the Ohio river there is a wide stretch of bottom land, varying in width from a mile to 6 mi. or more. From the Ohio river at Rockport to a point some 8 mi. west is a triangular body of hilly uplands, the hills rising from 30 to 60 ft. above the surrounding plains. The level lands of the southwestern part of the county have been divided into three plains—Lake plain, Pigeon plain and River plain. Lake plain, on the northeast, extends northwest from Swan pond ditch, north of Rockport, to, and a mile or more beyond, Lake mill, in the N. E. ¼ of Secs. 6, 7 S., 6 W., where it merges into Pigeon plain, which extends southeast of Pigeon creek to the Ohio river, including the level lands around Richland.

The River plain includes the level land along the Ohio river south of Rockport and north to Grandview. (See accompanying map.) These plains are comparatively level and below the high water mark of the Ohio river, the flood waters having passed through Lake plain into Pigeon creek twice in the last two decades—1883 and 1884.

It is quite possible that at one time the Ohio river turned northwest, north of the present site of Rockport, and flowed northwest through Lake plain, past Lake mill, and entered what is now known as Pigeon valley, north of Richland, where it turned south and entered its present valley between Enterprise and the Warrick county line.*

*For further discussion of this subject see Arthur Veatch's report on "An Old River Channel in Spencer County, Indiana," in the Proceedings of the Indiana Academy of Science for 1897.

1957. DRAINAGE.—The principal stream is the Ohio river, which forms the southern boundary of the county and receives the streams from the north. The extreme eastern part of the county is drained by Anderson river, a meandering stream with a narrow valley, enclosed between high and broken banks. To the west, and including the central part of the county, Crooked, Big Sandy and Little Sandy creeks flow south into the Ohio. The level lands of the northwest are drained by a number of small ditches leading off to the south into the Ohio and to the west into Pigeon creek, which bounds the county on the west.

1958. TRANSPORTATION FACILITIES.—The L., E. & St. L. C. R. R., Rockport division, crosses the county from north to south, passing through Lincoln City, Chrisney, and ending at Rockport. The Cannelton branch of the same road crosses the county from northwest to southeast, from Lincoln City to Anderson river, one mile above Maxville. The Evansville division of the L., E. & St. L. C. R. R. crosses the northern half of township 5 south, range 6 west. As stated above, the Ohio river bounds the county on the south and affords a splendid outlet for commerce to points east and west.

Section 2. Stratigraphy.*

1959. SURFACE GEOLOGY.—The outcropping strata of this county belong in the coal measures, the lowest numbers being exposed in the eastern part of the county along Anderson river. Farther west, higher members outcrop, the highest in the county capping the "knobs" north of Rockport and west of Centerville. Massive sandstone, which belongs in Division II, outcrops at a number of places. Typical exposures are found along Anderson river and Dead Fall creek in the east and along the Ohio river at Rockport. Heavy alluvial deposits occur on Pigeon, Lake and River plains.†

*There has been considerable question about the correctness of local correlations in the southeast corner of this county, principally through a possible confusion of the two limestones in Division III. At many places only one limestone is found over considerable area, and under conditions that render it difficult to say whether it is the upper or lower. Thus the worked coal along the eastern edge of the county is correlated as Coal IIa, upon the assumption that a limestone over it is the lower limestone. The statigraphy of this coal, however, has so many points of resemblance to Coal III near Buffaloville and elsewhere, that it has been thought the limestone referred to is either the upper limestone or the lower limestone well separated from its coal. Mr. Price's determinates, however, are followed in this report. G. H. A.

†See Mr. Veatch's report referred to above.

1960. COAL MEASURES.—The accompanying table will show the divisions and coals occurring in this county, with their measurements:

Division IV—
1. Space above Coal IV, sandstone and shale.
2. Coal IV found in the "knobs" north of Rockport and west of Centerville.

Division III—
3. Fire-clay, shale, sandstone and limestone, shales predominating.
4. Coal IIIb. Not persistent. Only workable at a few places in county.
5. Fire-clay, shales and sandstone, sandstone predominating.
6. COAL IIIa. Mined at Dale station, west of Enterprise, 1½ mi. southwest of Mariah hill, and a number of other points in the county.
7. Fire-clay, shale, slate and limestone, shale predominating.
8. Coal III. Probably the most persistent coal found in the county. Semi-block to block coal.

Division II—
9. Shale and sandstone.
10. Coal IIa. Mined around New Boston. Not persistent; runs out to the north and west.
11. Sandstone and shale.
12. Coal II. Mined south of St. Meinrad along Anderson river. Rather persistent along the eastern edge of the county, but probably runs out farther west.

Near St. Meinrad a number of thin coals were observed and noted in Division II, but being found at only this one place, they were not included in the above summary. The following section made along the hill between Black Hawk creek and Anderson river, one-quarter of a mile northeast of St. Meinrad, will give these thin coals with intervening strata (Sect. 953):

		Ft.	In.	Ft.	In.
1.	Surface	5	0	5	0
2.	Shale and shaly sandstone	10	0	15	0
3.	COAL ......1 in. to	0	2	15	2
4.	Sandstone	15	0	30	2
5.	Shale and shaly sandstone	5	0	35	2
6.	Covered (probably shale)	4	6	39	8
7.	Soft sandstone	5	6	45	2
8.	Covered	3	6	48	8
9.	Shale with cross-seams	8	0	56	8
10.	COAL	0	1	56	9
11.	Fire-clay	0	2	56	11
12.	Shale	2	6	59	5

		Ft.	In.	Ft.	In.
13.	COAL	0	5	59	10
14.	Shale	6	0	65	10
15.	Sandstone	1	0	66	10
16.	Sandstone and shale	4	6	71	4
17.	Covered	25	0	96	4
18.	Sandstone	7	0	103	4
19.	Shale	10	0	113	4
20.	Covered	4	0	117	4
21.	COAL II	4	0	121	4

Sandstone No. 4 is quarried. Stone for St. Meinrad Abby was quarried here. The stone is divided into 6 strata, 1½ ft., 1½ ft., 1 ft., 1½ ft., 3 ft. and 1½ ft., respectively, from top to bottom. The color of the stone is not constant.

Coal II (No. 21) is not found in the hill. Its horizon is probably below the foot of the hill in Black Hawk creek bottoms; but it is found just across the creek near the foot of the small hill on the south side of the creek.

Section 3. Distribution and Local Details.

Township 4 South, Range 4 West.

1961. Geography.—This township is located in the northeastern corner of the county, including the northern part of the civil township of Harrison. The only town in this township is St. Meinrad, situated on Anderson river at the mouth of Black Hawk creek, in Secs. 13 and 14. With the exception of one mile and a half, the eastern boundary is formed by Anderson river, which receives a number of small streams from the West, the largest of which are Pinch creek and Black Hawk creek.

A high ridge crosses the township from north to south, dividing it into halves, the eastern half drained by Anderson river and its affluents and the western half by Crooked creek and Hudson creek.

This township is very rough, especially the eastern half, where the hills rise from 100 to 240 ft. above the creek valleys. The western half is not so broken; the hills are probably as high, but the slopes not so precipitous. The valley of Anderson river varies in width from one-quarter to one-half a mile or more. The nearest railroad is the L., E. & St. L. C. R. R., three miles to the west. The Cannelton branch of the same road is three and a half to five miles away to the south.

1962. Stratigraphy.—The outcropping strata of this township belong in Divisions II and III, with two coals exposed, Coals III and II. Three very thin coals were noted at one point in the township,

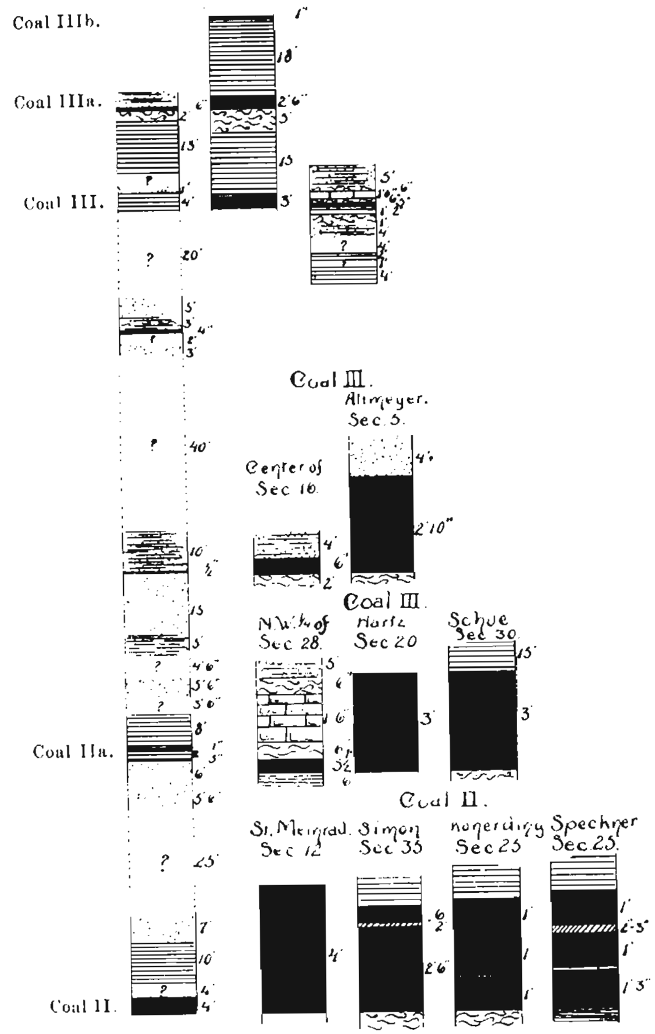


Plate LXVIII. Columnar and coal sections in T. 4 S., R. 4 W.

but as they seem to be very "pockety," in fact observed at but this one place, no attempt was made toward correlating them. They belong in Division II. Coal IIa of township 5 south, range 4 west, thins down in coming north and occurs in this township only as basins. Coal II found in this township probably runs out in going south into township 5 south, 4 west. The following sections give the coals, with their accompanying strata and thickness:

1963. SECTION 953. SECTION ONE-FOURTH MILE NORTHEAST OF ST. MEINRAD.—In the S. W. ¼ of Sec. 12, Plate LXVIII.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	5	0	..	..	5	0
2. Shale and shaly sandstone	10	0	..	..	15	0
3. COAL ... 1 in. to	0	2	0	2	15	2
4. Sandstone	15	0	..	..	30	2
5. Shale and shaly sandstone	5	0	..	..	35	2
6. Covered	4	6	..	..	39	8
7. Soft sandstone	5	6	..	..	45	2
8. Covered	3	6	..	..	48	8
9. Shale	8	0	41	6	56	8
10. COAL	0	1	0	1	56	9
11. Fire-clay	0	2	..	..	56	11
12. Shale	2	6	2	8	59	5
13. COAL IIa (?)	0	5	0	5	59	10
14. Shale	6	0	..	..	65	10
15. Sandstone	1	0	..	..	66	10
16. Sandstone and shale	4	6	..	..	71	4
17. Covered	25	0	..	..	96	4
18. Sandstone	7	0	..	..	103	4
19. Shale	10	0	..	..	113	4
20. Covered	4	0	77	6	117	4
21. COAL II	4	0	4	0	121	4

In the S. W. ¼ of the N. E. ¼ of Sec. 2, and probably 40 ft. above the top of the foregoing section and 30 ft. below Coal III, occurs an outcrop of coal 4 in. thick This coal is very irregular and not at all persistent.

1964. SECTION 954. SECTION ALONG THE WAGON ROAD.—In the S. W. ¼ of the N. E. ¼ of Sec. 2.

	Ft.	In.
1. Covered	22	0
2. Sandstone	1	0
3. Shale	4	0
4. Covered	20	0
5. Sandstone, massive	5	0
6. Shale? and fire-clay?	2	0
7. Fire-clay	1	0
8. COAL	0	4
9. Covered	2	0
10. Sandstone, massive	3	0
	60	4

Exposures along the road from the top of the above section to Coal III seem to be largely of sandstone and shale.

1965. SECTION 955. SECTION ALONG THE HILL ONE-HALF MILE WEST OF ST. MEINRAD.—In S. E. ¼ of the N. W. ¼ of Sec. 14.

	Ft.	In.
1. Surface	2	0
2. Shale	7	0
3. Shale and flaggy sandstone	4	6
4. Shale to fine shaly sandstone	20	0
5. Sandstone	4	0
6. Shaly sandstone	2	0
7. Massive sandstone	5	0
	44	6

1966. SECTION 956. SECTION NEAR THE CENTER OF SEC. 16.—

	Ft.	In.	Ft.	In.
1. Soil	5	0	5	0
2. Sandstone and shale	4	0	9	0
3. COAL IIIa	0	6	9	6
4. Fire-clay	2	0	11	6
5. Shale	13	0	24	6
6. Covered	30	0	54	6

The lines of outcrop of Coals III and II are shown on the map. Coal II, if it is persistent, underlies all of the township except the extreme eastern part, and Coal III underlies the greater part of the western half of the township, outcropping on the east side and near the top of the dividing ridge between Anderson river and Crooked creek. Years ago, what seems to be this coal was drifted upon at Paul Wigger's, in the N. W. ¼ of the N. W. ¼ of Sec. 16, and at F. Wigger's, in the S. W. ¼ of Sec. 9. A crop of coal 6 in. thick was noted in the road near the center of Sec. 16. See above section.

This coal outcrops in the road running east and west across the N. W. ¼ of Sec. 28, 200 yds. west of the Troy and Jasper road (Sect. 958, Plate LXVIII):

	Ft.	In.
1. Surface	20	0
2. Shale and sandstone	5	0
3. Fire-clay, with coal trace	0	6
4. Hard, blue, fossiliferous limestone	1	6
5. Fire-clay	0	6
6. COAL III	0	5½

		Ft.	In.
7.	Blue shale	0	6
8.	Shale	0	8
9.	Fire-clay with coal traces	1	0
10.	Sandstone	2	0
11.	Shale and sandstone	2	0
12.	Covered	4	0
13.	Shale	2	0
14.	Covered	1	0
15.	Shale	4	0
		45	1½

Coal III was worked by a drift six years ago on the Hollander place, in N. E. ¼ of the S. E. ¼ of Sec. 19. Entrance closed at time of examination. Coal said to be 3 to 3½ ft. thick. Some coal has been drifted upon at Hartz's, in the S. W. ¼ of the S. W. ¼ of Sec. 20. Coal said to be a fairly good quality of coal. Average thickness of the coal is something near 3 ft. This same coal and Coal IIIa outcrop in the road in the S. W. ¼ of Sec. 20. Coal III has been worked at Adam Schue's, in the N. E. ¼ of the N. W. ¼ of Sec. 29, on the farm belonging to the Vortmann heirs, in the S. W. ¼ of Sec. 30, and at Schue's, in the N. E. ¼ of the N. W. ¼ of Sec. 30, where the following report was obtained: The coal varies in thickness from 3 ft. 3 in. to 3 ft., with an average of about 3 ft. Block to semi-block, with close cross seams—½ in. at farthest. Some little sulphur near the top. Dips to the northeast, with small rolls occasionally, but no faults. Burns well, leaving quite a lot of ashes, and makes no small amount of smoke and soot. The blacksmith at Mariah Hill says the coal is too light for shop use. Leaves but very few clinkers, but burns up quickly and goes out too soon. The roof is a shale some 12 or 15 ft. thick. Floor of fire-clay, shale and copperas rock. The following section of the hill near by was given by Mr. Schue (Sect. 959, Plate LXVIII):

		Ft.	In.
1.	Surface	6	0
2.	COAL streak IIIb	0	1
3.	Shale (?)	18	0
4.	COAL IIIa	2	6
5.	Fire-clay and soil	5	0
6.	Shale (?)	15	0
7.	COAL III	3	0
8.	Shale	0	4
9.	Copperas rock	0	1+
		50	0

These three coals, III, IIIa and IIIb, are found on the Vortmann place, in the S. W. ¼ of Sec. 31.

In the N. W. ¼ of Sec. 2 and the N. E. ¼ of Sec. 3, cherty limestone outcrops high on the hills locating the horizon of Coal III. What was considered as the same limestone outcrops in the road near the foot of the hill, near the center of the west side of the N. W. ¼ of Sec. 6.

1967. COAL IIIa.—This coal outcrops at a number of places in the N. W. ¼ of the township, and was noted, or reported, at but few places in the S. W. ¼ of the township. It is a thin coal and is worked at but a few places. Outcrops were noted in the N. E. ¼ of Sec. 18. Said to have been worked years ago on the Tretter place, in the N. W. ¼ of Sec. 17, on the Pund place, in the S. E. ¼ of the S. W. ¼ of Sec. 8, and on the Spayd place, in the S. W. ¼ of Sec. 8.

Section of a hill near the center of the south side of the S. W. ¼ of Sec. 6 (Sect. 960):

		Ft.	In.
1.	Surface	4	6
2.	Thin-bedded sandstone	1	0
3.	COAL IIIa	0	5
4.	Fire-clay	2	0
5.	Drab shale	15	0
		22	11

Section at John Metzger's, in the N. E. ¼ of the S. W. ¼ of Sec. 5 (Sect. 961):

		Ft.	In.
1.	Shaly sandstone	5	0
2.	COAL IIIa	0	7
3.	Fire-clay	1	6
		7	1

This coal has been drifted upon at Altmeyer's, in the S. E. ¼ of the N. E. ¼ of Sec. 5. The coal has an average of 34 in., but may run as low as 31 in. or as high as 37½ in. Section of the coal as found in the main entry (Sect. 962):

		Ft.	In.	Ft.	In.
1.	Hard bone COAL	0	1	0	1
2.	Hard and solid with sulphur threads	1	2	1	3
3.	Rather soft and dirty	1	1	2	4
4.	Soft, with sulphur balls	0	5	2	9
5.	Hard and lustrous	0	4½	3	1½

The roof is a solid sandstone, 4 ft. and more thick. Floor is a fire-clay. Coal dips to the east. This drift was worked last season with an output of 1,500 tons. The coal supplies local trade. The picked coal is used by the blacksmiths. This same coal has been worked on Rahman's place, in the N. W. ¼ of the N. E. ¼ of Sec. 5. Said to be in Jno. Shafer's well near by, in the same quarter section.

The coal outcrops in the road at the foot of the hill, in the N. E. ¼ of the N. E. ¼ of Sec. 5.

1968. Coal II.—The line of outcrop of this coal is shown on the map, coming low in the hills west of the flood plains of Anderson river. Ten years ago this coal was worked by a drift on Philip Simon's place, in the N. E. ¼ of the N. E. ¼ of Sec. 35. Bituminous to semi-block, varying in thickness from 3½ ft. to 1½ ft. Six inches from the top is a sulphur seam 2 in. thick. The coal above this seam is hard and lustrous. Roof is a hard shale. Floor is a fire-clay. The coal is probably 15 or 20 ft. above high water of Anderson river.

This coal has been drifted upon by two drifts, one old one at Konerding's, in the N. W. of the S. W. ¼ of Sec. 25. The coal runs from 3 to 4 ft. in thickness and is divided into three benches by discontinuous sulphur seams. The upper bench is 1 ft. thick, the middle bench 1 ft. 3 in. thick, and the lower one 1 ft. thick. Dips to the west. The roof is a coarse-grained blue to gray shale that holds up fairly well. Floor is a fire-clay. One of the drifts was worked some during last winter, with an output of 600 tons.

At the Speckner mine, in the S. W. ¼ of the N. W. ¼ of Sec. 25, this coal has been drifted upon. The miner reported the coal 3½ to 5 ft. thick, with an average of 4 ft. The coal is divided into three benches by sulphur seams. The top seam, 2 to 3 in. thick, is 1 ft. from the top. Above this seam the coal is hard and lustrous. Below the top sulphur seam is 10 to 12 in. of bituminous to semi-block, used by smiths for shop use. The bottom bench, 14 or 15 in. thick, is a bituminous coal and a good steam coal. The 4 or 5 in. of slate under the lower bench is used for mining. The roof was reported as a hard blue shale 12 or 15 ft. thick. Coal dips to the south with few rolls and one fault 50 ft. from the entrance; only a drop of 4 in.

During the last year 360 tons of coal have been taken out at the one drift now worked. The other and old drift has not been worked for some time.

This coal is mined extensively at the Monastery mine, in the N. E. ¼ of the N. E. ¼ of Sec. 26; some 800 tons having been mined during

last winter. Just west of the Monastery mine Conrad Lampert has worked the coal by a drift; also in the N. E. ¼ of the N. W. ¼ of the section.

The physical properties, roof, floor and quality of the coal, are about the same as at the above mentioned mines. The same coal is mined at the Fall mine, on Vaal's place, in the S. E. ¼ of the N. W. ¼ of Sec. 23, and formerly, but on a smaller scale, at the shaft on Mary New's place, in the northwestern part of St. Meinrad. At this mine the coal measured 27 in. No coal mined for two years.

Some coal is said to outcrop along the south bank of Black Hawk creek, in the N. W. ¼ of the N. W. ¼ of Sec. 14. A coal, some 30 or 40 ft. higher, was said to have been worked years ago by a drift in the north part of St. Meinrad. This is probably Coal IIa. At time of examination entrance to the drift was closed.

Township 5 South, Range 4 West, and a Part of Township 5 South, Range 3 West.

1969. Geography.—This township and partial township lie in the center of the eastern side of the county and are included in the southern part of Harrison and the northern half of Huff townships.

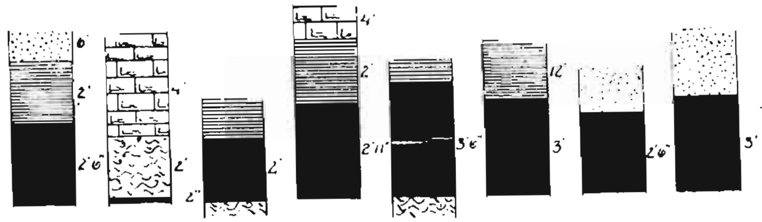


Fig. 865. Section of Coal IIIa in Ts. 5 and 6 S., R. 4 W.
Figs. 866-868. Sections of Coal III, same area.
Figs. 869-872. Sections of Coal IIa, same area.

New Boston, a small village, is situated in the southeastern corner of this territory and Fulda in Sec. 3, 5 S., 4 W., along the north side. Anderson river on the east drains the eastern side of township 5 south, range 4 west, and all of the partial township of 5 S., 3 W. The central and western parts of township 5 S., 4 W., are drained by Crooked and Little Crooked creeks.

The topography runs from high broken hills, rising from 50 to 200 ft., with abrupt slopes to narrow creek valleys, the widest one, that of Anderson river, on the east. Three high ridges enter the township on the north and extend south three miles or more—one between Anderson river and Little Crooked creek which crosses the township; another between the two forks of Little Crooked creek, which extends as far south as Sec. 22, township 5 S., 4 W., and the third one between the west fork of Little Crooked creek and Crooked creek, reaching south to Sec. 20, township 5 S., 4 W. The Cannelton branch of the L., E. & St. L. C. R. R. crosses the southeastern corner of township 5 S., 4 W.

1970. STRATIGRAPHY.—The outcropping strata of this township and partial township belong in Divisions II and III, with two coals exposed, Coals IIa and III. Coal II is pierced in a well at Fulda. The upper part of the high ridges running north and south is included in Division III, and the lower half with the southeastern part of the township is included in Division II.

The following sections from different parts of the townships will give the stratigraphy, with coals and their accompanying strata.

1971. SECTION 963. STRATA AS EXPOSED ALONG THE HILL WEST OF LITTLE CROOKED CREEK.—In the N. E. ¼ of the S. E. ¼ of Sec. 28.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	1	6	..	..	1	6
2. Red clay and fire-clay	3	0	..	..	4	6
3. Hard sandstone with iron	0	6	..	..	5	0
4. Blue shale	1	6	..	..	6	6
5. COAL III?	0	6	0	6	7	0
6. Red clay and fire-clay	3	0	..	..	10	0
7. Shale with cross-seams	2	0	..	..	12	0
8. Red clay and fire-clay	1	0	6	0	13	0
9. COAL IIa (?)	0	2	0	2	13	2
10. Fire-clay	2	0	..	..	15	2
11. Massive sandstone	10	0	..	..	25	2
12. Covered	6	0	..	..	31	2
13. Drab shale	4	0	..	..	35	2
14. Hard white sandstone	0	6	..	..	35	8
15. Fire-clay	1	0	..	..	36	8
16. Shale	2	0	..	..	38	8
17. Hard calcareous sandstone	2	0	..	..	40	8
18. Shale and clay	4	0	..	..	44	8
19. Drab shale	25	0	..	..	69	8
20. Hard calcareous sandstone	4	0	..	..	73	8
21. Covered to bed of Little Pigeon creek	20	0	..	..	93	8

To the north one-quarter of a mile, at the Mann mine, the coal is reported 4½ ft. thick. This coal seems lower in the hill than the lower coal in the foregoing section. Probably a different coal and not found in the hill where the section was run. The coals of this township are very irregular and "pockety."

1972. SECTION 964. SECTION OF A DRILLED WELL IN FULDA.—On Jno. Schneider's lot, as reported by Mr. Schneider.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil	12	0	..	..	12	0
2. Sandstone	8	0	..	..	20	0
3. COAL IIIa	0	8	0	8	20	8
4. Fire-clay	2?	0	..	..	22	8
5. ?	6	0	..	..	28	8
6. Limestone, hard	4	0	12	0	32	8
7. COAL III	0	8	0	8	33	4
8. Limestone	16?	0	..	..	49	4

1973. SECTION 965. SECTION OF DRILLED WELL.—At the flouring mill at Fulda, as reported by Ferdinand Lidaner, of that place.

	Ft.	In.	Ft.	In.
1. Soil	6	0	6	0
2. Sandstone	4	0	10	0
3. COAL IIa	0	6	10	6
4. Sandstone, hard	20 or 25	0	35	6
5. Shale	10	0	45	6
6. Soft white sandstone	75 or 76	0	121	6
7. COAL II	5 in. to 0	6	122	0
8. Shale and sandstone	58	0	180	0

This well is on grounds some 30 or 40 ft. lower than the Schneider well, and Coal IIa in this well is not found in the Schneider well.

Section along the hill south of the cross roads three-quarters of a mile southeast of Fulda (Sect. 966):

	Ft.	In.
1. Surface	20	0
2. Shale to shaly sandstone	9	0
3. Gray shale	2	0
4. Covered	3	0
5. Hard white and calcareous sandstone	1	6
6. Shale to shaly sandstone	15	0
7. Light drab shale	12	0
8. Covered with soil and hard calcareous sandstone	10	0
	72	6

Limestone was noted at a number of places along the road running south from Fulda to New Boston. The line of outcrop of Coal III is shown on the map, occurring rather high in the ridges. Limestone and a thin coal outcrop in the road high on the hill in the S. W. ¼ of Sec. 11. Coal 2 in. thick. Below is section of the hill (Sect. 967, Fig. 866):

	Ft.	In.
1. Surface	3	0
2. Shaly limestone	0	10
3. Limestone	4	0
4. Clay	2	0
5. COAL III	0	2
6. Covered to bottom of hill	40	0
	50	0

Limestone, marking the horizon of Coal III, outcrops in the road three-quarters of a mile west of Fulda. It is hard and bluish and 2 ft. thick.

Coal III has been worked by a slope on Andrew Rupprecht's place, in the N. W. ¼ of the S. E. ¼ of Sec. 4. Coal varies in thickness from 1 ft. 6 in. to 2 ft. 6 in.,with an average of 2 ft. (Fig. 867); semi-block with few sulphur balls. Dips to the west. Ten or 15 ft. above adjacent drainage. A ditch 3 ft. deep is needed to drain the slope. This slope was worked last season. Has shale roof and fire-clay floor. Below is a section along the small branch which is near the Rupprecht drift (Sect. 968):

	Ft.	In.
1. Surface	5	0
2. Shale and sandstone	5	0
3. Soft massive sandstone	8	0
4. Clay	1	0
5. Covered	30	0
6. Clay	3	0
7. COAL III	1	2
8. Shale and clay (?)	5	0
	58	2

The soft massive sandstone, No. (3) is, as far as lithological characteristics are concerned, the same as the massive sandstone above Coal IIIa, and the clay under this sandstone may mark the horizon of Coal IIIa.

Probably 10 ft. below the coal reported, No. (7), is another crop of coal of about the same thickness, which was considered as a slip, and not a separate coal.

An outcrop of cherty limestone was noted just south of the road and west of the railroad cut, in the N. E. ¼ of the N. E. ¼ of Sec. 32 (Sect. 969):

	Ft.	In.
1. Surface	4	0
2. Cherty limestone	2	0
3. Red clay	1	0
4. Covered	4	0
5. Shaly sandstone and loose limestone	8	0
6. Fire-clay	3	0
7. Coal streak	0	1
8. Covered	2	0
9. L., E. & St. L. C. R. R.	0	0
	24	1

A streak of coal dirt is exposed in the railroad cut, in the S. E. ¼ of the S. E. ¼ of Sec. 29.

Coal III was reported on Wolf Foertsch's place, 12 or 15 ft. above the coal drifted upon in the N. W. ¼ of the N. E. ¼ of Sec. 31.

Most of the coal mined in this township is taken out in the vicinity of New Boston. The coal belongs in Division II and has been correlated as Coal IIa. The following report of this coal was obtained at the Paulus drift, in the S. W. ¼ of the N. W. ¼ of Sec. 26. Thickness of coal runs 3 ft. to 4 ft. 4 in., with an average of 3 ft. 6 in. Divided into two benches by a discontinuous streak of sulphur and sulphur balls near the center. Lower bench blocks better and is a better quality of coal than the upper bench. This lower bench is used by blacksmiths after it has been carefully picked. Shale roof, that does not hold up very well. Rooms are run 10 to 20 ft. wide with two and three rows of props. Fire-clay floor (Fig. 869), coal dips to the south and has a few small rolls. Mine in operation employing 0 to 4 men. Same coal has been drifted upon at Kessig's, in the N. E. ¼ of the N. W. ¼ of Sec. 26 and the S. E. ¼ of the S. W. ¼ of Sec. 23; at Kluch's, in the S. W. ¼ of S. E. ¼ of Sec. 23; at Boehm's and at Foertch's, in the N. W. ¼ of the N. E. ¼ of Sec. 26. With the exception of the last mentioned place these mines are all in operation, employing from 0 to 4 men.

A thin coal is found in the road near the top of the hill 200 yds. east of New Boston; coal 1 in. thick, and lower than the coal worked west and northwest of New Boston, and is not persistent.

Coal IIa has been worked by two drifts on Foertsch's farm, in the N. W. ¼ of the N. E. ¼ of Sec. 31. Coal, a semi-block, is divided into two benches by a sulphur streak and sulphur balls, the lower bench blocking better, and is a better quality of coal than the upper one. Formerly the coal was picked and wedged down, but the miners shoot it now. The maximum and minimum thickness are 3 ft. 3 in. and 2 ft. 6 in. respectively. Above the coal is 12 ft.+ of shale. Mr. Foertsch reports a soft black rock 2 ft. and more thick under the coal (Fig. 870). The coal dips to the west with rolls 10 or 14 in. high. At one place in the main entry a large roll was found cutting the coal down to less than 1 ft. in thickness. During the past season some 150 tons of coal were taken out. But little coal has been taken out of one of the drifts, it having been worked but one season. The coal lies 5 ft. above high water mark of Crooked creek, and probably 15 ft. above the bed of the creek. The back water of Ohio river rises to about 5 ft. of the coal. The best part of the coal is very good blacksmith coal. Coal increases in thickness further back in the hill. At the old drift the coal is drawn up on the tip-house by a mule and windlass.

Coal IIIa has been drifted upon in the N. W. ¼ of the N. W. ¼ of Sec. 18 on Absalom Harris's farm. Entrance to the drift closed. Coal reported 30 in. thick, above which is some 2 or 3 ft. of shale (Fig. 865). Overlying the shale is a soft coarse-grained sandstone 5 or 6 ft. thick. This sandstone is exposed at the entrance. Probably 150 yds. down the branch, and 15 ft. lower than the coal mined above, is an outcrop of cherty limestone 4 or 5 ft. thick. This limestone marks the horizon of Coal III. Coal IIIa outcrops on Fred. Kauzler's place, in the N. E. ¼ of the S. E. ¼ of Sec. 7.

Township 6 South, Range 4 West.

1974. Geography.—This township lies in the east central part of the county, including the southern half of the civil township of Huff. The Ohio river crosses the township from the northeast to the southwest, forming the boundary between Indiana and Kentucky at this place. Anderson river bounds the township on the east. Crooked creek crosses the western half of the township, flowing south into the Ohio river. Dead Fall creek, a small stream, flows south across the eastern part of the township and empties into Anderson river one mile northeast of Maxville, a small village on the Ohio at the mouth of Anderson river. The topography runs from the level bottom lands of the Ohio to high irregular broken hills, rising from 75 to 225 ft. above the level of the adjacent valleys. The slopes of these hills are usually rough and broken with cliffs at intervals.

The cliffs of the Ohio river are irregular and broken, following the meandering of the stream and its affluents. An outcrop of massive sandstone occurs along the south bank of the river one-half mile below Maxville. The same sandstone outcrops at Troy on the north bank of the river. The Cannelton branch of the L., E. & St. L. C. R. R. crosses the northeastern corner of the township.

1975. Stratigraphy.—The outcropping strata of this township belong in Divisions II and III, with four coals exposed.

Coal II occurs along the bank of the river below Maxville, at low water mark and under the outcrop of massive sandstone. The following section will give but an imperfect idea of the coals exposed and the intervening strata.

1976. Section 970. Section of Gage's Hill.—In the N. E. ¼ of Sec. 16, as reported by John Rust.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and sandstone	30	0	..	..	30	0
2.	COAL	2	0	2	0	32	0
3.	Fire-clay	2	0	..	..	34	0
4.	Shale and sandstone	25	0	27	0	59	0
5.	COAL	0	8	0	8	59	8
6.	Shale, clay and sandstone	25	0	..	..	84	8
7.	Sandstone	3	0	28	0	87	8
8.	COAL	0	2	0	2	87	10
9.	Shale and sandstone	3	0	..	..	90	10
10.	Bed of Crooked creek	0	0	..	..	..	..

Coal No. (5) lies some 10 or 12 ft. above the high water mark of the Ohio river.

Among the data obtained while the report was in the printer's hands was found a section of this hill, apparently made with some care, though by whom could not be ascertained.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and sandstone	12	0	..	..	12	0
2.	Limestone	0	8	..	..	12	8
3.	COAL	0	11	0	11	13	7
4.	Fire-clay	1	0	..	..	14	7
5.	Shelly sandstone	4	0	..	..	18	7
6.	Solid sandstone	17	0	22	0	35	7
7.	COAL, poor sulphury, in drift, 2 ft. to	2	6	2	6	38	1
8.	Fire-clay	4	0	..	..	42	1
9.	Shelly sandstone, with 18 in. bed of iron ore	40	0	..	..	82	1
10.	Shale	2	0	46	0	84	1

		Ft.	In.	Ft.	In.	Ft.	In.
11.	COAL	1	5	1	5	85	6
12.	Fire-clay	3	6	..	..	89	0
13.	Sandstone	56	0	..	..	145	0
14.	Gray shale with some sandstone	24	0	..	..	169	0
15.	Blue shale	22	0	..	..	191	0
16.	Black shale	3	6	109	0	194	6
17.	COAL	2	6	2	6	197	0
18.	Fire-clay	5	6	..	..	202	6

1977. Section 971. Section near the Center of the South Side of the S. W. ¼ of Sec. 9.—

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Soil and loose sandstone	12	0	..	..	12	0
2.	COAL dirt	0	1	0	1	12	1
3.	Soil, clay and loose limestone	20	0	..	..	32	1
4.	Red and light clay mixed with loose chert	10	0	30	0	42	1
5.	COAL	0	5	0	5	42	6
6.	Fire-clay	2	0	..	..	44	6
7.	Sandstone	3	0	..	..	47	6
8.	Covered	3	0	..	..	50	6
9.	Sandstone	3	0	..	..	53	6
10.	Massive sandstone at bottom of hill in bed of branch	0	0	..	..	..	..

The limestone in this section does not seem to be in position, and as a whole this section is very unsatisfactory, owing to covered strata and slips. The coal dirt, No. (2), seems to correspond in position to the coal mined on the opposite side of the hill at Eberhard's.

1978. Section 972. Section near the Center of the East Side of the N. E. ¼ of Sec. 8.—

		Ft.	In.
1.	Surface	4	0
2.	Sandstone	8	0
3.	Shale and clay	4	0
4.	Covered	10	0
5.	Fire-clay and shale	2	0
6.	Shale and shaly sandstone	6	0
7.	Red clay and fire-clay	2	0
8.	Shale	2	0
9.	Covered	10	0
10.	Bed of branch	0	0
		48	0

Just above the red clay and fire-clay, No. (5), lay a large limestone boulder, probably not in position.

The line of outcrop of Coal III is shown on the map. This coal occurs high in the hills as a thin coal. Has been worked at but very few places. In the S. W. ¼ of the S. W. ¼ of Sec. 19 it has been drifted upon on W. H. Rice's farm. The following section was reported by Mr. Rice (Sect. 972a, Fig. 868):

		Ft.	In.
1.	Hard bluish limestone	4	0
2.	Slate	2	0
3.	COAL III	2	11
		8	11

Coal is said to be a block, free from sulphur. The drift has been abandoned for nine years or more. Mr. Rice reports another thin coal 100 ft. above the one worked, which is probably Coal IIIa.

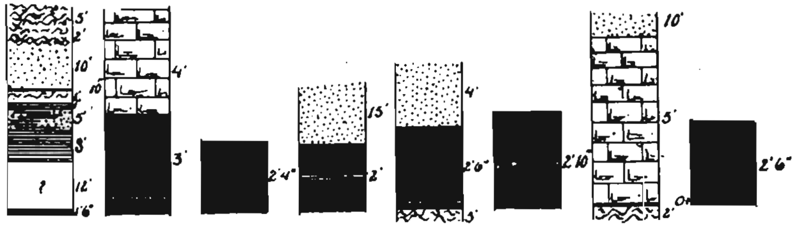
Coal II is said to occur in the bed of Anderson river near the mouth of Dead Fall creek, in the N. W. ¼ of Sec. 12. A higher coal is worked on the Hopkins place, near Maxville, in the S. W. ¼ of the S. W. ¼ of Sec. 12. The following report was given by Mr. Hopkins. The coal has a thickness of 28 to 32 in. with an average of 30 in. (Fig. 871). Semi-block, free from sulphur; sandstone roof, hard at places. Holds up very well. Rooms 16 to 18 ft. wide with but very few props. Mr. Hopkins reported limestone on top of the hill. Some few limestone boulders were found loose on the west side of the hill, some 20 ft. from the top, and above the entrance to the drift. Three coals were reported in this hill, including the one at low water mark in the Ohio river. The upper coal is the one worked by Mr. Hopkins, who has drifted upon the coal in two or three places. He reports the middle coal to be very thin. The upper coal corresponds to the coal near the top of the hill southeast of Troy. (See report on Perry county.)

More coal is taken out at the Eberhard drifts, in the S. W. ¼ of the S. E. ¼ of Sec. 9, than any other one point in this township. At Eberhard's the coal runs from 30 in. to 3 ft. 8 in., with an average of 3 ft. At the top of the coal occurs 6 in. of hard lustrous coal, which breaks down in very small pieces. Sandstone roof which varies a great deal in hardness (Fig. 872). Rooms 18 to 20 ft. wide with two rows of props. A bituminous coal with sulphur threads and a few discontinuous sulphur streaks scattered through it, and sulphur balls 1 ft. from the bottom. Smiths use the top part of the coal. Few rolls but no faults reported; coal dips gently to the northwest. Above the entrance lay a few pieces of chert which, as reported by the miner, came down from the top of the hill 50 or 60 ft. above the drift. Four men are employed during the winter and spring months and one during the summer months, with an annual output of some 600 tons. This is probably Coal IIa(?). Some three or four thin "pockety" coals are found in Division II in this part of the county, and their exact correlation was not attempted.

A coal 6 in. thick outcrops on John Rust's farm, in the S. W. ¼ of the S. W. ¼ of Sec. 4, and on Wm. Haskins' place, in the N. W. ¼ of the N. W. ¼ of Sec. 9. This is probably the same coal as that mined at Eberhard's, in the S. E. ¼ of the section.

Township 4 South, Range 5 West.

1979. Geography.—This township is located in the northwestern corner of the county and coincides with the civil township of Carter. Dale Station is located west of the center of the township, and Dale, a small village, is located in the northeastern quarter of the township. Lincoln City, the largest town in the township, is on the southern boundary line, in the southwestern corner of the township. Pigeon



873 Pigeon Cr. Sec. 27. — 874 Woods. Sec 19. — 875 Medcalf. Sec. 7. — 876 Ludwig. Sec. 27. — 877 Thorp. Sec. 22. — 878 Bro ner. Sec. 16. — 879 Dale. Sec. 7. — 880 Meyer. Sec. 26.

Fig. 873. Columnar section in T. 4 S., R. 5 W.
Figs. 874-875. Sections of Coal IIIb in same area.
Figs. 876-878. Sections of Coal IIIa in same area.
Figs. 879-880. Sections of Coal III in same area.

creek crosses the southern half of the township from east to west, draining that part of it. The northern half is drained by small streams running off to the north and west. The surface of this township is broken into low hills with gentle slopes and rather high and broad ridges. In the southeastern part the hills are higher, with steeper slopes. A high ridge crosses the township from north to south, forming the watershed between Pigeon creek on the west and Crooked creek on the east. The L., E. & St. L. C. R. R. crosses the township from north to south.

1980. Stratigraphy.—The prevailing outcrops of this township belong in Division III. The upper members of Division II are exposed in Secs. 25, 26, 27, 30, 31, 32, 29, 1 and 12. Lower members are pierced in a drilled well at Mariah Hill. Three workable coals are exposed, Coals II, IIIa and IIIb. Coal III is mined at Lincoln City and in Sec. 26. Coal IIIa is mined most extensively at Wilkey's and Brooner's, near Dale Station, and at Thorp's, in Sec. 22. Coal IIIb has been worked at Wood's, southwest of Dale, in Sec. 19, and at Metcalf's, in Sec. 7. The following sections will give the stratigraphy of the township.

1981. Section 973. Section South of Pigeon Creek.—In the N. W. ¼ of the S. W. ¼ of Sec. 27, Fig. 873.

		Ft.	In.	Ft.	In.
1.	Clay	5	0	5	0
2.	Fire-clay	2	0	7	0
3.	Sandstone, massive	10	0	17	0
4.	COAL IIIa	0	10	17	10
5.	Fire-clay	1	0	18	10
6.	Shale	1	6	20	4
7.	Shale and sandstone	5	0	25	4
8.	Shale, blue to drab, with coal streak	8	0	33	4
9.	Obscured	12	0	45	4
10.	COAL III	1	6	46	10

Coal III is found in the bed of Pigeon creek, dipping under at the east side of Sec. 27 and rising to the east, but running under again in Sec. 24.

1982. Section 974. Section of Drilled Well at Mariah Hill Marble Works.—At Mariah Hill, as reported by the proprietor, Andrew Schum.

		Ft.	In.
1.	Surface	8	0
2.	Sandstone	12	0
3.	COAL IIIa	2	0
4.	Fire-clay	78	0
5.	Sandstone, massive	18	0
6.	Dark fire-clay	20	0
7.	Soft sandstone	12	0
8.	Fire-clay	47	0
9.	Sandstone, solid	13	0
10.	Sand	6	0

The fire-clay reported in the above section is probably clay shale, as no such thickness of fire-clay outcrops on the hillsides in this vicinity, the greatest thickness probably not exceeding 4 ft.

Near the center of Sec. 22 there is a high hill known as Flint Hill. Coal IIIb underlies the top of this hill, including in all probably 16 acres. The coal is thin, but was mined some years ago on J. R. Thorp's land. The intervening strata at this point between Coals IIIb and IIIa consist largely of clays, shales and sandstone.

1983. SECTION 975. SECTION IN THE S. W. ¼ OF THE S. W. ¼ OF SEC. 34.—

	Ft.	In.	Ft.	In.
1. Surface	2	0	2	0
2. Shale and sandstone	10	0	12	0
3. Limestone	1	6	13	6
4. Fire-clay and shale	2	6	16	0
5. Shale and shaly sandstone	12	0	28	0
6. COAL	0	2	28	2
7. Clay	0	6	28	8
8. Covered	2	0	30	8
9. COAL	0	2	30	10
10. Red clay and fire-clay	2	0	32	10
11. COAL	0	5	33	3
12. Clay	1+	0	34	3

Coal IIIa(?) has done a very unusual thing at this place by dividing into three distinct coals. The horizon of Coal IIIb is indicated by the limestone No. (3). Coal III, 18 in. thick, is found one mile north in the bed of Pigeon creek.

1984. SECTION 976. SECTION OF WELL AT THE FLOURING MILL AT DALE.—In the N. W. ¼ of the N. E. ¼ of Sec. 7, Fig. 879.

	Ft.	In.
1. Soil	15	0
2. Soft sandstone	10	0
3. Limestone ....5 to	6	0
4. COAL streak	0	0
5. Clay	2?	0
	33	0

Coal streak under the limestone marks the horizon of Coal III.

The line of outcrop of Coal III is shown on the map, and occurs in the southwestern corner of the township, in the northeastern corner and near the center of the southeastern ¼ of the township, where it is above drainage along Pigeon creek, from the center of the north side of Sec. 25 west to the west side of Sec. 27.

This is probably the axis of an anticlinal fold. This coal does not outcrop in the northwestern part of the township, the line of outcrop being located with reference to the outcrop of the cherty limestone. Coal IIIa(?) was found above this cherty limestone, proving (?) that it was the limestone that overlies Coal III and not the limestone that is found above Coal IIIb.

Ten years ago Coal III was worked by a drift in the S. E. ¼ of the N. E. ¼ of Sec. 25. Coal reported 2 ft. 6 in. thick, divided into two benches by a sulphur streak, 10 in. of the lower bench a block to semi-block. What seems to be the same coal has been drifted upon on Balbach's place, in the S. E. ¼ of Sec. 25. Limestone, which locates the horizon of Coal III, was noted in the road 250 yds. south of the N. W. corner of the section and 150 yds. north of the center of the west side of the same section.

Coal III was worked by a drift several years ago on Jacob Meyer's place in the N. E. ¼ of the S. E. ¼ of Sec. 26. Coal said to be 2 ft. 6 in. thick (Fig. 880).

Coal IIIa outcrops on Fred Kokomoor's farm, in the S. W. ¼ of Sec. 26.

Section of the hill on the Lincoln City road 300 yds. west of the Santa Fe and Dale road, near the S. W. corner of Sec. 26 (Sect. 977):

	Ft.	In.
1. Surface	10	0
2. Sandstone and shale	15	0
3. COAL IIIa	0	4
4. Fire-clay	1	0
5. Shale	6	0
6. Covered	20	0
	52	4

Coal III is found in the bed of Pigeon creek under the bridge near the center of the west side of the S. W. ¼ of Sec. 27, said to be about 18 in. thick. Coal IIIa is mined near by at the Ludwig drift, where the coal runs from 18 in. to 2 ft. in thickness. Near the center of the coal is a 3 in. band of shale or bone coal (Fig. 876). The upper bench is the better coal—heavier, with less sulphur, and blocks better. The coal is a good steam coal but a poor quality of coal for smith's use.

1985. SECTION 978. SECTION FROM THE TOP OF THE HILL TO THE BED OF PIGEON CREEK AT LUDWIG'S.—

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface	5	0	..	..	5	0
2. Fire-clay	2	0	..	..	7	0
3. Bedded sandstone to shale	10	0	..	..	17	0

		Ft.	In.	Ft.	In.	Ft.	In.
4.	COAL IIIa	0	10	0	10	17	10
5.	Fire-clay	1	0	..	..	18	10
6.	Shale	1	6	..	..	20	4
7.	Shale and sandstone	5	0	..	..	25	4
8.	Blue to drab shale	8	0	..	..	33	4
9.	Covered	12	0	27	6	45	4
10.	COAL III	1	6	1	6	46	10
11.	Bed of Pigeon creek	0	0	..	..	..	..

In the blue to drab shale, No. (8), was noted a coal streak. Above the coal, No. (4), as found in the Ludwig drift is 6 ft. plus of massive sandstone.

Coal IIIa is worked by drifts at J. R. Thorp's in the S. E. ¼ of the N. W. ¼ of Sec. 22. The thickness of the coal, which is probably the greatest known thickness of this coal in the township, runs from 2 ft. to 2 ft. 11 in., with an average of 2 ft. and 6 in. One inch from the bottom is a streak of shale 2 in. thick. Some sulphur is scattered through the coal in discontinuous streaks and threads. Free from sulphur balls, and dips to the south. No rolls or faults, but slips of 2 in. Coal has a sandstone roof 4 ft. thick, and a fire-clay floor 5 ft. thick (Fig. 877). The coal lies about 20 ft. above the bed of the branch ½ mi. to the east. A ditch 3 ft. deep is needed to drain the drifts. The blacksmith at Mariah Hill reported this a very poor coal for shop use. Has too much sulphur and dirt. Thirty or forty feet above Coal IIIa is a heavy outcrop of cherty limestone which marks the horizon of Coal IIIb. This limestone is found only in this one hill, which is therefore called Flint Hill. On the north side of the hill, 30 ft. from the top, in the S. W. ¼ of the N. W. ¼ of Sec. 22, on Thorp's place, Coal IIIb was worked by a drift years ago. Coal said to be 1 ft. thick. Some coal has been worked on the south side of the hill in the S. W. ¼ of Sec. 22. Probably fifteen or sixteen acres are underlain by Coal IIIb at this place.

Coal II has been drifted upon on Fred Shrayer's place in the S. E. ¼ of the N. W. ¼ of Sec. 22, and on Goble's place, in the S. W. ¼ of the N. E. ¼ of the same section.

Coal IIIa outcrops at a number of places in the road west of Mariah Hill, in Secs. 14 and 15. From Mariah Hill west to Thorp's the rocks have a decided dip to the west.

Coal IIIa has been worked at quite a number of places in the vicinity of Dale Station, in Sec. 16. Some eleven or twelve strippings and drifts are found on Allen Brooner's place, in the S. W. ¼ of the S. E. ¼ of Sec. 16. At the stripping farthest south, where the coal was examined it measured 34 in. Seventeen inches from the top there is a streak of bone coal 1 to 7 in. thick. This coal contains quite a lot of sulphur; it is a bituminous to semi-block. It dips to the west and is above drainage. Although the coal has been entered at a number of places, no great amount of coal has been taken out. One or two of the drifts are worked at intervals and the others are closed up, only one stripping being worked at time of examination. The roof is of shale and sandstone (Fig. 878).

Coal IIIa, with its characteristic line of parting, its sulphur thread and streaks and its sandstone, has been worked at the following places:

West of the depot 100 yds. at Dale Station, coal worked here twelve years ago; at Wm. Wilkey's, in the road leading to Dale, just west of the branch near the center of the S. W. ¼ of Sec. 16; old drift on Geo. Thorp's place, in the S. E. ¼ of the S. W. ¼ of Sec. 16, and old drifts on Jas. White's place, east of the railroad in the N. E. ¼ of Sec. 16. Coal said to be 3 ft. thick.

What is probably Coal IIIb has been worked by a slope on J. Wood's, in the N. E. ¼ of the S. W. ¼ of Sec. 19. Coal reported 32 to 40 in. thick, with a limestone roof 4 ft. thick. Eight inches from the bottom was a sulphur seam at the entrances, but 40 yds. back it was within 4 in. of the bottom (Fig. 874). It may run out entirely further back. Coal dips to the east; semi-block.

Chert was observed outcropping in the road 20 ft. above the entrance to the drift, which is some 30 ft. above the creek bottoms to the west.

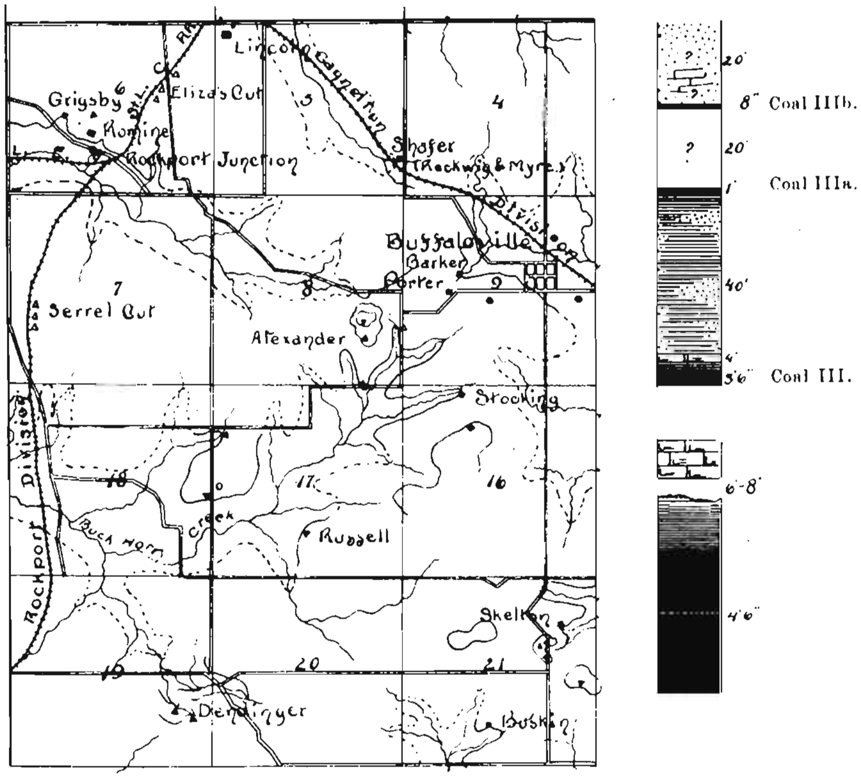
Probably Coal IIIb has been drifted upon at Medcalf's, in the S. W. ¼ of the S. E. ¼ of Sec. 7. Coal 22 to 30 in. thick. Average 28 in. (Fig. 875). Has some sulphur. Burns like hickory wood, leaving few ashes and no clinkers. It is not a caking coal. A ditch 6 ft. deep is needed to drain the mine.

Outcrops of Coal IIIb(?) were noted at the following places: In the road in the S. E. ¼ of the N. E. ¼ of Sec. 8, Coal 3 in. thick; in the road near the S. W. corner of Sec. 3, and 300 yds. west of the S. E. corner of the same section.

Township 5 South, Range 5 West.

1986. Geography.—This township lies northeast of the center of the county and coincides with the civil township of Clay. The eastern half of the township is drained by Blue Lick creek and the head waters of Crooked creek. The west half is drained by Buck Horn creek and the head waters of Big Sandy creek. A large continuous ridge crosses the township from north to south, passing ½ mi. west of Buffaloville and extending south, ½ mi. west of the center of the township. Short ridges run east and west from this central divide, rising from 50 to 125 ft. above the adjacent creek valleys. The Can-

882



881 883

Fig. 881. Sketch map of part of T. 5 S., R. 5 W.
Fig. 882. Columnar section at Alexander's, Sec. 8.
Fig. 883. Section of Coal III at Porter's, Sec. 9.

nelton branch of the L., E. & St. L. C. R. R. crosses the northeastern part of the township. The northwestern corner is crossed by the Rockport Division of the same road.

1987. Stratigraphy.—The outcropping strata of this township belong in Divisions II, III and IV, with three coals exposed, Coals III, IIIa and IIIb. Coals III and IIIa are workable; Coal III is the thicker and is worked the more extensively. Coal IIIa, being thin and very

irregular, has been opened at only a few places. The greatest thickness reported was at the old drift on the Stocking farm, in the N. E. ¼ of the N. W. ¼ of Sec. 16, where the coal is said to be 20 in. thick. For the relative position and variation of the coals, with their accompanying strata, see the sections below.

1988. Section 979. Section of the High Hill.—One-half mile west of Buffaloville, as given by Mr. Wm. Alexander, Fig. 882.

	Ft.	In.	Ft.	In.	Ft.	In.
1. Covered with lime and sandstone.	20	0	..	..	20	0
2. COAL IIIb	0	8	0	8	20	8
3. Covered with limestone and sandstone	20	0	20	0	40	8
4. COAL IIIa	1	0	1	0	41	8
5. Shale and sandstone	40	0	..	..	81	8
6. Shale and limestone	4	0	44	0	85	8
7. COAL III	3	6	3	6	89	2

The limestone over Coal III outcrops in the road near the center of the east side of the S. E. ¼ of Sec. 8.

1989. Section 980. Section along the Road.—Three hundred yards south of the center of the east side of Sec. 11.

	Ft.	In.
1. Surface	6	0
2. Massive to bedded sandstone	6	0
3. COAL IIIa	0	2½
4. Fire-clay	3	0
5. Drab shale	12	0
6. Fire-clay	2	6
7. Hard, impure sandy limestone	2	0
8. Sandy fire-clay	2	6
9. Obscured	3	0
10. Clay	5	0
11. Bedded sandstone	3	0
	45	2½

The limestone in the foregoing section marks the horizon of Coal III.

1990. Section 981. Section ¼ mi. South of Santa Fe.—Along the east side of the S. E. ¼ of Sec. 1.

	Ft.	In.
1. Surface	4	0
2. Shaly sandstone	3	6
3. Hard blue limestone	1?	0

		Ft.	In.
4.	Clay (?)	0	6
5.	Fire-clay and light shale	0	7
6.	Shale and shaly sandstone, with cross seams	3	6
7.	Ferruginous sandstone	0	10
8.	Shale (?)	1	6
9.	Hard blue limestone	2	0
10.	Obscured	4	0
11.	Limestone	1?	0
12.	Obscured	10	0
13.	Shaly sandstone and shale	5	0
14.	Obscured	5	0
15.	Branch bottom	0	0
		41	7

Although the strata showed plainly, a close examination for coal outcrop revealed none. It is quite possible that the upper limestone in the above section marks the horizon of Coal IIIb and the lower limestone locates the horizon of Coal III.

The line of outcrop of Coal III is shown on the map, following the meanderings of the creek and branches. It is mined more extensively probably at the Porter shaft, west of Buffaloville, in the N. E. ¼ of the S. W. ¼ of Sec. 9, than at any other point in the township. The following report of this mine was obtained through Mr. Porter's kindness and by personal examination. Maximum and minimum thickness of the coal, 4½ ft. and 3 ft., respectively, with an average thickness of 4 ft. (Fig. 883). A persistent sulphur seam 1 to ¼ in. thick divides the coal into two benches. Sulphur balls occur with this streak, but at no other place. Twelve inches of the coal on top has considerable peacock coal in it. All of the coal is a good quality of steam coal, and by picking it quite a lot of good coal for shop use can be found. Parts of the coal block fairly well—bituminous to semi-block. Dips to the northeast and is free from large rolls and faults. Burns to an ash, leaving very few clinkers. The shaft is 27 ft. deep and is entered by a ditch. Above the coal is some 6 or 8 ft. of shale and limestone, which makes a good roof. The rooms are run 16 to 18 ft. wide with two rows of props.

Coal 4 ft. thick was reported in Mr. Porter's well, 6 ft. below the surface, in the west side of Buffaloville, in the N. E. ¼ of the S. W. ¼ of Sec. 9.

Coal III is drifted upon at Barker's, in the S. E. ¼ of the N. W. ¼ of Sec. 9, some 300 yds. northeast of Porter's shaft. Coal reported by Mr. Barker 3 ft. 6 in. to 4 ft. 1 in. thick, with an average of 3 ft.

8 in. It has some sulphur near the top and bottom, otherwise it is a clear bituminous to semi-block coal, with an irregular roof of shale and limestone. One fault of 1½ ft. was reported with a number of large rolls. The shale above the coal runs from 0 to 8 in. The overlying limestone runs from 3 to 4 ft. in thickness but is impure, slacking very quickly when exposed (Fig. 887). The coal lies 5 ft. below drainage. A box 150 yds. long is necessary to drain the mine. The coal is too sulphurous for smith's use, unless carefully picked. Good steam coal.

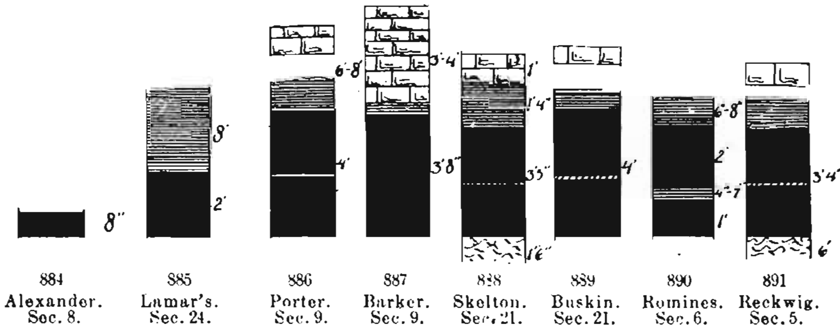


Fig. 884. Section of Coal IIIb, T. 5 S., R. 5 W.
Fig. 885. Section of Coal IIIa, T. 5 S., R 5 W.
Figs. 886–891. Sections of Coal III, T. 5 S., R. 5 W.

This coal is worked by a drift at Skelton's, in the S. E. ¼ of the N. E. ¼ of Sec. 21. Coal 3 to 4 ft. thick with an average of 3 ft. 5 in. Near the center of the coal is a sulphur seam 0 to 1 in. thick that divides the coal into two benches (Fig. 888). The upper bench is the better coal, blocks better and is free from sulphur streaks and balls. The lower bench is sulphurous, with a large number of sulphur balls near the bottom. The upper bench is a bituminous to semi-block; lower bench bituminous. The coal dips to the south and has a great many rather large rolls, but no faults. Smiths claim it to be a good coal for their use. Burns to an ash, leaving no clinkers or cinders; is easily lighted, burning with a cheerful blaze, forming but little soot. Below the coal is 1 ft. 6 in. of fire-clay. Roof formed of 16 in. of sheety shale and 0 to 1 ft. of limestone. About 60 ft. above the entrance of the drift, and 300 yds. to the southwest is an exposure of limestone 1½ to 3 ft. thick which marks the horizon of Coal IIIb. This limestone occurs near the top of the hill and is formed as detached bodies in the tops of the adjoining hills. About 250 yds. down the branch from the entrance of the mine is an exposure of limestone 4 ft. thick--hard, blue and fossiliferous—an excellent place to collect coal measure fossils.

Coal III is not exposed under this crop of limestone, but Mr. Skelton reports it there. As far as can be determined, the intervening strata between these two limestones are shales to shaly sandstone.

Coal 18 in. thick was reported outcropping on A. T. Ferguson's place in the N. E. ¼ of the S. E. ¼ of Sec. 24; probably Coal III.

A limestone, marking the horizon of Coal III, was noted 30 yds. south of the center of the east side of Sec. 27—hard, cherty and probably 20 ft. above Crooked creek. Also a coal streak, near the center of the south side of Sec. 22. Near the center of the east side of the S. E. ¼ of Sec. 11, in the road, an exposure of impure limestone was noted. This marks the horizon of Coal III. The same limestone outcrops on each side of the branch running southeast, ½ mi. south of Santa Fe. See foregoing section (Sect. 981). South of the branch, at J. L. Conner's, in the N. E. ¼ of the N. E. ¼ of Sec. 12, and just below the horizon of the limestone a coal 3 ft. thick was reported —Coal III.

What seems to be Coal III has been worked at a slope at Joe Buskin's in the S. E. ¼ of the S. W. ¼ of Sec. 21. Coal reported 4 ft. thick with a shale and limestone roof (Fig. 889). The coal is divided by a discontinuous sulphur seam, with two benches; the upper bench is a hard, lustrous coal, with but little sulphur; the lower bench is a soft bituminous coal, with a considerable amount of sulphur. The upper bench has some peacock coal scattered through it and is a better coal than the lower bench, especially for smiths' use. Free from rolls and faults; dips to the southwest.

Two coals, each 1 ft. thick, were reported outcropping on F. Dendinger's place, in the S. E. ¼ of Sec. 19. These coals are probably Coals IIIa and IIIb. Limestone was reported above the upper coal.

Coal III(?) outcrops on John Russell's farm, in the N. E. ¼ of the S. W. ¼ of Sec. 17; in the road 200 yds. south of the center of the east side of Sec. 18; in the road in the N. W. ¼ of the N. W. ¼ of Sec. 17, and in the road near the center of the north side of the N. E. ¼ of Sec. 17. In the hill ¼ mi. to the north of this last mentioned outcrop, and 1 mi. west of Buffaloville, Coals IIIa and IIIb outcrop; see section.

Coal III is worked by a slope at J. Romine's, in the N. E. ¼ of the S. W. ¼ of Sec. 6. Greatest thickness of coal is 3 ft. 6 in., and runs as low as 3 ft. or less, with an average of 3 ft. The coal is divided into two benches by a stratum of bituminous shale 4 to 7 in. thick (Fig.

890). The 2 ft. of coal above this shale is semi-block to block, with few sulphur balls. Below the dividing shale is 10 in. of soft, sulphurous, bituminous coal. Numbers of small rolls are found in the mine. Cross seams are very large, sometimes 1 ft. 6 in. wide, filled with fire-clay. Coal a poor quality for shop use. Above the coal is some 6 or 8 in. of shale. Mr. Romine reports two other coals higher in the hill—Coals IIIa and IIIb.

At the Shafer mine, now owned by Reckwig and Myre, in the N. E. ¼ of the S. E. ¼ of Sec. 5, Coal III has been worked by a shaft. Thickness of the coal varies from 3 ft. 8 in. to 3 ft., with an average of 3 ft. 4 in. (Fig. 891). A shooting coal with its characteristic sulphur band near the center; has two benches, the upper one a hard, lustrous, semi-block, the lower one a soft bituminous coal with sulphur balls and threads. Typical roof for Coal III. Five or 6 ft. of fire-clay reported under coal. Good steam coal. Until recently the engines on the Cannelton and Rockport divisions of the L., E. & St. L. C. R. R. were coaled here. For the last five years no coal has been worked at this mine. This coal is drifted upon at the Lincoln mine, in the N. W. ¼ of the N. W. ¼ of Sec. 5. Near the top of the hill, 40 ft. or more above Coal III, is the limestone marking the horizon of Coal IIIb. This limestone is exposed in Eliza's cut, ½ mi. southwest of Lincoln City.

Coal IIIa outcrops at the following places: Near the center of the north side of Sec. 2; at the N. E. corner of Sec. 2; at the center of the north side of Sec. 1, and 160 yds. east of the center of the west side of Sec. 11, where the section below was obtained (Sect. 982).

		Ft.	In.
1.	Surface	4	0
2.	Sandstone	6	0
3.	Hard bedded sandstone	8	0
4.	Shaly sandstone	8	0
5.	COAL IIIa	0	4
6.	Fire-clay	2	6
7.	Shale	10	0
8.	Sandstone	2	6
		41	4

Section near the center of Sec. 11 (Sect. 983):

		Ft.	In.
1.	Surface	6	0
2.	Massive sandstone	12	0
3.	COAL IIIa	0	3
4.	Fire-clay	1	0
		19	3

Section along the road 300 yds. south of the center of the east side of Sec. 11 (Sect. 984):

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	6	0	..	..	6	0
2.	Massive sandstone	6	0	..	..	12	0
3.	COAL IIIa	0	3	6	3	12	3
4.	Fire-clay	3	0	..	..	15	3
5.	Drab shale	12	0	..	..	27	3
6.	Sandy fire-clay	2	6	..	..	29	9
7.	Siliceous limestone	2	0	19	0	31	9
	Horizon of Coal III	0	0	0	0	..	..
8.	Fire-clay	1	0	..	..	32	9
9.	Obscured	3	0	..	..	35	9
10.	Red to yellow clay	5	0	..	..	40	9
11.	Bedded sandstone	3	0	..	..	43	9

The limestone, No. (7), marks the horizon of Coal III.

A thin coal was reported 5 or 6 ft. below the surface, in the N. E. ¼ of the N. E. ¼ of Sec. 9. What seems to be the same coal was reported to be under the railroad north of the depot at Buffaloville. This is probably Coal II(?).

Coal IIIa(?) has been drifted upon at Lamar's, in the N. E. ¼ of the N. E. ¼ of Sec. 24.

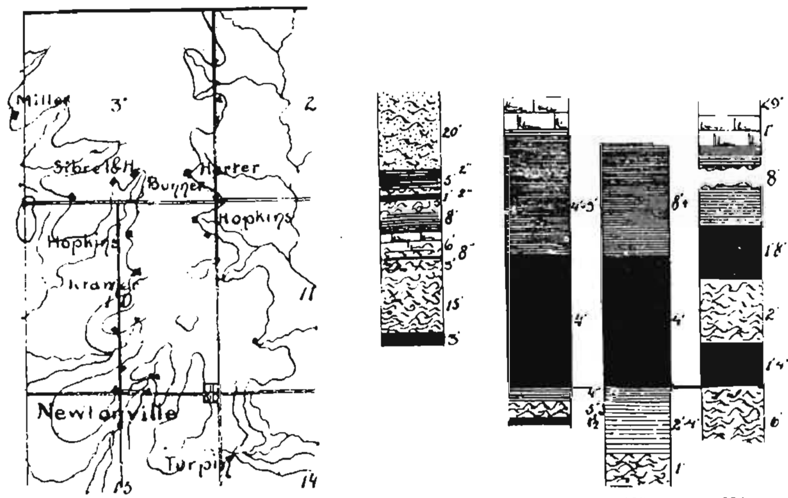
Section obtained at one of the three old drifts (Sect. 985, Fig. 885):

		Ft.	In.
1.	Soft shale	8	0
2.	COAL	2?	0
3.	Covered	8	0
4.	Bed of Crooked creek	0	0
		18	0

But very little coal has been taken out here for years. At present the entrance to the old drifts are closed. Years ago mining was carried on quite extensively, and some report that all the coal was mined out before the drifts were abandoned. The same coal was reached by a shaft in the N. E. ¼ of the S. E. ¼ of Sec. 13, on D. Schriefer's place. Mine not running now. But very little coal worked at this place.

Townships 6 and 7 South, Range 5 West.

1991. Geography.—These townships correspond with the civil township of Hammond, which lies southeast of the center of the county, located near the northeastern corner of township 6 south, range 5 west. These townships are drained by the Big and Little Sandy creeks, which flow south into the Ohio river. The topography



892 893 894 895 896

Sec. 10. Sibrel. Sec. 3. Bunner. Sec. 3. Brant. Sec. 18.

Fig. 892. Sketch map of part of T. 6 S., R. 5 W.
Fig. 893. Columnar section near Newtonville.
Figs. 894-896. Sections of Coal III in T. 6 S., R. 5 W.

runs from the low level lands of the Ohio river bottoms to long, more or less regular ridges, which rise from 30 to 75 ft., with rather gentle slopes. The nearest railroad is the L., E. & St. L. C. R. R. (Rockport division), which runs north and south within 1¼ mi. of the western boundary line of these townships.

1992. Stratigraphy.—The outcropping strata of these townships belong in Divisions II and III, with four coals exposed, Coals III, IIIa, IIIb and IIIc (?). I was of the opinion at first that Coal IIIc was Coal IV, and so correlated it, but later came to the conclusion that it did not correspond to Coal IV, and correlated as given above. Coal III and IIIc (?) are workable, Coal III being worked the more extensively. In fact, Coal IIIc is found only in the ridges just west of Newtonville, and has been worked by a stripping. The following sections will show the coals with their accompanying strata. The variation in strata is very marked.

Section along a small ravine near the S. W. corner of the S. W. ¼ of the S. E. ¼ of Sec. 10 (Sect. 986):

	Ft.	In.	Ft.	In.	Ft.	In.
1. Soil	1	0	1	0	1	0
2. COAL dirt	0	3	..	3	1	3
3. Light drab shale	4	0	..	..	5	3
4. Red clay	1	0	5	0	6	3
5. COAL IIIc (?)	1	2	1	2	7	5
6. Light drab shale	5	0	..	..	12	5

The coal has a decided dip to the east. Fifty yards down the ravine from the exposure of the coal, towards the cross-roads, is an exposure of limestone which seems to correspond with the limestone exposed in the road 300 yds. to the northwest. If this limestone is in position (the exposure was such that this point was left in doubt), the coal above seems to be Coal IV. But if this limestone is not in position, it may have come from above the horizon of the coal, in which case the coal would become unquestionably Coal IIIb. The red clay above the coal may mark the horizon of the limestone. However, the indications are that the limestone is in position. The stratigraphy, in a general way, of this neighborhood is expressed in the following section (Sect. 987, Fig. 893):

	Ft.	In.	Ft.	In.	Ft.	In.
1. Surface ....10 ft. to	20	0	..	..	20	0
2. COAL dirt ....1 in. to	0	2	..	2	20	2
3. Drab shale and clay......4 ft. to	5	0	5	0	25	2
4. COAL IIIb	1	2	1	2	26	4
5. Clay and light shale	8	0	..	..	34	4
6. Clay and limestone	6	0	14	0	40	4
7. COAL IIIa ....4 in. to	0	8	..	8	41	0
8. Fire-clay ....2 ft. to	3	0	..	..	44	0
9. Clay ....10 ft. to	15	0	18	0	59	0
10. COAL III	3	0	3	0	62	0
11. Covered	20	0	..	..	82	0
12. Bed of Little Sandy creek	0	0	..	..	..	..

Croppings of a massive stratum of soft sandstone were observed at a number of places in township 6 S., range 5 W., viz.: Over the coal at the Brant mine, in the S. E. ¼ of the N. E. ¼ of Sec. 18; along the small branches in the S. E. ¼ of the S. W. ¼ of Sec. 7; in the road in the N. W. ¼ of the N. W. ¼ of Sec. 18; in the N. E. ¼ of the N. E. ¼ of Sec. 19; above the coal and slate in the road 300 yds. east of the center of the west side of Sec. 17; in the road in the N. E ¼ of the N. E. ¼ of Sec. 27, and along the small branches in the N. E. ¼ of Sec. 23. Ordinarily, a coal is found some 8 or 10 ft. below this sandstone.

The line of outcrop of Coal III is shown on the map. This coal has been worked most in this township (6 S., R. 5 W.), in Secs. 3 and 10. The coal was examined at Hopkins's and Sibrel's, near the center of the south side of Sec. 3, with the following result:

Coal runs from 3 ft. 10 in. to 4 ft. 2 in. in thickness, with an average of 4 ft. Bituminous to semi-block, with sulphur streak and small rolls. The roof is of shale and limestone; the limestone is not persistent; only a small amount is found about the mine. The shale is from 4 to 5 ft. thick. (Fig. 894.) The rooms are run 20 ft. wide, with four rows of props.

This coal is said to be a very good steam coal, but a poor coal for shop use, as it has too much sulphur. Peacock coal was reported near the center of the coal. The upper part of the coal is best. The following section was given by the miner (Sect. 988):

	Ft.	In.
1. Limestone and slate	5	0
2. COAL III	4	0
3. Shale	0	4
4. Fire-clay	0	5
5. COAL, not continuous	0	1½
	9	10½

The same coal is drifted upon at Bunner's, in the S. W. ¼ of the S. E. ¼ of Sec. 3. Maximum thickness of the coal was 4 ft. 4 in., with an average of 4 ft.; 2 ft. of very hard semi-block on top, below which is 1 ft. of soft coal that breaks down in small irregular pieces. (Fig. 895.) The sulphur balls and sulphur threads are confined to this soft coal. At places some little bone coal is found above or below this coal. Below the soft coal is 4 in. of brash coal. Coal does not coke well and is a poor coal for shop use. Blacksmith at Newtonville says this coal is not good for forge use on account of its sulphur. Roof of hard sheety shale, with no limestone. Shale 8 ft. plus. Holds up only fairly well. The rooms are 18 ft. wide, with 5 rows of props. Floor reported 2 to 4 ft. of shale and then 1 ft. plus of fire-clay.

This coal is drifted upon at John Hopkins's, in the N. W. ¼ of the N. E. ¼ of Sec. 10, corresponding to the coal at Bunner's in physical details, etc. The same coal is drifted upon at J. L. Kramer's, in the S. W. ¼ of the N. E. ¼ of Sec. 10. Report of the coal at this mine corresponds to the above reports. Near the center of the coal is a band of sulphur 1 to 2 in. thick. During the last winter and summer something near 600 tons have been mined. This is about the same as mined at Bunner's and Hopkins's. Outcrops of this coal were noted in the road near the center of the west side of Sec. 2 and at the cross-roads at the southwestern corner of this section.

Some years ago this coal was worked on the Richards farm, in the S. W. ¼ of Sec. 11.

At the Sutton mine, owned by Jacob Raaf, in the N. E. ¼ of the S. E. ¼ of Sec. 23, this coal is worked by a drift and slope. Coal said to be 37 in. thick, with an average of 35 in. Semi-block to block, with smooth faces and few sulphur balls. At times this mine is flooded by Big Sandy creek. The same coal has been worked on the east side of the creek. The coal was reported at Pinistidt's, in the S. W. ¼ of Sec. 25, and 1 mi. north of Grandview, on Chas. Finch's farm, in the N. W. ¼ of the S. W. ¼ of Sec. 33, where it was said to be 18 in. thick. Coal had been drifted upon years ago. Above the entrance was 1 ft. plus of limestone; some 5 ft. higher was an exposure of 6 in. of limestone. Some 8 ft. above this limestone was an exposure of light yellowish sandstone that has been quarried some. Ten or 15 ft. below the entrance, and probably the same distance above the Ohio river bottoms, was an exposure of limestone 1 ft. plus. If this limestone is in position it may mark the horizon of Coal III, and the upper limestone the limestone above Coal IIIb. The limestone found near the bottom of the hill occurred at different heights, ranging in a space of 5 ft. It was a hard bluish and blue to gray fossiliferous stone.

Some 300 yds. west this limestone seems to be absent, as seen by the section run along the road in the N. E. ¼ of the S. E. ¼ of Sec. 32. Below is given the section (Sect. 990):

		Ft.	In.	Ft.	In.
1.	Soil, sandy	30	0	30	0
2.	Red clay	2	0	32	0
3.	Light clay and shale	1	6	33	6
4.	Shale	1	0	34	6
5.	Light bluish fire-clay and shale	1	3	35	9
6.	Coal streak	0	1	35	10
7.	Light sandy fire-clay	6	0	41	10
8.	Sandstone and shale	0	2	42	0
9.	Drab bluish shale	8	0	50	0
10.	Bottoms of Ohio river	0	0	..	..

The limestone exposed 300 yds. to the east at the entrance of the shaft evidently has run out before it reached the road.

Coal III is mined at J. D. Brant's, in the S. E. ¼ of the N. E. ¼ of Sec. 18. Through the kindness of Mr. Brant and by an examination of the coal, the following report was obtained: The coal here has done an unusual thing by separating into two benches, with 2 ft. of fire-clay between them. The coal and the fire-clay are 5 ft. thick (Sect. 991, Fig. 896):

		Ft.	In.
1.	Soft massive sandstone	29	0
2.	Limestone	1	0
3.	Shale, hard and sheety (reported)	8	0
4.	COAL	1	8
5.	Fire-clay	2	0
6.	COAL	1	4
		43	0

The upper bench of coal is a hard semi-block with very little sulphur and few sulphur balls. It is not as heavy as the lower bench and burns to an ash, leaving no clinkers. It is hard and lustrous. The lower coal is a hard block to semi-block and has some sulphur. It is not so lustrous as the upper coal and burns to an ash, leaving a few clinkers. It makes a better fire than the upper coal, but is harder to kindle. The top coal has been used by the smiths, who report it a fairly good coal for their use. The sandstone over the limestone and shale resembles very closely the sandstone over Coal IIIa. It is quite possible that these two benches of coal represent Coals III and IIIa(?).

Very little coal has been taken out, probably 75 tons in all, and if there is any change in the position of the two coals, they come closer together. It is more than probable that, if followed back far enough under the hill, the two benches will come together. Below the coal Mr. Brant reports 6 ft. of fire-clay. Under the fire-clay is 10 ft. plus of sandstone.

The coal is removed by a shaft. Some 200 yds. to the southeast of the shaft, Mr. Brant reports an outcrop of coal 16 in. thick, which is probably the same coal as mined at the shaft. At time of examination this crop was covered.

This same coal, Coal III, is drifted upon at B. F. Bersley's, in the S. W. ¼ of the S. E. ¼ of Sec. 7. Mr. Bersley gave the following report:

Average thickness of the coal, 2 ft. 6 in. The bottom part blocks best, but contains a number of sulphur balls. At the entrance there were two benches of coal separated by 8 to 10 in. of fire-clay. Farther back, 100 yds., the lower bench thins down to 2 or 3 in., and at places is entirely cut out, while the upper bench thickens. Roof is of sheety shale and large limestone boulders, which holds up fairly well. The rooms are run 16 ft. wide. Above the shale and limestone is 20 ft. or more of soft massive sandstone.

Six years ago Coal III was drifted upon in the N. E. ¼ of Sec. 24, on Talbott's place. Very little coal was taken out, but that which was mined was reported by Mr. Talbott to be of a very good quality. The old drift was examined, but the entrance was closed, making an examination of the coal impossible. Was reported 2 ft. thick, overlain with soft shale and limestone. The limestone was exposed some 4 or 5 ft. above the entrance and was an impure cherty disintegrating stone.

Fire-clay and shale were said to underlie the coal.

Coal IIIa (?) outcrops in the road near the center of the east side of Sec. 12 (Sect. 992):

		Ft.	*In.*
1.	Sandstone and soil	5	0
2.	Ferruginous sandstone	0	6
3.	Obscured	1	0
4.	COAL dirt IIIa (?)	0	1
5.	Fire-clay	1	0
		7	7

Coal IIIa is found in the hill ¼ mi. west of Newtonville. (See section under stratigraphy of this township, ¶1992.) What seems to be the same coal outcrops on Dr. Turpin's farm, in the S. W. ¼ of the N. W. ¼ of Sec. 14. Dr. Turpin reports the coal 16 in. thick, roofed with massive sandstone, some of which has been quarried and proved a valuable stone for local use.

Coals III and IIIa are found on W. H. Forsythe's farm, in the N. W. ¼ of Sec. 28. Coal III has been worked some at this place. Coal IIIa is probably 15 or 20 ft. above Coal III. Mr. Forsythe also reports a crop of coal in the N. E. ¼ of the N. E. ¼ of Sec. 32. This is probably Coal IIIa.

Coal III has been mined by a shaft at Loyd's, in the S. E. ¼ of the S. W. ¼ of Sec. 27. Mr. Loyd reported the coal 2 ft. 6 in. thick, covered with a sheety shale. The coal lies below the level of Big Sandy creek bed and is 10 ft. below the high water mark of Ohio river. The shaft is 30 ft. deep. No coal mined here for four or five years, or probably longer. Some 5 or 10 ft. above the entrance of the shaft and 100 yds. to the southeast is an outcrop of impure cherty limestone, which doubtless marks the horizon of Coal IIIb. Coal was not observed at this horizon, but Mr. Loyd reports a coal 22 in. thick under this limestone. Near the creek, in the N. W. ¼ of Sec. 27, Mr. Loyd

reports an outcrop of coal 2 ft. 6 in. thick, which is some 20 ft. above the level of the creek. This is probably Coal IIIa.

There is an outcrop of coal in the road along the west side of the N. W. ¼ of the N. W. ¼ of Sec. 23 (Sect. 993):

		Ft.	*In.*
1.	Soil	20	0
2.	Red clay	5	0
3.	COAL dirt IIIa (?)	0	2
4.	Shale and shaly sandstone	12	0
5.	Massive sandstone	15	0
		52	2

Coal 3 ft. thick was reported in a well 20 ft. deep in the N. W. ¼ of the S. E. ¼ of Sec. 15:

Township 7 south lies wholly in the Ohio river bottoms, the stratigraphy of which is seen in the following section:

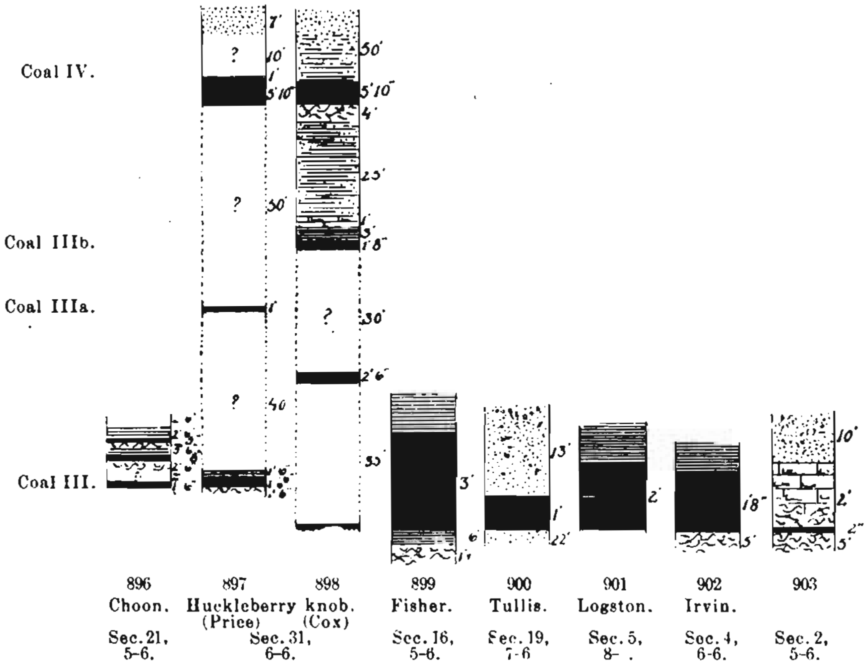
Well section at City Hotel, in Grand View, in the N. W. ¼ of the S. W. ¼ of Sec. 4 (Sect. 994):

		Ft.	*In.*
1.	Soil and clay	9	0
2.	Sand	12	0
3.	Gravel	22	0
		43	0

Township 5 South, Range 6 West. (Part in Spencer County.)

1993. Geography.—This township is located in the northwestern part of the county, and all but the southwestern quarter of the township is included in the civil township of Jackson. Pigeon creek crosses the northwestern part of the township, forming the boundary between Spencer and Warrick counties. The southern part of the township is drained by East Fork, a small stream flowing west into Pigeon creek. The topography runs from flat creek bottoms to somewhat hilly sections in the eastern and central parts, the hills rising from 30 to 60 ft., but usually with gentle slopes. The L., E. & St. L. C. R. R. (Evansville division) crosses the northern half of the township from east to west. The southeastern corner of the township is crossed by the Rockport division of the same road.

1994. Stratigraphy.—The outcropping strata of this township belong in Divisions II and III, with three coals exposed, Coal III, IIIa and IIIb (?). Coal III is the only coal worked, but Coal IIIa is probably workable at places. The relation of these coals with accompanying strata is given in the following section, made at the Choon stripping, in the N. E. ¼ of the N. E. ¼ of Sec. 21 (Sect. 995, Fig. 896):



Figs. 896-898. Columnar sections in Ts. 4-8 S., Rs. 6 and 7 W. (Spencer County).
Fig. 899. Section of Coal IV, same area.
Figs. 900-901. Sections of Coal IIIa, same area.
Figs. 902-903. Sections of Coal III, same area.

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Sandstone	2	6	..	..	2	6
2.	Drab to blue shale	2	6	5	0	5	0
3.	COAL IIIb	0	5	0	5	5	5
4.	Fire-clay and shale	3	6	..	..	8	11
5.	COAL IIIa	0	8	0	8	9	7
6.	Fire-clay, with specks of coal	2	6	..	..	12	1
7.	Covered	2	0	4	6	14	1
8.	COAL III	1	6	1	6	15	7

The lowest coal, Coal III, has been worked some, but at time of examination was covered. Mr. Choon reports a shale roof above the coal, coming in the 2 ft. of covered space in the foregoing section. These three coals all occur in the same ravine, and the crops are not 30 yds. apart. It is questionable whether these three coals are III,

IIIa and IIIb, as has been correlated. It may be that one coal has divided into the three coals. If they do represent the above mentioned coals, they are closer together at this place than at any other place in the county. What little coal has been mined has been reported to be a good coal.

Section of the hill leading down to Pigeon creek bottoms near the center of Sec. 10 and ½ mi. southeast of Pigeon station (Sect. 996):

		Ft.	In.
1.	Surface	6	0
2.	Massive sandstone	8	0
3.	Light sandy fire-clay	3	0
4.	COAL	0	8
5.	Fire-clay and red clay	4	6
6.	Bedded sandstone	6	6
7.	Shale and shaly sandstone	5	0
8.	Shaly sandstone	3	0
9.	Shale and shaly sandstone	15	0
10.	Pigeon creek bottoms	0	0
		51	8

Coals through this township do not seem to be persistent.

Outcroppings of a stratum of a soft yellowish sandstone were observed at quite a number of places, viz.: In the road near a small stream in the S. E. ¼ of Sec. 27; along the State road in the N. E. ¼ of Sec. 27; along the State road in the N. E. ¼ of Sec. 14, and along East Fork creek in Sec. 34. At most places this sandstone is very soft.

The line of outcrop of Coal III is shown on the map. The coal underlies the greater part of the eastern half of the township, that part of the township belonging in Spencer county.

Section near the center of the south side of the S. W. ¼ of Sec. 2 (Sect. 997):

		Ft.	In.
1.	Surface	4	0
2.	Sandstone	10	0
3.	Limestone and clay	2	0
4.	COAL III	0	2
5.	Fire-clay	5	0
		21	2

Coal III was worked, until two years ago, by a shaft on Wm. Harris's place, in the N. W. ¼ of the S. W. ¼ of Sec. 36. The following report was given by Mr. Harris: Shaft 40 ft. deep. Coal runs from 18 in. to 3 ft., with shale and limestone roof 4 or 5 ft. thick. The coal lies probably 20 ft. below the bed of East Fork. Some limestone boulders were lying about the shaft. This limestone is very fossiliferous. The coal seems to lie lower at this point than at other points east or west of this shaft. Same coal reported on Mrs. Stit's place, in the S. E. ¼ of Sec. 34, and on Dr. Jones's place, in the S. E. ¼ of Sec. 32.

Coal IIIa is said to outcrop on Delbert Partridge's place, in the S. E. ¼ of Sec. 32.

Township 6 South, Range 6 West.

1995. Geography.—This township is located in the west central part of the county, and is included in the civil township of Grass and one tier of sections along the north side of Ohio township.

Chrisney is located on the Rockport division of the L., E. & St. L. C. R. R., in the northeastern corner of the township. Centerville is located ½ mi. northeast of the center of the township. Honey creek rises one mile south of Chrisney and flows south along the railroad, draining the southeastern quarter of the township. The north and west parts are drained by small streams that flow north and west into Pigeon creek. The topography runs from low, gently rolling hils to high, precipitous ones, the highest of which are 200 ft. above the surrounding country. A line of irregular "knobs" begins on the north, in the N. W. ¼ of Sec. 16, and runs south through Secs. 16, 21, 28 and 33, rising from 50 to 200 ft. above the adjacent country. Usually these "knobs" have steep slopes, and vary in width from ¼ to ½ mi. The Rockport division of the L., E. & St. L. C. R. R. crosses the township from north to south one mile east of the eastern boundary line.

1996. Stratigraphy and Coals.—As is shown by an examination of the map, the outcropping strata of this township belong in Divisions III and IV, with three coals exposed, Coals III, IIIa and IV—all workable. Coal IV runs from 2 ft. to 5 ft. 10 in.; Coal III from 12 to 22 in. The following imperfect section will give the coals with accompanying strata:

1997. Section 998. Section Along Huckleberry Knob.—In S. E. ¼ Sec. 31, from top to Coal III, near its base, as given by Mr. Statler, of that neighborhood (Fig. 897):

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	10	0	..	..	10	0
2.	Massive sandstone ....6 ft. to	7	0	..	..	17	0
3.	Soil ....6 ft. to	10	0	..	..	27	0
4.	Slaty shale	1	0	28	0	28	0
5.	COAL (IV)	5	10	5	10	33	10
6.	Covered	50	0	50	0	83	10
7.	COAL IIIa	1	0	1	0	84	10
8.	Covered	40	0	..	..	124	10
9.	Slaty shale	1	6	..	..	126	4
10.	Copperas rock ....4 in. to	0	6	42	0	126	10
11.	COAL III	1	6	1	6	128	4
12.	Fire-clay	1	6	..	..	129	10

1998. Section 999. Section Made by E. T. Cox.—As given in the Second Report of the Geological Survey of Indiana for 1870 (Fig. 898):

		Ft.	In.	Ft.	In.
1.	Covered space, sandstone and siliceous shale	50	0	50	0
2.	COAL	5	10	55	10
3.	Fire-clay	4	0	59	10
4.	Siliceous shale	25	0	84	10
5.	Limestone	1	0	85	10
6.	Black bituminous sheety shale	3	0	88	10
7.	COAL	1	8	90	6
8.	Covered	30?	0	120	6
9.	COAL	2	6	123	0
10.	Covered	35	0	158	0
11.	COAL	?	?		

The prevailing outcrops over the township are massive sandstone, shaly sandstone and shale. At the following places the soft massive sandstone was observed: In the wagon road one-quarter mile south of Chrisney; in the wagon road three-quarters mile east of Centerville, near the center of the E. ½ of Sec. 14, and in the wagon road 600 yds. west of Bloomfield. The shaly sandstone outcrops at a number of places, the best exposures in Sec. 2. Along the road passing through the center of the section from east to west, 300 yds. east of the northeast corner of Chrisney, is a good exposure of blue to drab shale. This shale outcrops at a number of other places over the township.

The line of outcrop of Coals III and IV is shown on the map. Coal III underlies the greater part of the township. At Irvin's, in the N. W. ¼ of the S. W. ¼ of Sec. 4, this coal has been drifted upon. The mine has been abandoned for two years, and at the time of examination the drift had fallen in, covering the coal. The following report was given by Mr. Irwin:

The coal varies in thickness from 18 to 22 in., with an average of 20 in. (Fig. 902.) At the top is a hard lustrous coal 4 to 10 in. thick, with no horizontal or cross-seams. The coal below, 12 to 18 in. of block, is mined and the upper bench is then wedged down. Under this block is 3 or 4 in. of crumbling coal, forming the greater part of the slack coal. The roof is of hard sheety shale, breaking down into slabs 3 to 4 in. thick and 5 to 8 ft. long. Fire-clay 5 ft. plus forms the floor. The coal dips to the west. The blacksmith at Chrisney says the coal is not as good a coal for shop use as the Fisher coal, in Sec. 16. The coal chars well, but does not work clean. Has too much oil.

Well section near the center of the west half of Sec. 6 (Sect. 1000):

	Ft.	In.
1. Soil	12	0
2. Solid sandstone	5	0
3. Shale	25	0
4. Hard sheety shale	3	0
	45	0

On Wm. Statler's farm, 100 yds. south of the center of the E. ½ of Sec. 33, is an old stripping where Coal III has been worked. Coal 18 in. thick, and is 8 or 9 ft. below the surface.

Coal III has been drifted upon on Jas. Rasor's place, in the S. E. ¼ of the S. E. ¼ of Sec. 32. No coal has been worked at this place for ten years. The following section was given by Mr. Rasor (Sect. 1001):

	Ft.	In.
1. Shale ....4 ft. to	5	0
2. COAL III	1	6
3. Fire-clay	1+	0
	7	6

This same coal outcrops on the Shoemaker farm, in the S. W. ¼ of the N. W. ¼ of Sec. 33.

Well section in the N. E. ¼ of the N. E. ¼ of Sec. 32 (Sect. 1002):

	Ft.	In.
1. Soil	20	0
2. Sandstone	3	0
3. Soft shale ....4 ft. to	5	0
4. COAL	1	6
	29	6

Coal 18 in. thick was reported in Samuel McCulloch's well, in the N. E. ¼ of the N. W. ¼ of Sec. 28, and in Frank McCulloch's well, in the S. W. ¼ of the N. E. ¼ of Sec. 28.

An outcrop of coal 6 in. thick was noted east of Chrisney, in the road between Secs. 1 and 12 and 300 yds. east of the N. W. corner of Sec. 12.

Coal IV occurs high in the "knobs" in Secs. 16, 17, 28, 33 and 34. At the Fisher mine, in Sec. 16, west of Centerville, the coal is drifted upon. The coal varies in thickness from 2½ to 3¼ ft., with an average of 3 ft. (Fig. 899.) The coal blocks well and is wedged down; no powder is ever used in mining it. Ten inches from the top is a discontinuous band of sulphur balls 1 to 2 in. thick. The coal is a semi-block to bituminous, but, owing to the roof, the coal is never shot. The roof is shale; floor of "black jack" and sulphur 5 or 6 in. Under this comes 1 ft. plus of fire-clay. There is probably three-quarters of an acre of coal in this knob. Smiths report this coal to be by far the best coal in the county for their use. With this exception the coal has been mined out of these knobs. Ten or 12 years ago the coal was worked extensively. For further discussion of the "knob" coal, see report on township 7 S., 6 W.

Partial Townships 6 S., 7 W.; 7 S., 6 W.; 7 S., 8 W.; 8 S., 6 W.; and 8 S., 7 W.

1999. Geography.—These partial townships occupy the southwestern part of the county, including the civil townships of Luce and Ohio, and the western part of Grass township. Rockport, the county seat, is located on the Ohio river, in the eastern part of the civil township of Ohio, in Secs. 22, 23, 26 and 27, 7 S., 6 W. The southern and southeastern part of the territory is drained by small streams which empty into the Ohio river. The western part is drained by small tributaries of Little Pigeon creek. The northern part is drained by Lake drain, one part rising near Lake mill and flowing southeast into the Ohio river at Rockport. One other branch rises north of the low divide east of Lake mill and flows northwest into Little Pigeon creek. These two branches of Lake drain drain the Lake plain, a part of the alluvial plain of the old channel of the Ohio river. The topography runs from the wide bottom lands of the Ohio river to the gently rolling uplands bounded on the north by River plain, on the west by Pigeon plain and on the north and east by Lake plain and River plain. The hills of this region rise from 30 to 60 ft. above the surrounding plains, with gentle slopes forming an undulating surface. The "knobs" in the northwestern part of township 7 S., 6 W., rise 200 ft. or more above the level of Lake plain. The Rockport division of the L., E. & St. L. C. R. R. touches the northeastern corner of the county as far south as Rockport.

2000. STRATIGRAPHY.—The outcropping strata of these partial townships belong in Divisions III and IV, with four coals exposed, Coals III, IIIa and IIIb—all workable but Coal IIIb. This territory includes the plains of the southwestern part of the county, the triangular body of uplands and the southern end of the line of "knobs" to the north.

The following sections will give the stratigraphy of the uplands:

Section of Huckleberry knob, a part of which is in Sec. 3, 7 S., R. 6 W., which is given under the stratigraphy of 6 S., R. 6 W.

2001. SECTION 1003. WELL SECTION REPORTED AT D. F. HALL'S. —In N. E. ¼ of the S. W. ¼ of Sec. 26.

	Ft.	In.	Ft.	In.
1. Soil	20	0	20	0
2. Soft yellow sandstone	12	0	32	0
3. Blue shale	28	0	60	0
4. Shale, rather hard, slacks quickly	1	0	61	0
5. COAL?	0	7½	61	7½
6. Fire-clay	0	3	61	10½
7. Hard gray sandstone	15	0	76	10½
8. Shale	6	0	82	10½

Open well 5 ft. in diameter to this depth and a drilled hole 26 ft. farther, passing through the following strata:

	Ft.	In.	Ft.	In.
9. Shale	5	0	87	10½
10. COAL?, probably mixed with shale	4	6	92	4½
11. Sandstone	16	0	108	4½

Some 300 yds. east of Hall's, in the N. W. ¼ of the S. W. ¼ of Sec. 25, three coals were reported in a drilled well 118 ft. deep, the thickest coal near the bottom of the well, which level is below the bottom of Hall's well. These three coals probably correspond to Coal IIIa, III and II.

2002. SECTION 1004. SECTION OF DRILLED WELL.—Near the center of the south side of the S. W. ¼ of Sec. 18, 7 S., R. 6 W. Reported by Mr. David Tullis.

	Ft.	In.	Ft.	In.
1. Soil	17	0	17	0
2. Sandstone	13	0	30	0
3. COAL IIIa (?)	0	10	30	10
4. Sandstone	25	0	55	10
5. COAL III (?) and slate or shale	6	0	61	10
6. Fire-clay	1	0	62	10

2003. SECTION 1005. SECTION OF WELL AT DAVID TULLIS'S.—Near the center of the north side of the N. W. ¼ of Sec. 19, 7 S., R. 6 W. Reported by Mr. Tullis. (Fig. 900.)

	Ft.	In.	Ft.	In.
1. Soil	12	0	12	0
2. Sandstone	13?	0	25	0
3. COAL IIIa (?)	1	0	26	0
4. Sandstone	22	0	48	0
5. COAL III (?) and slate or shale	8	6	56	6

Section of well at the school house at the cross-roads at the center of the north side of Sec. 19, 7 S., R. 6 W. (Sect. 1006):

	Ft.	In.	Ft.	In.
1. Soil	18	0	18	0
2. Sandstone	2	0	20	0
3. COAL (?)	0	10	20	10
4. ?	43	2	64	0

Three seams of coal were reported in a drilled well 90 ft. deep in the S. E. ¼ of the S. W. ¼ of Sec. 19, 7 S., R. 6 W., the lower coal and slate or shale reported to be 9 ft. thick. This coal is much lower than the lowest coal in Tullis's well and probably corresponds to the lowest coal in the well east of Hall's, in the N. W. ¼ of the S. W. ¼ of Sec. 25.

2004. SECTION 1007. WELL SECTION AT ROCKPORT.—In the N. W. ¼ of the N. W. ¼ of Sec. 26. Reported by S. W. Stocking, of Rockport.

	Ft.	In.
1. Soil ....20 ft. or	30	0
2. Massive sandstone	40	0
3. Limestone	465	0
4. Black shale	405	0
	940	0

One coal 12 in. thick was pierced, but its position was forgotten. Mr. Stocking was of the opinion that it came between the sandstone and limestone.

Gas with a pressure of 140 lbs. was struck just below the limestone, but was soon drowned out by salt water.*

2005. COAL III.—The line of outcrop of this coal is shown on the map, following south, west of Lake drain, to Rockport, where it seems to pass below the level of the river, appearing south of Rockport running south and west past Enterprise, passing under the river some 2

* For the geology of the plains see Arthur Veatch's paper referred to above.

mi. west of this place. If this coal is persistent it is more than probable that it underlies the greater part of the southwestern corner of the county, or the partial townships given above. The coal was reported in a well at Lake mill, in the N. E. ¼ of Sec. 6, 7 S., R. 6 W., and on Mr. Ehrmann's place, in the N. W. ¼ of Sec. 8, 7 S., R. 6 W. The coal is said to be 14 or 15 in. thick, with a shale roof. The following section was given by Dr. Ehrmann (Sect. 1008):

		Ft.	*In.*
1.	Soil	20	0
2.	Shale and sandstone	0	3
3.	COAL IIIa	0	4
4.	Fire-clay	0	3
5.	Hard blue limestone	21+	0
		41	10

The limestone lies above the thicker coal. Probably 5 or 6 ft. below the horizon of the limestone is Coal III, 14 or 15 in. thick. The above section is a well section that does not go entirely through the limestone. The relative position of this limestone and Coal III is taken from the outcrop of Coal III near by.

Coal III outcrops at low water mark along the Ohio river at Enterprise, in Sec. 10, 8 S., R. 7 W. Quite a lot of coal was taken out here years ago, but very little during the past four or five years. The roof is a sheety shale some 4 or 5 ft. thick, overlain with 1 to 8 ft. of sandstone. About one-quarter of a mile above Enterprise, on the north bank of the river, is an exposure of sheety shale, with two anticlinal folds. The coal has been worked at different places along the river below Enterprise for one mile or more; the farthest place on L. Deise's place, near the center of the south side of Sec. 4. At the time of the examination the water was over the coal, but the sheety shale and sandstone were exposed.

2006. COAL IIIA.—This coal has been drifted upon and worked by a slope at a number of places, twelve in all—on Jno. Henderson's place, in the W. ½ of Sec. 4, and on the Logsdon place, in the E. ½ and N. W. ¼ of Sec. 5. In general the coal is the same as to quality, physical characteristics, roof, etc., at these different drifts. Only three of these drifts were worked during the last year. The following report was obtained at the Logsdon slope: The coal, with an average thickness of 2 ft., is divided into two benches by a sulphur seam ranging in thickness from the thickness of a knife blade to ½ in. (Fig. 901.) The lower bench is the better coal, and is used by the smiths for shop use. Burns with a clear blaze, leaving few ashes. Roof is said to be a

shale which holds up well. Rooms are 25 to 30 ft. wide, with two rows of props. Coal dips to the north, with few small rolls and no faults. During the past year some 160 tons have been taken out.

Coal is drawn up by horse and windlass. The coal lies some 4 ft. above the Ohio bottoms and is near high water mark of the river. Some years ago coal was taken out on Mrs. F. Luckdo's place, in the S. E. ¼ of Sec. 4.

Among the data found in June, 1897, is the following record of drilling on Sec. 5-8-7, on Wm. Stevenson's land. It is said to commence at low water mark and 56 ft. below the bed being worked. (Said to be supplying 10,000 to 15,000 bushels per year at that time.)

	Ft.	*In.*
Shale, 6 ft.; limestone, 6 in.; "slate," 4 ft.	10	6
COAL	0	8
Fire-clay, 4 ft.; sandstone, 15 ft.; clay shale, 7 ft.; gray shale, 12 ft.	38	0
Black shale, with streaks of COAL	3	4
"Water lime" or flint, very hard, could only drill 6 to 8 in. per day, 6 ft.; soft stone, 15 ft. 6 in.	21	6
	74	0

2007. SUMMARY OF COAL OF SPENCER COUNTY.—

Divisions contained: II, III and IV.
Coals contained: II, IIa, III, IIIa, IIIb, IIIc and IV.

ROUND NUMBER ESTIMATES.

Coal II.

Worked area	3	acres × av. thickness,	38	in. ×	100		11,400 tons.
Workable area	10	sq. mi. ×	"	3	ft. ×	500,000 =	15,000,000 tons.
Unworkable area	200	sq. mi. ×	"	1½	ft. ×	1,000,000 =	300,000,000 tons.
Total area	210	sq. mi					315,000,000 tons.

Coal IIa.

Worked area	4	acres × av. thickness,	3	ft. ×	1,000 =		12,000 tons.
Workable area	5	sq. mi. ×	"	3	ft. ×	500,000 =	7,500,000 tons.
Unworkable area	100	sq. mi. ×	"	1	ft. ×	1,000,000 =	100,000,000 tons.
Total area	105	sq. mi					107,500,000 tons.

Coal III.

Worked area	4	acres × av. thickness,	3	ft. ×	1,000 =		12,000 tons.
Workable area	20	sq. mi. ×	"	3	ft. ×	500,000 =	30,000,000 tons.
Unworkable area	200	sq. mi. ×	"	2	ft. ×	1,000,000 =	100,000,000 tons.
Total area	220	sq. mi					430,000,000 tons.

Coal IIIa.

