

INDIANA.

DEPARTMENT

OF

Geology and Natural History

(ELEVENTH ANNUAL REPORT.)

JOHN COLLETT,

State Geologist.

1881.

INDIANAPOLIS:

WM. B. BURFORD, STATE PRINTER.

1882.

COAL MEASURES.

The rocks of the coal measures are found in the counties of Posey, Vanderburgh, Warrick and Spencer, the Western parts of Perry and Crawford, in Gibson, Pike, Dubois, Knox, Daviess, Martin, Sullivan, Greene and Clay, the western part of Owen, and in Vigo, Parke, Vermillion, Fountain and Warren.

It is apparent, therefore, that the lower Silurian, being the oldest rocks brought to the surface, underlie all the more recent rocks which in succession have been deposited during the different ages of the earth's existence. A shaft or bore put down in the western part of Gibson county would pierce in succession all the geological formations of the State, and would show the approximate depth of each to be as follows:

General Section.

Coal measures	725 feet.
Sub-carboniferous.....	680 "
Devonian.....	200 "
Silurian.....	3,000 "
Total.....	<hr/> 4,605 "

MINES AND QUARRIES.

MINERAL COAL.

The coal mines of Indiana, although their development has only begun, is of high economic interest; the production has been limited to the demands of a new country with few factories, but the promise for the future from these treasure houses is grand. Our coal field embraces an area of nearly 7,000 square miles, offering a total of twelve seams at a depth ranging from nought to three hundred feet, and averaging eighty feet below the surface. Five of these seams, wherever met, are almost constantly workable, varying from two and a half to eleven feet, averaging four and a half feet in thickness; five other seams are mined at occasional favored localities; two minor coals are only worked by stripping for local use. The quality is fair to choice, as shown by analyses and tests in former geological reports.

"Block" or splint coal prevails in an area of six hundred square miles, which is used in the blast furnace, as it comes from the mine without cokeing. This Indiana block coal is of superior quality, rich in carbon, remarkably free from sulphur, ash and phosphorus, and well suited for manufacture of Bessemer steel and the highest metallurgic processes. It burns without cokeing, in a ruddy flame, like hickory wood, to a minimum of white ash. The cokeing coals furnish an excellent fuel for house, factory, mill or locomotive use. The abundance of coal and ease of access cheapen this fuel. It may be had in large lots on every line of railway at from five to ten cents per bushel, or at from \$1.50 to \$2.80 per ton.

The survey is indebted to report of R. Pumpelley, Special Agent of Tenth United States Census, for the following details of our mining industries for the census year:

Statistics of Indiana Coal Mines, 1880.

Number of counties with mines opened.....	19
Number of establishments	216
Maximum capacity of yearly production, tons.....	3,110,183
Product of same, tons.....	1,449,496
Value of product at mines.....	\$2,143,093
Irregular product local strip-banks, tons.....	4,831
Total product, tons.....	1,454,327
Value of total product at mines.....	\$2,150,258
Value of materials used in mines.....	\$158,604
Wages paid to all classes of labor.....	\$1,405,164
Men employed above ground.....	570
Men employed below ground.....	3,748
Boys, under 16, employed above ground	7
Boys, under 16, employed below ground	171
Total employes	4,496
Number of steam engines employed.....	65
Horse-power of steam engines	1,717
Value of all machinery, including engines.....	\$146,908
Value of explosives used.....	\$56,151
Amount employed as working capital.....	\$348,665
Value of mining plants.....	\$773,445
Value of real estate.....	\$1,146,859
Total capital employed and invested in establishments..	\$2,268,969
Tons paying royalty.....	899,356
Amount paid as royalty.....	\$137,311
Acres of coal land worked out.....	2,884
Acres of land unworked, attached to works	8,000
Acres of mining land unspecified.....	2,407
Total capital in establishments and irregular workings..	\$2,304,720
Acres available coal lands attached to working establishments	10,407
Average price per ton of product of regular mines, at mine.....	\$1 48
Average cost of labor per ton.....	\$0 97
Average cost of material, per ton.....	\$0 11
Average amount left for royalty, profit, etc., per ton..	\$0 40
Per cent. of capital used for working capital.....	15.37

Per cent. of capital in plant.....	34 09
Per cent. of capital in real estate.....	50 54
Average royalty paid, per ton.....	\$0 15
Average yearly earnings of man.....	\$318 85
Average per cent. of year worked.....	74.34
Average per cent. of year idle, except from strikes...	21.36
Average per cent. of year lost by strikes.....	4.30
Tons raised per man per day.....	1.47
Tons raised yearly per man.....	328.91
Per cent. ratio of product to maximum capacity.....	46.59

One Hundred Indiana Coal Mines Classified on the Basis of the Power Used.

Class 1. Mines using no power to supplement manual labor.
Class 2. Mines using the power of animals only.

Class 3. Mines using boiler-power not exceeding 100 horse-power.
Class 4. Mines using boiler-power exceeding 100 horse-power.