Worked area......	2	acres ×	av. thickness,	2½	ft. ×	1,000 –	5,000 tons.
Workable area....	1	sq. mi. ×	"	2½	ft. ×	500,000	1,250,000 tons.
Unworkable area.	200	sq. mi. ×	"	1	ft. ×	1,000,000	200,000,000 tons.
Total area	220	sq. mi	....				201,250,000 tons.

Coal IIIb.

Worked area......	1	acre ×	av. thickness,	2	ft. ×	1,000 =	2,000 tons.
Workable area....	100	acres ×	"	2	ft. ×	1,000 =	200,000 tons.
Unworkable area.	100	sq. mi. ×	"	6	in. ×	50,000 =	30,000,000 tons.
Total area	100	sq. mi	....				30,200,000 tons.

Coal IV.

Worked area	40?	acres ×	av. thickness,	4	ft. ×	1,000 =	160,000 tons.
Workable area....	1?	acre ×	"	3	ft. ×	1,000 –	3,000 tons.
Total area	41?	acres	....				163,000 tons.

Number of coals contained: 7.
Greatest thickness recorded: 5 ft. 10 in. Coal IV, in T. 6 S., R. 6 W.
Average of township averages: II, 22 in.; IIa, 25 in.; III, 26 in.; IIIa, 13¾ in.; IIIb, 9 in.; IV, 45 in.
Area underlain by coal: 300 sq. mi.
Area underlain by workable coal: 25 sq. mi.
Situated in townships: 4 S., 4 W.; 5 S., 4 W.; 4, 5 and 6 S., 5 W.
Estimated total tonnage of coal: 1,000,000,000.
Estimated total tonnage of coal removed: 200,000.
Estimated total tonnage of workable coal left: 50,000,000.
Number of mines working ten men or over in operation: 0.
Number of mines working less than ten men in operation: 36.
Total number of mines in operation: 36.
Large mines not in work: 0.
Small mines not in work: 37.
Outcrops: 100.
Total number of openings to coal: 298.

XXXVII. WARRICK COUNTY.

2008. References and Field Work.—

1862 (1859-60). Richard Owen, Rep. of a Geol. Reconn. of Ind., p. 189. (Half page.)

1862 (1859-60). Leo Lesquereux, same, p. 308. (Half page, L. L.)

1871 (1870). E. T. Cox, 2d Rep. of Geol. Surv. of Ind., pp. 155-162. Three columnar sections, four coal analyses. (E. T. C.)

1872 (1871-72). E. T. Cox, 3d and 4th Ann. Rep. of Geol. Surv. of Ind., pp. 104-106. One columnar section. (E. T. C.)

1872 (1871-72). John Collett, same, pp. 231, 274, 276, 279. Four columnar sections. (J. C., '72.)

1876 (1875). John Collett, same, 7th Ann. Rep., 249-250, 285, 289. Three columnar sections. (J. C., '75.)

1896 (1895). W. S. Blatchley, Ind. Dept. Geol. and Nat. Reso., 20th Ann. Rep., pp. 119, 120. One columnar section (coal measures). (W. S. B.)

1895 (May). G. H. Ashley, field work for this report.

Section 1. Geography.

2009. Position.—Warrick county is one of the southern tier of counties having the Ohio river for part of its southern boundary. It is close to the southwestern corner of the State, lying west and partly north of Spencer, south of Pike and the corners of Dubois and Gibson, and east of Vanderburgh and the corner of Gibson.

2010. Extent and Townships.—The county has an extreme length from north to south of 25½ mi., and width from east to west of 24½ mi. The area is 388 sq. mi. It includes all of T. 4 S., of R.'s 6, 7, 8 and 9 W.; T. 5 S., of R.'s 8 and 9 W.; T. 6 S., R. 8 W.; most of T. 5 S., R. 7 W.; T. 6 S., R. 9 W., and parts of T. 3 S., of R.'s 6, 7 and 8 W.; T. 5 S., R. 6 W.; T. 6 S., R. 7 W.; T. 7 S., R.'s 8 and 9 W. The civic townships are arranged as follows:

			Lane.	
Greer.	Hart.		Owen.	Pigeon.
Campbell.			Skelton.	
		Boone.		
Ohio.				
	Anderson.			

2011. ELEVATION.—The elevation of the county runs from about 330 ft. above tide in the southwestern corner to probably over 600 ft. in the high knobs in the northern part of the county. A few of the known elevations are as follows:

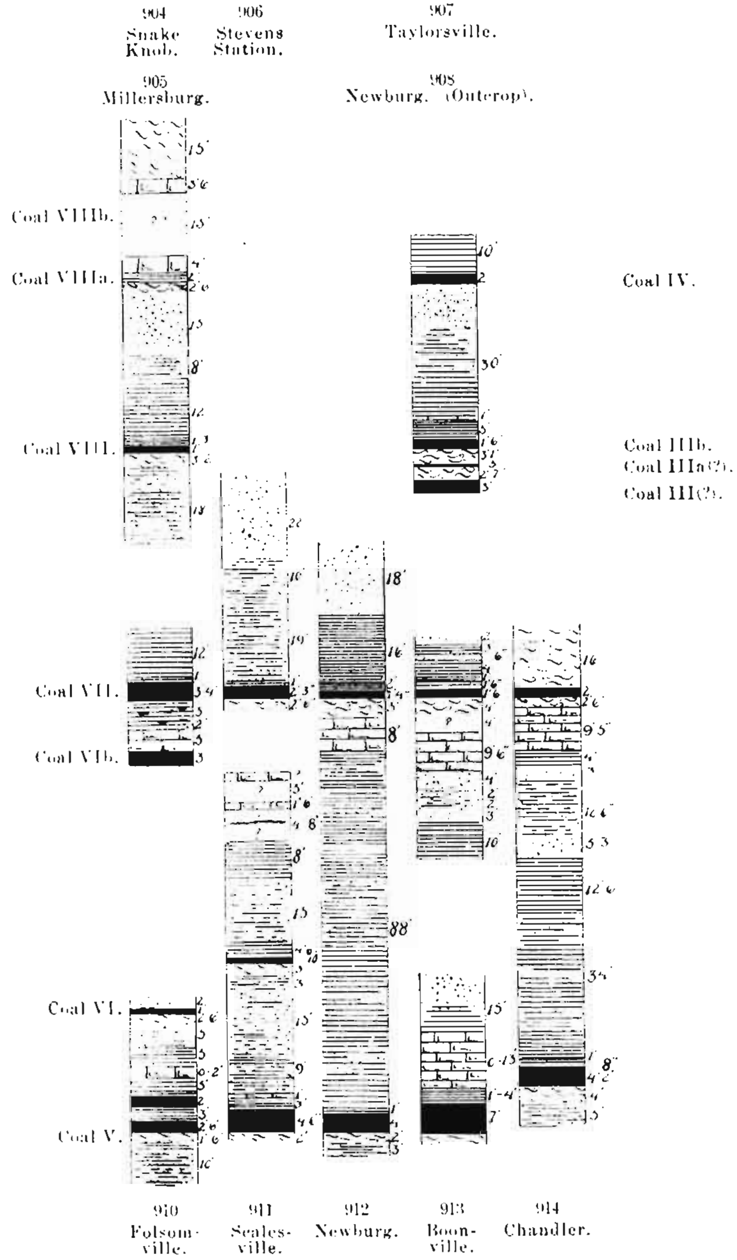
		Ft. A. T.
Tennysonville	L., E. & St. L. C. R. R.	451
Boonville	L., E. & St. L. C. R. R.	442
Chandler	L., E. & St. L. C. R. R.	467

2012. GENERAL TOPOGRAPHY.—The most of the topography is rolling, but rises into a high knobby ridge in the northern part of the county, where the waters draining south divide from those draining northwest. A noticeably high ridge runs down the western edge of Pigeon township. Isolated hills of some prominence occur in the southeastern part of Boone township and the northeastern part of Anderson township. The latter, around Yankeetown, appear to owe their existence in part to the limestone near the top of Division VI. (See cross-section on map.) Turning to the valleys, one is at once struck by the great width of the flat bottoms of the streams. Comparatively small streams have flat swampy bottoms a quarter or half mile wide, while in the larger streams, like Cypress, they are often from one to three miles wide. These facts are evidence that at some time in the past, probably of recent geologic time, all this region stood at a much higher elevation than at present, and at some time between has probably stood at a lower elevation than at present, with the result of filling up the old valleys. With the exception of these creek bottoms, most of the county is high and well drained.

Section 2. Stratigraphy.

2013. COAL MEASURES.—On account of the easy accessibility and thickness of Coal V, little drilling has been done in this county, and columnar sections of any extent are rare; therefore, we will figure and discuss the stratigraphy of the county at this point, taking up the coals more in detail under the township discussions.

The highest strata of the county outcrop in the high knobs along the divide between the Ohio and Patoka rivers. Mr. Collett gives the following section of Snake Knob, in Sec. 34-3-8, which is probably about all of Division VIII:



2014. SECTION 1009. SECTION OF SNAKE KNOB.—Sec. 34-3-8, Fig. 904. (J. C., '72, p. 279).

		Ft.	In.
1.	Soil and clay	15	0
2.	Limestone, shaly and flinty	3	6
3.	Space, covered, place of Coal VIIIb?	15	0
4.	Limestone, compact, flinty	4	0
5.	Clay, shale and nodules	2	0
6.	Place of Coal VIIIa?	0	0
7.	Fire-clay, buff	2	6
8.	Sandstone, coarse, red	15	0
9.	Sandy shale, with carbonaceous partings	8	0
10.	Clay shale, with pyritous partings	12	0
11.	"'Black clod,' rotten slate"	1	3
12.	COAL VIII	1	1
13.	Fire-clay	3	2
14.	Sandy shale and thin-bedded sandstone	18	0

This section shows Coal VIII and the two limestones near the top of the division. The horizons of Coal VIIIa and VIIIb are indicated on the basis of information obtained further west, though no coal appears here.

The most complete section down to the next coal has been obtained just across the county line at the old Stevens shaft.

2015. SECTION 1010. SECTION AT STEVENS SHAFT.—Sec. 7-6-9, Fig. 906. (J. C., '75, p. 288.)

		Ft.	In.	Ft.	In.
1.	Covered soil	8	0	8	0
2.	Choice yellow sandstone	22	0	30	0
3.	Siliceous shales, with iron shells (Top of shaft.)	10	0	40	0
4.	Gray and buff sandy shale, and also shales with thin shells and plates of ironstone	19	0	59	0
5.	Black shaly "clod"	1	0	60	0
6.	COAL VII	2	3	62	3
7.	Fire-clay in brook	2	6	64	9

It has been assumed that the sandstone at the top of this section is the same as the sandstone at the bottom of the preceding section. This may or may not be true. However, the space over Coal VII appears from this and other sections to contain a considerable thickness of massive sandstone overlying a shale containing numerous lines of iron concretions, resembling in that respect the equivalent strata northward at least as far as Vigo county.

Closely associated with Coal VII is in many places a coal which we have correlated as Coal VIb. In places it is only separated from Coal VII by fire-clay, but more commonly the limestone so persistently occurring near the top of Division VI comes between the two coals. This lower coal is thickest about Millersburg and Lynnville. The section at the former place is reported as follows (the lower coal is not exposed now):

2016. SECTION 1011. SECTION AT MILLERSBURG.—Sec. 11-5-9, Fig. 905. (J. C., '75, p. 286, for main part of section.)

		Ft.	In.
1.	Slope and clay shale	12	0
2.	Pyritous clay shale	1	0
3.	Black "clod," with fossils	1	0
4.	COAL VII—Laminated, good coal, 1 ft. 4 in.; choice cubic coal, 1 ft. 6 in.; bony, pyritous coal, 0 ft. 6 in.	3	4
5.	Clay shale, with pockets of impure coal	5	0
6.	Gray shale	2	0
7.	Blue limestone, very hard and ferruginous	5	0
8.	COAL VIb	3	0
		32	4

Complete sections from Coal VII to Coal V have been obtained at Chandler and Newburg.

2017. SECTION 1012. SECTION AT CHANDLER SHAFT.—Sec. 36-5-9, Fig. 914. (J. C., '75, p. 287.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Clay shale	16	0	..	..	16	0
2.	COAL VII, Millersburg and "Little Newburg"	2	6	2	0	18	0
3.	Fire-clay	2	6	..	..	20	6
4.	Blue dark limestone, with crinoid stems	9	5	..	..	29	11
5.	Clay shale (indurated)	4	0	..	..	33	11
6.	Hard sandstone	3	0	..	..	36	11
7.	Light clay shale	0	8	..	..	37	7
8.	Sand shale	11	10	..	..	49	5
9.	Sandstone	5	3	..	..	54	8
10.	Gray shale	10	5	..	..	65	1
11.	Dark clay shale	2	1	..	..	67	2
12.	Gray shale, with plates of sandstone	34	0	..	..	101	2
13.	Black shale	1	0	..	..	102	2
14.	Shaly "clod," with large boulders	0	8	84	10	102	10

	Ft.	In.	Ft.	In.	Ft.	In.
15. COAL V—Fair coal, 1 ft. 4 in.; pyrite parting, 0 to 0 ft. 2 in.; good coal, 1 ft. 4 in.; laminated coal, 1 ft. 4 in.	4	2	4	2	107	0
16. Fire-clay	4	0	..	..	111	0
17. Sandy shale, iron nodules	5	0	..	..	116	0

2018. SECTION 1013. SECTION AT NEWBURG SHAFT.—Sec. 2-7-9, Fig. 912. (J. C., '75, p. 287.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Massive yellow sandstone	18	0	..	..	18	0
2. Gray shale	16	0	..	..	34	0
3. Black shale and fire-clay	2	0	..	..	36	0
4. COAL VII. "Little Newburg"	1	4	1	4	37	4
5. Fire-clay	5	0	..	..	42	4
(Top of shaft.)						
6. Gray and buff limestone	8	0	..	..	50	4
7. Gray shale, with plates of sandstone	88	0	..	..	138	4
8. Hard shale, pyritous fossils	1	0	102	0	139	4
9. COAL V—Fair coal, 1 ft. 10 in.; pyritous parting, 0 ft. 2 in.; good coal, 2 ft. 0 in.	4	0	4	0	143	4
10. Fire-clay	2	0	..	..	145	4
11. Siliceous shale, pyrite pebbles	3	0	..	..	148	4

In Mr. Cox's report on Warrick county he gives a more complete section, as he included a drilling which started in the under clay of Coal V.

2019. SECTION 1014. SECTION AT NEWBURG.—(E. T. C., p. 156.)

	Ft.	In.	Ft.	In.	Ft.	In.
1. Loess, marl and soil	15	0	..	..	15	0
2. Brown sandstone	10	0	..	..	25	0
3. Sandy shale	15	0	..	..	40	0
4. COAL VII	?	?	?	?	..	..
5. Limestone	2	0	..	..	42	0
6. Black shale	1	0?	3	0	43	0
7. COAL VIb	1	6	1	6	44	6
8. Fire-clay	2	0	..	..	46	6
9. Gray sandy and clay shale	20	0	..	..	66	6
10. Brown schistose sandstone and gray shale	68	0	..	..	134	6
11. Black shale	1	6	91	6	136	0
12. COAL V	4	0	4	0	140	0
(Top of bore.)						
13. Fire-clay	3	6	..	..	143	6
14. Shale	2	0	..	..	145	6

	Ft.	In.	Ft.	In.	Ft.	In.
15. White and dark sandstone	23	6	..	..	169	0
16. Dark shale	58	0	..	..	227	0
17. Sandstone	37	0	124	0	264	0
18. COAL	1	0	1	0	265	0
19. Fire-clay	1	0	..	..	266	0
20. Light-colored sandstone	50	0	..	..	316	0
21. Dark shale	17	0	..	..	333	0
22. Gray shale	5	0	..	..	338	0
23. Reddish shale	5	0	..	..	343	0
24. Hard reddish rock, no grit	5	0	..	..	348	0
25. Gray shale	87	0	..	..	435	0
26. White sandstone	2	6	..	..	437	6

In the report on Perry county, Mr. Cox repeats this section, but with some changes. Thus, he omits Coal VIb, makes Coal VII 2 ft. 6 in. thick, with the limestone below it 8 ft. thick instead of 2 ft., and Coal V 5 ft. thick instead of 4 ft., with some other unimportant changes.

The exposed section near the Archibald shaft gave as follows:

2020. SECTION 1015. SECTION OF EXPOSED STRATA NEAR NEWBURG.—Fig. 908.

	Ft.	In.
1. Brown sandstone	2	0+
2. Gray clay shale	3	0+
3. Sandstone .3 in. to	0	6
4. Gray shale	4	0
5. Black to gray sheety shale .6 in. to	1	0
6. Gray shale .0 in. to	1	6
7. COAL VII	1	6
8. Gray fire-clay	4	0
9. Hidden	4	0
10. Limestone	9	6
11. Gray sandstone, with reddish iron nodules	4	0
12. Shaly sandstone	2	0
13. Gray sandy shale	2	0
14. Sandstone	3	0
15. Gray shale, to high water in river	10	0

Coal VI is absent in the sections given above, but will be found in sections in the northeastern part of the county. Its relation to Coal V is shown in the two following sections:

2021. SECTION 1016. SECTION ON SIGEL DIMMET PLACE.—N. W. of Folsomville, Sec. 28-4-7, Fig. 910.

	Ft.	In.
1. Brown shaly sandstone	2	0
2. COAL VI	1	0
3. Light drab fire-clay	2	6

		Ft.	In.
4.	Brown shaly sandstone	5	0
5.	Drab shale	5	0
6.	Black sheety shale	1	0
7.	COAL V—Coal, 2 ft. 0 in.; drab shale, 3 ft. 6 in.; coal, 2 ft. 6 in.	8	0
8.	Fire-clay	2	0
9.	Drab shaly sandstone	10	0

This section also shows Coal V in two benches, separated by up to 3 ft. 6 in. of shale.

2022. SECTION 1017. SECTION AT SCALESVILLE.—Fig. 911.

		Ft.	In.
1.	Limestone	?	?
2.	Hidden space	5	0
3.	Limestone	1	6
4.	Hidden, black streak as though outcrop of Coal VIb ....4 ft. to	8	0
5.	Shale, with lines of iron nodules	8	0
6.	Light brown shaly sandstone	15	0
7.	Light drab clay shale	4	0
8.	Dark blue shale	6	0
9.	COAL VI	..	10
10.	Dark shaly fire-clay	3	0
11.	Drab sandy shale	3	0
12.	Shaly sandstone ....10 ft. to	15	0
13.	Sandy to clay shale	9	0
14.	Limestone	1	0
15.	Brown sandy shale	2	0
16.	Black sheety shale	1	0
17.	COAL V—Coal, 1 ft. 6 in.; black shale or clay, 1 in. to 0 ft. 3 in.; coal, 2 ft. 11 in.	4	8
18.	Clay	2	0+

A section near Boonville will show the development of Coal V and the strata above at that point.

2023. SECTION 1018. SECTION AROUND BOONVILLE.—Fig. 913.

		Ft.	In.
1.	Sandstone and shale	15	0
2.	Limestone ....0 to	13	0
3.	Black shale ....1 ft. to	4	0
4.	COAL V ....4 ft. to 9 ft.	7	0
5.	Fire-clay.		

The following additional drilling records were obtained after the report went to press. They are all by Wm. Adams:

DRILLING AT PAGE'S.—Three miles southwest of Boonville.

	Ft.	In.
Surface	12	0
Sandstone, 5 ft.; clay shale, 10 ft.; sandstone, 9 ft.; shale, 8 ft. 6 in.; hard sandstone, 2 ft.; sandy shale, 4 ft. 3 in.; black shale, 4 ft.; clay shale, 7 ft.; black shale, 3 ft. 4 in.	53	1
COAL V	6	0
Fire-clay.		
	71	1

DRILLING ON WILLIAMS'S PLACE.—Six miles southwest of Boonville.

	Ft.	In.
Surface clay	16	0
Limestone, 11 ft. 9 in.; sandstone, 5 ft.; shale, 40 ft.	56	9
COAL V	4	8
	77	5

DRILLING ON DR. DUBOIS'S LAND.—Four miles north of Boonville.

	Ft.	In.
Surface clay	13	8
Limestone, 9 ft. 5 in.; clay shale, 8 in.; black shale, 1 ft. 3 in.; fire-clay, 2 ft.; sandy clay shale, 3 ft.; fire-clay, 8 in.; sandy shale, 11 ft. 10 in.; sandstone, 5 ft. 3 in.; gray shale, 10 ft. 5 in.; black bituminous shale, 2 ft. 1 in.; gray shale, 34 ft.; black shale, 4 in.; black calcareous ironstone, 8 in.	81	7
COAL V	5	8
	100	11

These sections show Divisions V and VI to have a combined thickness of from 90 ft. to over 100 ft. Below Coal VII there is usually, though not always, a little fire-clay, with sometimes a small amount of shale; below that is the limestone so persistently found near the top of Division VI. In places this approaches a thickness of 10 ft. Just below the limestone is frequently found Coal VIb, in some cases this being only a foot or two below Coal VII. Then comes a considerable thickness of shale and sandstone, near the bottom of which appears a coal which is correlated as Coal VI. It is found only in the north part of the county, and was not seen over a foot thick. At the bottom of Division V is Coal V, ranging from 4 ft. to 9 ft. in thickness, generally overlain by black shale, often sheety. The limestone which to the north is generally found over this black shale is not very persistent in this county, though found at many places, and often having a considerable thickness.

Divisions IV and III, with their coals, with the exception of what is correlated as Coal IIIb, are not well exposed in this county, and no complete sections of them were obtained. The drilling east of Newburg, near the mouth of Cypress creek, has already been given. That was made for oil, and whether for that reason, or because the coals were not there, it failed to find but one thin coal. A section by Mr. Cox, made a few miles further east, south of Yankeetown, reached down to a coal in the bottom of Little Pigeon creek, but this coal is supposed to be a coal in Division III, probably Coal IIIb. His section is as follows:

2024. SECTION 1019. SECTION AT SPEAR'S MINE.—Sec. 15-7-8. (E. T. C., p. 161.)

		Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
1.	Covered space containing sandstone and shale	50	0	..	..	50	0
2.	Limestone	4	0	..	..	54	0
3.	Sandstone	6	0	..	..	60	0
4.	Siliceous and argillaceous shale	51	0	..	..	111	0
5.	Tough blue clay	3	0	..	..	114	0
6.	Black bituminous shale	0	7	..	..	114	7
7.	COAL V (caking coal)	4	4	4	4	118	11
8.	Fire-clay	3	0	..	..	121	11
9.	Arenaceous and argillaceous shale	87	0	..	..	208	11
10.	Ferruginous black shale	..	10	..	..	209	9
11.	Black bituminous shale	1?	0	91	10	210	9
12.	COAL IIIb (?)	1	3	1	3	212	0
	Low water of Little Pigeon creek.						

The limestone near the top of this section is the limestone occurring but a short distance below Coal VII.

Coal IV and the upper coals of Division III are best exposed in the northeastern part of the county. There Coal IV appears to be from 50 to 75 ft. below Coal V, overlain, as in Pike county, by a shale, as at Taylorsville, suitable for brick, or, as near Tennyson, by a sandstone which replaces the shale. The coal itself varies from 3 ft. 6 in. down in thickness, and appears to be more often absent than present. From 15 to 40 ft. below Coal IV is Coal IIIb, which, in Sec. 29, northeast of Taylorsville, shows the following connected section (Sect. 1020):

		Ft.	*In.*
1.	Shale, grading into sandstone at top	30	0
2.	Ferruginous limestone	1	0
3.	Clay shale	4	0
4.	Dark shale	1	8
5.	Black sheety shale, fossiliferous	0	6
6.	Black shale, with fossiliferous concretions	0	10
7.	COAL IIIb	1	6
8.	Clay	3	0
9.	Bone coal or black shale	0	6
10.	Clay, with stigmaria	1	4
11.	Dark clay and shale	1	6
12.	COAL, poor ... 3 ft. to	2	0
13.	Clay	3	0

Though Coal IIIb has been stripped at numerous points, it is only at a few points that the underlying coal has been observed, and at most points its presence is seriously questioned. At two points thin coals were reported to come between the two main beds.

No definite information was obtained in this county of coals lower than those described. The drilling east of Newburg will probably not be received as final, as so many instances are known of wells drilled for oil or gas failing to find coal beds that later are successfully worked.

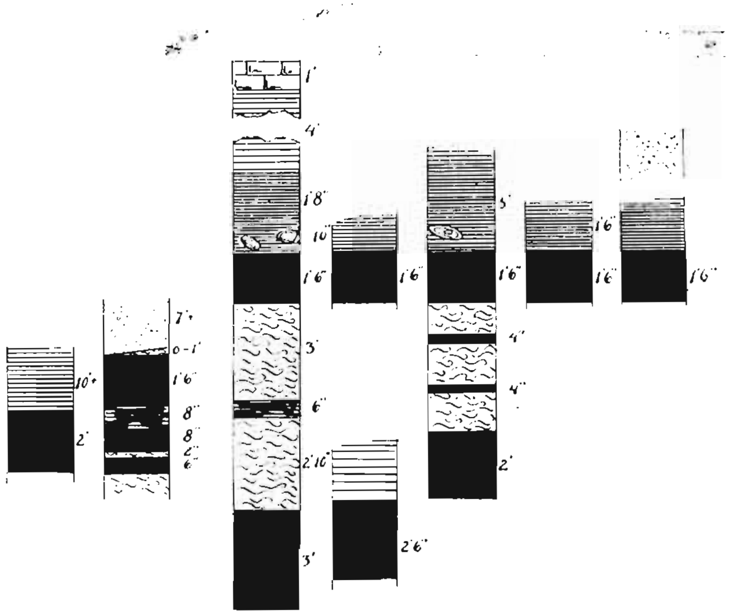
TOWNSHIPS 3 (PART), 4 AND 5 (PART) SOUTH, RANGE 6 WEST.

2025. GEOGRAPHY.—This area, corresponding with Pigeon and the eastern end of Skelton of the civic townships, lies in the northeastern corner of Warrick county, and comprises all of 4 south, 6 west, and 6 sq. mi. in the southwestern part of 3 south, 6 west, and the northwestern part of 5 south, 6 west.

The main streams, Polk Patch branch, Pigeon branch, Cocos creek, and their principal tributaries, have broad bottoms from a quarter of a mile to a mile wide, with generally gentle slopes stretching down to them. Along the western edge of the area is a high ridge with rather sharp irregular crest and steeper slopes. The topography becomes more rugged toward the north.

The Evansville branch of the Air Line crosses the southern end of the area.

2026. STRATIGRAPHY.—Practically all of Division IV and the top of Division III outcrop in this area. Coal V was not seen in this area, nor was a good section of Division IV obtained. Coal IV was seen at two points only. (Figs. 915 and 916.) Northwest of Selvin, on the Joel Taylor place, the coal runs from 22 in. to 2 ft. thick, while over it is 10 ft. or more of gray shale, appearing to be suitable for the manufacture of brick. (Fig. 915.)



Figs. 915-916. Sections of Coal IV in Ts. 3 to 5 S., R. 6 W.
Figs. 917-921. Sections of Coals IIIb, IIIa (?) and III (?) in same area.

The coal appeared to have the character of Coal IV in Pike county. In a small area of this coal north of Tennyson, in Sec. 7-5-6, the coal shows a greater thickness. At the H. G. Garrison bank, in the N. E. of N. W. Sec. 7, it shows the following section (Fig. 916, Sect. 1021):

		Ft.	*In.*
1.	Soft brown sandstone, making good roof, 6 ft. to	7	0
2.	White plastic clay ....0 to	1	0
3.	COAL IV—Coal, 1 ft. 6 in.; bone, 0 ft. 8 in.; coal, 0 ft. 8 in.; clay parting, 0 ft. 2 in.; coal, 0 ft. 6 in.	3	6
4.	Fire-clay.		

This coal is dug without shooting, blocking out in cubes of the thickness of the benches. The coal in this area is said to be soft and to tend to slack readily.

2027. COALS IN DIVISION III.—(Figs. 917 to 921.) There is an "18 in. bed" of coal overlain by black sheety shale that is stripped at many points in these townships. It was formerly called Coal "K," but is believed to correspond with Coal IIIb of previously described counties.

It has a thickness of 18 in. at practically every point seen or reported from, and at every point has a black sheety bituminous shale roof. In a few cases the limestone showed above the black shale, but not as a rule. Above these generally comes a considerable thickness of sandy shale or shaly sandstone, usually quite soft. This coal is everywhere reported to be an excellent blacksmith coal.

From 1 to 8 ft. below this coal in the neighborhood of Selvin is found another bed ranging from 2 ft. to 3 ft. 6 in. in thickness. It is generally reported to be of poor quality, and, as the space between the two coals is mainly clay, it probably does not have a very good roof. Its thickness and roof at several places are shown below.

NAME.	Location.	Thickness.	Roof.
D. J. Heming...	N. W. of S. E. of Sec. 30-3-6	2 ft. 0 in. to 2 ft. 6 in.	Light drab clay shale.
Elijah Byers....	S. W. of S. E. of Sec. 29-3-6	3 ft. 0 in.	Clay or clay shale.
T. E. Auskin....	N. E. of S. E. of Sec. 29-3-6	Up to 3 ft. 6 in.	
S. E. Ingram....	N. W. of S. E. (?) of Sec. 29-3-6	3 ft. 0 in. to 2 ft. 0 in.	Dark clay, 1 ft. 3 in.
—— Johnson ...	Sec. 33 (?), 3-6	3 ft. 0 in.	
Chas. Day......	N. E. of N. E. of Sec. 8-4-6.	1 ft. 6 in. to 2 ft. 0 in.	
Isaac Powers...	N. E. of N. E. of Sec. 6-5-6.	2 ft. 0 in. to 3 ft. 6 in. ?	Black shale, 2 in.

Between the two coals is mainly fire-clay showing one or two thin beds of black shale or bone coal (reported good coal in places).

2028. DISTRIBUTION OF COALS.—In T. 3 S., R. 6 W. (see Plate LXIX), in this county, Coal IIIb and the underlying coal are both generally above drainage. At Elijah Byers's and T. E. Auskin's, in the S. W. of S. E. and N. E. of S. E. of Sec. 29, respectively, the lower coal is 10 to 15 ft. above the creek. At the former place Coal IIIb lies 5 ft. above the lower bed, and it is reported that in places two 10 in. beds of coal come in the space, which otherwise is all fire-clay. The black shale roof of Coal IIIb is here 5 ft. thick, while in the road just north there is exposed still above about 30 ft. of shale, which tends to become massive sandstone towards the top of the hill. Some question is raised as to whether this sandstone and shale does not come above the horizon of Coal IV. Though no coal was seen between it and Coal IIIb, I am inclined to think that Coal IV is lacking here and that its horizon is quite close to Coal IIIb.

At the Auskin bank the space is from 4 ft. to 6 ft. between Coal IIIb and the lower coals. Down the stream from here these coals have been worked a little on the Spradley, J. Woods and Johnson places, in Secs. 32 and 33. The conditions are about the same as here. Up stream the coal below Coal IIIb reaches creek level at the center of Sec. 30, where it has been stripped on the D. J. Heming place. Coal IIIb is here 6 ft. above. In Sec. 32 Coal IIIb is in the branch bottom in the N. E. of S. W. of section just northeast of Selvin. It has been stripped some on the Thiry place. East of Selvin this coal is 8 or 10 ft. above drainage, where it has been stripped on Mrs. Bolin's place, S. W. of S. E. of Sec. 32. About 30 or 40 ft. or perhaps less above the coal at Thiry's is Coal IV. It crops out beside the road in the north edge of Selvin and almost at the same level. It appears to be somewhat lower just west, on the Joel Taylor place, N. E. of S. E. of Sec. 31, where it has been extensively stripped. See description above.

Coal V will be found on the top of the high ridge crossing the S. W. corner of Sec. 30. It was not seen in this township and is so near the top of the ridge that its extension into this township is questionable.

2029. TOWNSHIP 4 SOUTH, RANGE 6 WEST.—Coal IIIb is found at numerous points in the two western tiers of sections. It is well above drainage, so that it has been found principally near the heads of the streams. In Sec. 5 this coal has been stripped at the following points: Jacob Harter, N. W. of N. E.; David Miller, N. E. of N. E.; Chas. Cavin, S. E. of S. W.; A. Springton, N. E. of S. W.; James Day, S. W. of N. W. (?)

Further south and west it has been found at the following places, as above, always about 18 in. thick and overlain by black sheety shale; J. W. Baker, N. E. of S. E. of Sec. 6; William Taylor, S. E. of N. E. of Sec. 7, 10 or 15 ft. above drainage at this point. In the road just west there appears to be at least 30 ft. of massive brown sandstone over the coal, which weathers readily into sand. John Tuly, N. W. of S. W. of Sec. 8; Chas. Day, N. W. of N. E. of Sec. 8. Close to the school house, northeast of this stripping, a sharp little anticline is well exposed, the strata in the east having a dip of 38°. (See Fig. 922.)

Over the coal at the Day mine is: Surface, 4 ft.; drab clay shale, 2 ft.; black shale, 3 in.; drab shale, 1 ft.; black sheety shale, 5 ft.;

Coal IIIb, 1 ft. 6 in., fire-clay, etc. (see Fig. 919). James Southwood place, S. E. of N. E. of Sec. 8, where the top 3 or 4 in. of coal is shelly and separated by a smooth parting from the coal under.

In Sec. 20 it has been stripped on the Andrew Kitchen place, N. W. of S. E.; William Robinson's, N. E. of S. W. and S. W. of S. E.; John Tuly's, N. W. of S. W., and on John Perigo's, in the S. W. of S. W. of this section.

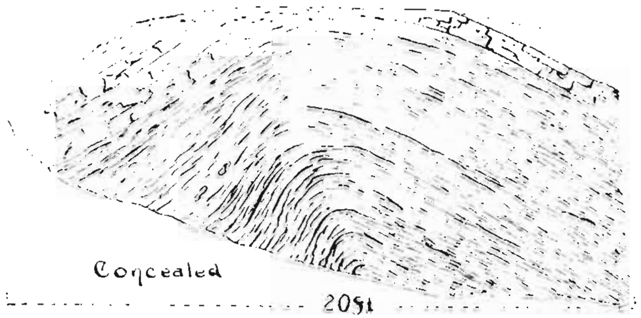


Fig. 922. Small anticline close to schoolhouse on Chas. Day place, Sec. 8, 4-6.

In Sec. 19 Coal IIIb is found on the Joseph Voils place, S. E. ¼; below this it occurs on the D. B. Rhodes place, N. W. ¼ of Sec. 30; James Byers place, in S. W. of N. W. of Sec. 29, and N. E. of S. E. of Sec. 30; J. S. Phillips, N. W. of N. W. of Sec. 29; Wm. B. Gentry, N. E. of N. E. of Sec. 31; James Crook, S. W. of N. E. of Sec. 31.

The position of this coal in this area will carry it well above the bottoms of Polk Patch branch. But little information was obtained concerning the coal in the lower ridge or divide east of Polk Patch branch. A coal, reported to be 2 ft. thick, has been dug on the James M. Bruner place, in Sec 10, about 10 ft. above the creek, and on the Geo. Eskridge (?) place, S. W. of N. W. of Sec. 23. The latter coal is reported to be 3 ft. thick. Neither coal was seen. The latter coal appeared to have black shale over it. Beside the road north of the center of Sec. 22, this coal shows in three benches as follows (Sect. 1022):

	Ft.	*In.*
Coal (exposed)	0	3+
Clay	0	6
Coal	0	2
Clay	0	4
Coal	1	6
Clay	3	0

I am not prepared to say what coal this is, but should expect to find Coal IIIa about in its position. A certain resemblance should be noted to Coal IIIb and its underlying coal around Selvin.

2030. TOWNSHIP 5 SOUTH, RANGE 6 WEST.—The highest land in the Warrick county part of this township lies in the N. W. ¼ of Sec. 7 and catches Coal IV. The coal lies nearer the top than the bottom of the ridge at the east where it has been drifted upon by H. G. Garrison. See section of coal and description above.

The same coal has been mined a little on the Hodge place, in the N. W. corner of Sec. 7, but is reported to have proved too poor to pay to work.

Coal IIIb outcrops on both the north and south side of this ridge, some 10 or 15 ft. below Coal IV and not far above the bottom land. In the N. E. of N. E. of Sec. 6, a 12-ft. shaft reaches a coal reported at from 2 ft. to 3 ft. 6 in. in thickness on the Isaac Powers place. This is below the level of the bottoms at that place and was thought to be in about the position of Coal IIIa. It is said to have only a few inches of black shale over it, with soil and clay above.

South of Tennyson a litle coal has been dug on the Marion Folsom place, in the N. E. of S. W. of Sec. 18. The coal is 10 to 15 ft. above Coce's creek and appears to have been overlain by black sheety shale. It is reported 3 ft. thick. It was questionably correlated as Coal IIIb.

The data show that as far as exposed there is no commercially workable coal in this area. Coal IV near Selvin may some day be worked in connection with its overlying shale for the manufacture of brick or tile.

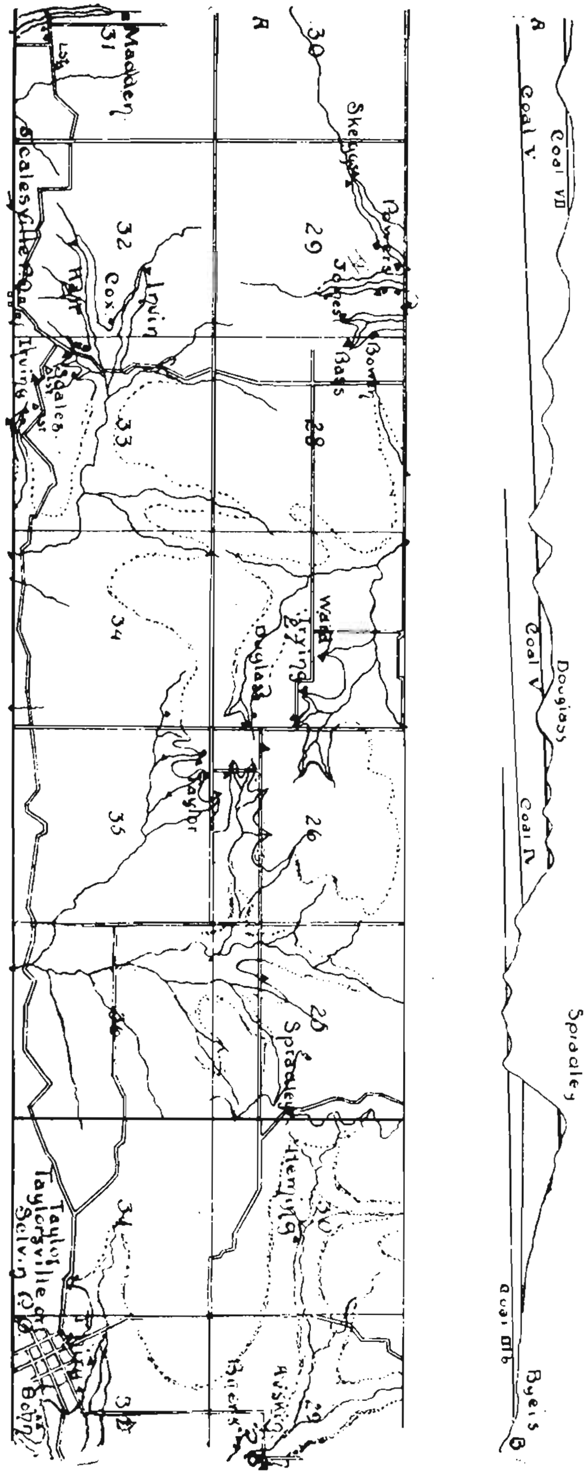
TOWNSHIP 3 SOUTH, RANGE 7 WEST. (PART IN WARRICK COUNTY.)

2031. GEOGRAPHY.—This area lies along the northern line of the county and corresponds with the northern half of Lane of the civic townships. It is crossed from east to west by a high irregular ridge making the watershed between the Patoka and Ohio rivers.

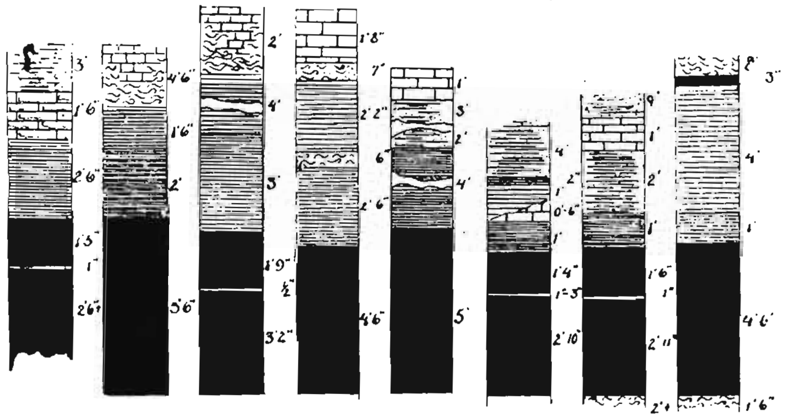
2132. STRATIGRAPHY.—Divisions VII to III outcrop in this area. A section running from Coal V almost up to Coal VII was given in ¶2022.

Coal VII was not seen and is found only in the highest ground in the western part of the area.

PLATE LXIX. Sketch map and cross section of parts of T. 3 S., Rs. 6 and 7 W.



Coal VI, where best exposed near Scalesville, showed a thickness of 10 in. and had a roof of shale overlain by sandstone. A 4 ft. 6 in. coal worked on the Madden place, in Sec. 31, was thought to be Coal VI, as it appeared to be about the right distance below the limestone at the top of Division VI, and it is overlain by first a few inches of shale and then by massive sandstone. The slope being full of water the coal could not be examined, but it is reported to be solid coal of desirable quality, and of the thickness given. At Thomas Spradley's Coal VI shows as a black band 3 in. thick, 5 ft. above Coal V.



923 Hall. Sec. 32 · 924 Douglass. Sec. 27. · 925 Taylor. Sec. 35. · 926 Miller. Sec. 29. · 927 Ward. Sec. 27. · 928 Irving. Sec. 33. · 929 Cox. Sec. 32. · 930 Spradley. Sec. 25.

Figs. 923-930. Sections of Coal V in T. 3 S., R. 7 W. (Warrick County.)

2033. COAL V is the principal coal of this area (see Figs. 923 to 930). As shown by the figures, while often a solid coal, it tends to have a clay parting above the center. The roof is the usual black sheety shale, overlain with limestone, with often light colored shale between the limestone and black shale.

The following sections of this coal and its roof were obtained in this area.

2034. SECTION 1023. SECTION AT THOMAS SPRADLEY'S.—N. E. of S. E. of Sec. 25, Fig. 930.

	Ft.	In.
1. Clay	8	0
2. Black band, position of Coal VI	0	3
3. Light brown shale	4	0
4. Black sheety shale	1	0
5. COAL V .....4 ft. 6 in. to	5	0
6. Fire-clay	1	6

2035. SECTION 1024. SECTION AT JOEL TAYLOR'S.—N. W. of N. W. of Sec. 35, Fig. 925.

	Ft.	In.
1. Light brown shale	4	0
2. Ferruginous dark brown shale	0	6
3. Light brown shale	1	0
4. Brown clay (leached limestone, with limestone boulders)	2	0
5. Light brown shale	4	0
6. Blue to black sheety shale, with concretions	3	0
7. COAL V—Coal, 1 ft. 9 in.; clay parting, 0 ft. ½ in.; coal, 3 ft. 2 in	5	0
8. Fire-clay	..	..

2036. SECTION 1025. SECTION ON FRANK DOUGLASS'S.—S. E. of S. E. of Sec. 27, Fig. 924.

	Ft.	In.
1. Surface	5	0
2. Gray or white to light brown, very fossiliferous, calcareous shale (leached limestone)	2	0
3. Shale, similar to last, but soft and shaly	2	6
4. Blue to black fissile shale	1	6
5. Black sheety shale	2	0
6. COAL V—Coal, 1 ft. 7 in.; partings; coal, 4 ft. 6 in. to 4 ft. 0 in	5	7

2037. SECTION 1026. SECTION ON G. W. WARD'S.—S. W. of N. E. of Sec. 27, Fig. 927:

	Ft.	In.
1. Limestone, fossiliferous	1	0
2. Light brown, calcareous, sandy, shaly clay (leached limestone)	3	0
3. Light brown sandy shale	2	0
4. Black sheety shale	3	0
5. Soft black shale	1	0
6. COAL V	5	0+

2038. SECTION 1027. SECTION AT MILLER MINE.—Sec. 29, Fig. 926 (J. C., '72, p. 276).

	Ft.	In.
1. Slope	20	0
2. Thin-bedded sandstone	8	0
3. Quarry sandstone	10	0
4. Sandy shale	9	0
5. Potters' clay, with ironstones	1	0
6. Ferruginous fossiliferous limestone	1	8
7. "Ferruginous paints"	0	7

		Ft.	In.
8.	Gray clay shale	2	2
9.	Ocherous clay	0	6
10.	Black, bituminous sheety shale	2	5
11.	COAL V—Shaly coal, 0 ft. 4 in.; fair coal, 1 ft. 0 in.; pyritous coal, 1 ft. 2 in.; good coal, 2 ft. 0 in.	4	6
12.	Fire-clay to creek	4	0

2039. SECTION 1028. SECTION ON IRVING PLACE.—S. E. of S. W. of Sec. 33, Fig. 928.

		Ft.	In.
1.	Massive sandstone	6	0
2.	Hidden ....8 ft. to	10	0
3.	Drab sandy shale	4	0
4.	Black sheety shale (possibly place of Coal VI)	0	2
5.	Drab clay shale	1	0
6.	Fossiliferous limestone ....0 to	0	6
7.	Black sheety shale	1	0
8.	COAL V—Coal, 1 ft. 4 in.; clay parting, 1 in. to 3 in.; coal, 3 ft. 0+ in.	4	7

In an open drift here the roof is 1 or 2 in. of black shale, over which is from 0 to 8 in. of decomposed limestone, then 8 ft.+ of light brown sandstone. The last is much cut up with joints and tends to come down.

2040. SECTION 1029. SECTION AT E. F. SCALES.—N. W. of S. W. of Sec. 33.

		Ft.	In.
1.	Surface	8	0
2.	Drab to gray shale	6	0
3.	Black sheety shale	1	0
4.	COAL V ....about	4	0

It is reported that in the old drift here the parting becomes 8 or 10 in. thick.

2041. SECTION 1030. SECTION ON BEN COX PLACE.—N. E. of S. E. of Sec. 32, Fig. 929.

		Ft.	In.
1.	Shaly sandstone	4	0
2.	Sandy to clay shale	9	0
3.	Limestone	1	0
4.	Brown sandy shale	2	0
5.	Black sheety shale	1	0
6.	COAL V—Coal, poor, 1 ft. 6 in.; black shale or clay, 1 in. to 0 ft. 3 in.; coal, 2 ft. 11 in.	4	8
7.	Clay	2	0+

2042. SECTION 1031. SECTION ON F. M. HALL PLACE.—N. E. of S. E. of Sec. 32, Fig. 923.

		Ft.	In.
1.	Massive sandstone	5	0
2.	Shelly sandstone	3	0
3.	Limestone	1	6
4.	Black shale	2	6
5.	COAL V—Coal, 1 ft. 5 in.; clay parting, 1 in.; coal (exposed), 2 ft. 6 in.	4	0+

In quality Coal V may be assumed to grade about as along the Air Line railroad in Pike county. Coal IV was not seen and Coal IIIb was seen only at one place (Sec. 25). It was there 10 in. thick, overlain by 6 in. of soft brown shale and that by black sheety shale, and underlain by 3 ft. of fire-clay.

2043. DISTRIBUTION OF COALS.—Coal V is found in the top of the high ridge on the eastern edge of Sec. 25. It is so near the top of the ridge that it must be very limited in area and would have to be mined largely by stripping.

Coal IIIb is a few feet above drainage in Secs. 25 and 36, and possibly in Sec. 35. Thin coals reported in the N. W. ¼ of Sec. 35 seemed to come in Division IV.

Coal V sets in again near the top of the divide between the South Fork of Patoka river and Coces creek and occupies an irregular area in Secs. 26, 35, 27, 34. Going westward it is found at lower levels, and in Secs. 28, 29, 32 and 33 gradually reaches drainage level. On the Joel Taylor place (formerly Hatfield) it has been extensively stripped and from a very early day; see ¶2035 for section here. Outcrops of this coal are noted in the heads of a number of ravines about here, coming not many feet below the top of the divide. The coal has been drifted upon to some extent. An outcrop in the road west of the center of the S. W. ¼ of Sec. 26 was correlated as Coal VI. Coal V is given as 4 ft. 6 in. thick in a well on Mr. Frank Douglas's place in the S. W. corner of Sec. 26, at a depth of 13 ft. It has also been extensively stripped and drifted upon on the same farm in the S. E. 40 of Sec. 27; see ¶2036 and Fig. 934.

In Sec. 28 the coal is reported as dug some on the H. M. Scales place, S. E. of N. E.; Chas. Bowen place, and Wm. Bass place, S. W. of N. W. of section.

In Sec. 29 the coal is at most of the exposures within 10 ft. of drainage level. It has been stripped or drifted upon on the John Bowen place, N. E. of N. E.; David Jones, S. E. of N. E., the coal being 3 ft. thick when stripped, but the regular roof and full thickness have not been reached as yet; David Powers, N. W. of N. E., stripped and drifted upon at several places; L. A. Shaggs, N. W. ¼ of the section. At the last mentioned place the coal reaches drainage and has been stripped in the branch. At the westernmost of the Powers' drift the coal is about 3 ft. above drainage, while at the easternmost it rises to 5 or 10 ft. above drainage. The section at these places was given in ¶2038. There appears to be a thin black shale parting about 1 ft. 6 in. from the top of the coal. West of this Coal V is below drainage and not exposed.

In Sec. 33 the top of Division VI is caught in the high narrow divide upon which Scalesville is situated. The limestone comes within 20 ft. of the top of the divide and below it is found 4 to 5 in. of bone coal, representing Coal IVb. Further down the hillsides are outcrops of Coal VI a foot or less thick. Going west into Sec. 31 Coal VI appears to reach drainage level near the center of the section on the John Elijah Madden place. It is 4 ft. 6 in. thick here, where it has been mined by a slope; see ¶2032. On the east and west road a little south of this the limestone near the top of the division is found not very far above the level of the coal and not more than half way up the hill. Above it in a spring was what was taken to be an outcrop of Coal VII.

In Secs. 33 and 32 Coal V has been drifted upon and stripped at a number of points, at most of which it is but a few feet above drainage. Sections were given above of the exposures on the Irving place, S. E. of S. W. of Sec. 33; E. F. Scales, N. W. of S. W. of Sec. 33; Ben Cox's place, and F. M. Hall place, in the S. W. ¼ of Sec. 32; see ¶¶2039-2042. It has also been stripped in S. E. of N. E. of Sec. 32, on the Thos. Irving place.

The data show quite clearly that Coal V is probably workable under all of the area within its outcrop with a thickness of from 4 to 6 ft.

Township 4 South, Range 7 West.

2044. Geography.—This township, lying in the northeastern part of the county, corresponds to Owen and the southern half of Lane of the civic townships.

The eastern half of the township is mainly low and rolling, due to the broad bottoms along Cocs creek and its main branches, between which are only low divides. A high hill a half mile or more long occurs at the eastern edge of Sec. 25. Barren branch has also rather

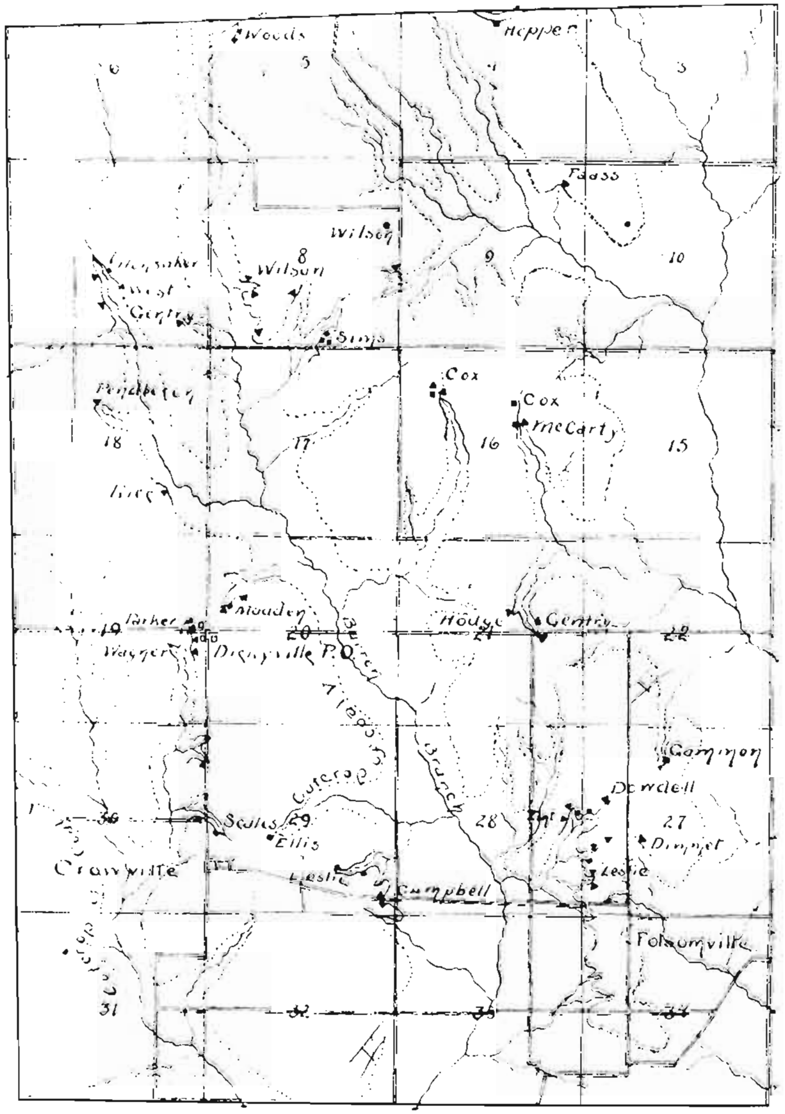
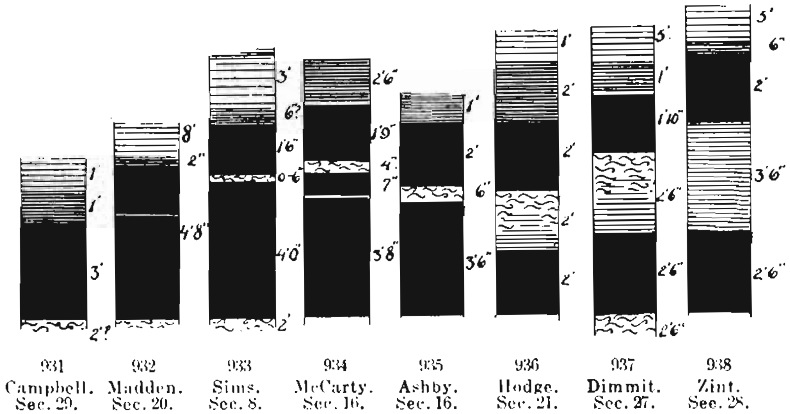


Plate LXX. Sketch map of part of T. 4 S., R. 7 W.

broad bottoms, but the divide between it and Coces creek is quite high, while between it and its branch west of Crowsville is a somewhat lower divide. It would appear that the strata accompanying Coal V have largely influenced the topography of this township.



Figs. 931-938. Sections of Coal V in T. 4 S., R. 7 W.; arranged to show splitting of bed.

2045. STRATIGRAPHY.—No trace of Coal VII was found in this township and it may be doubted if it occupies more than a very limited area, if any.

2046. COAL V, as in the township north, is the main coal and, from the standpoint of workability, the only coal yet found. It is of special interest in this area on account of its splitting. The following sections of the coal and accompanying strata are found in this township.

2047. SECTION 1032. SECTION AT JACOB SCALES.—N. W. of S. W. of Sec. 29.

	Ft.	In.
1. Light brown sandy and clay shale	10	0
2. Black shale	1	6
3. COAL V (reported) 5 ft. to	6	0

2048. SECTION 1033. SECTION AT POLLY CAMPBELL'S DRIFT.—S. E. 10 of Sec. 29. Fig. 931.

	Ft.	In.
1. Gray to brown shale to sandstone	10	0
2. Brown shale	1	0
3. Black sheety shale	1	0
4. COAL V	3	0
5. Light drab fire-clay	2	0
6. Gray sandy shale	4	0

2048a. SECTION 1033a. SECTION ON JOSEPH MADDEN PLACE.—S. W. of N. W. of Sec. 20. Fig. 932.

	Ft.	In.
1. Light brown shale	8	0
2. Black sheety shale	0	2
3. COAL V	4	8
4. Fire-clay.		

2049. SECTION 1034. SECTION ON HENRY SIMS' PLACE.—S. W. of S. E. of Sec. 8. Fig. 933.

	Ft.	In.
1. Brown shaly sandstone	10	0
2. Light drab shale	3	0
3. Black shale	0	6+
4. COAL V—Coal, 1 ft. 6 in; clay and shale, 0 to 0 ft. 6 in.; coal, 4 ft. 0 in.	6	0
5. Fire-clay	2	0
6. Shaly sandstone	6	0+

2050. SECTION 1035. SECTION AT COX & WALLACE'S MINE.—On Ashby Place, N. W. of N. W. of Sec. 21. Fig. 935.

	Ft.	In.
1. Black sheety shale	1	0
2. COAL V—Coal, 2 ft. 0 in.; clay parting, 0 ft. 6 in.; coal, 4 ft. to 3 ft. 6 in.	6	0

2051. SECTION 1036. SECTION ON JEHU HODGE PLACE.—S. W. of N. E. of Sec. 21. Fig. 936.

	Ft.	In.
1. Surface	3	0
2. Gray clay shale	2	0
3. Brown to blue fossiliferous limestone 1 ft. to	2	0
4. Gray clay shale	2	6
5. Blue fissile shale	1	0
6. Black sheety shale, with concretions	2	0
7. COAL V—Coal, 2 ft. 0 in.; clay and shale, 2 ft. 0 in.; coal, 2 ft. 0 in.+	6	0

See ¶2021 for section on Sigel Dimmit place (old Jas. Leslie). Fig. 937.

2052. SECTION 1037. SECTION ON JAMES ZINT'S PLACE.—S. E. of N. E. of Sec. 28. Fig. 938.

	Ft.	In.
1. Light brown soft sandstone	3	0
2. Gray clay shale (suitable for brick?) 3 ft. to	5	0
3. Black shale	0	6
4. COAL V—Coal, 2 ft. 0 in.; drab shale, 3 ft. 6 in.; coal, 2 ft. 6 in.	8	0

These sections show a coal of more than average thickness, but everywhere having a parting which to the northwest of Folsomville becomes several feet thick so that the coal in that area is hardly workable. As far as seen the roof appeared to be good.

2053. COAL IV was seen at only one point, that on the Hatfield and Hemingway place, S. E. of S. E. of Sec. 1, where the coal is reported 18 in. thick. It is overlain by brown sandstone.

2054. COAL IIIb was not seen, but reports indicate that it is very similar to the same bed in the township just east.

2055. DISTRIBUTION OF COALS.—Coal IIIb is above drainage only along the lower course of Coees creek, in Secs. 24, 25 and 26. It is reported to have been found on the John Hall place, in the S. W. ¼ of Sec. 24; St. Clair place. N. E. ¼ of Sec. 25, and S. W. ¼ of Sec. 25, on the E. St. Clair place. Coal IV should be a little above drainage over most or all of the two eastern tiers of sections.

Coal V is cut out across the bottoms of Barren branch and its tributaries, but underlies most of the upland of the western two-thirds of the township. In the western tier of sections it is usually close to drainage level, but rises to the east so that its eastern outcrop is close to the top of the divide between Barren and Coees creeks. At the southern end of this divide, in Sec. 34, it is uncertain whether the coal underlies the crest of the ridge as mapped, or whether it rises above the ridge in that section. Going north it has been stripped and drifted upon at a number of points on the Jas. Leslie and Sigel Dimmit places, in the S. W. ¼ of Sec. 27. The coal here is split, and at the southernmost openings it looked as though the upper bench would run out. On the John Dowdell place. S. W. of N. W. of Sec. 27, Coal V is reported 3 to 5 ft. thick (lower bench?). It shows its greatest separation on the James Zint place, S. E. of N. E. of Sec. 28, Fig. 938, and ¶2052. It has also been worked on the John Gammon place, N. E. of N. W. of Sec. 27; Jacob Gentry place. S. E. of N. E. of Sec. 21; John Hodge place; see Fig. 936 and ¶2051. It is, at the two latter places, but little below the summit of the divide.

In Sec. 16 it is at drainage level only near the heads of the streams. It has been mined and stripped by Messrs. Lesley and Barr on Mrs. McCarty's place, in the S. W. of N. E. of the section; on the Cox place, N. W. of N. E., and by Messrs. Cox and Wallace on the Ashby place, in the N. W. ¼ of the section. The coal in this section runs from 5 ft. to 6 ft. 6 in. or over.

On the Samuel Foss place, N. W. 40 of Sec. 10 and N. E. 40 of Sec. 9, it has been struck in a well, and it outcrops just west of the road. It is reported as 4 or 5 ft. thick, with 3 ft. of black shale over it and limestone above that. In Sec. 4 it has been worked a little on the Jas. Hooper place, just south of the Irving place, described in the last township. It is just above drainage at that point. In Sec. 5 Coal V is in or below the creek bottom, in the N. W. 40, where it has been stripped on the Mrs. Woods place. Further down it is reported on the Martha Judd place, in Sec. 5, and Thos. Judd place, in Sec. 6 (loc. ?).

In Sec. 8 Coal V is said to be 7 ft. thick in a well on the R. W. Wilson place, S. E. of N. E., and has been mined on the Rice Wilson place, in the S. W. ¼. In the S. W. of S. E. of Sec. 8 is the Henry Sims mine (see ¶2048, Fig. 933). The coal is here 10 to 15 ft. above Barren branch.

Coal V was struck on the Hardin Gentry place, in the S. E. 40 of Sec. 7, being 4 ft. thick, but top removed. In the S. W. ¼ of Sec. 7 it has been stripped up in a branch on the James Hunsaker and Jesse West places, being reported 5 ft. thick there. It is reported 5 ft. thick on the Jos. Pendleton and Warrick Rice places, in Sec. 18.

Near Dickyville P. O. it has been mined by stripping and drifting on the Joseph Madden place, S. W. of N. W. of Sec. 20 (see ¶2048a, and Fig. 932); Parker place, S. E. of N. E. of Sec. 19, and Wagner place, N. E. of S. E. of Sec. 19. At the latter two places the coal is at drainage level.

In Sec. 29 Coal V is found on the Jacob Scales place, N. W. of S E., where it is reported 5 to 6 ft. thick; in a well on the Thomas Ellis place, N. E. of S. W., where it is reported 4 ft. 6 in. thick. The section on the Campbell place was given in ¶2018, Fig. 931. This coal has also been mined on the Nelson Leslie place, N. W. of S. E. of Sec. 29. At all of these places the coal, while above drainage, is not far above the bottom land.

TOWNSHIPS 5 AND 6 SOUTH, RANGE 7 WEST.

(Plate LXXI, and see Plate LXXIV.)

2056. GEOGRAPHY.—These two partial townships are in the east central part of the county and correspond with the western part of Skelton and eastern edge of Boone of the civic townships.

The northwestern corner of this area tends to be somewhat hilly, but toward the southeast the surface tends to become flat and rolling. A high, irregular hill occurs in Secs. 16, 17 and 18 in T. 6 S., R. 7

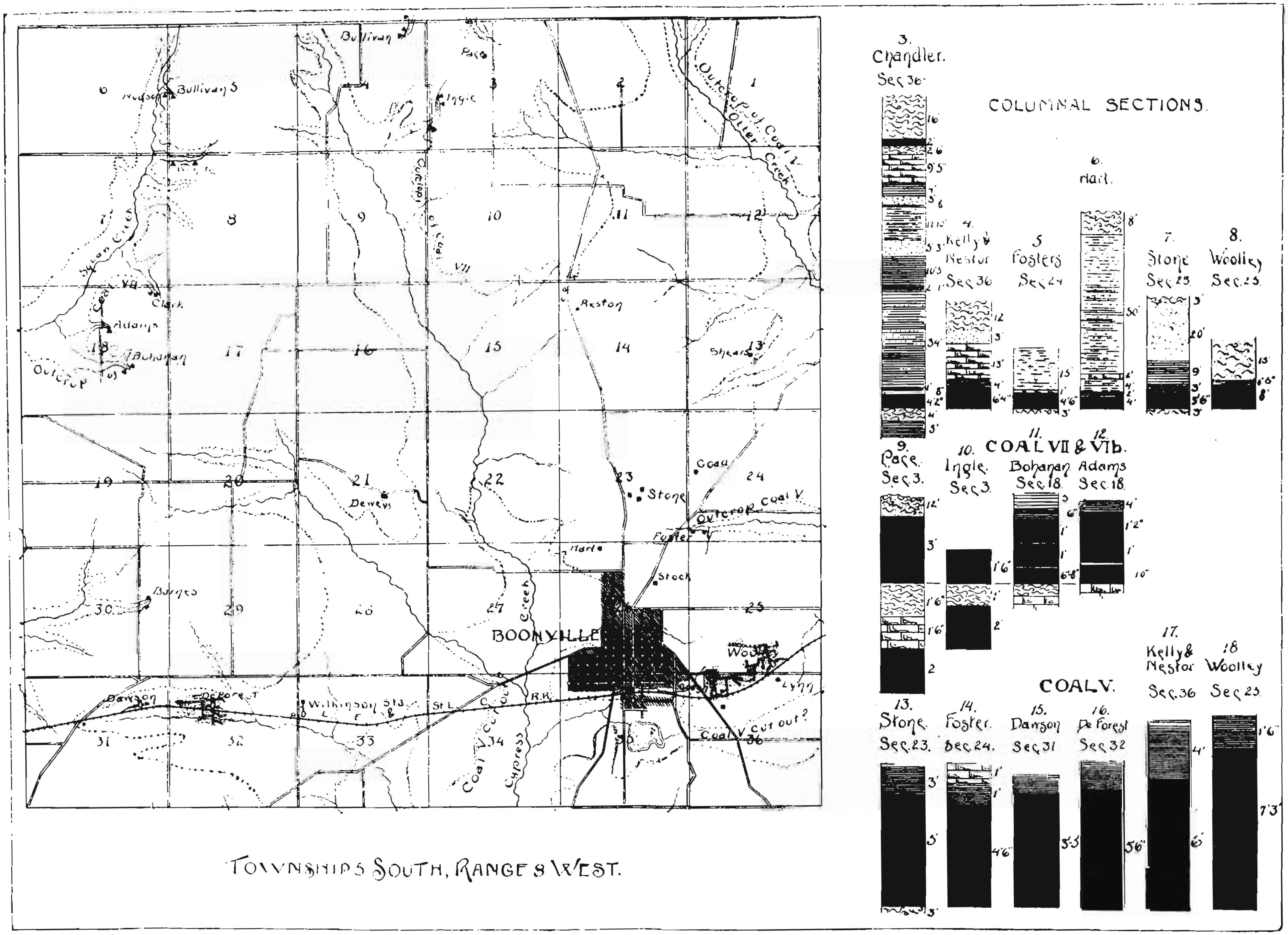


PLATE LXXIII.

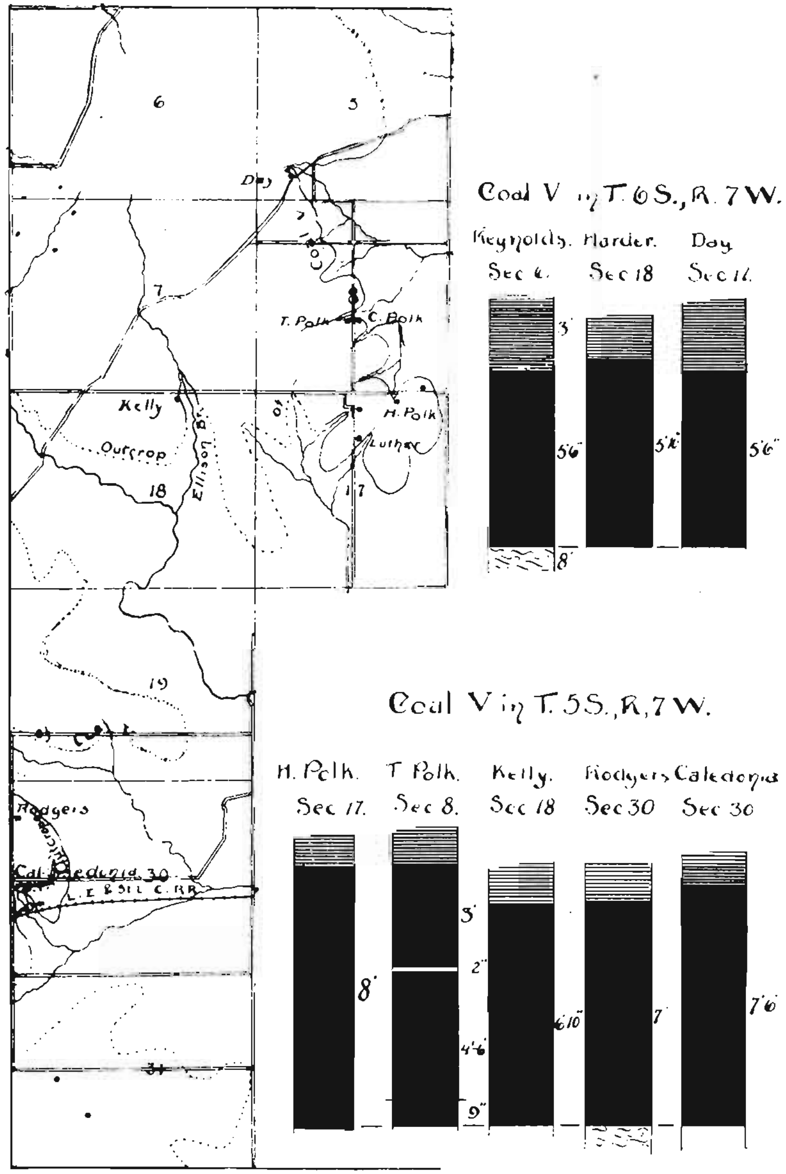


PLATE LXXI. Sketch map and sections of Coal V from T. 5 S., R. 7 W.

W., and in general the area enclosed by the line of outcrop of Coal V is high ground in contrast with lower ground around or to the west. There is considerable flat bottom land along all the larger streams in this area. The Evansville branch of the L., E. & St. L. C. R. R. crosses the area from east to west.

2057. STRATIGRAPHY.—Divisions V to III outcrop in this area, but, while Coal V is readily traceable, none of the coals below appear to have been worked even for local trade, and occurring in the more level part of the area they or their accompanying strata are but little known.

2058. COAL V, as shown by the figures on Plate LXXI, is unusually thick along the western edge of T. 5 S., R. 7 W., and of a somewhat less thickness further south. Some of the thicknesses reported or measured in this area are given in the following table:

NAME.	Location.	Thickness.	Roof.
Thomas Polk	N. E. of S. W. of Sec. 8-5-7	7 ft. 0 in. to 9 ft. 0 in.	Black shale.
Heilman Polk	N. W. of N. E. of Sec. 17-5-7	8 ft. 0 in.	Black shale.
Christ. Luther	S. W. of N. E. of Sec. 17-5-7	3 ft. 0 in. to 7 ft. 0 in.	Black shale.
Doman Kelly	N. W. of N. E. of Sec. 18-5-7	5 ft. 0 in. to 7 ft. 0 in.	Black shale.
J. L. Rodgers	N. W. of N. W. of Sec. 30-5-7	6 ft. 6 in. to 8 ft. 0 in.	Black shale.
Caledonia Coal Co.	N. W. of S. W. of Sec. 30-5-7	7 ft. 6 in.	Black shale.
....	S. W. ¼ of Sec. 31-5-7	6 ft. 0 in.	
W. Reynolds	N. W. of N. W. of Sec. 6-6-7	5 ft. 6 in.	Black shale.
Truman Day	S. W. of S. W. of Sec. 17-6-7	5 ft. 6 in.	Black shale.
Henry Harder	N. E. of S. E. of Sec. 18-6-7	5 ft. 10 in.	Black shale.

The quality of this coal may be judged from the analyses made in the township just west (see ¶2072). The roof is everywhere a black shale and is excellent, if it has sufficient cover. Much of this area, however, will probably prove deficient in thickness of roof material.

2059. DISTRIBUTION OF COALS.—As shown on the map, Coal V is of limited area in these townships. In T. 5 N., R. 7 W., it underlies all of Secs. 6 and 7 and parts of Secs. 5, 8, 17, 18, 19, 30 and 31. It has been stripped on the Steven Kelly and Perry Day places in Sec. 5; drifted upon or stripped on the Chas. Polk and Thomas Polk places in Sec. 8; struck in wells or outcrops on the Heilman Polk and Christ. Luther places in Secs. 8 and 17. At the Doman Kelly drift the coal measured 6 ft. 10 in., the top 4 in. being a little dryer than the rest.

The roof here is not very good, but gets better as they get further under the hill. At all of these places the coal is not far above the creek bottoms.

At the Rodgers shaft the coal is 7 ft. thick on an average. At the east shaft it is 12 ft. deep, and 40 ft. deep at the west shaft. The top 2 or 3 in. of the coal is bony. The roof is fair, containing some concretions. At the Caledonia Coal Company's mine the coal averages 7 ft. 6 in. and is reached by a slope (see Plate LXXXII in Part IV). The coal dips to the north here. The coal carries a good deal of sulphur. There are but few septaria in the roof. At a well in the center of the S. W. ¼ of Sec. 31, 6 ft. of coal is reported at a depth of 35 ft.

In Sec. 11 Coal IIIb appears to have been found on the John Small place, in the N. E. ¼. It is reported as 18 in. thick, overlain by black sheety shale, and is at this point a little below the level of the bottoms, being 6 ft. below the level of the branch near it. Coal was struck in a well in the N. W. ¼ of Sec. 11, and in the N. E. ¼ of Sec. 10 was noted an outcrop overlain by sandstone that was taken to be Coal IV. It was just above drainage. Around DeGonia springs they report 2 ft. of coal at about 22 ft. Near the center of Sec. 28 a test shaft was sunk 62 ft. by Preston Brashears. Drillings there are said to have reported a 7-ft. bed at a depth of 43 ft. below the first bed. It could not be learned what was found in the shaft. In Sec. 35 a little coal has been dug on the Austin White place. It is reported to lie a few feet above the level of the bottoms and to be 14 or 15 in. thick. Where stripped there was 4 in. of black sheety shale over it. It was thought to be Coal IIIb. About 2 ft. of coal is said to have been struck in a well on the Thomas White place, in the S. E. ¼ of Sec. 34, at a depth of about 26 ft.

In T. 6 S., R. 7 W., Coal V is mined in the N. W. 40 of Sec. 6, at the Wallace Russel shaft. It occupies a small area in Secs. 6 and 7 and further south. Coal V underlies part of the hill in Secs. 17 and 18. It lies about 60 ft. below the highest part of the hill. At the Truman Day mine, in Sec. 17, the coal is from 5 to 6 ft. thick, with the usual black shale roof. Where this is thick enough it serves well, as rooms 30 to 40 ft. will stand without a post. In places it is cut up by joint planes which tend to let down slabs 8 in. thick. In a well at the house the coal has 18 ft. of shale over it, with hard layers 4 or 5 ft. above the coal. Below the coal is 4 or 5 ft. of fire-clay and shale, with a sandy rock below. The coal averages a little thicker at the Henry Harder (formerly the Baker) slope, but has less roof.

In the S. E. ¼ of Sec. 17 a shaft was sunk 30 ft., on the Marcy place, which is said to have passed through 6 or 7 ft. of black shale and into fire-clay, the coal (IV or IIIb) being absent. A well on the west side of the road in this one-quarter section is said to have struck coal at 8 or 12 ft., the coal being a foot or more thick on the west side and running out on the east side. A short distance down the branch from this 2 ft. of coal crop out. Coal V is struck in wells in the N. E. ¼ of Sec. 18 and S. W. ¼ of Sec. 30, at the latter place the coal being 40 ft. deep, starting from high ground. In the S. E. of N. E. of Sec. 19 a drilling missed Coal V, but struck a 2-ft. coal at 65 ft. This coal is reported to be in the bottom of Little Pigeon creek, in the N. W. corner of Sec. 29, and to be 18 in. or 2 ft. thick.

As far as yet determined the workable coal of these two townships is confined to the area of Coal V along the western edge.

Townships 3 (Part) and 4 South, Range 8 West.

2060. Geography.—This area includes all of township 4 south, 8 west, and the southeastern part, or the part included in Warrick county, of 3 south, 8 west. It corresponds to Hart of the civic townships. The area in 3 south, 8 west, contains a high east and west irregular ridge, making the divide between the drainage of Patoka river from that directly to the Ohio. Smith Fork creek is the largest stream and drains westward. Township 4 south, 8 west, is principally rolling, with fairly broad bottoms along Big and Otter creeks, the principal streams.

The E. and I. R. R., 4 or 5 mi. west, and the Evansville branch of the L., E. & St. L. C. R. R., 5 or 6 mi. south, are the nearest railway connections.

2061. Stratigraphy.—Divisions VIII to V outcrop in this area, with coals VIII, VII, VIb and V found.

A fair section of Division VIII was given in ¶2014. Coal VII is the coal mainly found. No good sections of the division as a whole were obtained.

2062. Coal VII (see Figs. 939 to 943) runs about 3 ft. thick, usually overlain by a soft black shale. In places it is regularly divided into three benches by smooth or thin partings, as in the next township south. The black shale roof is said to be very poor, so that almost all the coal dug is by stripping. A few feet or less below Coal VII is found a 2-ft. coal which is correlated as Coal VIb. At the Daubs shaft it is reported to be 6 ft. below Coal VII and 2 ft. thick. At the

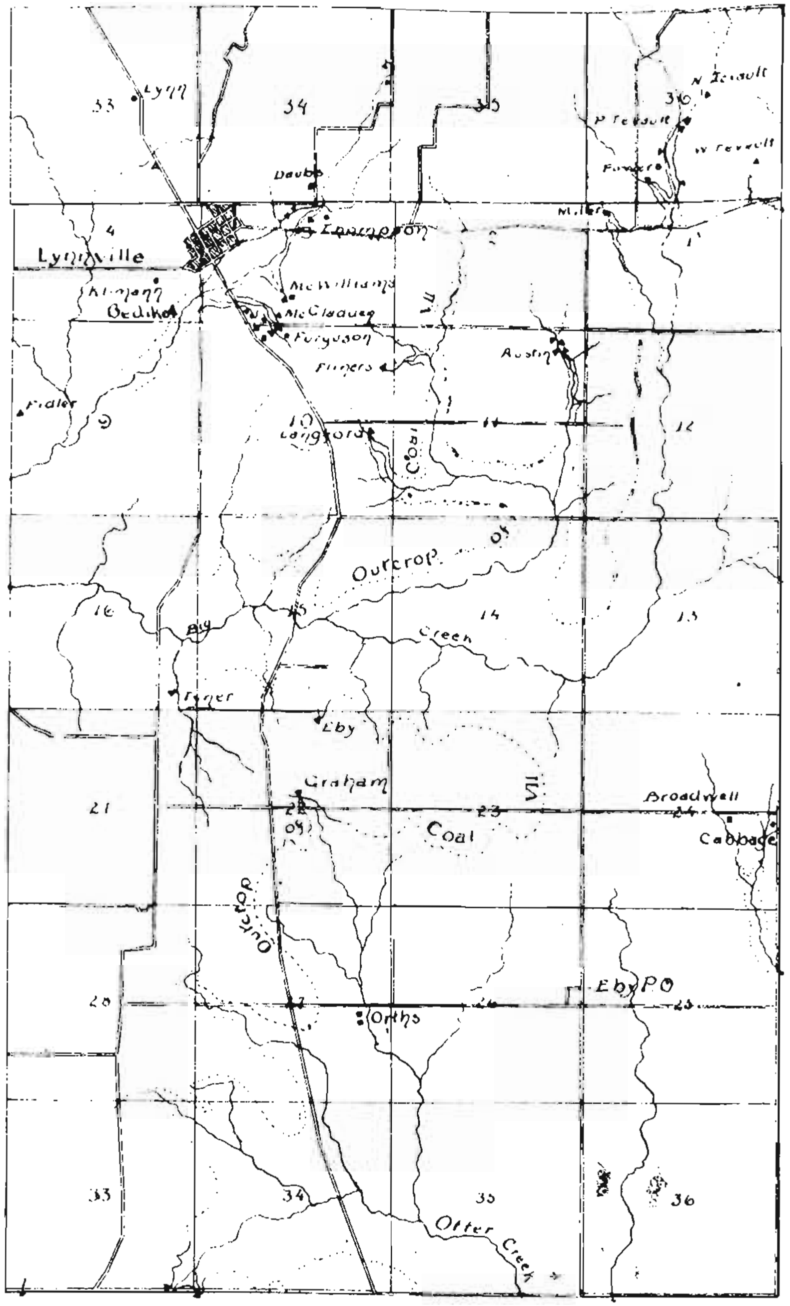
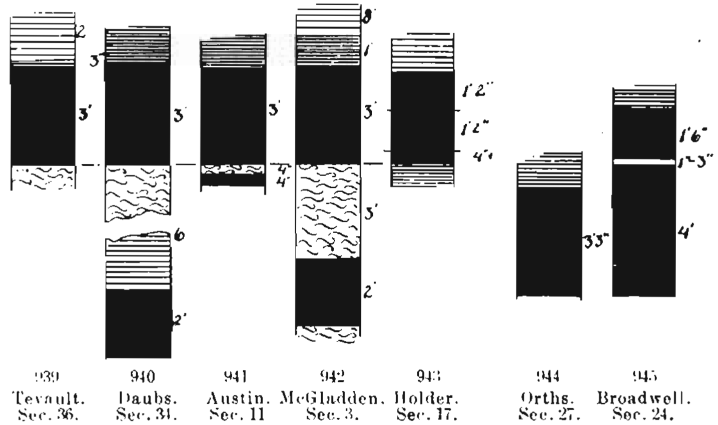


PLATE LXXII. Sketch map of part of Ts. 3 and 4 S., R. 8 W.

McGladden mine it is 3 ft. below and 2 ft. thick. At this mine the overlying black shale is 1 ft. thick and overlain by 8 ft. of gray clay shale. At the Austin stripping the lower coal is reported to be 1½ to 4 in. thick and only 4 in. below the upper coal, the fire-clay between being black.



Figs. 939-943. Sections of Coal VII and VIb in Ts. 3 and 4 S., R. 8 W.
Figs. 944-945. Sections of Coal V in T. 4 S., R. 8 W.

2063. COAL V is practically below drainage in all this area. At the D. F. Broadwell shaft it runs about 5 ft. 6 in. thick (Fig. 935), separated into two benches by a parting of black shale from 1 to 3 in. thick. The lower 4 ft. of coal is a good solid coal. The upper 1 ft. 6 in. bench is not so solid, though it burns well. On the Henry Orth place in Sec. 27, what is supposed to be Coal V is reported as 3 ft. to 3 ft. 6 in. thick. The coal at these places has the usual roof of black sheety shale, above which, at the Broadwell place, is clay shale with 10 to 15 ft. of light brown shaly limestone above the top of the shaft. Nothing is known of coals below this.

2064. DISTRIBUTION.—Coal V probably underlies this whole area, unless it is cut out in the stream channels in the southeastern corner of the district. At the D. F. Broadwell shaft, in Sec. 24, the coal is 11 ft. deep, or a little below stream level. At the Henry Orth (?) place it is just about at or below drainage. It has been mined here by stripping and by slopes.

Coal VII is at drainage level in Sec. 36-3-8, and has been stripped at numerous points, usually being about 3 ft. thick. The map shows the position of stripping on the Netter Tevault, Walter Tevault, Peter Tevault and Alvin Powers places, also on the Thomas Miller place, in Sec. 1-4-8. The coal is in the stream bed again in the N. E. corner of Sec. 11 on the Ed. Austin place. Much coal may yet be stripped here. In Sec. 34-3-8. Coal VII is reached at 28 ft. on the Daubs place, and is in the creek bed a little to the south on the Daniel Thompson place, in Sec. 3-4-8. In the south part of Sec. 3 it has been mined by slopes and stripping on the McWilliams and Simeon McGladden places and by shafts and stripping on the W. D. Ferguson place just south in Sec. 10.

It is struck at 40 ft. on the J. A. Lynn place, in Sec. 33-3-8, where it is 3 ft. 3 in. thick. In Sec. 4 it has been stripped on Mrs. Bediker's place, where it is reported to be 3 ft. 2 in. thick. A well drilling on Wm. C. Kliman's place is said to have struck 2 ft. 4 in. of coal at 45 ft. and 6 ft. 11 in. at a depth of about 60 ft. One of the drillers claimed that all of the coal struck was in two beds 3 ft. 2 in. and 3 ft. 3 in., respectively, separated by 18 in. of fire-clay, and that they corresponded to the coals so abundantly mined around Lynnville. Coal VII has been stripped also in the N. E. ¼ of Sec. 10, on the Fleener place, and N. E. ¼ of Sec. 10, on the Richard Langford place. At the latter the coal is said to run from 3 ft. to 3 ft. 6 in. in thickness and to have been worked for forty years.

Going westward the coal descends to creek level again in the N. W. corner of Sec. 17. It has been stripped here on the William Holder place and just west on the H. H. Bennett place. It runs here in three benches (Fig. 943), ranging in thickness from 3 ft. to 3 ft. 6 in. Over it is clay shale, and below it blue shale. This coal is reported to have been 4 ft. thick where worked on the Ed. Fidler place, in Sec. 9, and about 2 ft. 6 in. on the Stimpson place, in Sec. 5. A well drilled on the W. T. Ireland place is reported to have found 5 ft. of coal at 30 ft. This well started but little below the level of Big creek bottoms and would seem to be below the level of the coal at Bennett's. There may be more of a descent than is realized from here to the creek, or a slight north dip, or this may have gone below Coal VII and reached Coal V. This last hardly seems possible, however.

South of Big creek Coal VII is found nearer the top of the ridge, having been dug at Dr. S. L. Tyner's, Sec. 16; A. W. Elys, Sec. 22; J. B. Graham's, Sec. 22, and on John Bullivan's, in Sec. 33. At this place the coal is in the head of the ravine and not far below the top of the divide. Here, as elsewhere in this township, the shale in Division VII carries bands of ironstone.

Coal VIII and Division VIII are confined to the high, irregular divide near the north county line in T. 3 S., R. 8 W.

On the whole, Coal VII does not seem favorable for extensive development, but workable coal should be looked for about 100 ft. lower, at the horizon of Coal V.

Township 5 South, Range 8 West.

(Plate LXXIII, p. 1377.)

2065. Geography.—This township lies about in the center of the county and corresponds with the northwestern part of Boone of the civic townships. It is in the main rolling, without conspicuous hills, and with rather broad bottoms along Cypress and Otter creeks. The Evansville divison of the L., E. & St. L. C. R. R. crosses the southern part of the township. Boonville, the county seat, is in the southeastern part of the township.

2066. Stratigraphy.—As indicated by the columnar sections, Figs. 3 to 8 of Plate LXXIII, p. 1377, Coals V and VII and their accompanying strata from the outcropping rocks of this township. Of the sections figured, the section at Chandler has already been given (see ¶2017). The other sections figured are as follows:

2067. Section 1038. Section at Kelly and Nestor's (Gough) Mine.—Sec. 36, Fig. 4. (W. S. B., p. 119.)

		Ft.	In.
1.	Soil and surface clay	12	0
2.	Shelly sandstone, with numerous small iron kidneys	3	0
3.	Dark shaly limestone, fossiliferous	13	0
4.	Black fissile shale	4	0
5.	COAL V	6	4
6.	Fire-clay	?	?

2068. Section 1039. Section at Foster Drift.—Sec. 21, Fig. 5.

		Ft.	In.
1.	Surface	..	..
2.	Brown shaly sandstone and shale	15	0
3.	Brown limestone	1	0
4.	Black sheety shale	1	0
5.	COAL V	4	6
6.	Gray to yellow fire-clay	3	0

2069. SECTION 1040. SECTION AT D. L. HART'S MINE.—Probably near the last, though described as "a half mile northeast of Boonville, on Sec. 13." (E. T. C., p. 162, Fig. 6.)

	Ft.	In.
1. Soil and clay	8	0
2. Schistose sandstone and shale	50	0
3. Black bituminous, fossiliferous limestone	2	0
4. Sandy shale	4	0
5. Black, bituminous sheety shale	2	0
6. COAL V	4	0
7. Fire-clay	?	?

2070. SECTION 1041. SECTION ON WM. STONE'S PLACE.—Sec. 23, Fig. 7.

	Ft.	In.
1. Surface	3	0
2. Micaceous gray sandstone about	20	0
3. Clay shale	9	0
4. Black sheety shale, with septaria	3	0
5. COAL V 4 ft. to 7 ft.	5	6
6. Fire-clay	3	0

2071. SECTION 1042. SECTION AT J. WOOLLEY COAL COMPANY'S MINE.—Sec. 25, Fig. 8.

	Ft.	In.
1. Surface	15	0
2. Black sheety shale, with some septaria	1	6
3. COAL V, up to 9 ft. 6 in.; average, 6 ft.; measured 7 ft. 3 in.	8	0

2071*a*. SECTION 1042*a*. SECTION OF WELL AT BOONVILLE.—By Wm. Adams.

	Ft.	In.
1. Surface clay	10	0
2. Clay shale	20	0
3. Black shale, with large concretions	10	3
4. COAL V, with 4 partings	6	2
5. Fire-clay.		

This was obtained after drawings had been made.

2072. COAL V, as shown in the preceding sections and Figs. 13 to 18, range in thickness from 3 ft. to 9 ft. 6 in., with an average of about 5 ft., being thickest to the east and thinning to the west. The top of the coal for a few inches, as in Pike county, is soft and tends to be bony; otherwise the coal is solid and good.

An analysis of this coal from the DeForest mine, by Mr. Noyes, gave as follows:

Fixed carbon	45.07	
Volatile combustible matter	39.09	
Total combustible matter		84.16
Ash	9.76	
Moisture	6.08	
Sulphur	2.14	
Total waste		18.98

As far as could be learned, the coal has a reputation above the Evansville coal, but not up to the best of the Pike county coal. The roof is the usual black shale and appears to hold well, notwithstanding its extreme thinness in some of the mines.

2073. COAL VII is exposed along Squaw creek and elsewhere. It runs about 3 ft. thick (Figs. 9 to 12), usually in three benches. The overlying material is usually black shale for a few inches, then clay shale. Below is fire-clay, then limestone, the fire-clay not showing at some places; below the limestone is Coal VIb, 2 ft. or less thick. Coal VIb appears to be lacking in places. The relation of the two coals at the Pace and Ingle places, in Sec. 3, is shown in Figs. 9 and 10.

2074. DISTRIBUTION OF COALS.—Coal VII is confined to the western and northern part of the township. There is a body of it between Otter creek and the head waters of Cypress creek. To the east this rises nearly to the top of the divide. At the Joseph Pace place or well, up toward the top of the divide, it is only 12 ft. to the coals. The section here is shown in Fig. 9. It is somewhat lower where it was formerly stripped on the Thomas Ingle place. Limestone was noted at this place, but was not included in the section which was reported for here. (See Fig. 10.) The limestone underlying Coal VII was noted at a few places on the north side of Secs. 3 and 4. Coal VII has been stripped on the John Bullivan place, in Sec. 4, where it occurs nearly at the head of the divide. The limestone below this coal was also observed beside the road in the N. W. corner of Sec. 14, suggesting that Coal VII hardly reaches to the cross-roads.

Going down Squaw creek, Coal VII, 3 ft. thick, is just above creek level on the John Bullivan place, in Sec. 5, and Samuel Hudson place, in Sec. 6. In the N. W. corner of Sec. 8 it has been stripped on Sarah Wilhite's place. In Sec. 18 it gets further above the level of the creek. It has been drifted upon on the Elijah Clark place, in the N. E. ¼; on the Chas. Adams place, in the S. W. of N. E., and on the G. W. Bohanan place, in the S. E. ¼ of the section. At the last two the coal is reported in three benches, as figured, of which the middle is considered the best coal. At the Adams mine there was only a half inch of fire-clay between the coal and the limestone. In Sec. 30 Coal VII is not far below the upland level, where it has been dug on the Barnes place.

Coal V is about at drainage along the eastern edge of the township. Along Otter creek it is just about at the creek level or a little above. It is reported to be 4 ft. thick at a depth of 5 ft. on the Shears place, near the center of Sec. 13. On the Arthur Reston place, in the N. W. ¼ of Sec. 14, it is reported to be 2½ ft. to 3 ft. of coal. This drilling started in a hollow.

In Sec. 23 Coal V has been worked from several openings on Wm. Stone's place. It runs from 20 to 30 ft. or more deep. (See ¶2070 and Figs. 7 and 13.) The coal runs from 4 ft. to 7 ft. in thickness, averaging about 5 ft. The roof is black sheety shale, with many concretions; it holds up well. In Sec. 24 Coal V is worked on the Foster place, in the S. W. ¼. (See ¶2068 for section here, also Figs. 5 and 14.) The coal here is just at drainage. The coal is reported to have been found 5 ft. thick in a well on the Peter Goad place, in the N. W. ¼ of Sec. 24.

At the Stock mine, in the N. E. ¼ of Sec. 26, which starts on high ground, the coal is said to be 56 ft. deep. (See Plate LXXXIX.)

At Boonville no coal is struck at the courthouse or flour mill, but it is struck in the southwestern part of town, thus indicating an area in which the coal is cut out.

East of Boonville the coal is extensively worked at the Gough mine of Kelly and Nestor (see ¶2067) and at the Big Vein mine of the J. Woolley Coal Company. The coal here measured 7 ft. 3 in. and is said to run up to 9 ft. 6 in. in basins or pockets; will average through the mine about 6 ft. The top two or three inches is often a cannel coal. The black sheety shale roof contains some septaria, but as a rule they do not extend down into the coal so as to interfere with mining. As the outcrop is approached the coal gets thinner and more sulphury, and greater difficulty is experienced in holding the roof up. The coal is about 15 ft. deep at the foot of the slope. (See Plate LXXXII.)

The data indicate that the coal is cut out across the center of Secs. 35 and 36. And it seems probable that it has been cut out under the bottoms of Cypress creek, in Secs. 22, 27 and 34, and possibly in Sec. 33, as indicated on the map.

It has been worked by slope at Wilkinson's station, at the west side of Sec. 33 (St. Elmo mine).

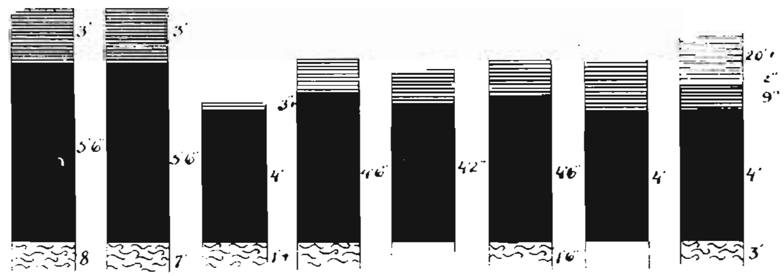
At the DeForest mine, in Sec. 32, Coal V is 70 ft. deep and runs from 4 ft. 6 in. to 6 ft. thick, averaging about 5 ft. 6 in. The black sheety shale roof contains concretions in places. Below the coal is sandstone. At the Mary Dawson mine, in Sec. 31, Coal V is 96 ft. deep and reported to run 5 ft. thick on the south, and 3 ft. thick on the north. The roof is black shale and good.

It would thus seem as though Coal V should be found workable under all of the area within its outcrop, and Coal VII not workable except on a small scale.

Township 6 South, Range 8 West.

2075. Geography.—This township lies south of the center of the county and corresponds with the southwestern part of Boone, southeastern part of Ohio and northern part of Anderson of the civic townships.

Most of the eastern half of the township is hilly, the hills rising 100 to 150 ft. or more above drainage. Running from Sec. 3 to Sec. 32 are the broad flat bottoms of Cypress creek, ranging from a mile to 3 mi. broad. The northwestern part of the township and western edge range from rolling to hilly.



946 Smiths. Sec. 1. | 947 Whitmer. Sec. 1. | 948 Taylor. Sec. 11. | 949 Lowell. Sec. 10. | 950 Henman. Sec. 11. | 951 Bullock. Sec. 25. | 952 Eble. Sec. 36. | 953 Haberstook. Sec. 35.

Figs. 946–953. Sections of Coal V in T. 6 S., R. 8 W.

2076. Stratigraphy.—Divisions VII, VI, V and IV outcrop here. Coal VII is found at a few places, but nowhere workable. Its horizon is frequently indicated by the outcrops of the limestone which lies but a few feet below it. At no point was this coal being mined. Coal VIb was not noticed in this township.

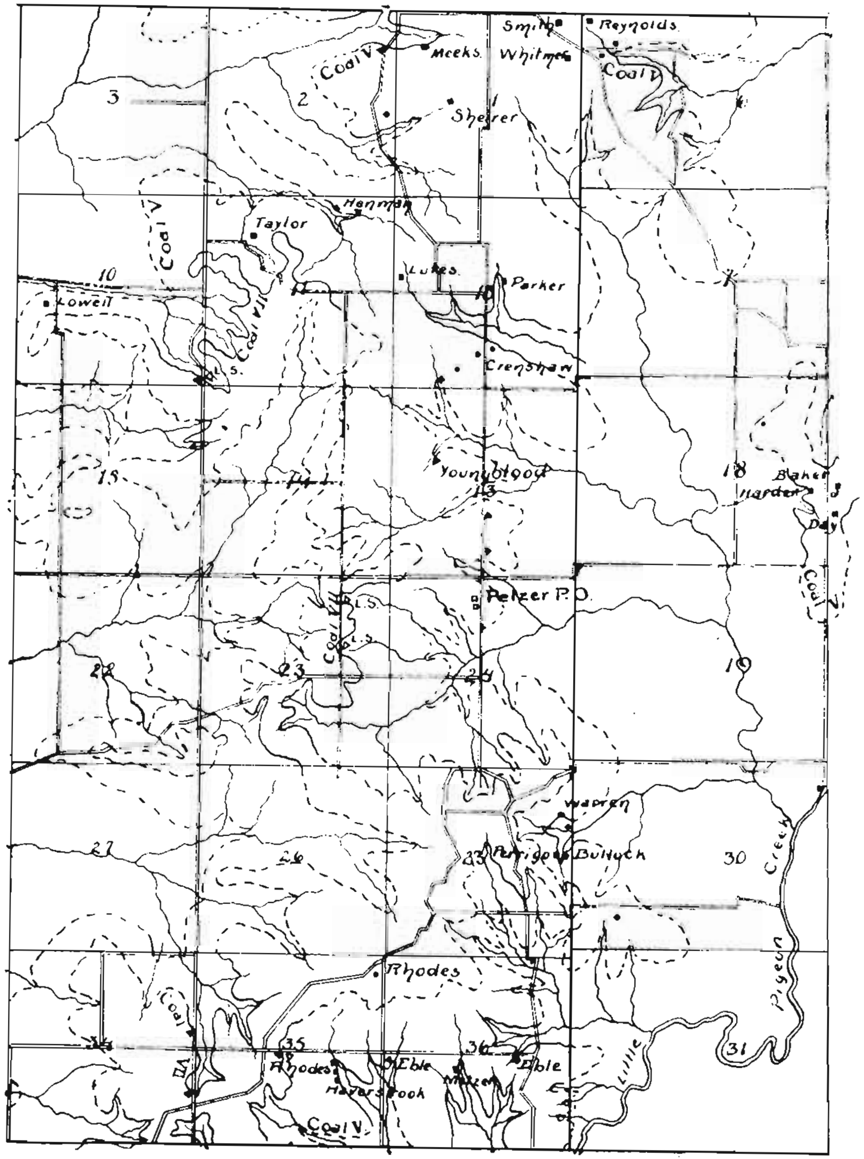


PLATE LXXIV. Sketch map of parts of T. 6 S., Rs. 7 and 8 W.

Coal V, as to the north, is the important coal here. (See Figs. 946 to 953.) As shown in the figures, it tends to run thinner here than in the last township, averaging but little over 4 ft. In the northeastern corner the thickness is greater, ranging between 5 and 6 ft., but toward the south the average runs down to 4 ft. or under. In all cases the coal appears to have no regular parting. The roof is always black shale, generally sheety, and usually good. In general, the limestone, which to the north is commonly found over this black shale, is absent in this area.

A section in the northeastern part of the township gave as follows:

2077. SECTION 1043. SECTION AT EPH. WHITMER'S MINE.

		Ft.	In.
1.	Surface	10	0
2.	Sandstone	23	0
3.	Clay shale	18	0
4.	Black shale	3	0
5.	COAL V, 5-6 ft.	5	6
6.	Fire-clay	4	0

2078. DISTRIBUTION OF COAL.—Taking up first the area east of Cypress creek, the distribution of the horizons of Coals V and VII is shown on the sketch map. Coal VII will be seen to be confined to a narrow but very irregular strip along the crest of the ridge. As a rule, it lies about 100 ft. above the main drainage levels and from 0 to 50 ft. below the top of the ridge. At the C. L. Rhodes place, in the N. E. corner of Sec. 35, Coal VII is 18 in. thick and 40 ft. below the top of the ridge. Aside from this, only outcrops were observed or outcrops of the underlying limestone which showed its position in the hill.

Coal V occurs a little above drainage along the eastern line of the township and a little below drainage along the eastern edge of Cypress creek bottoms. In Sec. 1 this coal is reached by shaft at the Smith mine and Eph. Whitmer mine. At the latter the coal is 40 ft. deep. The slope near the road in the N. W. $\frac{1}{4}$ of Sec. 6-6-7 was sunk by Mr. Whitmer, who says that the coal rises 25 ft. from the shaft to the slope. It also rises rapidly from his shaft to the Reynolds and Smith shafts. To the north of the latter it continues to rise until it outcrops. At the Meek mine, in the N. W. $\frac{1}{4}$ of Sec. 1, the coal is above the creek level, and has been mined by drifting. Across Secs. 2 and 3 the westward dip will probably exceed the drainage dip so as to carry the coal slightly below drainage. At the John W. Lowell mine, in the S. W. ¼ of Sec. 10, the coal is 25 ft. deep, and, as the shaft starts about on the level of the bottoms, it throws the coal that much below Cypress creek. (See Fig. 949.) At the Thos. Taylor mine, in the N. W. ¼ of Sec. 11, the coal is 19 ft. deep, or just below the bottom land which occurs in the S. W. ¼ of Sec. 2. The coal here is 4 ft. thick, with an exposure of 3 in. of black shale above and 1 ft. of drab fire-clay below. (See Fig. 948.) Coal V is 4 ft. 2 in. thick where drifted upon by Mr. Henman, in the N. E. ¼ of Sec. 11. In Sec. 12 Coal V has been worked by drift on the Thos. Parker place, in the N. E. ¼; by shaft on the John Lutes place, in the N. W. ¼, reported 17 or 18 ft. deep, and by shaft on the Crenshaw place, in the S. W. ¼, where it is 12 ft. deep. The coal here is under 4 ft. thick, the top coal being 3 or 4 in. thick, while the rest divides easily into layers of 8 or 10 in., the bottom 6 in. blocking out. The coal is struck in a number of wells in the south part of this section. In Sec. 13 the coal has been stripped on the Youngblood place and elsewhere.

In Sec. 25 Coal V has been mined on the Chas. Bullock, Nathan Perigo and Warren places. The coal runs about 4 ft. 6 in. thick, the middle being the best. The top 3 to 6 in. is harder than the rest and sticks to the roof. The roof is black sheety shale, as usual, and good. The coal is hard and is mined by shooting on the solid. A 4 ft. bed of coal is reported to have been struck at 13 ft. in a well on the Warren place, and at a level which would put it 25 or 30 ft. below Coal V.

In Secs. 35 and 36 Coal V has been drifted upon on the George Heer place, in the N. E. ¼ of Sec. 36; Roman Eble and Margaret Boner places, in the S. E. ¼, and Frank Metzger and S. Eble places, in the S. W. ¼ of Sec. 36. Also, on the F. W. Haberstook and C. L. Rhodes places, in the S. E. ¼ of Sec. 35. At the Haberstook place, which appears to be typical of all these places, the coal averages about 4 ft., with but little variation, the best coal being the bottom 1 ft. Over the coal is 8 to 10 in. of black shale, not making a good roof, then 1 or 2 in. of clay, with 20 ft. or more of gray shale above that. Below the coal is 3 ft. of hard fire-clay. Going up the hill from this mine much sandstone is exposed in the road until the limestone and outcrop of Coal VII is reached.

Along the flats of Cypress creek Coal V, while below drainage in the main, is probably cut out by the erosion of an earlier date when this area stood at a higher elevation.

On the upland west of Cypress creek, the horizon of Coal VII is clearly indicated in Secs. 5 and 8 by the outcrops of the coal, always accompanied with the underlying limestone. A well on the John McConnell place, in the N. W. ¼ of Sec. 8, is reported to have struck Coal V, 4 ft. thick, at a depth of 60 ft., or about 10 ft. below the neighboring drainage. This well was thought to start about at the level of Coal VII. On the south line of Sec. 4, 4 ft. of coal was reported to have been dug some on the George Edwards place. Coal 4 ft. thick is reported to have formerly been worked on the Wm. South place, near the center of Sec. 29, and a well near the center of Sec. 30 is said to have struck coal at a depth of 25 ft.

Township 7 South, Range 8 West. (Part in Warrick County.)

2079. Geography.—This partial township in the main agrees with Anderson of the civic townships. The southeastern corner, south of Little Pigeon creek, is river bottom. Most of Secs. 5, 6, 7 and 8 is flat land, belonging to the bottoms of the Ohio or of Cypress creek.

An isolated hill rises in the south part of Sec. 8. The rest of the township is a continuation of the topography of the eastern part of the last township, except that the steep hillsides here show but little tendency to wash, and will stand continuous cultivation. Some question was raised as to whether this was due to the loess character of the soil or to the influence of the limestone which caps these hills.

2080. Stratigraphy.—Coal VII appears to have thinned out in this area; at least, no trace of it was noticed. Its horizon is quite clearly indicated by the outcrops of the underlying limestone. Coal V measured 4 ft. in thickness at all the mines that were opened, in all cases with a black sheety shale roof. At the A. V. Herring slope, in Sec. 14, this black shale was 18 in. thick, overlain by gray clay shale. A section at the Spears mine by Mr. Cox was given in ¶2024, Sect. 1019.

2081. Distribution.—Along the eastern outcrop of Coal V, as shown on the map, it is from 30 to 50 ft. above the bottoms of Little Pigeon creek. In the S. E. ¼ of Sec. 11 it has been stripped in the bottom of a branch and mined by a 12 to 15 ft. shaft just north, both on the Fisher place. In the N. E. ¼ of Sec. 14 is the J. H. Horton mine, the coal here being fully 30 ft. above Little Pigeon creek bottom. Near the center of this section is the old Spear mine, one of the oldest mines in the county or in the State. At one time a trestle was built from this mine to the river, but it was later washed away by the high water. In the N. W. ¼ of Sec. 14 the coal is mined by slopes on the A. V. Herring and Charles Whitney mines, the coal

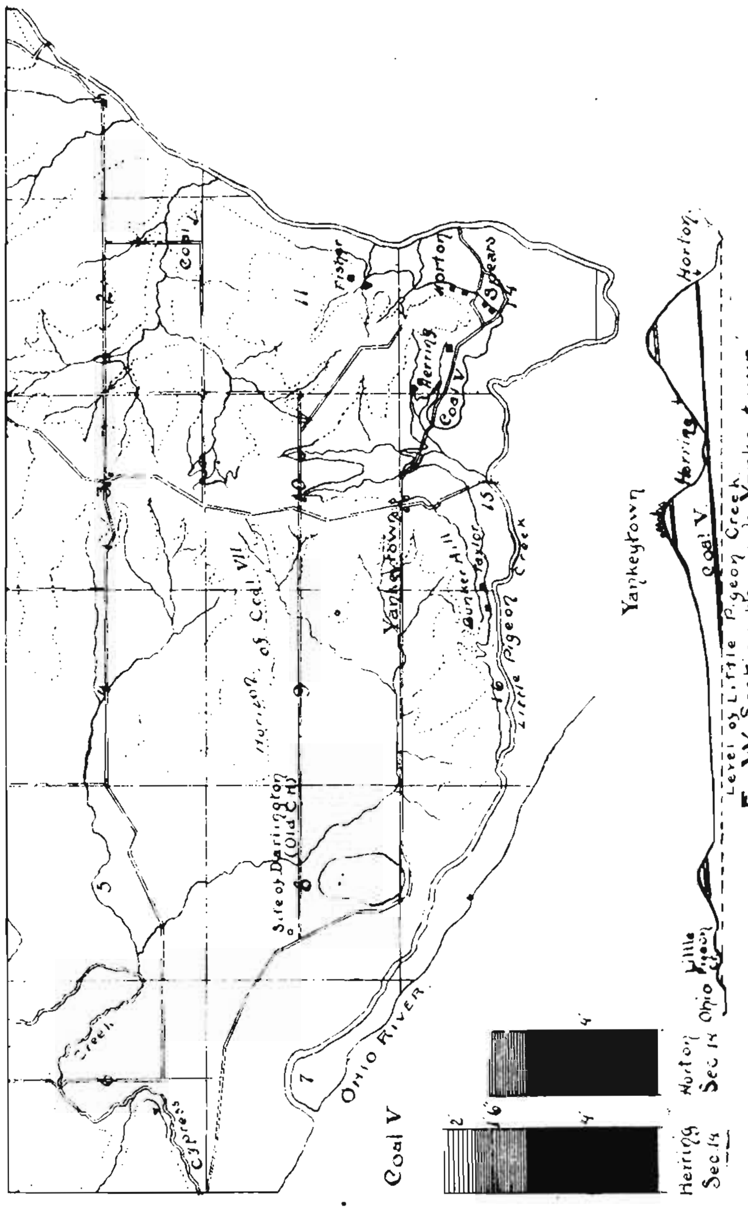


PLATE LXXV. Sketch map, cross section and coal sections, T. 7 S., R. 8 W.

at these points being about at drainage. In an early day Coal V was dug at a number of places in the foot of the bluffs on the P. Taylor farm, the coal being loaded from the mine directly into flatboats on Little Pigeon creek. Coal V passes under the level of the Ohio probably near the western edge of this township.

Coal VII, or its horizon, occurs near the top of the hills to the east, but gradually descends to the west until in the hill in Sec. 8 it is not very far above the bottom land, as indicated in the cross-section.

Townships 4 and 5 South, Range 9 West.

2082. Geography.—These townships occupy the northwestern part of the county and correspond to Greer and to the main part of Campbell of the civic townships. In general, the topography has the character of a rather level or rolling upland, into which the streams have cut their channels to depths of up to 75 ft. In preglacial times the watershed between the Ohio and Wabash rivers appears to have passed through the center of Greer township, Big creek having at that time its outlet to the northwest. Escape in that direction being cut off by the glacier, it overflowed the divide on the south and cut a channel through it which eventually became the outlet of the Big creek drainage basin. This part of the creek, with its narrow, sharply trenched valley, is in rather marked contrast with the broad bottoms of Big creek in the northwestern part of this township, or of Pigeon creek in the southern part of Campbell township. The E. & I. division of the E. & T. H. crosses the western side of Greer township and the Evansville division of the L., E. & St. L. C. R. R. crosses the southeastern corner of the area.

2083. Stratigraphy.—Sections of Chandler and Millersburg, or Canal P. O., have already been given; they are refigured on Plate LXXVI. Coal VII probably reaches its greatest thickness for the southern part of the State in Greer township. In the center of that township it ranges from 4 ft. 6 in. up to 6 ft., with an average of 5 ft. In the center is a dirt or clay shale band of 4 or 5 in. This suggests that the unusual thickness here is due to Coals VII and VIb running close together here. Above the coal here is one or two inches of bone, then clay shale, with thin bands of iron ore for a thickness of 30 ft. or more. The roof is not very good, the bone always coming down. The bottom of the coal is the best. It is bright, rich-looking coal.

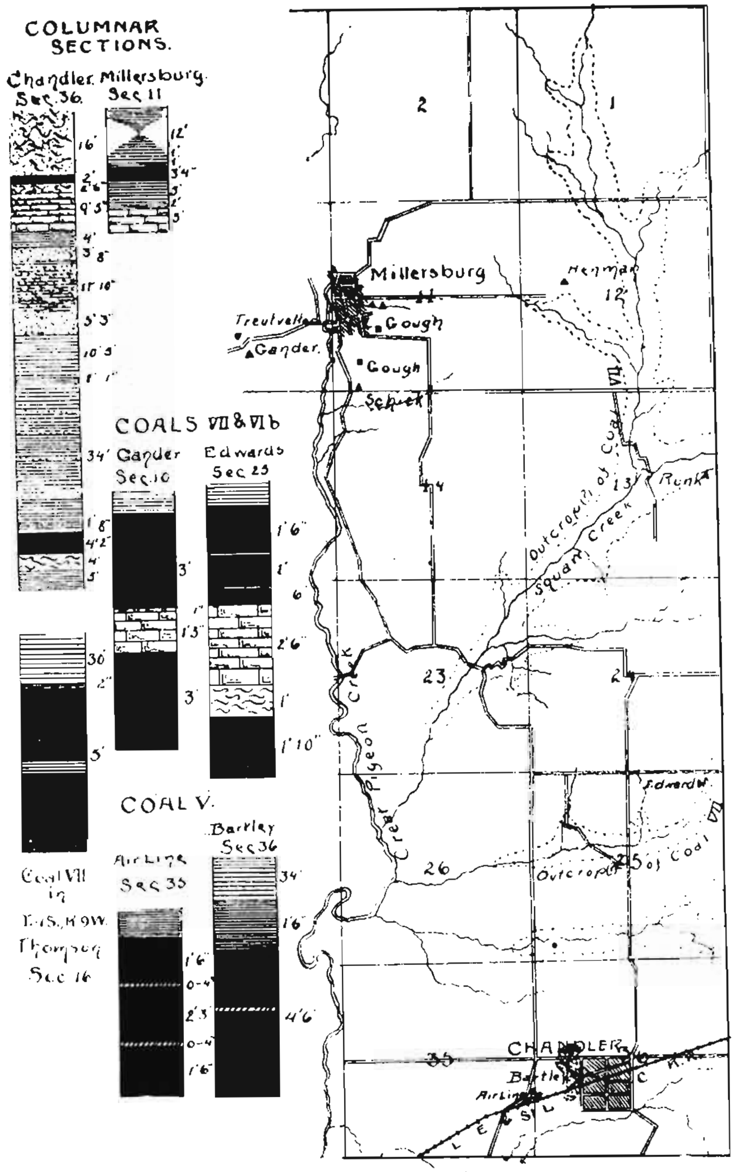


PLATE LXXVI. Sketch map, columnar and coal sections, T. 5 S., R. 9 W.

Coal VIII, 18 in. thick, is met with at Elberfeld. In Campbell township, Coals VII and VIb are both well developed at Millersburg. Coal VII runs about 3 ft. thick, regularly divided into three benches, as far as determined. At the Edwards place, in Sec. 25, these run as follows: Top bench, 1 ft. 6 in.; shale, ¼ in.; middle bench, 1 ft.; clay, ½ to 1 in.; bottom bench, poor, 6 in. The roof is usually a gray clay shale. At several places Coal VIb was reported to lie but a few feet below Coal VII and to have a thickness of up to 3 ft.

The main rock between the two is the limestone overlying Coal VIb. (See Plate LXXVI.)

Coal V, in the southeastern corner of this area, runs from 4 ft. to 5 ft. 6 in. thick. It usually shows one or two sulphur bands. These are in the nature of streaks, in such form that it is necessary to throw away from 4 to 8 in. of the thickness of the coal for each streak. These streaks are not entirely persistent, so that the loess does not occur all through the mines. The roof is usually black sheety shale, with but few concretions except in places. This black shale makes a good roof if it is held up. However, if it comes down, the rock above it will tend to come down to a height of 10 or 15 ft. The floor is a hard sandy fire-clay.

2084. Distribution.—In a general way Coal VII is found just about at the level of Pigeon creek or a little below. Due perhaps to the fall of the creek there is an apparent rise to the south. It has been struck in wells in the N. E. ¼ of Sec. 13-4-9; on the G. W. Miller place the coal is at least 4 ft. thick at a depth of 18 ft., and on the S. B. Miller place the well went through 4 ft. of coal into limestone. The roof here was clay shale. In the S. E. ¼ of Sec. 16 Coal VII is reached at 26 ft., at the Daniel Thompson mine. This would make the coal 6 or 8 ft. below Pigeon creek. At Elberfeld the public well is reported to go through an 18 in. bed of coal, probably Coal VIII, at a depth of 35 ft. The roof is clay shale.

Coal VII should be reached by a 75 ft. drilling at most points in Greer township, and it is probably not over 100 ft. deep at any point.

Near Millersburg, Coal VII has been stripped on the Ed. Gander and Herman Treutvetter places, in Sec. 10, the coal being figured in Plate LXXVI. It comes just below the level of the bottom land. It has been stripped at the bridge, north of town, and on the Jacob Schick place, all in the bed of the canal. At the bridge there was shale between the limestone and the coal, and Coal VIb was reported as 2 ft. 6 in. thick.

Coal VII was formerly extensively stripped northeast of town in a branch, and more recently mined southeast of town by a 30 to 40 ft.

shaft, on John Gough's place. The coal here is in three benches. This coal has also been stripped on Samuel Henman's, in Sec. 12, and Jacob Runk's in Sec. 13. Also on Samuel Edwards's, in the N. E. corner of Sec. 25, where the section is as given on Plate LXXVI.

In Secs. 35 and 36 Coal V is being worked, being 100 ft. deep in the Patrick Bartley or old Chandler shaft, and 120 ft. in the Air Line mine of Hall and Loraine. At the former one sulphur band is found and at the latter, two, ranging from 0 to 4 in., as shown on Plate LXXVI. Coal VII is 18 in. thick and 23 ft. 6 in. deep in the Air Line shaft.

Coal is reported to have been stripped in Pigeon creek on the August Felmer place, in Sec. 32.

It seems quite possible that Coal VII will prove workable in parts of this area at the level given above, while about 80 ft. below should be found Coal V, which may generally be counted on as workable.

Townships 6 and 7 South, Range 9 West.

2085. Geography.—This area makes the southwestern corner of the county, and corresponds with the main part of Ohio of the civic townships. The western side of the area tends to be very flat, while the eastern part is a rather high level divide. The Evansville division of the L., E. & St. L. C. R. R. crosses the northwestern corner of the area, and the Evansville Suburban and Newburg Railway reaches Newburg on the south.

2086. Stratigraphy.—The sections around Newburg were given above and can be referred to. Coal VII appears to be too thin to work wherever seen in this area. Around Newburg it is reported to run from 1 ft. to 18 in.

Coal V has long been worked east of Newburg, and is still worked there. It runs about 4 ft. thick, not ranging much above or below that. In places it shows the sulphur bands up to 3 or 4 in. thick. The coal is of fair quality. The roof is black shale, 1 ft. 6 in. to 3 ft. thick, overlain by gray shale. Below the coal is up to 10 ft. of fire-clay.

2087. Distribution.—Coming south from Chandler it would appear that the strata rise rapidly, so that Coal VII, which was 23 ft. deep in the Air Line mine, outcrops well up the hill in Secs. 2 and 11, estimated to be at least 30 ft. above the coal in the shaft. This was

at first taken to be a coal above Coal VII, but the work done afterward seems to leave little doubt that it was Coal VII. The coal is reported as 18 in. thick in a well in the S. E. ¼ of Sec. 2, at a depth of 30 ft. Below its outcrop is seen the limestone of the top of Division VI.

A test shaft was sunk 100 ft. or more on the John Wentenheimer place, in Sec. 3, but failed to reach workable coal, and so was abandoned.

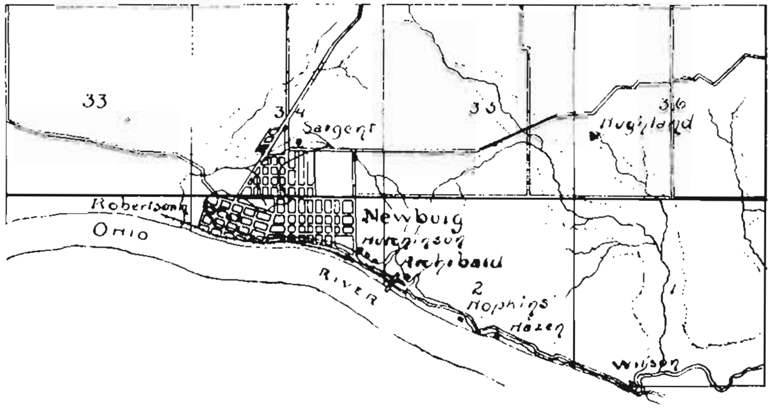


Fig. 953. Sketch map of parts of Ts. 6 and 7 S., R. 9 W.

Coal VII has been worked in times past on the Jacob Hughland place, in the S. W. ¼; the Ely Smith place, in the S. E. ¼, and at other places in Sec. 36.

At the shaft of Sargeant Bros., in the north part of Newburg, Coal V is 100 ft. deep and about 4 ft. thick. West of Newburg, at the Robertson mine, in Sec. 4-7-9, the coal is 4 ft. thick and 120 ft. deep. Going east from Newburg along the river road is first passed the old Hutchinson shaft, claimed by Mr. Wilson, formerly mine inspector, to be the oldest shaft in the State. Just beyond that, in the S. W. of N. W. of Sec. 2, is the Star mine of John Archibald. Coal V is 100 ft. deep here and estimated to come about 27 ft. below low water in the river. Coal VII and the underlying limestone are well exposed along the side of the road here, the coal coming about 10 ft. below the top of the Star shaft, or 90 ft. above Coal V. (See ¶2019, Sect. 1014.) Beyond the Star shaft are the old shafts of C. F. Hopkins, formerly Wm. Love, Eliza A. Hazen and the Owlhead mine near the mouth of Cypress creek, now owned by Dr. Wilson. This is said to be one of the earliest mines here.

In general, it would appear as though Coal VII was not workable in this area; Coal V is probably workable under nearly all of it, and, judging from the drilling made near the mouth of Cypress creek and what is found at Evansville, no workable coal ought to be expected below Coal V.

2088. SUMMARY OF COAL OF WARRICK COUNTY.—

Divisions contained: VIII, VII, VI, V, IV, III, etc.
Coals contained: VIII, VII, VI, V, IV, IIIb, IIIa, III, etc.

ROUND NUMBER ESTIMATES.

Coal VII.

Worked area	10 acres ×	av. thickness,	3 ft. ×	1,000 =	30,000 tons.
Workable area	20 sq. mi. ×	"	3 ft. ×	500,000	30,000,000 tons.
Unworkable area	100 sq. mi.	"	1½ ft. ×	1,000,000 =	150,000,000 tons.
Total area	120 sq. mi.				180,000,000 tons.

Coal V.

Worked area	1 sq. mi. ×	av. thickness,	4 ft. ×	500,000 =	2,000,000 tons.
Workable area	150 sq. mi. ×	"	4 ft. ×	500,000 =	300,000,000 tons.
Unworkable area	50 sq. mi. ×	"	2 ft. ×	1,000,000 =	100,000,000 tons.
Total area	200 sq. mi				402,000,000 tons.

Coals VIII, VI, IV, IIIb, IIIa, III, Etc.

Worked area	20 acres ×	av. thickness,	2 ft. ×	1,000	40,000 tons.
Workable area	10 sq. mi. ×	"	3 ft. ×	500,000 =	15,000,000 tons.
Unworkable area	300 sq. mi. ×	"	5 ft. ×	1,000,000	1,500,000,000 tons.
Total area	310 sq. mi.				1,515,000,000 tons.

Number of coals contained: 8+.
Greatest thickness recorded: 9 ft. Coal V.
Area underlain by coal: 350 sq. mi.
Area underlain by workable coal: 175 sq. mi.
Estimated total tonnage of coal: 2,000,000,000.
Estimated total tonnage of coal removed: 2,000,000.
Estimated total tonnage of workable coal left: 345,000,000.
Number of mines working ten men or over in operation: 7.
Number of mines working less than ten men in operation: 90.
Total number of mines in operation: 97.
Large mines abandoned: 8.
Small mines not running, including strippings: 175.
Outcrops, etc.: 70.
Total number of openings to coal: 350.

XXXVIII. VANDERBURGH COUNTY.

2089. REFERENCES AND FIELD WORK.—

1876 (1875). John Collett, 7th Ann. Rep., Geol. Surv. of Ind., pp. 297-307. One columnar section. (L. L.)

1876 (1875). John Collett, 7th Ann. Rep., Geol. Surv. of Ind., pp. 240-300. Detailed report, map, twenty columnar sections. (J. C.)

1876 (1875). E. T. Cox, same, p. 65. Two coal analyses. (E. T. C.)

1896 (1895). W. S. Blatchley, 20th Ann. Rep., Dept. Geol. and Nat. Reso., pp. 116-119. (W. S. B.)

1897 (1896). W. S. Noyes, 21st Ann. Rep., p. 105. One coal analysis.

1898. G. H. Ashley, field work for this report. In the main, this report is based on that of Mr. Collett, as very little additional exploration for coal appears to have been done, all of the mines being clustered about Evansville.

Section 1. Geography.

2090. POSITION.—This county is one of the southern counties, lying west of Warrick, south of Gibson and separated from Illinois only by Posey county.

2091. EXTENT AND TOWNSHIPS.—The county has an extreme length from north to south of 23½ mi. and a width from east to west of 12 or 13 mi. It includes townships 5 and 6 south of ranges 10 and 11 west, parts of 6 south, 9 west; 7 south, 10 west. The civic townships are arranged as follows:

	Armstrong.		Scott.
	German.		Center.
Perry.		Pigeon.	Knight.
Union.			

It has an area of 240 sq. mi.

2092. ELEVATION AND TOPOGRAPHY.—The following elevations are known: Evansville, 378 ft. above tide; low water at Evansville, 326 ft. above tide; Erskine's, 381 ft. 6 in.; Inglefield, 466 ft. above tide.

The main features of the topography are a fairly level tableland crossing the northern part of the county, the Ohio river bottoms from 2 to 5 mi. wide along the southern edge, the broad bottoms along Pigeon and other creeks, and the intermediate broken area, in parts rolling, and to a less extent presenting rather steep or abrupt slopes. The upland is from 150 to 350 ft. above low water in the Ohio.

Section 2. Geology.

2093. STRATIGRAPHY.—The following sections give quite a comprehensive vertical exhibit of the strata and furnish some basis for the discussion of the distribution of the coals.

Taking up first the exposed sections, it will be seen that the outcropping rocks belong entirely in Divisions VII, VIII and IX. Division IX is usually represented only by a considerable thickness of massive sandstone. In Division VIII the stratum most abundantly exposed is a thick limestone. This is well exposed west and northwest of Evansville. Stratigraphically, it is supposed to correspond with the limestone near the top of Division VIII, as found at Merom, Sullivan county. It was Mr. Collett's idea that the limestone here represented both of the limestones at Merom, the intermediate strata having pinched out. However, as there appears to be a more or less regular coal horizon above the limestone here, we are inclined to consider it the equivalent of the lower limestone at Merom, and that the coal above is more or less nearly at the horizon of Coal VIIIb of the Merom section.

2094. SECTION 1014. SECTION AT BABYTOWN AND PHILLIP KOCH'S. Sec. 14-6-11, Fig. 7 of Plate LXXVII. (J. C., p. 272.)

		Ft.	*In.*
1.	Soil	10	0
2.	Merom sandstone (soft)	45	0
3.	COAL (VIIIb?)	1	5
4.	Siliceous shale	3	0
5.	Laminated sandstone, ripple marked, some good quarry stone	19	0
6.	Blue limestone	2	0
7.	Conglomerate, siliceous and ferriferous—place of flint	2	0
8.	Yellow ferruginous limestone	7	0
9.	Siliceous shale to brook	35	0
		124	5

This coal does not show in a well on the same land.

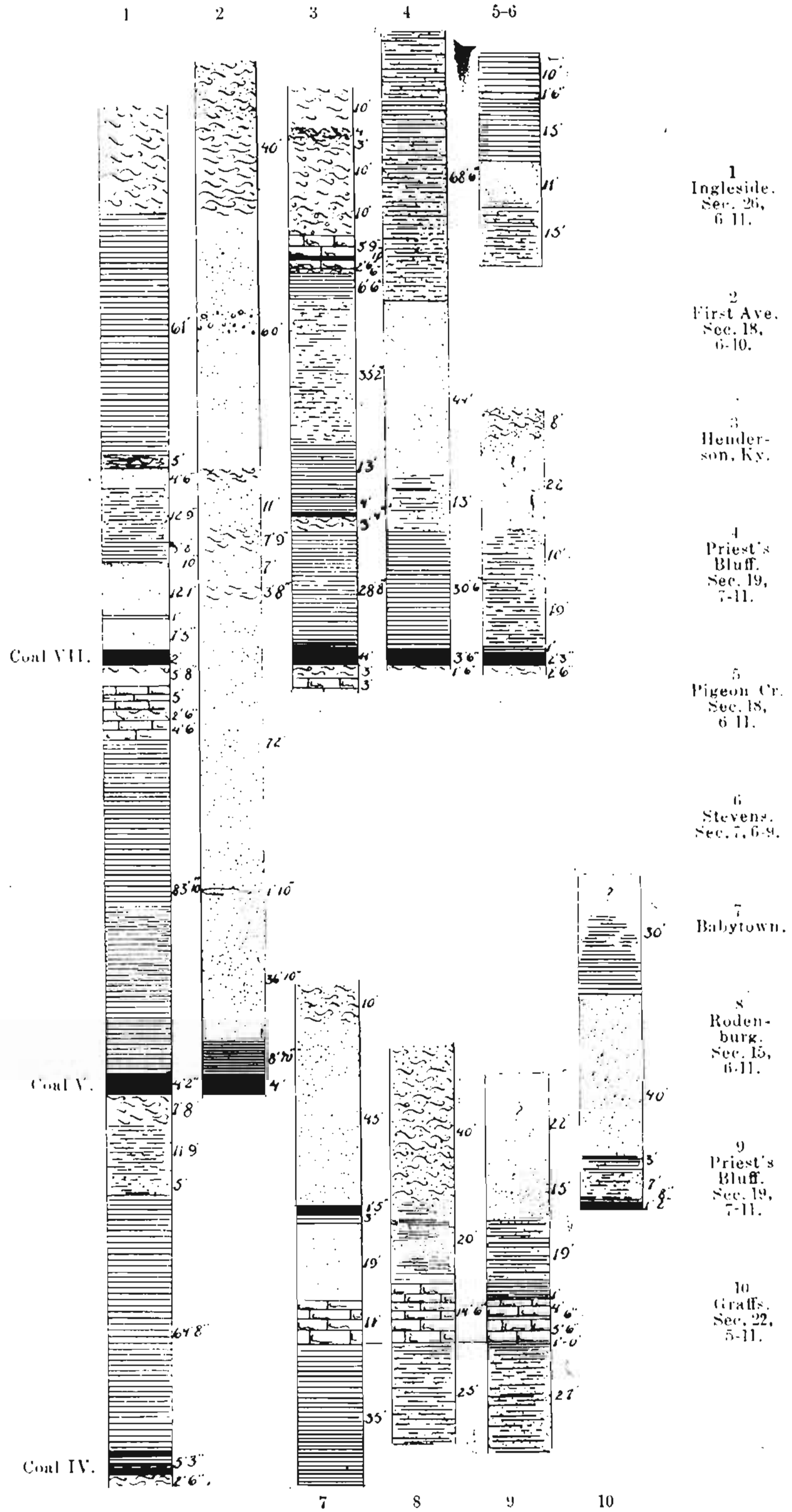


PLATE LXXVII. Columnar sections in Vanderburgh County.

2095. SECTION 1045. BABYTOWN WELL.—A. Koch's land. (J. C., p. 274.)

		Ft.	In.
1.	Soil	10	0
2.	Soft, incoherent sandstone	2	0
3.	Soft Merom sandstone, massive bed	43	0
4.	Siliceous sandstone, no coal	16	0
		71	0

The following section is obtained on adjoining land:

2096. SECTION 1046. SECTION AT CHAS. RODENBURG'S QUARRY.—S. W. ¼ Sec. 15-6-11, Fig. 8 of Plate LXXVII. (J. C., p. 274.)

		Ft.	In.
1.	Clay and loess	40	0
2.	Merom (?) sandstone and siliceous shale	20	0
3.	Blue chinky limestone	2	4
4.	Conglomerate, with argillaceous and flinty material, fossils	3	0
5.	Gray limestone, weathering yellow, brecciated with crushed fossils	5	0
6.	Parting, fossils ... 0 to	0	2
7.	Gray laminated limestone	4	0
8.	Siliceous shale, ironstone nodules and plates of sandstone	25	0
		99	6

Mr. Collett describes the Merom sandstone here as follows: "The rock is 20 to 40 ft. thick, and is composed of sharp angular grains of sand, with small partings or veins of soft hematite and a few trunks and stems of plants. The sand is but slightly agglutinated, or, disintegrating from ancient exposure, is soft and incoherent, and may be removed with a shovel, scarcely requiring the aid of a pick or blast. On exposure the iron is removed by rain and dew or by washing. The sand is white, clean, excellent for plastering, etc., and may be used for the manufacture of glass."

To the southwest of Rodenburg's quarry the following section is exposed on the land of J. W. G. Stimson:

2097. SECTION 1047. SECTION AT STIMSON'S SPRING.—Four miles west of Evansville, S. W. ¼ Sec. 28-6-11. (J. C., p. 275.)

		Ft.	In.
1.	Loess and soil	3	0
2.	Merom rock	6	0
3.	Siliceous shale, with nodules	13	0
4.	Upper hard blue limestone	3	2
5.	Parting, shale and fire-clay	..	4
6.	Yellow limestone, with crinoid stems, etc.	3	9
7.	Shales and sandstones to brook	22	0
		51	3

At Michael Glick's limekiln, S. W. ¼ Sec. 32-6-11, stone has been burned, making a good, strong lime. The following outcrop was noted (Sect. 1048, J. C., p. 275):

		Ft.	In.
1.	Loess, soil	20	0
2.	Red sand, loess	4	0
3.	Soft Merom sandstone	26	0
4.	Shaly sandstone	12	0
5.	Blue limestone	1	0
6.	Calcareous gray shale, with plates of chert of 2 to 8 in., and containing fossils	3	0
7.	Gray and buff limestone, with fossils	8	0
8.	Gray shale in brook	2	0
		76	0

In the north part of the county a thin coal is found at several places. Its relation to the Merom sandstone is shown in the following three sections:

2098. SECTION 1049. SECTION AT GEO. HELGERT'S.—S. W. ¼ Sec. 7-5-11. (J. C., p. 279.)

		Ft.	In.
1.	Slope, Merom sandstone	70	0
2.	Calcareous shale (limestone)	1	6
3.	Black sheety shale	2	0
4.	COAL	1	6
5.	Laminated fire-clay in brook	1	0
		76	0

2099. SECTION 1050. SECTION AT JOHN KOHLER'S.—S. E. ¼ Sec. 3-6-11. (J. C., p. 281.)

		Ft.	In.
1.	Soil and loess	10	0
2.	Merom sandstone	25	0
3.	Gray shale	4	0
4.	COAL	1	6
5.	Laminated fire-clay	2	0
		42	6

2100. SECTION 1051. SECTION AT GEO. GRAFF'S.—N. E. ¼ Sec. 22-5-11, Fig. 10. (J. C., p. 280.)

		Ft.	In.
1.	Covered and variegated shale	30	0
2.	Soft Merom sandstone	8	0
3.	Laminated Merom sandstone	20	0
4.	Massive Merom sandstone	12	0
5.	Shale and sandstone	3	0
6.	Blue sandstone and shale	7	0
7.	Black shale	0	8
8.	COAL	1	2
9.	Sandy shale	4	0
		85	10

Probably the best section connecting the Merom sandstone with the coals not outcropping is that obtained at Priest's bluff, at the southwestern corner of the county, partly from outcrops and partly from a boring.

2101. SECTION 1052. SECTION AT BLUFF ON GEO. M. PRIEST'S PLACE.—W. ½ Sec. 19-7-11. Figs. 9 (outcrop) and 4 (boring). (J. C., p. 277.)

		Ft.	In.
1.	Covered	22	0
2.	Yellow ferriferous Merom sandstone	15	0
3.	Pyritous clay shale, with plates of sandstone	19	0
4.	Black carbonaceous shale ...1 ft. to	0	0
5.	Blue limestone ...1 ft. to	4	0
6.	Parting, coal?	0	6
7.	Buff chinky limestone	5	6
8.	Blue and black shale, horizon of coal? ...1 ft. to	0	0
9.	Sandy shale, with iron nodules	27	0
	In bore, high-water mark.		
10.	Sandy shale, with good iron ore in bands and nodules	36	6
11.	Sandy shale, with nodules	30	0
12.	Hard concretions	2	0
13.	Sandstone	44	3
14.	Laminated sandstone and shale	13	0
15.	Blue shales	27	0
16.	Very dark shales	3	6
17.	Coal VII?	3	6
18.	Fire-clay	1	6
		254	3

The lower part of this section is somewhat better gotten from a record of the People's mine in Henderson, just across the river in Kentucky.

2102. SECTION 1053. SECTION IN "PEOPLE'S MINE" SHAFT.—Henderson, Ky., Fig. 3. (J. C., p. 271.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Yellow clay and sand	10	0	..	..	10	0
2.	Black peaty soil	4	0	..	..	14	0
3.	Blue clay	3	0	..	..	17	0
4.	Yellow clay to quicksand	10	0	..	..	27	0
5.	Clay and sand, with boulders 1 to 6 in. in diameter, and a variety of sub-tropical fresh-water mussels, etc.	10	0	..	..	37	0
6.	Porous limestone	1	0	..	..	38	0
7.	Fire-clay parting	0	3	..	..	38	3
8.	Blue limestone	2	6	..	..	40	9
9.	Shale and COAL	0	10	0	10	41	7
10.	Solid limestone, weathering yellow	2	6	..	..	44	1
11.	Fire-clay	0	6	..	..	44	7
12.	Soft clay shale	4	10	..	..	49	5
13.	Black shale	0	2	..	..	49	7
14.	Clay shale, with limestone boulders	1	6	..	..	51	1
15.	Shaly sandstone	5	2	..	..	55	3
16.	Shaly sandstone	30	0	..	..	85	3
17.	Gray shale	13	0	..	..	98	3
18.	Black shale	4	0	61	0	102	3
19.	COAL parting ...0 to	0	4	0	4	102	7
20.	Hard stony fire-clay	3	0	..	..	105	7
21.	Siliceous shale, with ironstones	27	0	..	..	132	7
22.	Black shale, with fossil shells	1	8	31	8	138	3
23.	COAL VII	4	0	4	0	138	3
24.	Fire-clay	3	0	..	..	141	3
25.	Hard, fine blue limestone to bottom of shaft	3	0	..	..	144	3

The coal being dug close to Evansville comes from the horizon of Coal V, and two sections may be given connecting the sections already given with Coal V.

2103. SECTION 1054. SECTION AT FIRST AVENUE MINE.—(Avondale.) Sec. 26, Fig. 2. (J. C., p. 270.)

		Ft.	In.
1.	Surface	9	6
2.	Blue clay	30	6
3.	Gray sand	2	6
4.	Blue mud (quicksand)	22	3
5.	Gravel and shells	6	0
6.	Fire-clay and sand	28	3

		Ft.	In.
7.	Gravel and sand	1	0
8.	Sandstone	2	0
9.	Fire-clay	2	9
10.	Sandstone	11	0
11.	Fire-clay	7	9
12.	Sandstone	7	0
13.	Fire-clay, with pebbles	2	8
14.	Sandy clay	1	0
15.	Sandstone, with iron balls	72	0
16.	Concretion	1	10
17.	Sandstone	36	10
18.	"Rock slate"	6	0
19.	Black shale	2	10
20.	COAL V	4	0
		257	8

The section of the Ingleside mine, formerly the Bodium, gives the strata for some distance below Coal V.

2104. SECTION 1055. SECTION IN INGLESIDE SHAFT.—Sec. 26-6-11, Fig. 1. (J. C., p. 265.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Clay and alluvial sand	29	0	..	..	29	0
2.	Clay and shale	61	0	90	0	90	0
3.	Shaly coal and fire-clay	3	0	3	0	93	0
4.	Sandstone	4	6	..	..	97	6
5.	Siliceous clay shales	12	9	..	..	110	3
6.	Shale and ironstones	5	8	..	..	115	11
7.	Fire-clay	..	10	..	..	116	9
8.	Ferriferous sandstone	7	9	..	..	124	6
9.	Fire-clay with sandstone iron	12	3	..	..	136	9
10.	Sandstone (ferriferous)	12	1	..	..	148	10
11.	Shale	1	0	..	..	149	10
12.	Sandstone	7	5	64	3	157	3
13.	COAL ~~VII~~ ("Little Newburg")	2	11	2	11	160	2
14.	Fire-clay with iron balls	5	8	..	..	165	10
15.	Limestone	5	0	..	..	170	8
16.	Fire-clay parting	2	6	..	..	173	2
17.	Limestone	..	6	..	..	177	8
18.	Gray shale, black at bottom	83	10	105	9	261	6
19.	COAL V ("Main Newburg")	4	2	4	2	265	8
20.	Fire-clay	4	0	..	..	269	8
21.	Fire-clay with pyrite	3	8	..	..	273	4
22.	Siliceous shale	11	9	..	..	284	1
23.	Argillaceous sandstone	5	0	..	..	289	1
24.	Gray shale	64	0	..	..	353	1

		Ft.	In.	Ft.	In.	Ft.	In.
25.	Clay shale (fern bed)	0	3	87	8	353	4
26.	COAL IV—Impure cannel, 1 ft. 6 in.; pyritous shale, 1 ft. 4 in.; slaty cannel, 1 ft. 2 in.; semi-caking coal, 1 ft. 3 in.	5	3	5	3	358	7
27.	Fire-clay	2	6	..	..	361	1

Mr. Ingle reports that 90 ft. below Coal IV a 2 ft. bed of good coal was met with, while 90 ft. still lower a 4 ft. coal was found, but it contained too much sulphur to be of value.

In a well sunk in the Crescent City park, Coal V was passed without being noted, but the 2 ft. coal reported by Mr. Ingle was 1 ft. 6 in. thick, the 1 ft. coal was not observed, and a coal 1 ft. 6 in. thick reported at a depth of nearly 700 ft. Though the section is given to show the position of these lower coals, it is probable that little dependence can be put on the record, as the well was bored for oil and not for coal.

2105. SECTION 1056. SECTION OF CRESCENT CITY ARTESIAN WELL.—East of Sunnyside mine. (J. C., p. 269.)

		Ft.	In.	Ft.	In.	Ft.	In.
1.	Surface	17	0	..	..	17	0
2.	Clay shale	31	0	..	..	48	0
3.	Gray sandstone	2	6	..	..	50	6
4.	Clay shale	37	6	..	..	88	0
5.	Very hard gray sandstone	1	0	..	..	89	0
6.	Shaly COAL	1	6	1	6	90	6
7.	Shale	6	0	..	..	96	6
8.	Gray ?	44	6	..	..	141	0
9.	Soft shale	11	0	..	..	152	0
10.	Soft gray sandstone	18	0	..	..	170	0
11.	Hard dark sandstone	5	0	..	..	175	0
12.	Gray flint?	2	0	..	..	177	0
13.	Dark gray sandstone. Salt water.	62	0	..	..	239	0
14.	Hard black shale (coal?). [COAL V probably near the top of this]	73	0	..	..	312	0
15.	Gray sandstone	65	0	..	..	377	0
16.	Flint	6	0	..	..	383	0
17.	Hard gray shale	5	0	..	..	388	0
18.	Hard shaly sandstone	34	0	..	..	422	0
19.	Gray shale	55	0	386	6	477	0
20.	COAL III?	1	6	1	6	478	6
21.	Gray shale and sandstone	134	0	..	..	612	6
22.	Dark sandstone with salt water	5	0	..	..	617	6

	Ft.	In.	Ft.	In.	Ft.	In.
23. Hard pure sandstone conglomerate	50	0	..	..	667	6
24. COAL and shale	0	6	0	6	668	0
25. Clay shale	10	0	..	..	678	0
26. COAL	1	6	1	6	679	6
27. Fire-clay	0	6	..	..	680	0

As the 4 ft. coal reported by Mr. Ingle came 30 ft. above the rock containing salt water, it was probably passed about 30 ft. from the bottom of No. 21.

2106. COAL VII (see Figs. 2-6 of Plate LXXVIII) has been but little worked in this county. It probably averages under 3 ft. thick, and while it may prove workable in places, especially toward the northeastern part of the county, will probably prove too thin to work at the depth it will be found in the western part of the county. Its roof varies from black shale to sandstone, but usually there is a short distance above the coal quite a thickness of shale with lines of iron nodules; below the coal is characteristically clay shale, then limestone.

2107. COAL V (Figs. 9-13 of Plate LXXVIII) is the coal long and extensively worked at Evansville. The Ingleside mine was worked in the 50's, then known as the Bodium shaft. This coal averages about 4 ft. or a little over, and in most of the mines maintains its thickness with great regularity, seldom varying from the average more than 3 or 4 in. either way. At most points where seen it appeared to have no regular parting. At the Ingleside mine a 2 in. parting is reported as coming a little over a foot from the top.

An analysis of this coal from the Sunnyside mine yielded Mr. Noyes as follows:

Fixed carbon	48.14	
Volatile combustible matter	38.59	
Total combustible matter		86.73
Ash	6.83	
Moistrue	6.44	
Sulphur	1.85	
Total waste		14.12

This would indicate a good grade of coal, in fact, better than the average of the State. It is, however, brought into competition with

coals of still higher grade, so it is not generally spoken of very highly by local dealers and users. An analysis by Mr. Cox gave as follows (E. T. C., p. 65):

	Top.		Middle.		Bottom.	
Fixed carbon	44.00		48.50		46.00	
Volatile combustible matter	39.50		42.00		39.50	
Total combustible matter		83.50		90.50		85.50
Ash, white	13.50		6.00		11.00	
Moisture	3.00		3.50		3.50	
Total waste		16.50		9.50		14.50

The roof of this coal is a black sheety shale, with a few concretions. This makes a fair to good roof. Above it is usually clay shale, which in a few places replaces the black shale. This clay shale, when exposed by the falling of the black shale, is generally found to be rather weak, and tends to fall readily, and when it is only a few feet thick, may all come down.

Below the coal is fire-clay; which shows a tendency to creep in a few places, but is not generally reported to do so.

2108. DISTRIBUTION OF COALS.—None of the workable coals outcrop in this area. Coal VII is at or not far below drainage in some of the valleys along the eastern edge of the map, but the dip to the west carries it rapidly to quite a depth. The coals that outcrop belong in Division VIII. The Merom sandstone of Division IX is generally above drainage, and, except in the eastern part of the county, usually forms all the higher parts of the uplands. The workable coal is found at Evansville at a little over 100 ft. above tide, and, as it is found at the same depth or a little lower at Princeton, it may be assumed to have approximately that depth across the center of the county in a north and south line. Along the eastern edge of the county Coal V should be sought at from 200 to 300 ft. above tide, while along the western side of the county it ought to be found within 50 ft. above or below tide level. Knowing the elevation of any point in the county above low water at Evansville, which is 326 ft. above tide, the approximate depth to workable coal may readily be calculated. The evidence seems to suggest that Coal V is the only coal that may be calculated upon to be persistently workable. Coal VII may prove workable in places, and coals below Coal V may be found workable in places, but have not been found so as yet.

Beginning at the north, no coal is at present worked in T.'s 4 or 5 S., R.'s 10 or 11 W. A boring at Inglefield is reported to have given as follows:

2109. SECTION 1057. SECTION OF BORING AT INGLEFIELD.—Sec. 8-5-10, by W. Adams, for proprietors of Browning mill. (J. C., p. 284.)

		Ft.	In.
1.	Surface clay	10	0
2.	Red Merom sandstone	36	0
3.	Carbonaceous parting, COAL	0	4
4.	Hard flinty limestone	4	0
5.	Clay parting	1	8
6.	Flinty gray limestone (?)	6	0
7.	Light gray sandstone	20	0
8.	Soft white limestone	8	0
9.	Clay shale	16	3
10.	Shale	20	0
11.	Gray flinty limestone	3	2
12.	Clay shale	26	0
13.	White limestone (?)	30	0
14.	Gray shale	20	0
15.	Fire-clay	10	0
16.	COAL VII? or VIII at 209 ft. 5 in.	1	6
17.	Fire-clay	4	0
18.	Gray shale	10	0
19.	Clay shale	28	0
20.	Sandstone	3	0
21.	Black shale	2	0
22.	Sandstone	17	0
		276	11

Attention has already been called to the fact that the wells drilled by Mr. Adams invariably show more limestone than is found to outcrop or than is given in other drillings or shaft sections, indicating some error in the method of determining the limestone. It may be questioned if the coal met with in this drilling is Coal VII, as, since Inglefield is well up toward the summit level of the county, we should expect Coal VII to lie at least 300 ft. deep here. The unconformity between the Merom sandstone and the underlying shales is said to show well in the railroad cut south of Inglefield.

Outcrops of the Merom sandstone and the limestone near the top of Division IX occur in the S. W. ¼ of Sec. 17-5-10, on the J. W. Knowles place; also on the John Klaser place, in the N. W. ¼ of Sec. 23-4-11.

A section has already been given of the strata exposed at Geo. Graff's place, N. E. ¼ of Sec. 22-5-11. The coal here is 1 ft. 2 in. thick, and belongs in Division VIII. Thin coal is found at several places around St. Wendell being 11 in. thick on the John Tenbarge place, in the W. ½ of Sec. 6-5-11, and 1 ft. 6 in. thick on the Geo. Helfert place, S. W. ¼ Sec. 7-5-11. (See section above.) Workable coal is probably 500 or more ft. deep in most of this area, unless Coal VII proves workable.

In township 6 south are practically all of the working mines. Coal VII was at one time mined by a shaft on the Silas Stevens place, N. E. ¼ Sec. 7-6-9. The coal was 20 ft. deep and 2 ft. 3 in. thick. It is reported to have been a rich, fat caking coal, but too thin to work.

The Merom sandstone is found in most of the upland west of the E. & T. H. R. R., and a short distance below it is the limestone which is quarried for road material at a large number of points north and west of Evansville. It ranges up to 8 or 9 ft. thick. The section from the high hill at Mechanicsburg down to Pigeon creek is as follows:

2110. SECTION 1058. SECTION AT MECHANICSBURG.—Pigeon creek, S. W. ¼ Sec. 8-6-10. (J. C., p. 282.)

		Ft.	In.
1.	Clay soil	26	0
2.	Yellow clay	8	0
3.	Blue shale, decomposing shale	8	0
4.	Place of limestone	5	0
5.	Covered slope—shale	41	0
6.	Gray shale	10	0
7.	Banded sandstone passing into shale	1	6
8.	Gray shale	15	0
9.	Sandstone passing into shale	11	0
10.	Siliceous shale with iron stone	15	0
		140	6

The section at Babytown was given above. Thin coals outcrop in the S. W. ¼ of Sec. 14-6-11, on the Philip Koch land, and on the D. S. Lytle place, in the same section, and, before the opening of the Ingleside shaft, coal was hauled to Evansville from the John Kohler place, in the S. E. ¼ of Sec. 3-6-11, to partially supply the light coal trade there. The coal was 1 ft. 6 in. thick. (See above section.)

The mines about Evansville are shown on Plate LXXVIII. To the northeast there is the Union mine of the Evansville Union Coal Company. The coal is here 235 ft. deep and ranges within 3 or 4 in. of 4 ft. A partial section here as given by the superintendent was as follows (Sect. 1059, Fig. 13 of Plate LXXVIII):

		Ft.	In.
1.	Surface	75	0
2.	Space	?	?
3.	Coal	1	0
4.	Fire-clay	4	0
5.	Clay shale	30	0
6.	Sandstone	120?	0
7.	"Tumble rock" (described as like a conglomerate)	7	0
8.	Gray clay shale	4	0
9.	Black sheety shale ....1 ft. to	1	4
10.	COAL V	4	0

The dip here is to the northwest. The roof cuts badly. In places the black shale runs out and the clay shale makes the roof, making a poor roof.

At the Diamond mine the coal is 255 ft. deep and ranges between 3 ft. and 4 ft. 6 in. The most of the sulphur here occurs in the middle of the coal. The roof is black shale and fair, the overlying gray or white rock not coming down. Limestone is reported to underlie the fire-clay. The fire-clay is 2 ft. thick and firm.

At the First Avenue mine the coal is 265 ft. deep and does not vary more than 2 in. from 4 ft. The most of the sulphur here is near the bottom. The roof is black shale and fair if preserved, but if allowed to fall, the overlying shale tends to come down too. The fire-clay is soft, tending to heave and sometimes cutting off the coal.

The Unity mine was not running when visited. At the Sunnyside mine the coal is 265 ft. deep, the same as at the Ingleside mine, and the coal runs practically the same as in the preceding mine. These two mines are among the most extensive in the State, the Ingleside being one of the oldest mines. Notwithstanding the amount of work done under the river at the latter mine, it is a very dry mine.

2111. Summary of Coal of Vanderburgh County.—

Divisions contained: IX down.
Coals contained: VIIIb, VIIIa, VIII, VII, V, IV, III, etc.

Round Number Estimates.

Coal VII.

Workable area .. 20	sq. mi. × av. thickness, 3½ ft. ×	500,000 =	35,000,000 tons.
Unworkable area. 180	sq. mi. × " 2 ft. ×	1,000,000 =	360,000,000 tons.
Total area .. 200	sq. mi.		395,000,000 tons.

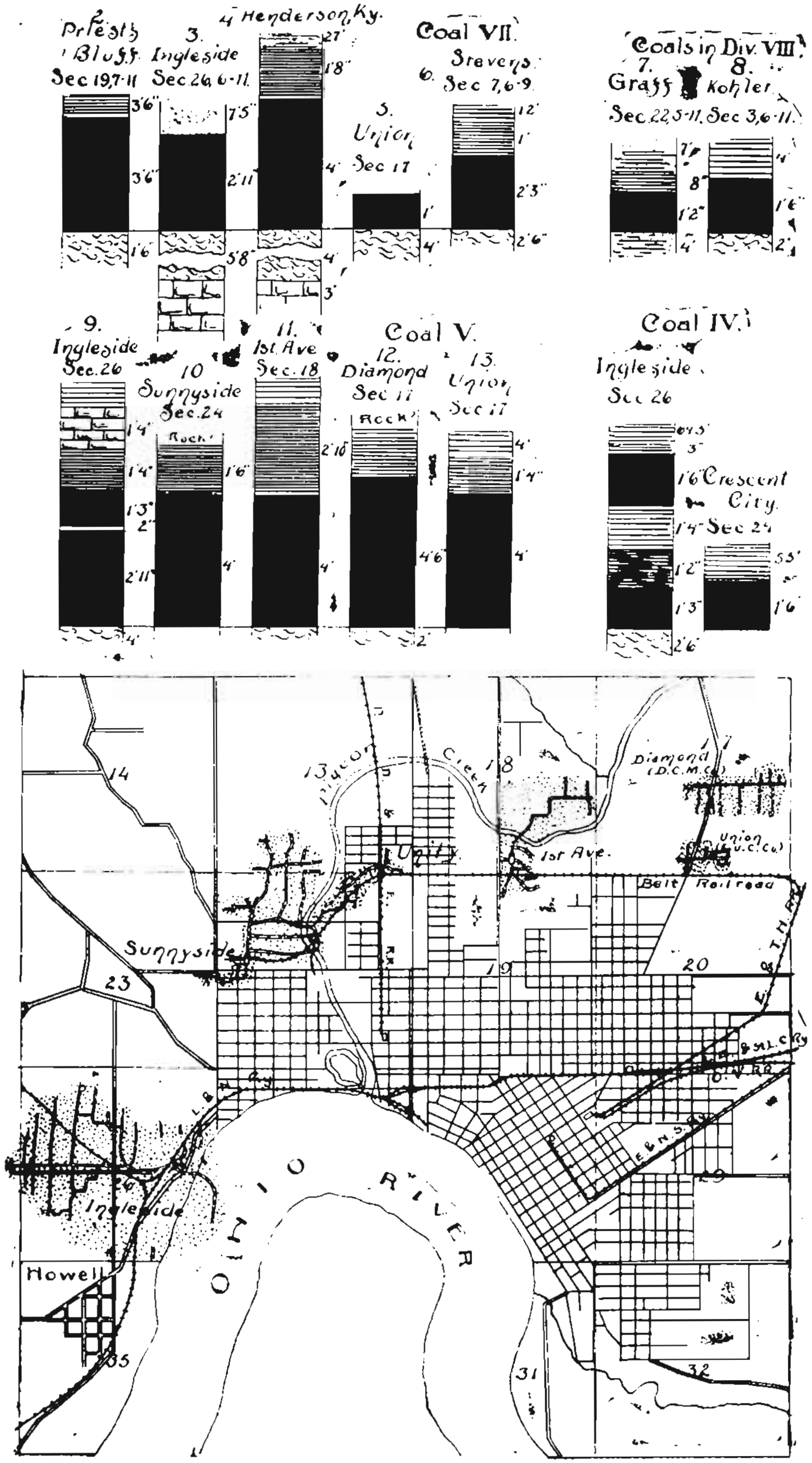


Plate LXXVIII. Sketch map of coal field around Evansville and coal sections from Vanderburgh County.

Coal V.

Worked area	1½ sq. mi. ×	av. thickness,	4 ft. ×	500,000 =	3,000,000	tons.
Workable area...200	sq. mi. ×	"	4 ft. ×	1,000,000 =	800,000,000	tons.
Unworkable area 30	sq. mi. ×	"	2 ft. ×	1,000,000 =	60,000,000	tons.
Total area..231½	sq. mi	....			863,000,000	tons.

Coals above Coal VII and below Coal V.

Unworkable area 200 sq. mi. × av. thickness, 5 ft. × 1,000,000 = 1,000,000,000 tons.

Number of coals contained: 7+.
Greatest thickness recorded: 4 ft. 6 in.
Area underlain by coal: 240 sq. mi.
Area underlain by workable coal: 200 sq. mi.
Estimated total tonnage of coal: 2,258,000,000 tons.
Estimated total tonnage of coal removed: 3,000,000 tons.
Estimated total tonnage of workable coal left: 835,000,000 tons.
Number of mines working ten men or over in operation: 6.
Number of mines working less than ten men in operation: 0?.
Total number of mines in operation: 6.
Large mines abandoned: 0.
Strippings, outcrops, etc.: 10.
Total number of openings to coal: 16+.

XXXIX. POSEY COUNTY.

2112. References and Field Work.—

1862 (1859-60). Richard Owen, Rep. of a Geol. Reconn. of Ind., pp. 190-191. One columnar section. (R. O.)

1862 (1859-60). Leo Lesquereux, same, pp. 292-297. Five columnar sections. (L. L.)

1884 (1883). John Collett, Dept. Geol. and Nat. Hist., 13th Ann. Rep., pp. 45-70. Nine columnar sections, detailed report.

1898. E. M. Kindle, notes for this report.

2113. Position.—Posey county lies in the southwestern corner of the State, with Gibson county on the north and Vanderburgh county on the east. On the south the Ohio river separates the county from Kentucky, and on the west Illinois is separated from it by the Wabash river.

2114. Extent.—It has an extent from north to south of 31 mi., from east to west of 21 mi. with an area of 420 sq. mi.. It is included in townships 4 to 8 south of ranges 12 to 15 west.

2115. Elevations and Topography.—The following elevations are known:

	Ft. A. T.
Griffin, P., D. & E. R. R.	482
Stewartsville, P., D. & E. R. R.	565
Poseyville, P., D. & E. R. R.	525
Wendells, P., D. & E. R. R.	528
Mt. Vernon, L. & N. R. R.	407

The topography consists of bottoms of varying width along the rivers and gently rolling uplands. The broad alluvial plains range up to 5 mi. or more in width. Aside from the bounding rivers, the drainage is principally through Black river in the northern part and Big creek through the center of the county. Numerous ponds or lakes occur in the flat belt along the rivers. Details of drainage are given by the map.

2116. Geology.—As far as learned, none of the workable coal beds have as yet been struck in this county. The deepest bore of which we have record is one drilled at Mt. Vernon, 400 ft. deep, which struck six coals, of which the thickest was only 1 ft. 3 in. thick. What is judged to be Coal VII was reported as struck at Priest's bluff, at the southeastern corner of the county, at a depth of 145 ft. below high water. Coal V should be looked for about 100 ft. deeper, or 250 ft. below high water, at the eastern edge of the county. To have carried this coal below the bottom of the Mt. Vernon boring would require a dip of about 12.5 ft. per mile. Whether such a dip exists or not, we have no data at hand to show. If the dip is less, then the Mt. Vernon boring reached the horizon of Coal V and found the coal thin, and the prospect for coal for that part of the county is not encouraging. Before accepting such a conclusion, however, borings should be made to a depth of at least 800 ft. to make sure that a rapid dip has not carried Coal V below the depths so far reached by drilling.

The question may be considered in another way. Mt. Vernon, Evansville and Boonville lie nearly in a straight line, with Evansville just about half way between the other two places. At Boonville Coal V has about the elevation of 390 or 440 ft. above tide (according to the authority taken), say 425 ft. At Evansville Coal V is about 125 ft. above tide, giving a dip of 300 ft. between the two places. If this dip continues to Mt. Vernon it will carry Coal V to 175 ft. below tide or about 580 ft. below the level of the town. On this basis it is evident that the dip might be only half as much between Evansville and Mt. Vernon as between Boonville and Evansville and still have carried Coal V below the drilling mentioned, supposing that to have started from the level of town.

On the whole, without conclusive evidence, we are disposed to believe in the existence of at least one bed of workable coal in this county. As to depth, that depends on whether the horizon of Coal V was reached in the Mt. Vernon bore or not. We are not inclined to think that it was, in which case this horizon should be looked for at a depth of between 400 and 650 ft. below the levels of high water in the Ohio and Wabash rivers.

The section of the drilling at Mt. Vernon is as follows:

2117. SECTION 1060. RECORD OF COAL BORING AT MT. VERNON. —Furnished to Dr. David T. Day by Messrs. Ed. Brown & Son, of Mt. Vernon.

	Ft.	In.	Ft.	In.	Ft.	In.
Yellow clay	27	0	..	..	27	0
Brown soapstone	42	0	..	..	71	0
White sandstone (Merom)	32	0	..	..	103	0
COAL	0	2	0	2	103	2
Limestone with streaks of fire-clay	4	0	..	..	107	2
Blue shale	7	10	11	10	115	0
COAL	1	0	1	0	116	0
Fire-clay	5	0	..	..	121	0
Sulphur mixed with fire-clay	3	0	..	..	124	0
Soapstone	3	0	..	..	127	0
Dark blue shale	25	0	..	..	152	0
Limestone	7	0	43	0	159	0
COAL	0	2	0	2	159	2
Dark shale	21	0	..	..	180	2
Sandstone	0	6	..	..	180	8
Soapstone	22	6	..	..	202	2
Sandstone	5	6	..	..	207	8
Sandstone and shale about every alternate foot	19	0	68	6	226	8
COAL	0	6	0	6	227	2
Shale streaked with sandstone	5	6	..	..	232	8
Soapstone	10	0	..	..	242	8
Dark shale	17	6	..	..	260	2
Black coal shale	3	0	36	0	263	2
COAL	0	4	0	4	263	6
Blue fire-clay	12	0	..	..	275	6
Dark fire-clay	13	0	..	..	288	6
Sandstone	3	0	..	..	291	6
Shale streaked with sand	4	6	..	..	296	0
Blue shale with small white streaks	46	0	..	..	342	0
Soft dark blue shale	46	6	..	..	388	6
Black shale	1	0	..	..	389	6
Bastard shale	1	6	..	..	391	0
Rock	0	6	128	0	391	6
COAL	1	3	1	3	392	9
Fire-clay	7	0	..	..	399	9
Soapstone	7	3	..	..	407	0

While the report was in press a partial section of a boring made by Mr. John R. Evertson in 1872 was found. It is reported to have gone down one square west of the court house. It gave 52 in. of coal at 276 ft.

The Priest's Bluff section and bore, just across the line in Vanderburgh county, reached Coal VII at a depth of 145 ft. below high water in the Ohio river (see report on Vanderburgh county). With these two exceptions all of the sections and drillings of which we have records appear not to go below Division VIII. The Merom sandstone of Division IX is perhaps one of the most conspicuous rocks of the county. The limestones of Division VIII, through their slight economic use appear to be conspicuous in places. The coals of Division VIII are seldom more than a foot or two thick and of practically no commercial importance.

The Merom sandstone is well exposed at a quarry on the Andrew Keck place, S. W. ¼ Sec. 36-7-12. Mr. Collett reports in the lower strata here Calamites and worn trunks of coal plants with a thin seam of coal (6 to 8 in.) below the quarry. A thin coal was formerly worked for blacksmithing on the Dow farm, N. W. ¼, Sec. 1-6-12.

Coal has been found at several points around St. Wendell. At the mill about 2 ft. of coal is found at about 20 ft. down. In the ravine 200 yds. west is the following section (Sect. 1061, E. M. K.):

		Ft.	In.
1.	Yellow surface clay	10	0
2.	Friable micaceous sandstone	10	0
3.	Covered	5	0
4.	Hard gray to blue limestone with crinoid stems	1	8
5.	Blue shale	1	0
6.	Black sheety shale	?	?
7.	Bone coal	..	3
8.	Black carbonaceous shale	..	8
9.	Blue gray clay shale with plants	2	0
10.	Sandy shale	4	0
11.	Shelly sandstone	1	6

Another well in town is reported to have found 2 ft. 6 in. of coal at a depth of 60 ft., well 176 ft. deep.

A 160 ft. well at Dr. Fluck's, half a mile south of town, is reported to have found 14 to 18 in. of coal at 10 ft. down, and 8 in. at 125 ft. down. Near the house the section is (Sect. 1062, E. M. K.):

		Ft.	In.
1.	Surface clay	10	0
2.	Sandstone, buff, friable	33	0
3.	Gray shale	10	0
4.	Limestone shale	2	1
5.	Black sheety shale	2	2
6.	Blue shale	1	8
7.	Bone coal .....1 in. to	0	3
8.	Limestone .....3 in. to	2	1
9.	COAL .....6 in. to	0	10
10.	Shale .....2 ft. to	3	0
11.	Shelly sandstone	1	8
12.	Gray sandy shale	4	0
13.	Sandstone	0	10
14.	Shale	3	0
15.	Bone coal	0	2
16.	Shale and fire-clay	3	0

Section at Blairsville (Sect. 1063, L. L., p. 295, and J. C., p. 59):

		Ft.	In.
1.	Alluvial soil and loess	5	0
2.	Shales and shaly sandstone	15	0
3.	COAL, bone	0	3
4.	Fire-clay with broken plants	6	0
5.	Sandstone	6	0
6.	Fire-clay and trace of coal	0	3
7.	Shales and shaly sandstone to creek.		

A 208 ft. well at the foundry at Wadesville is reported to have struck three thin coals.

On Macadoo creek, on the Cartwright and adjacent farms, a 12 to 18-in. bed of coal has been worked a little by stripping. At New Harmony a test drill hole was put down to a depth of 355 ft. It is reported that coals were struck as follows:

	Ft.
2 ft. 6 in. of coal and shale at	124
1 ft. 6 in. of coal and shale at	258
0 ft. 3 in. of coal and shale at	300

This well started about 50 ft. above low water in the Wabash. At the upper end of the Cut-Off at New Harmony is the following section (Sect. 1064, E. M. K.):

		Ft.	In.
1.	Silt	20	0
2.	Coarse buff sandstone	20?	0
3.	Sandy shale	25	0
4.	COAL .....14 in. to	1	4
5.	Fire-clay .....2 ft. 6 in. to	4	0
6.	Yellow earthy limestone.....1 ft. 8 in. to	4	0
7.	Blue clay and clay shale	5	0
8.	Sandy gray shale	8	0
9.	Sandstone .....1 ft. to	10	0
10.	Limestone, black bituminous.....2 ft. to	4	0
11.	Bone coal	0	4
12.	Fire-clay	1	0
13.	Shelly sandstone and sandy shale	3	6

A little lower down the coal and limestone run out entirely and sandy shale rises from the water to a height of 40 or 50 ft. In the reports of the Geol. Surv. of Ill., Vol. 6, p. 69, is given the following section of the rocks at Graysville, just accross the river from the northwestern corner of the county (Sect. 1065):

		Ft.	In.
1.	Covered slope of loess and drift	48	0
2.	Heavy bedded sandstone	15	0
3.	Slope with partial outcrops of shale	25	0
4.	Sandy shale .....7 ft. to	8	0
5.	Blue clay shale with bands of fossiliferous iron ore	4	0
6.	Bituminous shale .....6 in. to	0	10
7.	Calcareous shale and shaly bituminous limestone, 0 to	3	0
8.	Black shale .....6 in. to	0	1
9.	Green clay shale or fire-clay.....1 ft. to	2	0
10.	Sandy shale and sandstone in river bed...10 ft. to	12	0

2118. SUMMARY OF COAL FOR POSEY COUNTY.—

Divisions contained: Div. IX down.
Coals contained: Not yet designated.

ROUND NUMBER ESTIMATES.

Coal V. (On assumption that it is present and workable.)

Workable area .. 200 sq. mi. × by av. thickness 4 ft. × 500,000 = 400,000,000 tons.
Unworkable area 200 sq. mi. × " 1 ft. × 1,000,000 = 200,000,000 tons.
Total area...... 400 sq. mi. .... 600,000,000 tons.

Other Coals.

Unworkable area 200 sq. mi. × av. thickness 5 ft. × 1,000,000 = 1,000,000,000 tons.

Number of coals contained: 6+.
Greatest thickness recorded: 2 ft. 6 in.
Area underlain by coal: 420 sq. mi.+
Area underlain by workable coal: 200 sq. mi.?
Estimated total tonnage of coal: 1,600,000,000.
Estimated total tonnage of coal removed: Practically none.
Estimated total tonnage of workable coal left: 400,000,000.
Number of mines working ten men or over in operation: None.
Number of mines working less than ten men in operation: None.
Total number of mines in operation: None.
Large mines not in work: None.
Small mines not in work: None.
Strippings, outcrops, etc.: 12.
Total number of openings to coal: 12.

SUMMARY OF COUNTY COAL SUMMARIES.

2119. Explanation.—The summary tables at the end of each county have been prepared in an attempt to answer with somewhat definite figures the inquiries constantly being made: "How much coal is there in such and such a county?" "How much of it is workable?" "How nearly is it worked out?" Yet it is perfectly evident that any such attempt is largely guess work, on account of the unknown factors always present. When a given coal bed has been mined or found by drillings at numerous points in a fairly limited area, and within that area shows very little variation, it may be assumed with some degree of reliability that it originally covered that area with approximately the average thickness given by the data obtained, and the question becomes largely one of estimating the loss through erosions of later date. However, when we assume that because the coal is very regular in that area of possibly several hundred square miles, it is also regular in an adjacent area from which we have no data, we may be right or we may be very far from right. But in many, if not in a majority of cases, the matter is still more difficult, because we have in such cases pretty clear evidence that the coal beds are not regular but lying in pockets or basins of workable coal. As one of the members of the survey once expressed it, the color was the only regular thing about the coal beds he had been studying.

In our figures we have attempted to be very conservative, especially in dealing with undeveloped areas. This is evidenced in one way by the fact that, while in nearly, if not all of the counties, we have increased the number of coals found, we have in almost if not quite every case cut down the amount of coal, and especially the available or workable coal, from the estimates of the earlier survey, in some cases our figures being less than one-thirtieth of the earlier figures. Our estimates of the amount of workable coal are based on workable as at present understood in Indiana. With such conditions as exist to-day in Kansas or many of the western States it is probable that the amount of workable coal in the State would have to be doubled, perhaps many times over. Thus, at Vincennes the workable coal is estimated to average 3 ft. thick. With mining such as done at Leavenworth, Kansas, over 20 ft. of workable coal exists there, still leaving 10 or 12 ft. of unworkable coal. It is quite probable that, with changing conditions and changing methods of mining no small part of what is now classed as unworkable will come to be considered as workable coal.

In estimating the tonnage of each bed under a county, we have multiplied the estimated area under which the bed has been worked out, is workable, or is not workable, by the estimated thickness of the coal and the product by a factor intended to represent the amount of coal under a unit area per unit of thickness. A uniform bed of coal 1 ft. thick under a square mile of area will contain almost 1,000,000 tons. That factor is therefore used in estimating the amount of coal where the coal is not workable. Where the coal is workable, however, it is desirable that our figures should show not so much the amount of coal in the seam as the amount that can be gotten out of the seam. This varies greatly with different coals and different methods. By the long-wall method in a regular seam, free from rolls or cut-outs or other interruptions, from ninety to one hundred per cent. of the coal may be won. By the pillar and stall method it will seldom be possible to remove over eighty-five per cent. On the other hand, irregularities of one kind or another are liable to cut this percentage down to below fifty per cent. We have, therefore, taken as a conservative factor fifty per cent., or have multiplied the area times the thickness by almost one-half of the cubic contents of the seam. The factors principally used are as follows:

Total Amount in Bed.

1 acre,	1 in. thick, contains about	130 tons	(factor taken,	130)
1 acre,	1 ft. thick, contains about	1,560 tons	(factor taken,	1,500)
1 sq. mi.	1 in. thick, contains about	83,200 tons	(factor taken,	80,000)
1 sq. mi.	1 ft. thick, contains about	975,000 tons	(factor taken,	1,000,000)

Net Tonnage of Workable Coals.

1 acre, 1 in. thick, 80 to 100 tons.
1 acre, 1 ft. thick, 1,000 to 1,200 tons.
1 sq. mi., 1 in. thick, 50,000 to 60,000 tons.
1 sq. mi., 1 ft. thick, 500,000 to 750,000 tons.

The county summaries are summarized in the following tables:

2120. SUMMARY OF COUNTY SUMMARIES.

	Number of Coals Contained.	Greatest Thickness Recorded. Ft.	In.	Area Underlain by Coal, in sq. mi.	Area Underlain by Workable Coal, in sq. mi.	Estimated Total Tonnage of Coal.	Estimated Total Tonnage of Coal Removed or Rendered Unworkable.	Estimated Total Tonnage of Workable Coal Left.
Warren	4	4	2	300	30	472,000,000	60,000	43,500,000
Fountain	7	8	+	325	75	500,000,000	2,733,000	128,750,000
Montgomery	1	......		½	0	100,000	0	0
Putnam	2	3	0	C.M.100	¾	56,000,000	25,000	1,800,000
Parke	11	7	6	C.M.470	100	1 000,000,000	12,000,000	424,000,000
Vermillion	11+	7	0	250	100	1,457,600,000	5,350,000	441,000,000
Owen	4	6	1	125	30	67,000,000	600,000	15,000,000
Clay	14	8+		250	100	1,000,000,000	50,000,000	150,000,000
Vigo	11+	7+		400	300	3,375,000,000	6,500,000	1,000,000,000
Greene	9	7		300	50+	1,000,000,000	4,000,000	150,000,000
Sullivan	9+	9+		440	365	4,650,000,000	9,000,000	950,000,000
Martin	7?	4		175	14	330,000,000	300,000	20,000,000
Daviess	15	7	3	400	200	2,378,000,000	5,250,000	320,000,000
Knox	15	6+		540	300+	7,000,000,000	760,000	950,000,000
Orange	2	2	8	1	⅛	840,000	200	200,000
Crawford	3	4		12	½	9,200,000	none?	400,000
Dubois	9	5		300	40	947,000,000	87,000	52,500,000
Pike	10+	10	2	330	200	1,836,000,000	1,293,000	630,000,000
Gibson	10+	7	7	450	400	6,675,000,000	66,000	1,175,000,000
Perry	7	5	8	30	6	36,500,000	3,100,000	8,750,000
Spencer	7	5	10	300	25	1,000,000,000	200,000	50,000,000
Warrick	8	9	0	356	175	2,000,000,000	2,000,000	345,000,000
Vanderburgh	7+	4	6	240	200	2,258,000,000	3,000,000	835,000,000
Posey	6+	2	6	420	200	1,600,000,000	none	400,000,000
Total	27±	10	2	6,508	3,051	39,618,240,000	106,024,200	8,090,900,000
Approximately	27+	10		6,500	3,000	40,000,000,000	100,000,000	8,000,000,000

Total area surveyed, about 9,000 square miles.

2121. As a corollary of these figures the following figures may be deduced:

Proportion of whole amount of coal in Indiana removed: 1-400.
Proportion of workable coal in Indiana removed: 1-80.
Average rate of removal (50 years): Less than 2,000,000 a year.
Life of field if past average rate of removal be maintained: 4,000 years.
Rate of removal in 1898: About 5,000,000 tons a year.
Life of field if rate of 1898 be maintained: 1,600 years.
Rate of increase of coal production last 18 years: 166,666 tons per year.
Life of field if rate of increase be maintained: 280 years.

(Due to the exhaustion of gas, this rate is liable to increase very rapidly for a few years, but in all probability, in five or ten years, will assume a smaller and more regular rate of increase, though it can hardly be predicted as to how the new rate will compare with the past rate.)

These figures are based on the assumption of present conditions continuing. Constantly improving methods will tend to lengthen the life of the field by securing a larger proportion of the coal in a given area and by rendering workable much coal now considered unworkable. On the other hand, changes and exhaustion of competing fields and the invention of better methods of utilizing the Indiana coal, by increasing the demand, will tend to shorten the life of the field. On the whole, it seems safe to assume that the life of the Indiana coal field is at least 300 years, and probably more.

County estimated to contain the most coal: Knox.
County containing thickest coal (measured by survey): Pike, 10 ft. 2 in.
Place at which greatest total thickness of coal is reported: Vincennes, 32 ft. 7 in.
County producing greatest amount of coal: Clay.

KEY TO COUNTIES ON PLATE LXXIX.

A. Warren.
B. Fountain.
C. Putnam.
D. Parke.
E. Vermillion.
F. Owen.
G. Clay.
H. Vigo.
I. Greene.
J. Sullivan.
K. Martin.
L. Daviess.
M. Knox.
N. Crawford.
O. Dubois.
P. Pike.
Q. Gibson.
R. Perry.
S. Spencer.
T. Warrick.
U. Vanderburgh.
V. Posey.

KEY TO MINES ON PLATE LXXIX. (See list in Mine Inspector's Report.)

1. Brazil Block No. 1.
2. Monarch.
3. Fairview.
4. Diamond.
5. Gladstone.
6. Brazil Block No. 11.
7. Brazil Block No. 8.
8. Pratt.
9. Eureka No. 2.
10. Eureka No. 3.
11. World's Fair.
12. Rob Roy.
13. Brazil.
14. Dewey.
15. Gart No. 5.
16. Gart No. 3.
17. Crawford No. 4.
18. Lucinda.
19. Columbia No. 4.
20. Louise.
21. Crawford Nos. 5 and 2.
22. Pyrah No. 3.
23. Briar Hill.
24. Markland.
25. Harrison No. 2.
26. Harrison No. 3.
27. Klondyke.
28. Superior.
29. San Pedro.
30. Crawford No. 3.

DAVIESS COUNTY.

31. Cabel No. 4.
32. Cabel No. 9.
33. Wilson's No. 4.
34. Montgomery No. 1.
35. Montgomery No. 2.
36. Montgomery No. 3.
37. Mutual.
38. Hoosier.
39. Union.
40. Stuffle.
41. Hawkins.

FOUNTAIN COUNTY.

41a. Indiana Bituminous.
42. Sturm.

GIBSON COUNTY.

43. Oswald.

GREENE COUNTY.

44. Island No. 1.
45. Island No. 2.
46. Island Valley.
47. Fluhart.
48. South Linton.
49. Summit.
50. Summit No. 2.
51. Templeton.

KNOX COUNTY.

52. Prospect Hill.
53. Bicknell.
54. Edwardsport.

MARTIN COUNTY.

55. Tunnel.

PARKE COUNTY.

56. Parke No. 8.
57. Cox No. 3.
58. Mecca No. 1.
59. Lucia.
60. Lyford No. 2.
61. Brazil Block No. 12.
62. Standard.
63. Columbia No. 2.
64. Columbia No. 1.
65. McIntosh No. 1.
66. McIntosh No. 3.
67. Otter Creek.
68. Crawford No. 1.
69. Hardscrabble.

PERRY COUNTY.

70. Cannelton.
71. Troy.

PIKE COUNTY.

72. Woolley.
73. Blackburn.
74. Little's.
75. Ayrshire.
76. Carbon.
77. Hartwell.

SULLIVAN COUNTY.

78. Jackson Hill.
79. Harrison.
80. Phenix.
81. Star City.
82. Shelburn.
83. Sullivan.
84. Bush Creek.
85. Bunker Hill.
86. Briar Hill.
87. Dugger.

VANDERBURGH COUNTY.

88. Union.
89. Diamond.
90. First Avenue.
91. Sunnyside.
92. Ingleside.

VERMILLION COUNTY.

93. Buckeye.
94. Brouillet's Creek No. 3.
95. Brouillet's Creek No. 4.
96. Prince.
97. Torrey No. 4.
98. Cayuga.

VIGO COUNTY.

99. Peerless.
100. Union.
101. Diamond No. 2.
102. Grant.
103. Nickel Plate.
104. Eureka.
105. Ray.
106. Ehrlich.
107. Hector.
108. Parke No. 10.
109. Brick Works.
110. Miller.
111. Murry.
112. Broadhurst.
113. Larimer.

WARRICK COUNTY.

114. Star.
115. Britzius.
116. Air Line.
117. Chandler.
118. Big Vein.
119. Caledonia.
120. Gough.

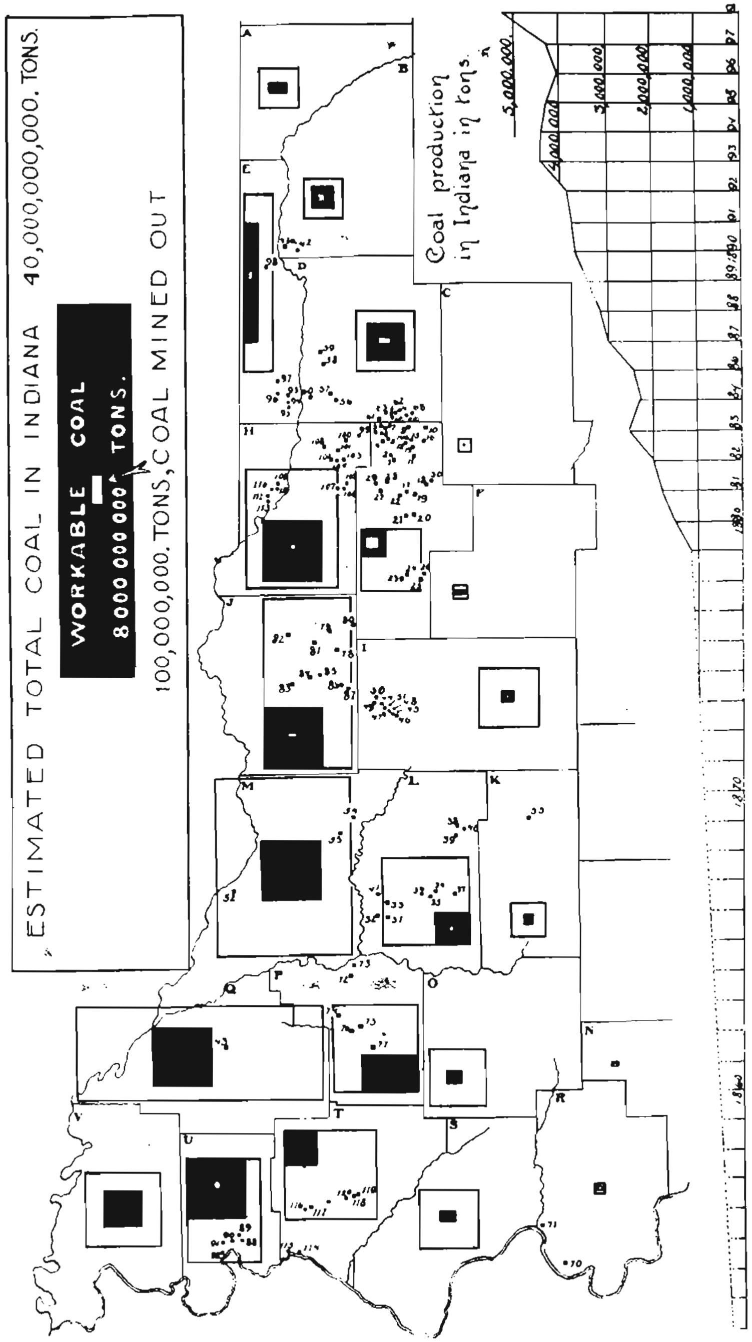


PLATE LXXIX. Chart of coal and mining in Indiana.

Showing: By outside squares, total amount of coal in each county and in the State. 1 sq. in.—10,000,000,000 tons being the scale; solid black squares, relative amount of workable coal in each county and in State; inside light squares, relative amount of coal worked out in counties and State; position of all mines on inspector's list; diagram of coal production of Indiana in tons. (See further on opposite page.)

2122. ADDENDA.—About the middle of June, 1899, a large quantity of data was brought to light in the course of some cleaning up in the basement of the State House. Much of this data was in the form of drilling records that had been sent to the Geologist's office in past years. Most of it proved to have already been obtained from other sources, while much of it was found to add but little if any to what was already known. Some of the data, however, proved of value in giving information at points where information had been lacking before or at which the information already obtained needed confirmation. As the first half and more of the report had already been printed, a few of the sections from the area treated in that part of the report are added here.

2123. SECTION 1066. SECTION AT CHAMBERSBURG.—(Just east of Veedersburg) On Christopher Keesling's land, near Big Four R. R.

		Ft.	In.
1.	Surface, red clay	8	0
2.	Sand	19	7
3.	Reddish sandstone, "place of coal in ravine"	4	0
4.	Bluish shale, 2 ft.; (5) clay with pebbles, 2 ft.; (6) bluish shale, 3 ft. 5 in.; (7) white sandstone, 19 ft.	26	5
8.	COAL	0	8
9.	Bluish shale	19	7
10.	Block COAL IV	4	0
11.	Fire-clay	..	..
		82	3

The reference in No. 3 is to a 28-in. outcrop of coal that occurs in a ravine 200 yds. south and 19 ft. below where the drilling started. The 4 ft. coal is doubtless the one worked at Veedersburg.

2124. SECTION 1067. SECTION OF DRILLING NEAR COAL CREEK P. O.—By James W. King, E. ½ of N. E. ¼ of Sec. 8-19-8.

		Ft.	In.
1.	Surface	41	2
2.	Fire-clay	5	0
3.	Gray shale	51	0
4.	COAL IV	4	0
		101	2

Other drillings just east of this show from 1 ft. to 11 ft. 6 in. of black shale between the gray shale and the coal. As showing what is below the worked bed at Coal Creek P. O. (Snoddy's Mill), the following section is of interest:

2125. SECTION 1068. SECTION OF DRILLING FOR NEBEKER, GICH & FREY.—Sec. 1-18-9.

		Ft.	In.
1.	Drift	2	0
2.	Clay shale, 16 ft.; (3) shale, 2 ft.	18	0
4.	COAL IV	6	0
5.	Fire-clay, 1 ft.; (6) shaly sandstone, 23 ft.; (7) hard, massive sandstone, 45 ft. 6 in.; (8) clay shale, 6 ft. 6 in.	76	0
9.	COAL	0	10
10.	Black shale	2	2
11.	COAL	0	10
12.	Fire-clay, 9 ft. 2 in.; (13) very hard sandstone, 2 ft.	11	2
		117	0

Three of the drillings yield data concerning Coal VI in a part of Clay county in which we had greatly desired to obtain data about that coal but had not succeeded; that is, about Cory.

2126. SECTION 1069. SECTION ON H. PATTEN LAND.—S. ½ S. E. ¼ Sec. 6-11-7, by E. L. Ferguson.

		Ft.	In.
1.	Clay, 20 ft.; (2) boulder clay, 45 ft.	65	0
3.	Blue shale	2	0
4.	COAL VII	4	6
5.	Fire-clay, 1 ft.; (6) "hard pan," 5 ft. 7 in.; (7) "sand," 1 ft.; (8) "hard pan," 2 ft.; (9) clay shale, 2 ft.; (10) white sandstone, 5 ft.; (11) black shale, 17 ft.	34	7
12.	COAL VI	7	4
13.	Fire-clay	..	..
		113	5

2127. SECTION 1070. SECTION ON GEORGE DONHAM'S.—S. ½ S. W. ¼ of Sec. 9-11-7.

	Ft.	In.
Surface clay, 14 ft.; boulder clay, 28 ft.	42	0
COAL	0	4
Blue "hard pan," 52 ft.; shale, 1 ft. 2 in.	53	2
COAL VI	6	5
	101	11

2128. SECTION 1071. SECTION ON D. FERGUSON'S LAND.—W. ½ N. W. ¼ of Sec. 4-10-7.

	Ft.	In.
Surface clay	16	0
Sandstone	44	4
COAL VI?	3	10
Fire-clay	4	0
COAL	0	10
Fine potter's clay, 13 ft.; blue clay shale, 7 ft.; blue shale, 3 ft.	23	0
COAL	2	10
Fire-clay	..	..
	94	10

2129. SECTION 1072. SECTION OF DRILLING ON WM. MUIR'S FARM.—One mile east of Howesville, Clay county.

	Ft.	In.
Drift	20	0
Clay shale	1	0
COAL	0	3
Clay shale, 31 ft.; limestone, 1 ft. 1 in.; clay shale, 11 ft.; white sandstone, 14 ft.; clay shale, 2 ft.; limestone, 9 in.; clay shale, 5 ft.; hard shale, 5 ft.	69	10
	91	1

PART IV.—MINES, MINING AND UTILIZATION OF COAL.

XL. COAL MINING METHODS—PROSPECTING AND OPENING MINE.

Section 1. Prospecting.

2130. The location, position, extent and thickness of a bed of coal are determined either by a study of the outcrops of the coal or by drilling. In the great majority of cases, the mining of any region originates through the observation of outcrops of the coal bed worked, while later developments often are the results of explorations with the drill.

2131. COAL OUTCROPS.—To a large extent in Indiana the development of mining through observations of the natural outcrop have been accidental. In many cases the coal outcrops in a bluff, so that it could hardly escape the notice of the least observing. The frontispiece is an illustration of this. It is only rarely that such a thickness of coal is as well exposed as in this case, though a few other exposures equally good or even better were observed. In such cases the location and position of the coal are determined without special effort on the part of the prospector. In another class of outcrops the exposure is due to the cutting of a stream in its bed. In this case the coal is usually first observed as "float" or coal fragments in the stream channel. If these be carefully followed up they will usually lead one to the point where the bed of coal and the bed of the stream cross each other. Sometimes these outcrops are only exposed at times, as after a freshet, and at other times will be covered by the dirt and gravel being carried down by the stream.

2132. Outcrops of the two classes mentioned will hardly average more than one or two to the township, though the drift covered part of the coal field. Outcrops are rare in any case in that part of the field, but the majority will be found to be of a third class. In this no good exposure of coal exists. The outcrop consists of a line of black dirt or smut a few inches thick on the average, usually underlain by the white or gray under clay. Singularly enough, even though a bed of coal be four or five feet thick, it will commonly pinch down to a mere smut mark, while the under clay usually shows more or less nearly its whole thickness in outcrop. It thus is quite generally as much or more observable than the overlying coal, and in many cases, where the coal is not even represented by a smut mark, it forms the sole criterion of the presence of coal. In Plate LXXX is shown at the left, from a photograph taken at a cut at right angles to the face of the hill, the pinching down of a 5-ft. bed so that where it reached the undisturbed surface just to the left of the plate, it is hardly discernible above the thick outcrop of fire-clay. At most points along the bluff, no trace of an outcrop was observable.

2133. In general, such outcrops should be looked for at points where the land shows the most marked declivity, or where due to any cause fresh exposures occur on a hillside. Gentle slopes seldom yield outcrops. Where streams undercut their banks, and in the roadside gutters, where roads descend hills, are the most favorable places to find outcrops.

2134. In some cases where, over a given tract of land, no coal outcrop can be found, other factors must be brought to bear. Thus, turning to the report and maps on the township in which one is prospecting, it will be noticed that, according to the map, the outcropping rocks at the point in question belong to a certain division of the coal measures. Turning to the columnar sections for that township and the discussion which follows it will be noted that in that division perhaps there is a limestone, or a massive sandstone or some other recognizable layer which can be found outcropping in the tract being examined. Having found the outcrop of such a layer it gives the clue to the position of the nearest coal.

2135. Having found the coal bed, the next thing is to ascertain its extent, thickness and quality.

Where the outcrop is a clear-cut exposure, the thickness and quality are readily obtained. Its quality should be tested by actual trials for steam, household and blacksmith purposes, and, where possible, for its gas-making properties. In exposures of the second class, usually an hour or two's digging will suffice to expose the full thickness of the coal, when it can be examined as above. In exposures of the third class, it is usually easier to go to a point up the hill and back of the outcrop and drill down through the coal. If it shows a satisfactory

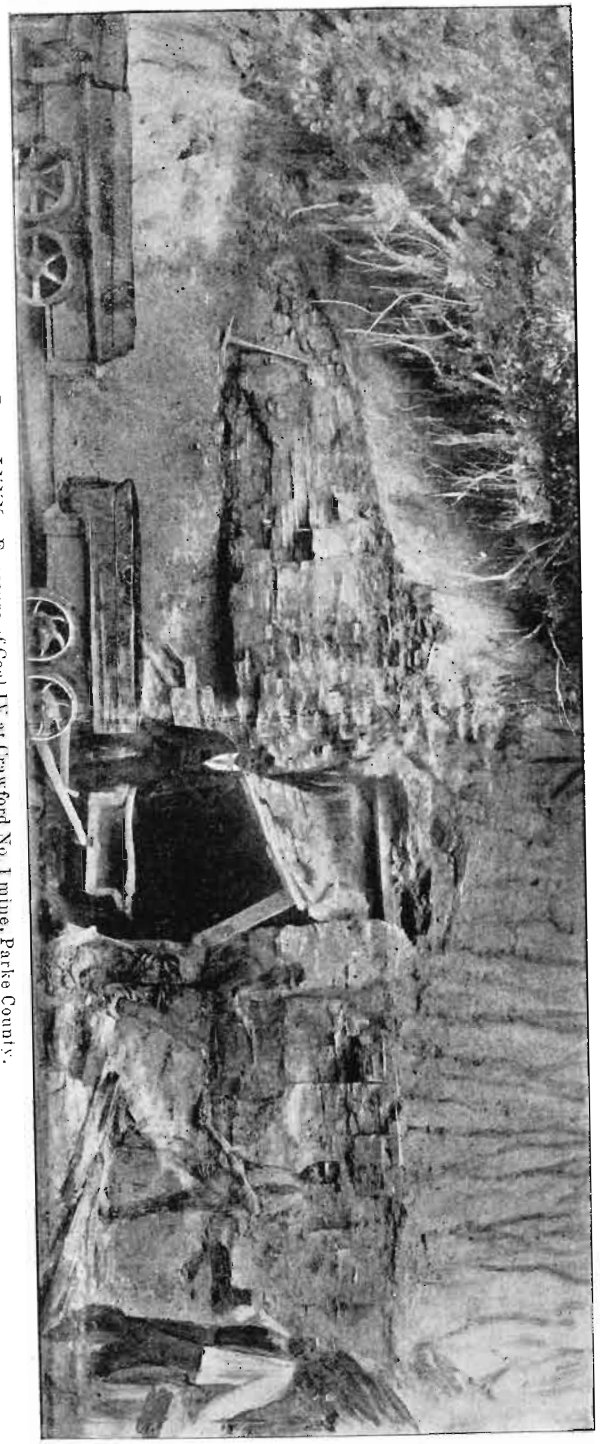


PLATE LXXX. Exposure of Coal IV at Crawford No. 1 mine, Parke County.

The part of the plate at the right shows the face of the coal, 5 ft. thick, parallel to its line of outcrop, but at the back of an open cut 20 to 30 ft. deep. The part of the plate at the left is taken at right angles to the preceding, and shows one side of the open cut. Notice in this the pinching down of the coal toward the left for place of outcropping.)

thickness, an open cut may be made on the outcrop, or, where necessary, a test tunnel driven into the solid coal to ascertain with more exactness its thickness and quality.

2136. It is next important to find out if the coal bed extends under the whole area and how it dips. These may sometimes be determined from the study of the outcrops, but more often the drill is brought into play. Where outcrops are abundant, an instrumental survey is made along the line of outcrop. In this way the lowest exposed point of the coal bed is determined; and if the thickness and quality of the coal be tested at each outcrop, a very good idea may be obtained as to its extent and workability in general.

2137. The Drill.—The drills used in prospecting are of two kinds: the common, jumper or churn drill, as it is variously called, and the diamond or core drill. In the first drill a hole is simply ground down through the rock by the pounding of the solid bit. In some cases the bit is made of a piece of gas piping, in which case something of a core is obtained.

The driller can, as a rule, recognize when he passes from one kind of rock to another by the action of the drill, and the sand pump soon brings up the ground-up sediment, from which the character of the rock may be determined. As a matter of fact, the experienced driller can generally tell by the action of his drill in what kind of rock he is drilling.

2138. Sources of Error with Churn Drill.—The principal source of error in the use of this drill is the inability of most drillers to recognize with accuracy the character of the rock brought up by the sand pump. Very few of the drillers have had any more than a picked-up knowledge of rocks, and when, as is very common with coal measure rocks, the rock of whatever kind contains an admixture of other materials, only a few of our drillers can correctly determine and report upon the character of such a rock from a hand specimen, and how much less when ground up to a fine powder. The way different rocks drill to a certain extent offsets this lack of information. Thus, the powder from a gray shale and a limestone may appear identical to the naked eye, but the drill enters one perhaps a score of times faster than the other, and thus enables the driller to distinguish between them.

2139. In the case of many of the deeper drillings, where steam is used, and where it is the custom usually to stop drilling and clean out the bore hole every five feet, records are usually unreliable.

2140. Interpretation of Churn Drill Records.—It is often possible to obtain valuable information from a very poor drilling record, where one is familiar with typical sections of the particular horizon being drilled. Thus, the driller can usually distinguish coal from sandstone or light-colored shale, but often fails to distinguish between good coal and bone coal or bituminous shale. Thus, he may report "very hard rock" or "hard sandstone" overlying five feet of coal. Suppose that we know from a study of exposures or mine sections that at about that horizon occurs a coal bed 2 to 3 ft. thick, overlain by about an equal amount of black bituminous shale, and that in turn by limestone, the drill record, though very imperfect, and by itself misleading, allows us to recognize what coal bed was passed through and its depth; only, we write limestone for "hard rock," and instead of 5 ft. of coal write 5 ft. of coal and black shale, in about the proportion of 1 to 1, the shale overlying. Churn drill records are usually of value in proportion as other data exist for their interpretation. So that the record of an isolated drilling should usually be taken with great allowance.

2141. Notwithstanding what has been said, the records of drillings by some drillers who use a churn drill are thoroughly reliable, in some cases more so than records of core drillings by inexperienced persons. Of this character are most of the churn drill records obtained from the larger operators.

2142. The Diamond or Core Drill consists essentially of a drill which, instead of being a solid rod, is a hollow tube, whose lower edge is set with bort or black diamonds, and instead of pounding up and down is made to revolve, cutting a cylindrical hole and leaving a solid core of the rocks passed through, which can be raised and examined with as great minuteness as is desired. Here, again, the lack of an accurate acquaintance with rocks leads to some surprisingly erroneous records. These drills are made to revolve by hand, horse power, steam or electric power. Where properly interpreted the core drill will yield almost as accurate a record as a test shaft.

2143. Use of the Drill.—In practice some operators use the diamond drill exclusively, others the churn drill exclusively, and still others use the core drill in prospecting and the churn drill in developing. This is perhaps the most economical method. In some cases the churn drill is used in preliminary prospecting until what appears to be a workable field is found, when it is tested with the core drill.

2144. In developing it is customary with the shallow beds common in Indiana to go over the whole territory to be worked, the closeness of the drilling depending on the local conditions. In some cases every ten acres is drilled upon before any steps are taken for opening the mine. The object is not alone to determine the extent and thickness of the coal, but as much, or often more, to obtain the topography, or hills and hollows of the coal. This requires that the position and level of each drill hole be obtained, measured from some point as base. An excellent plan then sometimes followed is to make a topographic map of the coal. This is done by plotting the drill holes on a map on whatever scale be desired, and drawing contour lines through points of equal elevation. Such a map proves of the greatest help later in locating the mine entrance and in planning for entries and for drainage.

Section 2. Opening the Mine.

2145. Manner of Entrance.—Methods of making an entrance to the coal divide themselves into three classes, according as the entrance is horizontal, vertical or inclined, and the entrance is known respectively as a drift, or adit, or water level, a shaft, or a slope. The purposes of these openings are, first, to give entrance to men, mules, timber, etc., to the mine; second, to give outlet for the product and waste of the mine; third, as openings of ingress and egress for the air needed for the ventilation of the mine; fourth, as openings for the removal of the water that finds its way into the mine; fifth, as an escapement for the miners in case of accident. In small mines one opening often serves for all purposes, but as soon as a mine begins to operate extensively it becomes necessary to have more than one opening, and often a number of openings are made into a mine for the different purposes enumerated above. Often by the use of partitions in some of the openings the expense of a number of openings is saved. In general, the main opening is the one which serves as an exit for the product and waste of the mine.

2146. To discuss the method of entrance intelligently, it should be kept in mind that the preparation of the coal for market and its delivery to the transporting vehicle is usually done as soon as it comes from the mine, and to do this without rehandling requires that the coal, when brought from the mine, have an elevation of from 15 to 20 ft. above the top of the transporting vehicle when loaded. In case the coal is shipped by coal cars, as is usual in Indiana, it should be brought to from 20 to 30 ft. above the rails of the loading switch.

2147. Selecting Character and Point of Main Entrance.—In the close competition in the coal trade to-day, the correct or incorrect opening and laying out of the mine may determine whether it can be worked at a profit or a loss. We can only point out here the main factors which must be taken into consideration, as in any particular case so many details are concerned that only a competent mining engineer on the ground can plan the work. As the opening, though made primarily to allow entrance to the coal, is mainly used for the withdrawal of the coal, it is so placed as to allow the removal of the coal with the least effort and with the greatest rapidity. Other things being equal, the opening is made at the lowest point of the coal bed, as shown by the drillings or study of the outcrop. This allows down-grade haulage from all parts of the mine, and as the haulage ways are usually utilized for the drainage of the mine, allows of a simple system of drainage. If the coal outcrops, the entrance will be by drifting, and is driven at the lowest point of the outcrop. If this outcrop is very near drainage level, however, the coal would have to be elevated to be screened and loaded, and then a slope may be driven, or the fact of its outcropping entirely neglected and a shaft driven at some distant point, usually the point at which the coal is at the lowest level. Again, the best or only method of approach to the mine for a shipping switch may not be in the valley, but up on the high land, in which case a shaft may prove most economical, even though the coal outcrops well above the adjacent valley. In some cases two or three beds are to be worked, and often the lowest point of one is some distance from the lowest point of the other beds. In such cases it may be found best to run inclined tunnels from the lower beds to the upper, and take all the coal out of the mine by way of the upper bed, or it may be found best to use drop shafts from the upper to the lower beds, and hoist all the coal from the level of the lower bed. In some cases the possible positions of a switch are all at some distance from the lowest point of the coal, in which case the coal may be raised by shaft at its lowest point and then hauled to the railroad, or the haulage ways of the mine may be made to center at the lowest point, from which the coal is then drawn by rope hauling to a shaft, slope or drift situated beside the switch. It will thus be seen that many factors are often concerned which may make the problem a complicated one, and its solution difficult.

2148. Shafts.—The shafts are rectangular openings sunk perpendicularly from the surface through the intervening strata to the coal. Among the small mines these are of all sizes and shapes. One round shaft was found in Knox county. Generally in these small mines the shaft is sometimes square, from 4 to 6 ft. in diameter, sometimes a little longer in one direction and one end partitioned off for ventilation, sometimes long enough in one direction to allow its being divided into a compartment for hoisting coal, one for hoisting water, and sometimes a third for ventilation; or the two main compartments may

Fig. 954. Cut showing top of shaft after being equipped.

Note gates to shaft; posts and caps for timbering rooms: screens seen from below, etc. (Brazil Block Coal Co.'s Shaft No. 5.)

be separated by a tight partition, and one side used for the upcast air shaft. With the larger mines the shaft has two compartments, and often three. In size they will vary between 6 by 10 ft. to 8 by 12 ft. or more. Usually the shaft contains the two hoistways only, but often a third compartment is made for a pumpway, airway or manway. The shaft is usually sunk by hand in this State, but it is only a question of time when mining or quarrying machinery, as rock drills, etc., will be used.

2149. In sinking, a large iron hoisting bucket is used, usually swung on pivots to facilitate emptying. In some cases the permanent engines are set up and used for hoisting, while often this office is performed by horse power or by any old engine at hand or obtainable.

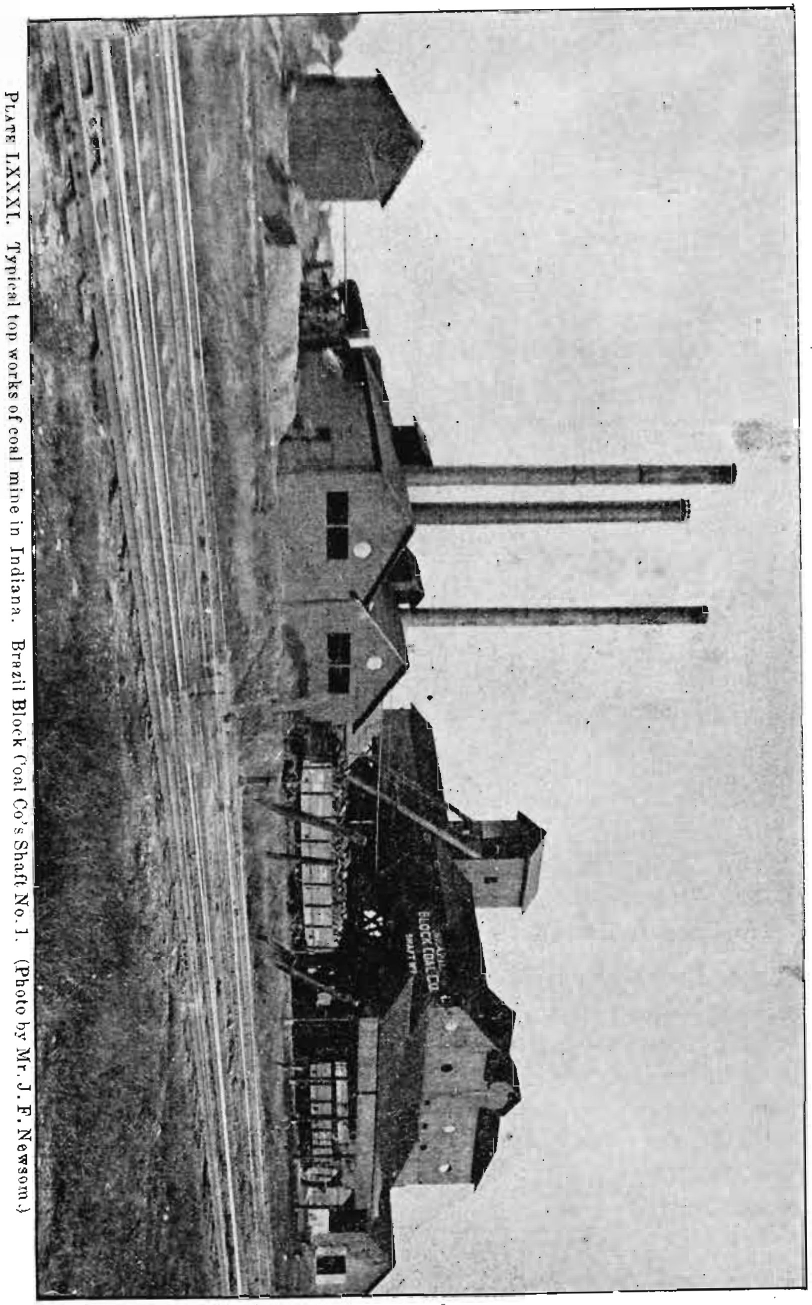


Plate LXXXI. Typical top works of coal mine in Indiana. Brazil Block Coal Co.'s Shaft No. 1. (Photo by Mr. J. F. Newsom.)

In some cases the shaft is heavily timbered to the bottom, or it may only be timbered through the surface and other soft strata. Where quicksands are encountered, it is usual to use one or another of the methods of freezing such beds by the use of freezing mixtures circulated in pipes driven down. The shaft can then be sunk through the frozen sand as though it were a solid bed and heavily timbered. The equipment of the shaft will be mentioned further on. Plate LXXXI shows typically the external appearance of a shaft mine.

2150. SLOPES.—A slope is an incline plane driven down to the coal, either following the dip of the coal or being driven through the rocks overlying the coal, as shown typically in Plate LXXXII.

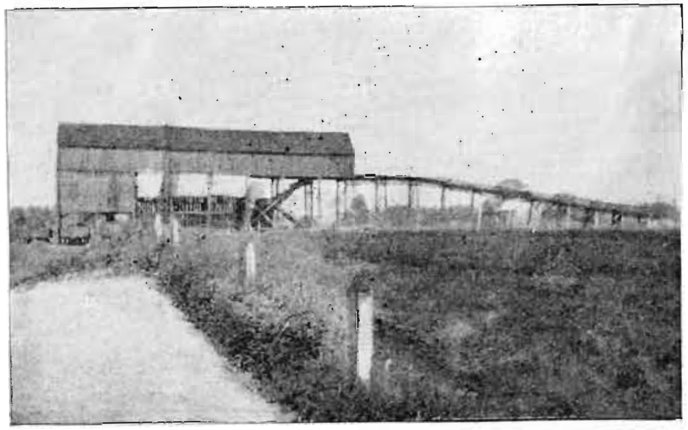
2151. In shape and general character it is usually similar to the main traveling ways of the mine, of which it is in reality only a continuation, except in its always being equipped with a rope of some kind and hoisting machinery for drawing the mine cars up its incline. It is thus an inclined opening of approximately the same height as the main traveling way or entry leading to it, and of the same or double width, according as it is to contain one or two tracks. For a large output, two tracks are always necessary. It may thus be driven from 4 ft. 6 in. to 7 ft. high, and from 6 ft. to 15 ft. broad. In sinking, it is usual to make an open cut for a short distance where the slope starts in soft material. The following figures (Plate LXXXII) will give an idea of the form of slopes common in Indiana.

2152. THE SUMP OR SUMPT.—At the bottom of a shaft or slope it is usual to dig an opening or cistern to serve as a reservoir for the drainage of water of the mine, and from which it is pumped. If the shaft or slope is not sunk to the lowest point of the coal, the sump is placed at that lowest point when it is reached.

2153. THE DRIFT OR ENTRY.—As a drift is simply an entry which reaches daylight without a change of grade, one description will serve for both. The entries or traveling ways are passages or tunnels leading from the main opening of the mine to the various parts of the mine, and serve as haulage ways for the coal, as a passage for the air ventilating the mine, for the drainage and as a passage for the power used, as well as for a traveling way for the men and animals. There are usually one or more main entries from which at definite intervals cross or side entries are driven, as will be explained later. For the purposes of ventilation, it is usual to drive two parallel entries, or sometimes three, one of these serving simply as an "air course," by which name it is known.

Slope at Big Vein mine, Boonville, Warrick County.

Slope at Brazil Brick and Pipe Co's mine, near Brazil.



Slope at Caledonia mine, Boonville, Warrick County.

PLATE LXXXII. Types of slopes in Indiana.

2154. Fig. 955 shows a typical cross-section of an entry as commonly found in Indiana. The height will vary with the thickness of the coal, unless the coal is thin, when it is usual to make the entries at least 4 ft. 6 in. in height, as required by law. When the coal is thick, the entry is often 6 or 8 ft. high, and in some cases, where the shale roof is tender and tends to fall readily, the entry may become

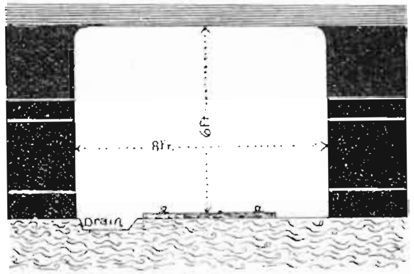
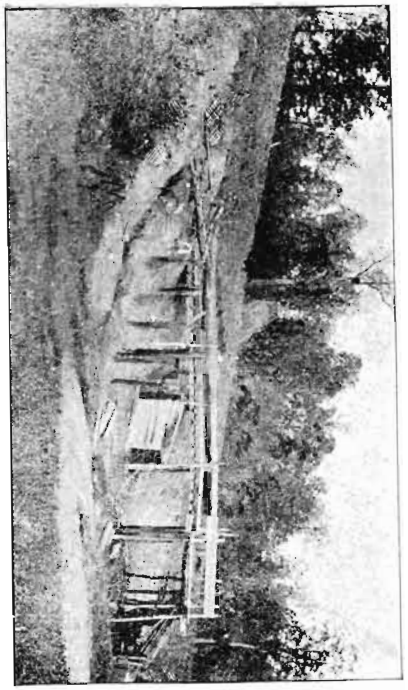
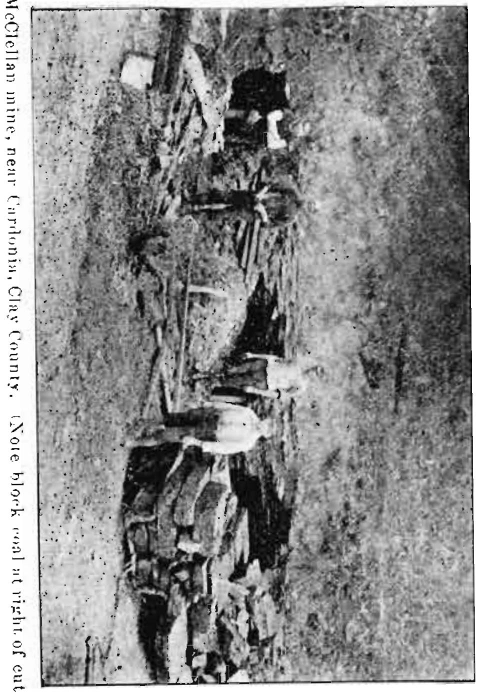


Fig. 955. Cut showing typical cross section of entry.

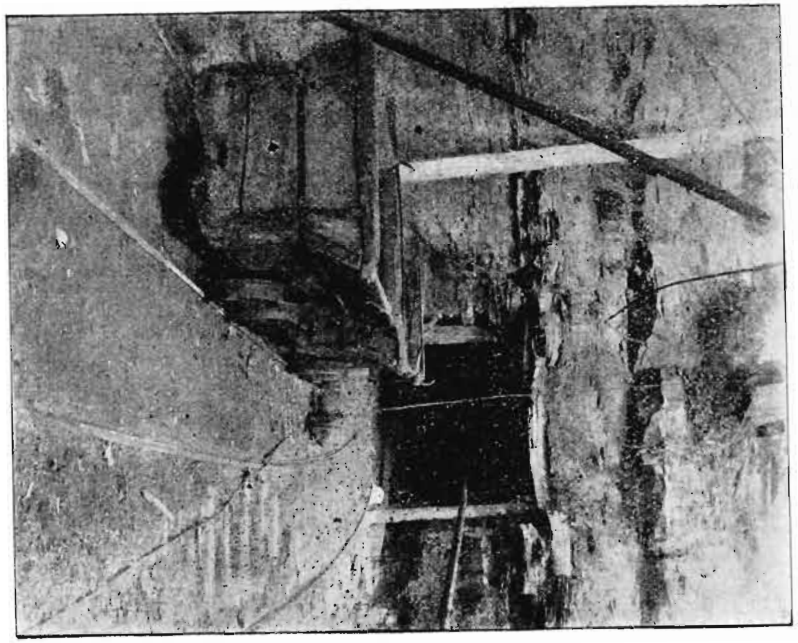
15 or 20 ft. in height. In the latter case it is usual to cover the entry with rough slabs or "lagging" to prevent accidents from roof falls. In width, the entries vary greatly, commonly being at least 6 ft. wide and often much more. At the "pit" bottom, or foot of the shaft, and at other places in the main entries, the entry is widened to allow the laying of two tracks to allow the mine cars to pass. Such places are commonly known as "double partings." Where coal is worked on both sides of a shaft, the law requires that a passage be cut around the foot of the shaft, so that persons may pass from one side to the other without passing under the cages, thus avoiding risk of accidents from falling coal. In many cases, also, rooms are dug out near the foot of the shaft, in which are placed the pumps, hauling machinery, etc. In the case of pumps, these rooms or alcoves are often placed a little above the coal, so as to keep the pump above water in case of the mine being flooded. In case the coal bed does not run level or with a uniform grade, it is often necessary to take down the roof or raise the floor sufficiently to keep the entry level or on a uniform grade, or at least to keep the grade as low as possible. In some cases this has required the raising of the floor to a depth of over 20 ft., as in the case shown in Fig. 3 in Part I. Entry driving is usually a slow and expensive process, as it is necessary not only to pay the miner for the coal obtained at the usual rate, but a certain amount per linear yard in addition. Plate LXXXIII shows the mouths of typical drift mines as found in Indiana.



Robling mine, near Winslow, Pike County.



McClellan mine, near Carbonia, Clay County. (Note block coal at right of cut.)



Phoenix mine at Alum Cave, Sullivan County.

PLATE LXXXIII. Types of drifts in Indiana, large and small.

XLI. METHODS OF WORKING COAL.

2155. In a general way, the method of pillar and room, which is everywhere followed in Indiana at present, consists first of driving entries or haulage ways in the coal in various directions, usually at right angles, and at convenient distances apart. Then, on either side of certain of these entries, rectangular spaces of coal are worked out. These spaces are known as the rooms, and the coal left between the rooms to support the roof is called the pillar. Afterward it is usual to "draw the pillar," or remove the coal it contains. This is made clearer by an examination of Plate LXXXIV, which represents typically a common method of laying out such a mine in this State. The shaft is shown in the lower left-hand corner, from which there extends the "main entry." For the purposes of ventilation it is customary to drive at least two entries. From these, at distances apart of from 300 to 600 ft., side or "cross entries" are driven, and from these cross entries the rooms are turned off, as shown. It will be noticed that the pillar between the main entries is left quite thick or "heavy;" between the cross entries thinner than between the main entries, yet heavier than between the rooms. The rooms are usually started in quite narrow, from 6 to 12 ft., then, after going in from 9 to 15 ft., they are widened out their full width. In Plate LXXXV are shown types of rooms taken from different mines in Indiana. "B" is probably the most common form of room. In this case the room will range from 15 to 30 ft. in width, average about 24 ft., with a pillar whose thickness is about half the width of the room. The "neck" of the room is about 6 or 8 ft. wide and 10 to 12 ft. long; then the room is opened out at an angle of 45°, and all on one side of the neck, so that the track will run down the room close to the pillar or rib, a great convenience when the pillar is drawn. Often the room is opened out each way from the neck, as in the two rooms "C." The length of the room varies greatly, about 150 ft. being a common length.

In the practice in this State, in mines where the coal is dug with the pick, it is usual to assign one man to each room. In some cases the pillar is left thin, as in "A," and is not removed. In other cases the pillar is not so thin near the entry, but the rooms are driven wider and wider until when completed there is practically no pillar left at the end of the room (a very dangerous practice), and in this case, also, the pillar is not removed. In either of the last two cases the coal of the pillar is lost—a practice which can never be considered as good. Every 45 ft. an opening or "breakthrough" is cut through

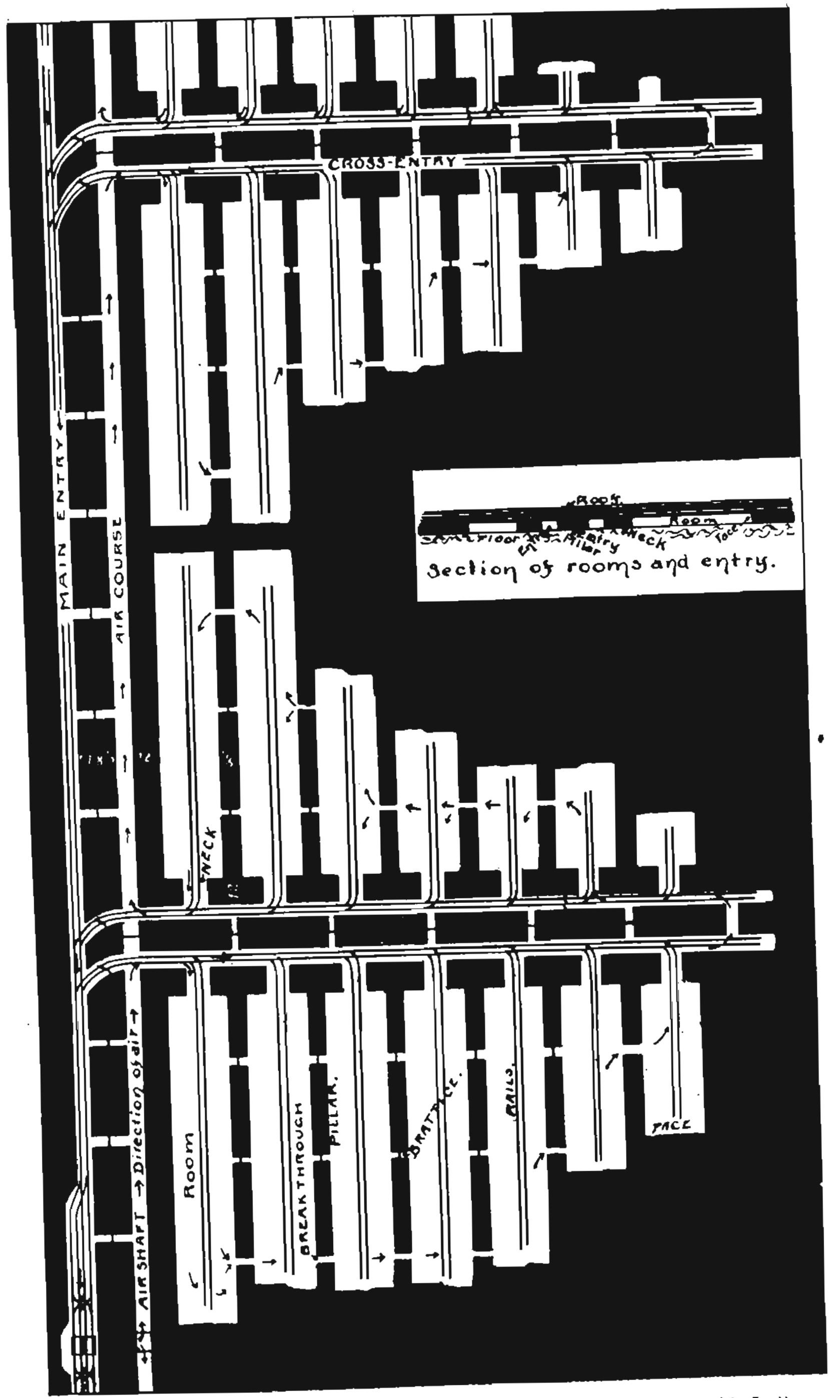


PLATE LXXXIV. Typical plan of room and pillar mine as commonly followed in Indiana.

the pillar for the purpose of ventilation. Where machines are used the rooms are often driven double, as in Fig. "D," the room being 40 to 60 ft. wide.

When the under-clay is very soft, the weight of the roof forces the pillars down into it, causing it to squeeze out or "creep," filling up and closing the entries, and making the pillars a total loss, if not indeed shutting off large districts of half-worked coal. (See Fig. 956.)

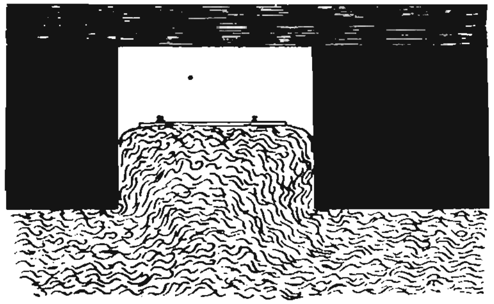


Fig. 956. Sketch showing "creeping" of fire-clay in entry. (Broadhurst mine, Vigo county.)

Various methods of laying out the rooms and pillars are adopted to overcome the difficulty. In too many cases the evil is assumed to be unavoidable, and no effort is made to surmount it except to work the coal out as rapidly as possible, with the idea of getting as much of the coal as can be gotten before the creeping prevents further work, and leave the rest. Such a method, or lack of method, is wasteful in the extreme, and can not be too much condemned.

2156. Probably the best method is to drive the entries through the solid coal to the limits of the area to be worked, leaving very heavy pillars between the two entries of a pair. Then rooms are started at the ends of the entries and the work is carried back toward the shaft, the pillars being drawn as fast as the rooms are completed. In this way the entries can be kept open to where the coal is being mined until all the coal has been won. The difficulty of this method is the large expenditure required before any returns are received from the mine.

2157. In Plate LXXXV, at "E" and "F," are shown two of the methods used in this State under the above conditions. "E" is the method used at the Grant mine, Vigo county. In this case a 30 ft. pillar is left next to the main entry; then every third pillar is left

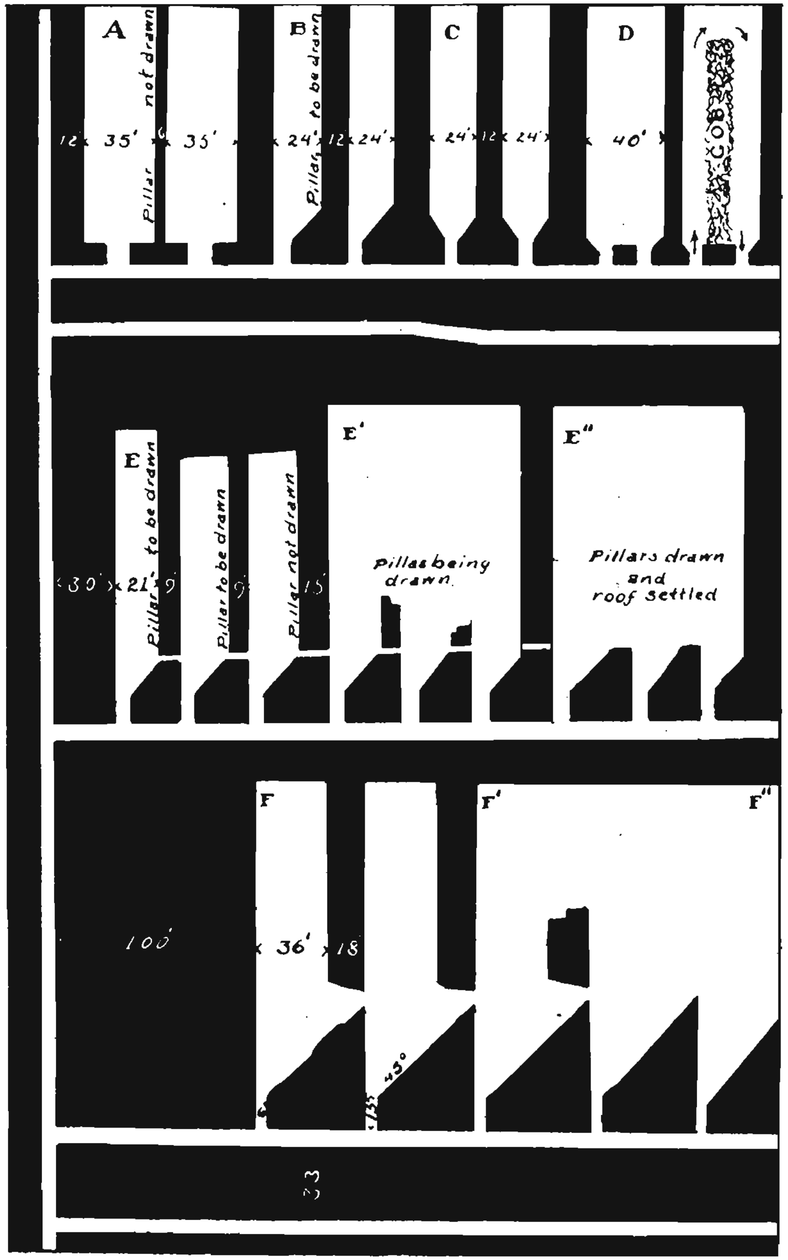


PLATE LXXXV. Types of rooms used in working coal in Indiana.

15 ft. thick, the other room pillars being made only 9 ft. thick, and then drawn. When the two thin pillars are drawn, it makes a room 90 ft. wide, and the roof being allowed to settle in the broad rooms to a certain extent relieves the pressure in that particular region. The 15 ft. pillar is lost, and for that reason, if for no other, the method can not be commended.

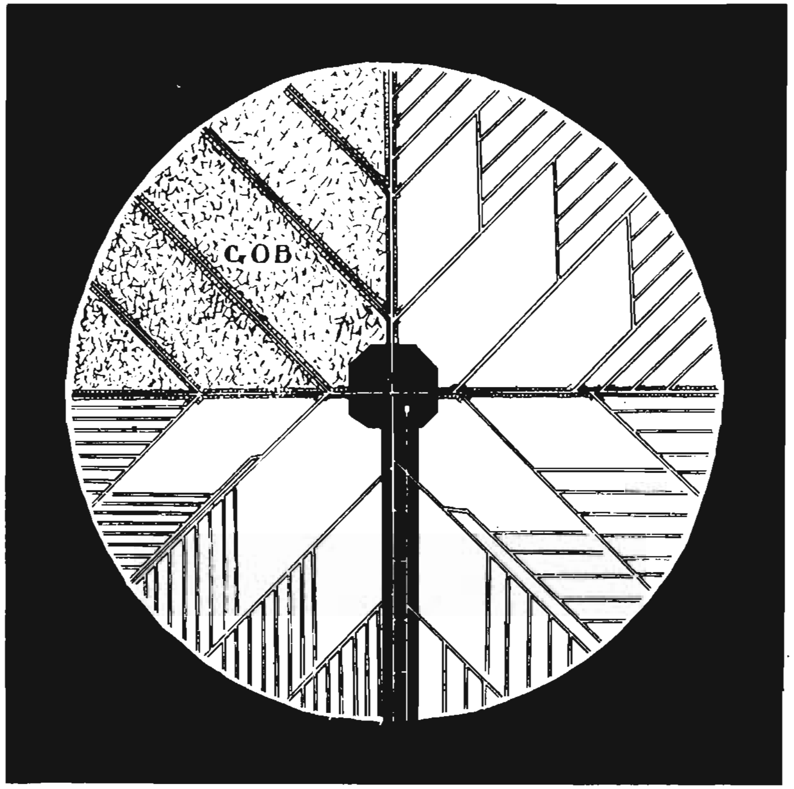


Fig. 957. Figure showing diagramatically some of the methods used in "long wall advancing." In the upper left hand corner is a method used where the roof is strong, while the other quarters show methods used where the roof is weaker in different degrees. (Gob is omitted from the other three quarters for the sake of clearness.)

2158. At "F" is shown the method used at Cox No. 3 mine, and being adopted elsewhere, and which is considered the best advancing method practiced in the State to overcome creep. In this case the main entry pillars are left very heavy, being 100 ft. thick. The cross-entry pillar is left 33 ft. thick, the room pillar 18 ft. thick. The

rooms are turned off 54 ft. apart, being driven in 15 ft. before being widened out; they are then opened out at an angle of 45° and carried through to the next room. By this method there is little danger of the entries becoming closed, and all the pillars are drawn unless there is a loss of some of the entry pillars.

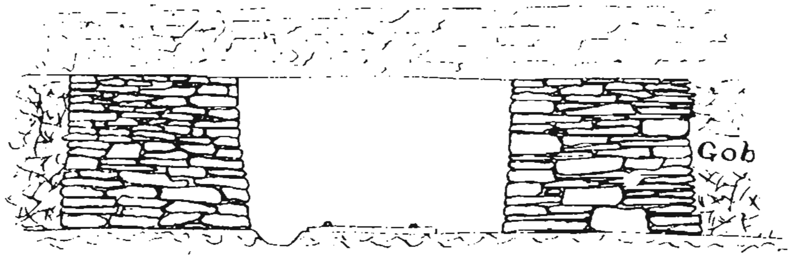


Fig. 958. Cross section of entry with gob walls when first made.

2159. LONG WALL MINING.—In long wall advancing the coal is all removed as the work advances, and the mining is done along a more or less evenly advancing face or "long wall," the roadways being maintained by side walls built of "gob" or the refuse rock obtained in mining, or, if that be unsuitable or insufficient, by rock

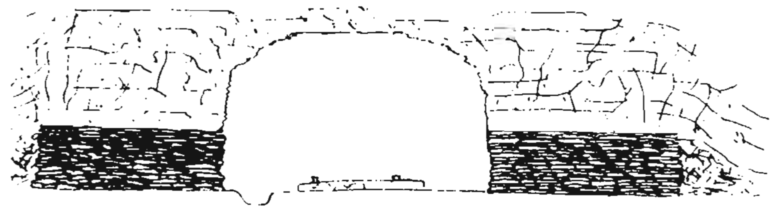


Fig. 959. Same, after gob has settled under weight of roof, and sufficient of the roof has been taken down to give the necessary height in the entry for hauling.

taken from the roof, or if necessary, by timber or other material carried into the mine. The rest of the gob is thrown into the spaces between the good walls, and then the roof settles and fills the space left by mining. In Fig. 957 is shown diagramatically the principles of long wall advancing. It is usual to leave a very heavy pillar about the shaft, though sometimes even that coal is removed, the roof allowed to settle, and then the entries dug out of the settled material. In some cases heavy entry pillars are left along the main entries, but as these pillars are generally lost, the more usual practice is to use gob-packed entries entirely. Such an entry, when first built, will look as in Fig. 958. After the roof has settled and sufficient height has been obtained by taking down roof, the entry may look as in Fig. 959. When the roof is very solid, the gob roads, turned off from the entries at 45°, may be some distance apart, and a track laid along the working face of the coal, so that the mine cars are loaded at points along the face and hauled to the nearest roadway, and so out to the shaft. Where the roof is very weak the roadways must be placed quite close together and the cars only go to the end of the roadway. In this case the coal has to be hauled to them. The lower left-hand corner of Fig. 957 shows the method with very weak roof.

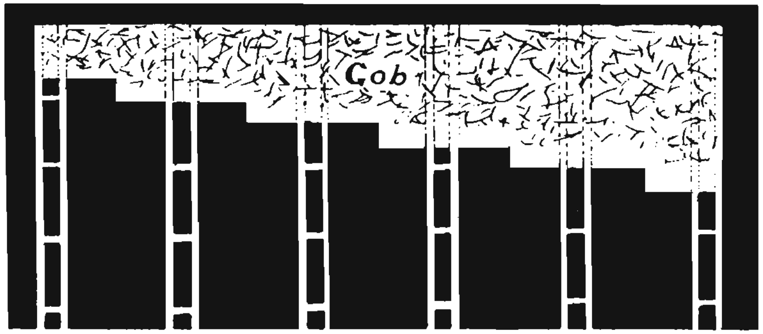


Fig. 960. Type of long wall retreating, in which parallel entries are driven to land lines of the area to be worked, and then the coal between the entries is mined out, working back or "retreating" toward the shaft.

2160. As the work advances from the shaft, most of the old roadways are gobbed up and abandoned. Where the seam is uniform the work may be carried forward in a circle, as in Fig. 957, until the extent of the face may make it better to work the coal in districts. In a coal possessing marked slips or joints it may be found best to work the coal in districts. In such a case parallel entries are usually driven a convenient distance apart, and then, leaving heavy entry pillars or not, the coal between the entries is worked out as in long wall. This system is apt to be wasteful of coal along the main entries, difficult to ventilate, etc., but may be necessary where the output of a mine is irregular or the roof or coal not uniform through a mine.

2161. Long wall is carried on either "advancing" or "retreating." In the latter case pairs of entries are driven to the limits of the territory to be worked, then all connected by a heading, and the coal is

then worked out towards the shaft. By this method practically all the coal can be obtained. The disadvantage is principally the one of large initial expense, while the advantages are many, as the mine is more easily ventilated, the haulage roads are more easily maintained, the miner being able to devote his whole time to mining and other work at the face rather than in spending it in building walls, and for many other reasons which need not be dwelt upon here. (See Fig. 960.)

Fig. 961. Type of combination of long wall with pillar and room method.

In Fig. 961 is shown one of the numerous modifications of working by long wall and pillar and room combined. In carrying the work forward the method is to drive double rooms, with the pillar between perhaps twice the width of the rooms; then the pillars are all drawn together in districts, much as in long wall retreating. So many of the modifications of the methods given are due to local conditions or local customs that no attempt will be made to show them.

2162. As with any other engineering problem, no method, however excellent in itself, is the best system for every place. In practice, long wall mining is constantly growing in favor, and there can be little doubt that, in modified forms to meet local conditions, long wall mining is bound some day to largely supplant room and pillar mining. The attempt to support the weight of 100 to 200 or more feet of strata by a small fraction of one of the most fragile beds while we remove the rest of that bed can not be characterized as an excellent way of providing security to life and property.

2163. Some of the advantages of long wall over pillar and room mining are: Removal of a much larger percentage of the coal; the amount of narrow driven work in long wall advancing has been estimated to be only about one-twenty-fifth of the same work in pillar and room; less tracking is required; hardly any separate air courses are required; practically no bratticing is required; comparatively few doors and stoppings; the cubic capacity of open mine in long wall is only a small fraction of what it is in pillar and room, and hence a much smaller quantity of air will suffice for ventilation; the settling of the roof tends to assist in breaking down the coal after it has been undermined. Some of the disadvantages of long wall mining are: The settling of the roof where the seam is shallow is apt to allow surface water to reach the mine and flood it, or, if carried on under valuable buildings or other property, the settling is apt to be uneven, resulting in more or less deterioration, if not destruction, of such property; where, as is common in Indiana, the demand, and consequently the output, is very fluctuating, it is often difficult or impossible to keep the working face open.

2164. It is probably the shallowness of most of the mines of Indiana, combined with the fluctuations in output, that has prevented the adoption of long wall methods. As time goes on, however, it will be necessary to follow the coals down their dip to the westward, and this will mean deeper and deeper mines, so that that objection is apt to be a constantly decreasing one. The difficulty of a fluctuating demand and output will have to be met by the introduction of panels or districts into the system.

XLII. VENTILATION.

2165. OBJECT OF VENTILATION.—The object of ventilation is twofold: First, the furnishing of the miners with pure air to replace that vitiated by their breathing, by the gases given off by the coal and by the operations of mining; and, second, to dilute the explosive gases given off from the coal or shale till they are nonexplosive.

2166. NATURAL VENTILATION.—Most of the small mines of the State make no provision whatever for ventilation. Fortunately, due to the difference in temperature common between the air inside and that outside of the mine, there is usually a slight tendency for a mine to ventilate itself. Thus, even where the workings consist of only

an entry driven in, there will tend to be a certain amount of ventilation, as illustrated in Fig. 962. Thus in summer, as illustrated in the figure, the warm air from outside will pass into the drift at the top, and, becoming cool as it goes back, settles to the bottom, and finally returns close to the floor and leaves the drift as a current of cold air that can sometimes be felt very preceptibly for several yards from the mouth of the drift.

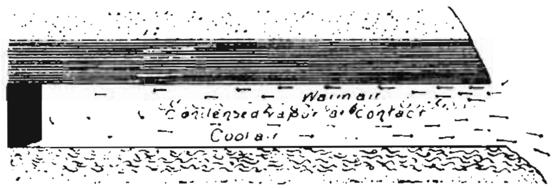
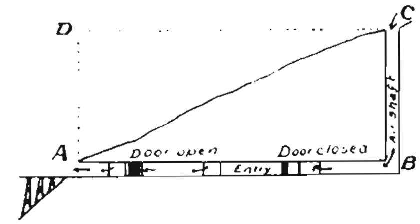


Fig. 962. Diagram showi g natural ventilation of an entry driven into the side of a hill.

A more efficient method, and one usually adopted in the small neighborhood mines if they plan to work the coal at all extensively, is that of having an air shaft, as shown in Fig. 963. Thus, if AB be



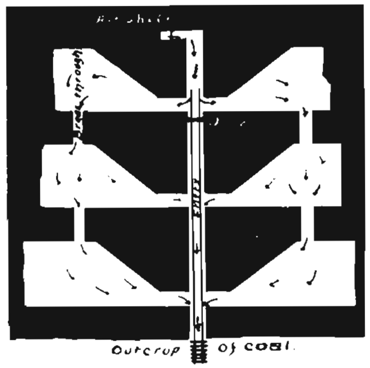


Fig. 963. Vertical cross section of small mine to show circulation of air by means of air shaft. (Summer time.)
Fig. 964. Plan of same mine, showing circulation of air through mine.

the entry, an air shaft, CB, is sunk to meet the entry or some chosen part of the workings. In the summer time the air will generally be warmer outside than in, and, consequently, a column of air in CB is heavier than a column of the warmer air outside of equal length, AD. As a result, the pressure at B is greater than at A, and the air will move from C to A. BC then becomes the intake or downcast. Fig. 694 shows the way the air is made to circulate through the mine. In the case shown the air is entering at the air shaft or at C, and a door across the entry throws the air into the rooms either side; from these, openings to the adjacent rooms, called "breakthroughs," allow it to pass through one after another of the rooms until it finally escapes at the mouth of the entry. If, as is the case in winter, the air outside be colder than the air inside, the current will be reversed and the air will enter at A and pass out at C. BC then becomes the upcast. In this case the door near the mouth of the drift would be closed, throwing the air into the first pair of rooms. It is, of course, necessary to open the door each time a car passes. As the rooms progress, new breakthroughs are made and the old one stopped up, in that way the air being carried as near the working face as possible.

The same principle holds good for a slope or shaft, providing that the air shaft extends to above or below the mouth of the slope or shaft. Of course, the longer the air shaft, the greater the difference in the pressure at A and B for a given difference of temperature inside and outside the mine. In many cases the attempt is made to increase the height of the column of air, BC, by building a chimney above C of boards, barrels or in other ways. Where the height or character of the hill prevents this method, the plan is sometimes followed of driving double entries and building a chimney from the mouth of one of them. The first difficulty with any natural method of ventilation is that as soon as the temperature outside and in becomes equal, the air ceases to circulate, and in any case the current becomes less and less as the temperature inside and out approximate each other. In the second place, as the workings increase in extent, the distance the air has to go increases the friction or drag, so that an air shaft which would provide fairly good ventilation in a mine just starting will soon prove inadequate. Then it becomes necessary to take another step in the method of ventilation; that is, the introduction of a furnace.

2167. THE FURNACE.—This method consists in building a fire at the bottom of the air shaft. Thus, by heating the air in the air shaft, it becomes light and the pressure at B is reduced in consequence, so that the air will enter at A and pass out at C, and BC becomes permanently an upcast. This fire may be a few coals in a wire basket hung at the bottom of the shaft, or an elaborate brick furnace burning many tons of coal a day. Even as late as 1880 the furnace was the means used to ventilate some of the largest mines in Indiana. To-day all the larger and many of the smaller mines are ventilated by fans, and a great saving made. As the ventilation of a small mine by a furnace involves practically the same principles and is accomplished in the same way as by an air shaft depending on natural ventilation, and as the ventilating of a large mine by a furnace requires the same method of laying out mines and directing currents as when an exhaust fan is used, furnace ventilation need not be discussed further here.

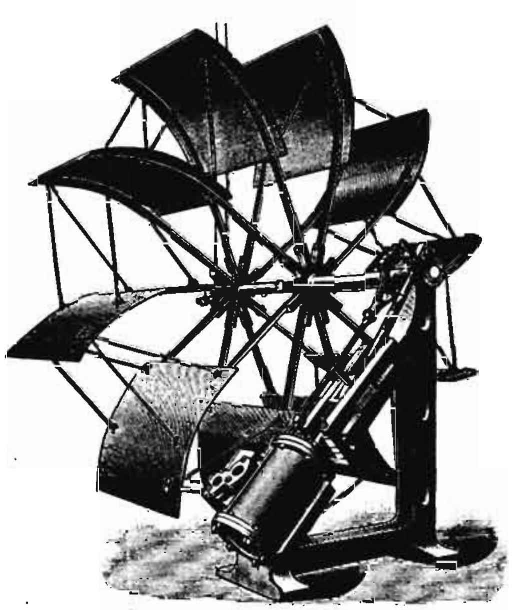


Fig. 965. Type of fan common in Indiana. Kindness of Crawford & McCrimmon, Brazil, Ind.

2168. VENTILATION BY FANS.—As stated above, the efficiency of revolving fans over other methods of ventilation is so great that they have practically superseded all other methods for the large mines. These fans are usually large paddle-wheel-like arrangements, with curved blades working in an inclosed space. They range from 4 ft. up to 20 ft. or more in diameter, 10 or 12 ft. being a common size in Indiana, and are run by a small independent steam engine, which is usually attached directly to a crank on the axis of the fan. They either blow or exhaust. Exhaust fans are seldom used with shafts, for the reason that when so used the main shaft usually becomes the downcast, and in very cold weather the cold air being drawn down the shaft tends to freeze the water which will almost always be found dripping there, rendering it necessary oftentimes to chop out a great deal of ice before the cages can be moved. Again, in case of the tipple catching fire, the smoke and fumes are drawn down the shaft and all through the mine, with often most serious results to those in the mine. As yet, the fans in this State are all of the type indicated. As the demand for greater efficiency in all parts of mine machinery in-

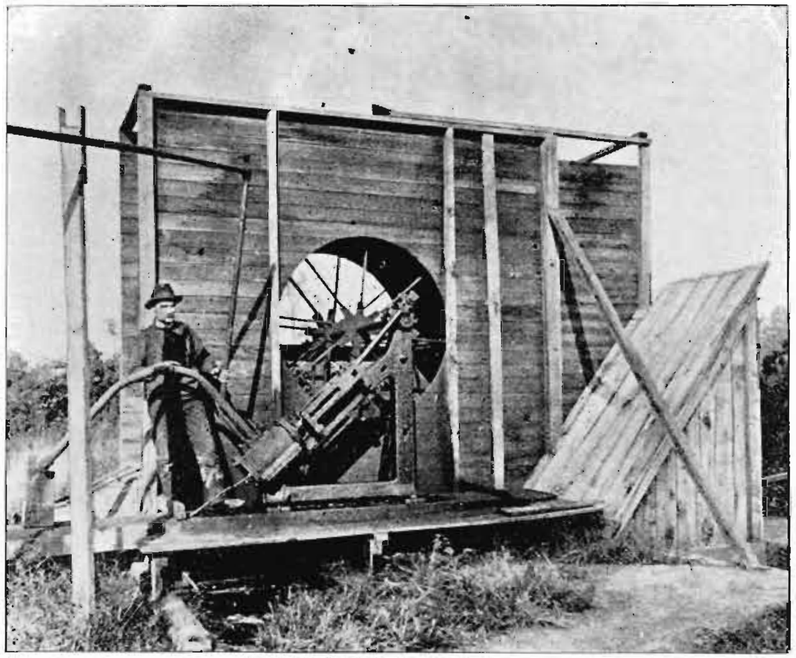


Fig. 966. Outside appearance of ventilating fan house, Peerless mine, Coal Bluff. Ind. (Photo by Mr. J. F. Newsom.)

creases, no doubt they will give way to more efficient forms of fan. They bear about the same relation to a fan of proper design that an old-fashioned water-wheel does to a modern turbine.

2169. STEAM JET VENTILATION.—One other method of producing a current is in use to a small extent; that is, ventilation by a steam jet. In this a pipe is carried from the engine or boiler part or all the way down the air shaft and turned so that the open end is upward. Steam being allowed to escape from the pipe with some force produces an upward current in the air shaft and secures some resemblance to ventilation. For a very small mine the ventilation thus produced may be ample; but in any case the efficiency of such a method is so small

as compared with the efficiency of a fan driven by the same amount of steam that it might almost be compared to trying to run a train by the pressure of steam escaping in the rear.

2170. VENTILATION BY DOUBLE ENTRY.—With the introduction of better methods of producing a current came better methods of utilization of those currents. This led to the abandonment of the single

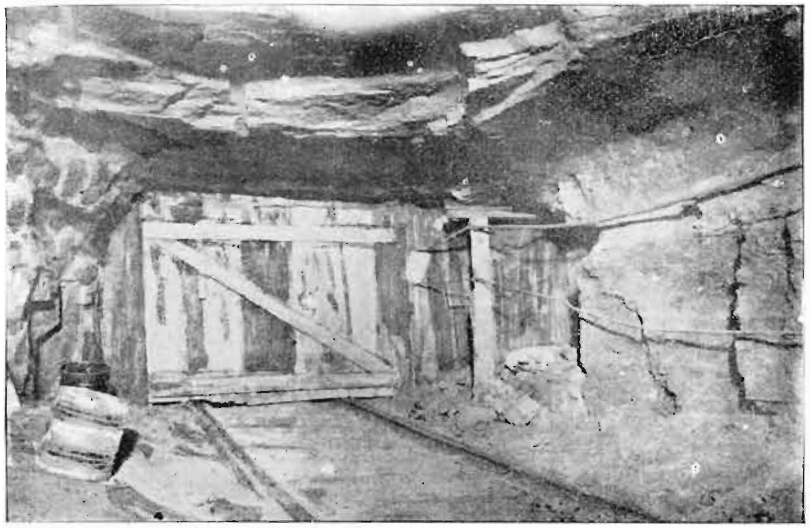


Fig. 967. Type of cut-off door commonly used in directing air currents in mines in Indiana. Brazil Block Coal Co.'s No. 1 mine. From flashlight photo by Mr. J. F. Newsom.

entry system, as figured in Fig. 964 (though the most of the neighborhood mines still stick to that plan), and the adoption of the double entry plan. This is the method in common use in all the large mines of the State. The method is exhibited in Plate LXXXIV. Essentially it consists in driving parallel entries which, being connected at the advancing end, serve as a circuit for the circulation of the air. In practice these entries are from 8 to 50 ft. apart, and connecting breakthroughs are driven every 45 ft., as required by law. As each new breakthrough is made, the one last used is stopped up or "bratticed" air-tight. As with the rooms, the ventilation is only partial while working ahead of each breakthrough, and is often very bad, particularly in driving a new breakthrough in a heavy pillar, where the ventilation is almost nothing.

2171. DOORS.—In case the air current is required to cross an entry without connecting with it, it is carried over the entry in a combination of box and overhead tunnel, usually, known as an over-cast. Doors are used to direct the current in desired directions at the intersections of entries. These doors are usually in charge of boys known as "trapper boys," who open and close them to allow the passage of the mine cars. Many of the better equipped mines now use mechanical devices to open and close these doors. These, as far as observed in this State, consist of an elevated rail up on to which the car runs, when its weight forces the rail down and opens the door. As the car leaves the track a counterpoise weight carries the rail back and closes the door. Of course, every time the door is opened the air current is for the time interrupted. In Plate LXXXIV the course of the air can be followed by noting the arrows.

2172. REGULATORS.—At points where the air course divides it is important to have the proper proportion go in each direction. If, as is usually the case, due to the difference in length or shape of passages traversed by the two currents, the frictional resistances are not equal, it is evident that the most of the current will follow the course offering the least resistance. To offset this, "regulators" are placed in the passages, by which the size of the passage at that point can be changed so that by compelling the air that is to pass through the shorter course to enter through a smaller opening of the proper size, the amount of air that enters can be proportioned to the needs of each entry.

2173. SPLITTING THE AIR CURRENT.—It is too often the practice to drive all the air around the whole mine. Better practice divides or "splits" the air so that one part goes through one part of the mine, another part through a different portion of the mine, etc. The advantages of this are: A better distribution of the fresh air; the friction of passages and rooms is divided among the different splits, thus greatly reducing the work required of the fan; on account of the smaller amount of friction, much less power is required to drive the air; with the reduced friction it is not necessary to give the air a velocity that renders it difficult to keep the lamps going, etc. On the other hand, too frequent splitting will reduce the current till it becomes sluggish and ineffective.

2174. TRIPLE AIR COURSES.—Where power haulage is used, especially electric, it is often very desirable to avoid the use of doors for directing the air currents. This is accomplished by the use of a third

air course. Many systems are in use. Fig. 968 shows the system as practiced in more or less modified form at some of the large mines of Pennsylvania. In this case the air is driven out central entries to the extreme points of working, from which it works its way back through the rooms to the main haulage ways and out. In some cases the fresh air is carried in through the side entries, and is drawn through the rooms and out by way of the third entry. In some cases the central entry only is used for haulage, and the air is carried out the side entries.

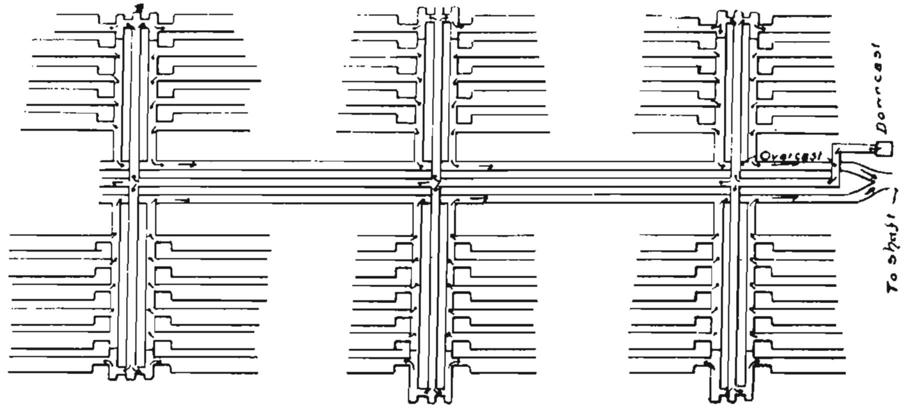


Fig. 968. Diagram showing method of securing ventilation with the minimum number of doors by the use of three entries.

2175. LONG WALL VENTILATION.—As already stated, the ventilation of a mine worked long wall is comparatively simple and effective. Where the work is being carried forward more or less nearly in a circle, the air may simply be carried out in opposite directions to the faces, then split and carried around the working face through a quadrant where the currents unite and return to the shaft in directions at right angles to their outgoing directions. Not only does this require the minimum distance for the air to pass and thus a minimum of power to drive it, but the miner is working always in the current and not a varying distance ahead of it.

In the line of improvement and higher efficiency it has occurred to the writer that greater efficiency could be secured by abandoning the air course system and substituting piping the air to just the points where it is needed. By such a system the mine could be worked single entry. There need be no breakthroughs, no brattices, no doors, practically no leakage. The air in all cases could be carried to the face of the rooms where it was needed, and only to those rooms. The length of piping required would at any one time be practically the same as is now required to serve the machines in a mine using compressed air machines. Size of pipe and pressure to give the greatest efficiency would have to be calculated. By this method each miner would receive pure air unvitiated by passing through other working places. To save using large sizes of pipe to reach workings at a distance from the fans or air pumps, high pressures could be used in the main lines, or by the use of small shafts or large drill holes the fans either on the surface or below could follow the workings, especially if electric fans or pumps are used. Lacking the time to determine the feasibility of the plan, these suggestions are simply given for what they are worth.

2176. Mine Gases.—In this State, due principally to the fact that the mines are so near the surface, little trouble is met with from the accumulation of mine gases, and but little account need be made of them in planning the ventilation. In some of the deeper mines—and the number of these will increase as time goes on—the mine gases become a source of danger. The gas most commonly met with is that known as marsh gas, a combination of carbon and hydrogen, which, when mixed with a small quantity of air, becomes the explosive fire-damp. When pure marsh gas, it will burn without explosion, or if sufficiently diluted with air, it will not explode. Both methods are used of getting rid of the gas—first, by burning it as it escapes from "blowers" or holes in the rock or coal in a pure state; second, by diluting it with an abundance of pure air. The first method is too often followed, and can not be too highly condemned. The extinguishment of such a "blower" of gas where there is not adequate ventilation quickly leads to the formation of an explosive mixture which explodes as soon as a light is reached, with, as often as not, fatal results to many or all of the miners in the mine—for those not killed by the explosion may be suffocated by the black damp or gas that is formed by the exploding of the fire-damp. The best remedy is an abundant air current through all parts of the mine and a competent fire boss. In extreme cases, a boring might be made from the surface at the point of escape and the gas drawn off by piping and burned at the surface.

XLIII. DRAINAGE.

2177. Natural Drainage.—Very few mines of any extent in this State drain themselves—first, because there are now very few large mines working the coal from the outcrop, and where the coal is so worked it is only here and there one that has the coal dipping from every point to the mouth of the drift. If this point is but a few feet above the lowest part of the mine, natural drainage may often be secured by digging a ditch in the bottom to the required depth from the lowest point of the coal to the outcrop.

2178. Siphon Drainage.—Where the lowest point of the coal is so far below some other point of the entry between there and the mouth of the entry as to make natural drainage impracticable, the result may be accomplished by means of a siphon. This is simply a tube whose joints are air-tight running from the lowest point of the coal to a still lower point outside of the mine at which the water is to be discharged. The conditions necessary are that the discharge end of the pipe be lower than the intake end; that no point in the pipe be more than about 20 ft. higher than the point of intake, and that the joints be air-tight. A hand pump placed at the highest part of the pipe pumps the air out and sets the siphon going, after which it runs itself. As far as noted, no siphons are used in Indiana. There appear, however, to be a few mines in which their use would save the expense of pumping. In Pennsylvania siphons are in successful operation in lengths of up to almost a mile. Their use in this State would not be so much draining mines as in draining parts of mines where the coal occurs in isolated basins.

2179. Water Bailers.—The shaft being the usual form of mine entrance, and the coal usually being below adjacent drainage level in Indiana, most of the mines require that the drainage water be hoisted out of the mine. The simplest means of accomplishing this is with some sort of a bucket or box. In most of the small mines a barrel is used. The sump to which the mine drains is placed below one compartment of the shaft, and a barrel or box alternates with the cage in the other compartment in rising and descending. In many cases the box is attached below the cage and a box full of water raised every time the cage is raised. This plan is even adopted in some of the largest mines.

2180. PUMPS.—In by far the majority of cases in this State it is necessary to resort to pumping to free the mine of water. This is due to the fact that most of the mines are shaft mines, and the coal is generally below the level of adjacent drainage. The common practice is then to lead the water from all parts of the mine by ditches in the entries to the sump or sumps placed at the lowest points of the coal. In perhaps a majority of cases one sump is usually placed at or near the foot of the shaft. Steam pumps are principally used. These are placed in the mine near the sump and force the water to the surface. The steam is furnished from the boilers on the surface. In many cases the sump and pump are long distances from the shaft, the steam being carried in pipes through the entries and the water driven up through a driven pipe. On account of the loss of power in conveying steam such long distances, we look for the introduction of electric pumps or compressed air pumps in those mines using one or the other of those forms of power which find it necessary to place pumps at some distance from the shaft and boiler house. Some of the mines require as many as five large pumps to keep them free of water, especially where connected with old workings. In some of the latter cases, where possible, it would seem to be economy to build heavy retaining dams to shut off the old workings and let them fill up. Such dams should, of course, be strong enough to stand any pressure that may be brought against them, which might in some cases be equal to the pressure of a column of water of a height equal to the depth of the mine. As a rule, this should not be done where no accurate map of the old mine has been made. In some cases the coal forms too ready a passage for water to make such shutting off effective.

As old mines tend to fill up with water and thus become a source of danger to later mines which, working up to the same lines, might break through into the old workings, and thus be themselves flooded, with a possibility of loss of life, it has long been a law that before the abandonment of any mine a map of it should be filed with the Mine Inspector. As this often entailed an expense of several hundred dollars after a mine had ceased to produce, the law was not effective, and has recently been replaced by one which requires such maps to be filed each year of all mines operating.

It is not an uncommon occurrence in Indiana to have mines flooded from surface waters. This not only renders the mine idle, often for weeks or months, but leads to considerable expense in pumping it out. Such flooding may usually be avoided if two points are kept in mind: Never locate a shaft or any opening to the coal so that its top is below the level of highest water of adjacent streams; leave

the coal under stream channels where there is any possibility of breaking through by the settling of rooms, till the last. Entries may usually be driven under such streams with safety, but there is always danger, if an attempt is made to open rooms, that when the roof settles the stream will simply be turned into the mine. In the map given of shaft No. 8, Plate LXXXIII, the broad band of unworked coal across the center of the mine is under Otter creek.

In the laying out of the mine, drainage plays an important part, as it is desirable that the mine be so planned that the coal is mined up the dip as much as possible, and then the rooms will drain themselves. Where the entries are driven directly up or down the dip, it is often customary to drive the rooms not quite at right angles to the entry, but inclining slightly up the dip, thus securing better drainage.

XLIV. A WORD OF SUGGESTION TO HOLDERS OF UNDEVELOPED COAL LANDS.

2181. Many of the readers of this report are owners of land in the coal area, which you have reason to believe is underlain by workable coal of good quality. You have, perhaps, or are contemplating opening up a little bank, primarily to supply yourself with coal, and secondarily to furnish a little to your neighbors, if they desire it, to help pay for the expense of opening up. If so, a word of suggestion may not be without value. Remember, in the first place, that if the coal is worth developing at all, it is worth developing properly, and for several reasons: First, a mine properly opened up does not require to be reopened every fall, as a majority of the small mines do; second, you will generally save any possibility of having to abandon your mine just when you have it in shape to get coal rapidly by finding you can not drain it, having opened at the wrong place as regards the dip; third, though not always at first, in a short time the economy in mining and getting the coal out will more than pay for the extra trouble of proper openings; fourth, by proper methods all the coal may be taken out. There are, however, other reasons which are even stronger. Your property is to-day perhaps out of reach of transportation facilities, and would actually sell for little if any more with the coal under it than it would without the coal. That will not always be so. The extensive mining of ten or twenty years from now will be carried on where to-day are only small neighborhood mines, or not even that. It may be that the rapid failure of natural gas in

Indiana will result in the early development of many such regions. Suppose that five or ten years from now your land is brought within reach of the market by the introduction of a switch of a railroad. You value it to-day at say $50 an acre. Suppose there is a 5 ft. bed of coal under it, what will it then be worth per acre? At a royalty of ten cents per ton, from $500 to $750 per acre; at a royalty of five cents a ton, half that. Under these conditions you may desire to operate on your own land extensively, or you may desire to lease or sell to parties who will. Now if, while operating on a small scale, you have done so in a proper way, it may make your property more desirable than surrounding property, which otherwise is as good, or possibly a little better. On the other hand, if you have followed the all too common method of gouging into the coal without any regard for system or the future consequences, your property will certainly be at a disadvantage as compared with similar property about you. In the first case the mine can become a paying one almost from the start. In the latter case not only do you lose the value of the coal removed, which, of course, you do in the former case, but usually several times the area actually mined out is rendered valueless by the lack of a proper system in mining; and, further, it often means a large extra expense to drive entries through these old works. So that, as a rule, experienced companies would prefer to start a mine in untouched coal rather than at points where it has been improperly mined. In view of the effect on the coal value of the land, the methods sometimes adopted are as reasonable as it would be to chop a single board off from a standing pine tree.

These are only part of the arguments in favor of opening up even a small country bank systematically or not at all. Having decided, however, to open up a bank, the following suggestions are worth considering:

First. Open the mine at the proper place, as regards drainage in particular, even if it requires some trouble and expense.

Second. Drive double entries and of sufficient size to allow a large output later if desired, and leave heavier entry pillars than would be done if the coal were to be worked out continuously and quickly. In case the coal is reached by a shaft, it may not be necessary to make that at once as large as would be required to ship several hundred tons a day, as it can readily be enlarged afterward. With the entries, however, it is different. If the entries are small, with small pillars between and at the side, they can only be enlarged at the expense of the pillars, perhaps already too small.

Third. Do not gouge promiscuously into the side of the entries or turn off rooms from your main entry as soon as under cover. Carefully plan a system of cross-entries, and follow your plans if possible, even if you never mine out more than one or two rooms.

Fourth. Take especial pains to preserve the roof of your entries, by substantial timbering, if necessary, and by proper drainage keep the mine as free from water as possible.

Fifth. With mines that are only worked a few months in the fall and winter, it may not be advisable to attempt to work by the long wall method, but it might prove an advantage if the mine were planned so that, if desired some time in the future, the long wall method could be readily adopted.

Sixth. Time and attention given to preparing the coal by proper screening, cleaning of sulphur, shale, etc., is not time wasted, but may prove the best sort of an investment.

XLV. MINING AND REMOVING COAL.

This chapter will discuss the methods of mining the coal, of hauling and raising it to the surface.

Section 1. Coal Mining.

2182. GENERAL METHODS.—Several methods of "breaking out" the coal are followed. The most common method is to under-cut the coal as far as the miner can, and then it is either wedged or blocked down, or holes are drilled in the coal, which is then blasted or shot down with powder.

Often the coal is undermined in the under-clay, or in the bone coal, where that occurs at the bottom of the seam, as it often does. Frequently the coal is sheared at one side of the room or at the center of the room. Where the coal contains partings of clay or shale, or bone coal, the "bearing in" may with economy be done in it. Often the bearing in is done in a layer of soft coal or in a layer which is hard and brittle and so chips easily. Such a layer is known as the "bench mining," as the different divisions are known as benches. In such cases it not infrequently happens that after the removal of the bench mining across a broad room the bench above will, of its own weight, sag down, becoming fractured and yielding readily to the pick. In such case it is often the custom to raise the underlying bench by wedges; in this way the coal is mined readily and without powder. It is an aim in mining not only to get the coal out as rapidly as possible, but to get out as large proportion of large coal, or, as it is known, "lump coal." For this reason the use of powder is avoided where possible. In mining the block coal the use of powder is seldom necessary, as the natural jointing of the coal greatly facilitates its breaking out. In such coal the direction of entries and rooms is generally laid out on directions so as to facilitate taking advantage of the slips. In long wall mining it is seldom necessary to more than "bear in" under the coal, the wedging action of the roof, which is gradually settling behind the work, breaking off the coal in huge chunks, requiring neither powder, bar nor even wedge to bring them down.

In some cases the coal is not undermined or dug in any way, but is simply drilled and shot down with powder, or, as it is called, "shot on the solid."

The various methods of mining are not usually confined to special districts, but are adopted to meet the special requirements of the seam being mined, so that often quite different methods are used in different parts of the same mine. Much also depends on the miner himself and his previous practice.

2183. Mining by Machinery.—In the use of mining machinery Indiana has been in the vanguard. In 1896 inquiry showed that in percentage of coal mined by machinery Indiana stood second of the eastern or central States, being surpassed only by Montana and Alaska of the western, in the latter there being but one mine, which used machines, so, of course, the whole output was machine mined. The machine in most common use in Indiana is the Harrison compressed air machine. Any one who has watched the operation of a common compressed air rock drill will understand its action. This machine is shown in Plate LXXXVI. It is simply an air cylinder in which compressed air drives a piston-rod or bar which chips out the coal. It is mounted on wheels and is operated on a platform sloping to the face of the coal. The operator half lies on the platform, and by means of the handles and by the use of his feet bracing against the wheels, directs its blows. An assistant shovels the slack out of the way and attends to moving the platforms. (There are usually two to save time in shifting the machine.) In moving the machine from one room to another, a light truck is used. For shearing, the machine is mounted on a pair of high wheels.

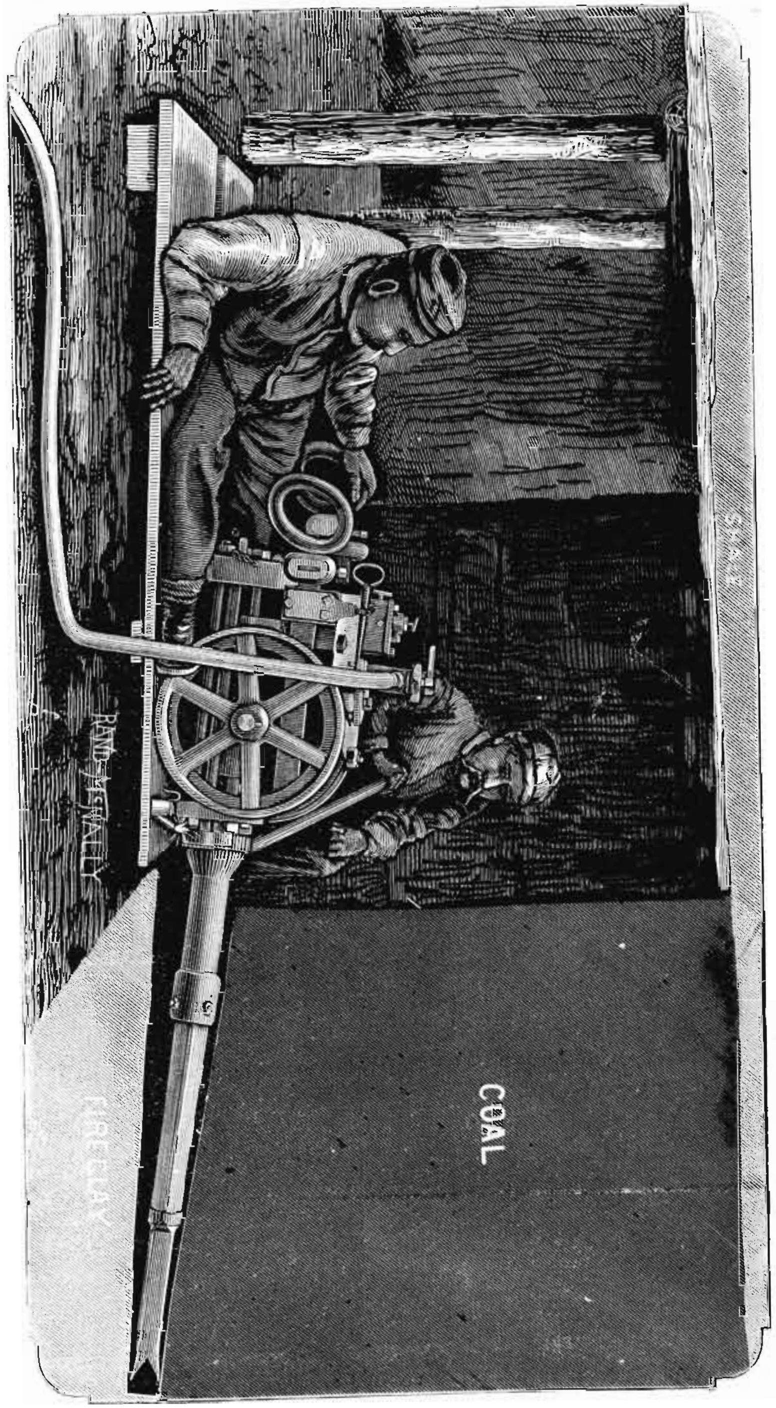


PLATE LXXXVI. Harrison compressed air mining machine at work.

These machines use a pressure of up to 75 lbs., the air being compressed in air compressors of 120 H. P. capacity. It is then conveyed into the mine and to the various rooms by iron piping. With a pressure of 75 lbs. at the compressor, the pressure at the machines

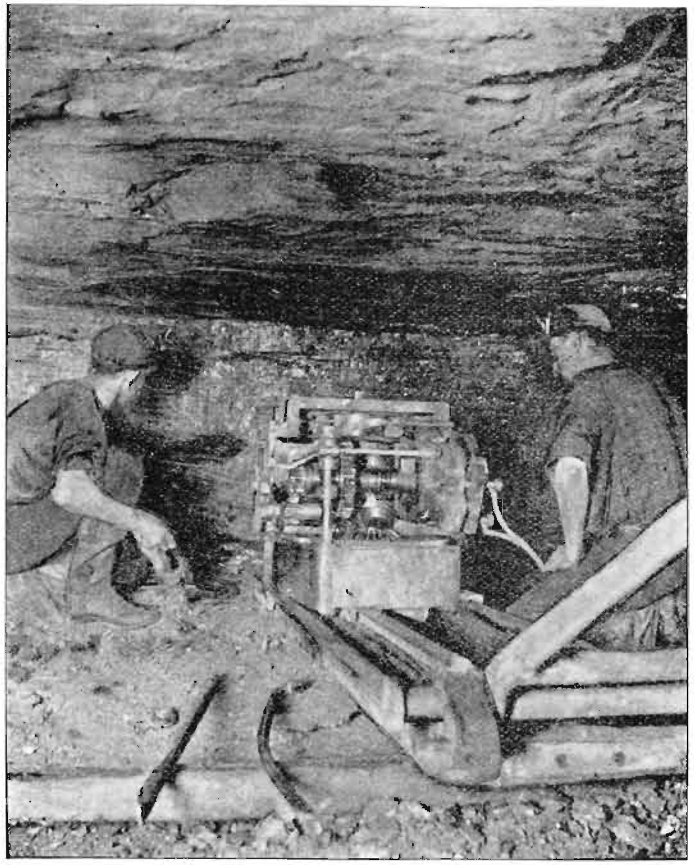


Fig. 970. Electric chain machine at work in Mecca mine. From flashlight photo by Mr. W. Paul Zimmerman.

will range from 60 lbs. down, according to the number of machines working, distance from compressor, etc. One compressor is sufficient to drive a dozen or more machines, which deliver about 200 blows per minute each, and will undercut to a depth of 5 ft. or a little more.

The extended use of the machine testifies to its efficiency. One of the objections to it is its tendency to produce deafness in those operating it.

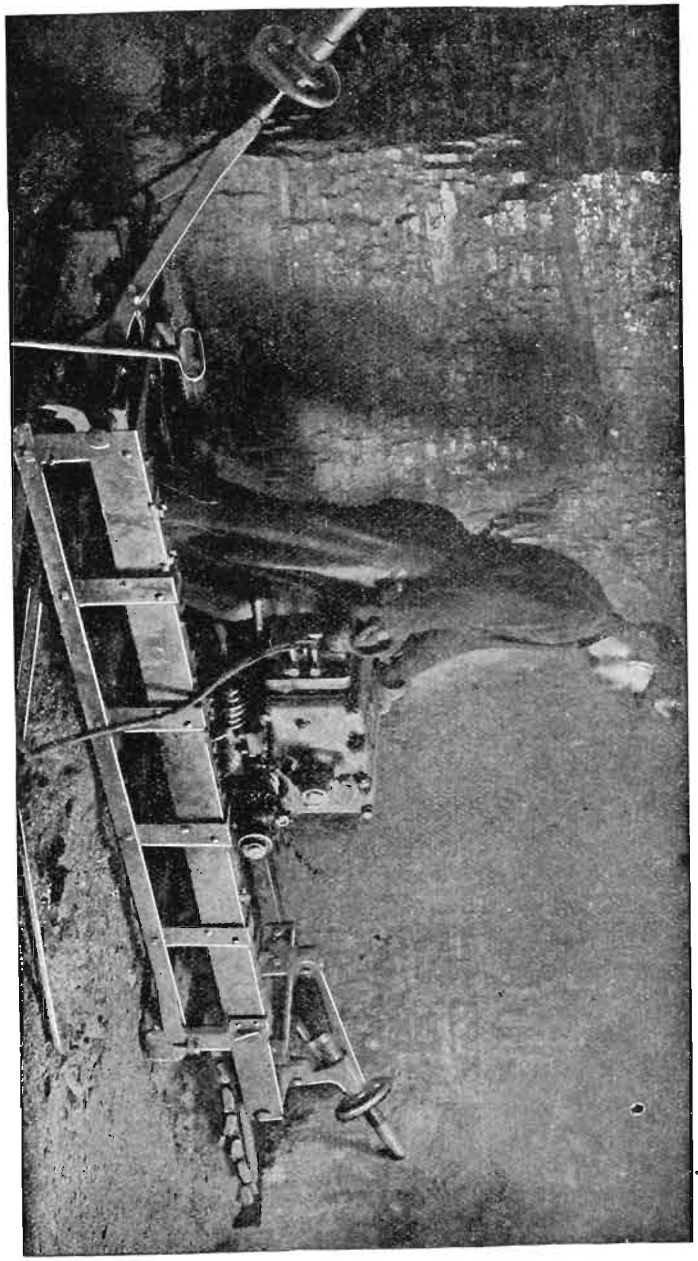


PLATE LXXXVII. Jeffrey Electric Mining Machine at work. Maximum undercut, 7 feet deep, 44 inches wide, 4 inches high. Makes complete undercut, in and out, in less than four minutes.

Several types of electric machines are in use. These usually are what are known as bar or chain machines, the latter predominating. In principle the chain machine consists of a low horizontal frame, as shown in Plate LXXXVII, around which is driven a chain set with teeth much like an endless band saw. In fact, it is in principle only a saw, and may be said to have originated in some unsuccessful attempts to use a circular saw for the purpose, only that in the coal cutter, on account of the damage to which the teeth are liable, they are replaceable. These teeth are set somewhat after the manner of saw teeth, so as to make clearance for themselves and the frame, which in this case requires that every third tooth be set to cut between the paths of the other two. In this machine, as the teeth cut, the frame or cutter-head around which they are carried is advanced under the coal, making a cut about 3 ft. 6 in. in width and 4 in. high and under-cutting the coal to a depth of up to 7 ft. Such a cut will be made in four or five minutes, depending somewhat upon the coal. These machines cut faster than the pick machines, but require more power and are several times as heavy, a disadvantage in moving from room to room. The machines of this type in use in this State are the Jeffrey, the Independent and the Morgan Gardner.

Another form of the electric machine is the Legg or bar machine. In this a bar set with teeth is made to revolve forward and downward; at the same time it is fed forward. It has the disadvantage over the preceding machine of cutting across the bedding of the coal and of having to grind up all the sulphur balls it meets.

Of the forms of machines not used in this State might be mentioned those designed for use only in narrow work and those designed for long wall mining. These will undoubtedly come into use with the adoption of long wall mining, but need not be dwelt upon here.

In the Mecca No. 1 mine, and elsewhere, there have recently been installed electric drills. (See Fig. 971.) In such a drill the driving power is a small electric motor supplied from the dynamo in the power house. Similar drills are made to be operated by compressed air. With either of these power drills from 30 to 60 ft. an hour can be drilled, requiring one man and a boy to operate it. Such a drill will weigh about 150 lbs., being built to stand the rough usage they are liable to sustain.

2184. Timbering.—In addition to mining the coal, the miner has usually to timber his room and load his own coal. With some roofs, especially where it is a black sheety shale overlain by limestone, no timbering is needed for a room of 40 ft. or under width. The writer

has seen such rooms in this State, where the roof has stood for years without a prop in rooms 40 ft. wide, and still it shows no signs of weakness or flaking. In other mines that have been in operation many

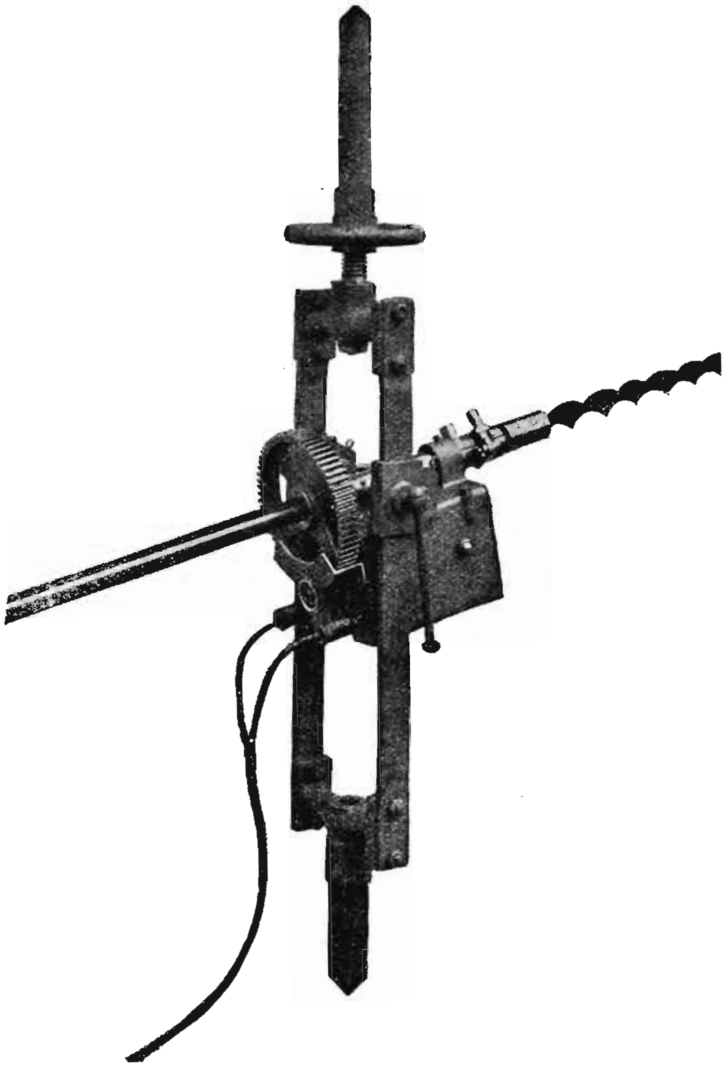
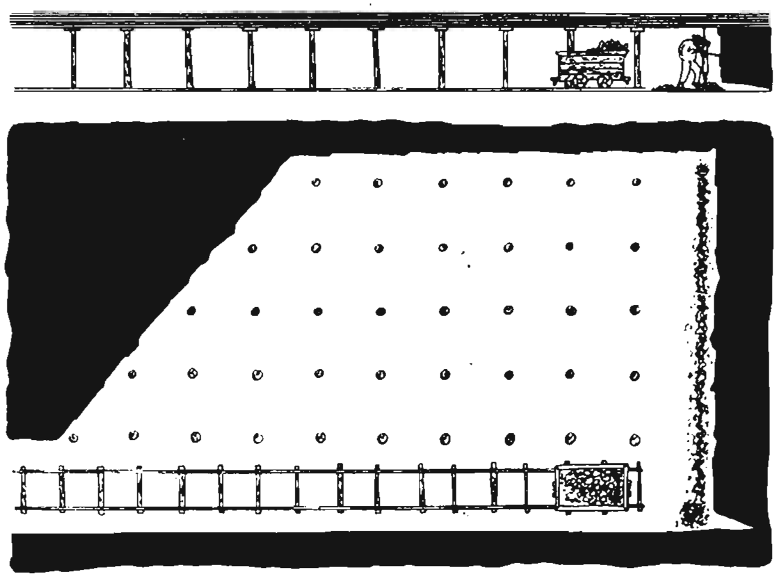


Fig. 971. Jeffrey Electric Drill.

years it is not uncommon to find that the roof in the entries has flaked down until the entry has become fifteen to twenty feet high. In most of the mines of the State some timbering is necessary; a not uncommon average would be one post to from every square yard to every four square yards. As the object of timbering is to keep the roof intact, two points are usually kept in mind: First, to see that the posts are set in regular rows at regular distances apart to insure an equal distribution of the load; second, to see that the posts have flat square bearings, and that where wedging is resorted to to make them tight, such wedging does not interfere with the whole top of the post sustaining an equal pressure. In order to make the bearing broader, it



Figs. 972 973. Cross section and plan of typically timbered room. Scale 12 ft., 1 in.

is usual to put a piece of flat board on top. In this State the custom is for the miner to set his own posts, which are furnished to him at his room by the operators or company. It is specified by the law that the company shall keep a blackboard, on which the miner puts down the number and length of timbers required by him, and they are later distributed to him by the day men. In some mines the roof needs to be timbered so closely to the working face that it would seriously interfere with the use of certain forms of mining machines, especially the electric chain machines, which require quite a little room to work in. In a majority of cases where the roof is shale the part of the roof immediately overlying the coal is not as solid as that a few inches or more above. This part of the roof tends to come down,

and is called the "draw slate." In some cases it is taken down before the posts are set up; in other cases it flakes down afterwards, usually a column of it remaining over the posts. Where the roof is a clay shale only a foot or two thick, overlain by sandstone, it is quite common for the shale to come down, leaving the sandstone for a roof.

Figs. 972 and 973 show a typically timbered room in plain and cross-section.

In long wall mining, with a strong roof, and with a sufficient supply of proper material to build walls, no timbering is required. Fig. 974 shows a section of long wall mining face in a thin seam with strong roof.

Where the roof is tender, timbering is usually resorted to, the entry walls are built as usual and the rest of the gob thrown around the posts.

Section 2. Removing Coal.

2185. Loading. In this State, where pillar and room is universal, it is the common custom to run the mine cars right to the working face, where they are loaded. The mine cars used in the State are of a variety of patterns and sizes. (See especially Plates LXXX, LXXXII, LXXXIII.) They are planned to hold from one-half ton to two tons. In loading, it is most common to shovel the coal in, regardless of size, such coal being called "run of mine." Another very common practice is to build up the sides of the car with the large lumps, often to a height of a foot or two above the side of the car, and shovel the finer coal into the center. Due to the rule common with the miners' union, the cars are distributed to the rooms in regular rotation, so that each miner during the day will send out the same number of cars. This practice leads the more industrious to make each load sent out as large as possible. In some cases, to prevent the overloading of the hoisting cages, the companies place beams in the entry at a given height to serve as a check to overloading the cars. In some cases the slack or small coal is shoveled into the bottom of the car and topped up with lumps. In some cases forks are used instead of shovels in loading, so that the slack and smallest coal is left in the mine.

In long wall, with strong roof, the cars are run along the working face on a temporary track, as shown in Fig. 974. Where the roof is very tender, so that the posts have to be set too close to the face to al-


MAP (In Part)
OF
BRAZIL BLOCK COAL CO'S
MINE No 8
PLANNED &, LAID OUT by P J MOONEY
SCALE
DRAWN BY G. H. A.

Pl. LXXXVIII.

low the passage of a car, small boxes or "buggies" without wheels are used, as these can be pushed along the face by hand to the end of the adjacent roadway and there loaded into the regular cars.

2186. MINE HAULAGE.—In the small country banks it is the common practice to push the cars to the mouth of the mine by hand, using wooden rails. The cars in such cases, of course, are small. In mines just opening or only working two or three men, each miner

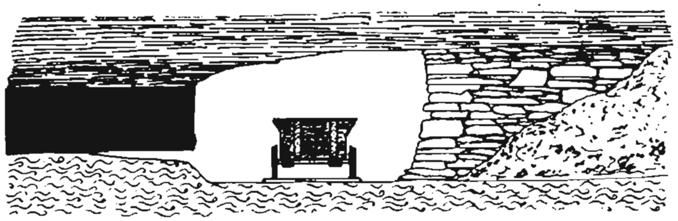


Fig. 974. Section at face in long wall mining with strong roof, showing position of track, gob wall, etc.

usually pushes his own car out. When the number of miners reaches say five or six or more, one man, or, if the grades are light, a boy, is employed to push the cars out. As mining advances, or with a larger number of miners, mules or horses are introduced, the mule being the common animal. This system expanded becomes the system in common practice in a majority of the larger mines. Where large cars are used, or with very heavy grades, one car makes a load. In other cases two cars make a load or "trip." These mules are usually driven and cared for by boys of from fifteen to twenty, known as "drivers." In some cases the mules stay in the mines continuously; more commonly, however, they are brought out each night, as they are found to do better by this practice, especially in keeping their eyesight. They are either lowered on the cages or enter the mine through the inclined manway, a separate division of that being prepared for them. Reference has already been made to the "trappers," boys whose duty it is to open and close the ventilating doors. Mention has also been made of patent self-opening doors. The rail used is usually a light iron T-rail, with wooden rails in the rooms. Turnouts or "double partings" are placed at convenient intervals to allow the passing of full and empty cars.

Three methods of power haulage are used in this State, viz., first, tail rope; second, endless rope, and third, electric.

2187. TAIL ROPE HAULAGE.—This system is the one in the most common use. See Fig. 975. In this system the cars are hauled to the foot of the shaft or mouth of the mine by a heavy wire rope, known as the "main rope," and the empties hauled back by a lighter rope known as the "tail rope." The hauling engine has two drums and is usually placed near the foot of the shaft, as in the figure. The

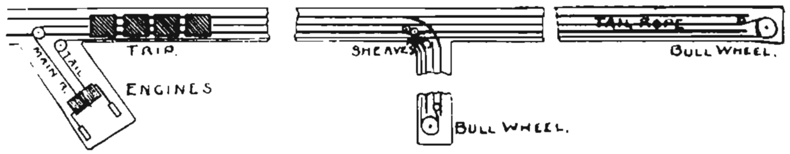


Fig. 975. Diagram showing working of tail-rope system of mine haulage.

tail rope is, as stated, somewhat lighter than the main rope and twice as long. It runs from the drum of the engine, at the side of the track, to the point at which hauling is done, where it passes around a wheel 4 to 8 ft. in diameter, known as the "bull wheel." When the trip is drawn out the tail rope is attached to the last car, serving as a brake if needed, and on the return it serves to draw the empty cars back. Tail rope haulage may be of almost any desired length, some hauls in Pennsylvania being as much as three miles long, though in this State most of the hauls are between one-half and one mile in length. Usually quite a number of cars are taken at each haul, ranging in this State from five to twenty-five. In some cases the coal is hauled from the cross entries as well as the main entry. In that case a joint is made in the rope opposite each of these cross entries, and an additional length of rope twice the length of the cross entry is used in each cross entry. Many ingenious devices have been brought forward to make a satisfactory coupling. In some cases, though not in this State, an engine is placed at each end of the haul.

Mules are used to draw the cars to the double partings, where the trips are made up. A suggestion from the practice at the Loyal Hanna mines, to which the writer's attention was called by Mr. McKinny, may not come amiss. It is there the practice to make a double parting in the main entry just beyond the last cross entry in which rope haulage is installed. Until work has been driven forward and the haulage system perfected in the next cross entry all the coal mined beyond this point is brought to this double parting. A partial trip is made up, and to the front car is attached a wire rope as long as the trip to be hauled out of the adjacent entry. As the trip being hauled out of that entry approaches the main entry it runs slowly and as it reaches the main entry the end of the wire rope just mentioned is attached to a hook in the front car. In this way the partial trip in the main entry is added to the trip in the cross entry without stopping the latter. The tail rope is transferred from the last car of the cross entry trip to the last car of the main entry cars. The engineer is signaled by means of wires running beside the track and within reach of the driver in charge of the trip.

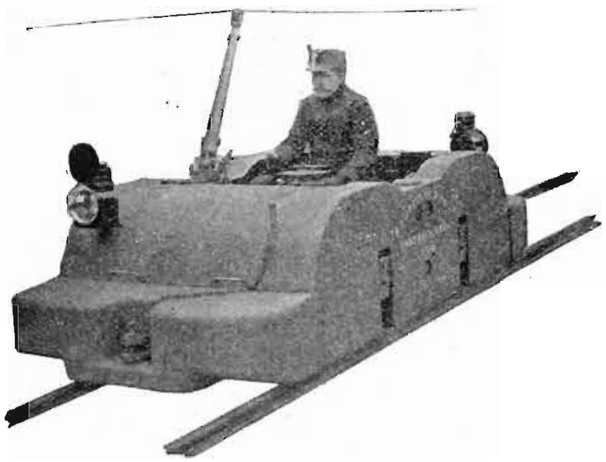
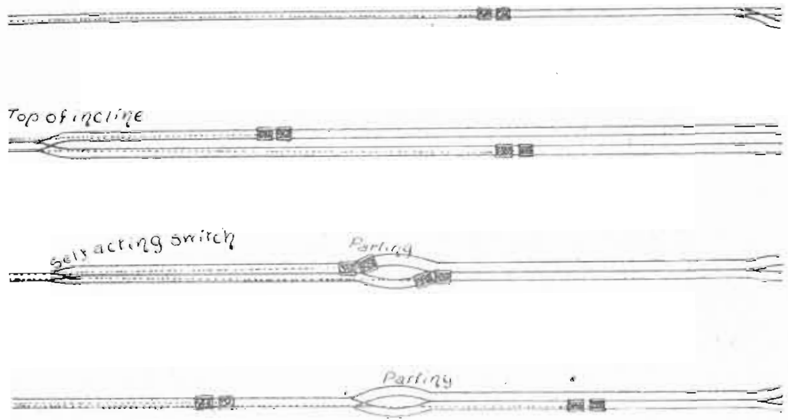


Fig. 976. The Jeffrey's electric locomotive, for use in the mines.

2188. Endless Rope Haulage.—As ordinarily understood, there are no endless rope haulage plants in this State. The nearest approach to it is at the Brazil Brick and Pipe Works' slope (see Plate LXXXII). This differs from tail rope only in that instead of winding the two ropes up on a drum, one rope is used which is given a turn around a large grooved drive wheel, and is driven in alternate directions according as the trip is going out or returning. It has the usual advantage of an endless rope of requiring one-third less rope and also the disadvantage of an endless rope of being always taut, much of the wear resulting from that fact.

As usually understood, endless rope haulage supposes a single taut rope running continuously in one direction. Two entries are required for the haulage, the full trips being drawn out one entry and returning through the other. The system is similar to that in use with cable street cars in some of the large cities, modified to meet the special conditions.

2188a. Electric Haulage.—Electric haulage is in operation in the Brazil Block No. 1, Hymera, Mecca and other mines. The principles of electric street car haulage are adopted, modified to suit underground conditions. Fig. 976 gives a view of a Jeffrey motor. The trolly arm is of course very short and is placed on one side of the motor, the trolly wire being usually placed over one of the rails. The main advantage of electric haulage is that the system can readily be extended to any part of the mine and can keep pace with the advancing face. As the motor can also be used much as a switch engine, with a little care, there is a gain in that direction.



Figs. 977-980. Plans of tracks used in slopes.

Electric haulage appears to be gaining in favor, especially where used in connection with electric mining machines, electric drills, electric pumps, etc. In order to shorten the haulage of the coal, a system of radiating entries has been used in the Brazil Block Coal Co.'s No. 8 mine. The plan of this mine was prepared by Mr. P. J. Mooney, and it is reported to have proven very satisfactory, it having been found to have many other advantages besides the one mentioned. See Plate LXXXVIII, p. 1473.

2189. Hoisting by Slopes.—In slope mines the coal is drawn up an inclined way, usually by steam. In some of the small mines horse power is used, when they are known as "gin mines." To an upright drum is attached a long heavy arm, and a horse attached to this is driven in a circle, winding up the rope on the drum. In a few cases a windlass and hand power are used. While resembling rope haulage in many respects it differs in these: Usually the haul is comparatively short, one rope usually being used, the grade generally being sufficient to carry the cars back and drag the rope after them. In Figs. 977 to 980 are shown some of the plans of tracks. In some cases just a single track is used. Such a slope is very slow unless the grade be so light that many cars can be handled at a time. More often the track is made double all or part of the way, or at least has a "turnout," so that cars going up can pass others going down, as shown in the figures.

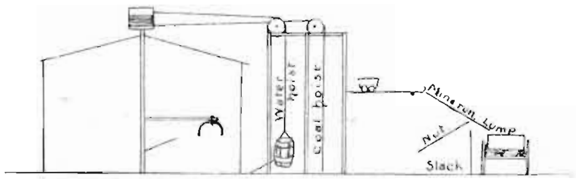


Fig. 981. Vertical plan of head works of typical "gin shaft."

2190. SHAFT HOISTING.—It is interesting to trace the evolution from the crude box hoisted by windlass to large shaft equipments hoisting 1,000 tons or more a day. Thus at one end we have the crude wooden box holding perhaps a couple of bushels, and requiring a dozen trips to raise a ton, the shaft a square hole just large enough to allow the passage of the box. Then comes the "gin shaft," where horse power is used, and which may otherwise be like the other except that a little larger box is used.

Next the shaft is made double, and the rope, instead of winding up on the drum, is given a few turns on the drum and passes back to the other side of the shaft. At first it may be that there is a cage only in one side, and in the other a barrel for hoisting water. Next the box is replaced by a platform similar to that of a common freight elevator, upon which the boxes are placed. Or if cars have been adopted for the mine, tracks are laid on the platform or cage and the cars are pushed on to that, one cage rising as the other descends (see Fig. 981).

In the next case the horse gives way to a steam engine provided with a drum. The early engine may be a thrashing engine that hoists coal one part of the season, runs a thrashing machine during another, and runs a buzz-saw during another. Sometimes they are fitted up to hoist coal or saw wood as may be desired, by a shift in the belting. Next comes the regular single-acting hoisting engine, then the double-acting hoisting engine. By means of a cord or chain wound on the

Stock mine, northeast of Boonville, Warrick county.

St. Mary's mine, at St. Mary's-in-the-Woods, Vigo county.

PLATE LXXXIX. Types of well equipped "small mines" or "country banks," in Indiana.

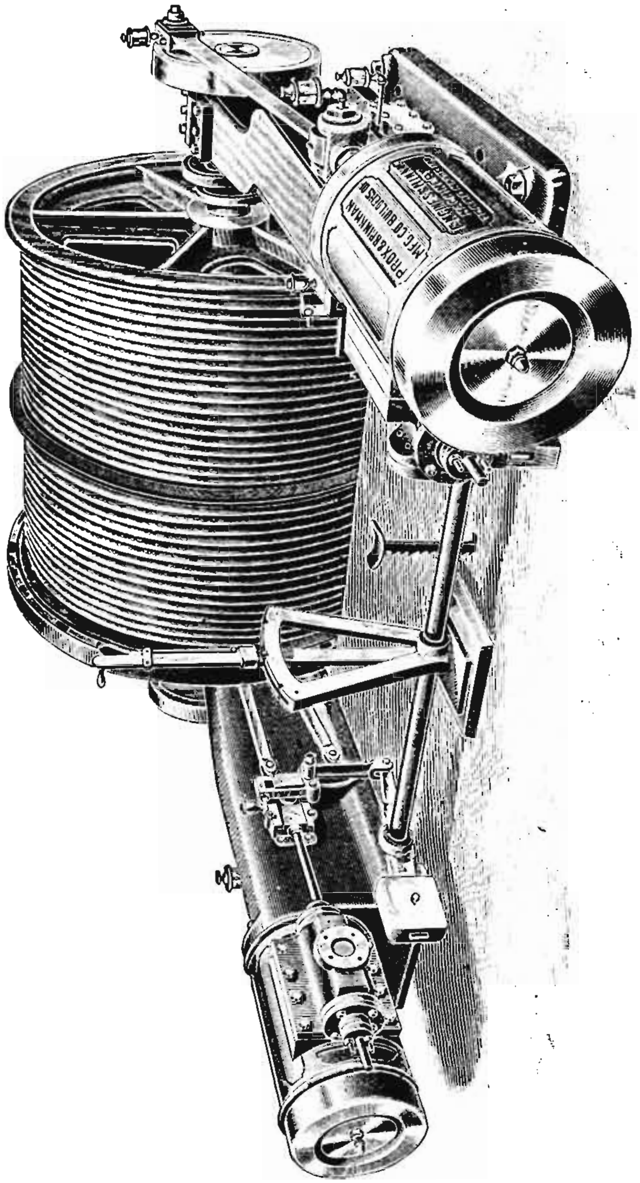


Fig. 982. Type of hoisting engine commonly used in Indiana. Kindness of Prox & Brinkman Manufacturing Company, Terre Haute.

axle, which raises or lowers a pointer, the engineer knows where the cages are. Improved dials and other pointers are also in use to a small extent.

The next improvement is in self-dumping cages. In the smaller mines the car is hauled off from the cage on to a platform, dumped and returned to the cage, or, sometimes, to save time for the cage, the platform is arranged so that as a full car reaches the top and is hauled off from one side, the car which preceded it, now empty, is pushed on from the other side; then, as the cage descends, the full car is emptied and pushed around to the opposite side of the shaft ready to be put on the cage as soon as it reaches the top. With the self-dumping cages, they are usually arranged so that, as the cage with the car which it holds fast approaches the top, a trigger or guide throws or allows it to fall forward, emptying the car of its load. See Plate XC. The starting of the cage downward throws the platform and car back into position. At the foot of the shaft is usually a group of "pit men," whose duty it is to load the full cars on to the cages and unload the empty cars. When the full car is loaded on to the cage the engineer is signaled by pulling a wire.

The law throws many safeguards about the shaft. Thus, requiring a certified engineer at the hoisting engine, the use of a prescribed set of signals, slow hoisting when men are on, not more than six men to ride at once, no one to ride on a cage when it is hoisting coal, the frequent examination of the rope, safety catches on the cages, gates at the head of the shaft and at any landings other than the lowest, a passage around the shaft if it is used from both sides, etc.

Where mining is carried on more extensively than in this State, double-deck cages are often used.

In this connection the writer is led to ask the suggestive question: Why could not, at least in some cases, the usual large and expensive hoisting shaft be replaced by a much smaller shaft through which the coal is hoisted by means of a conveyor? Such conveyors are already used on a small scale for elevating small coal at the tipples of many of the mines, and they can be and are made to do all kinds of heavy work.

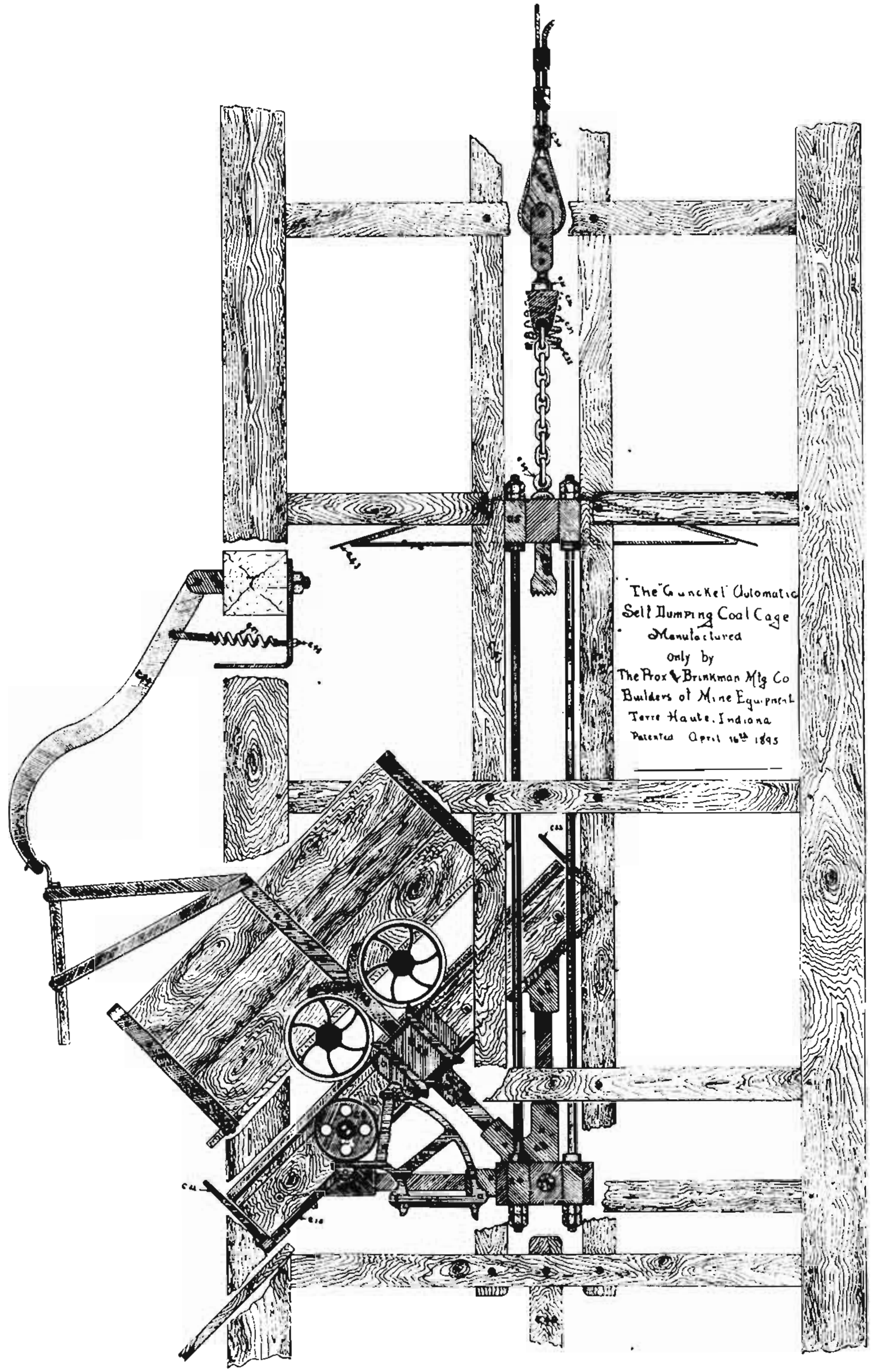


PLATE XC. Diagram showing action of one of the self-dumping cages used at many of the mines in Indiana. Kindness of Prox & Brinkman Manufacturing Company.

XLVI. PREPARING COAL FOR MARKET AND MARKETING IT.

2191. SCREENING THE COAL.—While for some purposes the coal is used just as it is mined, known as run-of-mine, as a rule it is desired by the trade sorted according to size. This is accomplished by screening. In the smallest mines this is done by the use of tined forks instead of shovels or by sticks nailed lengthwise on a frame an inch or two apart, and that being set up at an inclination, the coal is

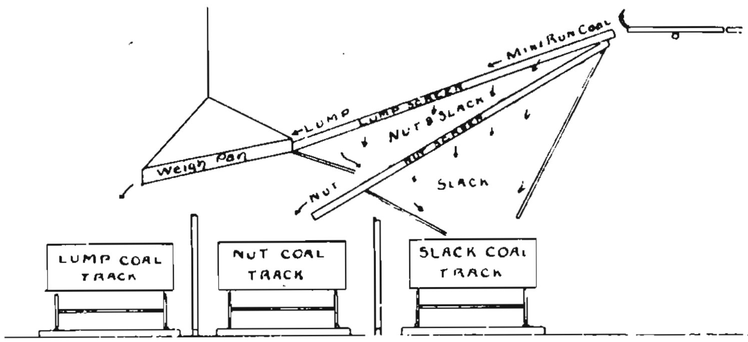


Fig. 983. Diagram showing manner of screening and delivering coal to cars in ordinary practice in Indiana.

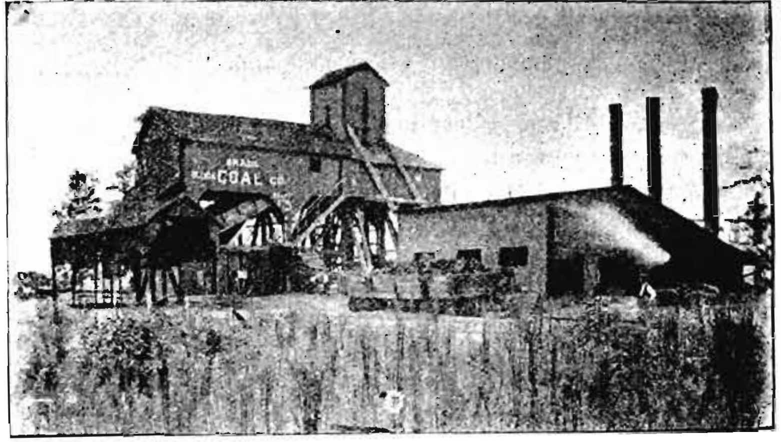
dumped over it, the finer coal passing through, being known then as screenings or slack. It is then but a step to the use of iron bars set a standard distance apart. In common practice two sets of bars are used separating the coal into three sizes. The first set of bars are set one and one-fourth inches apart, and all coal that passes over them is known as "lump coal." The coal that passes through then falls on another set of bars placed three-fourths of an inch apart. The coal that passed through the first screen but over the second is known as "nut" coal. What passed through the second screen is known as "screenings" or "slack." The arrangement of these screens and the way the coal is delivered to the cars is shown in Fig. 983.

As the screenings not only separates the coal into different sizes, but to a certain extent serves to separate the smaller pieces of shale ("slate") and pyrite ("sulphur"), it is becoming more and more a matter of economic importance that this screening be done as well as possible. This has led to the introduction of improved screens.

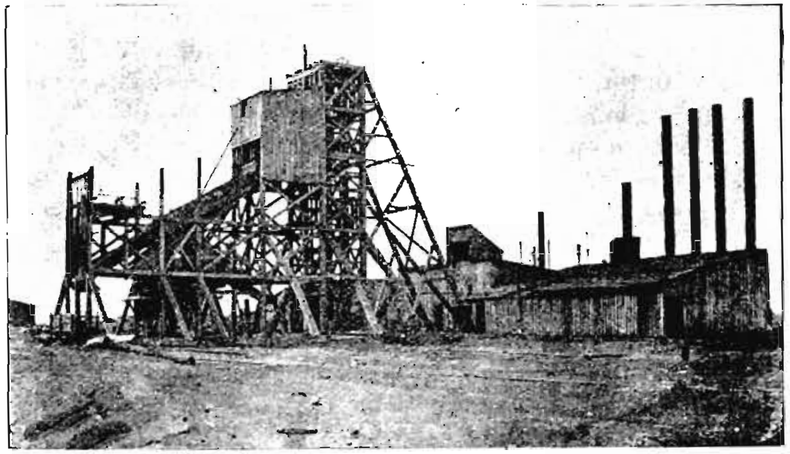
In this State these screens are of two kinds, shaking and revolving. In the shaking screens they are suspended near the ends by short rods with freedom of oscillation, and a slight shaking motion is given them by a small engine through the medium of eccentrics. Various devices are resorted to to counterbalance the motion and to prevent the shaking of the frame work or building. In the revolving screen the screen is made in the form of a cylinder arranged to revolve in a nearly horizontal position, the coal being delivered at one end of the cylinder and what is too large to pass through the mesh passes out at the lower end. The revolving screens are used especially in separating the smaller sizes of coal. With the shaking and revolving screens only a small angle from the horizontal is required, and the coal is delivered to the cars in an almost steady current. These screens are usually made of punched sheet iron. By these screens, by a simple change of plate, there can be obtained a considerable range of sizes. Thus, the coal may be delivered all over 6 in. or over 4 in.; over 4 and under 6 in., etc.

In common practice the coal cars are carried by the cages to a height of 25 or 30 ft. above the ground, where they are drawn off by hand on to a platform, then pushed forward a short distance to a short tipping platform, which, being supported on an axle, allows the car to swing forward and empty its load over the screen. This platform, the tipping platform, screens and weighing apparatus are all usually enclosed, and form together what in this State is commonly known as the tipple. Where self-dumping cages are used the platforms are not needed.

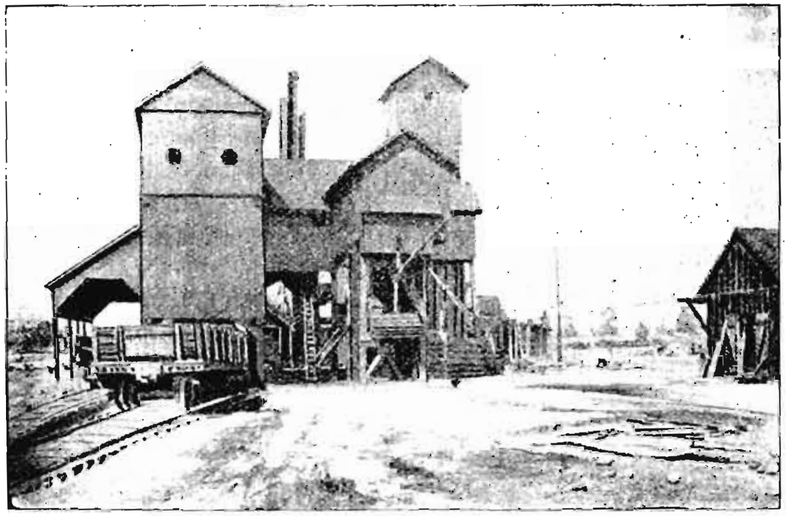
2192. Weighing the Coal.—By legal enactment the coal is required to be weighed run-of-mine. The statute having been found invalid by the supreme court, the usual practice is to weigh only the lump coal. It is, of course, understood that the miner is paid according to the weight of coal sent out by him. Each miner has a number, and when he sends a car out he hangs a metal tag with his number on a hook on his car. In some cases the coal is weighed before being dumped, platform scales being placed in the way between the top of the shaft and the tipping table. In other cases where self-dumping cages are used and it is desired to weigh run-of-mine, the coal is first dumped into a weighing pan suspended from a scale beam. After being weighed the end is raised and the coal allowed to pass on down over the screens. Probably the most common method is to have the suspended weighing pan at the bottom of the first screen, so that it receives all of the lump coal, which, being weighed, is allowed to run



Brazil Block Coal Co.'s shaft, No. 5, at Cardonia, Clay county.



Harrison mine, at Hymera, Sullivan county.



Brazil Block Coal Co.'s shaft, No. 1. (See Plate LXXXI.)

Plate XCI. Types of head works of shaft mines in Indiana.

into the car. Still another method frequently used is to have the car for lump coal stand on a railroad platform, and as each mine car is emptied over the screens the added weight of lump is credited to the man whose number is attached to the car. The law gives the miners the privilege of employing one of their own number to assist in the weighing and serve as their representative to secure correct returns. He is known as the check weigh-man. It is also required that the scales be tested each morning.

2193. Washing and Cleaning the Coal.—Competition and a more exacting trade are constantly leading to better methods of freeing the coal from shale and pyrite. It is still true that in most of the mines the freedom of the coal from these impurities is secured first through the watchfulness of the miner in his room, he being expected to throw out any foreign matter found in the coal, and of what escapes him of the larger pieces much is thrown out by the man who attends to the loading of the railroad cars or "flats." With the shaking screens the coal passes slowly and gives a good opportunity for the removal of the shale. In rare cases boys are employed to pick over the coal as it passes over the screens.

The greatest proportion of impurity, however, is to be found in the smaller sizes of coal, and it is for the cleaning of these that the washer is introduced. This depends for its action upon the difference in specific gravity of coal and the foreign substances. Thus, Indiana coal will average in weight about 80 lbs. to the cubic foot, "slate" twice as much, and pyrite four times as much. If thrown into water all will sink. If, however, the water is rising, the coal will be kept at the surface, though the others will still sink, if the current be not too strong. In practice, in this State, a common form of washer consists of a hopper or inverted cone-shaped box, arranged so that water enters at the bottom and flows off at the top, thus producing an upward current of the required strength. The fine coal being carried by endless conveyors from the tipple is emptied on to the surface of the water in the hopper. As these start to sink, the upward current carries the coal back to the surface while the heavier impurities continue settling to the bottom, from whence, by means of valves, they are drawn off from time to time. The coal is carried off by the escaping water at the top on to a screen, which allows the water to escape while the coal is passed along. Then by means of conveyors it is carried to revolving screens, where it is separated into as many sizes as desired. From these it may be conveyed to bins, which serve for storage unless the demand is steady. In many cases the coal

is crushed before going to the washer. Where water is scarce the same water is used over and over. In some cases the waste goes into a crusher, after which it is returned to the washer. In this way some of the coal which contains so much sulphur as to sink when first passed through is broken up so that the coal can be separated and a saving effected. (See Fig. 984.)

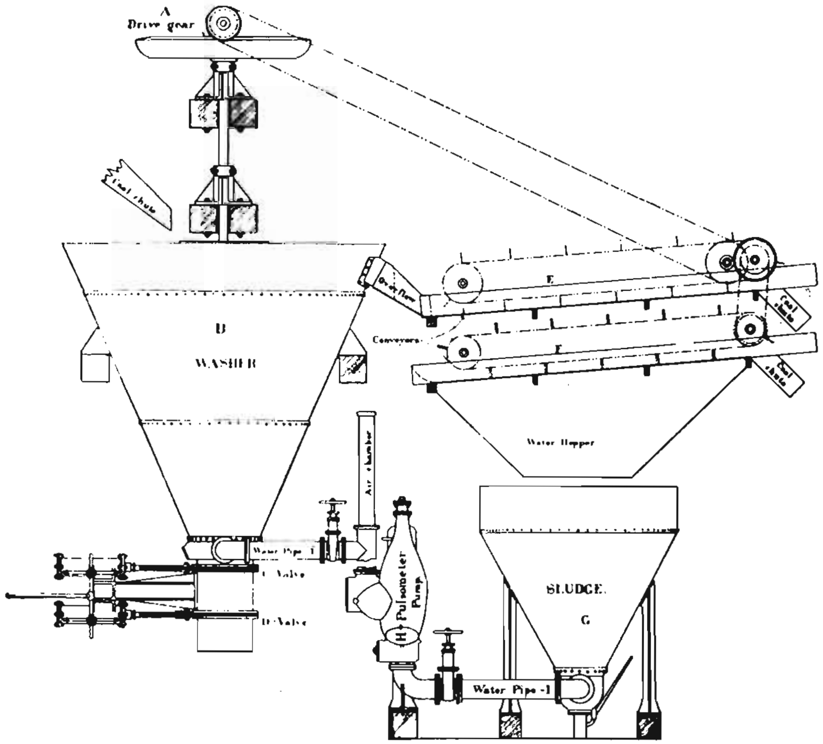


Fig. 984. Diagram of washing plant and accessories, illustrating the main features of the plant at Cox No. 3 mine. Kindness of the Jeffrey Manufacturing Company.

The impure caking coals, when crushed and washed, are found to answer many purposes for which it was formerly necessary to use the much purer block coal.

2194. Transportation from the Mines.—As a rule, the coal is loaded directly from the tipple into railroad cars. These hold 20 or 25 tons, the latter predominating. There is a tendency towards the use of greater and greater carrying capacity, so that cars holding 30, 35, 40 or even 50 tons are becoming common.

In some cases the mines are situated close to the main track of some railway, and a very short switch is all that is necessary. In other cases the mines are situated eight or ten miles from a railway, and switches have to be built. Usually switches to single mines are not over three or four miles long. Where a group of mines can be reached or approached by a single switch, and the conditions seem to warrant a large output, long switches are used. Thus, the Stringtown, Fountain county, mines were reached by a switch from Danville, Ill., which had to cross the Wabash river. Of the longer switches may be mentioned the New Pittsburg switch, or "branch," in Sullivan county; the Caseyville branch in Vigo, Clay and Parke counties; the Center Point branch, in Clay county; the Linton and Dugger branch, in Greene and Sullivan counties. These range from five to twenty miles long. It is a common practice for the railway company to furnish the rails, while the mine owners furnish the ties and grade the proposed switch. There are usually three and sometimes four tracks under the tipple, unless it is a double one; that is, one that loads on each side to switches from different roads, when there are more. The empty cars are run past the tipple, and run back under the tipple by gravity, as they are wanted. A few of the coal companies own or lease locomotives to do the switching about the mines. Such locomotives are either old engines leased from the railroad company or "pony" engines obtained for the express purpose.

As a rule, the railway company furnishes the cars and does the switching; in a few cases the mine operators have owned the cars used.

In some cases coal is drawn to the railway from the mine in the mine cars. About half a mile is the longest haul of that kind observed.

Lack of railroad transportation is the one element that perhaps more than any other prevents the development of many of the mining regions of the State. In some few cases these are not far from railroads, but are so placed with reference to surface topography that the natural difficulties attending the building of a switch at that point have hitherto prevented the undertaking. In other cases these areas are at some distance from the railroad. In either case the suggestion is made that connection might be made by means of an electric tramway. As is well known, an electric motor can climb hills or take curves entirely impracticable to an ordinary locomotive. Such a tramway could therefore be built at a small part of the cost of a standard gauge switch, and in places impracticable for the latter. Such electric haulage might be but an expansion of haulage system in the mine, or it might be limited entirely to outside haulage. Where the haul is a long one, a group of mines may be served, and during the dull season, merchandise and farm products might help out on the cost of operating the road, or, if it is independent of the mines, as an additional source of profit. In Pennsylvania the mine cars are often drawn from one to five miles before being emptied, steam mine engines often supplying the power.

XLVII. UTILIZATION OF WASTE PRODUCTS.

2195. MANUFACTURE OF FUEL GAS.—Under the head of utilization of coal is discussed the manufacture, transportation and utilization of fuel gas, and the conclusion is there reached that, with the methods now being introduced, gas making for fuel purposes can be successfully carried on in the Indiana coal field for the supply of the rest of the State. If so, the problem of utilizing all of our friable coals would seem to be largely solved. With most of our coals it is doubtless true that they will require washing before using for this purpose.

2196. COKING.—This has also been discussed under the head of utilization of coal, which see.

2197. BRIQUETTE MAKING.—Of the mines of the State having more fine coal or slack than can be disposed of, many find that such slack will not produce a marketable coke, and many of the block and semi-block coals will practically not coke at all. A method of utilizing such coal would seem to be by making it into briquettes.

Briefly, this consists in grinding the fine coal in specially prepared machinery; then in washing this fine material; then in cementing it with different substances, one of the most successful being a mixture of tar, oleine and soda; others are pitch and magnesia cement; 100 or 200 lbs. of such a mixture is added to a ton of wash slack or culm, the mixing being very thoroughly done by a sort of pug-mill at a suitably high temperature, and the whole then pressed into brick-like or small blocks, or into ovoid or egg-shaped eggettes. The hydraulic press principle is used in producing most of the cubical, oblong or irregular forms. The eggettes are produced by running the material between heavy rolls whose faces have corresponding semi-oval shaped cavities. Briquettes are extensively made in Europe, though only to a small degree in this country. Some of their advantages are that a greater weight can be neatly packed in a given space, can be easily handled, stored or transported. When properly made, they produce no smoke in combustion and but little ash, and for domestic purposes have many of the advantages of anthracite coal.

Briquettes usually make a hotter fire than coal. They are successfully used in the production of gas, producing a much richer illuminating gas than is generally made from coal, and that notwithstanding the cheap and inferior material used. The suggestion is made, though I do not know of its having been tried, that the non-caking coals which we are especially discussing, when treated with tar or some such mixture as mentioned above, might produce a desirable coke. Experiment with anthracite culm is found to make a stronger coke than any other coke.

The chief advantage of briquetting in this State, however, would seem to be as a method of utilizing what otherwise might be wasted and to compete with anthracite for domestic use.

2198. Powdered Coal.—A method of utilizing fine coal which is proving very successful with anthracite culm is to grind it to a powder and feed it into the furnace through a pipe, mixed with air in a blast. This does away with grates, opening and closing furnace doors, with the cooling which results, and where properly prepared, secures very complete combustion of the coal. This is offset to a greater or less extent by the cost of grinding the coal to a dust.*

This coal dust has also been successfully utilized in burning brick by kneading with the clay, whereby a considerable saving is effected in amount of fuel used and in the time of burning.

2199. Utilization of Under-Clay or Shale.—The great increase of late years in the usage of clay products—as in paving brick, roof tile, hollow tile for building—makes suitable clays and shales marketable articles. Such clays sometimes sell for almost as much as the coal. In many mines it is necessary to take up a foot or two of the underlying clay, the handling of which, particularly if it has to be taken from the mine, may involve considerable expense, as well as greatly reducing the efficiency of the shaft. It might, therefore, pay well to have tests made of the clay as to its suitability for the manufacture of some clay product. In this connection it should be remembered that very different qualities are demanded for clays used for different purposes. Thus, a clay that was shown by test to be undesirable for vitrified brick, might prove very desirable for tile. Often

*Combustion of Coal, W. M. Barr, p. 239; Indianapolis, 1879.
Science, Dec. 28, 1888.
Ann. Rep. of Chief U. S. Bureau of Steam Engineering for 1876.

something that may be lacking in the clay may be easily supplied by mixing a small quantity of some other clay with it. Thus utilized, it will usually not only pay for its removal, a clear saving, but will also pay for its preparation and marketing, with a profit besides.

Many coal beds of excellent quality which are too thin to work by themselves will become available if worked in connection with their accompanying clay or shale.

2199a. Utilizing the Bituminous Shales or Bone Coal.—A large number of the coal beds have closely associated with them black bituminous shale, or less often bone coal. A few of the beds are almost invariably overlain by from one to several feet of the bituminous shale, while bone coal one or two feet thick often underlies or overlies certain coal beds over large areas. Such shales or bone coal are usually rich in gas, if distilled at a high temperature, or in oils if distilled at a low temperature.

In 1895 a test was made at the New Albany gas works of the black shale of Devonian age occurring there. The gas obtained was richer than from Pittsburg coal, and the yield 45 per cent. as much. An analysis of the black shale at New Albany by Mr. Hans Duden showed:

Volatile organic matter	14.16
Fixed carbon	9.30
Water	.50
Ash	76.04

Analyses of the bone (cannel) coal or roof shales overlying some of the coal beds, by Mr. Cox, show as follows:

Volatile organic matter	25.00	32.00	25.00
Fixed carbon	28.00	34.00	39.00
Water	5.50	7.50	4.00
Ash	41.00	26.00	32.00

An examination of these analyses shows about double the percentage of gas that was found in the New Albany shale, and from three to over four times the amount of fixed carbon, with correspondingly low amounts of ash.

Such shales, to be economically employed, would require specially designed and constructed plants, and would, of course, yield no coke. Analyses would indicate that in such specially prepared plants as used in some parts of Europe a ton of some of these bone coals would yield as much gas as a ton of Pittsburg coal, and of much higher illuminating power, the reduced cost of material more than offsetting the value of the coke now produced. This, of course, is largely an assumption, based on what is or has been done elsewhere, and has yet to be proven for this field. It is, however, given as a suggestion which might lead to the utilization of what is now a waste product at the mines. It is also possible that the coke left in the process might be used in the manufacture of producer or water gas.

XLVIII. THE FINANCES OF COAL.

James Epperson and George H. Ashley.

NOTE.—The major part of the labor of this chapter, that of collecting the data, is principally the work of Mr. Epperson. It had been expected that he would also arrange the matter collected, but it was found that, with his other work, it would be impossible to have it ready when the rest of the report went to press.—G. H. A.

2200. The various items to be considered may be taken up under the following heads:

I. Cost of coal in place.
II. Cost of opening and equipping mine.
III. Labor cost of coal at the mine.
IV. Operating materials, etc.
V. Office expenses.
VI. Summary of cost of coal on car at mine.
VII. Selling price at mine.
VIII. Cost of transportation.
IX. Selling price at important points.
X. Summary of cost of a ton of coal.
XI. Outside items.
XII. Earnings of miners.

I. Cost of Coal in Place.

2201. (a) Royalty Paid in Different Parts of Indiana.—The value of unworked coal in the ground is usually taken as the royalty paid for it when extracted. This varies greatly at different places and has shown a steady tendency to decrease. In the early days of the block coal field much coal was worked on which a royalty of 20 cents a ton was paid. Mr. Cox, in his report on Clay county, p. 61, in estimating the value of block coal, valued it at 1 cent a bushel, or 25 cents a ton. Whether such a valuation was based on royalties paid, he does not state. In his report on Greene county, and in Mr. Collett's report on Sullivan county, they give $\frac{1}{2}$ cent a bushel, or a shilling a ton, as the royalty then paid in those regions. Some of the mines in the same area to-day are paying from 3 to 5 cents a ton mine run. A shilling a ton is still not an uncommon royalty for small mines, but at present few of the large mines pay over 10 cents a ton. While exact data were not obtained, it is probable that the major part of the coal mines under recent leases does not pay over 5 or $6\frac{1}{4}$ cents a ton of screened coal. In the south part of the State royalties even run below that, perhaps the lowest noted being in Gibson county, 3 cents a ton of screened coal. In Pike and Warrick counties, $3\frac{1}{8}$ cents a ton, equivalent to $\frac{1}{8}$ cent a bushel of mine run coal, is often the royalty, some of the mines, however, paying double that. The former royalty ten or twelve years ago, according to Mr. Woolley, was from $\frac{3}{8}$ to $\frac{1}{2}$ cent on mine run coal.

2202. (b) Value of Coal Lands.—No reliable rule can be laid down as to the value of coal lands, nor were sufficient data obtained to show how coal lands vary in price over the field. In a general way, lands that sell for from \$30 to \$60 an acre without coal will sell at from \$40 to \$100 an acre where known to be underlain with coal. But many factors influence this. Lands at some distance from railroads or working mines may often be obtained very cheaply, as at \$25 an acre or less, while coal lands adjoining properties being worked may be held at a very high figure. When it is recalled that an acre of ground containing a 5 ft. bed ought to yield at least 6,000 tons of coal, which at 5 cents a ton would give a royalty of \$300, or at 10 cents a ton a royalty of \$600 an acre, it is evident that lands that seem bound to be worked within a very few years are often held for a large fraction of the estimated royalty on the coal under them.

In general, it may be safe to say that on the average the owner of the coal is paid 4 or 5 cents a ton.

II. Cost of Opening and Equipping Mine.

2203. It has not been possible to get estimates for all the items that come under this head. As suggestive of some of the more important expenses to be met, the various items that have occurred to us are mentioned, and where figures have been obtained they will be given.

2204. (a) Cost of Drilling, Surveying, Locating Lands, Recording Deeds, Leases, Etc.—This preliminary work varies greatly in cost. There are many cases in Indiana where entries have been driven or shafts sunk without any preliminary drilling, and in such cases the cost of these items has been merely nominal. On the other hand, most of the older companies have found as a result of their experience that money expended for such preliminary exploration generally gives very high returns. Mr. Hamilton Smith, in a letter published in the State Agricultural Reports for 1856, in speaking of the operations of the American Cannel Coal Company at Cannelton, says: "This does not include the expense attending surveys, experimental shafts, borings, levelings and engineering generally, wherein this company have expended at least twenty-five thousand dollars, from first to last, and perhaps have lost more than that sum by not employing competent coal viewers and making the necessary preliminary examinations at an earlier period." Further on he mentions cases of losses due to these causes. In one case, after $20,000 had been expended, it was found, after a month's work, that the coal could not be worked for lack of suitable roof.

2205. (b) Cost of Land for Surface Plant.—Whether the coal to be worked is leased or purchased, it is usual for a coal company to own the land upon which is situated the shaft and other buildings, comprising what is known as the surface plant. It may be safe to say that from five to ten acres are usually owned for such a purpose. Some plants located next to a right of way to a railroad may often get along with much less. Land for this purpose may then be reckoned at from $200 to $1,000. In some cases the land is given by the owners of the coal, in order to have the coal worked.

2206. (c) Cost of Lease of Right of Way for Switch.

2207. (d) Cost of Sinking Shaft.—In a general way, it may be said that the cost of sinking the shaft will run from $5 to $50 a foot. At one of the mines over 100 ft. deep the labor cost $11 per foot.

Where the work is done by the day the cost will generally depend on the character of the rock gone through. The surface material, while easier to sink through in some ways, generally requires immediate timbering, and this adds to the time required and expense. Where the ground is fairly dry and solid, the shaft timbers, perhaps 10 by 12 in., may be set from 1 to 3 ft. apart and lagged behind with 2 in. plank. Where the ground is soft and wet, the timbers require to be set skin to skin, and in some cases it has been found necessary to put a shoe on the lowest timbers, sinking them in the method usually adopted for sinking caisson. Such soft ground usually increases the cost of sinking to a considerable extent, and when combined with large bodies of water, has in several cases in this State led to the abandoning of shafts partly sunk and the selection of new sites. Where a shaft encounters considerable water it may be necessary to sink small auxiliary shafts into which the water may be led from the main shaft, and from which it may be pumped. These items are mentioned as showing a few of the additional items of expense that may not be calculated upon in first estimates. The writer recalls cases in this State where peculiarly hard rock has been encountered, and shafts are said to have cost over $40 a foot for short distances. In a general way, it may be safe to count on the sinking, timbering and setting of guides of a shaft to average about $20 a foot. Mr. Hamilton Smith, writing from Cannelton in 1856, says: "For shafting and purposes of ventilation or proving coal, we usually pay $1 per foot for the first thirty feet, increasing 50 cents every ten feet."*

2208. (e) Sinking Air Shaft and Escape.—In this, much the same conditions have to be met, except that the shaft is smaller, and as it is frequently not dug until the mine is in operation and equipped with pumps, etc., it is sometimes possible, by drilling to the workings below, to draw off any water encountered without so much difficulty as in the first shaft. One such an air shaft, 5 by 7 ft., was sunk to between 200 and 300 ft. at a contract cost of $8 per foot. At another mine a 50 ft. air shaft and manway cost $1.50 a foot. Occasionally tunnels are used in mines working two beds; one such, 120 yds. long, cost $1,000.

2209. (f) Erection of Tipple and Equipment.—This should include tipple frame and cover, braces, sheaves, screens and weighing pans, scales and scale houses. The only estimate at hand is one made by Mr. Carrol, which gives the cost of "tipple, blacksmith shop, etc.,"

* Indiana Agricultural Reports, 1856, p. 538.

at $1,300. It is not known just what items this will include and what not. If improved screens are used, the cost will, of course, be much higher. Mr. Carrol estimates shaking screens in two sections with eccentrics set on driving shaft 180° apart, to counteract vibration, and having a 5 in. stroke, with engine complete, about $1,250. This may also include revolving screens, conveyors or elevators, etc.

2210. (g) Scales will vary from $75 to $1,000 for the more expensive railroad scales. At one of the mines the screens and scales cost close to $200. At another mine scales alone cost $250, while railroad scales are quoted at from $700 to $1,000.

2211. (h) Cages.—These vary greatly, from the simple platform built by the mine blacksmith and carpenter to the more elaborate and expensive self-dumping cages. (See general estimate.)

2212. (i) Boilers and Housing.—Mr. Carrol estimates the cost of four plain shell boilers 40 in. by 30 ft., with house and brickwork complete, at $1,500. To this should be added pond and piping for water supply, tracking from shaft for coal supply, etc.

2213. (j) Hoisting Engines, Cables, Etc.—Mr. Carrol's estimate for hoisting engine, ropes, self-dumping cages, including engine foundation, is $2,800. A double hoisting engine at one of the mines cost $1,200. In another case a 40 H. P. single engine cost $300.

2214. (k) Blacksmith Shop and Accessories.

2215. (l) Powder House.

2216. (m) Fan and Engine, Fan House.

2217. (n) Pumps and Piping.—At one of the mines two pumps cost, respectively, $165 and $190. At one of the mines using six pumps in and around the mine, two of these cost $1,000. In another case a duplex mine pump, 7 by 4 by 10, is quoted at $136.

2218. (o) Switch to Connect with Railroad.—Grading and ties usually furnished by mine operators, and often rails, the latter, and sometimes the former also, to be returned in rebates on shipments. Making cuts and fills will vary from 10 cents to $1 a yard, according to material and conditions. In one case a switch 1,100 ft. long, on very level ground, cost $190 for grading, and ties $200.

2219. (p) Mine Cars.—Mr. Hamilton Smith gave the price of 20-bushel cars in 1856 as about $25. At one of the mines using 150 cars for a daily output of 350 tons the cars cost $22 each, or $3,300

for the mine. At another mine, with an output of 250 tons a day, 40 cars are used, costing $17 each, or $680.

2220. (q) Mules and Stables.

2221. (r) Equipment with Mining Machines.—See general estimates.

2222. (s) Equipment of Power Drill.

2223. (t) Equipment with Rope or Electric Haulage.—See general estimates.

2224. (u) Equipment with Washing Plant.

2225. (v) Equipment of Storage Bins.

2226. (w) Fencing, Telephone to Main Office, Etc.

2227. (x) Equipment of Main Office.

2228. (y) Company Store and Stock.

2229. (z) Estimates of Cost of Opening Actual Plants.—........ mine, shaft about 50 ft. deep, average equipment, pick mine, bar screens, mule haulage; cost of tipple, machinery and sinking shaft, a little over $14,000.

.... mine, shaft about 50 ft. deep, well equipped for large outputs, mining machines, improved screens, self-dumping cages, etc., etc.; machinery estimated to have cost, when new, $10,000.

.... mine, slope; tipple and machinery, about $18,000.

.... mine, shaft about 250 ft. deep, including air shaft, and all ready to ship coal, $32,000.

.... mine; electric equipment alone is given as costing as follows:

1 dynamo, 135 H. P., 250 volts, 400 amperes	$1,400
1 dynamo engine	1,000
2 motors at $1,200, 35 H. P., 7 tons	2,400
3 mining machines at $1,000	3,000
Belt and switch-board	300
1 fan, electric	125
1 pump, electric	125
Total	$8,350

This is in addition to:

1 double hoisting engine, 65 H. P.
1 single engine, 20 H. P., to run elevators to carry coal to boiler-room.
1 single engine, 35 H. P., for short rope haulage.
6 boilers, 10-ft. steam fan and engine, self-dumping cages, etc., etc.

Mr. Hamilton Smith, writing in 1856, says: "The cost of opening a coal mine by an 'adit level,' preparing the galleries and entries for delivery of say three thousand bushels daily, building inside and outside cars, purchase of mules and erection of necessary buildings, construction of railroads not over one mile in length, and all prepared for permanent and economic use, will range here on the Ohio river from say $40,000 to $60,000." (This does not include borings, surveyings, etc.)

2230. In 1897, 124 mines yielded a product of 4,078,085 tons of coal, which is estimated to represent an invested capital of $1,600,000, or about $12,000 as the average capital invested in each mine. Judging from such data as were obtained, this estimate is much too low. The data obtained suggest that to open and equip a mine with shallow shaft, simple but good machinery, for a daily output of 200 tons, will hardly cost less than $10,000, and may cost much more; while to open a deep mine and equip it throughout with modern machinery may cost from $50,000 up.

In 1897, it will be observed according to the estimate given above, one ton of coal was mined for every 37 cents of capital represented. At 6 per cent. this represents a cost of a little over 2 cents a ton. Taking individual cases, we find that the interest at 6 per cent. on investment runs from 2.6 cents per ton to 4.5 cents per ton, with an average of 3.7 cents. It would therefore seem safe to take 3 cents a ton as representing the interest on equipment.

2231. Costs of machinery, of course, are readily obtained from the manufacturers, to which must be added the cost of setting up, etc. To indicate how rapidly such items as the last mount up, the following itemized account of the cost of setting up a dynamo and engine is appended:

The pit for the engine foundation is 15 ft. long, 9 ft. wide, 7 ft. deep, and cost to excavate it	$10 00
10,000 brick at $5.50 per thousand, for engine foundation	55 00
Freight on brick, $12.50; sand, $1; hauling sand, $2; screening, $2	17 50
Cement and freight	39 00
Masons and helpers	23 33
Unloading engine from car	8 50
Placing on foundation	4 00
Polishing engine	2 86
	$160 19

The pit for generator foundation is 6 ft. long, 8 ft. wide and 7 ft. deep, and cost to excavate	$6 45
4,000 brick at $5.50 per thousand for foundation	22 00
Freight on brick, $5; cement and freight, $14	19 00
Sand, 50 cents; hauling sand, $1; screening, $1	2 50
Mason and helpers	10 08
Unloading generator from car	4 00
Placing on foundation, $2; polishing and sandpapering, $5.55	7 55
Total	$71 58
Setting up engine	160 19
Setting up generator	71 58
Total	$231 77

III. Labor Cost of Coal at the Mine.

2232. (a) For Narrow Work.—Before the coal can be regularly mined, there is always a certain expense for narrow work, entries and the necks of rooms. As the entries are constantly being extended and new rooms being turned, this becomes a regular source of expense, as not only is the coal paid for at the regular rates, but a given amount extra, known as yardage. At present, in the bituminous coal field, this amounts to $1.37 per yard for entries 7 to 9 ft. wide and down to 84 cents for 12 ft. entries for pick work, and for machine work 98 cents and 61 cents, respectively. The turning of rooms costs $3.30 for pick or 98 cents for machine mining, varying, of course, according to width or length. The amount of yardage differs greatly at different mines, but, figured down to cost per ton of coal of output, came, for the data at hand, to from 1.6 to 2 cents a ton. Perhaps the latter figure would be safe. This does not include tracking, etc.

2233. (b) Laying Track, Ditching, Brushing Roof, Etc.—This will be considered in connection with the subject of day labor about the mine.

2234. (c) Mining and Loading Coal.—In his letter in 1856, Mr. Hamilton Smith gives the following list of prices paid at that time at some points in Indiana and elsewhere:

Hawesville, Ky.	2¾ cents per bushel=68¾ cents a ton.
Uniontown, Ky.	4 cents per bushel=100 cents a ton.
Cannelton, Ind.	2½ cents per bushel=62½ cents a ton.
Newburg (Warrick Co.?)	3½ cents per bushel=93⅜ cents a ton.
Brazil, Ind.	3½ cents per bushel=93¾ cents a ton.
St. Louis, Mo.	4 cents per bushel=100 cents a ton.
Breck'ridge, Ky. (Cannel)	5 cents per bushel=125 cents a ton.

2235. At the time of the strike in 1897 the prices paid in Indiana were as follows:

BITUMINOUS.—Screened lump, generally 56 cents per ton, same as Ohio; over diamond bar screen, with 1¼ in. spaces between bars; bars mostly 1 in. square, set on edge.
In southern Indiana, flat bars 1½ in. between, as equivalent to 1¼ in. spaces diamond setting.
Run of mine price optional with operators, based on proportion of screenings.
Brazil Block.—Coal 3 ft. 1 in. thick and over, 66 cents per ton, lump; coal 2 ft. 10 in. to 3 ft. 1 in., 71 cents per ton lump; coal under 2 ft. 10 in., 76 cents per ton lump; over screens, 72 ft. superficial area, diamond bars, 1¼ in. apart.
Indiana day's work, nine hours.

2236. Following the strike a new scale was agreed upon, and, as that scale is still in force when this report goes to press, it may be well to give the agreements entered into at Chicago and subsequently at Terre Haute and Brazil. They are as follows:

THE AGREEMENT.

Contract between the Operators of the Central Competitive Coal Field and the United Mine Workers of America.

Chicago, January 28.

The following agreement, made and entered into in joint interstate convention in this city (Chicago, Ill.), January 26, 1898, by and between the operators and miners of Illinois, Indiana, Ohio and western Pennsylvania, known as the Pittsburg thin-vein district, witnesseth:

1. That an equal price for mining screened lump coal shall hereafter from a base scale in all the districts above named, excepting the State of Illinois, the block coal district of Indiana to pay ten cents per ton over that of Hocking valley, western Pennsylvania and Indiana bituminous district, and that the price of pick run of mine coal in Hocking valley and western Pennsylvania shall be determined by the actual percentage of screenings passing through such screen as is hereinafter provided, it being understood and agreed that screened or run of mine coal may be mined and paid for on the above basis at the option of the operators, according to market requirements, and the operators of Indiana bituminous shall also have like option of mining and paying for run of mine or screen coal.

2. That the screen hereby adopted for the State of Ohio, western Pennsylvania and the bituminous district of Indiana shall be uniform in size, six feet wide by twelve feet long, built of flat or acorn-shaped bar of not less than five-eighths of an inch surface, with one and one-fourth inches between bars, free from obstructions, and that such screen shall rest upon a sufficient number of bearings to hold the bars in proper position.

3. That the block coal district of Indiana may continue the use of the diamond screen of present size and pattern, with the privilege of run of mine coal, the mining price of which shall be determined by the actual screenings, and that the State of Illinois shall be absolutely upon a run of mine system, and shall be paid for on that basis.

4. That an advance of ten cents per ton of 2,000 pounds for pick mined screened coal shall take effect in western Pennsylvania, Hocking valley and Indiana bituminous districts on April 1, 1898, and that Grape Creek, Ill., and the bituminous district of Indiana shall pay 40 cents per ton run of mine coal from and after same date, based upon 66 cents per ton screened coal in Ohio, western Pennsylvania and the Indiana bituminous district, same to continue in force until the expiration of this contract.

5. That on and after April 1, 1898, the eight-hour work-day, with eight hours' pay, consisting of six days per week, shall be in effect in all of the districts represented, and that uniform wages for day labor shall be paid the different classes of labor in the fields named, and that internal differences in any of the States or districts, both as to prices or conditions, shall be referred to the States or districts affected for adjustment.

6. That the same relative prices and conditions between machine and pick mining that have existed in the different States shall be continued during the life of this contract.

7. That present prices for pick and machine mining and all classes of day labor shall be maintained in the competitive States and districts until April 1, 1898.

8. That the United Mine Workers organization, a party to this contract, do hereby further agree to afford all possible protection to the other parties hereto against any unfair competition resulting from a failure to maintain scale rates.

9. That this contract shall remain in full force and effect from April 1, 1898, to April 1, 1899, and that our next annual interstate convention shall convene in the city of Pittsburg on the third Tuesday in January, 1899.

Adopted.

For Illinois Operators—J. H. Garaghty and E. T. Bent.
For Indiana Bituminous Operators—Walter S. Bogle.
For Indiana Block Operators—C. B. Niblock.
For Pittsburg Thin Vein District Operators—J. C. Dysart, F. M. Osborne.
For Illinois Miners—J. M. Hunter and W. D. Ryan.
For Indiana Bituminous Miners—W. G. Knight and J. H. Kennedy.
For Indiana Block Coal Miners—J. E. Evans.
For Ohio Miners—W. E. Farms and T. L. Lewis.
For Pittsburg Thin Vein Miners—Patrick Dolan, Edward McKay.
For West Virginia Miners—Henry Stephenson.
Members National Executive Board U. M. W. of A.—Fred Dilcher, John Fahy, Henry Stephenson, Edward McKay, J. H. Kennedy and W. D. Ryan.
M. D. Ratchford, President U. M. W. of A.
John Mitchell, Vice-President U. M. W. of A.
W. C. Pearce, Secretary-Treasurer U. M. W. of A.

Terre Haute Agreement.

The following agreement, entered into in the joint State convention at Terre Haute, Indiana, March 26, 1898, by and between the bituminous operators and the miners of the State, witnesseth:

First. That the declaration of the contract by and between the operators of the competitive coal fields and the United Mine Workers of America, entered into at Chicago, Illinois, January 27, 1898, and at Columbus, Ohio, March 10, 1898, be, and hereby are, reaffirmed in the identical terms therein employed.

Second. That further details and scale of prices for pick and machine mining in the State of Indiana, for one year beginning April 1, 1898, shall be as follows:

Pick Mining.

Yardage.

In entries 7 to 9 ft. wide.............................. $1 37
In entries 12 ft. price shall be ⅝ of narrow work, or...... 84

Wide entries shall not exceed 13 ft., it being understood that this applies to entry work only, and not to rooms where it is necessary to run them 13 ft. wide.

Breakthroughs.

Breakthroughs in entries shall be paid for at entry price. Breakthroughs between rooms, when sheared or blocked, shall be paid for at entry price, but no breakthroughs shall be driven without the consent of the operator. Nothing herein shall interfere with strict compliance with the law governing breakthroughs.

Room Turning.

Room turning.. $3 30

Room necks to be driven 12 ft. in and widened at an angle of 45° when so desired by operator. Any distance in excess of above shall be paid for proportionately.

Machine Work.

Yardage.

In entries 7 to 9 ft.................................. $0 98
In entries 12 ft. wide, ⅝ of price for narrow entries, or... 61

When the machine runners in 12 ft. entries are paid by the day, and entry is not sheared, the shooters and loaders shall be paid two-thirds of the yardage. It is understood that this applies to entry work only, and not to rooms when it is necessary to run them 13 ft. wide.

Breakthroughs.

Breakthroughs between entries, same as entry price.

Room Turning.

Room turning.. $0 98

Room necks to be driven 12 ft. in and widened at an angle of 45° when so desired by operators. Any distance in excess of the above shall be paid for proportionately.

When room necks are driven 12 ft. wide, price shall be ⅝ of regular price, or 61 cents.

Day Work Punching Machines.

Machine cutting when paid for by the day shall be for—
Cutter $2 35
Helper 1 85

Day Work Chain or Cutter Bar Machines.

When paid for by the day shall be—

Cutter $2 35
Helper 2 11

It being understood that a day's work shall not be less than twenty-seven (27) cuts. All cuts in excess of twenty-seven (27) shall be paid for proportionately.

Price per ton for Machine Mining.

When paid for by the ton the price of coal mined with machines shall be three-fourths of the price paid for pick mined coal, or 49½ cents.

General.

It is further agreed that if any differences arise between the operators and the miners at any pit a settlement shall be arrived at without stopping of work. If the parties immediately affected cannot reach an adjustment between themselves, the question shall be referred to the President and Secretary of the United Mine Workers of America representing District No. 11, and the President and Secretary of the Coal Operators' Association of the same district, whose action shall be final; but no miner or operator interested in the differences shall be a member of said committee.

That where the coal is paid for mine run, or on screened coal basis, it shall be mined in a careful, workmanlike manner, and when loaded on the miner's car it shall, as nearly as possible, be free from slate, bone coal, sulphur and other impurities.

Payment for all labor shall be made twice per month, not later than the 10th and 25th of each month.

It is further agreed that the operators shall offer no objection to the check-off for checkweighman and for dues for the Federation, provided that no check-off shall be made against any person until he shall have first given his consent in writing to his employer. This applies to all underground day work, as well as miners.

The time of beginning work in the morning and the length of intermission at noon shall be considered a local question.

That these resolutions be compiled in the form of a contract and signed by the President and Secretary of the United Mine Workers of America representing District No. 11, and the President and Secretary of the Bituminous Coal Operators' Association of Indiana, that they be printed and a copy sent to each and every mine and posted.

In witness whereof, we have hereunto subscribed our names this 26th day of March, 1898.

W. D. VAN HORN,
President U. M. W. of A., District No. 11.

Attest: J. H. KENNEDY,
Secretary U. M. W. of A., District No. 11.

J. SMITH TALLEY,
President Bituminous Coal Operators' Association of Indiana.

Attest: J. W. LANDRUM,
Secretary Coal Operators' Association, State of Indiana.

CONTRACT.

Contract between the Operators, Miners and Laborers of the Brazil Block Coal District.

Entered into this 24th day of March, 1898, between the Operators' Scale Committee of the block coal district, and the Executive Board of the United Mine Workers of America, representing District No. 8.

First. That the declaration of the contract by and between the operators in the competitive coal fields with the United Mine Workers of America, entered into at Chicago, Illinois, January 27, 1898, be hereby reaffirmed in the identical terms therein employed.

Second. That the scale of pick mining price of 2,000 lbs. of screened block of the standard thickness shall be 76 cents from April 1, 1898, until April 1, 1899, with payment for low coal upon the following scale:

For all coal 3 ft. 1 in. and over	76 cents.
For all coal 2 ft. 10 in. and under 3 ft. 1 in	81 cents.
For all coal under 2 ft. 10 in	86 cents.

That the payment for all coal dug, and for labor performed, shall be semi-monthly within ten (10) days after the ending of each half month. It being understood, also, that the price for digging unscreened coal shall be an equivalent of the price paid for screened coal.

It is understood and agreed by both parties to continue work for the coming year, the same as has been done in the year just ending.

That the mode and manner of weighing this coal and the time for paying the same shall be, and remain for the coming year, the same as is now in force in this district.

It is also agreed on the part of the operators not to require the miners to put down their own road. Also to give each miner as near as possible an equal turn of cars, and not to allow the day hands to load coal on idle days. No miner shall be discharged or discriminated against because of his refusal to do work by the day when called upon by the pit boss.

It is also agreed not to require miners to load or clean falls unless they are caused by some fault of the miner not properly timbering his working place, or his having shot or otherwise caused his timbers to become insecure, in which case it will be the duty of the miner to put his place in good order again.

It is further agreed that if any differences arise between the operator and the miner at any pit a settlement shall be arrived at without stopping of work. If the parties immediately affected cannot reach an adjustment between themselves, the question shall be referred to the Executive Board of the United Mine Workers of America, representing District No. 8, and an equal number of operators, whose actions shall be final; but no miner or operator interested in the differences shall be a member of said committee.

That all narrow work or yardage be paid an average throughout the block coal district, proportionate to the advance in the price of mining.

That the hour to begin work in the morning shall be 7:00 a. m., with thirty (30) minutes' stop for dinner, and begin shooting at 3:30 p. m., from April 1, 1898, to October 1, 1898, and from October 1, 1898, to April 1, 1899, the mines shall start at 7:30 a. m., with thirty (30) minutes' stop for dinner, and begin shooting at four (4) o'clock

INSIDE DAY WAGE SCALE OF EIGHT HOURS A DAY.

The following resolution was adopted at the meeting of the scale committee of Interstate Convention at Chicago, January 28, 1898:

"Resolved, That two operators and two miners of each State meet at Columbus, Ohio, on the second Tuesday of March, or March 8, 1898, at the Chittenden Hotel, to formulate a uniform day work scale, based upon the district upon which the mining price is based."

In accordance therewith, the representatives of the various competitive districts met at the Chittenden Hotel, and agreed upon the following scale of wages and conditions to govern all inside day labor for the year beginning April 1, next, and ending April 1, 1899:

Inside Day Scale.

Track layers	$1 90
Track layers' helpers	1 75
Trappers	75
Bottom cagers	1 75

Drivers	$1 75
Trip riders	1 75
Water haulers	1 75
Timber men, where such are employed	1 90
Pipe men for compressed air plates	1 85
Common men in long wall mines in the third vein district in northern Illinois	1 75
All other inside day labor	1 75

The above schedule of day wages only applies to men in the performance of their labor, and does not apply to boys, unless they do and are employed to do a man's work.

That the eight hours a day means eight hours' work in the mine at the usual working places for all classes of inside day labor. This shall be exclusive of the time required in reaching said working places in the morning, and departing from the same at night.

Regarding drivers: They shall take their mules to and from the stables, and the time required in doing so shall not include any part of the day's labor, their work beginning when they reach the parting at which they receive empty cars; but in no case shall the driver's time be docked while he is waiting for said cars at the point named. But when the men go in the mine in the morning they shall be entitled to two hours' pay, whether or not the mine works the full two hours, but after the first two hours the men shall be paid for every hour thereafter by the hour, or for each hour's work, or fractional part thereof.

If for any reason the regular routine of work cannot be furnished inside labor for a portion of the first two hours, the operators may furnish other than the regular labor for the unexpired time.

This contract is entered into in good faith by both parties, and there is to be no deviation from it by the operators, miners or day laborers.

W. H. ZIMMERMAN,	SAMUEL ANDERSON,
W. W. RISHER,	BARNEY NAVIN,
M. H. JOHNSON,	WILLIAM THOMPSON,
WM. H. ZELLER,	PETER FLEMING,
JAS. H. MCCLELLAND,	WILLIAM WILSON,
Committee on behalf of Operators for the Block Coal District.	Executive Committee District No. 8, United Mine Workers of America, for the Block Coal Miners.

It will be seen from this that the cost of mining lump coal, where paid for by the ton, is practically fixed. Where it is paid for by the ton, run of mine, the price varies according to the proportion of screened coal produced. Thus, where the lump coal amounts to 66 per cent. the price paid is 40 cents a ton. With the soft coals of Pike county and other places where the lump coal amounts to less than half of the coal mined, 30 to 33 cents is paid.

Where machines are used, payment is made in various ways. As given in the agreement, the price per ton is three-quarters that of picked mine coal. In some cases the digging is paid for by the cut and the loading by the ton. Thus, in a mine using electric machines, the machine runner receives 8 19-27 cents and the helper 7 22-27 cents per cut, or a total of $1.15 7-27 for seven cuts, yielding in this case 25 tons, making the cost per ton 4 62-100 cents for the undercutting. Loaders in this case receive 21 72-100 cents per ton, to be divided among them. This makes the total cost of labor for mining and loading coal 26 34-100 cents a ton. In some mines they pay by the foot for cutting, by the day for shooting and by the car for loading, and still other methods are adopted.

2237. (d) Removal of Coal from the Mine, Screening, Weighing and Loading.—The men necessary for this part of the work are paid by the day, with but few exceptions. This part of the subject can be best studied by taking actual lists of day men for different kinds of mines and different outputs.

Thus, for a small new mine with an output of 200 tons a day, short haulage:

Day Men at .... Mine.

Men.	*Number.*	*Daily Wage.*	*Total.*
Drivers	2	$1 75	$3 50
Roadmen	1	1 90	1 90
Mine boss	1	2 40	2 40
Engineer	1	2 40	2 40
Dumpers	2	$1 75 and 1 50	3 25
Trimmer	1	$1 75	1 75
Total			$15 20
Average of 200 tons			076

An expense of 7.6 cents on this score. (Cars here hold 3,000 lbs.) This perhaps is the lowest extreme. Next let us take a typical pick mine, with a capacity of 400 tons a day. The figures for such work from an actual case are as follows:

Day Men at .... Mine.

Men.	*Number.*	*Daily Wage.*	*Total.*
Drivers	8	$1 75	$14 00
Road men	2	1 90	3 80
Trapper	1	1 00	1 00

Men.	*Number.*	*Daily Wage.*	*Total.*
Trapper	1	75	75
Cager	1	1 96	1 96
Load dropper	1	1 75	1 75
Driver, boss	1	1 90	1 90
Mine boss	1	2 60	2 60
Engineer	1	2 12	2 12
Fireman	1	1 70	1 70
Blacksmith	1	2 00	2 00
Weigh boss	1	1 60	1 60
Flat dropper	1	1 10	1 10
Dumper	1	1 75	1 75
Trimmer	1	1 50	1 50
Stableman	1	1 62½	1 62½
Night watch	1	1 62½	1 62½
Total			$42 78
Average of 400			106

This item in this case increases the cost of the coal by 10.6 cents a ton.

A third example may be taken of a pick mine whose output comes between the other two. (Capacity, 300 tons daily.)

Day Men at .... Mine.

Men.	*Number.*	*Daily Wage.*	*Total.*
Drivers	12	$1 75	$21 00
Timbermen	2	1 90	3 80
Road men	3	1 90	5 70
Bottom lifters	2	1 75	3 50
Cager	1	1 75	1 75
Greaser	1	1 00	1 00
Mine boss	1	3 00	3 00
Engineer	1	2 00	2 00
Night men	2	1 60	3 20
Firemen	2	1 60	3 20
Weigh boss	1	2 00	2 00
Blacksmith	1	2 00	2 00
Leveler	1	1 50	1 50
Pumper	1	1 50	1 50
Total			$55 15
Average of 300 tons			15

In this case men cost about 15 cents a ton. Compared with the first case, it shows somewhat the difference between a new mine with short hauls and an old mine with long hauls. In the first case the drivers haul 100 tons apiece, and one road man can take care of the entries. In the latter case each driver only hauls 25 tons a day, and there is required extra a cager and greaser, and for the entries, five men instead of one.

Still another case of a mine with an output of 250 tons gave as follows:

Day Men at .... Mine.

Men.	*Number.*	*Daily Wage.*	*Total.*
Drivers	6	$1 25	$7 50
Road layers	2	$1 50 and $1 25	2 75
Pit man	1	1 25	1 25
Trappers	3	50	1 50
Mine boss	1	2 00	2 00
Engineer	1	1 60	1 60
Fireman	1	1 00	1 00
Weigh boss	1	1 35	1 35
Dumper	1	1 25	1 25
Trimmer	1	1 25	1 25
Stableman	1	50	50
Total			$21 95
Average of 250 tons			087

A cost in this case of 8.7 cents per ton. This, as might be judged, is a southern mine, where wages are lower than farther north.

Turning to machine mines, the following figures are for an electric mine, having at the time an output of 550 (?) tons a day.

Day Men at .... Mine.

Men.	*Number.*	*Daily Wage.*	*Total.*
Mine boss	1	$2 60	$2 60
Drivers	9	1 75	15 75
Motormen	2	1 75	3 50
Wireman	1	1 75	1 75
Roadmen	2	1 90	3 80
Timbermen	2	1 90	3 80
Cagers	3	1 75	5 25
Trappers	6	75	4 50
Pumpers	3	$1 00 to $1 80	4 55
Hoisting engineer	1	2 00	2 00

Men.	Number.	Daily Wage.	Total.
Night engineer	1	1 75	1 75
Firemen	2	$1 75 and $1 50	3 25
Weigh boss	1	1 75	1 75
Blacksmith	1	2 00	2 00
Flat trimmers	4	1 50	6 00
Dumper	1	1 25	1 25
Carpenter	1	1 75	1 75
Rouster	1	1 50	1 50
Stableman	1	1 60	1 60
Total			$68 35
Average of 550 tons			.123

This gives a total of 12.3 cents a ton as the cost of day labor at mine.

In a mine using air machines to mine and rope haulage, the figures will be somewhat different, and may be given for a mine delivering 1,000 tons a day:

Day Men at .... Mine.

Men.	Number.	Daily Wage.	Total.
Drivers	17	$1 75	$29 75
Roadmen	3	1 90	5 70
Bratticeman	1	1 90	1 90
Jerrys or roustabouts	2	1 90	3 80
Trappers	5	75	3 75
Pumper	1	1 75	1 75
Pipeman	1	1 85	1 85
Water hauler	1	1 75	1 75
Cagers	2	1 96⅞	3 93¾
Assistants	2	1 75	3 50
Rope riders	2	1 90	3 80
Bottom engineer	1	1 53	1 53
Driver boss	1	1 73	1 73
Mine boss	1	2 60	2 60
Engineer	1	2 10	2 10
Night watch	1	1 33⅓	1 33⅓
Firemen	2	1 53⅓	3 06⅔
Assistant fireman	1	1 25	1 25
Blacksmiths	2	2 00	4 00
Trimmers	4	1 45	5 80
Rousters	2	1 10	2 20
Dumper	1	2 00	2 00
Dumper	1	1 76	1 76
Weigh boss	2	2 10	4 20

Men.	Number.	Daily Wage.	Total.
Empty runners	2	1 45	2 90
Top stableman	1	1 15	1 15
Top boss	1	1 73	1 73
Machine boss	1	2 25	2 25
Total			$103 08⅜
Average of 1,000 tons			.103

In this case day labor amounts to 10 cents a ton. Adding these costs to the costs of labor for mining and yardage, there is obtained as the labor cost of the coal mine run:

	Cost of Mining.	Day Labor.	Yardage.	Total.
First case	$0 40	$0 07	$0 02	$0 49
Second case	40	10	02	52
Third case	57 (?)	15	02	74
Fourth case	30	08	02	40+
Fifth case	26	12	02	40+
Sixth case	30?	10	02	42+

Due to omissions and other causes, it is probable costs are 5 to 10 cents above these figures. In one machine mine the amount paid for a certain period ran in the following ratio:

Wages paid machine men and helpers	$207 62	
Loaders	874 97	
		$1,082 59
Inside men	$596 38	
Top men and monthly men	389 40	
		985 78
		$2,068 37

During this time the proportional output was 4,374 tons, run of mine, or 47 cents a ton for labor. It will be noticed that the cost of yardage, getting coal out of mine, screening, weighing and loading on flats is almost as much as the digging and loading on mine cars. That is where the machine mine loses much of the advantage it gains in reduced cost of mining coal.

In the State Statistician's report for 1895-96, he gives reports from eighty-six mines, in which 2,737,686 tons of coal were mined and $2,196,868 paid for wages in mining it. This gives a total of 80.2 cents a ton as the labor cost of the coal.

IV. Operating Materials.

2238. (a) Rails and Ties.—In one of the mines these were estimated at 18 yds. a day of 16 lb. iron rail, costing $6.33. About twenty-seven ties 3 in. by 5 in. by 5 ft. at 5 cents each, $1.35, or 1.4 cents a ton of output. Tracking and rooms, 6.25 cents for 25 tons of coal, or .25 cents a ton, making 1.65 cents a ton for the mine. At other mines estimates run down to .25 cents per ton.

2239. (b) Timber.—This item is largely influenced by the character of the roof, and will run from a small fraction of a cent per ton for some mines with good roof (.2 cents in one mine) to 2 cents a ton, and probably will average not far from 1 cent a ton. Posts cost from $15 to $30 a thousand. In some of the mines the entries require almost no timbering, while in others, after a few years, the entries require not only considerable timbering, but a good deal of lagging. This would add slightly to the above amount, so that 1 cent a ton for the average is probably none too high.

2240. (c) Oil, Feed for Mules, Coal for Boilers, Etc.—From figures obtained, the oil for cars and engines will cost about $\frac{1}{8}$ of a cent a ton. Feed for mules will run about 15 to 20 cents each day, or from .25 to 1 cent per ton, depending on whether mechanical haulage is used and upon the length of haul. Probably .25 cent per ton for mines using mechanical haulage and .5 cent for those using only mule haulage.

2241. (d) Other Items.—It is probable that other expenses, brattices, repairs to roofs and to machinery, deterioration of cars, cables, cages and machinery, judging from such figures as are at hand, will cost not less on an average than 3 cents a ton.

Summing up these items it seems probable that cost of operating materials will average not far from 5 cents a ton.

V. Office Expenses, etc.

2242. These will include books, stationery, stamps, advertising, mine maps and surveying, book-keepers, superintendent, rent, taxes, insurance and many other items. Upon this we have so little data that our estimates are little more than guesses. However, it is probable that few companies run under 1 cent a ton, and it is easy to figure up expenses that would run up to several cents a ton. Some of the operators say that 5 cents a ton is not too high.

VI. Summary of Cost of Coal on Car.

2243. The following table gives a summary of the cost of coal on the car in cents:

	A.	*B.*	*C.*	*D.*	*E.*
Royalty	3.3	5.0	10.0	5.0	5.0
Interest on equipment	2.0	2.0	2.0	4.0	4.0
Cost of labor	40.0	50.0	74.0	47.0	45.0
Operating materials	5.0	5.0	5.0	5.0	5.0
Office expenses	1.0	5.0	5.0	5.0	5.0
Total	51.3	67.0	96.0	66.0	64.0

A is supposed to represent conditions in the southern part of the State for a pick mine; in other words, minimum cost (at schedule preceding strike of 1899). B, pick mine in northern part of field, bituminous coal. C, pick mine on block field, representing greatest cost. D and E, different types of machine mines.

As we had not all the data for any single mine, the above figures are only approximate, but suggest that a ton of run of mine coal can hardly be placed on a flat under fairly average conditions for less than 50 cents, or 2 cents a bushel, while it may run up in the block field to close to $1, or 4 cents a bushel. The average for the field will probably be between 60 and 70 cents, and I am not sure that it would be far out of the way to say that a ton of run of mine coal will cost not far from the schedule price paid for pick mining of lump coal, except in the block field, where it would seem to run considerably over.

In practice it is the custom of many operators to charge all the expenses of the mine to the lump coal, letting any sale of small coal go to profit and loss. On this basis a ton of lump coal will cost more nearly the same over the field. Thus, the most of the southern coal is rather soft, many of the mines yielding only 45 per cent. of lump, which would make the lump coal cost $1.10 a ton when run of mine costs $0.50. Where run of mine costs $0.60 a ton and 66 per cent. is lump, the lump coal would cost on this basis $0.90 a ton. Where run of mine coal costs $0.90 and 75 per cent. is lump, the lump costs $1.20. On this basis it is evident that lump coal is often sold for less than it costs, and it is also evident that the method does not give a fair idea of the cost of the lump coal except on the basis of the small coal being so much waste. The method is used because of the uncertainty attending the sale of the small coal. At times this brings a good price, and again is almost given away. Formerly there was small demand for the small coal, but the introduction of fire grates adapted for its burning and better screening are creating a larger and steadier demand for it.

Another way to look at it is to consider a ton of lump coal as costing the same percentage of the total cost of the coal that it bears to the total amount of coal mined. Some operators follow this method, and one of the largest operators remarked that it was only a question of time, with improved methods of cleaning and sizing coal, and improvements in grates, when all sizes of coal would sell at the same price. This practically makes the cost of a ton of lump coal, a ton of screening or a ton of mine run coal the same. Thus, if run of mine costs 60 cents a ton to place on flats, and is 66 per cent. lump, three tons will cost $1.98 and yield two tons of lump, which cost $1.32, or 66 cents a ton, and one ton of screening, costing 66 cents. If the lump coal sells for 90 cents, it sells for a profit of 24 cents a ton, and if the screenings sell for 30 cents a ton, they sell for a loss of 36 cents a ton, the net profit in this case being 4 cents a ton, or equivalent to selling run of mine at 70 cents a ton.

On this basis it would seem as though the mining and handling of the small coals was being carried on at a direct loss, and the question would arise, Why not leave the small coal in the mine and make a profit of 24 cents a ton on the output instead of 4 cents? The answer is that the small coal has been considered only a by-product in the mining and removing of the lump coal; that the lump can not be mined without the production of small coal, and that the small coal having been produced, it is more economic to remove it and to sell it than to leave it in the mine.

A third method of looking at the subject would throw all the expense on the lump coal, except the labor cost of removing and preparing the small coal. Without knowing what per cent. of the small coal resulted from the handling of the lump coal after it is loaded into the mine cars, it would be difficult to estimate the costs on this basis. A rough estimate, based on the assumption that one-quarter of every ton of small coal was produced by the abrasion of the lump coal while it is being removed and screened, and so falls on the lump side of the expense account, gave, for a case like that given just above, cost of run of mine coal 60 cents—two-thirds lump.

Equivalent cost of lump coal..........................	$0 86
Equivalent cost of screenings..........................	25

This is, of course, only suggestive. On this basis it is evident that the screenings must sell for the 25 cents, or whatever the actual cost is, or else the profit on the lump coal will have to cover the deficiency.

VII. Selling Price at Mines.

2244. Average prices for Indiana coal since 1889 in counties averaging 10,000 tons or over:*

County.	*1889.*	*1890.*	*1891.*	*1892.*	*1893.*	*1894.*	*1895.*	*1896.*
Clay......	$1.14	$1.01	$1.15	$1.25	$1.29	$1.13	$1.07	$0.96
Daviess...	1.02	1.04	1.12	1.11	.97	1.03	.94	.87
Fountain..	1.29	1.00	.99	.89	1.00	1.08	....	.80
Gibson....	....	....	....	....	....	.78	....	.75
Greene....	.91	.94	.91	.84	.83	.96	.69	.77
Knox.....	....	....	....	.84	1.10	.84	.98	.78
Parke.....	1.05	1.09	1.13	1.09	1.16	1.07	.98	.87
Perry.....	1.18	1.05	1.10	.86	1.13	1.12½	1.12	1.12
Pike......	.83	.98	.90	.87	.76	.77	.77	.69
Spencer...	1.15	.96	.88	.80	.84	1.03	1.01	1.34
Sullivan...	.94	.94	1.01	.89	.88	.82	.84	.67
Vand'b'gh.	1.16	1.02	1.09	1.06	1.08	.96	1.03	1.03
Vermillion	.89	1.17	.98	.96	.96	.82	.81	.75
Vigo......	.88	.80	.80	1.14	.95	.95	.78	.70
Warrick...	....	....	.77	.81	.89	.72	.72	.66
State...	$1.02	$0.99	$1.03	$1.08	$1.07	$0.96	$0.91	$0.84

If anything like these figures hold in 1898, it shows a profit over the cost of coal of from 1 cent to 50 cents, though most of them range from 5 to 15 cents.

VIII. Cost of Transportation.

2245. In the following table is given the railway tariff from some of the principal mining centers to some of the main selling centers:

Parke county to Chicago..............................	
Parke county to South Bend..........................	
Parke county to Indianapolis..........................	
Brazil to Chicago...................................	
Brazil to South Bend................................	
Brazil to Indianapolis..............................	$0 50
Linton to Chicago..................................	
Linton to Indianapolis..............................	50
Washington to St. Louis............................	
Pike county to St. Louis............................	

Through an oversight the figures for this table were not procured.

IX. Wholesale and Retail Selling Price of Indiana Coal at Important Points.

2246. The following table from Mineral Resources for 1896-97 is the most comprehensive table available, and I understand that prices do not differ much from those prevailing at that time:

* Mineral Statistics, U. S., 1896-97, p. 511.

Table of Selling Prices of Coal in Indiana in 1896.

TOWNS.	Steam Coal. Wholesale. Highest.	Steam Coal. Wholesale. Lowest.	Steam Coal. Retail. Highest.	Steam Coal. Retail. Lowest.	Domestic Coal. Wholesale. Highest.	Domestic Coal. Wholesale. Lowest.	Domestic Coal. Retail. Highest.	Domestic Coal. Retail. Lowest.	Kind of Coal Used. Steam.	Kind of Coal Used. Domestic.
Anderson						$2 30		$3 50		
Elkhart			$3 50	$2 50			$4 50	4 00	Pocahontas and Hocking	Jackson Hill.
Evansville				75				1 40		
Ft. Wayne (?)	$3 00	$2 10	2 10	1 80	$4 50	3 75	2 50	2 10	Ohio and Indiana	Ohio.
Indianapolis	85	45	1 50	1 00	1 75	1 45	3 00	2 50		Brazil block.
Indianapolis	85	45	1 50	1 00	1 50	1 35	2 75	2 25		Island City.
Indianapolis	85	45	1 50	1 00	2 25	2 05	3 75	3 00		Pittsburg.
Jeffersonville	1 50	1 35	2 00	1 40	3 05	2 35	3 05	2 78	Pittsburg	Pittsburg.
Lafayette	1 10	1 00	2 50	2 00	2 90	2 45	4 50	4 50	Slack	Pittsburg.
Logansport	1 75	1 75			3 10	2 85	4 50	4 00	Indiana	Pittsburg.
Michigan City	2 30	2 25	3 25	3 00			3 50	3 25	Indiana block	Indiana.
New Albany			1 50	1 25			2 75			
Richmond	2 40	1 90			2 75	2 20	3 50	3 09		
South Bend			1 80	1 55				2 50	Indiana	Indiana block.
South Bend			2 00	1 90			3 00	3 50	Indiana block	Hocking Valley.
South Bend								4 00	Indiana block	Cannel.
Terre Haute	55	45	1 00	75	85	80	1 80	1 60	Indiana block	Indiana block.

A comparison of the wholesale and retail prices given here shows from 30 cents to $1.40 as the cost of retailing and delivering. In the latter case it is possible that the wholesale price is the price paid by the wholesale companies for the coal at the mine, and includes transportation.

2247. X. Summary of Cost of One Ton of Coal.

To original owner	$0 03 to	$0 10
To capital invested at 6 per cent	02 to	045
To labor and mine expense	50 to	1 00
To operator	05 to	50
To transportation	.. to	..
To retailing and delivering	30 to	1 40
Cost to retail purchaser	75 to	3 25

Possibly an average of lump coal sold in Indianapolis on the basis of three-fourths lump to the ton of mine run would give:

To original owner	$0 05
To capital invested	03
To labor and mine expense	87
To operator	15
To transportation	50
To retailing and delivering $0.50 to	90
	$2 50

As stated before, the conditions vary so from mine to mine that probably at no one mine would just such figures be found correct, and at some of the mines will vary greatly from that. Variations in the price largely affect the operator and retailer, the other items being more or less stable.

XI. Additional Items.

2248. In addition to the above items are many items which indirectly influence the results greatly. Perhaps the greatest is the loss recurring more or less periodically from strikes. This loss falls heavily on both operators and miners. In coal mining, as in most mining, though to a somewhat less degree than in most, there is a certain amount of hazard constantly involving losses. These are due to unforeseen irregularities in the coal, moneys wasted in examining or trying to develop unworkable territory, the flooding of the mine or other accidents often unavoidable, but as often due to poor planning. These things tend to cut down the profits of the operators. On the other side are usually more or less regular items of income not included above. Thus, the miner is required to furnish his own tools, powder, etc., and keep his tools sharpened. The company usually does the last for him at so much a month or week, amounting to about a cent a ton. Powder is usually sold to the men by the company, costing the miner about a cent a ton in ascertained cases and yielding often considerable profit to the operator. Among other items of more or less profit to the operator may be mentioned rents of miners' houses, but most important of all, where it exists, the company store. This is a store furnishing all the necessities of life, and often has all the completeness of stock of a department store, at which the employes may or may not be expected to trade, and which may or may not sell goods at a greater profit than other stores.

XII. Earnings of Miners.

2249. On this question the best information at hand is that obtained by the State Statistician and published in his report for 1895-96. It applies to the conditions existing then. We give it verbatim:

"Employes' Statements.—Of the 6,208 miners employed (according to the reports received by the Bureau), the Bureau has statements from 846, about 10.5 per cent. of all, and bases the facts and conclusions on their statements, believing that they will fairly represent the whole number.

"Nationality—Days Worked.—An analysis of the 846 reports shows that of the 6,208 miners, 3,725 are native and 3,483 foreign born. Number of hours constituting a day's work, 9; number of days worked the past year, 147. [Since strike 8 hours constitute a day's work.—G. H. A.]

"Single and Married.—The number of single men, as shown by these reports, is 932; married, 5,276, with an average to the family of those married of 5.1.

"Wages—Tons Mined Per Day.—It is shown by these reports that the average tons of coal mined per day is 3; average price received per ton, 57.1 cents [1898, 69 cents], making the average daily earnings $1.71, and for the 147 days worked during the year, $251.37. The average cost for powder and sharpening tools [oil, etc.] is 34.3 cents per day; for the 147 days, $50.32, leaving the net earnings for the year $201.05.

"Losses From Screening.—Of the 846 who report, 244 estimate the loss to them from screening at 40 cents per day, or $50.80 each for the year.

"Property Owners—Renters.—Of the 5,276 who are married, 2,076 own their homes and 3,650 pay monthly rental of $4.53; $54.36 per annum, a total for the 3,650 of $198,414.

"Building and Loan Shares.—Nine per cent. of the whole number (578) carry each an average of 3½ shares of building and loan stock, an aggregate of 1,923 shares. Of these, 208 say they have built houses by aid of these associations.

"Are You Compelled to Trade at Company Store?—To this question 558 of the 846 give an answer, 83 per cent saying 'no,' and 17 per cent. saying 'yes.' Many of those who say 'no,' add 'you are expected to.'

"Per Cent. of Earnings Spent in Companies' Stores.—Of the 846 the above question was answered by 468, or 55 per cent., which of the 6,208 would be 3,413, say they spend 74 per cent. of their earnings in the stores of the companies for whom they work. Not a few say 100 per cent.

"Do Companies Charge More than Other Stores?—Five hundred of the 846, 60 per cent., answer this question. Of these, 292, 58 per cent., answer 'no,' while 208, 42 per cent., say 'yes.' "

2250. For the sake of comparison and to show some other facts of interest, some figures are given from a paper by Mr. E. R. S. Gould in the Johns Hopkins University Studies in Historical and Political Science:

Families of which statistics were obtained (American miners)	508	
Average number of persons in family	5.3	
Owning homes	134	
Giving information concerning size of house	335	
Average number of rooms	3.9	
Maintained entirely by husband	294	or 57.9 per cent.
Total earnings of family	$550 30	
Of which husband earns	426 73	or 77.5 per cent.
Expenditures—		
Rent	61 19	or 11.7 per cent.
Food	237 44	or 45.3 per cent.
Clothing	112 10	or 21.4 per cent.
Books and newspapers, 80.3 per cent. buy, and spend	5 30	or 1 per cent.
Alcoholic drinks, 60 per cent. use, and spend	18 09	or 3.4 per cent.
Tobacco, 85.8 per cent. use, and spend	9 30	or 1.8 per cent.
Total	$524 71	
Surplus representing year's saving	$25 59	or 4.7 per cent.

XLIX. UTILIZATION AND AVAILABILITY OF INDIANA COALS.

2251. USES OF COAL.—It is an interesting fact that coal, perhaps the most valuable and useful mineral known to us, is of no direct use to us. We can not eat it, wear it or live in it; in short, with insignificant exception, we make no direct use of coal. Coal is of use to us only as it ceases to be coal. Its value lies in its indirect use through chemical changes it may be made to undergo. That chemical change, for the larger part, is a simple one. It consists, in brief, of the union of the carbon and hydrogen of the coal with the oxygen of the air or of metallic ores, forming the new chemical compounds, oxides of carbon and oxides of hydrogen, or chemically, CO or CO_2 (ultimately always CO_2) carbon monoxide or carbon dioxide, and H_2O hydrogen monoxide or common water. It then becomes an interesting fact that the new substances formed by this chemical action are, commercially speaking, of no value. Its value lies mainly in two results accomplished through the chemical changes it undergoes:

1. The production of energy in the form of heat or light.

2. The reduction of certain chemical compounds, especially iron oxide.

It is not my province to attempt to enumerate the almost innumerable uses of coal under these two heads, or the less important ones that do not fall under these heads, of which, all told, there are not a few; but to briefly touch on the few principal uses which are generally considered as forming the market for coal. These may be conveniently grouped as follows:

I. The production of energy
  (A) Direct production of direct results.
    (a) Warming and cooking.
  (B) Direct production of indirect results.
    (a) Through steam.
    (b) Through electricity.
  (C) Indirect production of results.
    (a) Conversion into gas.
      1. Illuminating.
      2. Producer gas.
      3. Semi-water gas.
      4. Water gas.

    (b) Transportation as gas.
    (c) Utilization as gas.
II. Reduction of ores, etc.
  (A) Direct.
  (B) Indirect.

This classification lays no claim to completeness and may be imperfect in many ways, but will serve the purpose we have in view. Of these topics the ones which do, or are likely in the near future to elicit the most inquiry are probably I (B) (a) and I (C) (a), (b) and (c). Therefore, the most of the attention will be given to these.

I. The Production of Energy.

(A) DIRECT PRODUCTION OF DIRECT RESULTS.

(a) WARMING AND COOKING.

2252. The direct results of the chemical actions referred to above are the withdrawal of oxygen from the air or from some compound and the production of energy in the form of heat, and it may be of light. While the production of light by the direct burning of coal may be a strong factor in the selection of coals for certain purposes, it can hardly be included in the commercial uses of coal.

An examination of the ultimate analyses of coal as given in Part I shows only two oxidizable substances (omitting the sulphur, etc.)—carbon and hydrogen. Where the sulphur is determined, it is a common rule to consider the heat obtained from the burning of half of it. To aid in studying the heat value of coals, the following table has been prepared. It is partly from known determinations, but in the main the figures have been especially calculated from the figures usually given as the "heat of formation" of the resultant compounds or from averages of the figures in the analyses given by Mr. Noyes in the 1896 report. It will be recalled that there are two heat units, the calorie, commonly used in scientific work and used in the tables of analyses given further on, and the *British thermal unit* (B. T. U.), generally used in engineering work. The calorie is the amount of heat required to raise the temperature of 1 gram of pure water from 0° to 1° centigrade. For convenience, a unit 1,000 times as large is sometimes taken, known as the great or large calorie, by making the kilogram instead of the gram the unit of weight. The British thermal unit is the heat required to raise a pound of water 1° Fahrenheit.

Heat of formation of CO (J. Thompson)	28.5 great calories.
Heat of formation of CO_2 (J. Thompson)	96.9 great calories.
Heat of formation of H_2O, liquid (J. Thompson)	68.3 great calories.
Heat of formation of H_2O, vapor (J. Thompson)	58.0 great calories.
One gram of carbon (C) in burning to CO_2 yields	8,080 calories.
One gram of carbon (C) in burning to CO yields	2,380 calories.
One gram of hydrogen (H) in burning to H_2O yields	34,460 calories.
One gram of hydrogen (H) in burning to H_2O (vapor) yields	28,600 calories.
One pound of carbon in burning to CO yields	4,400 B. T. U.
One pound of carbon in burning to CO_2 yields	14,400 B. T. U.
One pound of carbon in burning from CO to CO_2 yields	10,092 B. T. U.
One gram of average (Noyes's analyses) Pittsburg coal yields	7,259 calories.
One gram of average (Noyes's analyses) Indiana coal yields	6,879 calories.
One pound of average (Noyes's analyses) Pittsburg coal yields	13,066 B. T. U.
One pound of average (Noyes's analyses) Indiana coal yields	12,382 B. T. U.
One (long) ton of anthracite yields	29,000,000 B. T. U.
One (short) ton of average Pittsburg coal yields	26,132,200 B. T. U.
One (short) ton of average Indiana coal yields	24,764,000 B. T. U.
The fixed carbon (average) in one ton of Pittsburg coal yields	15,840,000 B. T. U.
The fixed carbon (average) in one ton of Indiana coal yields	13,864,000 B. T. U.
The gas (average) in one ton of Pittsburg coal yields	10,292,000 B. T. U.
The gas (average) in one ton of Indiana coal yields	10,900,080 B. T. U.

The following figures are added for comparison:

One gram of coke yields (Kich. Ginth., Technologisches Wörterbuch, 618)	6,500 calories.
One gram of peat yields (Kich. Ginth., Technologisches Wörterbuch, 618)	4,500 calories.
One gram of turf (air dried) yields (Kich. Ginth., Technologisches Wörterbuch, 618)	3,000 calories.
One gram of wood yields (Kich. Ginth., Technologisches Wörterbuch, 618)	2,800 calories.
One gram of petroleum yields (Kich. Ginth., Technologisches Wörterbuch, 618)	10,000 calories.
One gallon of petroleum (7.1) yields (Kich. Ginth., Technologisches Wörterbuch, 618)	127,800 B. T. U.
One thousand cubic feet of natural gas (Phillips) about	1,164,030 B. T. U.

Theoretically one pound of Pittsburg coal = 11.2 cubic ft. of Pittsburg gas.[*]
One thousand cubic feet of natural gas will evaporate 1,203 pounds of water.[†]

[*] Calculated from figures given above. Mr. Emerson McMillin, in Vol. VI of Geol. Survey of Ohio Reports, pp. 538-540, calculated the heat value of natural gas at 1,103,292 B. T. U. According to Prof. Phillips, one ton of Pittsburg coal is theoretically equivalent to 22,400 cu. ft. of gas. It appears to be commonly stated that one ton of Pittsburg coal is equivalent to from 31,000 cu. ft. to nearly 37,000 cu. ft. of gas. Thus Mr. S. A. Ford calculated natural gas

Practically one pound of Pittsburg coal = 7.5 cubic feet of Pittsburg gas,[*] or as more generally accepted = 10 cu. ft. of Pittsburg gas.
Theoretically one ton of Pittsburg coal = 22,400 cu. ft. of Pittsburg gas.
Theoretically one ton of Indiana coal = 21,200 cu. ft. of Indiana gas.
Practically one ton of Indiana coal = 20,000 cu. ft. of Indiana gas.

2253. Desirable Qualities for Household Coal.—Coal for domestic purposes is used in an open grate, in closed stoves with ordinary fire bowl and flat grate, or with basket grates in small furnaces for hot air heating, and in cooking stoves. These different uses to a certain extent demand different varieties of coal, yet certain qualities are esteemed for all. Of these may be mentioned, not too rapid or fierce combustion, capacity for remaining ignited at low temperature, with but little draught, freedom from sulphur. In the open grate, cheerfulness is an object sought, and consequently a coal giving much flame is desirable, yet this flame must be as free from smoke as possible, or it will produce an objectionable amount of soot and dirt. As grate fires are apt to be kindled frequently, they, in common with cooking stoves, demand a coal that kindles readily. Self-feeding and base-burning stoves require a dry, non-caking coal, like our block or most of the semi-block coals or anthracite. The rapid-burning steam coals are not usually desirable for household purposes, as they tend to burn out grates, require frequent attention, tending to burn fiercely at times and to die out quickly, and, as they often carry large quantities of sulphur, will in such a case produce stifling gases if the draught be imperfect. Sulphurous coals do not

to have a heat value of 210,069,604 calories. On this basis 1,000 cu. ft. of gas are equal in heat value to 57.25 lbs. of carbon, 67.97 lbs. of coke, or 54.4 lbs. of bituminous coal or 58.40 lbs. of anthracite coal. Or one ton of Pittsburg coal is theoretically equal to 36,764 cu. ft. of Pittsburg gas. Prof. Howard of Columbus calculated the heat value of gas to be 228,461,115 calories; or one ton of Pittsburg coal equals 31,085 cu. ft. of Findlay gas. (Quoted from Penn. Geol. Rep. in Geol. Surv. of Ohio, Vol. VI, p. 138, and 20th Ann. Rep. Geol. Surv. of Ind., p. 380.) Prof. Orton goes on to say (see same reference) that one lb. of Pittsburg coal is theoretically equal to 18.3 cu. ft. of Pittsburg gas, but practically less than 7 cu. ft. of gas will do the work of one pound of coal. The figures to which I have access do not seem to sustain these results. Thus, reducing the heat values given above to British thermal units, we have in round numbers 883,000 B. T. U. and 905,000 B. T. U., respectively. Dividing the first of these by 967, the latent heat of steam, we have 1,000 cu. ft. of natural gas will evaporate (theoretically) 861 lbs. of water. But in actual tests 1,000 cu. ft. of natural gas have evaporated as high as 978 lbs. or higher (See U.S. Geol. Surv., 18 Ann. Rep., Part V, cont., p. 899), in other words, an efficiency of over 100 per cent.

Or, taken from another standpoint, assuming natural gas to have an efficiency of 80 per cent. in a good boiler, if 18.3 cu. ft. of gas were theoretically equal to one lb. of coal, 22 cu. ft. of gas in practice would be equal to the theoretical value of one lb. of coal; or if 7 cu. ft. of the gas were found to be equal to one lb. of coal in practice, the coal by those figures would have an efficiency of only about 31 per cent. As a matter of fact Pittsburg coal has easily double that efficiency in well-designed boilers, indicating error in the original figures.

[†] Revised Judgment of Committee of Engineers, Soc. W. Pa. (For test see Scientific American, Supplement No. 520, Dec. 19, 1885.)

usually clinker as badly in household use as in steam use, on account of the lower temperature. A coal with a light pulverulent ash is the best, and, of course, the smaller the quantity of ash the less trouble of its removal.

Here again the value of testing a coal is apparent. Mr. A., after repeated trials, finds that a certain coal gives the best results when fired under the boilers at his factory, and at once concludes that that is the best coal, and proceeds to introduce it at his house for the usual household purposes. The result will often be far from satisfactory, though he may not give the matter close enough attention to be aware of that fact. In reality, it might have been that one of the coals that gave the poorest results at his factory would have been the most economical and efficient at his home.

It is a poor coal, indeed, that will not give good service somewhere, and the practice of condemning a coal because it fails in a certain capacity may be very unfair. There are to-day in Indiana many excellent coals lying unworked because they failed to give satisfactory service under a steam boiler. And conversely many excellent steam coals are lying untouched because when first discovered and tried in a stove by the discoverer they burned the grates out, and, having no other use for them himself, he makes no further effort at their development.

At present in Indiana a large percentage of household fires depend entirely upon natural gas. That this is an ideal fuel for that purpose need not be stated. Its low cost, requiring no handling, making no ash to be removed, neither smoke to darken the sky and render all things smutty and black, and its freedom from sulphur and other impurities make it *the* fuel par excellence. Under proper supervision and care it has proved itself a safe fuel. But there is only a limited quantity, and that is being rapidly exhausted. This fact needs no emphasis after the events of the winter of 1898-99. Under indirect uses of coal will be discussed the question, "Can coal be made to produce a gas to take the place of natural gas upon the exhaustion of the latter?"

(B) DIRECT PRODUCTION OF INDIRECT RESULTS.

(a) Through Steam.

2254. Steam Value of Indiana Coal as Based on Analyses.—For this discussion it will be necessary for us to confine ourselves to the recent analyses, as giving a fairer idea of the commercial value of our coals. (See Appendix A.)

The more direct results under this head might be divided into heating by steam and production of mechanical energy by steam; but for our purpose the two may be considered together. At present the direct use of coal for the production of steam exceeds all the other uses combined. The value of any given coal depends on the quantity of steam a given quantity of coal will evaporate, or the quantity of water a given quantity of coal will raise 1° in temperature.

Examining the table, it will be noted that 1 kilogram of Indiana coal will raise 6,879 kilograms of water 1° C., or 1 ton of Indiana coal will raise 24,764,400 pounds of water 1° F. As to evaporating effect, 1 lb. of Indiana coal will evaporate from about 12 to nearly 13.5 lbs. of water, starting from the boiling point. This, of course, is its theoretical evaporative effect. As compared with Pittsburg coal, the latter runs from 13.5 to 14.6 lbs. of water evaporated per pound of coal. As a matter of practice, probably not much over two-thirds of that effect can be obtained; in other words, a first-class coal in a first-class boiler will seldom evaporate more than 10 lbs. of water per pound of coal.

2255. The following table shows evaporative effect in pounds of water evaporated per pound of coal, of different coals from various tests, most of the table being taken from Mr. Arthur Winslow's report on the coals of Arkansas:

COALS.	[1]Johnson.	[2]Blake.	[3]Potter.	[4]Meigs, Meigs Boiler.	[4a]Meigs, Little Giant Boiler.	[5]Babcock & Wilcox Boilers.	[6]Navy Yard Tests.	[6a]Same, Equivalent Evap. from 212°.
Pittsburg	8.20		8.50	8.78	6.74	10.20		
Huntington, Ark			8.50					
Jenny Lind, Ark			8.40					
Coal Hill, Ark			7.50					
Kansas Coals		6.50						
Leavenworth, Kan				6.49	6.42			
Indiana Block, Ind		7.21				9.47		
Cannelton, Ind	7.31			7.32	7.12			
Run of Mines, Ill						9.49		
Staunton, Ill						5.09		
McAlester, I. T				7.68	6.96			
San Antonio, M. Co., Tex					4.46			
Fair Haven, Washington							6.85	8.05
Pocahontas, Va. and W. Va.							7.95	9.38
Pocahontas, Va. and W. Va.							7.70	9.02
George's Creek, Md							6.21	7.45
Standard Victor							6.59	7.92

[1]Experiments on the evaporative power and other properties of American coal. Report to the Secretary of the Navy, 1844, by Walter R. Johnson.

[2]The evaporative power of Kansas coals, by L. T. Blake, 6th Biennial Report of Kan. State Board of Agri.

[3]Test made for Ark. Geol. Surv., Ann. Rep., 1880, Vol. III, p. 72 et seq.

[4]Report on Fuel for the Army, by Quartermaster-General Meigs, 1882.

[4a]Same.

[5]Evaporative Power of Bituminous Coals, by Wm. Kent, Trans. Amer. Soc. Mech. Engrs., 1883.

[6]Tests made at Navy Yards of U. S., Sen. Ex. Doc. No. 82, 53d Congress, third session.

[6a]Same, giving equivalent evaporation from and at 212° F.

The difference is due to losses in several ways: First, radiation from exterior of furnace and boilers; second, heat carried out by chimney by escaping gases; third, imperfect combustion of combustible materials; fourth, heat used up in evaporating water in coal, etc. The first loss is approximately the same for different coals, provided similar conditions are maintained; and so also the second loss depends, with a given boiler, etc., on the temperature. The third loss may take place in two ways—by the escape of the volatile gases without burning, and by part of the carbon burning to CO instead of CO_2, thereby losing between two-thirds and three-fourths of the heat value of the carbon so burnt. To insure the combustion of all the fixed carbon, it

is usual to admit to the fire double the amount of air theoretically necessary, and this large amount of comparatively cool air cools down the volatile gases so that they are only partially consumed. The introduction of a hot air draught in the place of the cool by raising the general temperature will doubtless secure more complete combustion of the gases. Of two coals the loss will be greater for the one having the larger percentage of gas. In this respect Indiana coal is at a disadvantage with many of the eastern coals, as it, in common with most western coals, runs high in gas, from 35 per cent. to 45 per cent., with an average of about 38 per cent. This is sometimes expressed as "fuel ratio"=fixed carbon÷volatile hydro-carbons. This ratio for some of the competing States is as follows:

Indiana, average of twenty analyses	1.26
Belleville coal (Illinois), average of six mines	1.32
Western coal fields, Kentucky	1.49
Rich hill coal, Missouri	1.29
Westmoreland Gas Coal Company, Pennsylvania	1.46
Connellsville coal, Pennsylvania, "standard coking coal"	1.98
Pocahontas coal, Virginia, "semi-bituminous," caking	3.95
Bernice coal, Pennsylvania, semi-anthracite	10.30
Wilkesbarre, Pennsylvania, anthracite	19.33

Due to its low fuel ratio, Indiana coal in present practice falls a little short of the ratio of its total heat units to those of Pittsburg coal, or instead of 93 per cent. it is probable this low fuel ratio will make the Indiana coal not over 90 per cent. as efficient as Pittsburg.

Again, Indiana coal is at a disadvantage on account of the large percentage of water carried. As has been previously stated, the water is a waste product, in that it does not burn, but it absorbs large quantities of heat in being vaporized. Thus, a pound of water at 60° F. will take (212°—60°)+967=1119 B. T. U. One per cent. of water in a ton is 20 lbs., which would absorb 22,380 B. T. U.; 10 per cent. would absorb 223,800 B. T. U. In round numbers it may be said that 10 per cent. of moisture means a loss of about 10 per cent. in the efficiency of the coal. Comparing coals gives for moisture:

Indiana coal, average of twenty analyses	8.45
Iowa coal, average of sixty-four analyses	8.57
Illinois, about like Indiana.	
Ohio coals, average of 149 analyses	4.65
Missouri coals, average of 112 analyses	3.40
Kansas coals, average of thirty-eight analyses	4.79
Pennsylvania coals, average of ninety-seven analyses (bituminous)	1.03
Pennsylvania coals, average of thirty-three analyses (anthracite)	3.35

Looking over the analyses, it is interesting to note that the so-called block coals of Indiana, which from one standpoint, are commonly spoken of as dry coals, are, from the standpoint of moisture, the wet coals, usually running over 8 per cent. of water, while the so-called bituminous or caking coals of the State generally run under 8 per cent. In most of the analyses by Mr. Cox the coals were allowed to dry in the laboratory to a large extent. It is of interest to take one of Mr. Noyes's analyses, and suppose that by drying all but about 1 per cent. of water is removed, and having recalculated the per cent. of the remaining parts, compare it with the original analyses and with an average of the best of the analyses of Pennsylvania and West Virginia coal by Mr. Noyes. Gauged by the heating effect, the Little Redstone coal is nearly an average of the Pittsburg coals, and the Beck's run coal is the best. Of the Indiana coals, that from Brazil Block No. 1 is not far from the average.

	B. B. No. 1 (Wet).	*B. B. No. 1 (Dry).*	*Little Redstone.*	*Beck's Run.*
Total combustible matter	85.12	97.8	91.00	96.06
Volatile combustible matter...	35.16	40.4	35.88	36.01
Fixed carbon	49.96	57.4	55.20	60.05
Moisture	13.82	.9	.98	2.09
Ash	1.06	1.2	7.94	1.85
Sulphur	1.47	1.7	.82	.64
Heating effect	6810.	7755.	7316.	7726.

While the commercial drying of the block coals seems now out of the question, it is of interest to note that could it be done Indiana block coal would be able to show a theoretic heating effect as good or better than any bituminous coal in the country.

The ash detracts from the value of a coal largely in the expense of handling. Five per cent. of ash means 100 lbs. to the ton, or 1 ton in every 40 tons flat of coal. It also requires removing from the furnace room, and often to a considerable distance. Indiana coals compare well with other coals in this respect, even when taken under the conditions that these samples were.

Indiana, average of twenty analyses....................	5.61
Illinois, average of six analyses	7.60
Arkansas, average of twenty-four analyses	6.76
Kansas, average of thirty-eight analyses	10.19
Pennsylvania, average of seventy-six analyses (bituminous)	5.35
Maryland (Cumberland)	6.40
Pocahontas, Virginia, average of fifteen analyses.........	5.19
Anthracite, Pennsylvania, average of thirty-three analyses	8.31

In percentage of sulphur the Indiana block coal is as low as the best. The caking coals average about with other western coals and higher than most of the eastern coals. As with the ash, this factor in the analyses is largely affected by the method of sampling.

2256. In comparing Indiana block coal with Illinois coals the following analyses and comparisons are of interest. The letter was written in 1876 and published in 1884.

H. G. Sleight, Indianapolis:

Dear Sir—The following is the result of the analyses, made in the laboratory of the State Geologist, of the three samples of coal which you brought me for that purpose:

No. 1 block coal, taken at random from a car load shipped from Brazil, Clay county, Indiana.

No. 2, from Wilmington, Ill., on the Chicago & Alton Railroad; also taken from the delivery at Chicago.

No. 3, Minonk coal, Ill., on the Illinois Central Railroad; also taken from the delivery at Chicago.

No. 1 is an ordinary sample of block coal. No. 2 is a glossy, jet black caking coal, with specks and scales of pyrites. No. 3 is a very brilliant black caking coal, which, when broken, shows numerous markings of sulphide of iron.

A large lump of each sample was reduced to fine powder and kept, well stoppered, in separate bottles. From these bottles, which contained proper average samples of the coals, the quantities were taken necessary to complete the separate processes to which a coal must be subjected in order to point out its commercial value. For convenience these coals will now be referred to by the numbers given above. The results are given in 100 parts of coal:

No. 1. Indiana Block Coal.

Specific gravity, 1.285. A cubic foot weighs 80.31 lbs.

Ash, white	2.50
Fixed carbon	56.50
Coke	59.00
Volatile matter	32.50
Water	8.50
Total	100.00
Iron	0.82
Alumina	1.20
Silica, lime and magnesia..............................	0.48
Ash	2.50

Total sulphur, 1.43. The iron is combined with 0.947 of sulphur, leaving 0.493 of sulphur combined with the other constituents of the ash and carbon. This coal contains 7.424 calculated heat units, and one pound will convert 11.4 lbs. of water from 0° Cent. (32° Fahr.) into steam at 100° Cent. (212° Fahr.).

No. 2. Wilmington Coal.

Specific gravity, 1.248. A cubic foot weighs 78 lbs.

Ash, red	6.50
Fixed carbon	46.00
Coke	52.50
Volatile matter	37.50
Water	10.00
	100.00

Total amount of sulphur in this coal, 4.74 per cent.; iron, 4.34 per cent.=9.298 of pyrites; this would be in excess of the sulphur, so that all the iron does not exist as sulphide. The ash is composed of iron, 4.34; silica, 2.16.

This coal contains, by calculation, 6,762 units of heat. One pound will convert 10.4 lbs. of water from 0° Cent. (32° Fahr.) into steam at 100° Cent. (212° Fahr.).

No. 3. Minonk Coal.

Specific gravity, 1.232. A cubic foot weighs 77 lbs.

Ash, brown	5.50	
Fixed carbon	48.00	
Coke		53.50
Volatile matter	35.00	
Water	11.50	
		100.00

Total sulphur, 3.63 per cent. Sulphur, combined with iron, 2.719. Sulphur, combined with other mineral matter, 0.911.

Composition of ash—

Iron	2.38
Alumina	0.80
Silica	2.32

This coal contains 6,756 calculated heat units. One pound will convert 10.3 lbs. of water from 0° Cent. (32° Fahr.) into steam at 100° Cent. (212° Fahr.).

From this it will be seen that one ton of the Indiana block coal will convert into steam, from 0° Cent. (32° Fahr.) to 100° Cent. (212° Fahr.), 22,-800 lbs. of water, while the Illinois coals will only convert into steam, under the same conditions, 20,800; a difference of 2,000 pounds in favor of the block coal, or nearly eight barrels.

In addition to its superior heat-producing properties, the Indiana block coal contains a minimum quantity of sulphur and ash, while the other coals contain these injurious diluents in great excess.

I need hardly dwell upon the injurious effect which the sulphur exerts upon grate bars, fire boxes and boilers, where it is used for generating steam, since it is well known to all intelligent engine drivers that when the sulphur is brought in contact with red-hot iron it causes it to fuse or lose its tenacity; thus, the sulphur from coal will destroy grate bars, fire boxes, and, sooner or later, the boilers themselves.

The pyritiferous ash of the Illinois coals will also give great trouble, since it will fuse into clinkers, which, by their rapid accumulation, stop the draft and otherwise derange the perfect combustion of the coal, so that frequent stops must be made, or favorable moments taken, to remove them from the fire chamber. On passenger trains using such coals, much inconvenience is also experienced by the passengers, who are compelled to inhale the sulphurous fumes which escape from the smoke-stack and are wafted back into the coaches by the motion of the train.

No inconsiderable part of the commercial value of a coal depends upon its strength and resistance to atmospheric agencies, which cause it to crumble and waste when stocked. In this respect, again, Indiana coal will endure stocking for years without deterioration or loss from crumbling, while Illinois coals will crumble into dust from the decomposition of sulphide of iron which it contains in such large quantities. It is given in Trautwine's "Engineer's Pocket Book" that 4.47 tons of water will carry a passenger train 20 to 30 mi., or even more if the grades are light. Then, assuming for the sake of comparison, that the evaporation of 4.47 tons of water will run a given train 25 mi., one ton will run it 5.7 mi. Now, a ton of Indiana block coal will convert into steam one ton more water than the Illinois coal; consequently, it will, under like conditions, run a train 5.7 mi. farther than the Wilmington or Minonk coals—a difference of more than 20 per cent. in favor of Indiana coal. Indeed, so different is the Indiana block coal from the Illinois coals here reported on, chemically and physically, that they can not rightly come into competition for steam and house purposes, where a due regard is paid to economy of fuel, safety to machinery, comfort and health.

E. T. COX,
State Geologist.

Indianapolis, March, 1876.

2257. Steam Value of Indiana Coal in Practice.—Believing that the truest test of a coal is its behavior in practical work, considerable correspondence was entered into with leading firms all over the State in a large variety of industries, to ascertain, if possible, how Indiana coal compared with other coals, especially Pittsburg, as that is often taken as a standard—first, in steam producing power per ton of coal; second, in steam-producing power per dollar of fuel cost; third, in production of ash, effect on grate-bar, etc., etc.

Our inquiries were very liberally responded to, though, unfortunately, but a small percentage of those written to have had experience with other than Indiana coal, or in some cases only with some other coal, and still fewer could give definite figures.

In regard to the comparative steam-producing power of Indiana coal as compared with other coals, the replies on the whole indicate a difference in favor of Pittsburg coal about in accord with the conclusions drawn from a comparison of their analyses.

Before giving recent correspondence it may be well to quote a test made some years ago and printed in the report for 1883 (p. 41):

Mr. J. J. Turner, Superintendent of the Indianapolis & Vincennes R. R., made for some weeks a careful test of the comparative merits of Indiana coal (from Greene county) and the celebrated Pittsburg coal, with especial reference to locomotive purposes, with the following results:

	Pittsburg.	*Indiana.*
Wheels hauled one mile per ton of coal..........	.97	.99
Gallons of water evaporated per ton of coal......	.53	.52
Average temperature during test................	39.00	39.00
Total consumption	.40	.35

Turning to the recent correspondence, we find a considerable difference of opinion, as may be judged from the quotations that follow.

In general the users of Indiana coal seem well satisfied. The following extract is a sample of the expressions used by many:

We are buying altogether Indiana coal. This coal we can state we find satisfactory, as far as steam producing per dollar of fuel cost is concerned and as regards production of ash or effect on grate bars.

That in many cases this satisfactoriness is largely due to the financial aspect of the case is evidenced from such letters as the following:

We use Indiana slack coal and have never used much else. We find it satisfactory, price considered, but from what Pittsburg and Ohio coal we have used, we think it will do 25 per cent. more work pound for pound. We have no figures on which to base this assertion, so you may consider it a random statement.

While, without definite knowledge, I judge that the comparison in this case, as in many others, is between Indiana slack and Pittsburg lump. Slack coal, as is very well known, suffers a great loss as compared with lump coal, in transportation, and in burning by dropping through the grate, even where especially designed grates are used.

Perhaps a still greater source of loss is from the oxidations of the volatile hydrocarbons, which may be insignificant in lump block coal, but may be very high in a wet slack coal, amounting in some cases to as much as half the heat value of the coal. See paragraphs on weathering of coal, further on. We regret that more emphasis was not laid in our inquiries, that the form of the coals compared be given, as it would seem probable that in such cases as the above and others Indiana slack is compared with eastern lump, or, in other words, low-grade Indiana coal is compared with high-grade eastern coal, though we do not know that such is the case.

Again, in some cases the use to which the coal is put makes a great difference. Thus, from an extensive tool works they write:

We are consumers of different kinds of coal, but do not use any Pittsburg coal. Our Indiana coal we use only for steam purposes. We use anthracite, Virginia smithing coal and Connelsville coke, and, of course, we find that the last three named items are much superior to the Indiana coal, although for steam purposes our Indiana coal can not be excelled.

A gentleman familiar with the use of Pittsburg and Linton coal at a city water works plant and at a large stone quarry writes:

We use (at the water works) Pittsburg mine run, as it only takes about half as many cars of coal as Linton coal. * * * Linton coal is a good steam coal, and at the quarry there has not been such a marked difference in cost. We consider the Pittsburg about the same cost as Greene county. (At 50 cents per ton more.) The difference in the two plants, I think, comes from a different demand—one for a slow fire and the other a full fire, the Pittsburg holding the fire better.

We have regretted not being able to give more definite figures, as, after all, they tell the story better than opinions not based on figures. The most definite figures obtained were from a "very careful ten days' test" of "Indiana block coal and Ohio lump" in one of our large water works plants, which gave the following:

	Tons.
Ohio coal used in ten days	75,487
Brazil coal used in ten days	61,600
Difference	13,887
Ohio coal required to pump 1,000,000 gallons of water......	6.7
Indiana coal required to pump 1,000,000 gallons of water....	6.5
Difference ....420 lbs. or	.2
	Lbs.
1 ton of Ohio coal makes ashes	172
1 ton of Brazil coal makes ashes	149

Other figures will be given under the next heading.

2258. As regards the comparative value of block and bituminous slacks, the following letter from a prominent foundry in Brazil is of interest:

> Referring to your letter of the 29th ult., will say that Indiana block coal is equal to any coal in its freedom from sulphur, but, in our opinion, does not make as much heat as Pittsburg or West Virginia coal, and is, of course, much cheaper in this locality. In using slack for steam boiler furnaces, we find the bituminous slack of this locality (which is about the same as the Illinois slack) makes greater heat than block coal slack, and is cheaper, but is far more sulphury, and hence more injurious to boilers and grates.

The letters quoted from have been selected as characteristic of those received, and, in connection with others from which we do not feel at liberty to quote, go to show quite conclusively that: First, with present practice, Indiana coal will average from 5 to 15 per cent. lower in heating power than Pittsburg or West Virginia coal. That, without regard to cost, some of the Indiana coals are better than some of the eastern coals shipped into this State. That if Indiana slack or run of mine (which usually contains a larger per cent. of slack than eastern coals) be compared with eastern coals in the same form, the heat value will be still more in favor of the eastern coals. This is probably due, as stated above, to the oxidation of the volatile hydrocarbons in the fine coal by weathering. That Indiana block coal comes nearer Pittsburg coal for most purposes than other western coals.

Among the interesting things brought out in the letters not quoted from is that many firms having experimented with different Indiana coals have selected the coal which gave them the best results, and in these selections a large variety of coals have been picked out, indicating that good coal is not confined to any one district of the State. These results indicate that the conclusions reached by a study of the analyses are very nearly correct.

2259. From the commercial standpoint a more important question than the first is: How do Indiana coals compare with other coals in steam production per dollar of fuel cost? In most cases the question is not: What is the best coal? but, What coal will give the most power per dollar of cost? In this case location plays a most important role, inasmuch as it influences the cost of coal through freight charges. Let us take an example: One pound of Coal A will evaporate 10 lbs. of water; 1 lb. of Coal B will evaporate 9 lbs. of water. Which will be the cheaper coal to use when A costs $2.25 at the engine room, and B $2.00 at the engine room? To evaporate 900,000 lbs. of water will require 45 tons of A or 50 tons of B; 45 tons of A cost $101.25; 50 tons of B cost $100.00; difference, $1.25, apparently in favor of cheaper coal. But when it is considered that 5 tons more of B have to be handled, with a corresponding increase in ashes to be removed, the difference about disappears, and may easily be reversed if the coal requires much handling. If, however, we assume A to cost $2.50 and B $2.00, the difference in evaporating 900,000 lbs. of water is $12.50, a difference that would ordinarily much more than pay the extra cost of handling. From the above example we might formulate a very general rule, as follows: Where the best heating effect of two coals is in the ratio of 9 to 10 (about the ratio between Indiana and Pittsburg coal), it will be more economical to use the better coal if its cost be not more than one-eighth above the cost of the poorer coal. If it be more than that, the poorer coal will yield the better results for the money. This rule makes no account of sulphur, character of ash, of smoke, and numerous other factors that may in practice greatly affect the problem.

Indianapolis is situated about 70 mi. from the Brazil block field and 90 mi. from the Linton field, and the conditions there may be taken for most of the towns within 100 mi. of the Indiana coal field. On December 9, 1898, the retail price of domestic coals in Indianapolis was as follows:

Indiana coal from Linton	$2 75
Indiana block coal	3 00
Pittsburg, Pocahontas, etc	4 00
Slack coal on switch, to large consumers	75

Cost of Pittsburg over Brazil block, one-third. Cost of Pittsburg over Linton coal, five-elevenths. Under the rule given above, Pittsburg coal could not compete in this market with Indiana coal.

In 1896 steam coal (Indiana) and domestic coals ranged in Indianapolis as follows:*

	Domestic Coals.				Steam Coal.			
	Wholesale.		Retail.		Wholesale.		Retail.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
Brazil block	$1 75	$1 45	$3 00	$2 50	......	......	......	......
Linton	1 50	1 35	2 75	2 25	$0 85	$0 45	$1 50	$1 00
Pittsburg	2 25	2 05	2 75	3 00	......	......	......	......

* Mineral Resources of U. S. for 1896, p. 386.

No quotations were given for foreign steam coals. That Pittsburg coal can not compete in Indianapolis is evident from the letters received from Indianapolis firms, of which it is only necessary to quote from one or two of the largest concerns here:

The Indiana coal can be laid down at Indianapolis at so much less than Pittsburg, that Pittsburg coal is hardly considered available in this district for fuel purposes for large plants.

We have not used Pittsburg coal. It is too expensive for our use. We burn mixed nut and slack under our boilers, and get such coal here in Indiana.

South Bend is about 200 mi. from Brazil, only places in the extreme northeastern corner of the State exceeding it in distance. It may therefore be taken as representing the extreme of unfavorable conditions for Indiana coal on account of the long haul for Indiana coal. It will therefore be interesting to know how Indiana coal competes with outside coals there. Here, again, results differ. The fact that, as might be expected, South Bend is on the border of the Indiana market has led many of the large firms there to make more or less extensive tests.

Reference has already been made to tests by the City Water Works Department. From the financial standpoint these gave the following results:

Ohio coal used in ten days.. 75.487 tons, at $2.82 per ton.		$212 97
Brazil coal used in ten days. 61.600 tons, at $2.44 per ton.		150 30
Difference 13.887		$62 67
Cost of pumping 1,000,000 gallons of water with Ohio coal		$18 80
Cost of pumping 1,000,000 gallons of water with Indiana coal		15 98
Amount saved per 1,000,000 gallons pumped with Brazil coal..		$2 82

We have already quoted from a firm there who prefer Indiana coal, on account of the price, even though in their opinion Pittsburg coal will do 25 per cent. more work. One of the largest plants in the State, situated there, writes:

We have made very exhaustive tests on this question. * * * In a general way, the Indiana coal does not compare with the Ohio coal as to quality. Taking into consideration the freight, we are using Indiana coal.

On the other hand, some of the tests seemed to give the opposite result. Thus, another of the large plants there writes:

Can only say that our experiments have not been as thorough as they should have been to give you the data you desire. * * * We are now using, and have been for some months, a Youghiogheny coal from the Pittsburg district. This is a better coal for steam purposes, as well as for use in annealing ovens, and, while the cost per ton is slightly higher, delivered in our yards, the quality is much superior, and the actual saving on a financial basis is 7.2 per cent. Aside from this, there is a saving in the handling, as a less quantity is burned, and the cost of truckage and of unloading is also materially decreased, owing to a considerably less quantity having to be handled per day.

Another large firm writes:

We have made some experiments with Indiana block coal and also with Pennsylvania coal. The crude results, without any corrections, are as follows: With Pennsylvania coal at 25 cents per ton above Indiana block, we found a difference of about 15 per cent in favor of Pennsylvania coal.

These and other letters from South Bend indicate that its distance from the Indiana field is so great that the freight charges on Indiana coal make it cost almost if not quite as much as Pittsburg, from the standpoint of steam produced per dollar of fuel cost. The balance of evidence in this case seems to be a little in favor of the Indiana coal. Now, an examination of the State map will show at once that there are only a few towns in the northeastern corner of the State that are farther from the Indiana coal field than South Bend. And, while, in going east instead of northeast of the Indiana coal field, the same conditions as at South Bend will be found at a less distance from Brazil (on account of the reduced haul for Pittsburg or Ohio coals), still it is believed that, except the limited areas that get water transportation from the east, over the greater part of the State, Indiana coal will do more work than outside coals per dollar of fuel cost. Of course, local conditions, as long haul by wagon, etc., will materially modify these conclusions. We are led to this conclusion, not alone from the arguments given above, but because they seem to be backed by the experience of our correspondents at numerous places. Thus, Laporte is but a little within the limits given, but the two following quotations are samples of the letters from there:

We do not use any Ohio, Pennsylvania or Virginia coals; freight charges on this stock are against us, and we are buying altogether Indiana coal.

Last year the strike was prolonged and we used Pittsburg and West Virginia coals, and, while they burn and make steam satisfactorily, yet they are so dear that we were glad to get a supply of Island coal again.

In general, therefore, we are led to conclude that, for a steam coal to be used in Indiana, Indiana coal gives the best results for the money.

In comparing different coals, different results are often the result of different adaptability of the furnace to the fuel used. The best furnace and best method of firing is the one which gets the highest value out of the coal, and these differ greatly for different coals. Thus certain coals require a special form of grate, a certain thickness of fire and a certain amount of draft to yield good results. Another coal which, under proper conditions, will yield as good or better results, may, if burned under the conditions favorable to the first coal, appear to be of very inferior quality. Thus in an actual test of a certain coal it evaporated 6.32 lbs. of water per pound of coal, but, deducting what fell through the grate (for it was a very friable coal), it was found to have evaporated 10.5 lbs. of water per pound of combustible. Pittsburg coal, in the same furnace, under a similar test, showed 8.41 and 9.10 lbs. of water evaporated per pound of coal and per pound of combustible, respectively. In this case the character of the furnace made the Pittsburg coal seem much the stronger, while actually the two coals had the comparative strength of 100 to 115.

(b) Through Electricity.

2260. At the present time an electric current is obtained from coal by first burning the coal to produce steam, expanding the steam to produce mechanical motion, using the mechanical motion to drive a dynamo. At each step of the process much energy is lost, so that the energy of the electric current finally obtained amounts to only one-tenth to one-hundredth of the energy possessed by the coal. The high efficiency of electric dynamos and the facility with which energy can be transmitted for short distances by an electric current has led to much thought and time being given to the problem of obtaining an electric current directly from the combustion of the coal. While much progress has been made, the matter must still be considered in the experimental stage, and therefore will receive only this passing notice here.

Suffice to say that the most successful work has been done by Dr. W. W. Jacques and by Dr. Alfred Coehn. The Jacques process consists in brief in blowing air through a bath of fused caustic soda with a carbon anode and an iron cathode, by which is obtained a large current with a small voltage. The work of these investigators is discussed quite fully in the technical magazines of the past few years.

(B) INDIRECT PRODUCTION OF DIRECT RESULTS.

(a) Conversion of Coal into Gas.

2261. This phase of the subject has for us in Indiana the widest interest, for several reasons. Primarily the widespread and continued use of natural gas has made our people appreciate the advantages of gas as a fuel, with the consequent great reluctance to returning to the use of coal again. Second, much of our State is threaded with pipe lines, and many of our cities are thoroughly equipped for distributing fuel in the form of gas. Third, there has arisen out of the necessities of the case a class of men trained in all the practical phases of gas transportation and distribution. Fourth, Indiana coal is high in gas or the volatile hydrocarbons, and if the coal can be burned in the form of gas it will yield a much higher efficiency as compared with other coals than at present. Fifth, while at present large consumers of coal for power purposes are using slack, formerly a waste product, and obtaining it often at a price below all competition, yet it seems evident that it is only a question of time, and that not long, when this increasing demand for cheap coals will raise the price, until, in the words of one of the largest shippers of coal in the State, the size of the coal will have nothing to do with its selling price, but lump and slack will sell for the same or at prices proportional to their heating value. Sixth, the gradual improvement of the gas engine with efficiencies of 20 per cent. or more from the gas or 15 to 20 per cent. from the coal, and of the new heat motors recently introduced in Europe, with an efficiency of over 34 per cent. as against 4 to 14 per cent. for steam engines, is likely in the future to create a constantly increasing demand for gaseous fuels.

Accordingly, the question is a common one with thinking men all over the State: "Can we not utilize our coal fields in the production of a gas that shall take the place of the natural gas when that gives out?" Realizing the importance of this subject, the writer had hoped to give the matter considerable study, but there proved not to be time, and the best he is able to do is to present a sort of summary of a few of the well-known processes and such scattered facts as could be picked up in a few hours' reconnoissance in this field. It is hoped they may be suggestive and may interest competent persons sufficiently to induce them to go deeper into the subject, with the result of the final practical solution of the problems presented.

Coal is a solid, yet it requires but a small amount of heat to drive off a large volume of gaseous matter, and there is left a light porous solid known as coke. The larger part of this gas is combustible, and, what is more, a pound of it when burned will yield a larger amount of heat than a pound of the carbon which is left, and which, in the present method of burning coal, is mainly depended upon for the production of heat. Further, if the carbon remaining be burned with an insufficient supply of air or oxygen, there is formed carbon monoxide, CO, which is a combustible gas, and still has a large part of the heating power of the carbon. This suggests very briefly how the solid fuel coal may be converted into a gaseous fuel. In practice, quite varying processes are used, yielding quite different results.

The different results obtained may be tabulated as follows:

Illuminating gas or coal gas.
Producer gas.
Water gas.
Dowson or semi-water gas.
Rose-Hastings and other modifications of above.
Acetylene gas.

The principles underlying and main operations in the production of the above gases may be briefly stated:

2262. Illuminating Gas.—This gas is simply the volatile hydrocarbons of the coal which are driven off by heat. In practice it is made in two ways—in a closed retort when the gas is the object sought, and in a modified retort, the coke oven, in which the coke is the product desired and the gas is too often wasted.

In the first case the coal is placed in a series of clay retorts to which air has not access and heated in furnaces until the volatile matter is driven off. After coming off from the retort, it, the gas, is carried through a series of purifiers which remove the tar, ammonia, sulphur and other impurities. This, the ordinary process of making "artificial gas," is too well known to need lengthy description.

The second case is only a modification of the first, although a different object is in view. The ordinary bee-hive coke oven is like a gas retort in principle, except that the heat necessary to produce the coke is obtained by the combustion of part of the charge of coal. In the more modern coke oven, however, the principle of the gas retort is more closely followed, and the heat is derived by the burning of part of the gas in flues in the side walls of the oven. In this case the two processes are quite similar, except that the coke retort is five or six times as large in each dimension, and in the first case the heat is supplied by part of the coke, which is there a by-product, while in the other case the heat is supplied by part of the gas. In the latter case the gas deprived of its tar, ammonia and benzole before being burned in the

oven flues. In the first case all the gas is obtained, in the latter not much more than half. Whether tried or not, the suggestion has been made that the heat necessary for the coking might be supplied by producer gas, which is much poorer and cheaper.

2263. Producer Gas.—This gas is made by forcing air into an incandescent mass of coke. In principle, the air, as it enters the combustion chamber, supplies oxygen to the carbon of the coal and there is formed CO_2 as in most cases of the combustion of the coal; but as it passes upward through the mass, this CO_2 meets large quantities of uncombined carbon, and this unites with part of the oxygen of the CO_2, leaving CO and forming large additional quantities of CO. So that the gas that passes off is composed mainly of CO and the inert nitrogen (N) of the air. The gas which passes off from a blast furnace is largely of this nature, and early forms of retorts for making producer gas were modeled after the blast furnace, a type that is being returned to. As just stated, producer gas contains a large percentage of nitrogen. This formed four-fifths of the air driven into the furnace, and necessarily passed on and became part of the gas resulting from the process. As it will not burn nor support combustion, it becomes that much dead matter in the gas. Various attempts have been made to find a process of cheaply withdrawing the nitrogen, but, as it does not combine actively, these efforts have as yet met with small success. Better success has been met with by substituting a gas for the air that, while supplying the oxygen, contained no inert gas. The substance used is water in the form of steam, and the product is called water gas.

2264. Water Gas is made by forcing a current of superheated steam through a mass of incandescent carbon in the form of coal or coke. In this case, instead of the nitrogen associated with the oxygen, as in the air, we have hydrogen (H) united with the oxygen, but in the presence of the highly heated carbon the union is broken up and the oxygen unites with the carbon, as before passing out as CO, but in this case associated with hydrogen, a highly combustible gas, instead of nitrogen. In this case the associated gas, hydrogen, is of small volume and consequently the quantity of gas produced per ton of coal is much smaller than in the manufacture of producer gas, but makes up by being much richer. Unfortunately the process is not continuous, as the heat required to disassociate the steam tends to cool the mass of carbon below the point where the desired changes will take place. It is therefore necessary to first drive air through the mass until its temperature is sufficiently high, when the air is turned off and steam is driven through. The plant required may be described as an upright retort or generator, a boiler for generating steam, a superheater, and a fan for drawing the gases through the retorts. Frequently two or more retorts are used, alternating in their action. As the gas produced is nonluminous it is usual to add to the gas as it passes through the top of the generator a small quantity of some form of petroleum, and as the gas is drawn through the superheater this petroleum is broken up into the lighter fixed gases, thereby greatly enriching the water gas; when thus enriched water gas is known as carburetted water gas. It is not necessary here to go into the details of the process, and it will of course be understood that as little heat as possible is wasted, the superheaters and boilers being heated from the heat carried out by the gases.

2265. DOWSON, OR SEMI-WATER GAS is a result of a combination of the principles of the manufacture of water gas and producer gas, as in it a combined current of air and steam is driven into the retort or generator, the air being in sufficient amount to keep the mass of carbon at the high temperature necessary. This gas, as might be expected, contains a large mixture of nitrogen, but it contains a higher percentage of combustible gases than the producer gas.

2266. MODIFICATIONS OF THE ABOVE PROCESSES.—A difficulty encountered with much of Indiana's coal in the manufacture of these gases is its caking property, a property that would seriously interfere with drawing a current of air or steam through any considerable mass of it. The suggestion is made that the gas could be successfully made by first driving off the volatile hydrocarbons in a coking retort and then transferring the coke so produced to retorts or generators without cooling. It would seem as though such an apparatus could be devised, by which the coking and generating could be carried on simultaneously, the coking retorts perhaps being placed above the generators so that the waste heat of the generators would do the coking while the coke could be transferred without cooling to the generators below. The gas from the coking retorts, ordinary coal gas, would then be mixed with the gas produced in the generator, whether that be producer, water or Dowson gas.

Other processes for utilizing bituminous coals are already in the market. As an illustration of these may be described the Rose-Hastings process, which is being tried with success at Louisville, Ky. The following brief description of this process is given by Mr. Joseph D. Weeks in the 16th Ann. Rep. Geol. Surv. U. S., Part IV, Mineral Resources, p. 419: "This process * * * uses soft coal and what

are known as cumulative generators. The plant in operation at Louisville can be described as having four upright retorts or generators and one superheater, all set in a circle. Soft coal is charged into three of these retorts and coke into the fourth. Air is driven through the three coal chambers, burning a portion of the coal and heating them to a high temperature, the resulting hot gases being meanwhile carried down through the coke, in this way heating it up without burning it. The heat necessary to start the blast and also that required to bring the coke to the finishing temperature is gained by a short blast upward through the coke. When the machine has been brought to the right heat and before the blast is stopped, a charge of soft coal is dumped into each one of the coal chambers. The blast is then stopped and steam turned under each of the coal chambers, and, mingling with the coal gas distilled off from the fresh charge of soft coal, passes over to the coke chamber, down through the red-hot coke, where it has the vapors of oil changed into fixed gases, and up through the superheater, where this process is thoroughly completed."

Since writing the above we have received from the Bridgewater Gas Company, of East Liverpool, Ohio, a short description of the process they are using by which they are enabled to produce a gas that competes with natural gas at 20 cents a thousand for domestic use. The main features of the process seem to be that instead of blowing air through the coal, as in making producer gas, the air is first driven through manganate of soda, which absorbs the oxygen. The oxygen is then released with steam and the steam and oxygen driven together through the generator. This surplus of oxygen is sufficient to keep the temperature of the mass up to the point where the steam is dis-associated and so the process becomes continuous. The bituminous coal found in that section is used. The result is a gas of about 500 heat units.

At an experimental plant erected at Scranton, Pa., by Mr. J. Gardner Sanderson, he claims that by actual measurement they were able to produce and store from 120,000 to 188,000 cu. ft. of gas with one ton of fine waste from the washing of anthracite culm. That was from what was left after the marketable sizes had been screened out.

2267. ACETYLENE GAS.—This gas, which has only recently been introduced commercially, and especially for lighting, is made by quite a different process from the others. The gas has the formula C_2H_2 and is made by the action of CaC_2 or calcium carbide on water. The recent notable extension in the use of this gas is due to improved methods of producing CaC_2 on a commercial scale. At present this is made by the action of a powerful electric arc on a mixture of powdered coal or coke and lime. The two substances are mixed in the proportion of 87½ lbs. of lime to 56¼ lbs. of carbon, which yields theoretically 100 lbs. of CaC_2, the rest passing off as CO. In contact with water this carbide yields acetylene gas C_2H_2 and CaO, H_2O.

2268. Composition of the Gases.—In this connection it will be of interest to add the composition of natural gas.

COMPONENTS.	Natural Gas. (Finley.)		Coal Gas.		Producer Gas.	
	*1	2	3	4	5	6
	Vol.	Wt.	Vol.	Wt.	Vol.	Wt.
Hydrogen .... H	2.18	.268	46.00	8.21	6.00	.458
Marsh gas .... CH_4	92.60	90.383	40.00	57.20	3.00	1.831
Carbonic oxide .... CO	.50	.857	6.00	15.02	23.50	25.095
Olefiant gas .... C_2H_4	.31	.531	4.00	10.01	....	....
Carbonic acid .... CO_2	.26	.700	.50	1.97	1.50	2.517
Nitrogen .... N	3.61	6.178	1.50	3.75	65.00	69.413
Oxygen .... O	.34	.666	.50	1.43	....	....
Hydrogen sulphide .... H_2S	.20	.417	....	....	....	....
Water vapor .... H_2O	....	....	1.50	2.41	1.00	.686

COMPONENTS.	Water Gas.		Producer Gas.	Dowson Gas.	Sanderson Gas.	Taylor Gas.
	7	8	9	10	11	12
	Vol.	Wt.	Vol.	Wt.		
Hydrogen .... H	45.00	5.431	2.80	14.00	19.85	4.51
Marsh gas .... CH_4	2.00	1.931	....	....	0.66	1.79
Carbonic oxide .... CO	45.00	76.041	33.30	27.20	28.80	25.38
Olefiant gas .... C_2H_4	....	....	....	....	....	....
Carbonic acid .... CO_2	4.00	10.622	.50	5.2	3.80	4.02
Nitrogen .... N	2.00	3.380	63.40	53.3	46.46	64.04
Oxygen .... O	.50	.965	....	....	0.40	0.26
Hydrogen sulphide .... H_2S	....	....	....	....	....	....
Water vapor .... H_2O	1.50	1.630	....	....	....	....

*Nos. 1-8 by Emerson McMillin, Geological Surv. of Ohio, VI, pp. 538-543; Nos 9-10 by Arthur Kitson, Jour. Franklin Inst., Dec., 1890, p. 321; No. 11 by J. Gardner Sanderson, from anthracite culm at Scranton; No. 12 by H. W. Spangler, of gas made by Taylor process at Otto Gas Engine Works at Philadelphia.

It will be seen from the above that natural gas is principally marsh gas; coal gas is likewise largely marsh gas, but with considerable quantities of hydrogen, carbonic oxide and olefiant gas; producer gas is principally carbonic oxide and nitrogen, water gas principally carbonic oxide, with some carbonic acid and hydrogen. Dowson gas is principally hydrogen, carbonic oxide and nitrogen. Acetylene gas is not a mixed gas like the others. Mr. Edward H. Earnshaw gives the following analyses of coal gas and carburetted water gas:*

	Coal Gas.	*Water Gas.*
Benzene vapor	.50	.6
Heavy hydrocarbons	4.25	12.8
Carbonic acid	8.04	30.7
Hydrogen	47.04	32.4
Marsh gas	36.02	13.9
Higher paraffins	0.00	2.4
Carbonic acid	1.60	2.7
Oxygen	.39	.7
Nitrogen	2.16	3.8

2269. Weight of Gases.—These gases have the following specific gravities:†

Natural gas (Finley)	.570
Coal gas	.450
Water gas	.570
Producer gas	1.000
Air	1.000

1,000 ft. of of air will weigh at 40° F.	80.0 lbs.
1,000 ft. of natural gas will weigh at 40° F.	45.6 lbs.
1,000 ft. of coal gas will weigh at 40° F.	32.0 lbs.
1,000 ft. of water gas will weigh at 40° F.	45.6 lbs.
1,000 ft. of producer gas will weigh at 40° F.	80.0 lbs.

2270. Caloric Value of Gases.—As taken from different sources, the gases mentioned yield about the following heat units in burning:

One foot of natural gas yields (about)	1,100	B. T. U.
One foot of coal gas yields (about)	730	B. T. U.
One foot of water gas yields (about)	320	B. T. U.
One foot of water gas (enriched) yields (about).	680	B. T. U.
One foot of producer gas yields (about)	150	B. T. U.

*Chemical Composition and Technical Analysis of Water Gas, Edw. H. Earnshaw, Jour. Franklin Inst., 146, p. 161, Sept., 1898.

†McMillin, Geol. Surv. of Ohio, VI, 537.

One foot of Dowson gas yields (about)	180	B. T. U.
One foot of Rose-Hastings gas yields (about)	410	B. T. U.
One foot of Rose-Hastings gas (enriched) yields (about)	650	B. T. U.
One foot of acetylene gas yields (about)	1,476.7	B. T. U.
One foot of East Liverpool gas yields (about)	500	B. T. U.

From these figures it will be seen that coal gas yields only about three-fourths as much heat as natural gas for equal volumes; water gas, unenriched, less than one-third; enriched, over one-half; producer gas, one-seventh or less, etc.

By the pound the difference is still more marked. Mr. McMillin gives the following figures:

One pound of natural gas yields	24,195	B. T. U.
One pound of coal gas yields	22,968	B. T. U.
One pound of water gas (unenriched) yields	7,069	B. T. U.
One pound of producer gas yields	1,957	B. T. U.

The difference in amount of water evaporated from a temperature of 60° F., when the resulting gases are escaping at 500° F., and when there is 20 per cent. excess of air introduced with all the gases (and in all cases ignoring radiation), has been figured out by Mr. McMillin as follows:

1,000 ft. of natural gas will evaporate 893 lbs. of water.
1,000 ft. of coal gas will evaporate 590 lbs. of water.
1,000 ft. of water gas will evaporate 262 lbs. of water.
1,000 ft. of producer gas will evaporate 115 lbs. of water.

We are now ready to proceed to the most important item:

2271. Total Heating Power of Gases from One Ton of Coal, and Cost of Same.—In the preceding paragraph it would seem that the advantage was all on the side of coal gas, or, to a less extent, of water gas. But in that it is forgotten that one ton of coal will yield much less coal gas or water gas than of producer gas or Dowson gas, and that when that factor is taken into account the difference largely disappears.

Youghiogheny gas coal yields 4.34 cu. ft. of gas to the pound of coal at the Indianapolis gas works, according to Mr. Cox, while he gives for Indiana cannel coal about 5 cu. ft. and Indiana caking coal about 4 cu. ft. According to these figures, one ton of Indiana coal would yield about 8,000 cu. ft. of coal gas. One ton of coal (anthracite) converted into CO with air gives 60,000 cu. ft., and, adding the 110,000 cu. ft. of nitrogen that enters with the air, we have one ton of coal yielding 170,000 cu. ft. of producer gas.

Mr. Kitson, from his experience,* estimates that in making semi-water or Dowson gas under the best conditions, with the steam furnished at a temperature of 500° F. from a separate boiler, 1 ton of coal will decompose 1,500 pounds of steam, yielding:

H	166 lbs. or	29,800 cu. ft.
CO	4,194 lbs. or	53,700 cu. ft.
N	5,179 lbs. or	63,500 cu. ft.
CO_2	733 lbs. or	6,000 cu. ft.
	10,072	153,000

But, deducting ⅛ to ¼ of a ton for the heat necessary to raise the temperature of the steam, the results are reduced to 130,000 cu. ft. of gas, or, if the heat of the cooling gas be utilized, say 150,000 cu. ft.

Water gas, unenriched, under the best conditions yields about 40,000 cu. ft. of gas to the ton of coal.

Rose-Hastings gas, enriched, yields about 64,000 cu. ft. to the ton of coal, though in this case it should be noted that the oil and coke that enter into the process will often cost more than double what the coal costs.

In the manufacture of acetylene gas one ton of coal is used in making 214 lbs. of calcium carbide, and as one pound of the latter yields from 5.5 to 5.75 cu. ft. of gas, a ton of coal will yield over 13,310 cu. ft. of gas. Here, again, there are other items that very materially affect the result from the standpoint of cost.

Combining the figures of this paragraph with those of the last, there results as the product of one ton of coal:

Coal gas	8,000 cu. ft.×	730 B. T. U.=	5,840,000
Producer gas	170,000 cu. ft.×	150 B. T. U.=	25,500,000
Dowson gas	150,000 cu. ft.×	180 B. T. U.=	27,000,000
Water gas (not enriched)	40,000 cu. ft.×	330 B. T. U.=	12,800,000
Rose-Hastings gas (enriched)	64,000 cu. ft. ×	650 B. T. U.=	41,600,000
Acetylene gas	13,300 cu. ft. ×	1,476 B. T. U.=	19,630,800

Here again the figures tell only a partial story, as the desideratum is the number of heat units for a given cost, and in the different processes the initial cost of the ton of coal may be the most important item or it may be a very small item. Thus in the Rose-Hastings

*Jour. Frank. Inst., XXXVIII, 321.

process the coal in the generator represents only a little over one-fourth the cost of the materials used. Lack of time has prevented getting figures that may be used for comparison. Such figures, however, as are at hand may be suggestive.

As to the cost of making coal gas, I can do little better than to quote from an article by Mr. Edw. W. Bemis on "Recent Results of Municipal Gas Making in the United States," in Vol. VII of the Review of Reviews (American magazine). He gives the figures for ten cities which he had studied. Of these all made coal gas at the time except Philadelphia, which was using 40 per cent. of water gas (doubtless carburetted). Bellefontaine and Hamilton, Ohio, had just introduced improved processes by which the cost was much reduced. Thus at Bellefontaine, using an Askins gas plant with a capacity of 126,000 cu. ft. a day, of 22 candle power, the cost of 1,000 ft. in the holder (not counting interest or taxes) was 20 cents. Adding 10 cents for interest, etc., makes cost of making gas 30 cents per 1,000 ft. The distribution will cost from 10 to 30 cents extra.

At the cities to be mentioned coal ranges in price from $1.64 at Wheeling, W. Va., to $4.39 at Danville, Va. Of the by-products the coke sells at these cities for from 3.5 cents at Wheeling to 10 cents at several of the cities; tar, per barrel of 50 gallons, sells at from $1.32 at Richmond, Va., to $3.90 at Hamilton, Ohio.

The desired figures are included in the following table:

CITY.	Cost in Holder, in Cents.	Cost at Point of Consumption, in Cents.	Interest at 5 Per Cent. and Taxes at 2 Per Cent., in Cents.	Total Cost per 1,000 Feet, in Cents.
Philadelphia	48	85.5	20.6	106.1
Richmond, Va	Others not determined.	84.3	23.1	107.4
Alexandria, Va		94.3	29.3	125.6
Henderson, Ky		58.1	32.3	80.4
Wheeling, W. Va		35.4	20.4	55.8
Bellefontaine, Ohio		63.7	30.8	94.5
Danville, Va		107.7	32.7	140.4
Charlottesville, Va		46.5	38.8	85.3
Hamilton, Ohio	42.2	52.4	43.3	95.7
Fredericksburg, Va	......	127.1	47.0	174.1

In many of the above cases local causes serve to account for the difference exhibited.

It is quite probable that since that article was written (1893), advanced methods have very materially lowered the figures given. The utilizing of the coke to make water gas to be enriched and mixed with the coal gas is making considerable saving.

For comparison, the cost of 1,000 cu. ft. of illuminating gas as made in Indianapolis in 1896-97 is given. (From detailed report made June 18, 1899, of an examination of the books of the Indianapolis Gas Company for the mayor and board of public works.)

Coal	$0.206
Cannel coal	.017
Lime	.011
Naphtha for Lowe gas process	.027
Other materials	.077
Cost of materials	$0.338
Labor at works	$0.180
Superintendence	.028
Taking meter statements	.036
Clerk hire	.029
General office salaries	.050
Main items of labor, etc	$0.323
Repairs at works and residual expense (freight, etc.)	$0.133
Repairs, lines, etc	.055
Operating pipe lines	.043
Repairs, etc	$0.231
Taxes	$0.065
Other items	.054
Total	$1.011
Less receipts from residuals	.326
Net cost of 1,000 cu. ft. (not including interest on investment)	$0.685

From this it would seem that the cost of the gas in the holder was:

Materials	$0.338
Labor and superintendence	.208
Repairs and residual expense	.133
	$0.679
Less receipts from residuals	.326
	$0.343

While the cost of distribution, etc., is practically an equal amount.

These figures are for a yearly output of practically 200,000,000 cu. ft. From statements of the officers of the company, it was evident that by more than doubling the output the cost per 1,000 ft. would be materially decreased, possibly one-fourth; that is, on a basis of an output of 500,000,000 cu. ft. a year, the costs would be nearer:

Cost in holder	$0 28
Distribution, etc.	22
Selling price	75

The gas produced is a mixture of coal gas and carburetted water gas, no natural gas being used, according to the statement of the company.

The figures for from February 1, 1898, to February 1, 1899, gave a net cost of 69.81 cents per 1,000 cu. ft. The same week this report was made the local gas company of Cincinnati made a proposition to the Board of Public Works for a 20-year franchise on the basis of selling illuminating gas for 75 cents per 1,000 cu. ft. and fuel gas at 50 cents per 1,000 cu. ft. This is mentioned as showing the downward tendency in the cost and selling price of coal gas.

Mr. Weeks gives the following figures of materials used and cost at assumed prices of these materials in the manufacture of Rose-Hastings gas, having been favored with a statement as to the actual amount used in making over 10,000,000 cu. ft. of 20 candle power gas at the Louisville works.

Materials used to make 10,596,000 ft. of Rose-Hastings gas—

Oil	gallons	21,325,000
Soft coal slack	lbs.	328,503,900
Coke	lbs.	60,932,175
Boiler coal	lbs.	87,954,270

Average per 1,000 cu. ft.—

Oil	gallons	2.01
Coal	lbs.	31.00
Coke	lbs.	5.75
Boiler coal	lbs.	8.30

By taking a location where oil is 1.5 a gallon, coal $1.20 a ton, coke $2.40 a ton, which approximate the conditions at Indianapolis, the cost of materials per 1,000 cu. ft. would be:

	Cents.
Oil, 2.01 gallons, at 1.5 cents	3.02
Coal, 31 lbs., at $1.20 a ton	1.86
Coke, 5.75 lbs., at $2.40 a ton	.67
Boiler coal, 8.3 lbs., at $1.20 a ton	.38
Total	5.93
Add for labor	1.60
	7.53

This of course does not include interest or taxes, etc. Distribution would amount to, as before, 10 to 30 cents per 1,000 ft.

This plant is used to augment the supply of natural gas on cold days, etc.

Mr. Kitson estimates that with coal at $3 a ton it should not cost over 2.5 cents per 1,000 ft. to make Dowson or semi-water gas. I judge that would not include labor, interest, taxes, etc.

I have not at hand figures giving cost or estimates of cost of water gas.

In a paper in the Journal of Franklin Institute, No. 139, p. 321, Mr. J. J. Suckert expresses his belief that calcium carbide can be obtained at a cost of $5 a ton. He gives tables showing the debit and credit sides of the account of a firm who are making it as a by-product in the manufacture of fire and dry-pressed brick, in which the calcium carbide is credited as selling at $7 a ton. In other articles describing its manufacture, the cost of manufacture is placed variously at from $20 to $40 a ton. If it can be made for $5 a ton, the cost of materials for 1,000 cu. ft. of acetylene gas would not be far from 50 cents.

From the above figures we may derive the following:

Cost of 1,000 cu. ft. of coal gas (material and labor only), say	33.33	cents.
Cost of 1,000 cu. ft. of Askins gas (material and labor only), say	20.00	cents.
Cost of 1,000 cu. ft. of Rose-Hastings gas (material and labor only), say	7.53	cents.
Cost of 1,000 cu. ft. of Dowson gas (material and labor only), say	2.50	cents(?)
Cost of 1,000 cu. ft. of acetylene gas (material and labor only), say	50 00+	cents.
Cost of 3,000 cu. ft. of coal gas (material and labor only), say		$1.00.
Cost of 5,000 cu. ft. of Askins gas (material and labor only), say		1.00.
Cost of 13,200 cu. ft. of Rose-Hastings gas (material and labor only), say		1.00.
Cost of 40,000 cu. ft. of Dowson gas (material and labor only), say		1.00.
Cost of 2,000 cu. ft. of acetylene gas (material and labor only), say		1.00+.

$1.00 worth (per cost) of coal gas yields	3,000 × 730 = 2,190,000	B. T. U.
$1.00 worth (per cost) of Rose-Hastings gas yields	13,200 × 650 = 7,580,000	B. T. U.
$1.00 worth (per cost) of Dowson gas yields	40,000 × 180 = 7,200,000	B. T. U.
$1.00 worth (per cost) of acetylene gas yields	2,000 × 1,476 = 2,952,000—	B. T. U.

As stated above, these figures must not be considered as representing with any accuracy the comparative value of the different gases, but may be considered as showing that, as far as our data goes, carburetted water gas, semi-water gas and modifications of these yield many times as much heat per dollar of cost as the common illuminating or coal gas.

Mr. F. C. Phillips, of Western University, Alleghany, Pa., has calculated the calorific power of natural gas,* and his figures show for 1,000 cu. ft.:

> Available heat units: 261,190 to 324,210.
> Pounds of water (previously heated to 100° C.) evaporated: 1073.8 to 1333.
> Pounds of pure charcoal equal in heating power: 71.26 to 88.45.

But it is found that in practical use the natural gas has an efficiency much greater than that of the coal, so that practically one ton of Pittsburg coal is equivalent to less than 22,400 cu. ft. of natural gas, or it may be safe to say that one ton of Indiana coal is equivalent to 20,000 cu. ft. of Indiana gas.

In the 18th Ann. Rep. of the U. S. Geol. Surv., Mineral Resources, except coal, p. 897, Mr. F. H. Oliphant gives the following equivalents:

Twenty cubic feet or 1 lb. of natural gas will evaporate 20 lbs. of water at 212°.

Sixteen cubic feet of natural gas or 1 lb. of oil will evaporate 16 lbs. of water at 212°.

Ten cubic feet of natural gas or 1 lb. of coal will evaporate 10 lbs. of water at 212°.

Ten cubic feet of natural gas, therefore, equals 1 lb. of coal, or 20,000 cu. ft. of natural gas equals 2,000 lbs. or one short ton of coal; 4,800 cu. ft. of natural gas equals 300 lbs. of oil (1 barrel 34° B.); $4\frac{1}{8}$ barrels of oil equals 1 ton of coal.

Mr. Leach, State Supervisor of Gas, reports tests made at Kokomo, Ind., in which the results gave:

One ton of Indiana coal did same work as 20,000 cu. ft. of natural gas.

One ton of anthracite coal did same work as 29,527 cu. ft. of natural gas.

Boiler required 1 cu. ft. per minute per horse power, or 60 cu. ft. per horse power hour.

The Standard Oil Company, according to "Steam" (published by Babcock & Wilcox Company), estimate that 173 gallons are equal to a gross ton of coal, allowing for incidental savings, as in grate-bars,

* Am. Chem. Jour., XVI, 406-429.

carting ashes, attendance, etc. This is but a trifle below the other estimate, as it makes 4.11 barrels of oil equivalent to 1 ton of coal.

Taking the general figures that, bulk for bulk, coal gas will evaporate two-thirds as much, and enriched water gas one half as much as natural gas, we obtain the following costs of the different fuels necessary to evaporate 10 tons of water:

Fuel.	*Amount required.*	*Cost.*	*Total.*
Coal	1 ton,*	$1.00 to $4.00 per ton (delivered)	=$1.00 to $4.00
Natural gas	20,000 cu. ft.,	05 to 20 per 1,000 (delivered)	= 1.00 to 4.00
Oil (crude)	173 gal.,	015 to 03 per gal. (delivered)	= 2.59 to 5.19
Coal gas	30,000 cu. ft.,	25 to 35 per 1,000 + $0.25 to $0 35	=15.00 to 21.00
Water gas	40,000 cu. ft.,	08 to 18 per 1,000 + 15 to 30	= 9.20 to 16 80
Rose Hasting	40,000 cu. ft.,	08 to 12 per 1,000 + 15 to 30	= 9.20 to 16.80
E. Liverpool, etc	40,000 cu. ft.,	08 to 12 per 1,000 + 15 to 30	= 9.20 to 16.80
Dowson or semi-water gas	120,000 cu. ft.,	025 to 05 per 1,000 + .05 to .10 for delivery.	9.00 to 15.00

These figures must not be considered as more than suggestive of comparative results. They indicate, first, that with gas at the present price in Indianapolis ($0.06 to $0.10 a thousand cu. ft.), coal can not compete for domestic use nor can any artificial gas be made to successfully compete with it, nor would it be feasible for the present natural gas companies to supplement their natural gas supplies with an artificial gas during times of excessive demands, as during extreme cold weather. Second, that with present prices, or probable future prices with present methods, artificial gases can not be made to compete with coal from the financial standpoint, though there would be some competition due to natural advantages of a gaseous fuel over a solid fuel. Third, they indicate that for fuel purposes coal gas can not compete with strictly fuel gases. Fourth, that as between the different fuel gases the margin of favor is not strongly on the side of any one gas or process, as far as the information we were able to obtain goes. In general, that with present methods the advantage will all be on the side of coal.

If, for a moment, we consider present tendencies, it will be evident that the tendency will be for the gaseous fuels to gain in advantage over coal, and, in view of the failure of natural gas, for artificial gases to gain over natural gas. For, while coal has shown a slight downward tendency in price, artificial gases for fuel purposes have shown a marked decrease in cost of production. Further, coal mining has reached a stage where improvements will lower the price but small fractions at a time, while fuel gas engineering is still in a somewhat primitive stage. Again, mechanical engineering appears to be having

* Say 1.3 tons Indiana slack.

much greater success in raising the efficiency of gas engines than in increasing the efficiency of the steam engine. And still further is the constant gain in the efficiency of transporting potential energy in a gaseous form rather than in the solid form. These and other factors seem to show the tendency to be in favor of artificial fuel gases. Thus I would make the suggestion that to secure the highest efficiency, other things being equal, a gas made mainly from coal should be made in the mine. That is, having prepared a point in the mine by replacing the pillars of coal with stone or masonry and secured the necessary height of rooms by taking down roof or taking up the floor, set up the plant for the manufacture of gas at that point. By this plan the principal raw material would be obtained at a minimum, nor does it appear that in most cases this advantage would be offset by other disadvantages.

Considering these tendencies, it seems safe to predict that within a very few years it may be possible, by using the best processes under the best conditions, to sell a fuel gas in cities not over 100 miles from the coal field that will be little, if any, more expensive than coal for household purposes, and which by the use of gas engines may successfully compete with coal for steam production.

2272. TRANSPORTATION OF ENERGY.—Energy is transported in one of two forms, kenetic or potential. An electric current is an example of the first, a car load of coal is an example of the second. The one is active energy, the other is stored energy. The one is subject to loss through everything that can absorb energy with which it may come in contact. For this reason it can be transmitted only limited distances, depending on the ability to insulate it from those substances which will absorb its energy. For this reason it is generally conceded that where energy is to be transmitted long distances it should be in the potential form. Electricity has taken a prominent place in recent years in the transmission of power, but experience seems to show that where the power is to be transmitted over 30 mi. it is cheaper to ship the coal than to send the same power by electricity. Mr. N. W. Perry* cites the case of the New York Edison Illuminating Station, where it is found cheaper to haul coal two miles by cart at a cost of 45 cents a ton to their plant in the heart of the city, with the enormous rents there, than to locate on the water front, where rents are cheap and the coal can be taken directly from the boat, and to transmit their electricity by wire the additional two miles. The suggestion is often made that with the high efficiency now attained by the electric dynamo

* Engineering Magazine, XII, 49.

and motor, it would be cheaper to convert the energy of the coal into electric energy at or in the mine and transmit it by large copper cables to the points at which it is to be used. The plan is attractive and it is possible may be rendered feasible by future inventions in electricity. Probably the greatest distance that electricity has been transmitted in quantity is from the River Neckar, at Lauffen, Germany, to Frankfort, a distance of 109 mi. Fresno, California, receives power 35 mi., using a triphase alternating current and pressure of 11,200 volts. Sacramento, Cal., receives 3,000 H. P. from Folsom, 24 mi. away, using the same system and a pressure of 11,500 volts. Perhaps the most notable example is the system in operation between Niagara Falls and Buffalo, with a capacity of between 50,000 and 100,000 H. P. President A. E. Kennelly, in his inaugural address before the American Institute of Electrical Engineers, says that a copper rope one-half inch in diameter will carry 2,500 kilowatts (equals about 3,350 H. P.), by maintaining an effective potential of 10,000 volts, with a loss of energy of two-thirds of 1 per cent. per mile. One suggestion that has been made in this connection is the conversion of the coal into gas at or in the mine and its immediate use without loss of heat in a gas engine or heat motor coupled directly to the dynamo. In fact, at the time of writing, investigations being carried out along the line of the transmission of electric energy without wires suggest that the near future may entirely revolutionize the utilization and transmission of the energy of coal, and suggest that we may soon have the energy of the coal transformed into electric energy in the mine and from thence distributed without wires to whatsoever points it may be desired. Turning from this to accomplished facts, it is found that, taking into consideration the losses in transit and the great first cost of conductors, the electric current can not compete with the coal car over any considerable distance.

The cost of railroad transportation of coal is generally estimated at .5 or ½ cent per ton per mile. At $1 a ton, 200 tons can be carried at a cost of 1 ton, or 200 horse power requires 1 horse power to transmit it one mile. With coal at $3, one horse power will serve to transmit 600 horse power. Mr. Perry estimates that to transmit every one mile by electricity costs 145 times as much as to transport the equivalent coal 1 mi. by rail. As compared with these, Mr. Denny Lane has estimated that with ordinary 16 candle power coal gas 3,000 horse power could be sent a distance of 1 mi. for 1 horse power, or being 1-30 of 1 per cent. of the power transmitted. I do not know whether this includes that most important item, interest on investment, or not.

If cast-iron piping is used, its weight per mile as given by Mr. McMillin,* may be used to calculate its cost per mile on a basis of $20 a ton.

Pipe 6 in. in diameter 7-16 in. thick, will weigh 158,400 lbs., cost $1,584.
Pipe 12 in. in diameter ⅝ in. thick, will weigh 440,000 lbs., cost $4,400.
Pipe 24 in. in diameter ⅞ in. thick, will weigh 1,188,000 lbs., cost $11,880.
Pipe 30 in. in diameter 1 in. thick, will weigh 1,737,000 lbs., cost $17,370.

Wrought iron, according to the same authority, gives:

Pipe 3 in. in diameter will cost, at	$0 20 a foot,	$1,056.
Pipe 6 in. in diameter will cost, at	55 a foot,	2,904.
Pipe 12 in. in diameter will cost, at	2 40 a foot,	12,672.
Pipe 15 in. in diameter will cost, at	3 70 a foot,	19,536.

The comparative carrying capacity of the different-sized pipe is indicated in the following table, where for comparison the pressure in each case is 2 in. and the length of pipe 1,000 yds.:

	Cu. ft. per hour.
A 3 in. pipe 1,000 yd. long with pressure 2 in. will discharge	1,482
A 6 in. pipe 1,000 yd. long with pressure 2 in. will discharge	8,408
A 12 in. pipe 1,000 yd. long with pressure 2 in. will discharge	47,433
A 24 in. pipe 1,000 yd. long with pressure 2 in. will discharge	377,770
A 36 in. pipe 1,000 yd. long with pressure 2 in. will discharge	741,830

Mr. McMillin gives the cost of laying pipe less than 10 in. in diameter 4 ft. deep at from 10 to 15 cents per lineal foot. In cities and towns, of course, that would be much increased. Wrought-iron pipes, which are always used where the pressure is high, are screwed together by steam engines at small cost. The cost of joints for cast-iron pipe is considerable, estimated at from $100.00 for 3-in. pipe to $1,500.00 for 30-in. pipe, per mile.

These figures show that the cost of a plant, piping, pumping stations, etc., to supply a city like Indianapolis from the coal field would probably cost not less than $2,000,000, upon which the interest at 5 per cent. would be $100,000 a year. That factor alone would pay the freight on 200,000 tons of coal, and must be carefully considered in discussing the feasibility of piping gas from the coal field. But when it comes to making the gas at points already supplied with pipe lines

* Geol. Surv. of Ohio, VI, 528.

and distributing pipes, there comes in the factor of the loss of such lines if they are to be abandoned on the exhaustion of the gas fields.

One of the best suggestions yet made in this connection is that, since upon the exhaustion of the gas the pipe lines now running from the gas field to such cities as Indianapolis will be of no value in their present position, and since the pipe is the main item of expense, these lines of pipe may be taken up and relaid so as to connect those cities with the coal field. This can be done at a comparatively small expense.

Friction in pipe lines is estimated to reduce the pressure at about the rate of 7 lbs. per mile, thus requiring a pressure of 200 lbs. to drive the gas 30 mi.*

Mr. Leach reports the following figures for the Logansport line:

Length of line, 45 miles. Crooked line, supplies several towns and many farmers en route.

Pressure at supply end	295 lbs.
Pressure at receiving end	60 lbs.
Loss in transit	235 lbs.

Or 5.2 lbs. per mile.

Considering the tendency of some of the gases to condense when sent under high pressure, it would seem advisable to draw the gas through the pipes, by frequent pump stations, until the distributing point is reached.

For piping long distances, producer gas is out of the question and Dowson or semi-water gas is at a serious disadvantage, because to get the same power as by coal gas requires the piping of three times the quantity of gas, or in other words the cost of transmitting a given quantity of energy by Dowson gas will cost three times as much as to transmit the same energy by coal gas or enriched water gas. These facts suggest that the most efficient gas to pipe long distances will be a gas which is a combination of coal gas and enriched water gas. If the gas is to be made at the point of distribution, Dowson or semi-water gas may prove the cheaper.

2273. This leads to a few words about the advantages of the gas engine. Mr. F. H. Oliphant gives the following table,† showing the efficiency of different types of engines:

* Rep. Cham. Comm., Pitts., p. 35.
† Mineral Resources of U. S., 1896, p. 897.

Fuel per Indicated Horse Power per Hour.

TYPE OF ENGINE.	EQUIVALENT OF GAS AND COAL.	
	Gas.	Coal.
	Cu. Ft.	*Lbs.*
Gas Engine	13	1.3
Triple expansion condensing	16	1.6
Double expansion condensing	20	2.0
Single cylinder and cut-off	40	4.0
Ordinary high pressure without cut-off	75	7.5

It will thus be seen that the gas engine has a higher efficiency than the highest type of steam engine. The ordinary type of engine will use from 4 to 5 lbs. of coal to produce a horse power for an hour. Assuming 5 lbs., 1 ton of coal would furnish, through such an engine, 33,000×60×2,000÷5=872,000,000 units of work. Theoretically, 1 ton of Pittsburg coal will furnish 26,000,000×772=20,072,000,000 units of work, so that such an engine does not utilize more than 1-25 or 4 per cent. of the actual energy of the coal.

In a paper read by Mr. J. Gardner Sanderson before the Scranton Board of Trade in 1877, he says: "I found at the Otto gas engine works, West Philadelphia, where they employ gas engine power, the gas being produced with Buckwheat coal, costing $2.65 per ton in their bins, that their weekly cost per horse power fuel was 6 cents and under, and that 1 lb. of coal furnishes 1 horse power per hour. The Otto company guarantees 1 horse power per hour for 1¼ lbs. of anthracite pea coal, with producers and engines of their own construction."

"At Danbury, Conn., gas and electricity are furnished by the same company. They have three 100 horse power Otto gas engines, run with producer gas, made with anthracite egg coal, costing at the time of my visit $5 per ton. They are satisfied they have a very economical plant, and say they get 1 horse power per hour with 1 lb. of coal."

More satisfactory still are actual figures from actual tests, and through the kindness of Mr. Piper I am enabled to give some of the results of tests made of the White and Middleton gas engines in use at the Soldiers' and Sailors' Monument in Indianapolis. Only two of the tests are given. At another test, the figures for which were not at hand, still better results were obtained:

Number of test	4	7
Duration in minutes	20	20
Gas in cubic feet (10 minutes)	38	79

Air: holes open in air drum	9	9
Air: Suction (inches of water)	1	13/16
Air in cubic feet (10 minutes)	975.6	879.66
Ratio of air to gas	14.89	11.13
Water in pounds (5 minutes)	138	124
Temperature of water (Cent.): Entering	13.5	13.5
Temperature of water (Cent.): Leaving	45.0	49.0
Revolutions per minute	200	200
Explosions per minute	58	100
Ratio of explosions to double revolutions	.58	1
Weight on brake in pounds	27⅜	67.5
Brake, H. P.	13.47	28.66
Horse power lost in jacket	36.5	39.6
Horse power in gas burned	89.3	185.7
Gas per eff. H. P. hour	16.9	16.34
Reading spring balance	11	38
Temperature of air and gas	18.5	19.0
Practical efficiency	15.0	15.4
Distribution of heat—		
Effective work done on brake, in H. P.	13.47	28.66
Effective work done on brake, in per cent.	15.1	15.6
Work wasted in water jacket, in H. P.	36.50	39.6
Work wasted in water jacket, in per cent.	40.8	21.3
Work lost in exhaust, radiation, etc., in H. P.	39.33	117.44
Work lost in exhaust, radiation, etc., in per cent.	44.1	63.1
Total work given to engine, in H. P.	89.3	185.7
Total work given to engine, in per cent.	100.0	100.0

Mr. N. W. Perry cites* the case of a gas engine at the Pantin flour mills, which, by using Dowson gas, developed an indicated horse power of 280 (220 b. h. p.) by the consumption of the equivalent of 1.03 lbs. of coal per brake horse power, equal to an efficiency of about 20 per cent.; and even higher efficiencies are reported. That, on the basis of the above table, would be nearly equivalent to getting one horse power per hour from 10 cu. ft. of natural gas. On that estimate, that would be equivalent to 15 ft. of coal gas, 20 ft. of carburetted water gas or 60 ft. of semi-water gas; or 1 ton of coal would yield, in an ordinary engine, 400 horse power.

4,000 cu. ft. of natural gas in gas engine will yield...400 H. P.
6,000 cu. ft. of coal gas in gas engine will yield......400 H. P.
8,000 cu. ft. of water gas in gas engine will yield.....400 H. P.
24,000 cu. ft. of Dowson gas in gas engine will yield...400 H. P.

* Engineering Magazine, XII, 49 et seq.

If these figures are correct, then, to equal the cost of coal per horse power per hour for different costs of coal (of Pittsburg quality), these gases should cost as follows:

COST OF COAL.	EQUIVALENT COSTS OF GASES PER 1,000 FEET.		
	Coal Gas.	Water Gas.	Dowson Gas.
$1.00	$0 25	$0 16	$0 04
2.00	0 50	0 32	0 08
3.00	0 75	0 48	0 12

In other words, carburetted water gas at 50 cents, used in a gas engine, would by these figures be as economical as $3 coal used under an ordinary boiler with an ordinary engine. To compete with double or triple expansion engines it would have to sell at as low as 20 to 25 cents. These figures are only intended to be suggestive, and may not be fully realized in practice.

This subject should not be passed without a mention of recent results in the production of high efficiency motors, like the Diesel heat motor, recently introduced in Europe, in which the gas or oil is ignited by the heat of compressed air and burns steadily as it enters the cylinder. A single cylinder engine of this type is reported to have given an efficiency of 34.7 per cent., and later forms of up to three cylinders, at present operating, are claimed to do even better. It would seem as though an engine built on this principle would also be more free from the liability to disarrangement and break-down than the gas engine, on account of the absence of explosive action and probably lower temperature of combustion.

But little has been said in the above about producer gas, and the impression may have been left that it was an early product of experimentation in the manufacture of fuel gases, and that its low heat value had caused it to be cast aside. On the contrary, it has to-day a very extended and successful use. A large per cent. of the operations in metallurgy are now conducted by the aid of producer gas generated in Siemens and other producer furnaces. And it is found to yield a great saving over the direct utilization of coal. But in these cases the gas is used close to the point at which it is made, so that a large part of what would be waste heat is utilized in the regenerative chambers. Dowson gas is also being used to some extent in the same way, the gases being burned without cooling, the generator being placed close to the furnace. As an instance of this, Mr. Sanderson, in the paper quoted above, says that "at Oxford, N. J., gaseous fuel from anthracite, Buckwheat, was used in the furnaces at the nail works, and Mr. Lukins informed me that about 600 lbs. of Buckwheat coal converted into gas did the work of 1,000 lbs. of egg coal used direct. Besides the convenience of handling and certainty of the heat, was freedom from dust and sulphur."

Producer gas, however, can not be conducted long distances, except at an expense out of proportion to its value as a heat producer, and we have been interested in this inquiry principally in a fuel that could take the place of natural gas, not alone as a heat producer, but in the facility with which it could be distributed and handled.

2274. A word may well be added concerning the value of the different gases for illuminating purposes. The illuminating power of the gases may be stated thus:

Natural gas burning 5 ft. per hour in ordinary tip, furnishes about 6 candle power.

Natural gas burning 5 ft. per hour in argand burner furnishes about 12 candle power.

Natural gas burning 5½ ft. per hour with mantel (thoria, etc.) furnishes about 70 candle power.

Coal gas burning 5 ft. per hour in ordinary tip furnishes from 16 to 22 candle power.*

Coal gas burning 5 ft. per hour in Welsbach burner furnishes about 70 candle power.

Acetylene gas burning 5 ft. per hour in Welsbach burner furnishes about 250 candle power.

Carburetted water gas and gases like the Rose-Hastings run about the same as coal gas. It is seen from this that acetylene gas, which was not considered as an available source of heat for steam and heating purposes, is to be a close competitor of coal gas for lighting purposes, if indeed it is not bound to supersede it. As between coal gas burned in the ordinary tip and acetylene gas burned in the same way, there can be little doubt as to which will survive. Whether it can overcome the competition of the future cheap combined coal and water gas burned in Welshbach and other improved burners will be decided in the future.

Mr. Cox, in his third and fourth annual reports (1872), gives the result of a study of some of the Indiana coals in regard to their production of gas, as compared with standard Youghiogheny gas coal.

*Improved tips are now made somewhat on the principle of the Bunsen burner, in which by securing a more perfect combustion it is claimed the same quantity of light is obtained by the use of but a fraction of the gas ordinarily required.

Without going into details, his results may be tabulated as follows (Youghiogheny considered 100):

	Gas Yield.	Illuminating Power.	Coke.
Cannelsburg cannel, Coal II.............	1.20	1.50	.58
Standard shaft, Coal VII..............	.90	.88	.90
Wilson shaft, Coal VI...................	.98	.88	.97

In quality, Indiana coke is not of a high grade, not being strong, and generally filled with large cells that give it a honey-comb appearance. The best coke seen by the writer in this State is some recently made from the Princeton coal.

II. Use of Coal in Metallurgical Processes.

(A.) DIRECT USE.

2275. Indiana has long been famous for its possession of a coal suitable for direct use in the reduction of ores and other metallurgical processes. A caking coal cannot be used direct in the blast furnace, as its caking property causes it to run together and prevent the passage of the blast. A non-caking coal, to be successfully used, must also possess the other qualities; it must be extremely free from sulphur and it must be strong enough to bear the burden placed upon it in the furnace. Indiana block coal meets these requirements in a remarkable degree. As a matter of fact, the block coal, as with any non-caking coal used in the furnace, is coked in the upper part of the furnace at a cost of considerable heat, and whether the presence of volatile hydrocarbons thus driven off in the top of the furnace compensates for the loss of heat, I can not say. Considering that these gases are combustible as they come from the furnaces, and that they are not all required for heating the air blast, it would seem as though an establishment where the heat value of these gases was fully utilized could run more economically using coal as a fuel than by using coke. It is also evident that to succeed with the use of coal direct the furnace must be designed with that in view. Whether through lack of proper design in the blast furnace, or a failure to utilize the heat of the gases distilled from the coal, or, as suggested elsewhere, through a failure of Indiana iron ores to realize expectations, the fact remains that there are to-day no blast furnaces in Indiana using block coal. That due, perhaps, to one of the first causes mentioned, block coal did not give entire satisfaction in the furnaces of this State, may be judged from a paragraph by Mr. Cox in his report for 1873, p. 113:

"Indiana Block Coal is of itself very strong and able to bear up as much burden as coke, but it is, by the heat in the upper part of the furnace, converted into a dense coke before it meets the blast, where it enters into perfect combustion. That my readers may comprehend the important part performed by the blast, I will state that more than five tons of air are required for every ton of pig iron smelted. From the fact that the raw coal is changed to coke before it is burned, the effect produced by the two materials, coke and raw coal, are the same in the zone of fusion, and it is only in the upper part of the furnace that we must look for dissimilar effects. Here the raw coal is gradually heated, and the hydrogen and hydrocarbons, which form about forty parts of its substance, are distilled off, and the gaseous contents of the shaft are, consequently, about 37 per cent. greater than when coke is the fuel; it follows, therefore, that, if the size of the throat and gas flues are properly adjusted for coke, they must be made at least one-third larger for raw coal. If this point is not attended to, the furnace must lose heat, through want of perfect combustion, run irregular, and consume vastly more fuel per ton of pig iron made.

"Mr. I. Lothian Bell, in his valuable work on the Chemical Phenomena of the Blast Furnace, says that 'raw coal in the blast furnace requires the extra heat produced by 15 lbs. of coke for every 100 lbs. of coal to expel the volatile matter, or in other words, to coke it, and its reducing powers are diminished, consequently, in that proportion.' Mr. Bell arrives at this conclusion by ascertaining that 15 lbs. of coke are burned under the retorts, at the gas works, for expelling the gas from 100 lbs. of coal, and he estimates the calories of coal and coke to be about the same. A similar showing is made if we reason from the process of making coke in ovens. Here the heat necessary for distillation is derived from the expelled gas, and of that one-third only is required for the operation, and the other two-thirds are wasted for want of means to utilize it.

"Under the most favorable management at Cleveland, in the north of England, twenty-two and one-half hundred weight of coke will smelt one ton of pig iron from Cleveland ironstone. This stone is a lean carbonate of iron, very similar in composition to the Clarke county (Indiana) ore. Twenty-two and five-tenths hundred weight, or 2,520 lbs. of coke, will correspond to 3,360 lbs. of block coal, and I have no doubt but that, when we have discovered the proper form of furnace and the best mode of preparing the stock at our command, less than two tons of block coal will be required to make a ton of pig iron.

"The loss of heat by absorption, when raw coal is used in the blast furnace, is more than compensated for by the highly deoxidizing action of the hydrogen and hydrocarbons in which the ore is so completely bathed. The amount of oxygen absorbed from the ore by carbonic oxide, when the fuel is coke, reaches, under favorable conditions, about 30 per cent. of the entire oxygen which it contains. Now, there is no reason why this reducing action of carbonic oxide should not proceed to completion if those acids which facilitate the reduction are present in sufficient quantity.

"It has been proven by investigation that moisture must be present to promote this favorable action of carbonic oxide, and indeed it is mentioned by some that the process of deoxidation cannot take place in the furnace without it. Raw coal supplies this essential constituent (H_2O), together with hydrogen (H), in far greater abundance than coke; and since hydrogen is a much better deoxidizer than carbonic oxide, and the hydrocarbons themselves being almost as good absorbents for oxygen as the latter gas, I have every reason to believe that, when used under the most favorable conditions, we will obtain as large yield of iron with the Indiana block coal fuel as can be obtained from the same ores with coke, and the quality of the iron will be superior to that made with the latter fuel.

"I am satisfied that most, if not all, of the difficulties experienced by the cooling and irregular working of the raw coal furnaces in this State come from a want of sufficient sized outlet at the throat for the waste gases, for it must be borne in mind that the heat of the furnace, within certain bounds, depends upon a good upward draft."

In his report for the preceding year he gives 4,250 lbs. as the amount of coal required in Clay county to make a ton of iron. It would seem as though the key to the successful use of block coal in the blast furnace was, first, proper design of furnace, and, second, complete utilization of the gases that escape.

As yet, gaseous fuels have not proved successful in the reduction of ore, apparently because the ore needs the separating influence of the coal or coke to prevent its forming an agglutinated mass, through which the blast can not be driven until it has reached the stage of a melted metal.

2276. Coking.—In certain metallurgical processes, as the obtaining of iron from its ore, certain qualities are required of the fuel. Two of these are purity and a lack of cohesiveness when burning. The caking coal of the State, from its property of running together when burning, and from its usual lack of purity, lacks both of the qualities

mentioned. Block coal has those qualities, but is limited in quantity. However, if a caking coal be heated out of contact with air, or with a very limited supply, the volatile gas is driven off, leaving a hard gray mass of nearly pure carbon, that has the property of not running together when burning and of being somewhat freer of sulphur than the coal of which it was made, and may be very free of sulphur where the coal used is first crushed and then washed.

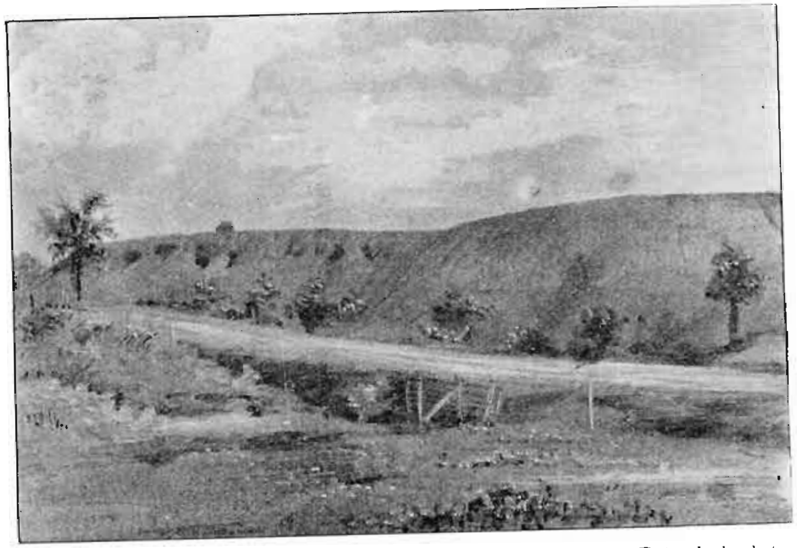


Fig. 985. Slack pile at Ehrlich mine at Seeleyville, Vigo county. Extends back to tipple, of which the top just shows in distance on left side. Showing enormous volume of waste (fine coal, etc.) by former methods of mining and preparing coal for market.

In many mines the coal is soft, and the proportion of small coal to lump is so great that it is difficult or impossible to find sale for much of this fine coal, which thus becomes a waste product. (See Fig. 985.)

If it be found that it is suitable for the making of coke, a saving may be made by the erection of a coking plant.

In this State the bee-hive oven is used exclusively. Fig. 986 shows the exterior appearance of a row of ovens. The single ovens are dome or bee-hive shaped, 10 to 12 ft. in diameter and 6 or 8 ft. high. They are built of fire brick encased in an outer wall of stone. Along the top of the row of ovens runs a track, and under this is a hole in the top of each oven. The washed coal is charged to the ovens through the hole in the top from cars on the track just mentioned. The coal is spread evenly on the floor until the oven is full. In front of each oven will be noticed a hole, which is closed with an iron door. The oven being full, the coal is ignited. Air is admitted at the bottom, while the gases pass off through the hole in the top. These gases, at first pale, gradually become darker and stronger. After twenty-four hours the air holes are closed, but the gases are allowed to escape for another twelve hours. Then the upper hole being closed, the coke is

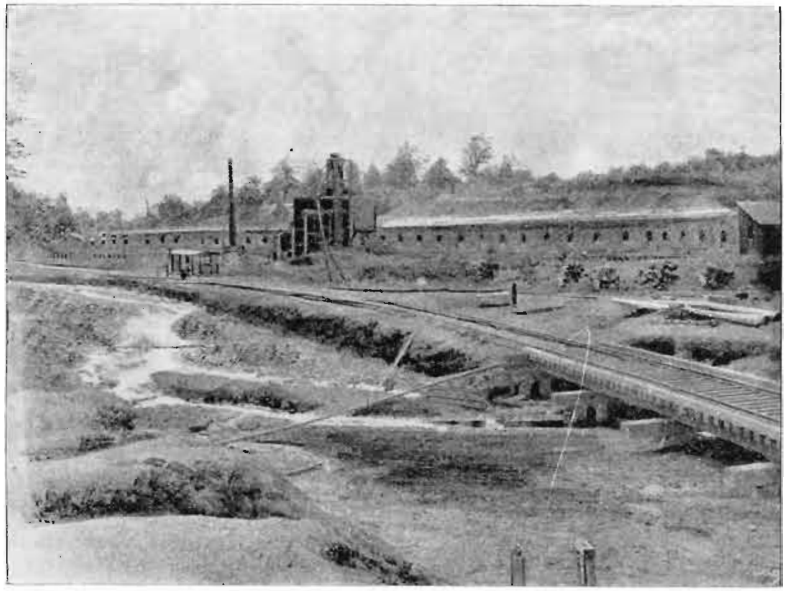


Fig. 986. Coke ovens at Alum Cave, Sullivan county. Type of those used in Indiana.

allowed to cool for twelve hours. Then the coke is drawn, being first drenched with water. Except for the first charging, the oven walls retain sufficient heat from one charge to the next to ignite the last charge.

Remembering that the coke is composed of the fixed carbon plus the ash, an examination of the analyses of the Indiana coals as given beyond, especially the more recent analyses by Mr. Noyes, will show the theoretic per cent. of coke from these coals is little if any over 55 per cent., against about 75 per cent. for the well known coking coals of Pennsylvania. That is, theoretically, two tons of Indiana coal are required to produce one ton of coke. In practice the actual percentage of coke will be probably a little less than the theoretic per cent. This

loss is largely due to the coke consumed in the coking process. In 1896, 8,956 tons of coal in Indiana produced 4,353 tons of coke, a yield of 49 per cent. This coke sold for $1.99.

Numerous ovens are now made to in part remedy that loss by supplying part of the heat by the combustion of the gases in flues around and under the oven; these are known as short retort ovens. These are broadly of two classes—the regenerative oven, which uses vertical flues and a high heat, and the recuperative ovens, using horizontal flues and a comparatively low heat, the latter seeming to be preferable. These reduce the time and labor required, thus making a saving in that way as well as in the amount of coke per ton of coal used.

A still further saving is effected in the use of by-product ovens, which are planned not only to save in labor, but to save the ammonia and tar. Thus, it is estimated that, with a fairly efficient condensing plant, one ton of coal will on the average yield 25 lbs. of sulphate of ammonia and 60 lbs. of tar, which would yield a handsome return.

Again, certain recent forms of ovens are found to yield combustible gases equal to as high as eight or nine horse power a year per oven for an oven averaging 520 tons a year.

With the style of oven at present in use in this State, and the much smaller coke per cent. of our coals as compared with Pennsylvania, it must be conceded that we can not compete with them in outside trade, but must be limited to local trade; but with such by-product ovens as may now be had, we see no reason why Indiana coke should not become a profitable article of manufacture.

L. APPENDICES.

Appendix A. Coal Analyses.

As first handed in, the manuscript contained a chapter giving all the analyses of Indiana coal known to have been made. But after the report was well in press, it was found that it was going to make a much larger volume than was anticipated, and in order to reduce its volume somewhat, it was decided to omit all of the analyses numbering between 400 and 500, except the few made recently upon which reliance could be placed as giving quite closely the relative commercial values of the coals concerned. No small number of such omitted analyses had been given, in part, in the descriptive matter of Part III, though the tables omitted showed, in each case, physical appearance and quality, specific gravity, color of ash, percentage of coke, appearance of coke, heating effect and evaporating effect, in addition to what is given in Part III.

The adaptability of any coal is determined in two ways: (1) By a chemical analysis; (2) by actual tests.

Several hundred analyses of Indiana coals have been made, though a large proportion of these have only a limited value, for three reasons: (1) Inadequate method of sampling; (2) loss of moisture before analysis; (3) lack of sulphur determinations. Recently a number of analyses have been made by Mr. W. A. Noyes, part of which were published in the 21st Ann. Rep. of this department. A few other analyses have been obtained.

Method of Analysis.—As the bulk of the analyses given in the report were made by Mr. Cox or his assistants, it may not be out of place to give his own description of his manner of conducting a coal analysis:*

"It is a matter of no little difficulty to select from a mine a proper sample for analysis, at least such a sample as will represent the average commercial value of the seam. The best way, therefore, is to take samples from the top, middle and bottom parts of the seam. These should be carefully labeled, wrapped in paper and sent to the laboratory as soon thereafter as practicable. On arriving at the laboratory they should be taken in hand at once.

"About a pound of each sample should be pulverized fine enough to be passed through a porcelain colendar with one-tenth inch perforations, then transferred to bottles with good cork stoppers. Each bottle should be labeled, showing the date of mining, when bottled, name of mine, etc. These bottles serve as stocks from which the different quantities are to be taken that serve for analysis. It is not a good plan to mix the portions taken from different parts of the seam and consider the mixture an average sample, so that one set of analyses may serve; for, though it might furnish a fair statement of the commercial value of the seam, it would leave us in ignorance of much useful information in regard to the true character of the seam.

"Proximate Analysis.—One gram is charred in a covered platinum crucible of about one fluid ounce capacity. The heat is derived from a three-jet Bunsen gas burner, and the crucible is kept at a bright red heat until the escaping gas ceases to burn and the condensed carbon disappears from the cover. The weight of the charred

*Geol. Surv. of Ind., 7th Ann. Rep., 1875, pp. 34-36.

mass gives the coke, and the volatile matter is estimated by the loss. To determine the hygroscopic water, one decigram of pulverized coal is weighed in a small, shallow platinum capsule and placed in a hot air bath, where it remains at a temperature of 100° to 105° C. for one hour; the loss gives the water. The capsule, with the dry coal, is then placed over the strong flame of a Bunsen burner until it is consumed to ash.

"The weight of the ash is deducted from the coke to find the fixed carbon, and the weight of the water is deducted from the total volatile matter to find the per cent. of combustible gas.

"All this appears very simple, but it requires great care and attention in order to obtain reliable results. The temperature of 100° C. (212° F.) is recommended, since it is believed that a higher temperature is no more effective and is more liable to produce decomposition of the volatile constituents."

As shown in this description, and as shown by his analyses as given in Part III, Mr. Cox did not separate the sulphur in his analyses. In his analyses the sulphur in part remained in the ash and in part was driven off with the gases.

Recent Analyses.—A few analyses recently made by Mr. W. A. Noyes, or under his direction, will also be given. The method of analysis used was the same in principle as that used by Mr. Cox, and is described in detail by Mr. Noyes in the 21st Annual Report of the State Geologist, p. 99. The main difference lay in the manner of procuring the material analyzed. The more recent method of the first analyses, as described by Mr. Noyes, is: "The samples, with one exception were taken in the mines at the face of the vein, beginning at the top and cutting down at several places in such manner as to procure an average sample of the coal. These large samples were then broken into small pieces and 'quartered' down to secure the smaller sample, which was submitted to analysis. These samples were taken in the mines by Mr. Robert Fisher, State Inspector of Mines, and Mr. James Epperson, Assistant Mine Inspector, and not by owners of the mines." As regards reliability and the analysis showing the average quality of any coal, there can be no question of the superiority of the latter method of obtaining samples over the earlier of picking out hand specimens for testing. Where analyses of the same coal were made by both methods, Mr. Noyes's results will be adopted, as tending to give more nearly the commercial value of the coal. For the analyses made in 1898 a somewhat different method of sampling was adopted, in the endeavor to obtain more nearly the commercial product. The method as given by Mr. Noyes is as follows:

"SAMPLING COAL FROM CAR.—Start near one corner of the car and drive a scoop shovel down into the coal as far as it will reach. Bring it up with all the coal it will carry and throw into a wheelbarrow or box. In this manner take six shovelfuls from each side of the car at equal distances apart, and six through the center of the car—eighteen shovelfuls in all. If the coal is mostly in large blocks, take pieces of the same weight as the shovelful, but take also some of the finer or slack coal, if there is any in the car, taking it in such proportion that the proportion of slack in the sample will be as nearly as possible the same as in the car.

"Break the coal of the sample so that no pieces are larger than an orange. Mix and pile in a regular heap, sweeping the dust into the heap. Cut twice across the center, and take all of two opposite quarters. Make a heap of the part taken or of the part remaining, and repeat. When the amount of coal has been reduced somewhat, break what remains finer and quarter down again till a sample is obtained which will fill a pint or a quart fruit jar. Put in the jar at once and screw the cap on tight.

"If the sampling is done at the mines, shovelfuls may be taken at regular intervals as the car is filled, or at longer regular intervals as several cars are filled."

In 1883 Mr. G. M. Lavette prepared a table of all the coal analyses made of Indiana coal up to that time. This is now out of print.

By calculation from the percentage of carbon and hydrogen contained, there can be determined the number of units of weight of water one unit of weight of the coal will raise 1° C. This is called the heating effect of the coal. If this number be divided by 536.5, the latent heat of steam, there will be obtained a number representing the units of weight of water at the boiling point which will be converted into steam by one unit of coal. Thus, it may represent the number of pounds of water evaporated by one pound of coal or the number of kilograms or number of tons of water evaporated by one kilogram or one ton of coal. This number shows the evaporative effect of the coal. A comparison of the numbers in these two columns for different coals is supposed to show the relative heating or evaporative effect of the two coals. In actual present practice, one pound of good coal will evaporate in a good boiler about ten pounds of steam.

The first group of analyses was made by Mr. Noyes for the 21st Ann. Rep. (1896), and include for comparison seven coals from Pennsylvania and West Virginia. The averages of this table were used in the chapter on availability of Indiana coals.

Number.	COUNTY.	NAME OF COAL AND OWNERS.	Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Moisture.	Ash.	Sulphur.	Heating Effect—Calories per Kilogram, Calculated.	Heating Effect—Calories per Kilogram, Berthier's Test.	Evaporative Effect—Pounds of of Water per Pound of Coal.
1	Vanderburgh	Sunnyside Coal and Coke Company, Evansville	86.73	38.59	48.14	6.44	6.83	1.85	6,924	6,759	12.9
2	Warrick	Deforest mine	84.16	39.09	45.07	6.08	9.76	2.14	6,705	6,339	12.5
3	Knox	Edwardsport coal mine, Edwardsport Coal and Mining Co.	82.03	36.00	46.0	8.75	9.22	3.08	6,495	6,345	12.1
4	Knox	Bicknel mine, Bicknel Coal Company	83.76	35.22	48.54	7.61	8.63	1.67	6,692	6,489	12.5
5	Daviess	Cabel and Kauffmann	87.15	37.99	49.16	6.50	6.35	1.85	6,958	6,981	13.0
6	Sullivan	Star City	87.30	38.53	48.77	9.40	3.30	1.23	6,995	7,002	13.0
7	Sullivan	Alum Cave	84.77	42.60	42.17	6.49	8.74	3.18	6,712	6,894	12.5
8	Greene	Buckeye or Fluhart, Linton Coal and Mining Company	86.79	35.69	51.10	7.81	5.40	0.72	6,974	6,618	13.0
9	Greene	Summit mine, Dugger and Neil Coal Company	87.54	35.30	52.24	7.44	5.02	0.61	7,041	6,852	13.1
10	Greene	Island City mine No. 1, Island City Coal Company	86.47	35.97	50.50	7.12	6.41	0.84	6,944	6,819	13.0
11	Vigo	Ray mine, Seeleyville, Vigo County Coal Company	84.46	40.25	44.21	7.57	7.97	4.01	6,656	6,762	12.4
12	Clay	Gart No. 5 shaft, Brazil Block Coal Company	85.27	36.11	49.16	11.20	3.53	0.62	6,856	6,774	12.8
13	Clay	Brazil Block No. 1 shaft, Brazil Block Coal Company	85.12	45.16	49.96	13.82	1.06	1.47	6,810	6,588	12.9
14	Clay	Eureka Mine No. 1, Carbon, Eureka Block Coal Company	86.74	36.32	50.42	9.80	3.46	0.34	6,985	7,050	13.1
15	Clay	Crawford No. 3 mine, Crawford Coal Co.	84.58	36.34	48.23	11.26	4.16	0.56	6,803	6,858	12.7
16	Clay	Columbia No. 2 mine, Teller, McLelland & Co.	89.52	36.75	52.77	7.47	3.01	0.57	7,202	7,344	13.4
17	Owen	Lancaster No. 4 mine	83.85	36.45	47.40	12.73	3.42	0.55	6,744	6,636	12.6
18	Parke	McIntosh No. 1 mine, near Diamond, I. McIntosh & Co.	87.70	36.69	51.01	8.21	4.09	0.95	7,039	7,008	13.1
19	Parke	Cox No. 3 shaft, "bituminous," Brazil Block Coal Co.	88.33	41.88	46.45	6.49	5.18	2.93	7,009	6,897	13.1
20	Pittsburg coals	Beck's Run, first pool, Hays Coal Company	96.06	36.01	60.05	2.09	1.85	0.64	7,726	....	14.6
21	Pittsburg coals	Anchor, fourth pool, Beaumont Coal Company	89.84	35.30	54.54	1.30	8.86	0.45	7,230	....	13.5
22	Pittsburg coals	Caledonia, fourth pool, T. J. Wood	90.26	35.22	55.04	1.35	8.39	0.69	7,256	....	13.5
23	Pittsburg coals	Stony Hill, fourth pool, John D. Nixon	92.74	35.46	57.28	1.11	6.15	0.56	7,462	....	13.9
24	Pittsburg coals	Little Redstone, fourth pool, Little Redstone Coal Co.	91.08	35.88	55.20	0.98	7.94	0.82	7,316	....	13.7
25	West Virginia coals	Raymond, Marmet Smith Coal and Mining Company	91.16	40.14	51.02	3.20	5.64	2.25	7,266	....	13.6
26	West Virginia coals	Belmont, Belmont Coal Company, Belmont, W. Va.	90.04	37.84	52.20	1.45	8.51	0.46	7,248	....	13.5
		Average of Indiana coals	86.36	38.22	48.14	8.45	5.61	1.52	6,879	....	12.7

The same report also contains the following analyses by Mr. J. R. McTaggart and Mr. H. W. Carver, first published in the Journal of the American Chemical Society, Vol. 17, p. 843. These, Mr. Noyes tells me, were properly sampled from the cars at Terre Haute, and so should be of value:

COMPONENT.	New Pittsburg A.	New Pittsburg B.	Lancaster.	Brazil.	Shelburn.	Shop.
Moisture	6.83	5.89	12.66	8.98	8.63	2.36
Volatile combustible matter	39.92	42.23	34.44	34.49	38.82	31.11
Fixed carbon	39.93	40.40	47.22	50.30	43.45	42.44
Ash	13.31	11.48	2.68	6.22	9.05	24.09
Carbon	62.88	65.26	71.40	70.50	66.86	57.32
Hydrogen	5.07	5.17	5.56	4.76	5.30	4.56
Nitrogen	1.01	1.17	1.54	1.36	1.50	1.44
Oxygen	13.06	13.25	18.42	16.29	15.69	9.93
Ash (corrected)	17.98	15.15	3.07	7.09	10.65	26.75
Sulphur	7.46	5.88	0.62	1.39	2.57	4.25
Iron, calculated	6.53	5.14	0.54	1.22	2.25	3.72

The following additional analyses were made for this department under the direction of Mr. Noyes:

MINE.	Total Combustible Matter.	Volatile Combustible Matter.	Fixed Carbon.	Moisture.	Ash.	Sulphur.	Heating Effect, Calories per Kilogram—Calculated.	Evaporative Effect—Pounds of Water per pound of Coal.
Ayrshire mine, Pike county	82.47	41.32	41.15	10.75	6.78	0.81	6,622.24	12.36
Pleasantville, Sullivan county	81.28	37.61	43.67	11.30	7.42	3.13	6,433.40	12.0
Cannelburg (cannel coal)*	75.43	49.08	26.35	1.47	23.10	1.48	6,027.48	11.25
Blackburn, Pike county	87.33	43.38	43.95	7.47	5.20	5.21	6,918.41	12.9
Oswald mine, Gibson county	83.02	37.72	45.30	7.88	9.10	2.71	6,590.76	12.29
Farnsworth, Coal VII	78.29	34.40	43.89	12.07	9.64	1.03	6,276.84	11.71
Coke from coal, Oswold mine, Princeton	88.34	0.20	88.14	0.14	11.52	1.89	7,053.18	13.16
Coal from Gifford mine, by T. H. Watson	77.15	37.67	39.48	13.12	9.73	2.95	6,107.37	11.4

* The coke from the "cannel coal" was pulverulent.

Appendix B. Mines, Etc.

As originally handed in, this appendix formed Division LI of the report, and consisted in the main of tables, in which were gathered all the data obtained about the small mines of the State. To reduce the volume of the present report, these tables are omitted here, but may be given in connection with some future report of the Mine Inspector.

For obtaining data at the small mines, the following outline was worked out as a basis for inquiry:

1. Mine—
   (a) Name.
   (b) Owner or owners.
   (c) When opened, and history.
   (d) Miles to railroad.
   (e) Present condition.
2. Coal—
   (a) What seam.
   (b) Greatest thickness.
   (c) Least thickness.
   (d) Average thickness.
   (e) Quality, appearance, etc., used successfully for what purposes.
   (f) Dip, structure, cleavage, faults, etc.
3. Roof—
   (a) Material.
   (b) Thickness.
   (c) Character.
   (d) Draw slate.
4. Floor—
   (a) Material.
   (b) Thickness.
   (c) Character.
5. Entrance—
   (a) Drift, slope or shaft.
   (b) Depth.
   (c) Equipment.
6. Power used—
   (a) For hauling.
   (b) For hoisting, etc.
7. Mining methods—
   (a) Method of mining.
   (b) Width of room.
   (c) Width of pillar.
   (d) Timbering, etc.
8. Ventilation.
9. Number of men employed and for how long.
10. Annual yield in bushels or tons.
11. Area worked out.

The omitted tables contained the data gathered on the basis of the above outline. In lieu of these, we will simply give a table which summarizes the portion of the county summaries pertaining to mines, etc.:

COUNTY.	Number of mines working 10 men or over.	Number of mines working less than 10 men.	Total number of mines in operation.	Large mines abandoned.	Small mines not working.	Strippings, outcrops, etc.	Total number of opening to coal.
Warren	....	16	16	....	41	40	97
Fountain	2	26	28	16	37	95	176
Montgomery	....	....	....	....	....	7	7
Putnam	....	9	9	....	....	113	112
Parke	13	? 53	? 66	22	....	210	231
Vermillion	5	47	52	3	140	65	260
Owen	1	27	28	3	....	....	200
Clay	30	18	48	91	100	511	750
Vigo	15	25	40	15	75	125	255
Greene	6	89	95	3	....	462	560
Sullivan	12	43	55	6	....	233	294
Martin	1	37	38	....	100	112	250
Daviess	12	40	52	22	50	150	274
Knox	3	9	12	5	14	66	97
Orange	....	1	1	....	2	13	16
Crawford	....	....	....	....	4	9	13
Dubois	1	35	36	3	39	194	233
Pike	6	125	131	3	150	267	450
Gibson	1	4	5	....	6	45	56
Perry	2	38	40	....	67	56	163
Spencer	....	36	36	....	37 +	100	298
Warrick	7	93	100	8	....	255	363
Vanderburgh	6	0 ?	6	....	....	10	16
Posey	....	....	....	....	....	12	12
Total	123	731	852	200	862	3,150	5,183

From the above table it would appear that over 5,000 coal openings or exposures had been visited or located in our work. Of these three-fifths, or over 3,000, were small strippings or outcrops, or wells or drillings, the small strippings largely predominating. The other two-fifths, or 2,000, were classible as mines, of which number over one-half have been abandoned or have not been worked of late years, leaving about 850 mines which are or may be open part or all of the year; of this number, 123 are large mines visited by the Inspector.

The classification of the small mines, strippings, etc., has been a difficult problem. As a matter of fact, with few exceptions all outcrops have been stripped from some. In many cases this has only amounted to a bushel or two. In more cases the man upon whose farm the coal outcrops has obtained his winter's supply of coal from such outcrops, sometimes for a single year, sometimes year after year. In many cases such outcrops are only depended upon to get coal for thrashing or some similar purpose. It hardly seems proper to call these mines, though often in the course of time thousands of bushels may be taken in this way. Most of the strippings of the above table are of this character. Next there comes the stripping from which a man may sell some coal to his neighbors; in this way these strippings grade up until strippings were met in which in midsummer were working as high as fourteen men. The same thing is true where the outcrop occurs in a steep hillside, so that mines of this character run all the way from those which have had a total output of a bushel or two to well equipped drifts or shafts, like those illustrated in Plate LXXXIX, which run the whole year and usually keep just below the ten-men limit, while the output may run from five to ten tons a day for six months in the summer, and from 40 to 50 tons a day for the other six months.

Again, to determine whether to call a mine a working mine or not, is often a difficult problem. Some of the small mines work the year round; some will get out coal in the summer only, when it is called for, but the majority are practically abandoned from planting time or earlier until October, so that their opening up the following fall is often governed by the condition they may be in at that time. Thus, they may be opened regularly for several falls and then abandoned for several years, then opened up again for a year or two or more. In general, the small mines, when visited in the summer, were neither working nor in a condition to be examined. In the second column of the table, therefore, are included all the small mines which were worked the preceding winter or which are generally worked winters, though possibly not the winter or two preceding our examination.

REPORT OF THE STATE INSPECTOR OF MINES FOR INDIANA, 1898.

By ROBERT FISHER.

INDIANAPOLIS, IND., January 17, 1899.

PROF. W. S. BLATCHLEY, *State Geologist of Indiana:*

I transmit herewith my fourth annual report as Inspector of Mines. It is not so complete as I should have been pleased to make it, as other duties which are made imperative by the statutes have made large calls upon the time of myself and my assistant during the period which I had intended to devote to its preparation.

There were five fatal and several serious accidents during the month of December, 1898, which accounts for part of the delay, and several calls for special inspections were responded to during the same period. With your permission, I shall file a supplementary report previous to retiring from office, March 11, covering some points which I have been compelled to neglect at this time.

ROBERT FISHER,
Inspector of Mines.

REPORT

OF

INSPECTOR OF MINES

TO THE

STATE GEOLOGIST.

1898.

ROBERT FISHER, INSPECTOR.
JAMES EPPERSON, ASSISTANT.

In beginning the last annual report which I shall have the honor to file, I think it is a fitting time to review the history of the Mining Department in this State, and to some extent the legislation governing the industry, and I do this, though it to some extent repeats what was said in the introduction to my report for 1897.

The first legislation enacted in the State of Indiana for the regulation of mines was approved March 8, 1879. It provided for one Mine Inspector, who was allowed a fee of five dollars for each inspection made, and his jurisdiction extended over all mines in the State, without reference to the number of men employed, the territory excavated or the amount of coal produced. Not more than two inspections of any mine were to be made during any year. The law was modeled after that in force in the State of Illinois at that time, and provided for second outlets in certain cases, maps of mines to be made by operators and copies of the same to be filed with the Inspector, ventilation affording at least 100 cu. ft. of fresh air for each person and 300 cu. ft. for each mule used in the mine, precautions to be taken in working toward abandoned works, covers on cages and gates on shafts, daily examinations of ropes and places known to contain dangerous gases, and preventing the employment of boys under fourteen years of age. The Inspector was appointed by the Governor, to serve four years. Penalties were provided for a violation of the provisions of the act. The report of Herbert H. Richard, the first Inspector, shows that during the year 1879-1880 there were in the State 177 mines of all classes, but a great many were small mines that worked only in the fall of the year. The mines were generally deficient in ventilation and in other respects. A great improvement was noted on the second visit. The only fan reported in the State had just been erected by the Brazil Block Coal Company at its mine in the town of Brazil.

In the codification of the laws of Indiana in 1881, several changes in the mining laws were made. The section requiring mine maps to be made was dropped, and a provision inserted that maps should be made on request of the owner of the land, the miners employed or the owners of the mine, and that the expense be borne by the party causing the survey to be made. The appointment of an Inspector was made subject to the consent of the Senate, the term reduced to two years, and a salary provided instead of fees, which were discontinued. Mines employing less than ten men were exempted from the provisions of the act, and the inspection of scales by the Inspector was provided for. The report for 1881-1882 shows a marked improvement in the condition of the mines. Though ventilation was still defective, the work of improvement had been rapidly moving on, and fourteen fans were reported as being in operation in Clay county alone, with others scattered over the State.

The General Assembly of 1883 amended the law so as to provide "that the rope used for hoisting and lowering in every coal mine shall be a wire rope," and providing for the employment of a check weighman by the miners employed at any mine.

March 5, 1885, an act was approved providing for driven air courses parallel with all entries, providing for breakthroughs every 75 ft., requiring owners and operators of mines to keep a sufficient supply of timbers at the mine and deliver them to the working places, maps of abandoned mines to be filed with the county recorder, safety catches on cages, and requiring foremen to visit working places every alternate day. In 1889 a difference in politics between the Governor and the Legislature led to the enactment of a law placing the power of appointment in the General Assembly. This led to litigation between the two appointees, to the detriment of the mining interests. The Supreme Court finally sustained the Governor, and in 1891 an act was

passed creating the Bureau of Geology and Natural Resources, and making the Mining Department a branch of that bureau, and placing the appointment of the Inspector in the hands of the State Geologist, to whom he reports. The law also gives the Inspector an assistant, appointed by himself and removable by him for cause. The Inspector and his assistant are required to be residents of the State of Indiana for five years immediately preceding their appointment and practical miners of at least ten years' experience, and no person is eligible to either place who is or may be pecuniarily interested in any coal mine in the State. Another act of the same Legislature requires the use of accurate scales of standard manufacture for weighing coal, the testing of scales each morning by weighmen, providing for lights and gates at the top vein where two veins are being worked, a code of signals for hoisting shafts, requiring the Inspector to investigate, with a coroner, all fatal accidents occurring in and about mines, splits in ventilating currents, breakthroughs every 45 ft., reports of air circulating in the mine to be recorded to the Inspector monthly, and prohibiting the employment of females. In 1897 a law was enacted providing for the examination of mine bosses, fire bosses and hoisting engineers by the Inspector of Mines, providing for notice to the Inspector of all serious accidents occurring in mines, requiring mine bosses to give a written acknowledgment when notice is given of an unsafe place, providing that when an escape-way is over 150 ft. deep a hoisting apparatus may take the place of a stairway in such shaft, requiring operators to make and file with the Inspector maps of mines and to make monthly reports of tonnage and wages, and providing an office in the State House for the Inspector.

From the above it will be seen that the Mining Department of this State has no official relation to any other of the State authorities than the State Geologist, and that the only relation between them is that the Geologist appoints the Inspector of Mines and receives his annual report. The powers of the Inspector may be briefly summarized as follows:

1. To enter and inspect mines and to order such improvements as he considers necessary for the health and comfort of the employes.

2. After giving a reasonable time for such improvements, to order the removal of workmen from the mine or part of the mine which is unsafe or not sufficiently ventilated.

3. To examine and grant certificates to applicants for the positions of mine boss, fire boss and hoisting engineer.

4. To appoint a competent mining engineer to make a survey and map of any mine in the State when the owner or operator has failed to furnish a satisfactory map.

5. To forbid the use of scales which are found to be inaccurate.

And his duties are:

1. To make at least two inspections annually of each mine and the machinery and appliances connected therewith.

2. To collect and tabulate the statistics of the coal industry of the State.

3. To see that the mining laws of the State are enforced, and prosecute wilful violations of the same.

4. To make an annual report to the State Geologist of the work of his department.

The number of mines coming within the jurisdiction of the department in 1897 was 126; men employed, 7,999, and tons of coal produced, 5,146,920. Fatal accidents, 16, or one to each 254,880 tons of coal produced. The ventilation of most of the mines is good, fans being used at all but six, and two of those having natural ventilation to supply the men employed at nearly all seasons of the year, and furnaces being used in all of them when necessary.

The following have been the Inspectors under the different laws noted above:

Herbert H. Richards	1879-1881
Thomas Wilson, Jr.	1881-1885
Thomas McQuade	1885-1889
Thos. R. Tislow	1889-1891
Thomas McQuade	1891-1895
Robert Fisher	1895-1899

And the following have been assistants:

Welman A. Lackey	1891-1892
Michael Comiskey	1892-1894
Barney Martin	Jan. 1 to Mar. 15, 1895
Wm. McCloud	Mar. 15 to Dec. 1, 1895
James Epperson	Dec. 1, 1895

Since the creation of the office its incumbents have been handicapped by reason of the amount of territory to be covered with the force of Inspectors, and inadequate provision for the necessary traveling and other expenses incident to the proper performance of the work to be done.

LEGISLATION.

In the work of my office during the two years since the Legislature was in session, several places in the law have been found to be weak in the means provided for enforcing its provisions. The following amendments should be made to make the work of the Inspector effective:

1. In all cases where the Inspector is authorized to order the men out of a mine, he should be permitted to bring an injunction suit in the name of the State and to prosecute it without filing a bond, and have the services of the law officers of the State, as he now has in criminal cases.

2. Whenever the Mine Inspector shall find men working without sufficient air or under any unsafe condition, he should be authorized to bring suit immediately without giving the notice now required. As the law now stands, it permits mine operators to allow their mines to get into a bad condition between the visits of the Inspector, knowing that a reasonable time must be given to make repairs before they are subject to a fine. With the best work that can be done by the Mine Inspector and the law officers of the State, a mine *may* run in an unfit condition for ten months of the year.

3. When a new mine is opened, or one resumes work after a shut-down, notice should be given to the Inspector so that he may know of the fact. In several instances mines have been reopened after a long stoppage, and operated, usually under very bad conditions, for six weeks before knowledge of the fact comes to this office by the reports now required by law.

4. The Inspector should be given some supervision over small mines. There are numerous mines in the State which, during some part of the year, employ a sufficient number of men to bring them within the operation of the law, and for the rest of the year employ but a few men. If the Inspector visits them at a time when less than ten men are employed, he has no power to order improvements made, and the visit is wasted. When the number of men is increased, the mine is run without complying with the law, and as this is usually at the busy season of the year, visits of inspection can not be made without neglecting more important work. In addition to this, employes of small mines are denied the protection and benefits of the law at all times.

5. The increase of machine mining and the fact that all coal mined in this way is blasted as soon as cut, or at least during working hours, filling the working places with powder smoke, call for some regulation as to the use of blasting powder in mines.

If these changes are proposed in the Legislature, I shall render all assistance in my power to secure their passage. In this connection I will say that though in the compilation of the laws published in 1897 I invited suggestions as to changes required in them, no such suggestions have been received in such form that I can embody them in this report or present them to the Legislature. The above have been brought to my mind by the experience of the last four years in the work of the office.

In this connection I desire to say that in nearly all cases where it has been necessary to bring suits for the violation of the mining laws I have had the hearty co-operation of the prosecuting attorneys in bringing the cases to as speedy a trial as the law will permit. The delays allowed by the practice in our courts, however, make it a tedious and expensive matter to secure conviction, even where the voilation is a plain one. I am also sorry to say that I have not had the desired co-operation of the miners in reporting violations of the law or in giving evidence on prosecution.

REVIEW OF TRADE FOR THE YEAR.

As a whole, the coal business in the State of Indiana during the year 1898 has been fairly satisfactory. The question of wages as settled by the Chicago conference of January has been generally complied with in all of the district north of the B. & O. S. W. railroad, and there has been no general stoppage of work at any number of mines in this territory. The total production of coal in the State will reach more than five millions of tons, an increase of nearly one million tons over last year. The increase is partly accounted for by the fact that during the months of July, August and September, 1897, nearly all of the mines in the State were idle on account of the national strike begun on July 4, but aside from this there is a large increase in the amount of coal mined in the counties of Sullivan, Vigo, Vermillion and the bituminous mines in Parke county. This is partly offset by very slack work in the block coal district during the summer. The claim is made by the operators in this region that by the Chicago agreement they were placed at a disadvantage with respect to the Pittsburg district in Pennsylvania, and lost a large part of the trade that rightfully belongs to this field. An attempt will therefore be made in the next conference to have the differential between these districts restored to the point existing before last year. The miners of this district have instructed their delegates to oppose any reduction in the differential between the block and bituminous districts of this State, which is at present, as for several years past, ten cents per ton for pick mining. This is very likely to cause a serious disagreement in the conference to held at Pittsburg, and may have serious results on the business here for the next year, as it will be very difficult to increase the price in the East without a corresponding increase in the bituminous fields of the West. The last three months of the year have been very brisk in all parts of the State, and the production is nearly as large in the block coal district as it has ever been, and there is a great increase in the production of the bituminous mines over everything that has ever been known in the State. The only place where any complaint of slack work exists is on the line of the Pennsylvania railroad in Greene county, where there is a shortage of cars to move the product, and two-thirds time is about all that they have done.

South of the B. & O. S. W. railroad the United Mine Workers have made but small progress with their organization, and the Chicago agreement has not been in effect. Several attempts have been made to bring the miners there into the organization, but the operators seem to be unalterably opposed to working in harmony with the miners of the competitive district, as they claim that their principal competition comes from Kentucky and the Ohio river mines, and very little of their coal seeks an outlet north. There have been several small strikes in that district as a result of attempts to have the Chicago scale of prices adopted at different mines, but the year ends with all at work full time and with prospects of a continuance of the demand for some time to come. As the demand is mostly local, the continuance of cold weather will have a good effect on the prospects.

A strike has been in progress at the mines of Cabel & Co., at Washington, during the whole of the year, but the mines have been operated to some extent by miners brought from Kentucky, and mining machines have been introduced there, so that the company have kept up a fairly good production, though not nearly as good as they would have been had the business gone on without that interruption. The operators claim to be paying scale rates, so that the only question seems to be one of the recognition of the miners' organization. Within the last months the mines operated by the same parties at Hartwell, in Pike county, have been drawn into the fight, and an attempt is now being made to operate them with non-union labor, but with what success I am not able to say at present. The struggle seems to be no nearer an end than at this time last year. This is one of the few difficulties that the Labor Commissioners of the State have been unable to adjust during the year. The men who are on strike have the sympathy and support of organized labor in their contention, and are being generously supported.

More has been done in the way of new developments this year than for a long time previously. New mines have been opened in the different counties as follows: Clay, 8; Daviess, 1; Greene, 1; Parke, 1; Vermillion, 2; Vigo, 1. Total, 14. In addition, shafts that had been previously in operation have been sunk to lower veins as follows: In Clay, 1; Vermillion, 2, and two new shafts are in process of sinking.

Mining machine plants have been installed in three mines, and the use of machines has been temporarily abandoned at two. Electric haulage has been installed at two mines during the year, and is in process of installation at another.

On the basis of the November output, the present capacity of the mines of the State is 6,100,000 tons at mines employing over ten men, and it is really greater than this, as many more men could have been employed during that month at the mines which were in full operation, and shortage of railroad transportation curtailed production in other localities, as noted above.

The new year will open with most flattering prospects for the coal trade of the State, and the only thing that can prevent it from being the banner year in our history in the amount of production and wages paid will be an inequitable placing in the scale to be paid in this State by the joint conference of miners and operators to be held during the next month. Business has been done during the last year in this State, as in fact by the trade all over the country, at a very small margin of profit. The indications are fair at present for an improvement in this respect for the next year, and it is to be hoped that capital will be fairly well recompensed during the year.

Table Showing the Production of Coal in Tons of 2,000 Pounds in Indiana, During the Year 1898, at Mines Employing More than Ten Men.

COUNTY.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Clay	102,196	109,226	86,543	69,438	57,941	52,585	62,878	66,768	80,286	97,150	100,402	127,654	1,018,497
Davi ss	13,141	15,956	18,812	16,218	11,201	11,108	11,960	13,230	13,057	15,301	18,650	22,606	181,060
Dubois	629	692	389	576	363								2,649
Fountain	12,805	12,235	7,868	4,059	10,159	10,498	7,148	8,668	8,115	10,710	8,716	10,920	111,901
Gibson	1,774	4,746	2,471	2,810	1,991	2,435	2,269	2,307	3,224	7,082	8,400	7,777	47,286
Greene	69,519	49,752	35,321	38,528	27,971	27,540	25,069	40,319	58,371	45,785	55,564	44,983	518,722
Knox	5,133	3,992	3,502	2,984	1,949	3,104	2,919	3,513	3,751	5,706	6,249	7,655	50,457
Martin	1,144				460	510	558	409	502	482	367	620	5,052
Owen	1,293	1,231	987	941	772	205	682	469	691	666	421	455	8,813
Parke	59,757	47,010	63,747	43,169	33,683	35,456	29,576	42,044	43,293	50,417	72,823	81,169	612,144
Perry	2,453	2,058	2,495	2,208	2,496	2,113	1,727	2,517	1,993	1,007	2,910	2,310	27,087
Pike	19,188	17,542	15,890	16,295	16,495	13,591	14,325	14,228	12,662	10,003	27,136	54,466	240,821
Sullivan	62,362	48,164	53,878	60,190	63,830	50,909	45,178	43,821	53,934	62,520	75,754	56,902	677,442
Vanderburgh	19,815	17,986	16,831	13,3[illegible]2	11,472	10,034	11,339	11,555	15,928	23,224	22,825	19,401	193,802
Vermillion	33,000	32,046	40,660	35,373	20,246	18,614	19,908	27,131	49,014	46,340	36,410	41,205	399,947
Vigo	61,796	51,005	76,487	49,942	78,318	59,280	59,416	65,350	73,173	75,989	82,825	85,859	819,440
Warrick	11,636	10,525	8,385	8,754	4,269	5,945	6,660	7,557	5,785	10,062	11,631	20,715	111,924
Total	477,641	424,166	434,269	364,974	343,466	303,927	317,012	349,886	423,779	472,224	531,083	584,697	5,027,044
Estimated production of small mines													150,000
Grand total													5,177,044

INDIANA MINING INSTITUTE.

In July, 1897, the Indiana Mining Institute was organized for the purpose of social and educational improvement of the members by interchange of views and experiences in line with the work of mine management. The constitution prohibits anything tending to affect the question of wages, and the co-operation of all, whether employers or employes, along the line of improvement in mining methods, has been solicited. While it has not been so successful as could have been wished, the quarterly meetings of the institute have been interesting and instructive.

I give herewith a paper by Mr. D. J. Lloyd on the "Benefits of the Institute," as embodying the ideas of its organizers, and one by T. J. Mooney, M. E., as illustrating the subjects treated in the discussions held by the members.

While space does not permit their publication, papers by W. F. Brown, on "Mechanical Haulage," and by William Spears, on "A New Mine Pump Designed to Resist the Corrosive Action of Mine Water," are especially worthy of mention. Other papers published by the institute are on "Gases Met With in Mines," by J. T. Fogg; "Safety Lamps," by William Devonald; "Different Methods of Working Coal," by Gust. Stievenart, M. E., and "Long Wall Mining," by Roland Elston. Papers were also contributed by Dr. George H. Ashley, on "The Indiana Coal Survey," and by Robert Fisher, on "Mining Legislation." Copies of any of these may be obtained from the secretary, G. S. Patterson, Terre Haute, Indiana:

Benefits of the Institute.

BY DAVID J. LLOYD, TERRE HAUTE, IND.

[Terre Haute Meeting, April 22, 1898.]

When I was informed by our secretary that I was on the program for a paper to be read before this institute, I must say that I was surprised, being a stranger to most of you, and much more so particularly when the subject "Benefits of the Institute" was assigned to me. I felt then, and do yet, incompetent to do justice to so important an article.

However, feeling it my duty, I will attempt the task in order to be obedient to the committee on program. I trust, though, gentlemen, that you will pardon me should I fail to express myself in the language of a collegian of the true meaning of what this institute should and ought to be, as my school days were cut off when twelve years old and taken into the bowels of the earth to be made a collier, by which name we are better known across the water.

This institute should be, and is, I believe, a step in the right direction. It is the dawn of a brighter future; it should awaken general interest in each other, in study, and create a desire for higher proficiency. We should, therefore, contribute all in our power to make it a grand success.

This can only be done by attending as often as is possible and consecutively perform the duties assigned to us at all times by the committee on program, such as reading papers on various topics, to be genial and frank in open discussion.

This, then, gentlemen, is my idea of an ideal school of practical training, and by close application to the foregoing we can acquire a knowledge of technicalities, or a technical education, which many of us were deprived of in our early lives, which has with the constant change of conditions become a necessity. Methods that we now use in mining were not heard of fifty years ago.

So late as the year 1852 a committee of the House of Commons of England reported as follows:

"Your committee are of opinion that any system of ventilation depending upon complicated machinery is inadvisable, since under any disarrangement or fracture of its parts the ventilation is stopped or becomes inefficient.

"That the two systems which alone can be considered as rival powers are the furnace and steam jet."

You will find to-day, gentlemen, on the statutes of England, where said report has been completely reversed.

In 1861 the centrifugal fan at Elsecar was described to the North of England Institute of Mining Engineers by the late J. J. Atkinson, and to him must be given the credit of having in several papers on the subject first shown clearly the superiority of mechanical ventilators over every other system.

So that we are not only going to be benefited in the future by this institute, but are benefited by institutes of nearly forty years back.

Then, with the privileges that we now enjoy, shall I say that ignorance is crime, and that knowledge gained merely from self-experience is not sufficient in our daily vocation?

Inventions and discoveries have worked miracles. The possibilities of steam and compressed air have not yet beeen fathomed. "Electricity, with its wonderful achievements accomplished in the past ten years, is as yet, I believe, in its infancy."

As I said in my paper, "Electricity," read before the Illinois Mining Institute in the year 1892:

"No one has been able to tell us what electricity is, except that it is a property which resides in all matter, and which constantly seeks to establish an equilibrium. But of the nature of electricity, except through its observed effects, nothing is known; therefore it is only known to us by what it does, which, after all, perhaps, is the best way to know anything."

However, we must adapt ourselves to our changed surroundings and keep abreast of the times if we expect to hold our own in the struggle for existence.

Competition in all branches of industry is stronger, sharper and more active than ever before.

Especially is this the case in the industry in which we are interested: only that man to-day who has the ability, tact and education required to recognize, appropriate and employ the best and most advanced methods of mining will prove successful.

The legislatures of the various States have now appreciated this fact, hence the law requiring a higher standard of efficiency on the part of the mine foremen, managers and bosses.

The gentlemen who were instrumental in organizing this Mining Institute, which gives us an opportunity for the calm and intelligent interchange of opinions, also recognized this necessity.

Have I been too radical in intimating that it is not necessary to take a collegiate course in order to acquire a technical education?

The world is full of self-educated men, prominent in all the affairs of life, who are abundantly able to cope with the brightest graduates of Yale and Harvard colleges. We must take advantage of our present opportunities which surround us, employ spare moments in study and mental improvement.

Abraham Lincoln, I am told, never attended college; the elder Atkinson rose from the humbler walks of life; Sir George Elliott, the coal king of Great Britain, was a poor eight-year-old collier boy; William Hopton, author of the "Conversation on Mines, Between Father and Son," entered the mines when only seven years old.

Some of the distinguished gentlemen whom I have the honor of addressing, and who are recognized throughout the State as among the ablest mining men, were never matriculated at college.

Industry, energy and perseverance remove all obstacles and overcome all difficulties.

Is this institute, then, not, as I said, a step in the right direction?

Experience taught our forefathers that the inhalation of black-damp (carbonic acid gas, CO_2) was injurious to life, but they knew practically nothing of the gases that enter into its composition. They knew that fire-damp (marsh gas, CH_4) was explosive, but they did not consider it worth the trouble to ascertain under what circumstances nor when it attained its greatest explosive force, excepting the few who pushed and pried into the science and theory of mining, as we expect to do in this Mining Institute of Indiana, using as our motto, "Let us live and learn to-day, that we may know more to-morrow than we did yesterday."

We who come so frequently in contact with gases breathe atmospheric air in blissful ignorance of the fact that it is composed principally of oxygen and nitrogen.

Our knowledge of this most interesting branch of the science is confined to our ability to detect the gas when present and then to remove it.

Even this we are unable to do unless we have witnessed the same thing done repeatedly by some one else.

Practice enables us to drive entries, lay off rooms at certain angles and at given distances, with fair exactness and without so much as speaking acquaintance with trigonometry, geometry, sines and cosines, but, if asked why we do this or that, we are lost. Through ignorance we can not explain ourselves.

To what, then, is our ignorance attributable, and how can we overcome it? Our lack of technical education is directly responsible for our condition, and this can only be overcome by, as I said, applying ourselves diligently to the welfare of this institute, and taking as our motto the words given.

By securing the works of the ablest men, who have made the consideration of the problems which confront us in mines their life work. They can now be purchased for paltry sums.

By reading monthly and weekly periodicals, ably edited by men of high scientific attainments, devoted exclusively to the discussions of mining questions, which can be had for from $1 to $2 per year, and by all means would I advise a young man to take a course in a correspondence school, such as was instituted a few years ago, in connection with an institute organized for such purposes as this one is, can not fail to widen a member's mental faculty.

The institute carries with it innumerable advantages. A member comes in contact with the masterly minds of the State. He listens and comprehends. They are a source of instruction to him. He can appropriate their ideas and employ their knowledge they have gained in years of study and experience for his own purposes.

His acquired judgment enables him to discriminate between good and bad methods and to make a proper application of the former. He educates himself for every emergency, and adapts himself quickly to changes in the system of mining. He deals directly in science and theory of mining, as well as practical.

He is thoroughly familiar with all new systems of mining long before the change is made. His scientifical and theoretical knowledge enables him to apply his practical knowledge with less difficulty and more advantageously.

He will not indulge in costly experiments, that have been tried years before, when failures of such are fully discussed in the meetings of the institute.

These meetings will broaden our views, remove prejudice and cause us to entertain the views of others. It will make us more tolerant of the opinion of others.

We will no longer consider our own methods the only ones worthy of adoption. It will keep us out of the ruts and make us desirous of being benefited by the experience and teachings of others.

It will afford better protection to life and limb, reduce the number of accidents of all kinds in the State, and render property more secure.

It will produce greater skill, and skill leads to economy. It will stimulate to greater mental activity and will bring about a constant improvement. It will lead to investigation and discovery. It will revolutionize man and methods.

Let us then, indeed, gentlemen, put forth our very best efforts, throw wide open our doors and our arms, and make this institution a blessing to the Commonwealth of the State of Indiana.

The Profitable Amount of Coal to Mine from the "L" Seam of Coal—How to Mine It and How to Prevent Creeps and Squeezes.

BY P. J. MOONEY, MINING ENGINEER.

[Terre Haute Meeting, September 29, 1897.]

Indiana is destined to attain a higher rank in the list of coal-producing States than it has yet reached, and to gain that end it is essential for those engaged in mining to observe the strict rules of economy and to be certain that all operations come within the lines of true practicability.

One of the most vital points in the successful production of coal is to extract the most profitable amount of coal from the territory being worked with the least amount of local diversities from the original plan- allowing that practical changes could be a part of the plan.

Inasmuch as the loss from mining in the block coal seams of the State has been reduced to a minimum, being less than 10 per cent. in several mines that have been finished, this paper will be confined to a discussion of the "L" seam, one of the leading bituminous seams of Indiana, and which is extensively worked at Lyford, Coxville, Rosedale, Fontanet, Star City, Shelburn, Hymera, Vincennes and several other places in the State, and is a vein of coal which runs from six to seven feet thick, with a band of slate or fire-clay about six inches thick in the middle of it. A section of the strata at the place in mind where this seam is being worked is as follows:

SECTION OF STRATA.

	Ft.	*In.*
Surface sand, gravel, and hard pan	72	..
Blue slate	15	..
Black slate	4	..
Coal	1	..
Clay	2	..
Blue shale	29	..
Clay	1	..
Blue shale	26	..
Black slate	8	..
Coal and slate	1	..
Clay	3	..
Blue shale	8	..
Sand rock	6	..
Gray slate	3	..
Coal with 6 in. band in middle	7	9
Fire-clay	5	..
	191	9

The sandstone overlying the draw slate over the coal is a hard silicious rock with great transverse strength, and is very hard to break, requiring in some instances an excavated area of 150 by 200 ft. to gain that result. In the entries the draw slate breaks and falls in layers at intervals.

The fire-clay under the coal is of medium hardness, but disintegrates very rapidly when the pillars, on account of the overlying weight, exert an abnormal pressure on it. If, after the bottom begins to crack on account of this pressure coming on, water is allowed to run over the clay and percolate it, the disintegration is hastened. Simultaneous with this disintegration of the bottom, the pillars begin to crack and spall off, and frequently the pushing out of the fire-clay band in the coal is the first indication of unusual weight.

If this process continues, and it is very hard to stop after reaching this stage, and timber is then of little value, the pillars keep cracking and spalling off and are forced farther down in search of a solid footing as the bottom crumbles and recedes. The fire-clay is pushed out into the roadways and breakthroughs and piles up with the coal that has spalled off; the draw slate now usually adds to the disaster by breaking and falling, and there is a well-defined squeeze. The money spent to develop that part of the mine is usually lost. The probabilities are that the coal that was to be mined with those entries can never be profitably reached from any other direction, and the output of the mine is likely to decline at this time.

When this state of affairs comes to exist, it is apparent that the pillars were either too small or were wrongly proportioned, and, to arrive at a conclusion of how large the proper sized pillars should be, three illustrated plans will be described and shown, with their deductions. Before going into the explanation of these plans, it would be well to state that the best general way to work this seam is in panels from two hundred to three hundred yards wide, so as to protect all divisions of the territory from emergencies. These panels should be laid out to suit the most favorable haulage gradient, and cross-entries with 30-ft. center pillars should be turned off about 100 yds. apart to go across the short way of the panel. When the roof is normal, the rooms should be worked wide, with two roads in each, and should be driven half way to the next cross-entry. The pillars should be properly proportioned on a plan that would prevent creeps or squeezes, not only while the rooms are being driven up, but in such a way that the entries will remain uninjured after the room pillars have been drawn, so that advancing work will not be impeded. The pillars can best be made uniform by driving all work, including rooms on sights. Breakthroughs should be made at suitable places for air.

The dimensions of the places in all the plans are shown on the figures.

The first of the plans referred to, which is used extensively, is shown by Fig. 1,* and consists of turning a double room off the entry with

* By mistake the wrong plate was sent for Fig. 1. The rooms described and figured in Fig. 1 are of the general form indicated in D, Plate LXXXV, p. 1445, or of the rooms at the No. 8 mine, figured in Plate LXXXVIII, p. 1473, though in pillar dimensions, etc., resembling Plates XCII and XCIII.

two necks; these necks are driven in off the entry 12 ft., and are then connected square across, which leaves a pillar between the necks 12 ft. by 24. With this kind of rooms, pillars are usually left 12 ft. thick between the rooms, which makes in the room and entry pillars 28 per cent. of the coal when the rooms are driven up, but squeezes frequently develop in this class of work before the room pillars are drawn and often before the rooms are driven up.

Calculating the weight of the overlying strata at an average of 125 lbs. to the cubic foot, this makes a weight of 38 tons per square foot on all the pillars, but when the room pillars are drawn and the rooms caved, leaving 15 per cent. of the coal in the entry pillars, the strata remaining above the entry pillars form a wedge-shaped burden, widest at the surface, which makes the pressure on the entry pillars 28 tons per square foot, but the adhesive strength of the overlying strata to the surrounding strata is now almost lost, and this largely explains why the entries sometimes squeeze in later on, when they appeared to be all right at the time the room pillars were finished, and rooms caved to points shown by the dotted lines.

The pillars in this method of working can be changed by increasing the thickness of the pillars between the entries to more than 30 ft., but the objections to doing so are obvious; or, the pillars between the rooms could be made thicker; but unless increased enormously, the danger that is wished to be avoided is only intensified, because the weight is then thrown back from the face of the rooms on to the entry pillars, which were made but slightly larger by the change, while it would be best for the weight to incline towards the faces of the rooms.

Another plan used to some extent is shown by Fig. 2, and is a modification of the first. By this plan, the room is turned off the entry with one neck, which is driven in 12 ft.; then the room is widened parallel to the entry to the width of a double room. By this method the pillars are not materially strengthened, for when the stress comes on, the entry pillar is likely to crack at the point where it makes the conjunction with the room pillar, shown by the dotted line on Fig. 2.

After the room pillars are drawn, there is 17 per cent. of the total coal left in the entry pillars, and the pressure is 27 tons per square foot; hence, it will be seen that the entries are still liable to squeeze.

Fig. 3 illustrates the third plan, and is the only plan we use at Coxville, where, after a long test, workings developed on this principle have never squeezed. By this method the rooms are turned off the entries with a single neck. The neck, 7 ft. wide, is driven in 12 ft., and from there the room is widened on a 45° angle from the line of the entry until it is double room width, 36 or 38 ft. wide, and at this width is continued until it is half way to the next cross-entry; the pillars between the rooms are left 16 to 18 ft. thick.

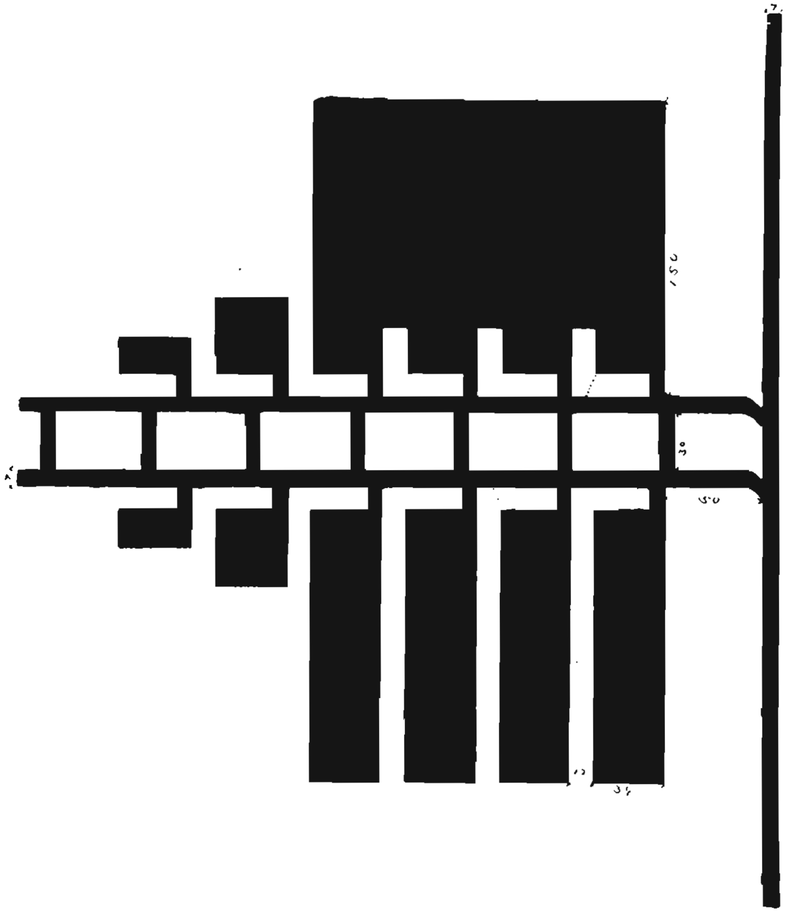


PLATE XCII (Fig. 2). Plan of double room with one neck widened parallel with entry.

This plan makes the entry pillar thickest and strongest at the center, with strong resisting sides, and the coal in the pillars, when the rooms are driven up, is 37 per cent. of the whole, with a weight on them of 28 tons per square foot. When the room pillars are drawn and the rooms caved, the coal in the entry pillars is 24 per cent., with a pressure on them of 22 tons per square foot, which is a favorable decrease of pressure compared with the other two plans described. Some

objection is made to this shape of room, because at the first thought it looks as though it would take too long to get a breakthrough made for air, but upon investigation it will be seen that as the room widens

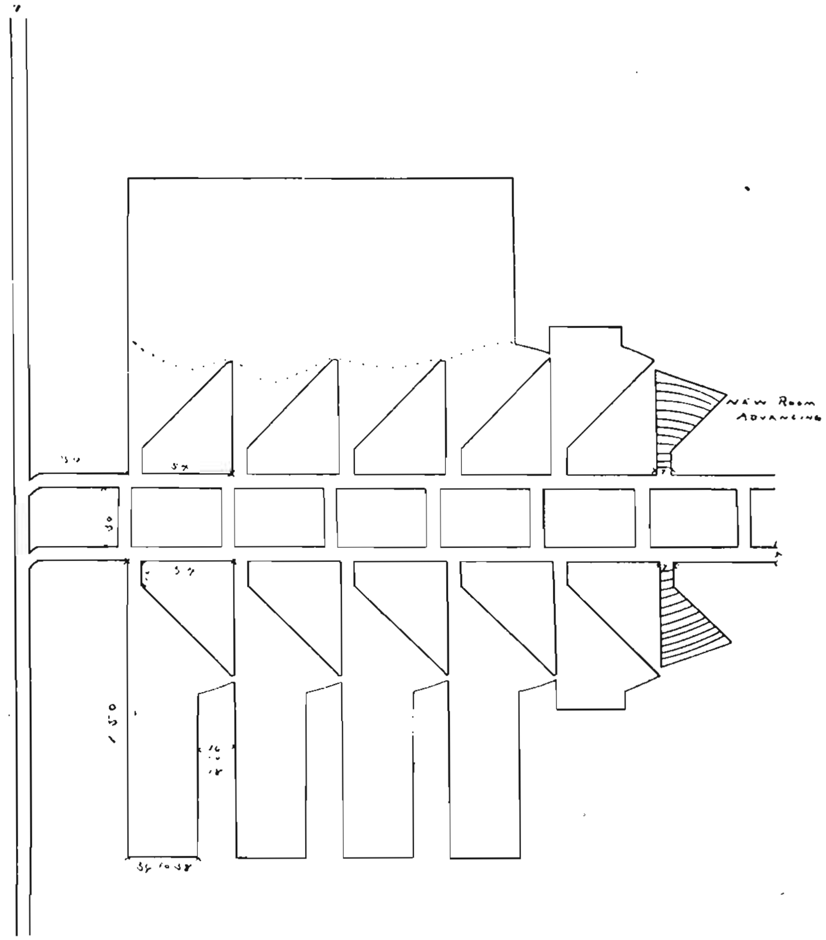


PLATE XCIII (Fig. 3). Plan of double room with one neck widened at 45° angle.

on the 45° angle it improves in foot face each foot advanced, and the angular widening can proceed until the room is 54 ft. wide, when the widening side will be over to the straight side line of the next room; the room can then be marked down to the proper width, 36 ft., leaving a pointed opening in the rib, which will be cut into by the next room when it reaches that point; and this second room will in turn make the breakthrough for the third; thus, each room makes the breakthrough in advance for the next. The draw slate does not break much in the rooms worked on this plan, and where it is suitable, some of the top coal is left up in the entrics to keep the draw slate from breaking there. To prevent a large accumulation of superincumbent weight, which condition invites squeezes, the room pillars should be drawn back to these angular pillars as soon as the rooms reach the maximum point to where they stay practically intact.

This leaves a line of caved finished work denoted by the dotted lines on Fig. 3, and is the only sure way to get the coal in the room pillars; for the rock is soft in places, which causes some of the rooms to cave, if allowed to stand indefinitely, and the leading object in view is to have absolute control of the pressure and the places until all are finished.

When a set of entries are finished, the entry pillars are usually surrounded by goaf, disintegrated draw slate and half-rotten timber, to such an extent that about one-half of the coal in them is all that it pays to mine, leaving 12 per cent. of the total territory in them, to which 5 per cent. for general emergency loss should be added, making the total loss 17 per cent.; hence, the amount of coal that can be profitably mined from this seam is 83 per cent. of the whole.

MAPS.

Mine maps have been filed by nearly all operators at the time required by law this year, and it has been necessary to appoint an engineer in but two cases. In one of those the mine had recently changed hands, and in the other the delay arose from the fact that the mine was under lease, and the owners and lessees had each been depending on the other to have the work done.

EXAMINATIONS.

Examinations of applicants for certificates of competence and service to act as mine boss, fire boss and hoisting engineer at coal mines have been held at the following times and places during the year, with the results given below:

PLACE.	APPLICANTS.			PASSED.			FAILED.		
	M. B.	F. B.	Eng.	M. B.	F. B.	Eng.	M. B.	F. B.	Eng.
Brazil, January 15	15	3	8	7	3	4	8	0	4
Washington, April 14	8	0	5	6	0	5	2	0	0
Terre Haute, July 15	20	0	11	9	0	4	11	0	7
Brazil, October 15	23	0	10	12	0	6	11	0	4
Evansville, December 15	4	0	13	2	0	11	2	0	2
Totals	70	3	47	36	3	30	34	0	17

From the number of applicants that attend the examinations, and from the inquiries that have been received as to the time and place of holding them in the future, I am of the opinion that it has had the effect of arousing an interest in education among the workers in the mines of the State which will raise the members of the craft in the estimation of the public, and eventually result in this great natural resource of our State being mined in a manner in the future that will save from waste and loss a much larger proportion of our coal seams than has been the case in the past. I give below a list of the certificates issued during the year, a sample list of questions given to each class of applicants, and the answers which were considered best to those given by the applicants for mine boss and hoisting engineers' certificates. The answers given are not by any one applicant, but what were considered the best were taken from the whole of the papers handed in:

Certificates of Competency Issued 1898.

MINE BOSSES.

George H. Doidge, Cardonia.
John E. Griffiths, Dugger.
Wm. McElrath, Perth.
Joseph C. Winn, Perth.
Wilson McIntyre, Carbon.
Gust. Stievenart, Brazil.
John Baird, Jr., Cardonia.
Henry Kocher, Washington.
David J. Lloyd, Terre Haute.
Rafe Cauldwell, Terre Haute.
Alex. Maule, Princeton.
Wm. A. Murry, Montgomery.
Wm. H. Lynn, Bicknell.
Peter May, Linton.
Silas Jones, Seeleyville.
F. Freeman, Bicknell.
J. C. Carrol, Clay City.
F. S. Carrol, Clay City.
J. T. Speirs, Diamond.
James Anderson, Winslow.
Archie Dinsmore, Cardonia.
F. S. Kelley, Danville, Ill.
John Mooney, Brazil.
John Barker, Cardonia.
Thomas Teal, Cardonia.
Edgar Karral, Voorhees.
F. S. Whippo, Ehrmandale.
W. G. Hodge, Brazil.
John P. Acree, Brazil.
Samuel Holden, Brazil.
John D. King, Brazil.
Jonathan Thomas, Carbon.
Wm. Dalrymple, Silverwood.
W. G. Spears, Brazil.
Ben Schrepferman, Brazil.
H. L. Katenhusen, Newburgh.

HOISTING ENGINEERS.

L. V. Simpson, Terre Haute.
Eli P. Berry, Center Point.
Hugh Kirkland, Diamond.
James N. Smith, Macksville.
Ed. Smith, Edwardsport.
F. Golliner, Macksville.
Wm. Maule, Princeton.
David J. Lloyd, Terre Haute.
M. W. Smith, Macksville.
Jeff. Walters, Cardonia.
William Barnes, Ayrshire.
G. D. Smith, Freelandville.
Chas. Mock, Clinton.
F. Gerner, Clinton.
Clifford Hardin, Carbon.
E. E. Bledsoe, Dugger.
Emmet Wehr, Carbon.
Clayton Bright, Silverwood.
M. D. Martin, Clinton.
William Abshier, Newburgh.
Frank S. Brenner, Newburgh.
Dan Briedenbach, Evansville.
William S. Cameron, Evansville.
Clarence Robertson, Newburgh.
Wm. Robertson, Newburgh.
Albert Langer, New Harmony.
Wm. A. Cecil, Evansville.
Geo. Bonenberger, Evansville.
Herman Koenig, Evansville.

FIRE BOSSES.

James Skene, Mecca.
Thomas Orr, Harmony.
James E. Griffiths, Dugger.

Certificates of Service.

MINE BOSSES.

Thomas B. Hall, Chandler.
Andrew Butterman, Turner.
Peter Ehrlich, Turner.
W. H. Bailey, Chicago, Ill.
James Teverbaugh, Washington.
Claude S. Peck, Brazil.
A. L. Tribble, Brazil.
F. P. Cristy, Clinton.
John Mushet, Sr., Lyford.
A. M. Roberts, Hymera.
Walter Irvine, Cass.
Wm. McCloud, Sullivan.
J. H. Irwin, Macksville.
Wm. Harris, Washington.
John P. Gilmour, Alum Cave.
Fred Whitmarsh, Cardonia.
Wm. N. Stevenson, Eagle.
Wm. L. Dalton, Clinton.
Thomas Williams, Cayuga.
William Byers, Brazil.
F. M. Wampler, Indian Springs.
John Young, Raglesville.
Thomas E. Sutton, Hymera.
Matthew Barr, Perth.
N. Schrepferman, Brazil.
Jacob Robbins, Silverwood.
Julius M. Archer, Harmony.

HOISTING ENGINEERS.

George D. Partington, Evansville.
James H. Eller, Voorhees.
Wm. Baum, Chandler.
John T. Shanks, Sullivan.
John R. Ogden, Rosedale.
Mate Gibson, Ehrmandale.
John H. Wilkinson, Alum Cave.
William Cummings, Carbon.
Fred Schrepferman, Brazil.
Charles Solomon, Washington.
James Chaney, Linton.
Nathan Williams, Ehrmandale.
Wm. H. Conkel, Farnsworth.
Joseph Dickinson, Clinton.
Claude Peck, Knightsville.
Benj. James, Diamond.

A. Podesta, Evansville.
John Sweeny, Evansville.
John A. Cummins, Alum Cave.
Henry Cash, Chandler.
W. D. Gummere, Del Carbo.
E. H. Adamson, Clinton.
A. W. McGranahan, Ehrmandale.

FIRE BOSS.

Simeon Woolley, Shelburn.

Questions for the Examination of Mine Bosses for State of Indiana.

[At Brazil, October 15, 1898.]

1. What are the duties of a mine boss as provided by the law of Indiana?

2. What duties imposed by law on "the owner, operator, agent, or lessee" are usually performed by the mine boss?

(Give the principal heads under which these duties fall, but it is not necessary to quote the law word for word.)

3. What duties other than those set out in the law are mine bosses usually required to perform at the mines of Indiana?

4. What, in your opinion, are the necessary qualifications of a mine boss, as to character, habits, education and experience?

5. Give the precautions required by law to be taken to prevent accidents in hoisting shafts in this State. (In substance, not necessary that it be the law word for word.)

6. Give in substance the law of Indiana in regard to (a) the amount of air to be forced into a mine, (b) how it shall be circulated, (c) what examination shall be made of working places with respect to their ventilation, (d) how the ventilation shall be provided, (e) in regard to splitting the air, (f) in regard to breakthroughs, (g) in regard to doors.

7. A five-foot vein of coal has a roof of three feet of hard black slate, overlain with four feet of limestone and has a fire-clay bottom three feet thick. The total cover over the coal is fifty feet. Give (a) width of entries and thickness of entry pillars, (b) width of rooms and thickness of room pillars, (c) what amount of coal should be left to protect the shaft.

8. Under what conditions would you consider the use of mining machines inadvisable? (b) What conditions are most advantageous to the use of punching machines for mining? (c) What condition would make the use of chain machines most desirable?

9. What are the different noxious gases found in mines? Give as fully as possible what you know of the properties and dangerous character of each gas.

10. A cross entry is driven at right angles to the main entry and reaches the bottom of a dip after going 175 yds. From the shaft to the point where the cross entry is turned is 700 ft. It is required to drive a water level in a straight line from the shaft to the dip in the cross entry. What is the distance?

11. In a certain mine the main air course and return are each 2,000 ft. long. The air course is badly fallen and the air is poor in all entries

and working places. The fan is being run to its full capacity. Name three ways in which the amount of air may be increased without putting in a larger fan.

12. In a mine the air splits at the bottom of the downcast. The air course on one side of the mine is 1,200 ft. long and on the other 2,700 ft. long; 25,000 cubic feet of air per minute is being sent into the mine. How much of it goes to each side of the mine, all other conditions being the same on both sides? (b) In the above case it is desired to have the same amount of air going to each side. How would you arrange to bring this about? (c) After arranging for this, would there be any change in the amount of air entering the mine, the power producing the current remaining the same?

13. At the face of the entry (E) shown in the sketch on the blackboard the coal has caught fire from a shot in the coal. At the point (b) on the air course there is a feeder giving off a large amount of marsh gas. How would you proceed to extinguish the fire or prevent it from spreading?

14. A vein of coal 7 ft. thick is opened by a shaft having two hoisting compartments each 6 ft. 6 in. by 7 ft. The roof is good and the bottom inclined to be soft. (a) What gauge of track would you use? (b) How would you build your main haulage road? (c) Give the dimensions of the cars you would use. (d) How much coal, mine run, should each car carry, broken coal weighing 70 lbs. per cubic foot?

15. In a given mine the main north entry runs 700 ft., the first east and the first west each run 200 ft., the second east and the second west each run 125 ft., all being double entries. The main south entry runs 300 ft., with a pair of entries on each side each 150 ft. in length. Allowing 33 ft. for each room and pillar, and one man to a working place—entry and rooms—(a) how many men would be employed? (b) How many mules would be needed? (c) The air measurements that should be shown at the face of each entry?

(Notice that the amount of air course on each side of the mine is the same as in question 12, and take your answer to that as the amount of air going to each side of the mine.)

16. How do you measure air in mines? (b) What instruments are necessary? (c) Assuming the dimensions of the air course in question 12 to be 4 ft. 6 in. by 7 ft., what is the velocity of the north current? Of the south current?

Answers to the Questions for the Examination of Mine Bosses.

[At Brazil, Ind., October 15, 1898.]

1. He shall (1) watch ventilation apparatus and air ways; (2) see that loose coal and rock on the traveling and air ways are secured against falling; (3) measure the air at the inlet and outlet and at the face of the entries once a week; (4) keep a record of such measurements and report monthly to the Inspector of Mines; (5) visit and examine working places each alternate day when men are or should be at work; (6) see that sufficient timbers are kept at working places; (7) order and direct that unsafe places be made safe when notified of them, and give written acknowledgment when he receives such notice; (8) give immediate notice to the Inspector of Mines when a serious or fatal accident occurs at his mine.

2. To see that escape ways are constructed and maintained as required by law; (b) that safety appliances are provided; (c) that the proper hoisting signals are used; (d) to split the ventilating current so that not more than fifty men work on any one current; (e) to have breakthroughs made every forty-five feet and all except that nearest the face closed and made air-tight; (f) to see that a sufficient supply of timber be kept at the mine; (g) to see that proper precautions are taken when approaching old works; (h) to see that no female or boy under fourteen years of age is employed in the mine.

3. To employ and discharge workmen; (b) to keep the time of the day men; (c) to lay off and direct the underground workings of the mine; (d) to make measurements of narrow work and report the same to the bookkeeper; (e) to make allowances for dead and deficient work; (f) to direct the employment of day men in and about the mine; (g) to take all possible steps to produce coal with the greatest economy consistent with the safety and comfort of the employes of the mine.

4. He should be honest and fair in his dealings with his employes and employers, deliberate in forming his opinions, and firm in his decisions, without being stubborn or obstinate; (b) he should be temperate and steady in his habits, giving close attention to his duties and be regular in performing them; (c) he should be able to read and write the English language clearly and legibly, and have sufficient knowledge to perform the duties specified in the answers to questions 1, 2 and 3 above; (d) he should have had sufficient experience to understand the best methods of mining applicable to different conditions, to detect dangerous conditions in the mine and take proper steps to remedy them, and be able to direct the drainage, timbering, ventilation and haulage; he should also have had some experience in dealing with men and directing their work.

5. None but sober and competent engineers shall be placed in charge of any engine where men are hoisted or lowered. (b) An adequate brake shall be attached to every drum or machine used for hoisting. (c) Also an indicator to show the position of the cage in the shaft. (d) The signal law shall be posted at the top and bottom of the shaft and in the engine room. (e) A wire rope shall be used for hoisting, and it shall be examined every morning by a competent person. (f) Cages must be covered, and have approved safety catches attached to them. (g) Safety gates must be placed at all landings. (h) Signal bells must be placed at the bottom of each shaft connecting with the engine room. (h) Reflecting lights must be placed within ten feet of the shaft at any vein worked above the bottom of the shaft. (i) A traveling way must be cut in the side of the shaft.

6. (a) One hundred cubic feet per minute for each person and three hundred cubic feet for each animal employed in the mine. (b) It must be circulated around main entries, cross entries and working places so that they shall be free from standing gas of all kinds. (c) Where fire damp is known or supposed to exist the working places shall be examined by a

competent person immediately before each shift. (d) By any suitable appliance, as furnace, fan, steam jet, or by natural draft. (e) Split so as to give a separate current to at least each fifty men. (f) Shall be made in every room forty-five feet apart, and all except the last shall be closed and made air-tight. (g) They shall be opened and closed by persons designated for that purpose.

7. (a) Eight ft. entry, 21 ft. pillar. (b) 21 ft. room and 9 ft. pillar. (c) A block of coal 160 ft. square. (Correct answers to this question may vary within reasonable limits.)

8. (a) A low vein, one with a bad roof, or one where a great deal of sulphur or other hard material is found in the mining bench. (b) A good roof, hard bottom, thick vein, with mining bench reasonably free from sulphur or boulders. (c) Less coal being taken for the cutting, a thin vein may be worked to advantage with chain machines; a stronger roof is required for chain than punching machines, and the mining bench should be entirely free from boulders and sulphur.

9. Black damp (CO_2) is heavy, will not support light, and kills by suffocation. Is easily detected by its effect on a light. (b) White damp (CO) is poisonous, being nearly the weight of the air, is diffused through it, is not easily detected and a very small percentage of it is very injurious. (c) Marsh gas (CH_4) is very light, may be detected with a safety lamp, when mixed with 9.5 times its volume of air, is very explosive and less so in proportions varying within certain limits both ways from this. (d) Choke damp is the product of an explosion of fire damp, is composed of various gases in varying proportion and is extremely fatal.

10. $\sqrt{(175\times3)^2\times700^2}=875$ ft.

11. (a) Split the air. (b) Enlarge the air course. (c) Sink an air shaft at the end of the air course farthest from the intake.

12. The quantity varies inversely as the square root of the lengths of the air ways, or as $\sqrt{1200}:\sqrt{2700}$. By extracting the root and reducing we get 2:3, or two-fifths of the air goes one way and three-fifths the other: $\frac{1}{5}\times25{,}000=5{,}000$.

$5{,}000\times2=10{,}000$ cu. ft., amount going to the long side.

$5{,}000\times3=15{,}000$ cu. ft., amount going to the short side.

(b) Split the air on the long side or 2; put in a regulator on the short side.

(c) By the first plan there would be more air forced into the mine; by the second there would be less.

13. This can be answered in several ways. The plan that was finally successful in the case I had in mind was to close the mouth of the shaft for four days, when the fire had stopped burning so briskly as at first. A brattice was then carried in on the air course side to carry air enough to keep the gas from the fire. The entry was then closed by an air-tight stopping and the fire allowed to smother itself. The other part of the mine is now working and feeling no bad effects from the fire. An explosion occurred from bratticing off the entry while the fire was still burning brightly.

14. (a) Three ft. 2 in. (b) Lay ties 5 in. by 3 in., 4 ft. 6 in. long on the bottom, 2 ft. apart from center to center; use 16-lb. iron, well spiked to each tie, the rails joined with fish plates; if possible drain all water off the road and ballast with rock or ashes. If the bottom is too soft for this use corduroy. (c) Cars 5 ft. 6 in. long, 2 ft. 6 in. wide at the bottom; sides, 10 in. high, straight up, then a 10-in. board set at such an angle that the car would be 3 ft. 6 in. wide at the top, and above that a 12-in. board. Use wheels 18 in. in diameter and have the frame work and running gear strongly built. (d) This car would contain 37 cu. ft., and would hold level full 2,600 lbs. or, with a foot of building on the top, about 4,000 lbs.

15. (a)—	*Men.*
Each 200-ft. entry gives 6 rooms, 6×4	24
Each 125-ft. entry gives 3 rooms, 4×3	12
Each 150-ft. entry gives 4 rooms, 4×4	16
16 entries, 1 man in each	16
Total men at work mining	68
3 drivers, 2 tracklayers, 1 timber man, 1 cager	7
3 mules.	
	75

Without allowing anything for leakage, there would be 10,000 cu. ft. per minute at the face of each entry on the north side and 15,000 at the face of each entry on the south side, and 25,000 cu. ft. at the inlet and outlet. If one-half these quantities were found I would consider the mine in fair condition, i. e., at the faces of the entries. The inlet and outlet would show the full amount.

[In grading answers to this question full credit was given to those showing 5,000 cu. ft. going to the north side and 2,300 to the south side, as some understood the question to ask what amount of air would be needed for the men employed.]

16. (a) Take the velocity by holding the anemometer for one minute in the air current, measure the height and width of the air way, multiply the three measurements together gives the cubic feet per minute. (b) Anemometer, tape line and timepiece.

(c) North, $\frac{10{,}000}{4.5\times7}=317$ ft. South, $\frac{15{,}000}{4.5\times7}=476$.

[In grading answers to (c) above if the wrong quantity was taken as the amount of air circulating, but the process was correct, full credit was given to the answer.]

Questions for the Examination of Hoisting Engineers for State of Indiana.

[At Brazil, October 15, 1898.]

1. Name the essential qualifications of a hoisting engineer as to (a) character, (b) habits, (c) education and (d) experience.

2. What is the result if the proper allowance is not made for the contraction and expansion of a steam boiler in setting?

3. What do you mean by expansion? (b) What causes it? (c) In which direction is it greatest—through length or the diameter of boiler? Give reason for your answer.

4. What pipe fittings, valves and other attachments are used in setting up and connecting a boiler and engine?

5. What in your opinion is the best kind of boiler for use in a coal mine? (b) Why do you prefer it over each of two other kinds?

6. What are the advantages of a double over a single hoisting engine?

7. (a) What is the use of a flywheel on an engine? (b) What is the effect if the flywheel is too light for its work? (c) If it is too heavy?

8. Why is a geared engine preferred to one coupled direct, at the mines of Indiana?

9. What should be the size of the cylinder of a single engine, with gear wheels in the ratio of one to six, connected to a drum 5 ft. in diameter, to hoist a weight of 4,000 lbs. from a shaft 85 ft. deep in 45 seconds? (b) What would be the speed of the engine—strokes per minute? (c) What would be the piston speed?

10. Describe the action of the reversing gear of a hoisting engine.

11. Give in substance the law relating to the qualifications of hoisting engineers at coal mines in Indiana.

12. Give in substance the laws intended for the prevention of accidents in hoisting shafts.

13. Give the signal law which is required to be posted in the engine room at mines in Indiana.

14. How can you learn, by comparing your steam and safety valve with each other, whether they are correct?

15. (a) What is the back pressure per square inch on the plunger of a pump which is raising water 175 ft.? (b) What mean effective steam pressure would be necessary to do this work if the steam cylinder is 6 in. in diameter, and the water cylinder is 4 in. in diameter, making no allowance for friction, or of the power required for suction?

16. (a) What kind and size of rope would you order to hoist a load of 5,000 lbs? (b) How would you examine a hoisting rope? (c) What indications would lead you to think that your rope was becoming defective?

Answers to the Questions Given for the Examination of Hoisting Engineers.

[At Brazil, Ind., October 15, 1898.]

1. (a) He should be upright and honest, so that he can be depended upon always to be at his post and do his whole duty. (b) He should always be sober and attentive when on duty and avoid all habits that will tend to affect his nerves. (c) He should be able to read and write the English language legibly, and know enough arithmetic to be able to calculate the proper set of valves and the power of an engine, and should have a good knowledge of the mechanical powers. (d) He should have sufficient experience to understand the care of boilers, proper methods of firing, and to quickly detect anything wrong in the steaming of his boilers or the running of his engine, and to be able to make all the small repairs necessary to keep his machinery in running order and to be well acquainted with the work of running the engine practically.

2. The boiler walls will be injured and cracked. This will interfere with the draft and will make the setting of boiler unsafe, and throw all the connections out of line.

3. (a) Increase of size. (b) Heat and the pressure of the steam in the boiler. (c) Lengthwise, as there is a greater body of metal to expand in that direction.

4. Steam, blow-off and feed pipes, water gauges, safety valve, steam gauge, manhead, globe valve, throttle valve, with the necessary sleeve, elbow, tee and reducing fittings.

5. (a) A two-flue boiler. (b) Because it has more heating surface than a cylinder boiler, and is more easily cleaned and taken care of than a tubular boiler. (The answers to this question will be given credit according to the answers to (b), as each kind of boiler has some advantages over the others.)

6. It can be run more steadily, and as the cranks are set at right angles there is no danger of its stopping on the dead center.

7. (a) To carry the engine over the center and to steady it in running, by taking up power in the middle of the stroke and giving it out at the end of the stroke. (b) The engine will run "jerky" and would not be carried over the center with a heavy load. (c) It would require too much power to start the engine, and after it had got under headway it would be difficult to stop.

8. It allows the engine to run faster with the same speed in the drum, gives better control of the engine in a shallow shaft and at the same time allows the use of a larger drum, which is easier on the ropes.

(a) Assume an average steam pressure in the cylinder of 45 lbs. per square inch, then:

$$\frac{5000 \times 85 \times 60}{45 \times 45 \times .7584 \times 86.56} = 11.1.$$

Diameter of piston, and the size of the engine is 18 in. by 11.1 in.

9. (b) $\frac{85 \times 6 \times 60 \times 2}{5 \times 3.1416 \times 45} = 86.56$ strokes per minute.

(c) Assuming the cylinder to be 18 in. long then:

$$\frac{86.56 \times 18}{12} = 129.84 \text{ per minute.}$$

10. Throwing the reverse lever raises the block in the link and brings the opposite into action on the valve rod, causing it to travel in the opposite direction from that in which it was traveling when the block was at the bottom of the link, and steam is admitted to the opposite end of the cylinder at the corresponding point of the stroke of the engine, causing it to run in the opposite direction.

11. "No owner or agent of any coal mine in this State shall place in charge of any engine used for conveying into or hoisting out of any coal mine in this State any but experienced, competent and sober engineers." It shall be unlawful for any person to serve in the capacity of hoisting engineer of any coal mine in this State, without having first received from the Inspector of Mines a certificate of service or of competency.

12. None but sober and competent engineers shall be placed in charge of any engine where men are hoisted or lowered. (b) An adequate brake shall be attached to every drum or machine used for hoisting. (c) Also an indicator to show the position of the cage in the shaft. (d) The signals shall be posted at the top and bottom of the shaft and in the engine room. (e) A wire rope shall be used for hoisting, and it shall be examined every morning by a competent person. (f) Cages must be covered and have approved safety catches attached to them. (g) Safety gates must be placed at all landings. (h) Signal bells must be placed at the bottom of each shaft connecting with the engine room. (i) Reflecting lights must be placed within ten feet of the shaft at any vein worked above bottom of the shaft. (j) A traveling way must be cut in the side of the shaft.

13. There shall be a code of signals at all coal shafts in this State with a signal bell in the bottom of each shaft. One bell shall signify to hoist coal or empty cage, and also to stop either when in motion; two bells shall signify that men are coming up; when return signal is received from the engineer, men will get on the cage, and ring one bell to hoist; four bells shall signify to hoist slowly, implying danger. The engineer's signal for men to get on the cage shall be three bells.

14. Place the weight at different points on the lever of the safety valve, raise steam until it blows off, calculate the pressure on the safety valve and compare with that shown by the steam gauge.

15. (a) $\frac{175 \times 14.7}{34} = 75.558$ pounds pressure.

(b) $\frac{4 \times 4 \times .7854 \times 75.558}{6 \times 6 \times .7854} = 33.581$ pounds per square inch.

16. (a) Iron wire, 1 in. in diameter. (b) Have some other person to run the engine slowly, and I would stand at a point where I could get a good view of the rope, and watch for indications of broken wires or strands. (c) If the rope began to show broken wires, or if it had materially lengthened by use I should think that it was becoming defective. There are other signs that can only be noticed by constant practice.

Questions for Examination of Fire Bosses.

[At Brazil, Ind., January 15, 1898.]

1. What are the duties of a fire boss?

2. What would determine whether or not any particular part of a mine should be examined for gas?

3. What are the essential features of a safety lamp?

4. What indications does a safety lamp give of the presence of fire damp, when a small amount only is present?

5. What, when it is present as an explosive mixture?

6. What kinds of safety lamps have you used in places where fire damp was known to exist?

7. Which do you prefer? and why?

8. How would you remove fire damp from a working place, or render it harmless?

9. From where does the fire damp come that is found in mines?

10. What velocity of air is necessary to carry marsh gas out of a working place without allowing it to mix with the air?

11. In what parts of a mine is fire damp, or pure gas, most likely to be found?

12. In case the workings of a mine were being driven toward old works where there was reason to suspect the presence of gas, what precautions would you advise to prevent an accident from its being suddenly admitted to the working places?

13. Should a fall occur on your intake airway and a large amount of marsh gas be given off from the roof, what steps would you take to prevent an explosion and rescue the men at work inside?

14. What gases enter into the composition of fire damp, and in what proportions?

15. What is the effect of coal dust on an explosion of fire damp?

16. Give an outline of what you would do to rescue workmen after a heavy explosion.

INDIANA MINES.

I give below a list of mines which are in active operation on January 1, 1899, the person in charge of each mine and the number of men and animals employed in each, as shown by the December (1898) reports of mine bosses:

CLAY COUNTY.

Mine.	Mine Boss.	Address.	Employes. Inside.	Employes. Outside.	Animals used.
Brazil Block No. 1	John Bolin	Brazil	111	12	10
Monarch	James King	Brazil	15	1	2
Fairview	W. J. Price	Cardonia	51	5	5
Diamond	Jas. Cuthbertson	Brazil	131	9	6
Gladstone	W. P. McQuade	Brazil	96	9	11
Brazil Block No. 11	Martin Navin	Diamond	56	7	4
Brazil Block No. 8	Henry Payne	Brazil	156	17	13
Pratt	H. W. Jenkins	Perth	67	8	7
Eureka No. 2	W. T. Hopkins	Carbon	123	7	13
Eureka No. 3	John Quigley	Carbon	91	6	6
World's Fair	R. F. Jenkins	Knightsville	64	3	3
Rob Roy	Jas. Dunlop	Brazil	40	3	5
Brazil	Moses Marks	Cardonia	68	7	5
Dewey	John Cox, Sr	Brazil	102	2	7
Gart No. 5	A. Gilmour	Cardonia	164	10	11
Gart No. 3	Wm. Conroy	Brazil	99	9	10
Crawford No. 4	Sam'l Lindsay	Hoosierville	106	7	3
Lucinda or Columbia No. 5	M. Hoffman	Asherville	170	9	5
Columbia No. 4	T. Thompson	Hoosierville	51	4	2
Louise	Grif Howell	Center Point	25	4	3
Crawford No. 5 and 2	Walter Knox	Asherville	81	9	2
Pyrah No. 3	F. Eberwine	Knightsville	38	3	2
Briar Hill	F. S. Carrel	Clay City	28	5	3
Markland	Peter Andrew	Clay City	28	5	5
Harrison No. 2	Chas. Nash	Clay City	46	6	4
Harrison		Clay City			
Klondike	J. Ehrlich, Sr	Staunton	134	8	7
Superior	A. Butterman	Turner	30	5	3
San Pedro	Ed. Somers	Staunton	74	6	6
Crawford No. 3	Abandoned		35	4	1

DAVIESS COUNTY.

Mine.	Mine Boss.	Address.	Inside.	Outside.	Animals used.
Cabel No. 4	A. Kocher	Washington			
Cabel No. 9		Washington			
Wilson's No. 4	J. Teverbaugh	Washington	23	3	2
Montgomery No. 1	Jas. B. Brown	Montgomery	11	3	1
Montgomery No. 2	Jas. B. Brown	Montgomery	58	7	9
Montgomery No. 3	Geo. B. Brown	Montgomery	30	7	2
Mutual	D. W. Davis	Cannelburg	40	6	4
Hoosier	Grant Stov	Raglesville			
Union	A. W. Stickey	Raglesville	20	4	
Stuffles No. 3	W. A. Jacobs	Raglesville	11	2	
Hawkins	Thomas Harris	Washington	27	5	3

FOUNTAIN COUNTY.

Mine.	Mine Boss.	Address.	Inside.	Outside.	Animals used.
Indiana Bituminous	Wm. Dalrymple	Silverwood	70	7	9
Sturm	J. S. Tiley	Silverwood	17	2	3

GIBSON COUNTY.

Mine.	Mine Boss.	Address.	Employes. Inside.	Employes. Outside.	Animals used.
Oswald	J. C. Anderson	Princeton			

GREENE COUNTY.

Mine.	Mine Boss.	Address.	Inside.	Outside.	Animals used.
Island No. 1	S. C. Risher	Linton	108	14	8
Island No. 2	J. S. Newport	Linton	125	23	19
Island Valley	Joseph Fennell	Linton	44	3	6
Flubart	Thomas McQuade	Linton			
South Linton	Joseph Ferry	Linton	89	6	8
Summit	Frank Lockhart	Linton	110	10	11
Summit No. 2	H. W. Sexton	Linton			
Templeton	James Dunn	Linton	133	12	7

KNOX COUNTY.

Mine.	Mine Boss.	Address.	Inside.	Outside.	Animals used.
Prospect Hill	W. R. Scott	Vincennes	25	6	3
Bicknell	R. M. Freeman	Bicknell	35	4	2
Edwardsport	F. S. Kelly	Edwardsport			

MARTIN COUNTY.

Mine.	Mine Boss.	Address.	Inside.	Outside.	Animals used.
Tunnel	F. M. Wampler	Indian Springs			

PARKE COUNTY.

Mine.	Mine Boss.	Address.	Inside.	Outside.	Animals used.
Parke No. 8	George Mitch	Rosedale	70	11	8
Cox No. 3	George A. Davis	Coxville	133	22	20
Mecca No. 1	James Skene	Mecca	37	7	5
Lucia	F. J. Urbain	Mecca			
Lyford No. 2	John Mushett, Sr	Lyford			
Brazil Block No. 12	Robert J. Wallace	Diamond	85	11	5
Standard	John J. Scott	Brazil	101	6	6
Columbia No. 2	Jno. Chesterfield, Sr	Brazil	116	6	5
Columbia No. 1	Geo. Meyers	Brazil	70	5	7
McIntosh No. 1	Samuel Holden	Brazil	45	3	3
McIntosh No. 3	Jno. Chesterfield, Jr	Brazil	44	5	2
Otter Creek	John A. Bolin	Carbon	56	4	5
Crawford No. 1	Henry Schlatter	Carbon	67	6	4
Hardscrabble	John Paton	Lyford	8	0	1

PERRY COUNTY.

Mine.	Mine Boss.	Address.	Inside.	Outside.	Animals used.
Cannelton	George W. Briggs	Cannelton			
Troy	H. L. Williams	Troy	22	2	2

PIKE COUNTY.

Mine.	Mine Boss.	Address.	Inside.	Outside.	Animals used.
Woolley	H. T. Brewis	Petersburg	60	5	7
Blackburn	John R. Willey	Petersburg	34	7	6
Little's	Andrew Dodds	Littles	121	12	13
Carbon	Bartley Stinson	Sopha			
Ayrshire	John Jennings	Ayrshire			
Hartwell		Cabel			

SULLIVAN COUNTY.

MINE.	MINE BOSS.	ADDRESS.	EMPLOYES. Inside.	EMPLOYES. Outside.	Animals used.
Jackson Hill	G. H. Sargent	Eagle	113	13	24
Harrison	T. C. Sutton	Hymera	92	10	8
Phenix	Joseph Peters	Alum Cave	165	19	13
Star	Samuel Campbell	Del Carbo	83	19	13
Shelburn	Thos. Thomas	Shelburn	60	13	7
Sullivan	David Harrison	Sullivan	12	1	0
Bush Creek	John T. Fogg	Farnsworth	....	....	....
Bunker Hill	Frank Smith	Farnsworth	20	2	2
Briar Hill	....	Dugger	....	....	....
Dugger	H. A. Butler	Dugger	103	16	17

VANDERBURGH COUNTY.

Union	P. Schultheis	Evansville	29	6	3
Diamond	G. Bonenberger	Evansville	21	4	2
First Avenue	Frank Guenther	Evansville	....	....	....
Sunnyside	C. H. Baetz	Evansville	61	10	13
Ingleside	John Odell	Evansville	100	10	14

VERMILLION COUNTY.

Buckeye	William Chesterfield.	Clinton	110	9	10
Brouillet's Creek No. 3	D. W. James	Clinton	....	....	....
Brouillet's Creek No. 4	Steward Shirkie	Clinton	105	6	5
Prince	John Mushett, Jr	Clinton	125	11	7
Torrey No. 4	Edgar Karral	Voorhees	113	15	7
Cayuga	R. M. Irving	Cayuga	13	3	2

VIGO COUNTY.

Peerless	G. R. Anthony	Fontanet	127	9	10
Union	James Johnson	Fontanet	166	13	15
Diamond No. 2	Thomas Gregory	Fontanet	165	9	12
Grant	James Devonald	Burnett	70	10	10
Nickel Plate	D. J. Evans	Ehrmandale	23	7	3
Eureka	John W. Alvis	Ehrmandale	10	5	2
Ray	George West	Seeleyville	68	8	6
Ehrlich	H. B. Ehrlich	Seeleyville	40	7	4
Hector	William Grey	Seeleyville	64	7	5
Parke No. 10	Jeff Ladson	Heckland	99	12	10
Brick Works	Robert F. Bieler	Macksville	12	1	1
Miller	John Crosby	Terre Haute	....	....	....
Murray	Thomas G. Marshall.	Macksville	12	....	....
Broadhurst	John F. Erwin	Macksville	20	2	0
Larimer	W. L. Erwin	Macksville	21	3	0

WARRICK COUNTY.

Star	Geo. F. Archbold	Newburg	32	5	4
Britzius	H. J. Katenhusen	Newburg	....	....	....
Air Line	T. B. Hall	Chandler	....	....	....
Chandler	Patrick Bartley	Chandler	....	....	....
Big Vein	William Woolley	Boonville	38	6	7
Caledonia	F. P. Hargroves	Boonville	23	3	2
Gough	Wm. Kelley	Boonville	....	....	....

DESCRIPTIONS OF MINES.

During the year 1898 mines employing more than ten men have been operated in the counties of Clay, Daviess, Dubois, Fountain, Gibson, Greene, Knox, Martin, Owen, Parke, Perry, Pike, Sullivan, Vanderburgh, Vermillion, Vigo and Warrick. I give below a brief description of each mine, arranged in the alphabetical order of the counties:

Clay County.

Brazil Block Coal Company's No. 1.

This mine is located in the northern part of the city of Brazil, on the main line of the Chicago & Indiana Coal railroad. The coal is mined by electric machines, and an electric motor has been installed during the year. It is of a new pattern, the invention of Mr. E. Morgan, of Chicago. A description of the motor and an account of its work will be found in another part of this report. The shaft bottom is lighted with incandescent lamps. In securing the roof at the bottom of the shaft, instead of the timbers usually employed for that purpose, legs of $4\frac{1}{2}$ in. gas pipe and cross-bars of railroad iron are used. These are lagged overhead with 2 in. oak timber. The result to date has been highly satisfactory, as there has been no necessity for repairs to this work since the mine was opened, though the roof is one that is very sensitive to the action of the air, and timber in this vein requires frequent renewal. The double partings at the bottom of the shaft are floored, and the tracks are laid with heavy T iron. A great deal of water is found in this mine, as it is being operated in territory that is surrounded by abandoned mines. This, together with the fact that the under-clay is very soft, makes it necessary to corduroy all the haulage roads in the mine. On the last inspection of the mine a good deal of powder smoke was found in many places, but reports since then indicate a greatly improved condition in this respect, though I am convinced that the proper purity of the air in machine mines will not be secured in the absence of a statute on the subject. There is usually a thick fog of smoke or dust in the places where the machines are at work, which it has been impossible for us to have properly removed.

Monarch.

This mine is located northwest of the city of Brazil, at the Monarch sewer pipe works, and all the product is used at the factory. Shale from the roof and fire-clay from the bottom are taken out for this purpose, as well as the coal from the vein, and the workings are from 8 to 10 ft. high. A second outlet has been opened at this mine during the year, and it now complies with the law in all respects. It has always been found in good condition when inspected. Fifteen men are employed.

The Brazil Brick and Pipe Company have sunk a shaft during the year at their plant just north of the above for the purpose of securing clay and shale for use in their factory. It is well equipped and the owners are endeavoring to comply with the mining law, though, as they mine no coal, the mine does not come under the provisions of the law, it being applicable to coal mines exclusively. As the clay industry is being rapidly developed in this State, I would recommend that the law be amended to include clay mines where it is necessary to go under overlying surface and take clay out of a vein, as in this case.

FAIRVIEW.

This mine is located on the C. & I. C. railroad, four miles northwest of the city of Brazil. The main and lower veins of block coal are mined here. Very little work has been done here during the year, but on each of my inspections I found the mine in good condition. On the last visit the scales were not working satisfactorily, and repairs were ordered. The mine boss reported that he had discovered the difficulty and remedied it, and no complaints have been received from there since, so I suppose that they have been giving correct weights since then.

DIAMOND NO. 3.

This mine lies one mile west of the above and is reached by a switch from the C. & I. C. railroad. The same veins are worked here as at the Fairview, the lower vein having been opened during the year 1897. This mine has worked more regularly than the average of the block coal mines during the year, and has been found in good condition on all the inspections made during the year. James Cuthbertson, Sr., is still in charge, which insures a careful watch to keep the mine in the best possible condition. This company keeps a locomotive at the mine to do its switching.

Other mines on the main line of the C. & I. C. railroad are the Peerless, Cox No. 3, Mecca No. 1 and Lucia, all in Parke county, and descriptions of them will be found under the head of that county.

GLADSTONE.

This mine is located on the Coal Bluff branch of the C. & I. C. railroad, one mile east of the town of Coal Bluff, near the Vigo county line. In fact, coal is mined in both counties from the shaft at this mine. The lower vein of block coal is mined here, but it is not of as pure a quality as that mined further east, being to some extent of the same nature as the semi-block found in the vicinity of Clay City, in the southern end of the county. Bad roof has been found in the mine during the year, and several narrow escapes from serious accidents have occurred. But one man has been severely injured during the year. This was a miner who was injured by a piece of falling slate on the entry as he was going to work in the morning, and will probably result in a damage suit. The mine has been found in fair condition on each inspection made of it. Considerable trouble is experienced in keeping the air courses open, so the ventilation is not as good as could be desired, but with the attention given to it, we usually find it above the average of the mines of the State. A great improvement could be made if the quality of oil used were better, but many of the miners here, as elsewhere, seem to think that they should give no attention to their own comfort unless forced to do so by the State law or by those in authority at the mine, and for the sake of saving 1 cent per day in the cost of oil, will work in a continuous cloud of poisonous smoke of the most hurtful character of any gas found in the mines of the State. This is not the only mine in the State where this state of affairs exists, and I refer to it at greater length in another part of this report. Some fire-damp is generated in this mine, but with a careful daily examination by a competent fire boss, accidents from this cause have been prevented during the year.

BRAZIL BLOCK COAL COMPANY'S NO. 11.

This mine is located on the same railroad, two miles northeast of the above. No coal was mined here during the months from March to July, inclusive. The mine was in only passable condition when inspected in September, but every indication was that it was being rapidly improved. During the year electric mining machines were introduced. The power is supplied from the plant located at the No. 8 mine of the same company. The main and lower block coals are mined here, and machines are used in both veins. The roof in the lower vein is good, and there should be very little difficulty in keeping the working places in good condition with respect both to ventilation and safety. The main block seam, on the other hand, has a very treacherous roof, and requires constant care to prevent accidents from falling slate; also, the air courses are likely to be badly choked by falling slate unless constant care is taken to secure the roof and clean up all that falls from time to time. This company has, however, usually kept all its mines in excellent condition when they are in operation, and I feel confident that this will be no exception to the rule.

Brazil Block Coal Company's No. 8.

This mine is located on the same road, near the Parke county line. The coal is the lower vein of block, and is mined by electric machinery. The same difficulty exists in securing loaders that was noted in my report last year. This is partly caused by the fact that the working places are usually fouled by powder smoke from shots fired in the coal and in the bottom, nearly all the blasting being done during working hours. The roof over this coal is excellent, and the mining machines have every advantage that can possibly be secured in the vein in question. The only drawback is that the vein is thin. This seems to have been overcome sufficiently to make machine mining in this field a decided success, as is evidenced by the introduction of machines at the mines Nos. 11 and 12, owned by the same company. A description of the plan of the workings of this mine was given in my last report, and I will only add now that it has been carried on successfully during the present year. The circulation of air in the mine is all that could be asked; in fact, it is so strong in some places that drivers have difficulty in keeping lights on the entries. Still, it is not sufficient to carry out the smoke as it is generated in the mine.

Other mines on this branch road are McIntosh's Nos. 1 and 2, Standard, Columbia Nos. 1 and 2 and the Brazil Block Coal Company's No. 12, which are in Parke county, and descriptions of which will be found in the proper place in this report.

Pratt.

This mine is located on the main line of the I. & St. Louis division of the Big Four railroad. It has been operated since 1888, and has been described so frequently in former reports that no extended notice will be given here. But little work has been done here during

the year, and it has been inspected but once, when it was in fair condition for so old a mine. Most of its territory has been opened up, and though there may be several years' work in the mine yet, it will be mostly in removing pillars, and it is likely to be kept in good condition, as the mine boss, H. W. Jenkins, is a very careful manager. The mine lies one and one-half miles west of Coal Bluff.

Eureka No. 2.

This mine is located on the same railroad, at the eastern limits of the town of Carbon. The main and lower block coals are mined here, the latter being reached by a tunnel, and all the coal is hoisted from the bottom of the shaft. A great deal of territory has been excavated in the lower vein, and it is a very difficult matter to keep the works there properly ventilated, and usually a great many smoky places are found on inspection. These have always been remedied within the time allowed, and on a second inspection the mine has been found in fair condition, only to be neglected when a visit from the Inspector is not expected. The law should be amended to dispense with the notice to repair now required, so that mine managers would feel that it was necessary to keep their mines in repair at all times, as they would be liable to prosecution if the mine was found in bad condition on any visit of the Inspector. The history of the office shows that the power to prosecute has never been abused by any incumbent, while the checks upon this power are very often taken advantage of by the managers of mines. This is by no means the rule, but enough of it is done to cause a great deal of discomfort and danger to miners employed in the State.

The upper vein at this mine has not been so largely developed, and the ventilation of that was found to be in fairly good condition. The roof is bad and the roads wet and muddy, making the work there both dangerous and disagreeable. Good care by the management and employes has prevented an unusual number of accidents during the year. The scales at this mine were examined at the request of the miners, on a showing that the weighman and check-weighman differed as to their correctness. It was found that the weights given on the different parts of the scales did not agree, and they were condemned as incorrect. After several unsuccessful attempts to adjust them at the mine, they were sent to the scale works for repairs, and are now working well and satisfactorily to all parties. This is the only case during my term of office where a test has been made under the provisions of section 2 of the act of 1891. In all other cases where a disagreement existed in regard to scales, the parties have succeeded in having them properly adjusted without calling on myself or my assistant to settle the dispute. We have on each inspection of a mine given the scales a cursory examination, and have frequently ordered repairs to be made on them, which has usually been promptly done. The law requiring test weights to be kept at each mine gives the parties interested an opportunity to discover promptly when anything is wrong and to remedy it before it becomes serious.

Eureka No. 3.

This mine was opened during the latter part of last year, and has been idle for several months this year. It has been inspected but once, when it was found in good condition. It is located on the south side of the Big Four railroad, one mile west of Lena, and is near the eastern edge of the coal field, and the coal is harder to mine than it is nearer the center of the field. It is of good quality, however, and the mine is likely to prove a success. There is a large unworked territory surrounding the mine, but I am not in a position to know whether the vein runs regularly under it.

World's Fair.

This mine is located one mile northeast of the city of Brazil, and is reached by a switch from the main line of the Vandalia railroad. It has been operated very irregularly during the year, and all the work now being done is in removing pillars. With regular work it would be worked out and abandoned during the year 1899, but as it has been worked for several years it may last for a considerable time yet. The test entries mentioned in my report of last year failed to develop any coal that could be worked profitably, and that part of the work has been abandoned. Several accidents have occurred at this mine during the year, some of a serious character, from falling slate. From reports received, all seem to have been the result of the ordinary risks of the miner's occupation, and no special investigation has been made by this office as to the cause of any of them. When last inspected the mine was found in good condition, and it will probably be kept so until it is finally abandoned.

Rob Roy.

This mine has been developed during the year by the Lancaster Coal Company. It is located on an extension of the switch which serves the World's Fair mine and is located on the adjoining property, about one-fourth of a mile north of that mine. Mr. John Andrews, one of the oldest operators in this field, is the superintendent. Three veins of block coal are found on the territory, but the shaft has been sunk only to the second or main block coal, and no development has been made in the upper, or "rider" vein. Many faults have been found in the mine which has delayed the work of opening the mine, and a very small business has been done there up to the present time, though the probabilities are that it will prove a valuable property. As the the coal has been worked out of all the surrounding territory, there will probably be a great deal of water to contend with, and there will be some danger of breaking into old works, and great care will be needed to prevent accidents from this cause. However, as good maps of the surrounding mines will be found on file in the county recorder's office, it is probable that no difficulty will be found in working the mine safely, but the Inspector of Mines should give special attention to this point.

Brazil.

This mine is located immediately west of the above, but is reached by a switch from the Knightsville north branch of the Vandalia railroad. It is nearing abandonment and will probably be finished during the year 1899. Three veins of coal have been mined here, and all have been fairly well cleaned out, a very small percentage of the coal having been lost. This is especially true of the lower and rider veins. There has been considerable bad roof in the middle vein, which has caused the loss of more coal in this than in either of the other veins. A great deal of water has been handled at this mine, as the surrounding territory had been worked out and abandoned before this was opened, and had been allowed to fill up with water. Proper precautions have been taken in approaching the workings of the old mines, and the water was drained off without accident and with but slight delay to the operation of the mine. The lower vein is now entirely abandoned, and very little new work is being done in either of the other veins, most of the men being engaged in drawing pillars. The mine has been found in excellent condition on each inspection during the year.

Dewey.

This is a new mine, which has been opened during the year. It is also reached by a switch from the north branch of the Vandalia, and is located north of the town of Cardonia. The lower vein of block coal is being mined. It has been operated steadily ever since the coal has been struck. The main block vein is found here also, but at the shaft it was not found workable, and has not been opened up. The development of this mine has been rapid, over one hundred men being now employed in the mine, the first coal having been taken out in the month of August. The coal is of good height and the shaft is well located for haulage and drainage, the vein rising in nearly all directions from the shaft. When inspected, the mine was found in excellent condition, both as to equipment and underground work. No escape way had been provided, but the management assured me that it would be provided with all possible dispatch. When this is done the mine will be in excellent condition, and with a good roof and bottom, is likely to be kept so.

Gart No. 5.

This mine is located a short distance east of the above, and has the largest output of any pick mine in the block coal field. During the year the upper vein has been opened by a tunnel, and the output is now larger than when my report was made last year. On the last inspection many of the places in the lower vein were found to be smoky, though a good current of air was passing on the entries. This is to be attributed principally to the quality of the oil used in the mine, as is the case in a great many other places in the State, and it appears that statutory compulsion is the only possible remedy. The roof is generally good in the lower vein, but a great deal of roof has to be taken down to give the necessary height for the haulage roads in the mine, and as this is "gobbed" in the rooms, it interferes with the circulation of the air and has something to do with the condition of the air in the rooms. In the upper vein the ventilation was found in better condition than in the lower vein, but as is usual in this vein, the roof is not so good, and only careful timbering prevents frequent accidents. On the whole, the mine is in better condition than at the close of the last year, but is far short of the standard I should like to see reached. (See Plate L and Fig. 954 of Coal Report.)

Gart No. 3.

This mine is located on the Harmony north branch of the Vandalia railroad, one and one-fourth miles north of the main line. It is in territory nearly surrounded by abandoned works and makes a great deal of water, six pumps being in use at the mine. Very little work has been done at the mine during the year, and it was not in very good condition when inspected last. The mine was idle at the time of the inspection, and but two men were at work. The main and lower block coals are worked in this mine, the coal from both being hoisted from the bottom of the shaft, the upper vein being reached by a tunnel. The works on the southeast of the shaft have been worked out and abandoned some time since and a good deal of black damp given off from the old works finds its way to the bottom of the shaft. None of it, however, reaches the side of the shaft where work is being done. The coal in the bottom vein is good and has an excellent roof in most places, but the dips are irregular, making the haulage bad and interfering with the drainage of the mine. As is usual in the main block vein, the roof in the upper vein at this mine requires a careful watch and a great deal of timber to keep it safe. The water is drained from it to the bottom vein through drill holes and is then pumped to the surface. Some of the pumps are located a considerable distance from the shaft and operate through drill holes to the surface, steam being carried to them above ground. This prevents the heat from being communicated to the air of the mine and is a great assistance to the ventilation.

The above are all the mines employing more than ten men that are in operation north of the Vandalia railroad and east of the Chicago and Eastern Illinois railroad in Clay county at present.

Columbia No. 5, or "Lucinda."

This mine is located on the Center Point Division of the Vandalia railroad two miles northeast of Ashersville. It is a new mine, having been opened during the present year, and began shipping coal in July. It has been very rapidly developed and is now one of the largest producers of block coal in the State. When inspected it was found in excellent condition, except for the fact, which is entirely too common in our mines, that a very poor quality of oil was being used. The equipment of this mine is the same that was used at the Briar Hill mine of the same company. Only one vein is being developed yet, but I understand that there is another on the property which will be opened up later, and the mine is likely to be long-lived as well as a large producer.

COLUMBIA NO. 4.

This mine is located one and one-fourth miles southwest of Ashersville, on the same branch. The upper vein, which had been worked at this mine since 1896, was abandoned during this year, and the shaft has been sunk to the lower vein. It is a very hard and irregular piece of coal, and the development has been very slow, only thirty-five men being employed inside at the last report received from the mine. There is quite an extensive territory of undeveloped coal surrounding this shaft, and it is to be hoped that better coal will be reached in the development of the mine. All the strata in the vicinity of the shaft seem to have been disturbed by volcanic action, and they are badly displaced. Several faults have been found in the mine and the roof is not regular. I presume that Mr. Ashley will discuss this matter at length in his report, as it refers to the upper vein, and I will only say that the same conditions in a less degree apply to the vein now being worked. In spite of the most careful management, several accidents have been reported from this mine during the year.

LOUISE.

One and one-half miles west of Center Point on a switch from the same branch. This mine has not been operated with any regularity since I have been in the office of Inspector. In fact it has not run long enough at a time to enable the managers to put it in workable condition before it has been shut down again. At the time of the last inspection only seventeen men were employed, and the ventilation was fairly good, but a great amount of dangerous roof was found. This the mine boss was ordered to repair at once, and he began the work before Mr. Epperson left the mine. I have no report as to how well the work has been carried out. He was also ordered to employ no more men until more ventilation was provided. A very few months' steady work would finish the mine, and I have been hoping each time that it has been started that it would be worked out before being closed down again. I still have the hope that this will prove to be the final "run."

CRAWFORD NO. 5.

Located one-half mile beyond the above; has been opened during the year. It equipped and opened in excellent shape, and, being under the superintendence of William Spears, we have every assurance that it will be kept so. Mr. Spears is one of the most successful mine superintendents in this district, and in my four years' experience as Inspector I do not remember that I have had occasion to order any changes at any mine under his charge, though he has had from three to five during that time. While the coal found in this mine is not as profitable to work as that at No. 2 of the same company, which has just been abandoned, it gives promise of producing a large amount of coal.

CRAWFORD NO. 4.

Situated immediately southeast of Hoosierville, on a switch from the main line of the Vandalia railroad; has been opened during the year to the bottom vein of block coal. When last inspected it was found in excellent condition. Though but recently sunk, there was a good current of air in all working places, and a second outlet was in course of construction which was finished a few days after my visit. The upper vein has been worked out of the territory in which this mine is opened, and there was considerable water being drawn from it, but it will probably soon be drained off and no danger is to be apprehended from it. This mine is also under the supervision of Mr. Spears.

BRIAR HILL.

This mine is located near the main line of the Evansville & Indianapolis railroad one mile northwest of Clay City. Very few men have been employed at this mine during the year, and the development of new work mentioned in my last report has not proceeded as rapidly as was anticipated, there being only twenty men employed inside at the date of the last report to this office. The ventilation of the mine when last inspected by Mr. Epperson was not in good condition, and several improvements were ordered and were immediately begun. No complaints have since then reached this office, and I presume that the repairs were carried out according to instructions. Less trouble has been experienced at this mine this year than usual on account of a great deal of the old work having been abandoned last year.

Markland.

This mine is located at the north limits of Clay City and had been run on a very small scale until near the end of last year. It was idle for several months during the summer this year, but at the time of the last report to this office thirty-five men were employed inside. A tram road has been built from the mine to the main line of the E. & I. R. R., and coal is shipped by this road to the Terre Haute market. There is a small territory under lease here and the mine is not likely to last long.

Harrison No. 2.

This mine is located on a branch of the E. & I. R. R., three miles east of Clay City. The dip of the coal in this mine is very irregular, which makes drainage difficult and the haulage bad. When last inspected the mine was found in fair condition, with a force of sixty-five men employed underground. The coal is of the character known as semi-block, the roof of gray slate and the bottom of fire-clay. The timbering and ventilation are well cared for when the mine is in operation, which it has been very regularly during the year, compared with others in Clay county, as will be seen by reference to the table giving the number of days each mine was in operation during the year, and but few accidents have occurred, which, with the difficulties to be met, speaks well for the management.

Harrison No. 3.

This mine is on the same branch as the above and is operated under the same management. It is a new mine, having been opened during the year. Considerable trouble is found in the coal in this mine and its development has been very slow, only twenty-five men being employed on November 1st. Since that time the force has been increased to some extent, as the trade has demanded an increased output. When last visited by Mr. Epperson the mine was not in operation, but seemed to be in good condition under the circumstances. It is probable that it will be more largely developed during the coming year.

The Lancaster No. 4 mine is situated further east on this branch, in Owen county. As it will probably be worked out and abandoned within the next two months, no further reference will be made to it in this report. There is quite a good deal of undeveloped territory in this vicinity, and the probabilities are that several mines will be opened in the neighborhood during the next few years.

Superior.

This is a bituminous mine located on the main line of the Vandalia railroad, one-fourth mile west of Turner. The southwestern part of this mine was worked out and abandoned during the year. On account of financial embarrassments, the mine did not run steadily during the fall months, and Mr. Ehrlich sold it to the Indiana Bituminous Coal Company about the middle of November. The latter company is developing the work to the northwest and is likely to make a more extensive mine of it than it has been heretofore, though very little progress has been made in that direction up to the present time. The probability is that a new shaft will be sunk here during the year 1899.

Klondyke.

This mine is reached by a switch from the main line of the Vandalia, and is located about a mile southeast of the town of Staunton. It is well equipped and is capable of handling a large production. It has been worked fairly steadily during the year. The coal is bituminous, about 7 ft. thick, and with a fairly good roof in some parts, but very bad in others. On each inspection made during the year this mine has been found in good condition, though on the last visit it was found necessary to order that an additional split should be made in the air current. This was to meet the requirement of the law that not more than fifty men shall be employed on any one current of air. In all other respects the mine was fully up to the standard. I might remark here that while it is absolutely necessary in thin veins that the air be divided strictly according to this rule, in thicker veins a larger current of air can circulate with a less velocity, and I have often found twice the statutory number of men on one current without suffering any discomfort. This, however, is not true in all cases, as many of the mines in thick veins are usually found in very bad condition on our regular visits.

San Pedro.

This mine is located north of Staunton on a switch from the main line of the Vandalia railroad. It has been found in good condition on each inspection made. The coal is bituminous, 7 ft. thick and of good quality. The coal lies near the surface and the roof is soft in many places, making it difficult to work with safety. Though several places have fallen in during the year, no serious accidents have occurred from this cause in the way of personal injuries, which speaks well for the management.

In addition to the mines described above, the following have been abandoned during the year, viz.: Brazil Block Coal Company's No. 7 and 10, Crawford Coal Company's No. 2 and 3, Excelsior, Nickel Plate, Briar Hill, or Columbia No. 3, and the Victoria mine. All of the above, except the Excelsior, were worked out and abandoned in the regular way, all coal which could be mined profitably having been taken out. The Excelsior was flooded by water breaking into the mine from a creek near by. This had occurred on two previous occasions, but the water had been pumped out and reopened each time before. When the last accident occurred, however, the management decided that it was too expensive and dangerous to work longer. The superintendent, H. B. Ehrlich, is entitled to great credit for having had the foresight to prevent loss of life, though I had advised against the reopening of the mine after the second time it was flooded. I hope that the history of this mine may prove a warning against attempting to work other mines in a like condition. The difficulty here was originally brought about by working the coal from under the watercourse without leaving sufficient support for the roof, and it was found impossible to secure it by timber after the water broke in the first time.

Daviess County.

Cabel No. 4.

This mine is located on a branch of the B. & O. S. W. R. R. some distance south of the city of Washington. The dip of the coal is irregular, giving heavy grades for haulage roads. In addition to this the bottom is a soft fire-clay, and where water is allowed to stand upon it the roads become very muddy, making the bringing of the coal to the bottom of the shaft a difficult and disagreeable piece of work. The coal is overlain by a fairly good shale roof, and where timbering is necessary it is well taken care of, so that the mine is worked on a regular plan and the coal is nearly all removed before any part of the mine is abandoned. The coal is bituminous, of a good quality, but the vein is very thin—less than 3 ft. in most places. The mine was idle from June to October of this year, but was found in good condition when last inspected.

Cabel No. 9.

This mine is on the same branch road as No. 4. Electric machines are used here for mining the coal. The conditions are about the same as at No. 4, but a band of draw slate from 2 to 20 in. in thickness is found at this mine above the coal. Owing to a dispute as to the payment which should be made for handling this slate by the miners, a strike has been carried on by the union at the two Cabel mines since April 1, 1897. A number of miners have been imported from the State of Kentucky, and some non-union men have joined them from among the old miners, permitting the mines to run to some extent. Some violence has occurred, owing to friction between the union and non-union miners, and some men have been seriously injured in the quarrels arising from this trouble. The dispute seems to be no nearer settlement now than a year ago, and the Hartwell mine in Pike county has recently been drawn into it by the miners joining the organization. Quite a large amount has been contributed by labor organizations in different parts of the country.

Hawkins.

This mine is located on the E. & I. R. R. a short distance north of the city of Washington. The coal is 6 ft. thick and is of a good quality. It has a bad roof and all entries are closely timbered. It is being finished preparatory to abandonment and only pillars being drawn. It will probably be finished this spring.

Duncan or Wilson's No. 4.

This mine is near the city of Washington and is operated to supply local trade. It is one of the few mines in the State coming under the mining law, where a gin is used for hoisting coal. Everything about the mine was in good condition when last examined.

Montgomery No. 1.

This mine is located on the main line of the B. & O. S. W. R. R. a short distance west of the town of Montgomery. The coal is a good quality of steam coal and is about 4 ft. thick, with a thin dirt band in the middle. The dip of the mine is very irregular and the bottom is soft, making it difficult to keep haulage roads in good condition. It is nearly worked out, but will probably run a few months of the year, though everything is working on pillars.

Montgomery No. 2.

Is located near the above and is brought to the same dump, most of it being taken by the railroad for locomotive use. The mine is in good condition. Both of the above mines have worked fairly well during the year, and there has been very little complaint of the condition of either of them at any time.

Montgomery No. 3.

Work on the opening of this mine was begun last year but proceeded very slowly, and no report was received from it at this office until that for the month of October, when fifteen men were employed. The mine is in the same vein as the two described last above, and is fairly well started away. On the last inspection made by Mr. Epperson it was found in good shape in most respects.

Mutual.

This is located at Clark's Station on the B. & O. S. W. R. R. The coal is hauled by mules over a tram road three-quarters of a mile in length from the mine to the tipple, which is near the main line of the railroad—is in fact a siding of the main line. This is the only mine now operating in the State where there is any cannel coal produced. The vein of this coal is about 3 ft. thick. One and one-half feet of bituminous coal underlies it, and the undermining is done in this stratum. This mine has most of the natural advantages that can be found in a vein of coal—good roof, regular dip, and very little water. The mine has always been found in good condition when inspected during my term of office. I have no separate report of the amount of cannel coal produced here, but should think that it would be more than three-quarters of the whole output of the mine, as a part of the bituminous coal is wasted in the process of mining, while the cannel coal is of such a nature that it makes nearly solid lump coal.

The above embrace all the mines that lie along the line of the B. & O. S. W. in Daviess county. In the vicinity of Shoals, in Martin county, there are quite a number of small mines, but none as far as I have been able to learn that employ more than ten men at any time, and they are operated only to supply local trade. In the northern part of Daviess county there are several small mines which employ from three to twenty men. The following are all of them that have come within the statute during the year.

Hoosier.

This mine was reported last year as the "Stoy" mine, and is located one mile east of the town of Raglesville. The coal is hoisted with a gin operated by horse power, and is hauled from the mine by wagons, the principal market being found in the immediate vicinity of the mine, though some is hauled to the line of the Indiana Southern railroad, a distance of three miles, and shipped from there. No animals are used in this mine or the others in this vicinity, all the coal being pushed to the shaft bottom by the miners. The mine has been found in good condition usually, when inspected during the last two years.

Union.

This mine was sold during the year to the Raglesville Coal Company, and has done very little work, not more than twelve men having been reported at any time since the first of March. It is probable that more than this number will be employed during the later months of the year, but I have no report at hand at this writing showing such to be the fact. Local trade, however, usually demands a larger force at this season.

Stuffle's No. 3.

This mine has been in operation on a small scale until very recently. It is one of the group referred to above as being in the vicinity of Raglesville, and there is nothing in the way of description to add to what has been said in regard to them. The mine has never been inspected, as on the last trip of my assistant to that district but few men were working in it and it did not come within the operation of the law.

In my last report the mine of the Raglesville Co-Operative Coal Company was described. This was operated by a company of miners during the fall of 1897, but the venture did not prove a financial success and the company disbanded. But few men are being employed there, if it is in operation at all, and it has not been inspected during the year.

The mines in Daviess county, as will be seen from the above, are small compared with those in other parts of the State. This is partly to be accounted for by the fact that the market is confined to the towns in the immediate neighborhood of the mines, with the exception of those on the line of the B. & O. S. W. R. R., which ship some east and west along that road.

Dubois County.

The only mine in this county, that at Huntingburg, was operated with a small force of men until July of the present year, when it was finally abandoned. As there were at no time more than seven men employed, no inspection was made during the year.

Fountain County.

INDIANA BITUMINOUS MINE.

This mine is located on the T., St. L & K. C. or "Clover Leaf" railroad, one mile northwest of the town of Silverwood. By reason of its location a ready market has usually been found for the coal produced, and it has operated more steadily than most of the mines of the State since it was opened. The coal is a good quality of bituminous and seems to give good satisfaction wherever it is used. The vein is very irregular in thickness, varying from 4½ to 7 ft., and has great changes of level, requiring considerable grading to make haulage roads of the proper grade to handle the coal economically, several cuts of 8 ft. in depth having been made in the mine. A fire has been burning in the eastern part of the mine for some time, but it has been kept under control and has not interfered with the operation of other parts of the mine. It has not, however, been extinguished. The present opening will probably soon be abandoned, as I am informed that a contract has been let to sink a new shaft north of the present one. This mine was found in good condition when last examined, and as it is under the care of William Dalrymple, formerly district mine inspector for the State of Ohio, I have no doubt that it will be kept so.

STURM.

This mine is located near the main line of the "Clover Leaf" railroad about one mile east of Silverwood. About twenty men are employed here and the coal is principally sold to the railroad for use on their locomotives. The mine has always been found in fair condition when inspected. The passage way to the second outlet required some attention in the way of timbering and cleaning when the mine was last visited, which was immediately attended to, according to the report sent me by the mine boss. In all other respects the mine was found to be operated in compliance with the mining law of the State.

Gibson County.

There is but one mine in this county which employs enough men to bring it under the provisions of the law. Several small mines are operated in different parts of the county, but no information has come to this office which would indicate that any of them have employed more than ten men at any time during the past year.

OSWALD.

This mine is located at the crossing of the Evansville & Terre Haute and the L., E. & St. L. or "Air Line" railroads. This property changed hands during the month of October last and is now owned and operated by the Princeton Coal Company, of which A. M. Ogle and W. W. Hubbard, of Indianapolis, both well known to the coal trade through their connection with the Island Coal Company, are large stockholders, and Louis J. Oswald, of Princeton, is the president. This mine is the deepest in the State—440 ft. The coal is an excellent quality of bituminous and should command a good trade if properly placed upon the market, as it undoubtedly will be under the present management. When last inspected, on December 17, it was found in excellent condition, though some accidents had recently occurred from falling slate. Fire damp is found in dangerous quantities in several parts of the mine, but for two years past no accidents have occurred from this source. While the extension of the works will increase the danger from this source, I think that with the means provided for the ventilation of the mine no accidents need occur in the absence of criminal negligence on the part of the employes and managers.

Greene County.

ISLAND No. 1.

This mine is located one and one-half miles south of Linton on the I. & V. coal branch railroad. It is the pioneer mine of Greene county, having been the first of any consequence opened in this coal field. On each inspection of this mine made during the year it has been found necessary to order quite a number of improvements made in the ventilation, and it has been very difficult to have the orders complied with. Five inspections were made during the year, and if time had permitted several more would have been made. When last inspected, October 9, there was considerable loose slate on the haulage ways, and the air was not split as required by law. In other respects the mine was in fair condition. The report of the mine boss for December indicates that the necessary change has since been made, so that no more than fifty men are employed on any one current of air, and as no accidents have occurred from falling slate on the entries I presume that the defective places pointed out by Mr. Epperson have been properly timbered or the loose slate taken down since the last inspection.

Island No. 2.

This mine is located one-half mile west of the town of Linton. It has a double tipple, coal from one side being loaded into railroad cars on the I. & I. S. R. R., and that from the other on the I. & V. coal branch. The coal here, as in fact in all the mines of this county, is 5 ft. in thickness and of excellent quality for steam and domestic use. The mine was inspected twice during the year, and found in excellent condition on both occasions.

Island Valley.

This mine is two miles southwest of Linton, on the I. & V. R. R. It is operated by a joint stock company, composed mostly of miners, and has been the most successful effort at co-operation that has been tried in the coal business in this State. The company are now engaged in sinking another shaft which will probably be in operation early in the year 1899. The old mine has usually been found in fair condition when inspected, though early this year some defects were noted and ordered remedied. The ventilation was poor in some parts of the mine and some bad slate was found on the main entry. Later reports show an improved condition in all respects.

Fluhart.

This mine is one and one-half miles southwest of Linton, and one of the largest mines in the State. It was found in good condition on both inspections made during the year. It is now in charge of Thomas McQuade, former Inspector of Mines for this State.

South Linton.

This mine is one mile south of the town of Linton. It was inspected twice during the year, and found in excellent condition on both occasions. While not fitted with such costly equipments as some others, it is one of the best regulated mines in the State. The coal is of the same character as is found in the other mines in this county.

Summit.

One mile west of Linton, has switches from the main line of the I. & I. S. and I. & V. branch railroads, giving it excellent shipping facilities, and it has a large capacity, which has been limited this year on account of the difficulty of getting railroad cars. This has been a common complaint at all the mines located on the two roads mentioned, however, so that the output for this year is not a fair indication of their productive capacity. The company operating this mine has a new shaft down to coal and it will be in the market with a large output for the 1899 trade. Several defects were found in the ventilation and timbering of this mine on the first inspection this year, but they were remedied at once when attention was called to them, and the mine has been found in good condition on each inspection since then.

Templeton.

This mine is in the corporate limits of the town of Linton and about three-quarters of a mile from the central part of the town, on the I. & I. S. railroad. It has usually been found in good condition when inspected, but on August 20 it was found necessary to order some improvements to make the mine comply with the requirements of the law, the air being weak in some places and there being sixty-one men on one of the currents of air, while the law permits but fifty at the most; also, some gates at the surface were needed. Four days were given to make the necessary changes, and they were completed within the time given.

Knox County.

Prospect Hill.

This mine is located near the city of Vincennes, and is operated entirely to supply local trade, having no railroad connections. For a great part of the year less than ten men were employed, and the escape shaft, sunk in 1897, was not kept in proper condition. Complaint reached this office in the month of October that more than the statutory number of men were working in the mine, without any means of egress except the main shaft. On inspection the complaint was found to be true, and the operators were ordered to clean up the roadway leading from the working part of the mine to the escapeway. This was done and no complaint has been received since. The mine is now leased to a co-operative company of miners. By the order of Mr. Epperson, the fan was moved from the main shaft to the second outlet early in the year, which has a good effect on the ventilation of the mine.

Bicknell.

This mine is at the town of Bicknell, on the main line of the I. & V. railroad. It is a small mine and runs very irregularly, but has always been found in good condition when inspected. For a part of this year it was operated by a co-operative company, but later the owners—the Bicknell Coal Company—took charge of and are now operating the mine.

Edwardsport.

This mine is one mile northeast of the town of Edwardsport, on the main line of the I. & V. railroad. It was visited twice during the year, but being idle at the time of the first visit, it was inspected but once while it was in operation. The second visit was made on account of a complaint having reached this office by an anonymous letter, and resulted, as such visits generally do, in finding that the mine was in good condition and that the letter had been written by a party who had some grudge at the mine boss. No recommendations were made, as no defects were found in the condition of the mine. It has been the rule of this office to pay no attention to letters of complaint unless signed by some person representing that he knew what he was writing about, and this rule would have been followed in this case but for the fact that an inspection was nearly due at the time the letter was received. While this is true, all letters giving true information as to the conditions existing at the mines of the State have been thankfully received and given prompt attention.

Martin County.

Tunnel.

This is a small mine at Tunnel Switch, on the Indiana Southern railroad, and is the only mine in the county employing more than ten men. It is opened by a drift and has natural drainage. The vein is from 30 to 36 in. thick and has good top and bottom, very little timber being necessary. When inspected, March 21, it was found necessary to order quite a number of improvements to secure the proper ventilation of the mine. They were promptly attended to by Mr. Dickie, who was then in charge of the mine. The mine is now being operated by F. M. Wampler under a lease from the company owning it. The output is small, and it is very difficult to keep miners there, as the vein is thin and hard to mine. Most of the coal is shipped to Bedford and east of there.

The only mine being operated in Owen county is Lancaster No. 4, which is nearly worked out, and will be abandoned within two months. There were but eight men employed on January 1, 1899.

Parke County.

Parke No. 8.

This mine is located one mile northwest of the town of Rosedale, on a switch from the Terre Haute & Logansport railroad, and has also a switch from the Chicago & Indiana Coal railroad. The coal averages 6 ft. in thickness, separated into two benches by a band of slate from 2 to 4 in. in thickness. The roof is a gray shale, which is hard when the coal is removed, but falls in large slabs when acted upon by the current of air used to ventilate the mine, making it very difficult to keep haulage and airways clean, and requiring a great deal of timber. I have had considerable trouble with this mine during the year. The ventilation is nearly always in bad condition, brought about partly by falls of slate in the airways and partly by the fact that coal is mined by machinery, and shots are fired at all times during the day, filling the air current with smoke at all times. The latter could probably be overcome if the air courses were kept clean and the current were properly divided, and, in fact, usually is, after they have been cleaned up by order of the Inspector, which has been necessary at the time of each regular inspection made since I have been in the office. In addition to the poor ventilation of the mine, the second outlet, which is through the abandoned No. 6 mine of the same company, has not been available since early in September, when the buildings at that mine were destroyed by fire, disabling the pumping machinery there. Water was allowed to rise in the passage-way between the two mines. Foul air also accumulated to such an extent that a light could not be carried through it. Complaint was made to me of the condition of the mine by miners employed in it, and on an inspection made on September 14, I found it necessary to give the following notice to the mine boss:

BRAZIL, IND., September 14, 1898.

GEORGE MITCH, Mine Boss, Parke No. 8 Mine:

As required by section 2, page 169. Acts of the General Assembly of Indiana for 1897, I hereby notify you that on my inspection of the above mine this day I find that the air does not go to the faces of any of your entries as it should. 2.—That the breakthroughs are not made regularly in rooms, which consequently are smoky. 3.—Your escape way is in bad shape on account of falls, water and bad air. 4.—On the pit top there is nothing to prevent a man from walking into the screen.

These matters must be remedied at once, or at least in a reasonable time, and I hereby give you ten days to rectify the defects noted above and report to me.

ROBERT FISHER,
Inspector of Mines.

On the 27th I made a return visit, and was informed by the mine boss that the escape-way was not passable, but that he expected to have it so on the next day, and that the ventilation was considerably improved. I requested the miners' committee to go with the boss through the escape-way and to report to me the condition in which they found it, which they did on the 29th, saying that they found it still impassable. I then notified the company that any work done in the mine after October 4, before the escape-way was available, would be at the risk of prosecution. Mr. Epperson made a visit to the mine a few days later and found the same condition existing, and the mine at work. I then filed an affidavit in the Parke Circuit Court against the company, which has not yet come to trial, the defendant having taken advantage of delay allowed by the practice in our courts, and the mine continues to operate in violation of the law in this respect. In cases of this kind I recommend that the Inspector should be authorized to bring an injunction suit in the name of the State without bond, and to immediately prevent the working of a mine under unsafe conditions. While I have had some cases similar in some respects to this, none have arisen where such a total disregard of the law was shown.

COX NO. 3.

Located on a switch from the C. & I. C. R. R., one ½ mi mile north of the above; is working the same vein of coal under nearly the same natural conditions, but by taking proper care of the air courses, it is usually found well ventilated. The escape-way here is through the No. 1 shaft, and was in fair condition when the mine was inspected on September 27. Some recommendations for the improvement of the ventilation were necessary. On a special visit by Mr. Epperson, October 11, some improvement was noted, but further repairs were necessary. The mine boss notified me later that he had done all that was ordered, but I have not found time to make another visit to learn if this is the fact.

MECCA NO. 1.

This mine is located at Mecca, about one mile south of the main line of the C. & I. C. R. R. The attempt mentioned in my last report to so arrange the haulage road that the electric motor could bring the coal from the principal workings of the mine, as originally intended, was not a success, and it is still being used for but a part of the distance, several mules still being used on the other part of the road to bring the coal to the point where the motor takes it. Two veins of coal are found here, but the upper lies very irregularly, and is reached by tunnels at different parts of the mine. Where the bottom vein is mined first, the strata between the two veins falls away, leaving the upper vein practically undermined, and there is nothing for the miner to do but to take the coal down. This work is somewhat dangerous, owing to the insecure bottom which is left to timber the roof of the upper vein upon; but as far as I am informed it has been carried out successfully to date. But very little new work is being opened, and the output has fallen off during the year. All working places were found in good condition on my last inspection, with the exception of the places in the upper vein mentioned above, which seem to be dangerous, but not so much so as to justify their being stopped.

LUCIA.

This is a mine at Perry's station, two miles north of Mecca, on the main line of the C. & I. C. R. R. When inspected, November 23, it was found in good condition, though all of the provisions of the law were not being strictly complied with. There was no speaking tube in the shaft nor any bell in the bottom of the shaft by which the engineer could give the return signals required by the law. Material was on the ground, however, to put them in. No escape-way had been provided, but probably will be before 5,000 sq. yds. have been excavated, as the contract has been let for the sinking of a second shaft. The vein is about 4 ft. thick, of a good quality of bituminous coal, and has a splendid roof and bottom. The coal is got by blasting off the solid, without undermining, and the only danger that will attend the work will be from the excessive use of powder. A reference to the list of acidents will show that those from that cause are increasing at a rapid rate. In view of this fact, I recommend that a law be enacted to regulate the use of powder in the mines of the State.

LYFORD NO. 2.

This mine is located near Lyford, on the main line of the Chicago & Eastern Illinois railroad. The conditions here are the same practically as at Cox No. 3 and Rosedale, and the mine having been idle so much since it was opened, the air courses are in very bad condition, being filled with fallen slate, and the breakthroughs are very poorly closed in the old parts of the mine, allowing a large leakage on the first of the air, making the ventilation deficient in a great many places. The mine has changed hands twice during the year. On March 1 it was sold to the "Scott Mines" Company, of Chicago, who operated the mine until the first of September, when they got into financial difficulties, and the mine was idle for two months, when the Wabash Coal Company, also of Chicago, took charge of it, and have since been operating the mine. During the two months of idleness no work in the way of keeping up the repairs in the mine was done, as no person seemed to know when the mine would be reopened or by whom, so that when it was reopened it was in very bad condition, both as to ventilation and timbering. I was requested by the mine committee to make an inspection shortly after operations were resumed, and did so on November 17. I gave the result of the inspection in the following letter to the mine boss:

BRAZIL, IND., November 17, 1898.

JOHN MUSHETT, Mine Boss,
Lyford No. 2 Mine:

As required by section 2, page 169, Acts of the General Assembly of Indiana for 1897, I hereby notify you that on my inspection of the above mine this day I find that the air is very bad in all places but one—on the "blind" or "stub" entry. All of these should be stopped until the air is carried into them by some means. They are in about the same condition as at the time of my last visit on August 23, when I ordered them to be stopped.

2. A door should be placed on the main air course between the seventh and eighth north entries, as there is nothing now to force the air into those entries.

3. After coming out of the sixth north the air leaks badly, and, when I was there, there was not sufficient air in either the seventh or eighth north, the main entry, or the ninth or tenth south, and the circulation was very weak in the seventh and eighth south entries.

4. While there appears to be a very good current of air starting into the third south, no part of it reaches the faces of the third and fourth south entries, and, as the first and second depend on this current for their supply, the air is bad near the faces of those entries.

5. The air is badly checked at the bottom of the shaft, by the fact that the air course is so much lower a few feet away from the shaft than it is where the air leaves the downcast. By enlarging this a better current of air could be got into the mine.

6. In the crosscut from the fourth to the fifth north entry there are several places that look dangerous. I marked one stone that should be taken down.

7. The entrance to the escape shaft is very low. It should be at least 5 ft. high, and is but little more than three.

The rooms mentioned in the blind entry must be stopped as soon as you can give the men other places. The air passing over the overcast should be carried to the face of the fourth north within a week, and the other points noted should be attended to within two weeks, and I hereby give you fifteen days to rectify the defects noted above and report to me.

ROBERT FISHER,
Inspector of Mines.

While my time has been so taken up with other duties since that time that I have not made another visit, I have been informed that the most of my instructions have been carried out and that the mine is now in fair condition.

The above are all bituminous mines, and, with the exception of the Mecca and the Lucia mines, are all working the same seam—that designated as "L" in Prof. Cox's reports. This vein is also extensively worked in Sullivan, Vermillion and Vigo counties, and furnishes a large proportion of the bituminous coal mined in the State. In another part of this report will be found a paper by P. J. Mooney, M. E., on the profitable working of this seam. The paper was read before the Mining Institute of Indiana, and aroused considerable interest among those present, and I think can be profitably reproduced here.

BRAZIL BLOCK COAL COMPANY'S NO. 12.

This mine is located on the Coal Bluff branch of the C. & I. C. R. R., just north of the Clay county line and west of the town of Caseyville. The shaft was sunk in 1897, but did not begin producing coal until January, 1898, and then but a small amount. It was shut down from the first of March until the month of August, when it was started with an equipment of electric machines. The main and rider veins of block coal are mined, the latter being reached by a tunnel from the other, and all the coal being hoisted from the same landing in the shaft. When inspected, on November 28, it was found in fair condition, except for the powder smoke from shots being carried in the air current. This is a complaint common to all mines using mining machines, and it seems to need additional legislation to provide a remedy. In this mine I found the most of this trouble in the work reached by the tunnel, but this probably arose from the fact that more firing had been done there at that time than in other parts of the mine. A split of the air current has been made in this part of the mine since my visit, and the conditions are reported as being considerably improved, the smoke being carried out of the mine more quickly by reason of having a shorter distance to travel.

STANDARD.

On the same branch railroad, one-half mile north of the Clay county line. It is arranged to load coal on a switch from the Chicago & Southeastern railroad also, having a dump on each side of the shaft. Both of the regular veins of block coal are mined. The coal from the upper or "main" block vein is lowered through a "drop shaft" to the level of the bottom vein and hoisted from the same landing at the bottom of the shaft. At the drop shaft no machinery is needed to handle the coal except a drum and brake, as the weight of the loaded car brings up the empty. Most of the men from the upper level are hoisted at the main shaft from a landing at the level of the upper vein. The mine boss at this mine seems to have been very neglectful, and on my regular inspection, on September 28, I found that many of the minor provisions of the law were not being complied with, though I had ordered the necessary work done on several previous occasions. In addition to this, the air was very bad in nearly all the upper vein workings. On a visit made October 25 I found that though some work had been done along the lines indicated in my notice given on the previous visit, the mine was not yet in approved

condition. Since then all of my recommendations have been followed and the mine is reported by the mine boss and miners working there to be in good shape.

COLUMBIA NO. 2.

This mine lies just southwest of the above, and is opened out in both veins, but on my last inspection there was no work being done in the upper vein. The mine has always been in good condition when I have inspected it, except that a very poor quality of oil is usually burned, making the mine smoky at all times. One complaint was received from this mine during the year, and the passage-way to the escape shaft having been allowed to fall and become unsafe, I called the attention of Mr. Chesterfield to the matter, and the road was cleaned up and put in good condition, and a satisfactory report of the matter made to me without the necessity of a visit from me.

COLUMBIA NO. 1.

This mine lies one-fourth of a mile north of the Standard, and is working the upper or main block seam. It was idle for quite a long time during the summer of this year, and, contrary to the usual rule in such cases, was found in good condition when inspected. On previous occasions there had usually been a good many workmen in this mine where the air was bad and others in places where there was bad roof, but on this inspection I found a good current of air in all the working places and the entries and air courses well timbered. In fact, the mine was in excellent condition in all respects.

MCINTOSH NO. 1.

This mine is situated west of the Standard, and is now operating principally in the lower vein, only a few places being worked in the upper vein to remove a block of coal that was left in to support the shaft when that vein was abandoned some years since. When last inspected, November 26, there was very little new work being done, nearly all of the coal being taken out of the pillars. Everything was in good condition, as far as I could see, and, with the exception of one short piece of entry that needed timbering, no places were found that were not in excellent shape. This mine will probably be abandoned early in the year 1899.

McIntosh No. 3.

This mine has been opened during the present year, and was inspected but once. It was not fully equipped at that time, and a few of the minor provisions of the law had not been complied with. The underground work of the mine was in good shape, though the bottom is very soft, which will cause a good deal of trouble in keeping haulage roads in order. Reports received since my visit show that all recommendations have been complied with and that the mine is now in first-class condition in all respects.

Otter Creek.

This mine is located on a coal switch of the Big Four railroad, two miles northeast of the town of Carbon. It was idle nearly all summer, and work in the upper vein has not been resumed. The shaft is now being operated in the lower vein of block coal. Some pillars still remain in the upper vein, which is now being cleaned up preparatory to removing them, and this vein will probably be worked out and abandoned early in the year 1899. The working parts of the mine were found in excellent condition when last inspected, on December 29, 1898.

Crawford No. 1.

This mine is located immediately east of that last described. The upper vein is worked out, and about half of the men in the lower vein are at work on pillars. When inspected by Mr. Epperson, December 29, it was reported in extra good condition, as it always has been when inspected during the last three years. It will probably be finished during the year 1899. It has run very irregularly during the current year, and if this should occur again it may be found on the list of active mines at the end of the next. There seems to be a great deal of trouble in getting railroad cars at all of the mines on this railroad which mine block coal. (See Plate LXXX of Coal Report.)

Perry County.

Cannelton.

This mine is located three miles northeast of the town of Cannelton. The coal lies in the hills above water level. The coal from two of these hills nearest the river has been worked out, and a haulage-way

is maintained through them, all coal mined in the present workings being hauled through them by mules for a distance of more than a mile. The works are quite extensive, but very little is now being done except to remove pillars. Ventilation is produced by a furnace, and this is the only extensive mine in which I have seen this method successfully employed. The market for the coal is found on the Ohio river, the company keeping a small locomotive to haul the coal from the dump to the river, where it is loaded into coal boats and sold to the steamboat trade.

Troy.

This mine is located one-half mile above the town of Troy. The coal is sold on the river. This mine is not worked very extensively, and as it has a good roof and a hard bottom, there is very little danger attending its operation. It has always been found in good condition, and there is very little to say in regard to it that will not be found in the tables which form a part of this report.

Pike County.

Woolley.

This mine is located near the south limits of the city of Petersburg, on the Evansville & Indianapolis railroad. It is worked on a very irregular plan, and without reference to the final saving of the room pillars. The mine has been reported in good condition on each inspection made during the year. A second outlet has been provided at the mine since my last report, and it now complies in all respects with the law.

Blackburn.

This mine is located at Blackburn station, on the E. & I. R. R., and is fitted up with one of the most complete screening arrangements to be found in the State. The screens are of the shaker pattern, making lump and nut coal. The motion of the screens is so adjusted that no jar to the tipple results from their operation. The device by which this is brought about is the invention of Mr. S. W. Little, president of the company operating the mine. Space will not permit a full description of the screens here. The mine is opened by a slope 450 ft. in length. The grades in the mine are light, and a good fireclay bottom makes the maintenance of good haulage roads an easy matter. The coal is a hard bituminous, 7½ ft. thick, overlain with a good black slate roof, requiring very little timber. Air courses are easily kept clean and the ventilation is good at all times. But little work has been done at the mine during the year, and it was inspected only once, when it was found in good condition.

Little's.

This mine is situated at Little's station, on the E. & I. R. R. It is comparatively dry and has a hard bottom. The dip of the vein, while not heavy, is very irregular in direction, which constitutes the only drawback to an easy haulage of the coal. The vein is from 5 to 6 ft. thick and is a good quality of bituminous coal. In the main part of the work no timber is required in the entries. Rooms are well timbered where it is necessary, and the ventilation is all that could be desired. An excellent manway serves as a second outlet to the mine, and as it is available at all times, but few men enter or leave the mine on the cages. This is in all respects a model mine, partly by reason of its natural advantages and partly by the good management used in laying out and conducting the work.

Carbon.

This mine is on the main line of the Louisville, Evansville & St. Louis Consolidated or "Air Line" railroad. It is opened by a slope 150 ft. in length. The coal is 4 ft. 4 in. thick, and is an excellent quality of bituminous. It has a good roof, requiring but little timber in the entries; air courses are kept clean, and the ventilation, which is produced by a furnace, is fairly good. The mine was idle when visited, June 8, but on a later inspection was found in good condition.

Ayrshire.

One mile east of the above is the largest mine in the county. It has a good roof and the entries require very little timber to keep them safe. The coal here has the reputation of being the best bituminous in the State, and enjoys a fairly good demand at all times. The only coke plant now in operation in the State is owned by the operator of this mine and is located near it. I have no report of the amount of coke made here this year, but the plant has been in operation most of the time. The coal is of a soft nature and makes a large proportion

of nut and slack. The slack is mostly utilized in the manufacture of coke. The ventilation of the mine is usually good, but on the last inspection it was found deficient in some parts of the mine. This has since been remedied, and the latest report shows the mine in fair condition in all respects.

Hartwell.

This mine is about five miles from the main line of the "Air Line" railroad, and is reached by a switch from that road. It is opened by a drift, and the coal is mined by machines of the Morgan Gardner type. On each of the two inspections made during the year the mine was found in good condition. At last reports the mine was idle on account of a strike against the organization of the men into the United Mine Workers' organization. Some of the men who have been working at the mines of Cabel & Co., at Washington, were sent to this place, and I presume that at the end of the year the mine is at work, with a small capacity. When the last visit was made to this territory by Mr. Epperson the strike had just begun, and the mine was not inspected.

Sullivan County.

Harrison.

This mine is located at the town of Hymera, on the Farmersburgh branch of the Evansville & Terre Haute R. R. The coal is a vein of good bituminous, 5 ft. 6 in. in thickness. It is one of the most costly equipped mines in the State, having the latest hoisting machinery and a very complete screening plant, also an electric plant operating haulage and mining machinery. At the last inspection the mine was found in bad condition, and several changes were ordered to improve the ventilation. The air shaft had been allowed to freeze up nearly solid, entirely shutting off the air from one side of the mine. When it was cleared out the ventilation was fairly good in all parts of the mine. A new fan, driven by electric power, has been placed at the air shaft this year, and each side of the mine now has a separate system of ventilation. Only gross neglect on the part of the underground management can prevent the mine from being kept in good condition. (See Plate XCI, p. 1483.)

PHŒNIX.

At Alum Cave, on the same branch as the above, is one among the largest mines in the State. The coal is mined by the Harrison machine, driven by compressed air. It is well equipped in screening machinery, having roller screens for cleaning the small coal, and a large washer, which enables the company to put all of its small coal into marketable shape. A coke plant of several ovens is located at this mine, but it has not been in operation for several years. The No. 2 mine was flooded early in the year, and has only recently been reopened. The coal has an average thickness of 6 ft. The mine has been found in bad condition with respect to ventilation on every visit made this year, of which there have been five, and another is due early in January to see if the improvements ordered at the last inspection have been carried out. The works are extensive, and the principal trouble seems to be that the stoppings and doors are not kept in good order. (See frontispiece; Plate LXXXIII, p. 1441, Fig. 986.)

STAR.

This is located at Gramercy Park, on the same branch road. It has an excellent equipment, including roller screens and an electric plant to operate mining machines. The ventilation of the mine is well carried out, each pair of entries having a separate current of air, thereby dispensing with the use of doors on the entries and making a large saving in the daily expenses of the mine. The mine has been found in good condition on every inspection made during the year.

JUMBO.

At Jackson Hill, on the same branch railroad. The coal here is 5 ft. 8 in. in thickness, and of good quality. Harrison mining machines, driven by compressed air, are used in this mine. The ventilation is provided for by two fans, one for each side of the mine. On each inspection made during the year this was found in a satisfactory condition, but the roof is bad and there is usually a good deal of timbering needed to make the entries and traveling ways safe. Several changes have been made in the position of mine superintendent at this mine during the year, and one mine boss was killed while at work timbering one of the entries.

SHELBURN.

At Shelburn, on the main line of the E. & T. H. R. R., is a machine mine, in which the Lechner and Harrison machines, driven by compressed air, are used. There are two shafts here, but the one known as No. 1 is now being used entirely as an air shaft. The mine has been in operation for a long time, and the air courses are in bad condition, making the ventilation of the mine a difficult matter. This is one of the few mines in the State which generate fire-damp in dangerous quantities, and this makes close attention to the ventilation necessary. An explosion of fire-damp occurred at this mine on August 2, by which three men were seriously burned. A shot had been fired in one of the entries at noon on that day which set fire to the coal. It was found impossible to extinguish the fire by ordinary means, and four men had gone into the mine in the evening to build stoppings across the entries to shut the air from the fire, in hopes of smothering it out by that method. One of the stoppings had been put in place, and while the men were at work on the other, the explosion occurred. It was supposed that gas from a blower had accumulated in the part of the entry inside of the point where the stoppings were being built and filled the entries to the point where the fire was burning, and had caught fire from the burning coal. The mine was closed down for several days and no air allowed to enter, during which time the fire was smothered to such an extent that the work of placing the stoppings as at first intended was successfully accomplished and that part of the mine shut off. Work has since been resumed in the other parts of the mine and successfully carried on.

SULLIVAN.

A short distance north of the depot, at the city of Sullivan, on the main line of the E. & T. H. R. R. It is an old mine that had been shut down for several years and was reopened during the summer of 1898. It is operated for local trade exclusively. It was only within the last two months of the year that there have been more than ten men employed at the mine. When first inspected it was found to lack a great many of the safety appliances required by law, and not all of them had been complied with when a later visit was made. Time was given to complete the work, which carried it over into the year 1899, and we hope that on another visit to the mine it will be found to meet the requirements of the statute.

Bush Creek.

Three miles east of Sullivan, on the Indiana & Illinois Southern railroad; has been idle a great part of the year, and but one inspection was made. The mine was then being opened up after a long period of idleness, and was not in good condition. There were but few men working in it, and all possible diligence was being used to get it into good order, which I think has been accomplished by this time. The mine has changed hands during the year and is now owned by McGregor & Campbell, of Brazil, Ind., and operated by Donald & Fogg, Farnsworth, Ind.

Bunker Hill.

One mile east of the above, on the same railroad. This mine has always been found in excellent condition, every precaution having been taken for the safety and comfort of the miners. It has changed hands during the year, Messrs. Hancock & Conkel, who opened and operated it for a number of years, retiring and being succeeded by Mr. Crowder, of Sullivan, Ind. It is now leased and operated by a company of miners, and is being run at about half its normal capacity. No complaint was found with the condition of the mine on the last inspection.

Freeman or Briar Hill.

One-half mile southwest of the town of Dugger. This mine has done very little work during the year. For the first three months of the year about thirty men were employed by the lessees, the Lyonton Coal Mining Company, but for a few months after that it was practically idle. It has since resumed operations, but I have had no report from it, and do not know what has been done. It was in good condition when inspected, June 5, and no inspection has since been made.

Dugger.

This mine is at the town of Dugger, on the same railroad. It has been improved a great deal during the present year. An electric mining machine plant has been put in and a new air shaft has been sunk near the head of the works. This has had the effect of improving the ventilation of the mine by giving the air a shorter course to travel. There is a good deal of bad roof in this mine, and constant care is necessary to prevent accidents from falls of slate. This has been very successfully done this year. The coal is 5 ft. in thickness, of a splendid quality, showing in some parts of the vein beautiful peacock colors. It usually commands a good trade, which has not been fully supplied this year, on account of a scarcity of railroad cars. The mine has facilities for loading coal on both the I. & I. S. and the I. & V. branch railroad, but both have been short of cars. The electric plant consists of a 150 H. P. engine, 100 K. W. dynamo and four Morgan-Gardner mining machines. The power is stated to be sufficient to run twelve machines of the type used here. A new head frame has been put up at the mine during the year, and the shaft has been enlarged to the size of 9 by 12 ft., and two new pumps have been added to the equipment.

There are a number of small mines operating in this county, some of which may at some time during the year have employed more than ten men; but if so, the fact did not come to the knowledge of this office, and no inspections have been made of any of them during the year.

Vanderburgh County.

Union.

Located just north of the city limits of Evansville, on the Stringtown road. It is operated by the Evansville Union Coal Mining Company, composed of about twelve miners. This, as are all other mines in this county, is opened by a shaft to a vein of bituminous coal that runs about 4 ft. in thickness. It is run exclusively for local trade and employs but few men. Considerable difficulty has been found in keeping the roof up, and the airways have usually been found in bad condition. The road to the escape-way was in bad shape on the last inspection of the mine, and it was ordered cleaned up. I have very little faith in this mine ever being got into a shape to work with either safety or profit, and but for the fact that most of the employes are members of the company, I should have attempted to close the mine. A good deal of work has been done in trying to get the mine in good condition, and I hope that it may be found in better shape on the next inspection.

Diamond.

This mine is one-half mile west of the above and is operated in the same vein, which is a fair quality of steam and domestic coal. As the trade is entirely local, few men were employed here at any time, and the mine is not largely developed. On the last inspection, September 10, the air was weak in all parts of the mine, and in some places a great deal of black damp was mixed with the air. A good deal of loose slate was also found, which was ordered taken down or timbered. The catches and covers on the cages and gates at the shaft were ordered repaired in six days, which I am informed was done.

First Avenue.

This mine is on the banks of Pigeon creek, near First avenue, in the city of Evansville; does a local trade and has also a switch from the Belt railroad, on which some coal is shipped. All of the old part of this mine was lost during the year by a squeeze, and it has been reopened in another body of coal. When inspected, September 9, it was in bad condition, but fifteen men were at work on repairs, which it was estimated would be completed in four weeks. It has since been reported by the mine boss that the repairs were completed and that the mine was in excellent condition on December 14.

Sunnyside.

This is the only mine in Vanderburgh county where mining machines are used; those of both Harrison and Ingersoll-Sargeant type are used, being driven by compressed air. The output has been increased some during the year, and the mine has been found in excellent condition on each inspection made, both with respect to ventilation and the means taken to insure the safety of the employes.

Ingleside.

This mine was located near the Ohio river, just below the city limits of Evansville, and is the oldest mine in the State, having been opened in 1858. It is convenient to the river and has a siding from the Louisville & Nashville railroad, on both of which shipments are made. Tail-rope haulage is in operation in the mine for a distance of 3,000 ft. It has always been found in good condition, except with respect to the escape-way, and this has been put in order during this year, so that now there is no complaint to be made of the mine in any respect, except that occasionally black-damp finds its way from the old works into the return air current, which might interfere with the use of the escape-way. This, however, is very seldom used, and by reversing the air in case of an accident, the difficulty could be removed and men could be taken from the mine in safety.

Vermillion County.

Buckeye.

This mine is about one and one-half miles northwest of the city of Clinton, on a branch of the Chicago & Eastern Illinois railroad. It is operated in the lower vein found in this locality, or the "L" seam, mentioned elsewhere in this report. The vein is from 5 ft. 10 in. to 6 ft. 6 in. thick, with a hard clay bottom. The experiment has been made, of which mention was made in my last report, of leaving a coal roof in the entries, and seems to have proven a success here, as no breaks have occurred where this has been done. This mine has always been found in good condition when inspected, except for the ever-present nuisance of bad oil, which fills the working places with smoke. If this could be done away with, the air would be fresh and pure in the mine at all times.

Brouillet's Creek No. 3.

This mine is one and one-half miles south of the above, on the same branch of the railroad. It has been operating in the upper seam of coal found in this territory, and the works in that vein are very extensive. The distance which coal had to be hauled, however, became so great that about November 1, this year, they were abandoned, and the shaft is now being sunk to the vein worked at the Buckeye. It will probably be ready to take out coal from this seam early in 1899.

Brouillet's Creek No. 4.

One mile south of the above; has been opened this year and began shipping coal in October. It has been one of the most rapidly developed mines that has ever been opened in this State. It is being worked in the upper vein and is now producing over 500 tons of coal per day. All the natural conditions here are favorable to the safe and profitable working of a mine, it having a good roof and dry, hard bottom. Several accidents have occurred at this mine since it began operation, from the use of powder, the coal being blasted from the solid without undermining and large charges of powder being used. Some of the shots fired seem to have all the force of an explosion of firedamp, though none of this gas has ever been found in the mine. It may be that coal dust has played a part in some of the most violent explosions, but in the only one which I have investigated—that in which two men lost their lives—after a careful investigation, I failed to find any of the conditions or results usually given as causing or accompanying explosions of coal dust. After my investigation of that accident, I gave the company the following notings, which seemed to me to cover the precautions necessary to prevent such accidents in the future:

BROUILLET'S CREEK COAL COMPANY,
Clinton, Ind.:

GENTLEMEN—In order to prevent, if possible, a repetition of the accident of December 10 you will observe the following instructions at your No. 4 mine.

1. Do not allow any rooms to be worked on any entry inside of the last open breakthrough.
2. Require entries to be cut clear to the end of every hole before it is fired.
3. Do not allow more than one shot to be lighted at any one time.
4. Complete your escape-way and make it available for the use of the men employed in the mine as quickly as possible.
5. Drive a connection from your escape-way to the main air course, so that men may pass out of the mine without going under the shaft.
6. Post two or more copies of this notice conspicuously about the mine.
7. Report to me within ten days what progress you have made in carrying out these instructions.

Very truly,
ROBERT FISHER,
Inspector of Mines.

No reports from this mine have reached me since then of any damage having been caused as a result of heavy shot firing, and I presume the proper precautions are being taken to prevent such damage, whether as a result of my instructions or as a result of greater care on the part of miners and employers in the mine.

PRINCE.

This is a new mine which has been opened during this year and began shipping coal in July. It is equipped with steel head-frame, self-dumping cages, shaking screens, powerful hoisting engines, with Crawford & McCrimmon's improved conical drum, and is capable of handling a large output of coal. It is opened in the upper vein coal, same as is mined at Brouillet's Creek No. 4. The mine makes a good deal of water, the bottom is soft and haulage roads are likely to be very hard to keep in good condition.

A trial of electric mining machines was made here, but it was found that the under-clay was so damp that when mining was done in that the machine became clogged and would not work properly. In the lower strata of the coal there were some small balls of sulphur, which prevented the machines doing good work in that, and the contemplated machine plant was not installed, but the mine is now being worked entirely by pick miners. The output now reaches nearly 400 tons per day, and the mine was found in excellent condition in all respects on the last inspection.

TORREY NO. 4.

This mine is located near the town of Geneva, three and one-half miles northwest of Clinton. The works in the upper vein have been abandoned during the summer. The mine is being reopened in the bottom vein, which presents the same condition here as at the other places where the same seam is worked. The development was carried on for a while with the machines that had been used in the upper vein, but, owing to a disagreement between the company and the miners as to the price that should be paid for machine work, the use of machines has been discontinued and the mine is now being worked by pick miners with fairly good success. The plan of the mine contemplates extensive operation when it is fully developed, and there is no doubt a large amount of coal will be produced here. The mine was in fair condition when last inspected. Each of the last two mines described has switches from the C. & E. I. road, which handles all the coal produced in this field.

CAYUGA.

This mine is at the plant of the Cayuga Pressed Brick Company, about one mile north of the town of Cayuga. It is operated exclusively by the works of the company. The coal is found to a depth of about 100 ft., and 50 ft. above this is found a vein of clay which is used by the company in the manufacture of a buff building brick. It is a question whether this mine comes under the operation of the mining law, as less than ten men are employed in the vein where coal is mined, and the law makes no provision for the control of clay mines.

In addition to the mines mentioned above, where the works in the upper vein have been abandoned during the year, the Fern Hill mine of the Hazel Creek Coal Company has been entirely abandoned. There are reported to be some small mines in the vicinity of Newport which at times employ more than ten men, but it was too late in the year when the information reached me to permit an investigation of the report.

Vigo County.

Peerless.

This mine is located on the main line of the C. & E. I. R. R., one-half mile north of the crossing of the Big Four railroad at Coal Bluff. The coal mined in this and the next ten mines described is the same vein as is mined at Rosedale and other points in the State. The bottom is soft, but the entries are well drained and the haulage roads are kept in good order. The coal is of a softer character than at most of the other places where this seam is found, and does not bear handling well. It is worked on a plan which provides for the recovery of most of the pillars from the rooms as well as from the entries before the mine is finally abandoned. In opening the mine, sufficient pillars were not left near the bottom of the shaft, and a squeeze closed the main air course. This makes it necessary to carry the intake air current along the main haulage-way, and a door on this road near the bottom of the shaft permits a large leakage. In spite of this fact, a good current of air is carried to the faces of the entries and the rooms are fairly well ventilated. All the entries and airways are well timbered, and the mine is always found in fair condition when inspected. The shaking screen which has been in use at this mine did not work entirely satisfactorily, and I understand that a part of it is being taken out. I have not learned the reasons for this action. Shaker screens used at the mines of this State have usually given satisfaction.

Union.

One and one-half miles northeast of Fontanet. The coal here is mined by Harrison machines, driven by compressed air. It is worked on the same plan as the Peerless, and nearly all the coal is finally saved. Haulage roads are good, being underlain with plank where the bottom is soft. The mine has always been found in excellent condition when inspected, and no improvements have ever been recommended by the Inspectors. It is one of the largest producers in the State, as will be seen by reference to the table of production, found in another part of this report.

Diamond No. 2.

Two and one-half miles southwest of Fontanet, on the Big Four railroad; has been developed greatly during the year, and has now nearly as large an output as the Union. The air compressor which has been at this mine for over a year has not been put into use yet. A shaking screen has been put into operation at this mine during the year, but it jars the head-frame of the shaft to such an extent that it can hardly be said to be a success. A great deal of trouble has been experienced in the western and southwestern parts of the mine from bad roof. In many places sand has run into the mine from falls, and also a great deal of water. When last inspected, all the places where the roof seemed weak were well timbered, and a good current of air was circulating in all parts of the mine. Some places were smoky, the result of the use of bad oil.

Grant.

This mine has nearly always been found in bad condition when inspected during my term of office. There is a good deal of bad roof in the mine, which is not always well timbered, and the mine is old and has been opened up over a large extent of territory. The older parts of the air courses have fallen badly and are blocked with slate in many places. It has been necessary to order them cleaned up at every inspection made, and after this is done they seem to be neglected till the Inspector calls again. The coal is mined by machinery, and as this requires firing of shots at all times of the day, powder smoke adds to the difficulty of keeping the mine well ventilated. Considerable improvements have been made in the surface plant this year, but practically nothing has been done to permanently improve the conditions underground. On the last visit made by Mr. Epperson he found the same conditions as usual, and was informed that the mine would probably be abandoned within four months. If this is done, this company will probably open a new mine during the year 1899, as they have a large territory available in which the coal has not been mined. It is to be hoped that the change will be made; otherwise it may be necessary to condemn the present mine and let it work under protest, as the law as it stands at present does not give the Inspector the necessary power to prevent it from going on as it has in the past.

Nickel Plate.

One mile east of the above, on the Brazil division of the C. & E. I. R. R. The vein here is 7 ft. thick, and lies in the hills on each side of the valley up which the railroad switch runs to the mine. Two fans are used to ventilate the mine, one for each side, and the mine has usually been found in good condition when inspected. It was shut down on October 28 and has worked but very little since, the Ehrmann Coal Company, owners of the mine, having gone out of the business. In December the mine and all the property connected with it were leased to Francis S. Peabody, of Chicago, who is now operating them. No inspection has been made since he took charge, but as Mr. D. J. Evans is continued in charge of the mine, I am sure it will be placed in good shape as quickly as possible and kept so.

Eureka.

One mile southwest of the above, on the same railroad, is a slope opened this year. But few men are employed in the mine, and it has not been developed very much. But one inspection was made during the year, and the mine was then found in good condition in all respects.

Vigo.

This mine lies one mile east of the Nickel Plate. It has been operated this year by Edward Davis under a lease, and has run very irregularly. Most of the available coal has been worked out of the territory, and the only coal that is left is in pillars. It will probably be abandoned during the year 1899. There have not been ten men employed at any time during the last two months, but the mine was found in excellent condition when examined late in December.

Ray.

This mine is located one-half mile east of the town of Seeleyville, on the main line of the T. H. & I. R. R. It has a very good equipment, everything about it being in first-rate shape. During the present year a mining machine plant has been installed here. Compressed air is the power used, and the machines are of the Harrison and Sullivan types. Nearly all conditions in the mine are favorable to the use of machines, and there can be but little doubt as to the success of the

new plan of working. This mine has always been found splendidly ventilated, and while there is some bad roof, the entries and air courses are always well timbered. There has been nothing to complain of at this mine during the year under review.

Ehrlich.

Immediately south of the town of Seeleyville. Considerable work was done in the improvement of this mine during the year. The water box which had taken up one of the hoisting compartments of the shaft was taken off and a pump placed in the mine to raise the water. This, however, did not last long, as the water coming out of the mine is filtered through the gob left in the old works and is impregnated with materials that have a very bad effect on iron, and the pump was soon eaten out by them. It was relined with brass and again put into service, and was doing satisfactory work when the mine was last inspected, but I have since been informed that it was again disabled and that the water boxes have again been put into use. This is a great drawback to the output of the mine. Quite a large part of the older works of the mine was finally abandoned during the year, all the pillars being drawn out, which has permitted the abandonment of some very bad roadways and air courses. On my last inspection I found that the parts of the mine that are still working are well ventilated and the roof fairly well timbered. This work was being pushed with all possible rapidity and the promise was that all parts of the mine would soon be in excellent condition. The road to the escapeway had been cleaned up to some extent, but as this is through a shaft that was opened over twenty years ago it cannot be put into satisfactory condition. In case of an accident, however, there would be an available means of escape from the mine.

Hector.

This mine is situated one-fourth of a mile west of Seeleyville. The roof is the best in this mine of any that I have seen working in this vein. The coal that is being worked is from 6 to 7 ft. thick, but on the east side of the mine there is some that is a great deal lower. This is not being worked at present, but probably will be later. The entries are well drained and the haulage roads are good, being high and having no timbers to interfere with the movements of the drivers. There is practically no bad roof in the mine, and the principal fault to be found with it is that the rooms are not sufficiently well timbered at all times. Though there is not much danger of accidents to workmen, lack of the proper amount of timber might cause damage in the future to the mine as a whole, if thin pillars should allow the roof to begin settling.

Parke No. 10.

Owned by the Parke County Coal Company; is situated near Heckland station on the T. H. & L. R. R. This mine was laid off on what is known as the three-entry system, the air being carried across the main entry near the bottom of the shaft, and an air course carried along each side of it. This divides the mine from the start into four ventilation districts, and if the proper attention were given to doors and stoppings there should never be any difficulty with the ventilation. The roof in this mine is good—sandstone in most places—and the bottom is a hard fire-clay, making a good haulage road where water is not allowed to stand upon it. It was inspected twice during the year. On the first visit it was found in excellent condition. Later in the year it was found that the doors and stoppings were being neglected and the air current was weak in some places in the mine. Several changes were suggested that would improve the conditions, and the mine boss reported later that they had been made. We have not found time to make another visit to the mine to learn the truth of the report. This should be one of the easiest mines in the State to keep in repair, and only gross neglect on the part of the managers will allow it to be in a condition that would call for complaints from any source.

Brick Works.

This mine is located at the works of the Terre Haute Brick and Pipe Company, on the west side of the Wabash river. All the coal produced now is used at the factory of the company, and but very few more than ten men have been employed at any time during the year. The vein mined here seems to be found of workable thickness only in this vicinity. It has a very soft fire-clay bottom and lies so near the surface that a great deal of water is found coming out of the coal and the roof, making it very difficult to keep roads in good condition. The roof is generally a soft shale which requires a great deal of timber, and in some places it is a "white top" that is impossible to hold with

timber. At my last visit I found but eight men at work in the mine, most of them taking out pillars, and nearly all of the new work that was being opened seemed to be going into this white top and did not promise to last long.

Murray-Lloyd.

This mine, located one-fourth mile south of the above was opened in 1897, but at the close of the year was in the hands of a receiver, and was not working, so that it did not appear in my report for that year. After several attempts to dispose of it at receiver's sale it was finally purchased by R. J. Smith, of Terre Haute, Indiana, and is now being operated by him. This is the only mine on the west side of the river that has railroad connection, it having a switch from the main line of the Vandalia. It was inspected twice after Mr. Smith began operating it and was found in bad condition on both occasions. At the time of the first inspection very few of the safeguards required by law had been provided at the mine, and the ventilation was very poor in nearly all the working places. On the second visit there were no covers on the cages, the traveling way around the shaft did not comply with the law, and in some parts of the mine the ventilation had not been improved. In those places but few men were employed, and an effort was being made to carry air into them. The men working there asked that they be allowed to continue under a promise that no more men be put into that part of the mine till more air should be provided, and I gave thirty days to do this. I have not found time to make a visit to learn whether this has been done, but I have heard no complaints and I presume that Mr. Marshall has carried out the instructions given.

Other mines in this territory are the Miller Bros., Broadhurst, Larimer, and Krackenberger. Of these the first and last were not found during the year at any time to be employing the number of men that are required for the law to take effect. One inspection was made of the Miller mine, and I found that the owners were trying to get it into condition to comply with the law, so that they could increase their force for the fall trade. The Krackenberger mine was reported in very bad condition, but as only seven men were employed I did not make an inspection.

The other two mines did not employ more than ten men during the summer, but when last inspected were found to be in full compliance with the mining law, as they usually have been since they began to employ more than nine men. They each do a large local trade during the fall and winter months.

Warrick County.

Star.

This mine is located one mile east of Newburgh on the Ohio river. This is one of the best regulated mines in the State, natural conditions helping greatly to produce this result, the vein lying nearly level and having a good roof and a hard bottom, and there being but little water to contend with. During the year the railroad from Newburgh to the mine was washed out, so that dependence for shipping facilities has been on the river entirely during the fall. No timber is used in the entries and but very little in the rooms. A good current of air is always maintained through the mine.

Britzius.

This mine was flooded during the spring, and Mr. Robertson abandoned it. It has been reopened and working with a few men. Up to December 15 there had not been ten men employed at any one time during the year and no inspections have been made.

Air Line.

This mine is located at Chandler on the Evansville division of the Air Line railroad. A fire destroyed the head frame at this mine early in the year, and the mine was inspected but once, when only seven men were employed. It was found to comply with the law except in a few minor particulars which could be easily remedied before the force of men was increased sufficiently to bring the mine within the operation of the law.

Chandler.

Located a short distance east of the above, near the depot at Chandler. On the first inspection during the year it was found necessary to order considerable retimbering in the mine and some improvement in the ventilation. A second outlet has been completed since my last report. There are seldom more than fifteen men employed at this mine, and the output is small. On the last inspection made the mine was found in good condition.

Big Vein.

This mine is located one mile east of Boonville, on the Air Line railroad. It is opened by a slope and the coal lies near the surface. The coal is mined by machinery, three mining machines and two Jeffrey air drills being in use. The roof is very soft, but no difficulty is experienced in holding the roof in the narrow work with timber. Where falls occur in rooms an opening is usually made to the surface. This assists materially in the ventilation of the mine. The coal is an excellent quality of bituminous, from 6 to 8 ft. thick. This mine is always found in splendid condition. (See Plate LXXXII, p. 1439.)

Caledonia.

Is situated east of the Big vein mine. During the summer there are but few men employed, and it was idle when visited. An inspection, however, showed that the mining law was being fairly well complied with, and as far as could be learned under the circumstances the mine was in good condition. (See Plate LXXXII, p. 1439.)

Gough.

This mine has always been found in excellent condition when inspected. It is in the same vein of coal as the two mines last described. The main opening is by a shaft and the second outlet by a slope 150 ft. away from it. From eighteen to twenty-five men are usually employed.

ACCIDENTS.

The year shows the usual proportion of accidents to the amount of coal produced. The following table will give a basis of comparison of the fatal accidents year by year since 1892. Previous to that time no reports of accidents were required to be made to the Inspector, and from 1892 to 1896 only fatal accidents were required to be reported. With the exception of those occurring in Vermillion county, there is but little to be said in addition to the trite statement that the ordinary precautions used by careful miners would have prevented the fatalities which have occurred during the year. The exceptions noted occurred from the excessive use of powder, and the remarks found in the notice of the Brouillet's Creek No. 4 mine cover all that need be said of them, as all occurred either directly or indirectly from the same cause. Either my assistant or myself investigated each fatal accident in conjunction with the coroner of the county in which it occurred, and records of such investigations are on file in this office for the guidance of my successor. It will be noticed that one of the fatalities reported was the result of a pick wound in the head. The evidence adduced on the investigation pointed very strongly to its having been a murder, and not properly to be classed as one resulting from the casualties of mining, but, as we could discover no clew to the perpetrator, I have included it in the list.

Minor Accidents Reported from Indiana Mines, 1898.

Date.	Name.	Cause.	Injury.	Mine.	County.
Jan. 11	John Burnett	Falling slate	Slight bruises	Brazil B. C. Co. No. 1	Clay.
Jan. 12	John Whitsen	Mine car	Broken leg, one bone	Grant	Vigo.
Jan. 13	William Porter	Mine car	Sprained ankle	Gart No. 5	Clay.
Jan. 26	John D. Berry	Falling coal	Leg broken, small bone	Hawkins	Daviess.
Jan. 29	Frank Purcell	Not given	Bruised ankle	Cabel No. 4	Daviess.
Jan. 29	Patrick Bartley	Coal from car	Foot mashed	Chandler	Warrick.
Jan. 29	Not reported			Buckeye	Vermillion.
Jan. 29	James Montague	Steel from anvil	Eye hurt	Star	Sullivan.
Feb. 2	W. C. Conners	Mine car	Foot bruised	Brazil B. C. Co. No. 8	Clay.
Feb. 24	Jas. C. Smith	Caught by cage	Bruised, not seriously	Grant	Vigo.
Feb. 24	Harvey Raabe	Coal on railroad car	Hand hurt slightly	Crawford C. Co. No. 3	Clay.
Feb. 24	Henry Woolridge	Coal fell down shaft	Shoulder bruised	Nickel Plate	Clay.
Feb. 24	George Gruse	Falling slate	Leg bruised	Fairview	Clay.
Feb. 24	H. B. Ehrlich[a]	Falling roof	Slight bruises	Klondyke	Clay.
Feb. 24	G. Hoffmann[a]	Falling roof	Slight bruises	Klondyke	Clay.
Mar. 19	Perry Bruster	Falling coal	Ankle sprained	Hartwell	Piko.
Mar. 22	George Kinkade	Fell in manway	Side bruised	Island City	Greene.
Mar. 8	Mike Hevoren	Mine cars	Hand hurt	Brazil B. C. Co. No. 8	Clay.
Mar. 26	D. Guimanni	Falling roof	Back hurt	Brazil B. C. Co. No. 8	Clay.
Mar. 24	Daniel Thomas	Mine cars	Foot and leg bruised	Gladstone	Clay.
Mar. 24	James Lawhorn	Mine cars	Leg hurt	Eureka No. 2	Clay.
Mar. 24	Fred Shepperd	Falling slate	Head bruised	Diamond No. 2	Vigo.
Mar. 24	Frank Salters	Mine cars	Ankle bruised	Peerless	Vigo.
Mar. 24	Luther Lake	Falling coal	Hips bruised	Union	Vigo.
Mar. 24	John Richards	Mine car	Leg bruised	Union	Vigo.
April 21	Henry Gordon	Falling slate	Side bruised	Brazil	Clay.
April 21	Jesse Hess	Falling slate	Hips bruised	Cox No. 3	Parke.
April 21	James Malloy	Falling coal	Not reported	Mecca No. 1	Parke.
April 27	George Frost	Falling coal	Collar bone broken	Crawford No. 1	Parke.
April 27	Ben Willoughby	Falling slate	Back hurt slightly	Diamond No. 2	Vigo.
April 27	James Rouke	Falling slate	Foot hurt	Union	Vigo.
May 3	James Faulds	Mine car and roof	Hand mashed slightly	Phenix	Sullivan.
May 12	Harvey Buck	Falling slate	Head bruised	Grant	Vigo.
May 14	Scott Mason	Falling slate	Slight	Hymera	Sullivan.
May 19	Martin Luther	Mine car	Back and side bruised	Briar Hill	Clay.
May 19	T. J. Russel	Mine car	Leg bruised badly	Superior	Clay.
May 21	Elmer Critchlow	Falling slate	Slight	Harrison No. 2	Clay.

[a] Both in one accident.

Minor Accidents Reported from Indiana Mines, 1898—Continued.

DATE.	NAME.	CAUSE.	INJURY.	MINE.	COUNTY.
May 21	Joseph Stamps	Not reported	Not serious	Ingleside	Vanderburgh.
June 2	James Liddil	Falling slate	Slight	Phenix	Sullivan.
June 9	Joseph Wright	Mining machine	Finger joint lost	Phenix	Sullivan.
June 10	Frank Fulford	Mine car	Ankle strained	Edwardsport	Knox.
June 16	Charles Miller	Mine car	Foot bruised	Briar Hill	Clay.
June 16	Edward VanFossen	Falling slate	Knee and hip hurt slightly	Phenix	Sullivan.
June 16	John Holden	Mine cars	Leg hurt	Brazil B. C. Co. No. 8	Clay.
June 16	Allen Meode	Falling slate	Not reported	Star	Sullivan.
June 16	John W. Alvis	Falling slate	Foot hurt slightly	Nickel Plate	Vigo.
June 30	Edward Cutty	Mine car	Slight bruises	Brazil B. C. Co. No. 8	Clay.
July 11	H. Vonderschmidt	Falling coal	Foot hurt	Brazil B. C. Co. No. 8	Clay.
July 14	Samuel Darby	By a bar slipping	Foot hurt	Briar Hill	Clay.
July 14	William Daugherty	Not reported		Klondyke	Clay.
July 25	William Krack	Railroad cars	Slight	Brazil B. C. Co. No. 12	Parke.
July 20	Richard Spur	Mine car	Foot hurt	Star	Sullivan.
July 20	D. Montague	Explosion of powder	Burns, not serious	Dewey	Clay.
Aug. 8	Leonard Rardin	Fell from scaffold	Nose broken	Phenix	Sullivan.
Aug. 29	George Cochran	Trolley wire	Head slightly cut	Phenix	Sullivan.
Aug. 4	John Remage	Mine car	Hand mashed	Brazil B. C. Co. No. 1	Clay.
Aug. 4	Andrew Matzura	Falling slate	Fingers cut	Brazil B. C. Co. No. 11	Clay.
Aug. 3	Thomas Skene	Mining machine	Hand hurt	Brazil B. C. Co. No. 8	Clay.
Aug. 8	John McCann	Mine cars	Thumb hurt	Brazil B. C. Co. No. 8	Clay.
Aug. 25	Roland Elstone	Falling slate	Slight	Brazil B. C. Co. No. 8	Clay.
Aug. 25	David Brenton	Went back on a shot	Slight bruises	Templeton	Greene.
Aug. 2	Thomas Thomas	Gas explosion	Not serious	Shelburn	Sullivan.
Aug. 2	Mark Headley	After damp of an explosion	Fainted	Shelburn	Sullivan.
Aug. 2	John Vasco	Blast in coal	Burns	Torrey No. 4	Vermillion.
Sept. 9	James Faulds	Mine car	Bruises, head and neck	Phenix	Sullivan.
Sept. 5	John Waller	Falling slate	Slight	Little's	Pike.
Sept. 21	Andrew Farmer	Falling slate	Head cut, jaw broken	Templeton	Greene.
Sept. 30	Martin Murdoch	Falling slate	Body and limbs bruised	Lyford No. 2	Vermillion.
Sept. 30	Samuel Hice	Falling coal	Leg hurt	Crawford No. 3	Clay.
Sept. 30	William Heacox	Mine car	Finger caught and bruised	Crawford No. 3	Clay.
Sept. 30	Uri Heacox	Falling coal	Hip bruised	Crawford No. 3	Clay.
Sept. 27	Doc Young	Mine car	Back strained	Silverwood No. 2	Fountain.
Sept. 12	C. Chesterfield	Falling slate	Back hurt	Columbia No. 2	Parke.
Sept. 12	John Milburn	Mining pick	Hand hurt	Hartwell	Pike.
Sept. 12	David Walters	Mine car	Back hurt slightly	Peerless	Vigo.
Sept. 12	James Brown	Falling slate	Head cut	Union	Vigo.

DATE.	NAME.	CAUSE.	INJURY.	MINE.	COUNTY.
Sept. 12	C. McClintock	Falling slate	Bruises	Nickel Plate	Vigo.
Sept. 27	William Rees	Mine car	Foot hurt	Eureka No. 2	Clay.
Oct. 27	James O'Herron	Falling slate	Back injured slightly	Eureka No. 2	Clay.
Oct. 27	Samuel Buck	Falling coal	Arm hurt slightly	Fairview	Clay.
Oct. 28	Charles Johnson	Falling slate	Leg hurt slightly	Cabel No. 4	Daviess.
Oct. 28	Andrew Gasper	Mine car	Ankle strained	Mecca No. 1	Parke.
Oct. 4	Edward Don	Mine car	Finger mashed	Standard	Parke.
Oct. 4	Jerry Coakley	Falling slate	Hand cut	Hartwell	Pike.
Oct. 4	Joe Bush	Not reported	Wrist dislocated	Sunnyside	Vanderburgh.
Oct. 4	J. Rees	Falling slate	Bruised slightly	Sunnyside	Vanderburgh.
Oct. 4	J. Lehman	Same accident	Bruises	Sunnyside	Vanderburgh.
Nov. 22	Perry Wilson	Caught by cage	Hand bruised	Phenix	Sullivan.
Nov. 25	H. C. Alford	Falling slate	Internal injuries	Mutual	Daviess.
Nov. 25	Thomas Robbins	Blast in coal	Body bruised	Eureka No. 2	Clay.
Nov. 25	William Dalton	Mine car	Heel bruised	Fairview	Clay.
Nov. 11	Charles Morens	Falling roof	Back, face and leg hurt	Klondyke	Clay.
Nov. 11	H. McClintock	Mine cars	Slight	Brazil B. C. Co. No. 11	Clay.
Nov. 11	Charles Witty	Hit with prop	Head cut slightly	Fluhart	Greene.
Nov. 2	James Clark	Falling slate	Back hurt slightly	Fluhart	Greene.
Nov. 12	William Lewis	Falling slate	Slight	Summit	Greene.
Nov. 9	William Lynn	Mine car	Slight injuries	Brazil B. C. Co. No. 12	Parke.
Nov. 21	Michael Kolibe	Mine car	Foot hurt slightly	Brazil B. C. Co. No. 12	Parke.
Nov. 26	Gus Mullet	Falling slate	Thumb bruised	Brazil B. C. Co. No. 12	Parke.
Nov. 26	William Reece	Mining machine	Thumb cut	Parke Co. C. Co. No. 10	Vigo.
Nov. 26	No name reported	Falling coal	Slight	Island Valley	Greene.
Nov. 26	James Pollom	Falling coal	Collar bone broken	Crawford No. 3	Clay.
Nov. 26	Clarence Reberger	Falling coal	Foot hurt	Crawford No. 2	Clay.
Dec. 23	Robert Turner	Falling roof	Face cut	Brazil B. C. Co. No. 1	Clay.
Dec. 30	Richard Reybould	Falling coal	Ear split	Gart No. 5	Clay.
Dec. 20	Alex. McCollum	Falling coal	Leg and arm hurt slightly	Crawford No. 5	Clay.
Dec. 9	Mort Reynolds	Mine car	Hand hurt	Pratt	Clay.
Dec. 9	James Wilson	Falling slate	Not reported	Columbia No. 1	Parke.
Dec. 9	L. Knox	Not reported		Crawford No. 1	Parke.
Dec. 9	Jacob Bell	Falling slate	Not reported	Woolley	Pike.
Dec. 9	Edward Cook	Not reported		Woolley	Pike.

Serious Accidents in Indiana, 1898.

Date.	Name.	Cause.	Injury.	Mine.	County.
Jan. 2	Nelson Hensley	Explosion, powder	Burns, left side	Island No. 2	Greene.
Jan. 10	Grif Owens	Falling slate	Broken leg	Otter Creek	Parke.
Jan. 15	John Stiles	Falling roof	Sprained back	Cabel	Daviess.
Jan. 21	J. Gulumetti	Explosion, loose powder	Bad burns	Brazil B. C. Co. No. 11	Clay.
Jan. 26	David Aitken	Falling slate	Back strained	Columbia No. 3	Clay.
Jan. 24	J. Schrepferman	Mine cars	Broken leg	Brazil B. C. Co. No. 1	Clay.
Jan. 9	Thomas Durkiman	Falling timber	Injured in back	Templeton	Greene.
Feb. 14	Andrew Bramlet	Coal on railroad car	Finger cut off	Brazil B. C. Co. No. 8	Clay.
Feb. 7	Albert Southard	Explosion of gas	Face, arms and body burned	Star	Sullivan.
Feb. 10	Louie Maher	Mine car in slope	Knee crushed	Duncan or No. 4	Daviess.
Feb. 12	Morgan Rosser	Falling slate	Back and kidneys badly hurt	Cox No. 3	Parke.
Feb. 18	James Boskell	Coal fell in shaft	Finger cut off	Brazil B. C. Co. No. 8	Clay.
Feb. 22	Grant Goff	Falling slate	Back strained	Columbia No. 4	Clay.
March —	George Thompson	Falling slate	Finger cut off	Troy	Perry.
March 18	Name not reported			Island No. 2	Greene.
April 7	Charles Whorter	Mine car	Shoulder badly bruised	Dugger	Sullivan.
April 7	W. M. Robinson	Falling slate	Toe broken	Dugger	Sullivan.
May 21	Daniel Winters	Falling slate	Back strained	Columbia No. 5	Clay.
June 21	Clarence Ridgely	Falling slate	Head and chest bruised badly	Oswald	Gibson.
June 21	Moses Yemm	Slate fell in shaft	Collar bone broken	Crawford No. 5	Clay.
June 18	Roland Elstone	Mining machine	Finger cut off	Brouillet's No. 3	Vermillion.
June 23	John Holdon	Falling slate	Hand broken	Brazil B. C. Co. No. 8	Clay.
June 23	J. W. Alvis	Falling slate	Foot hurt	Brazil B. C. Co. No. 12	Clay.
July 2	C. R. Rogers	Falling coal	Leg broken	Nickel Plate	Vigo.
July 2	W. Straker	Mine cars	Three ribs broken	Woolley	Pike.
July 27	August Lucarena	Went back on shot	Not reported	Sunnyside	Vanderburgh.
July 7	Edward Geiser	Falling slate	Flesh wounds	Brouillet's No. 3	Vermillion.
July 8	Fin Brand	Rope slipped off drum	Shoulder bruised	Oswald	Gibson.
July 3	Ed Mitchell	Falling slate	Bad bruises	Crawford No. 4	Clay.
July 28	Daniel Martin	Falling slate	Back bruised seriously	Brazil B. C. Co. No. 1	Clay.
July 28	John Wells	Shot through pillar	Arm and leg broken, int. inj's.	Gladstone	Clay.
Aug. 18	Rufus Harmon	Caught by cage	Head bruised	Eureka No. 2	Clay.
Aug. 3	Charles Meyers	Mine cars	Seriously bruised	Phenix	Sullivan.
Aug. 2	James McCombs	Explosion of gas	Seriously burned	Shelburn	Sullivan.
Aug. 2	David John	Explosion of gas	Seriously burned	Shelburn	Sullivan.
Aug. 2	John Thomas	Explosion of gas	Seriously burned	Shelburn	Sullivan.
Sept. 17	August Johnson	Falling slate	Leg broken	Silverwood No. 2	Fountain.
Oct. 5	J. Pursinger	Falling slate	Foot mashed, ankle broken	Troy	Perry.
Oct. 5	B. Crawford	Mine car	Leg broken	First Avenue	Vanderburgh.
Oct. 5	Jacob Bell	Falling slate	Two ribs broken	Crawford No. 1	Parke.
Oct. 10	John McCloney	Slipped on screen	Hand bruised	Phenix	Sullivan.
Oct. 10	James Leonard	Falling coal	Hand mashed	Phenix	Sullivan.
Oct. 10	William Leonard	Falling coal	Internal inj's, breast and back	Phenix	Sullivan.
Oct. 10	James Anderson	Falling slate	Arm hurt	Grant	Vigo.
Oct. 10	Henry Schepper	Falling slate	Head hurt	Grant	Vigo.
Oct. 12	Charles Withers	Falling roof	Back hurt	World's Fair	Clay.
Oct. 24	J. Alberson	Falling slate	Head and shoulders bruised	Prospect Hill	Knox.
Oct. 24	Sol Ward	Falling slate	Eye cut, hip bruised	Phenix	Sullivan.
Oct. 30	Prosper Julebert	Falling slate	Neck and ankle sprained	Brazil B. C. Co. No. 1	Clay.
Oct. 30	Joseph Summers	Cage in shaft	Two toes cut off	Island City	Greene.
Oct. 30	Joseph McBright	Falling coal	Bruised badly	South Linton	Greene.
Oct. 24	William Spillman	Blast in coal	Badly bruised	Ingleside	Vanderburgh.
Oct. 22	G. Chesterfield	Heavy shot in coal	Three ribs broken, int. hurts	Buckeye	Vermillion.
Nov. 30	John McGloire	Falling slate	Thigh broken	Templeton	Greene.
Dec. 5	David Carico	Falling slate	Leg broken	Oswald	Gibson.
Dec. 14	William Rhyan	Kicked by a mule	Three ribs and should'r brok'n	Buckeye	Vermillion.
Dec. 13	O. Jeremerick	Falling coal	Two ribs and shoulder broken	Cox No. 3	Parke.
Dec. 13	Herman Ham	Falling coal	Arm and ankle broken	Cox No. 3	Parke.
Dec. 17	Charles Eberwine	Falling slate	Arm and two ribs broken	Columbia No. 5	Clay.
Dec. 21	Harvey Patterson	Mine car	Head and shoulders bruised	Columbia No. 4	Clay.
Dec. 26	Thoms Berrisford	Falling slate	Hand dislocated	World's Fair	Clay.
Dec. 26	William Spriggs	Mine car	Hand dislocated	Diamond No. 3	Clay.
Dec. 28	Elmer Drake	Fell down shaft	Legs badly hurt	Superior	Clay.
Dec. 7	William Davis	Engineer lost control of his engine and cage fell	Severe concussions in all cases	Torrey No. 4	Vermillion.
Dec. 7	Henry Larimer				
Dec. 7	Fletcher Hamby				
Dec. 7	Owen Graham				
Dec. 3	John D. King	Falling slate	Leg broken and severe bruises	Monarch	Clay.
Dec. 3	David Carmichael	Falling coal	Thigh broken	San Pedro	Clay.
Dec. 21	David Hopkins	Falling slate	Leg broken	Peerless	Vigo.
Dec. 29	Fred Whippo	Mine car	Badly bruised	Nickel Plate	Vigo.

Fatal Accidents in Indiana Mines, 1898.

Date.	Name.	Cause.	Occupation.	Mine.	County.
Jan. 4	C. G. Smith	Cage caught him while looking down the shaft	Roustabout	Montgomery No. 1	Daviess.
Jan. 27	George Markle	Explosion of boiler	Fireman	Union	Vigo.
Feb. 10	Nat. McGill	Falling roof, January 14	Miner	World's Fair	Clay.
Feb. 10	Louis Deis	Falling slate, January 13	Miner	Sunnyside	Vanderburgh.
Feb. 12	John Posete	Pick in skull. No clew	Miner	Pratt	Clay.
Feb. 27	Herman Bounes	Falling slate, February 24	Miner	Flubart	Greene.
Mar. 5	Thomas O'Harris	Premature blast	Miner	Wooley	Pike.
Mar. 19	Frank Murphy	Falling slate	Miner	Island No. 2	Greene.
April 16	Alex. Ferguson	Falling slate	Miner	Nickel Plate	Vigo.
April 23	Joe Rafatto	Falling slate	Miner	Standard	Parke.
June 25	Frank Reni	Door blown open by a heavy shot	Miner	Brouillet's No. 3	Vermillion.
July 8	John Flatley	Both killed instantly by the same fall of slate	Miners	Cox No. 3	Parke.
July 8	Andrew Brumick				
Aug. 30	Sheridan Osborn	Falling slate	Miner	Hartwell	Pike.
Aug. 30	James Oswald	Both instantly killed by falling roof in working place	Miners	Superior	Clay.
Aug. 30	Charles Howalt				
Oct. 19	James M. Molar	Coal falling down shaft	Cager	Jumbo	Sullivan.
Dec. 8	Alonzo Colbert	Falling slate	Miner	Duncan or No. 4	Daviess.
Dec. 11	James Henry	Both died from injuries received from heavy shot firing on December 10	Miners	Brouillet's Creek No. 4	Vermillion.
Dec. 19	Newton Muncie				
Dec. 23	Albert Haag	Falling slate	Miner	Mutual	Daviess.
Dec. 25	George Dalton	Went back on a shot too soon	Miner	Buckeye	Vermillion.

Fatalities by Years.

Year.	Employes.	Tons of Coal.	Fatalities.
1879	3,459	1,196,490	.....
1880	....	1,550,375	.....
1881	4,567	1,771,536	10
1882	....	1,990,000	.....
1883	5,403	2,560,000	11
1884	5,716	2,260,000	9
1885	6,502	2,375,000	7
1886	6,406	3,000,000	7
1887	....	3,217,711	.....
1888	6,685	3,140,979	17
1889	....	....	.....
1890	6,550	3,791,211	5
1891	6,975	3,819,600	5
1892	7,600	4,408,471	19
1893	7,431	4,358,897	22
1894	....	....	.....
1895	7,885	4,202,084	23
1896	7,112	4,068,124	28
1897	7,984	4,088,100	16
1898	....	5,146,920	19

Note.—Where blanks occur there was no report.

LIST OF MINES.

Table Showing the Names and Addresses of Persons and Corporations Operating Coal Mines in the State of Indiana During the Year 1898, With the Names of Mines in Each County.

CLAY COUNTY.

Names.	Addresses.	Mines.	Remarks.
Allais & Urbain	Brazil	Victoria	Abandoned.
Brazil Block Coal Co	Brazil	No. 1 Mine	
Brazil Block Coal Co	Brazil	Gart No. 3	
Brazil Block Coal Co	Brazil	Gart No. 5	
Brazil Block Coal Co	Brazil	Mine No. 7	Suspended.
Brazil Block Coal Co	Brazil	Mine No. 8	
Brazil Block Coal Co	Brazil	Mine No. 10	Abandoned.
Brazil Block Coal Co	Brazil	Mine No. 11	
Briar Block Coal Co	Clay City	Briar Hill	
Chicago and Indiana Coal Co	Terre Haute	Harrison No. 2	
Chicago and Indiana Coal Co	Terre Haute	Harrison No. 3	New mine.
Coal Bluff Mining Co	Terre Haute	Pratt	
Crawford Coal Co	Brazil	Mine No. 2	Abandoned.
Crawford Coal Co	Brazil	Mine No. 3	Abandoned.
Crawford Coal Co	Brazil	Mine No. 4	New mine.
Crawford Coal Co	Brazil	Mine No. 5	New mine.
C. Ehrlich Coal Co	Turner	Klondyke	
C. Ehrlich & Co	Turner	Excelsior	Abandoned.
D. H. Davis Coal Co	Knightsville	World's Fair	
Ehrlich, Peter	Turner	Superior	Sold to I. B.
Eureka Block Coal Co	Terre Haute	Eureka No. 2	
Eureka Block Coal Co	Terre Haute	Eureka No. 3	New mine.
Diamond Block Coal Co	Chicago, Ill	Diamond No. 3	
Goucher, McAdoo & Co	Brazil	Monarch	
Jackson Coal and Mining Co	Brazil	Brazil	
Jackson Coal and Mining Co	Brazil	Nickel Plate	Abandoned.
Jackson Coal and Mining Co	Brazil	Dewey	New mine.
Peter Andrew	Clay City	Markland	
Otter Creek Coal Co	Brazil	Fairview	
Somers, Joseph	Staunton	San Pedro	
Weaver Coal Co	Center Point	Louise	
Zeller, McClellan & Co	Brazil	Columbia No. 3	Abandoned.
Zeller, McClellan & Co	Brazil	Columbia No. 4	
Zeller, McClellan & Co	Brazil	Columbia No. 5	New mine.
Lancaster Block Coal Co	Terre Haute	Rob Roy	

DAVIESS COUNTY.

Cabel & Co	Washington	Mine No. 4	
Cabel & Co	Washington	Mine No. 9	
Daviess County Coal Co	Montgomery	Mine No. 1	
Daviess County Coal Co	Montgomery	Mine No. 2	
Daviess County Coal Co	Montgomery	Mine No. 3	New mine.
Mutual Mining Co	Cannelburg	Mutual	
Raglesville Coal Co	Raglesville	Hoosier	
Stuffle, James	Raglesville	Mine No. 3	Small mine.
Washington Coal Co	Washington	Hawkins	
Washington Coal Co	Washington	Duncan	
Winkelpleck, Jonas	Raglesville	Union	Small mine.

DUBOIS COUNTY.

L. A. Southard	Huntingburg	Huntingburg	Abandoned.

LIST OF MINES—Continued.

FOUNTAIN COUNTY.

Names.	Addresses.	Mines.	Remarks.
Indiana Bit. Coal Co	Terre Haute	Silverwood No. 2	
Silverwood Coal Co	Silverwood	Sturm	

GIBSON COUNTY.

Maule Coal Co	Princeton	Oswald	See Note 2.

GREENE COUNTY.

Island Coal Co	Indianapolis	Island City	
Island Coal Co	Indianapolis	Island No. 2	
Island Valley C. and M. Co	Linton	Island Valley	
Linton C. and M. Co	Linton	Fluhart	
So. Linton Coal Co	Linton	South Linton	
Summit Coal Co	Bloomfield	Summit	
Western Ind. Coal Co	Terre Haute	Templeton	

KNOX COUNTY.

Bicknell Co-op. Coal Co	Bicknell	Bicknell	See Note 3.
Edwardsport Coal Co	Indianapolis	Edwardsport	
Prospect Hill Coal Co	Vincennes	Prospect Hill	See Note 4.

MARTIN COUNTY.

Bedford C. and M. Co	Bedford	Bedford	See Note 5.

OWEN COUNTY.

Lancaster Block C. Co	Terre Haute	Lancaster No. 4	

PARKE COUNTY.

Brazil Block Coal Co	Brazil	Cox No. 3	
Brazil Block Coal Co	Brazil	Brazil Block No. 12	
Brazil Block Coal Co	Brazil	Otter Creek	
Crawford Coal Co	Brazil	Mine No. 1	
McIntosh, I. & Co	Brazil	Mine No. 1	
McIntosh, I. & Co	Brazil	Mine No. 3	New mine.
Otter Creek Coal Co	Brazil	Mecca No. 1	
Parke County C. Co	Rosedale	Mine No. 8	
Rock Run Coal Co	Brazil	Lucia	New mine.
Standard Coal Co	Terre Haute	Standard	
Wabash Valley C. Co	Clinton	Lyford No. 2	See Note 6.
Zeller, McClellan & Co	Brazil	Columbia No. 1	
Zeller, McClellan & Co	Brazil	Columbia No. 2	

LIST OF MINES—Continued.

PERRY COUNTY.

NAMES.	ADDRESSES.	MINES.	REMARKS.
Amer. Cannel Coal Co	Cannelton	Cannelton	
Bergenroth Bros	Troy	Troy	

PIKE COUNTY.

Cabel-Kaufman Coal Co	Cabel	Hartwell	
Ingle, D	Oakland City	Ayrshire	
Jackson, W. A	Oakland City	Carbon	
The S. W. Little Coal Co	Evansville	Blackburn	
The S. W. Little Coal Co	Evansville	Little's	
The J. Woolley, Jr., Coal Co	Evansville	Woolley	

SULLIVAN COUNTY.

Hancock & Conkel	Farnsworth	Bunker Hill	See Note 7.
Harder-Hafer Coal Co	Del Carbo	Star	
Hymera Coal Co	Hymera	Harrison	
Ind. and Chicago Coal Co	Dugger	Dugger	
Jackson Hill Coal and Coke Co	Eagle	Jumbo	
Lyonton Coal Mining Co	Dugger	Briar Hill	
North Curryssville Coal Co	Shelburn	Curryssville	Abandoned.
New Pittsburgh Coal and C. Co	Alum Cave	Phenix	
Shelburn Mining Co	Shelburn	Shelburn No. 2	
Watson-Little Coal Co	Farnsworth	Bush Creek	See Note 8.
Sullivan Coal Co	Sullivan	Sullivan	Small.

VANDERBURGH COUNTY.

Diamond Coal Mining Co	Evansville	Diamond	
Ev. Union Coal Mining Co	Evansville	Union	
John Ingle Coal Co	Evansville	Ingleside	
Lozier, H. A	Evansville	First Avenue	
Sunnyside Coal and Coke Co	Evansville	Sunnyside	

VERMILLION COUNTY.

Brouillet's Creek Coal Co	Clinton	Mine No. 3	
Brouillet's Creek Coal Co	Clinton	Mine No. 4	New mine.
Hazel Creek Coal Co	Clinton	Fern Hill	Abandoned.
Keller Coal Co	Clinton	Prince	New mine.
McClellan, Estman & Co	Clinton	Buckeye	
Torrey Coal Co	Voorhees	Torrey No. 4	
Cayuga Press Brick Co	Cayuga	Eureka	

LIST OF MINES—Continued.

VIGO COUNTY.

NAMES.	ADDRESSES.	MINES.	REMARKS.
Broadhurst, J. N. & G	Macksville	Broadhurst	
Coal Bluff Mining Co	Terre Haute	Diamond No. 2	
Coal Bluff Mining Co	Terre Haute	Peerless	
Coal Bluff Mining Co	Terre Haute	Union	
Davis, Edward	Ehrmandale	Vigo	Small now.
Ehrlich, Julius	Seeleyville	Ehrlich	
Ehrman Coal Co	Terre Haute	Nickel Plate	See Note 9.
Grant Coal Mining Co	Burnett	Grant	
Lankford, William	Macksville	Larimer	
Loughner Coal Co	Seeleyville	Hector	
Murray & Lloyd	Macksville	Murray	See Note 10.
Nevins Coal Co	Fontanet	Eureka	New mine.
Parke County Coal Co	Rosedale	Mine No. 10	
Terre Haute Brick and Pipe Co	Terre Haute	Brick Works	Small now.
Vigo County Coal Co	Seeleyville	Ray	

WARRICK COUNTY.

Archbold, John	Evansville	Star	
Bartley, Patrick	Evansville	Chandler	
Caledonia Coal Co	Boonville	Caledonia	
DeForest Coal Co	Evansville	DeForest	Small now.
Hall and Lawrance	Chandler	Air Line	Irregular.
Kelley & Nester	Boonville	Gough	
J. Woolley, Jr., Coal Co	Evansville	Big Vein	

Notes.

1. The Superior mine in Clay county was sold by Peter Ehrlich to the Indiana Bituminous Coal Company, of Terre Haute, Ind., in the month of November, and has since been operated by that company.

2. The Oswald mine was sold in the month of October to the Princeton Coal Company, Princeton, Ind.

3. The Bicknell Co-operative Coal Company gave up their lease on the Bicknell mine and it has been operated by the Bicknell Coal Company since the month of September.

4. The Prospect Hill mine has been worked by the Prospect Hill Co-operative Coal Company since October.

5. The Tunnel mine has changed hands twice during the year and is now being operated under a lease by F. M. Wampler, Indian Springs, Ind.

6. The Lyford mine was operated from January to June by The Calumet Coal Company, from June to October by the "Scott Mines" Company, and since then by the present operators, as given in the table.

7. Hancock & Conkel sold the Bunker Hill mine to —— Crowder, Sullivan, Ind., and it is at present leased to a company who are operating it under the firm name of Smith, Lawson & Co., Farnsworth, Ind.

8. The Watson-Little Coal Company retired from business early in the year, and this mine has done very little work. At the close of the year it is being operated under a lease by Donald, Fogg & Co.

9. The Ehrman Coal Company ceased operating their Nickel Plate mine in October, and have leased it to F. S. Peabody, of Chicago, Ill., who began operations in the latter part of December.

10. The firm of Murray & Lloyd failed near the close of 1897. The mine did very little work until it was sold to R. J. Smith in September. It is at present operated by the purchaser, whose address is Terre Haute, Ind.

This year has been the most prolific of changes in the coal business in this State of any year since I have been in the office of Inspector. In addition to the changes noted above, several mines that were on the list in my report for 1897 have not employed more than ten men during this year, hence I have no report from them.

It will be seen from the above table that there have been ten mines abandoned during the year; five that are now working less than ten men, most of them having reduced their force preparatory to abandonment; one is suspended at present, which may be reopened during the year 1899, and twelve new mines have been opened during the year, which are now producing coal. In addition to these there are two new mines in Greene county which have not yet reported, though I understand at the close of the year that the vein has been reached in each of them. The probabilities are that there will be several new openings made early in the coming year.

TABLE

Showing the Number of Men and Mules Employed, Days Worked, Accidents Occurring, Kegs of Powder Used, and Total Coal Produced at Each Mine Reporting to this Office in 1898.

CLAY COUNTY.

NAME OF MINE.	Employed.			Days Worked.	Accidents.		Kegs of Powder Used.	Coal Produced.
	Men Inside.	Mules.	Men Outside.		Fatal.	Non-Fatal.		
Brazil Block No. 1	112	12	13	246	......	6	1,286	79,836
Gart No. 3	117	10	10	56	......	......	375	14,695
Gart No. 5	182	11	10	155	......	2	2,070	72,672
Brazil Block No. 7	38	2	1	12	......	......	33	1,026
Brazil Block No. 8	181	15	18	263	......	12	2,961	120,370
Brazil Block No. 11	39	3	4	206	......	3	846	15,094
Gladstone	89	8	9	230	......	2	3,635	71,719
Briar Hill	25	3	5	167	......	3	148	13,532
Harrison No. 2	48	4	6	135	......	1	672	20,511
Harrison No. 3	20	1	3	70	......	......	114	3,839
Pratt	70	6	6	134	1	......	......	27,810
Crawford No. 2	39	2	8	150	......	1	586	27,886
Crawford No. 3	75	5	6	156	......	5	......	29,824
Crawford No. 4	28	1	2	114	......	1	798	12,054
World's Fair	45	2	3	140	1	2	787	14,875
Diamond	82	5	8	158	......	1	3,425	63,538
Excelsior	27	4	4	8	......	......	40	599
Eureka No. 2	145	14	7	144	......	4	2,165	55,023
Eureka No. 3	49	2	3	124	......	......	286	18,237
Monarch	15	2	3	297	......	......	......	6,943
Brazil	113	6	7	188	......	1	956	43,543
Nickel Plate	36	2	3	95	......	1	250	7,067
Markland	22	3	4	161	......	......	554	9,811
Fairview	58	5	5	149	......	3	687	19,337
Louise	71	6	5	120	......	......	1,023	22,662
Columbia No. 3	14	2	2	40	......	1	82	2,175
Columbia No. 4	42	2	4	168	......	......	1,045	17,776
Klondyke	136	5	8	209	......	5	2,239	110,902
Superior	37	3	6	162	2	2	......	5,994
San Pedro	61	4	7	156	......	......	824	38,463
Victoria	27	4	2	100	......	......	243	7,947
Rob Roy	23	2	3	88	......	......	63	2,158
Columbia No. 5	151	4	7	100	......	1	481	30,675
Dewey	81	2	7	111	......	1	......	12,764
Crawford No. 5	46	1	6	72	......	3	465	12,262
Pyrah No. 3	36	2	3	75	......	......	115	4,888

DAVIESS COUNTY.

NAME OF MINE.	Men Inside.	Mules.	Men Outside.	Days Worked.	Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Cabel No. 4	38	4	6	174	......	2	662	14,199
Cabel No. 9	59	7	7	151	......	1	631	25,460
Montgomery No. 1	37	7	7	250	1	......	1,693	44,440
Montgomery No. 2	52	7	6	240	......	......	1,542	47,094
Montgomery No. 3	25	2	1	70	......	......	286	7,191
Mutual	38	4	7	154	1	2	546	6,550
Hoosier	10	......	2	183	......	......	......	4,693
Union	10	1	2	73	......	......	......	1,835
Hawkins	27	3	5	183	......	1	79	14,485
Duncan	15	1	3	173	1	1	46	7,228

TABLE—Continued.

DUBOIS COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Huntingburg	7	1	2	166	......	......	....	2,649

FOUNTAIN COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Silverwood No. 2	87	10	7	261	......	2	4,275	94,819
Sturm No. 2	21	2	3	290	......	......	869	17,082

GIBSON COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Oswald	63	4	12	170	......	3	1,553	47,286

GREENE COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Island City	85	7	12	140	......	1	....	67,768
Island No. 2	142	17	16	139	1	2	....	117,789
Island Valley	50	4	7	152	......	1	751	37,356
Fluhart	167	11	9	125	1	2	1,509	61,332
South Linton	74	5	6	133	......	1	1,175	51,566
Summit	119	15	13	143	......	1	2,462	103,080
Templeton	97	5	8	157	......	4	....	82,831

KNOX COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Bicknell	29	2	4	155	......	......	546	18,616
Edwardsport	39	4	8	138	......	1	542	29,888
Prospect Hill	18	3	5	217	......	1	382	10,853

MARTIN COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Tunnel	17	2	2	135	......	......	3	5,052

OWEN COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Lancaster No. 4	17	2	3	197	......	......	1	8,813

TABLE—Continued.

PARKE COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Brazil Block No. 12	37	2	7	238	......	5	635	17,646
Cox No. 3	130	19	22	240	2	4	1,344	153,612
Lyford No. 2	132	9	15	202	......	1	2,220	79,842
Mecca No. 1	43	5	7	196	......	2	1,653	30,089
Parke No. 8	59	7	10	196	......	......	888	93,620
Otter Creek	46	3	4	140	......	1	467	18,484
Standard	86	4	5	223	1	1	....	55,825
Columbia or Superior No. 1	53	4	5	96	......	......	779	26,176
Columbia or Superior No. 2	110	4	6	200	......	1	3,561	56,745
Crawford No. 1	91	5	5	131	......	3	167	34,627
McIntosh No. 1	67	4	5	210	......	......	921	32,463
McIntosh No. 2	35	2	5	106	......	......	445	7,115
McIntosh No. 3	53	3	4	42	......	......	503	5,900

PERRY COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Cannelton	31	4	6	140	......	......	36	16,703
Troy	17	2	2	250	......	2	309	10,384

PIKE COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Hartwell	41	6	5	118	1	3	477	16,458
Ayrshire	129	21	15	111	......	......	2,890	83,511
Blackburn	27	5	7	84	......	......	608	19,080
Littles	102	11	10	174	......	1	2,966	71,105
Carbon	23	2	4	185	......	......	433	18,335
Woolley	36	5	5	205	1	2	1,437	32,332

SULLIVAN COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Briar Hill	19	1	3	147	......	......	401	11,528
Bunker Hill	28	3	4	47	......	......	427	14,244
Dugger	79	13	12	149	......	2	....	69,364
Star	85	13	18	221	......	4	1,492	142,916
Jumbo	111	23	15	230	1	......	1,143	145,468
Curryville	25	2	6	17	......	......	19	1,124
Phenix No. 1	130	16	17	234	......	14	1,505	148,593
Hymera	75	9	12	202	......	1	582	105,772
Shelburn	43	6	11	151	......	5	707	33,735
Bush Creek	12	1	2	96	......	......	133	3,963
Sullivan	12	1	1	52	......	......	....	775

VANDERBURGH COUNTY.

NAME OF MINE.	Employed. Men Inside.	Mules.	Men Outside.	Days Worked.	Accidents. Fatal.	Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Diamond	21	3	4	218	......	......	678	15,697
Union	21	2	5	214	......	......	610	11,870
Ingleside	96	11	9	209	......	2	215	63,606
First Avenue	23	5	7	259	......	1	1,128	24,792
Sunnyside	62	12	9	214	1	2	1,725	77,827

TABLE—Continued.

VERMILLION COUNTY.

NAME OF MINE.	Employed. Men Inside.	Employed. Mules.	Employed. Men Outside.	Days Worked.	Accidents. Fatal.	Accidents. Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Brouillet's No. 4	103	5	6	128	2	......	2,558	44,041
Cayuga	15	2	3	78	......	......	......	2,630
Fern Hill	100	18	15	56	......	......	1,240	19,978
Prince	72	4	9	132	......	......	2,919	46,324
Brouillet's No. 3	122	14	8	160	1	2	6,194	107,924
Torrey No. 4	54	6	11	219	......	5	2,649	58,584
Buckeye	123	8	9	229	1	3	4,382	120,466

VIGO COUNTY.

NAME OF MINE.	Employed. Men Inside.	Employed. Mules.	Employed. Men Outside.	Days Worked.	Accidents. Fatal.	Accidents. Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Klondyke	19	1	4	97	......	......	285	5,337
Diamond No. 2	149	10	9	257	......	2	......	145,267
Peerless	108	7	9	210	......	3	......	87,565
Union	172	14	12	265	1	5	......	182,785
Broadhurst	13	2	1	294	......	......	......	10,478
Ehrlich	49	4	6	231	......	......	1,552	43,692
Nickel Plate	71	9	8	177	1	4	1,668	50,971
Hector	62	4	7	226	......	......	1,884	51,907
Grant	92	10	10	181	......	5	2,380	77,313
Parke No. 10	72	7	9	186	......	1	745	81,222
Brick Works	11	2	1	259	......	......	335	9,916
Vigo	20	1	4	113	......	......	287	9,800
Ray	48	4	6	178	......	......	930	48,322
St. Mary's	30	1	4	23	......	......	68	1,765
Murray	21	2	3	172	......	......	......	10,000

WARRICK COUNTY.

NAME OF MINE.	Employed. Men Inside.	Employed. Mules.	Employed. Men Outside.	Days Worked.	Accidents. Fatal.	Accidents. Non-Fatal.	Kegs of Powder Used.	Coal Produced.
Star	29	4	4	154	......	......	1,150	23,279
Chandler	11	3	3	147	......	1	......	6,061
Gough	22	3	4	150	......	......	516	18,219
Air Line	10	1	3	168	......	......	197	4,732
Big Vein	30	6	6	185	......	......	609	38,261
Caledonia	14	2	2	208	......	......	211	11,148
Brizius	16	2	3	60	......	......	65	2,444
DeForest	16	2	3	113	......	......	424	7,780

ANNUAL REPORT OF THE NATURAL GAS SUPERVISOR.

OFFICE OF THE NATURAL GAS SUPERVISOR.
KOKOMO, IND., January 9, 1899.

PROF. W. S. BLATCHLEY, *State Geologist:*

SIR—In obedience to the provisions of section 7504 of the Revised Statutes of the State of Indiana, I submit herewith to you the seventh annual report from this department. It is largely confined to the work of the department during the year 1898 and a statement of the present condition of the gas field.

Acknowledging the cordial support that I have received from you during the past year, I remain,

Yours respectfully,

J. C. LEACH,
State Natural Gas Supervisor.

ANNUAL REPORT

OF THE

NATURAL GAS SUPERVISOR

INTRODUCTORY.

In the former reports from this department, the various scientific questions suggested by the generation, storage, pressure, etc., of natural gas, as well as the phenomena attending the progress of the field as it is developed, have been briefly discussed. It is not necessary to refer to these subjects in this report. Information regarding the present condition of the field, and as to what can be done to effectually combat those elements and agencies that are menacing its life and the prosperity of those industries that have been so largely benefited by it, is most sought now. This report is largely devoted to these subjects.

The duties of the Natural Gas Supervisor, as summarized in a former report, are as follows:

1. To make a personal inspection, as far as it is practicable, of all the natural gas property in the State, including wells, pipe lines, machinery, etc., giving special attention to the precautions taken to insure the health and safety of workmen engaged in opening gas wells and laying mains and pipes and those who use natural gas for any purpose.

2. To collect and tabulate certain statistics regarding the geological formation of the gas field, gas wells, pipe lines and manufacturing industries of the "gas belt."

3. To see that all the provisions of the law pertaining to the drilling of wells and the piping and consumption of natural gas are faithfully carried out and that the penalties for the violation of the same are enforced.

4. To make an annual report to the State Geologist.

I have not found it possible to inspect all the natural gas property in the State during any one year. To those persons who have a knowledge of the number of gas wells and miles of pipe line, both large and small, not to say anything about the apparatus necessary to the regulation and consumption of this fuel, the above statement will be reasonable. The purpose of the inspection determines the class of property to be inspected and how often it should be done. I have not found it necessary to give much attention to the precautions taken to insure the health and safety of either those who work with natural gas or those who use it; not that I attach no importance to this phase of the subject, but the necessary care is usually taken by the persons directly interested. Persons engaged in drilling wells or laying pipe lines are usually experienced men who fully understand the dangerous character of this fuel, and the consumer in most cases is protected by regulators and safety devices under the care of competent superintendents. In a general way I have found it more necessary to give special attention to the precautions taken to prevent the waste of this fuel than to measures adopted to insure the safety of those who use it. Then, as the chief purpose of the work is to prevent the waste of gas, the attention of the Supervisor should be directed first and principally to the avenues of greatest waste. No one questions the importance of effective work in this line. I have given most of my time to this work during the past year, and the conditions found and work done will be noticed in another chapter.

The statistical information specified by the law authorizing reports from this department has been given in former reports and in the annual reports of the State Geologist and the Bureau of Statistics.

Reference to the natural gas law, its enforcement and needed legislation is made in another section of this report.

THE INDIANA NATURAL GAS FIELD, ITS PROGRESS AND PRESENT CONDITION.

To a majority of the readers of this report the history of the discovery and exploration of the Indiana natural gas field is well known, and the brief reference made to these subjects here is on account of their logical connection with other subjects in the report, and that it may be better understood. The use of natural gas for illuminating purposes dates to 1821. It was first used in Fredonia, Chautauqua county, New York. The supply, if it merits the name, was obtained from a water well and was, as would be expected, very small and transient. In 1843 a well 1,000 ft. deep near the Kanawha Valley, West Virginia, produced natural gas at "high pressure" and is the first of its kind of which there is any record. In Pennsylvania the first oil wells drilled (1859) produced some gas. At first it was allowed to escape into the air or was piped a safe distance from the wells and burned, but later was utilized under the boilers for drilling and pumping purposes. Natural gas was piped from what is known as the Murraysville field to Pittsburg in 1883. It soon became the domestic and manufacturing fuel of that city and vicinity and as its superiority as a fuel became better known the zeal of the prospectors in adjoining States increased. There were many failures and few successes, but these were the "beacon lights" for those exploring the earth's crust for the new fuel.

Geologists were not consulted. If gas had been found in the rocks underlying one locality or one State, why not another? Conditions, other than source, were not considered and but little thought was given it by those most actively engaged. Though "surface indications" were considered sometimes, there was nothing to indicate that like classes of the formation of the earth's crust were not deposited under like conditions and held similarly. If natural gas is found in certain formations in one region, why not in the same class of rocks in another?

If we adopt the commonly accepted theory, and the one that is vouched for by science, viz., that natural gas has its origin through the decomposition of organic matter contained in the rocks, it is reasonable to believe that it has been generated in greater or less quantities in nearly every geologic formation; and, if so generated, why is it found in commercially valuable quantities in such limited areas? The cause of this is found in the fact that a number of conditions besides source are necessary to natural gas accumulation, and it must be stored in large quantities to be valuable. Natural gas has been generated in every strata of the earth's crust containing organic matter and will continue to be as long as any organic matter remains and the necessary conditions (overlying deposits of sediment excluding the air and the proper temperature) are present. If this be true it settles all questions as to the generation of gas in any considerable quantities at present.

The conditions necessary to natural gas accumulation in any locality, named in the usual order, are source, reservoir and cover. Then, source is not the only condition necessary to gas accumulation, however important it may be. After the gas is generated it must be stored; to be so, the rock in which it is generated, or an adjoining rock, must be conditioned to hold it—must be a reservoir in which it may be imprisoned until set free by the drill. To be so conditioned, the storage rock must be porous, securely covered with a strata of rock impervious to gas or water and possess such a structural relief as will permit the various substances in the rock, gas, oil (if any) and water to arrange themselves in the order of their specific gravity. While the exploration for oil and gas that has been going on since they were discovered has not established any new laws regarding their generation, storage, etc., it has attested the correctness of the above statements. The areas of the earth's crust that are conditioned to be productive oil and gas fields are few.

Natural Gas in Trenton Limestone.

Previous to 1884 but little was known about the Trenton limestone except from its outcrops in Canada, New England, Kentucky, Iowa, Wisconsin, etc. It was thought to be a fairly uniform formation, underlying the middle States. Some deep wells had been drilled in the southern part of Ohio and other places, penetrating this limestone without any indications of oil or gas. As natural gas came into general use for fuel purposes in Pittsburg, the prospectors in Ohio became more active. "Surface indications" of natural gas had been noticed at many places, but they were especially prominent at Findlay and had been for a number of years. Water wells had been rendered useless by the presence of natural gas. It was frequently detected in sewers and other excavations. The first well to be drilled was finished November, 1884. The Trenton limestone was found at 1,092 ft., and the drill had not penetrated it far when the roar of the gas escaping from its rocky prison made it known that the efforts of the explorer had been rewarded; that a reservoir of nature's most valuable fuel had been found. This was the beginning of the natural gas industry in Ohio and Indiana. Heretofore natural gas and oil had been found in sandstones only. Now a new formation was to be explored. Ere long a sufficient number of wells had been drilled in the vicinity of Findlay to establish the fact that this limestone formation in that State was an extensive natural gas reservoir. Drilling now began in earnest. Nearly every county in the western part of the State made one or more efforts to secure the new fuel.

The State line proved no barrier to the drill. A well drilled at Portland, Jay county, Indiana, March, 1884, was a small "gasser." More successful results were obtained at Eaton, Delaware county, and Kokomo, Howard county, the same year. The drilling of numerous wells between Portland and Kokomo, and north and south of a line connecting these two cities, demonstrated the fact that Indiana had within her limits the largest and what has since proven to be the most productive natural gas field in the United States.

The Gas Reservoir.

Trenton limestone is a universal formation in Indiana, but, as elsewhere noted, not a universal gas-producing rock. The story of the drill in this field fully confirms statements made in this chapter regarding the conditions necessary to natural gas accumulation. In this field the gas is indigenous to the rocks in which it is found; that is, the Trenton limestone is both the source and the reservoir. For a geologic formation to be the source of natural gas, organic matter must have been deposited with the material that forms it. Of the Trenton limestone this is true, as is witnessed by the fossil remains shown at the outcrops. The fact that this formation is gas-producing over a comparatively small area, though underlying the entire State, is due to its textural and structural conditions in this productive area. The gas is held in the upper part of the limestone. This porous strata is not a pure limestone, the carbonate of lime having in part been displaced by carbonate of magnesia. The gas-producing rock seldom comes to the surface of the limestone, from 1 to 15 ft. of the uppermost portion usually being hard and non-porous. The porous part of the rock is very unequal in thickness. In the extreme southern part of the gas field it varies from 5 ft. to 10 ft. thick, while in a few localities of the north central part the drill has penetrated it 100 ft. without reaching the lower boundary.

The Utica shale overlies the Trenton limestone in Indiana and forms a practically impervious cover for the gas reservoir, a very necessary condition to natural gas accumulation. The necessary structural relief is furnished by an elevation in the rock known as the Cincinnati arch. The Trenton limestone, outcropping in every direction from this State, forms a large basin in which this arch is located. In Indiana it is a broad elevation crossing the State line between Lawrenceburg and Liberty and extending northwest. Where it enters the State it is 349 ft. below the surface and 158 ft. above sea level. It descends gradually to the northwest, and has a very uneven surface, with numerous small ridges extending at various angles from the main elevation. The Trenton limestone south of the gas reservoir is nearly a pure limestone and non-porous. This is also a very necessary condition in this field, for if it were porous from the present field southward to the outcrop, most of the gas that is found imprisoned in the rocks in this State would have disappeared from these outcrops long ago. The "surface indications" would have been far from the supply. From this it is seen that all the necessary conditions for gas accumulation are present in this field and that every condition present is necessary.

Development of the Field.

As has been said, when it became known that the Trenton limestone in this section of the State was a gas-producing rock, numerous companies were organized and the drill started on its mission of exploration. Nor was the drilling confined to any particular locality, but every section of the State was anxious to secure the advantages of this gaseous fuel. Though much capital and labor were lost by prospectors, it was not without some compensation to the State, for the "gas belt" was located and much valuable knowledge concerning the geological formation of the State was gained.

The natural gas territory in Indiana is in the eastern central part of the State. It is an irregular obovate in shape and does not exceed 100 mi. in length nor 70 mi. in width. It occupies the following counties in whole or in part, viz.: Blackford, Boone, Clinton, Decatur, Delaware, Grant, Hamilton, Hancock, Henry, Howard, Huntington, Jay, Madison, Marion, Miami, Rush, Shelby, Tipton, Wabash, Wayne and Wells. A very small portion of some of these counties is in the "gas belt,"[1] while within the area a few small tracts of barren territory have been found. As would be expected, the first gas companies were organized to supply the cities and towns with fuel, and the first wells usually drilled within their limits. However, it was but a short time until "farmer companies" throughout the field were supplying the rural districts, and every resident of the field had an opportunity to use the new fuel.

[1] See map accompanying Annual Report, 1897.

The use of natural gas was not to be restricted to domestic consumers nor to those within the confines of the "gas belt" only. Resident factories were quick to adopt it. The superiority of natural gas as a manufacturing fuel was well known. The abundance of the supply was advertised far and wide, and not always by business-like methods. All classes of factories, especially large fuel consumers, were anxious to locate in the new gas field. Its advantages caused manufacturing institutions of all classes to locate, until ere long the "gas belt" became the manufacturing center of the State. The competition that arose between cities and towns to locate factories caused many unwise things to be done to show that each particular city or town was in the "heart" of the field.

The initial rock pressure of this field was 325 pounds. This was sufficient to force the gas a considerable distance from the field. People living outside of the "gas belt" were anxious to secure the new fuel. From 1888 to 1892 pipe lines were constructed from the gas field to Indianapolis, Lebanon, Crawfordsville, Frankfort, Lafayette, Logansport, Peru, Wabash, Huntington, Bluffton, Ft. Wayne, Decatur, Union City, Richmond, Connersville, Shelbyville and Chicago. A little later two lines were laid from the eastern part of the field to Ohio, there, in addition to supplying some towns, to supplement the rapidly diminishing supply of others that had been supplied from the western field in that State. Prior to the construction of these pipe lines there had been no systematic drilling in the field or effort to pre-empt the territory. Cities were supplied from wells within their limits or the immediate vicinity, and but few factories were compelled to go beyond their own yard for fuel. The pipe lines tapped the gas reservoir at the nearest point, and have been extended from year to year toward what is considered the "heart" of the field. Excepting Connersville and Shelbyville, all the pipe line cities receive their supply of gas from territory north of the south line of Madison county. That territory north of this line is usually referred to as *the* gas field, and while it is the most productive part of the field, it will probably be exhausted before the territory south is. In the territory south of Carthage, Rush county, and especially the southwestern part of this county and the northwestern part of Decatur county, the gas rock is very thin and hard, lacking the porosity found in the northern section of the field. The wells seldom show any water. The gas passes very slowly from the rock to the well, and hence they are small, the average well supplying about twenty families with fuel and light. The texture of the rock nearly precludes the possibility of overwork. Natural gas has been used in that section for domestic purposes, and some little manufacturing, during the past eleven years, and the decline in the rock pressure has been comparatively small. The indications are that the gas in this section of the field is "water sealed" from the main gas area north.

The gas territory north of the line mentioned above is an irregular circle in shape. The geographical center of this area is near Alexandria, Madison county; but if the center of production or the "heart" of the field is that point, where the various pipe lines would appear to meet if extended along the line now indicated and uniformly each year from now on, it is about 15 mi. north of the geographical center. An examination of the map of the Indiana natural gas field accompanying my annual report for 1897 shows that the pipe lines from the west and southwest have made much greater extensions and occupy much more territory than those from the north and northwest. It does not follow from this that the territory of the former is less productive than the latter, for consumption has to do with the drilling of wells and pipe line extensions as well as the quality of the territory.

Pipe line companies soon found it necessary to plan their field of operation and hold large tracts of land under lease to protect their interests. This made it necessary for local gas companies and manufacturers to add an additional field expense. The leasing of territory has continued until practically the entire productive area is now under lease for gas and oil. I do not mean that all the territory is leased, but enough is to develop and exhaust the field. Of course, if the territory not leased were drilled, it would in a measure destroy the value of the territory that is leased. It is seldom that any gas company leases all the land in any locality, and when they do it is only for self-protection, and not that it is necessary that they may enjoy its natural gas resources.

As has been mentioned above, the pipe lines tapped the gas reservoir at the nearest point. The three companies that furnish gas to Indianapolis received their first supply from wells in southeastern Hamilton county. Since they have been compelled to extend their lines entirely through Madison county, and are drawing their gas from wells in northern Madison, southern Grant and northwestern Delaware county. The line to Crawfordsville was stopped in 1891 near Sheridan, but has since been extended 20 mi. The line to Lebanon was constructed in 1890 to the same point, and has been extended 15 mi. Frankfort was originally supplied from wells in the western part of Tipton county, but these have been long since abandoned, and the supply now comes from Duck Creek township, Madison county. The first natural gas used at Lafayette was from wells in the northwestern township of Tipton county. Wells in Grant county are now supplying practically all the gas for that city. In 1888-89 an 8 in. line was constructed from Logansport to a point 2 mi. south of Kokomo. This line has since been extended through Howard county and 5 mi. into Grant county. The Peru line is 15 mi. farther in the field than when first constructed, and the extensions amount to twice that amount. The line to Wabash, constructed in 1888, has been extended from the south line of that county half way through Grant county. The Huntington pipe line reaches 15 mi. into the field. Ft. Wayne and Bluffton at first drew their supply from the northern part of Blackford and the western part of Jay county, but have since entirely surrounded the former county with their lines. Union City has been making extensions from year to year, and the Richmond pipe line, built in 1888, has been extended 8 mi. north of its original termination, with parallel extensions. The Indiana Natural Gas and Oil Company (Chicago) has two 10 in. lines extending into Grant county. The Ohio and Indiana Gas Company and the Redkey Transportation Company have four parallel lines extending more than half way across Delaware county. Their first supply was largely from wells in Richland township, Jay county, and the eastern half of Niles township, Delaware county. In referring to the extensions above, I have not noticed the numerous parallel and lateral lines usually built by gas companies that they may the more completely occupy the territory through which their lines pass.

An examination of a map of the gas territory in the light of what has been said regarding the location of pipe lines will show but little undeveloped territory remaining. A small area, probably 150 sq. mi., embracing parts of Grant, Madison and Delaware counties, and Licking township, Blackford county, has not been invaded by pipe lines, though the decrease in the rock pressure of wells located therein during the past year has been nearly as great as that of wells connected with the lines. This territory is practically controlled by gas companies, and if the yearly extension of pipe lines is as great in the future as it has been in the past—and there are reasons why it should be greater—it will not require to exceed two years for these lines to completely occupy this territory. I do not wish to be understood as saying that I believe the field will be completely exhausted in two years; for doubtless, after the field is completely threaded with pipe lines, many wells will be drilled. The gas rock will not be opened deep and the per cent. of failures will be large; but the result will compensate for the cost. The territory in the immediate vicinity of

the pipe lines is practically "drilled out." There are tracts of land, some of considerable size, held under lease by cities, towns and factories, that are as yet undrilled. But, as the gas rock is a universal "pipe line," the gas unless sealed in some ridge or dome in the rock, tends to equalize, and a heavy draught in one locality effects the surrounding territory. The effect is to exhaust territory without drilling.

Wells are occasionally reported in old abandoned territory with a rock pressure much in excess of that in the most productive gas area. An examination usually shows but little gas, frequently not enough to raise the water. These wells were probably sealed from the field by the salt water when the pressure was high, and the light draught since has affected them but little.

It is not possibly to say how long the supply of gas in this field would have honored the draught of local consumers. The invasion of the field by pipe line companies will result in its comparatively speedy exhaustion and also a speedy remuneration to the landowners for the privileges granted the gas companies. Many landowners are receiving annual rentals equal to two and one-half dolars per acre for their entire farm, and a few have been receiving $200 per well for a number of years. One gas company paid $66,000 lease rentals last year In view of these facts, should landowners be interested in the efforts made to husband the supply of gas and thereby extend the life of the field? For every year that the life of a well is extended the landowner is the beneficiary to the extent of the annual rental.

The Decline of the Field.

The original rock pressure of this field was 325 pounds to the square inch. The pressure was practically the same throughout the field. This did not indicate, however, that all parts of the field were alike productive. The production of a field must be judged by the volume of flow of the wells, and the rock pressure does not indicate this.[1] In the early history of the gas field, before the draught on the gas rock has brought about local conditions affecting it, when a well is closed it becomes a part of the gas reservoir, and its pressure will finally be the maximum pressure of the field. After a field has been in service for a long time, local conditions may arise that will influence the pressure of one well and not of another in the same locality,

[1] See Twenty-first Annual Report of the Department of Geology and Natural Resources of the State of Indiana, 1895, pp. 349-50.

hence the difference in the pressure of different localities in this field at present. While the rock pressure does not indicate the productiveness of one well as compared with another, any material decline of the same indicates a diminution in the supply of gas.

The heavy consumption of gas by manufacturers and pipe line towns from this field soon became apparent in the decline of the rock pressure in those localities of largest draught. This did not show in these localities only, but in the interior of the field also, though the decline was not so marked. At first the heavy consumers drew their supply from the edge of the field and in the vicinity of cities and towns, and it was at these places that the decline in the rock pressure was first noticed. The records of this office do not indicate when the pressure began to decline. It is probable, however, that it began at the extreme edge of the field with the first heavy draught. The decline in the interior and productive part of the field was not sufficient to attract much attention prior to 1890. The general decline in the pressure of this field by years has been gradual, showing greater, of course, during periods of heavy consumption. In fact, the pressure of different localities has shown signs of equalization during the summer season; thus, in some instances, showing a slight increase of pressure. As the pressure declines, it becomes less uniform throughout the field, local influences becoming more influential. In 1895 the average of eight tests of rock pressure made in various parts of the undeveloped territory, that is, territory not invaded by pipe lines, and in which wells for local consumption only had been drilled, was 264 pounds.[1] At present the average pressure of the same localities is 181 pounds.[2] This is a decrease of 83 pounds in a little more than three years, or about 26 pounds per year. The average decrease in the rock pressure of the most productive part of the field, and that part upon which the draught is heaviest is greater than in older territory; for when the pressure of a well drops to a certain point any considerable draught or decrease in the pressure works an abandonment of the well. If the pressure of the wells throughout the field continued to decline until they showed no pressure at all, and conditions were such that the draught would continue uniform until the reservoir was exhausted, the average decrease would doubtless be about the same. The average rock pressure of the entire gas-producing area, November, 1897, was 191 pounds. At present the average of the same is 173 pounds, a decrease of 18 pounds during the past year, or eight pounds less than the yearly decrease, 1895-98, in territory undeveloped in 1895.

[1] Tests made September, 1895.
[2] Tests made November, 1898.

Salt water, universally present below the natural gas and oil (if any) in this field, is the most dangerous and difficult element with which the natural gas industry has to contend. As the supply of gas diminishes, the salt water horizon advances toward the highest point in the reservoir until it finally displaces the gas entirely, or a heavy draught upon any locality invites its presence, and as the draught continues it rises higher and higher until it ultimately seals what gas is left in the rocks. The structural condition of the rock has much to do with the aggressiveness of the salt water. The western part of the field was first to succumb to its force. It appeared early in the history of the field and overcame very productive wells with a rock pressure of 260 pounds. It has been advancing eastward since, until now there are but few wells that do not show some water. Wells apparently free from it when first drilled are soon "wet." In November, 1897, I tested thirty new wells in the western part of Grant county—and there is no territory more productive—and 50 per cent. did not show any water. November, 1898, I tested thirty-six new wells in the same county, in territory nearer the "heart" of the field, and but four of them did not show water. The wells in each instance were drilled about the same depth in the gas rock. This certainly indicates a rise of the salt water horizon and a diminution in the supply of gas. On the east side of the field the water has been less intrusive. More indications of oil are noticed. The water that is present does not wield a force sufficient to overcome the gas at a high pressure. In this part of the field I have known wells to do fair service at 90 pounds pressure in the presence of water, and an occasional one to become entirely exhausted without any sign of this element. As to the pressure at which the gas wells will succumb to the salt water in the various localities of the field, it is difficult to say. On the west side of the gas territory many wells have been "drowned out" and abandoned at 250 pounds pressure, while on the east side the water has advanced very slowly. What was said of the west side of the field can be, with some modifications, said of the southern part of the main gas area as well as of the north side. In these localities it has not been quite so intrusive as on the west side. I have mentioned its presence in the territory or productive part of the field. Many old wells are practically worthless now on account of its presence. Wells registering 175 pounds pressure fail to raise the water. Much depends upon the depth to which the wells are drilled in the rock and the draught upon the territory. Great care should be taken in drilling wells. Generally the inclination is to drill deeper and possible get a little better well, but it should be remembered that a small gas well is much more valuable than a large salt water well. The most successful gas companies watch the advance of the salt water and drill their wells accordingly.

Can anything be done to counteract the influence of the salt water? This question is often asked, and it can safely be answered in the affirmative. If the pressure in the well is strong enough to raise the water to the surface through the well tubing, it can be separated from the gas by means of an automatic separator. If any water should get into the line, drips can be arranged to catch it. If the pressure of the gas is not strong enough to lift the water through the well tubing, then the only thing to do is to reduce the size of the tubing to a point where the gas will lift it.

In concluding this chapter I will repeat the statements made in all my former reports, viz., that the past history and every condition in this gas field indicate its ultimate exhaustion. For those who are acquainted with the field and its ever-changing conditions this statement is not necessary, nor is it much more so for many who know nothing of these conditions and judge the future by the gas service in the past only. In most localities within the gas area the supply of this fuel has been ample to date, and the assertion that the supply is failing is often construed, and without just cause, as an effort in behalf of the gas companies to annul any dissatisfaction on the part of the consumer with the gas rates. I can only say that the field and its conditions are not open to gas companies only, but any citizen may personally know the true conditions. Any aid that I can give is at their command. It has been my desire that every one interested in Indiana's most valuable natural resource should be fully apprised of all the conditions affecting it. It has been very difficult to get the ordinary consumer, and in fact, some manufacturers, awakened to the conditions and a business-like appreciation of the same; to the necessity of husbanding the supply of this gaseous fuel

Summary.

Briefly summarized, the Indiana natural gas field shows the following conditions:

1. The gas resources of the territory in the gas field is practically all controlled by territory under lease, either by gas companies or manufacturers, and the pipe line companies, which are the large consumers of natural gas, have extended their lines from year to year and are apparently centering around Fairmount township, Grant county.

2. The undeveloped territory in the field, that not invaded by pipe lines and having only sufficient wells to supply local consumption, comprises about 150 sq. mi. in Grant, Madison and Delaware counties. Possibly a few square miles in Licking township, Blackford county, should be added to this.

3. If the yearly extension of pipe lines is as great in the future as it has been in the past it will not require to exceed two years to completely occupy this territory. It does not follow from what has been said that the natural gas field will be exhausted in two years; for after the field is threatened with pipe lines doubtless many wells will be drilled with results that will justify the expense.

4. The salt water that has been a menace to the natural gas interests from the beginning is becoming more intrusive day by day, there being but few wells in the field entirely free from its influence. Wells apparently free from it when drilled become wet soon after being attached to the line.

5. Rock pressure does not indicate the productiveness of one well as compared with another, but any material decline of the same indicates a diminution in the supply. The average rock pressure of the undeveloped territory in 1895 was 264 pounds. The average of the same territory at present is 181 pounds, a decrease of 83 pounds in a little more than three years. The average rock pressure of the entire gas-producing territory, November, 1897, was 191 pounds; November, 1898, the average of the same territory was 173, a decrease of 18 pounds.

6. The history of other gas fields, the past history of this and all its present conditions justify the statement that the supply of gas is failing and will finally be exhausted.

THE CONSUMPTION AND WASTE OF NATURAL GAS, AND FIELD WORK, 1898.

The work of this department has been almost wholly confined to the field during the past year. The value of natural gas as a fuel for domestic and manufacturing purposes, the progress of this field during the past twelve years and its present condition emphasize the fact that every effort possible should be directed toward the husbanding of this fuel. No waste should be permitted, and the same care and economy should be exercised in its use as with other fuels. It has been to the ends stated above that my work has been directed this year.

Every one who is at all familiar with this field and its past history knows of the great waste of this gaseous fuel that has been permitted from the beginning. By *waste* I mean the escape of gas into the air at places other than at the point of consumption. True, an extravagant use of this fuel is a waste of it, and it is equally true that it is so used in many places. But the way that gas is used and the amount used is largely under the control of the gas companies and consumers. The most that the Supervisor can expect to do in this line is to recommend such changes in regulators, mixers, burners, etc., and in the manner of consumption as will result in the best service with the least waste.

As I have said, more or less gas has been permitted to waste in this field from the beginning, but the amount thus wasted at present is very little compared with the same during the early history of the field. And, generally speaking, it is used with more care and with much more satisfactory results than formerly. The fact remains, however, that there are but few consumers, either domestic or manufacturing, that exercise that degree of economy in the use of this fuel that its value warrants, or that they would exercise if it were measured to them by the cubic foot, and they were compelled to pay for what they use; and also that there is more or less waste throughout the field. All of this is true in the face of the fact that the supply of natural gas is limited and that every cubic foot either consumed or wasted brings us that much nearer the time when we shall have to return to other fuel.

The Consumption of Gas.

The heaviest continued draught upon the gas field is the consumption. This should be true. It would also be true if not a foot of gas was used that was not necessary. Natural gas has fulfilled its highest mission when it has been used for the comfort and benefit of mankind. The time has been in this field when there was much indifference manifested by gas companies and consumers toward the manner of using natural gas. Burning from the open end of a pipe, it was used as a light. In the stove and furnace and under the boiler it was used without mixers, and at a dangerousy high pressure. This all meant much waste and unsatisfactory results. Time has wrought a change, but not a complete one.

Natural Gas Flambeaux.

During the early history of the field, and in fact until within the last three years, the most wasteful use of natural gas to be seen were the flambeaux burning in every section of the field. In many places they were allowed to burn day and night, year in and year out. A large amount of gas has been wasted in this way. At best natural gas is a very poor illuminant, and the amount consumed by these torches, compared with the light, was certainly a very extravagant use, if not an absolute waste. In line with this idea, the General Assembly of 1891 enacted a law prohibiting the use of flambeaux for illuminating purposes. This law encountered much opposition at first. Public sentiment was against it, and it was therefore difficult to enforce. Those opposed to the law and its enforcement contended that it abridged their rights as citizens; that natural gas is property, and as such the owner had a right to use it as he desired. The enforcement of the law, the State claimed, was but a judicious exercise of its police powers; that the welfare of the public overshadows the good of the individual. Prior to 1895 the law was not enforced. October of that year a suit brought in Blackford county by the Natural Gas Supervisor to enforce its provisions was carried to the Supreme Court of the State. With little delay that tribunal rendered a unanimous decision holding the law constitutional. That practically settled the question. I have had but little occasion to appeal to the law since.

Use of Gas by Drillers.

It is reasonable to suppose that gas and oil well drillers, prompted by self-interest, if nothing else, would use this fuel with care. This is seldom true. My attention was been called frequently to the lights used by them. There is no question but that natural gas makes the most convenient and practical light for drilling purposes, but so frequently the men in charge become careless and not only use more gas than is necessary, but permit it to waste. They are apt to burn more lights than are really necessary, one light in the derrick being sufficient, and neglect to turn them off during the day. While the use of natural gas torches of any size and at any time or place for illuminating purposes is a violation of the law, I have found by practical experience that the amount of gas consumed by them, when properly arranged, is less than that used in the number of "Jumbo" burners usually substituted where the torches are prohibited. I have endeavored during the past year to keep these lights to a reasonable limit and in so doing have been compelled to appeal to the law in six cases.

The fuel used by drillers is usually conveyed from a pipe line to the boiler through a small temporary line laid upon top of the ground. They are usually laid in a hurry and with but little pains, and seldom confine the gas as it should be. At the boiler the apparatus is crude and ill-adapted to its use, and as a consequence much more gas is used than is necessary. The remedy for all of this extravagant use or waste lies with the gas companies furnishing the gas. A little care and watchfulness on their part would stop one of the avenues of waste. I have given this subject some time during the past year, with good results.

Use of Gas by Factories.

It is difficult to believe that manufacturers would use natural gas extravagantly, much less permit it to be wasted; yet in some instances I have found both conditions existing. Manufacturers who have not been the victims of "free gas;" who have been compelled to go into the field, lease territory, construct pipe lines, etc., and consequently know something of the cost and expense of maintaining a fuel supply plant, usually practice a degree of economy in the consumption of their fuel, though seldom as rigid an economy as they observe in the consumption of other constituents of their product. Factory pipe lines, however, are usually in good condition, seldom having the service lines in the field that are maintained by gas companies, and the waste, if any, is usually in the factory. The question of factory light presents some difficulties. Natural gas makes a convenient light, but through lack of attention it often becomes a very wasteful use. The liability of breakage makes the use of glass globes or lamps almost impracticable. Any system of lights or class of burners are expensive if kept in repair and if not are soon practically flambeaux. It seems that the only practical solution of the light question is for factories, not extensive enough to warrant the maintenance of an electric light plant, to use "Jumbo" or similar burners. These to give an economical and satisfactory service should be kept in repair and used only when needed. Every factory should keep a man employed to care for their fuel supply plant. He should see that all gates, valves, etc., at the wells are in working condition; that all pipe lines and service lines are kept repaired; that the regulators are properly adjusted and

all mixers and burners are kept clean, so that combustion will be perfect and the full heating power of the gas realized. He should see that all lights are in repair, properly adjusted and lighted only when needed. This means some work, but a most profitable work, not only in saving gas, but in better service. Best results are only secured when combustion is perfect; then the full power of the gas is realized. Manufacturers are beginning to see the necessity of attention to the fuel item. In many cases it has given but little trouble in the past, but the first sign of failure of the wells that have been so faithful during the past ten years brings them face to face with the fuel question. Then it is that the question receives the proper consideration. I believe it is true that all manufacturers realize now as they never did before that the supply of this valuable fuel is limited, and that much depends upon how it is used from now on. During the past year I have found a majority anxious for suggestions regarding economical methods for using this fuel. They realize the necessity for this, and also that apparatus designed for such purpose usually gives the most satisfactory service. The manufacturers of the gas belt have given me much aid and encouragement during the past year in my efforts to enforce the law and husband the supply of this fuel. They are not all using natural gas in the manner that its value warrants, but their efforts now are in that direction.

The Use of Natural Gas by Private Consumers.

I will not detract from the merits of natural gas as a manufacturing fuel when I say that it renders the greatest service to the domestic consumer. It is clean and labor-saving, and when properly regulated maintains a uniform temperature. Imperfect service can be charged to the gas company, consumer, or both. Referring to this subject, I quote from my Annual Report, 1896:[1] "In order to realize the full heating power of natural gas, it is necessary to mix it with air. As to the proper proportion of air to gas, there is a difference of opinion; ten of air to one of gas is not far from correct. If this proportion is to be maintained, the pressure of the gas should not vary, for a mixer that will admit gas and air in the correct proportion when the gas is under a twelve-ounce pressure will admit a larger amount of gas if the pressure is increased to sixteen ounces. Ninety-six cubic feet of gas under a pressure of three-tenths of a pound will pass through a No.

[1] Twenty-first Annual Report of the Department of Geology and Natural Resources, Indiana, 1896, p. 450.

7 mixer in one hour, while under one-pound pressure 179 cu. ft. will pass through the same mixer in the same time. It is evident from the above that when a mixer is so adjusted that gas and air are admitted in the proper proportion the pressure of the gas should not be changed, unless the amount of air admitted is changed to correspond." Perfect service can only be had when combustion is complete. An economical and satisfactory gas service is invariably the result of an ample supply of gas furnished at a uniform pressure and after being mixed with the proper proportion of air, consumed in clean and scientifically arranged burners. It rests with the gas company to furnish the gas, regulate the pressure, and see that the mixers are adjusted to it, and with the consumer to keep all burners and other apparatus used in the consumption of this fuel clean and in repair. In the consumption of natural gas, the object should be perfect combustion, which always results in good service if the supply of the fuel is sufficient. Imperfect combustion means waste. The gas not consumed passes up the chimney or into the room. But incomplete combustion is not the only avenue of waste by domestic consumers. In a majority of the homes and business houses using gas, especially by the "contract system," more gas is consumed than is necessary. I believe that 50 per cent. of the heating power of the gas consumed by a large majority of gas consumers is wasted. That is to say, if furnaces, grates and stoves were properly arranged for gas, the damper adjusted and the burners and mixers clean and scientifically adjusted for the consumption of this fuel, more satisfactory service would be secured with one-half the fuel ordinarily consumed. I have especial reference to consumers within the "gas belt." The temperature of most dwellings is kept above the health limit, and not infrequently have I known the doors and windows to be opened when the gas should have been turned down. With the present system of selling gas, the "contract system," it is difficult to change conditions. However, the extravagant use and the waste of gas by domestic consumers can be reduced to a minimum and more satisfactory service rendered if both gas company and consumer make necessary and reasonable efforts in that line.

Another avenue of waste of natural gas in connection with all classes of consumption is the class of "heaters" used throughout the field. The gas used by farmers is usually conveyed through small pipes on top the ground to the consumer. The distance it is piped varies from a few rods to miles. If there be any water in the gas, and there usually is, much inconvenience is caused in winter by its freezing. To remedy this, the line is heated at intervals by gas fires. These, many times, are large open fires that result in little good. If a heater is necessary, a small brick furnace should be built over the line, and a very little gas will be sufficient. However, the greatest waste is not in the amount of gas used, but in the fact that in many instances the gas is never turned out. It is heated when the fires in the house are out. By the aid of the gas companies that have been permitting it, I have been able to remedy this abuse to some extent during the past year.

The Waste of Natural Gas.

A spirit of seeming indifference to the waste of natural gas on the part of those most interested in the life of the gas field and its prosperity has existed from its discovery until the present time. To this general statement should be added a qualifying clause, to wit, that during the past year a change has been wrought in the minds of most manufacturers and gas companies and a few consumers which has resulted in much good. During the early history of the field public sentiment was not only indifferent to the extravagant use and vandal-like waste permitted at that time, but it was in many instances positively opposed to the enforcement of law enacted to protect Indiana's most valuable resource. The reason for all this seems to rest in the manner that it was first used. During the first two or three years after its discovery, different localities in the field seemed to vie with each other as to the amount of gas they could use (waste). Gas wells with a daily capacity of 5,000,000 cu. ft. were permitted to burn day and night for weeks, apparently illuminating the field for miles around. Arches of gas pipe were raised over the principal streets of cities and towns, supporting hundreds of natural gas torches, to welcome the manufacturers who desired to locate in the "gas belt." Flambeaux lighted not only the streets of the cities and towns, but the farm-yards throughout the field. Much of the gas necessarily consumed was by the methods referred to above employed by gas companies, promoters and "boomers" to advertise to the world that Indiana had a gas field that would last for all time. A universal inducement offered by every city and corporation to manufacturers seeking a location in the bas gelt was one or more gas wells, or "free gas" for a specified time. In every proportion and counter-proportion "free gas" was included. The very term carries with it the idea of plenty, and its free use had some influence in creating the public sentiment that existed at that time toward the use and abuse of the new fuel. But little attention was given to the question of source of generation of gas. Those who witnessed the power exerted by this natural resource as it rushed forth from its rocky prison and enjoyed its luxury when reimprisoned were sure that nature had made provisions for its renewal—that it would last forever. It seems that everything conspired to create a feeling of security in the supply of this gaseous fuel and open-handedness in dispensing its privileges. To dislodge the erroneous ideas concerning the supply of natural gas and the limitations surrounding the same, and create a business-like sentiment in favor of reasonable economy in the use of it, has not been an easy task. Many consumers know nothing about this fuel except what they see at the point of consumption, and to those within the productive gas area there is but little evidence there that the supply is failing. However, evidence of the true condition is becoming more prominent. It is to be hoped that the citizens of the gas field will awake to a full realization of the situation and their duty in the premises at once. It is late, but not too late to do some good. Natural gas should be used with the same degree of economy as are other fuels, and not one cubic foot should be permitted to waste. The loss that the State has sustained on account of the waste of this fuel in the past can not be estimated. But it is the present that confronts us, and not the past, except only in so far as its errors and their effects serve us in the future. Can we not stop all waste and use what remains of this valuable natural resource with the care that its value warrants? The principal waste of natural gas has been by the consumer, from pipe and service lines and at the well. I have referred to the former in another section of this report.

Waste of Natural Gas from Pipe Lines.

In speaking of pipe lines I refer to large lines, fuel supply lines, and not the small one and two-inch lines usually used to convey gas from the well to the pipe line and from the pipe line to the consumer. Leaks in pipe lines are usually at the joints, caused by defective fittings or a lack of care in constructing the line. Some of the lines in this field have never caused any trouble. Every joint was perfect and the entire line tested and caulked until it was known to be absolutely tight. This is as it should be. In other instances they were constructed hurriedly and from lead joint pipe. These have caused much trouble and a waste of gas. I am glad to know that nearly, if not quite, all of these have been repaired during the past two years. The lines have been carefully inspected and air-tight clamps placed over defective joints. The pipe lines that I have been able to examine during the past year were in better repair than at any former examination. But few leaks were detected. Any material waste by this means can be prevented by watchfulness and prompt action on the part of gas companies and manufacturers.

The chief waste from gas lines is from the small lines that thread every section of the field. There are near 350 gas plants in the field, not including the fuel supply plants of factories. A majority of these distribute the gas from one or two wells through a score or more miles of small lines, varying from one-half to two inches in diameter. In addition, hundreds of miles of small lines, tributary to the pipe lines, thread the gas belt, conducting gas to farm houses. These lines have been in the past, and are at present, the source of much waste. I know how difficult it is to keep small lines lying on top the ground in repair. Being subject to a varying temperature, they may be perfectly tight one day and leak the next. The lines are mostly along the public highway, and in addition to being sources of waste, are dangerous to the public. Appreciating the importance of keeping the lines in repair, and knowing that it is not possible for the Supervisor to inspect all these lines, the Manufacturers' Association of the State employed two men last year to do this class of work. These men, under my supervision, traveled over these lines, and whenever a leak was detected, the responsible party was notified, which usually resulted in the line being repaired. Since that complete and thorough inspection the waste from this source has been small, compared with what it was before. If every gas company and manufacturer will keep their own lines in repair, the waste from this source will be practically stopped. Ordinarily, it is not necessary to urge people to care for their own property. But the indifference usually manifested toward the manner that natural gas is used is not noticed in the use of any other class of property. There is no law to compel owners of natural gas lines to keep them in repair and in a condition to confine the gas, unless what I have termed the penalty statute is broad enough to prohibit waste by this means. It would simplify matters very much and benefit the natural gas industry greatly if a law were enacted making it the duty of the Natural Gas Supervisor to have leaks in gas lines repaired, after the owner of the same had been duly notified of the necessity of the same, and making the cost of the same a lien on the line and wells attached thereto, recoverable by a civil action. If such a law were in effect it is probable that it would not be necessary to appeal to it often. Its influence would be felt without its enforcement.

The Oil Industry and Natural Gas.

Natural gas and oil are usually thought of as associated products of the earth's crust. Unquestionably, their origin and the conditions under which they were stored are the same; and it is not unreasonable that search be made for both in the same locality. Though this be true, the idea that oil always follows gas is erroneous. These hydrocarbons are sometimes found associated, but in this field it is the exception rather than the rule. In distinctively oil territory gas is sometimes found with the oil, but when oil is found in gas territory it is usually in "sand" below the "gas sand" and separated from it by a hard stratum of non-porous rock. As a rule, the "oil sand" produces some gas. The regular "gas sand" being above the "oil sand," natural gas can be produced without interfering with the oil below, but the production of the oil works a serious damage to the natural gas industry. It is claimed by some that where gas and oil are found associated, or in associated rocks, they can be separated and both products saved without detriment to either. It has not been done in this field. Oil has been found on the northeastern border of the field since 1886. What is known as the Indiana oil field occupies a portion of six counties,[1] viz.: Adams, Jay, Blackford, Wells, Grant and Huntington. This area is distinctively oil territory, and while its development has involved the waste of some gas, the amount has been insignificant compared with the value of the oil. Not enough gas is produced to operate the wells, pipe lines to the gas territory being necessary to secure gas for drilling and pumping purposes. Wells drilled too near the gas territory frequently prove to be large gas as well as oil wells. If the gas can not be used or disposed of to some gas company, it becomes necessary to close these wells. The oil companies in that part of the field have not shown a determined effort to produce oil regardless of the amount of gas wasted, as they have in some other sections. I have found it necessary to have some very productive oil wells in Blackford county closed to protect the natural gas industry, and have found the oil companies in most cases willing to comply with the law. Oil in small quantities has been noted in gas wells in a number of localities in the field, notably at Parker, Randolph county; Ohio, Hamilton county; Fortville, Hancock county, and Jonesboro, Grant county. Quite a productive field has been developed near Broad Ripple, Marion county, and while some gas has been found, it has not been wasted. The first successful attempt to develop an oil field in high pressure

[1] See "The Petroleum Industry in Indiana" (Blatchley), Twenty-first Annual Report of the Department of Geology and Natural Resources, Indiana, 1896.

gas territory was near Alexandria, Madison county, April, 1897. A well drilled on the Nimrod Carver farm, two and one-half miles northeast of that city, proved to be a good oil well, as well as a large gas well. The gas was located at the usual depth in the rock and the "oil sand" below with a stratum of hard non-porous rock between them. Some results of that "find" will never be known, viz., the value of the oil production and the value of the natural gas wasted. To those who are acquainted with the oil industry the result of the discovery of oil in territory hitherto unexplored for that product can be imagined. Oil operators flocked to Alexandria. Excitement ran high and the citizens of that city and the owners of land adjoining were jubilant over the prospects of becoming suddenly rich. For a time the future of the natural gas field in that locality looked dark, and not only of that locality, but of the entire field. Unusual rentals and large bonuses were paid for leases. Numerous companies were organized and derricks sprang up in every direction. Within three months twenty-eight wells had been drilled, of which eleven were fairly productive oil wells. From April 23, 1897, to March 4, 1898, seventy-five wells were drilled for oil. Of these, forty produced both gas and oil, thirty-three gas only, and two were "dry," producing neither oil nor gas. The gas wells were all tubed, packed and properly closed, but not as quickly as they should have been, for the reason that they were drilled for oil, and no preparation was made for tubing them until after they were drilled and found to be gas wells only. The forty oil wells remained open from the time they were drilled until March 12, 1898. From the day the first well was completed, the waste of gas from these wells was enormous, increasing, of course, with each new well. The gas escaping into the air daily from these wells just before they were closed was enough to supply any of the larger cities in the "gas belt" with fuel for all purposes. The manufacturers of Alexandria and the surrounding cities became alarmed about the future of their fuel supply; but aside from them, little heed was paid to the enormous daily waste of the fuel that had caused their city to grow from a small village to a prosperous manufacturing city. Farmers, merchants, professional men and, as improbable as it may seem, one or two manufacturers in Alexandria, became interested in oil companies and were apparently blind to the future of the gas field. Any measure that had for its object the protection of the natural gas supply at the expense of the oil industry was opposed.

In the meantime this prodigious waste went on and the rock pressure declined from 200 to 125 pounds during the summer. It was very difficult to enforce the law under the conditions, it being almost impossible to ascertain the owners of wells. Every attempt to interfere with the new industry was branded as an improper interference on the part of the State with the rights of the people. I am glad that these conditions did not always remain so; that the public mind changes. As time went on the citizens became aroused to the importance of the subject. A complete change of public sentiment was wrought, but it took nine months to bring it about. Parties who drilled for oil during the early excitement finally became most enthusiastic in favor of suppressing the enormous waste of this gaseous fuel that had been going on for months.

Laws Prohibiting the Waste of Natural Gas and Oil, and Their Enforcement.

The General Assembly of 1893 enacted a law[1] prohibiting the waste of natural gas and oil from wells and inflicting a penalty for its violation of two hundred dollars ($200) for the first offense and two hundred dollars ($200) for each ten days thereafter that the gas or oil is allowed to escape from the well. It will be noticed that the law is not criminal, but involves the infliction of a penalty for its violation, the same being recoverable in a civil action in the name of the State of Indiana for the use of the county in which the well is located.

At the beginning of the development of the territory in the vicinity of Alexandria for oil, the operators were advised as to the existence of the above statute and the purpose of the State to enforce its provisions. To it they manifested a perfect indifference, claiming that the law was not constitutional and that any effort to enforce it would be resisted through the Supreme Court of the United States.

The law specifying the duties of the State Natural Gas Supervisor makes it the duty of that officer to see that the laws pertaining to the drilling of gas and oil wells and the piping and consumption of natural gas are enforced. In obedience to this law I promptly filed the necessary information (owner of well, when completed, etc.) for complaints with the prosecuting attorneys of the counties in which the wells were located. Information was filed for thirty-two complaints in Madison county, eight in Delaware county and four in Blackford county. The first case to come to trial was the "State of Indiana for the use of Madison county vs. the Ohio Oil Company." In this case, the only one that has come to trial, the State obtained judgment in the circuit court for the full amount asked in the complaint, and attorney's fees. The case was promptly appealed to the Supreme Court of Indiana, and that tribunal without delay rendered a unani-

[1] See Acts of the General Assembly of Indiana, 1893, pp. 300-302.

mous opinion sustaining the finding of the Madison county circuit court and affirming the propositions of law[1] enunciated in its decision holding the flambeaux law constitutional. An appeal has been taken to the Supreme Court of the United States.

It soon became evident that to prohibit the waste of natural gas by the statutory provision referred to above was a slow process and if relief came from this source at all it would only be after the Supreme Court of the United States had declared the law unconstitutional. The question was a pressing one. Millions of cubic feet of gas were escaping into the air daily. The subject of injunctive relief had been discussed from the beginning but no action taken. Finally the Lippincott Glass Company, of Alexandria, filed an action in the Madison county circuit court vs. the Ohio Oil Company to enjoin them from allowing natural gas to escape into the open air from an oil well. Shortly after this case was filed, similar action was brought in the same court by the Attorney-General of the State on behalf of the State of Indiana vs. the Ohio Oil Company. In each case the defendant demurred to the complaint and the court sustained the demurrer. Judgment was rendered against the plaintiffs for costs. The cases were appealed to the supreme court of the State and the finding of the circuit court was reversed. This was a victory for the State and all interested in the natural gas industry that they were not slow to take advantage of. The same day that the supreme court handed down its decision the circuit court of Delaware county issued a temporary restraining order closing all the oil wells from which gas was escaping in that county. The next day a similar order from the Madison county circuit court closed five of the most wasteful wells in that county, and within ten days the remainder of the oil wells in the gas territory had been closed and have remained so since.

As I have said, but one case, brought to enforce the penalty statute, has come to trial. Twelve cases have been settled by the payment of penalties and costs. Four of these wells were in Blackford county and owned by the Manhattan Oil Company. Since closing its wells that company has shown a commendable disposition to save the natural gas production from their oil wells. The Allegheny Oil Company, of Allegheny, Pa., the owner of five wells in Delaware county and three in Madison county, have settled all cases against them. So far as I know, no other cases under the penalty statute have been settled.

As to the adequacy of the present statute to prevent the waste of natural gas from oil wells, I have not changed my opinion from that expressed in my last annual report. With the certain infliction of a

[1] See Twenty-second Annual Report of the Department of Geology and Natural Resources, Indiana, 1897, pp. 281-282.

penalty of two hundred dollars ($200) for the first offense and two hundred dollars ($200) for each ten days thereafter, so long as gas is allowed to escape from the well, oil operating in the Indiana gas field can not be profitable. To date, it has done but little to prevent the waste of gas, but this must be charged to the fact that its constitutionality is questioned. If the decision of the supreme court of Indiana is affirmed by the Supreme Court of the United States its adequacy can be definitely settled. However, whatever the result may be, the law could be made more effective by amendments. The greatest objection is that it involves the tedious delay of a civil action, and a delay means much when millions of cubic feet of gas are escaping in the air daily. Quite a number of the oil companies that operated in the Alexandria field were organized in other States and were represented in the field by an agent or manager who was not financially responsible. The difficulty in the case is plain. The law should be more drastic. Its violation should constitute a crime, punishable by a fine and imprisonment, if necessary, of the parties present and managing the oil property. This should render injunctive relief unnecessary. If the law prohibiting the waste of natural gas and oil is held to be constitutional by the supreme court of the United States, and when amended as indicated above, it is not probable that injunctive relief would be necessary in the future, but if it should be necessary, it would facilitate the proceedings very much if the State could be relieved from giving bond.

Needed Legislation to Protect the Natural Gas Industry.

In the light of the present condition of the gas field and the past experience of this department in trying to regulate the use of natural gas and prevent its waste, the following amendments to the present law are recommended:

1. The law prohibiting the flow of gas or oil from any well to escape into the air should be amended so that its violation would constitute a crime, punishable by a fine and imprisonment, if necessary, of the parties present and managing the oil property.

2. In case injunctive relief is necessary the State should be relieved from giving bond.

3. To prohibit the waste from all classes of natural gas lines, a law should be enacted making it the duty of the Natural Gas Supervisor to have all leaks in gas lines for the transportation of natural gas repaired, after a reasonable notice to the owner of the same of the necessity for such repairs, and making the cost of the repairs made a lien on the line and wells attached thereto.

REPORT

OF

STATE SUPERVISOR OF OIL INSPECTION

FOR 1898.

INSPECTION BY STATIONS.

	Bbls.
Angola	1,710
Argos	345
Attica	1,725
Auburn	1,260
Aurora	2,269
Batesville	1,100
Bedford	2,828
Bloomington	1,282
Bluffton	1,969
Bourbon	1,112
Brazil	2,431
Brookville	1,812
Bremen	155
Butler	540
Chicago, Ill.	304
Cincinnati, Ohio	3,273
Cleveland, Ohio	6,980
Columbia City	540
Columbus	2,595
Connersville	2,606
Corydon	486
Crawfordsville	3,005
Crown Point	969
Danville	1,577
Danville, Ill.	121
Decatur	1,328
Delphi	1,240
Elkhart	4,200
Evansville	17,809

	Bbls.
Fowler	1,610
Fort Wayne	7,168
Frankfort	2,300
Franklin	1,771
Garrett	555
Goshen	1,972
Greencastle	541
Greenfield	214
Greensburg	1,033
Hammond	3,451
Hartford City	122
Hobart	249
Huntington	3,280
Huntingburg	819
Indianapolis	51,960
Jeffersonville	3,187
Kendallville	1,080
Knox	356
Kokomo	2,533
Lafayette	9,235
Lagrange	540
Laporte	2,025
Liberty	212
Lebanon	2,455
Ligonier	720
Lima, Ohio	5,186
Logansport	6,467
Louisville, Ky.	5,312
Madison	3,787
Mansfield, Ohio	2,294
Marion	2,046
Martinsville	734
Mishawaka	2
Michigan City	2,031
Muncie	1,573
Nappanee	964
New Albany	3,791
New Castle	1,003
North Manchester	1,155
Peru	3,497
Pierceton	240
Plymouth	1,230
Porter	557
Portland	1,744
Princeton	1,520
Richmond	3,150
Rochester	1,433
Rockville	1,959
Rushville	1,823
Salem	102
Seymour	2,401

	Bbls.
Shelbyville	2,390
South Bend	7,956
St. Joe	90
Sullivan	893
Tell City	897
Terre Haute	10,857
Toledo, Ohio	2,068
Topeka	120
Union City	1,890
Valparaiso	1,640
Vincennes	5,181½
Wabash	1,907
Walkerton	1,115
Warsaw	1,538
Washington	2,040
Whiting	13,270
Total bbls. for year, by stations	276,812½

INSPECTION BY MONTHS.

1898.	Bbls.
January	33,167
February	25,652
March	22,590
April	19,278
May	15,027
June	13,090
July	9,978
August	17,229
September	22,896
October	30,313½
November	35,312
December	32,280
Total for year, by months	276.812½

TABLE SHOWING WHERE OIL WAS MANUFACTURED.

	Bbls.
Allegheny, Pa.	73
Altoona, Pa.	80
Chicago, Ill.	40
Cleveland, Ohio	11,671
Columbus, Ohio	449
Emelton, Pa.	147
Franklin, Pa.	1,232

	Bbls.
Freedom	68
Lima, Ohio	112,255
Oil City, Pa.	6,383
Pittsburg, Pa.	3,098
Reno, Pa.	514
Taylorstown, Pa.	515
Titusville, Pa.	2,090
Toledo, Ohio	13,222
Warren, Pa.	975
Washington, Pa.	11,178
Welker, Ohio	2,557
Whiting, Ind.	110,270½
	276,812½

TABLE SHOWING STATES WHERE OIL WAS MANUFACTURED.

	Bbls.
Illinois	40
Indiana	110,270½
Ohio	140,154
Pennsylvania	26,348
	276,812½

The following is a list of Deputy Supervisors of Oil Inspection on January 1, 1898:

Boltz, J. H.	Winchester, Ind.
Bowman, M. J.	Madison, Ind.
Carr, W. C.	Crawfordsville, Ind.
Cornell, J. B.	Goshen, Ind.
Crabbs, O. W.	Muncie, Ind.
Davidson, J. G.	Whiting, Ind.
Derr, Walter	South Bend, Ind.
Dorsey, C. B.	New Albany, Ind.
Dorsey, W. C.	Terre Haute, Ind.
Johnston, J. M.	Logansport, Ind.
Lockwood, C. W.	Peru, Ind.
McGee, Wm. H.	Lafayette, Ind.
Mills, L. B.	New Maysville, Ind.
Schutt, M. A.	Michigan City, Ind.
Sebring, W. D.	Portland, Ind.
Thorward, Theo.	Fort Wayne, Ind.
Weems, Robt. F.	Vincennes, Ind.
Zaring, W. C.	Evansville, Ind.

C. F. HALL,
State Supervisor of Oil Inspection.

INDEX.

Page.

Page.

Page.

Page.