CLASS.	Number of mines in class.	Aggregate maximum yearly capacity, net tons.	Product census year, net tons.	Value of census year's product at mines, in dollars.	Average yearly product, net tons per mine.	Average value per ton at mine.	Average cost of labor per ton mined.	Average number of days worked by each man.	Average earnings per man, census year.	Average per diem wages earned.	Average product per man per day worked, net tons.	Average horse-power to mine.	Tons mined per horse-power yearly.	Per cent. of value of product paid for labor.	Per cent. of value of product paid for materials.	Per cent. of value of product for profits, including interest, repairs, and royalty.	Average number of hands to mine, all classes of labor, including superintendence.
1.	12	42,808	9,807	13,291	817	1 35	87	162	\$202 00	\$1 25	1.44	64	5.0	31.0	3.5
2.	36	430,082	143,657	214,924	3,991	1 50	84	155	244 00	1 57	1.88	2.4	1,663	56	14.6	29.4	13.7
3.	48	2,000,000	1,144,243	1,705,166	23,839	1 49	97	230	346 00	1 50	1.55	44.0	592	65	7.0	23.0	67.0
4.	4	314,820	122,617	186,704	30,654	1 52	1 11	246	404 00	1 64	1.48	133.0	200	73	7.0	20.0	84.0
Total	100	2,787,710	1,420,324	\$2,120,035	14,203	\$1 49	\$0 97	222	\$337 00	\$1 52	1.56	23.1	505	65	7.8	27.2	40.9

"These tables illustrate, in a general way, the proposition that large mining establishments, which employ power and labor-saving machinery, can pay higher wages and give more steady employment to labor than smaller ones. The mines chosen in this State were typical ones of their classes. The large amount spent for 'materials' by Class 2 is, to a great extent, made up of feed, etc., for the animals used.

"As a general rule, too, the mines employing capital most liberally can afford to yield to labor a larger share of the value of the product, since their profits depend on the volume of their business. They also employ more skilled labor. It is believed that these features run through the entire mining industry."

Rank of the States East of the 100th Meridian, Producing Bituminous Coal in the Census Year ending June 1, 1880.

Number.	NAME OF STATE.	Product of Regular Mines, Tons of 2,000 Pounds.	Percentage of Total Product.	Number.	NAME OF STATE.	Product of Regular Mines, Tons of 2,000 Pounds.	Percentage of Total Product.
1	Pennsylvania . . .	18,004,988	44.665	11	Tennessee	494,491	1.227
2	Illinois	6,089,514	15.107	12	Alabama	322,934	0.801
3	Ohio	5,932,853	14.718	13	Georgia	154,644	0.383
4	Maryland	2,227,844	5.527	14	Michigan	100,800	0.250
5	West Virginia . . .	1,792,570	4.447	15	Virginia	40,520	0.100
6	Indiana	1,449,496	3.596	16	Arkansas	14,778	0.036
7	Iowa	1,442,333	3.578	17	Nebraska	200	...
8	Kentucky	935,857	2.322	18	North Carolina . .	250	...
9	Kansas	763,297	1.894				
10	Missouri	543,990	1.349		Total	40,311,459	100.00

Rank of States East of the 100th Meridian, as Producers of Bituminous Coal, according to the Census of 1870.

	Per cent. Gain in 1880.
1. Pennsylvania	131
2. Illinois	132
3. Ohio	135
4. Maryland	22
5. Missouri	13

	Per cent. Gain in 1880.
6. West Virginia	194
7. Indiana	231
8. Iowa	447
9. Kentucky	521
10. Tennessee	270
11. Virginia	34
12. Kansas	2,217
13. Michigan	258
14. Alabama	2,836

"The United States, exclusive of the territories, has gained 134.4 per cent. in weight of product. The average price per ton has fallen from \$1.99 to \$1.22 during the past decade, the price for 1870 being, of course, reckoned in paper dollars."

It was intended in this report to give a review of the coal industries of the State, repeating analyses given in former reports of the State Geologist, which have done so much to advance the commerce, manufactures and wealth of our people, but a short appropriation forbids the publication of this and other articles which are with reluctance omitted. Although our coal fields are but partly developed by access of railways, and the demand, constantly growing, is but in its infancy, Indiana will take pride in the fact that the coal out-put has increased in the last decade 231 per cent., or at the handsome rate of over 23 per cent. per annum, and she ranks as the sixth State of the Union in the production of coal.

CLAYS.

The beds of fire clay which underlie the coal seams are more persistent than the coals themselves. This material, which will be of great importance for door and window casing, cornices, etc., in the buildings of the future, when common safety will require fire-proof houses, is sufficiently abundant to supply the world, and can be cheaply mined after the coal is removed. Some of the clays are aluminous, offering choice material for sewer pipes, pumps, jars and terra cotta products; others are highly silicious, suitable for fire-brick, retorts, etc. At several

drainage of the country is rapidly drying up these reservoirs, and the shallow wells in dry seasons fail, but by penetrating the clay to the lower gravel an inexhaustible supply of good water can almost invariably be obtained. When the supply of water for domestic purposes shall be generally drawn from this lower reservoir the health of the people will be materially improved. These remarks apply equally to

RICHLAND TOWNSHIP,

Which lies directly east of Shawnee. This township shows a deep drift surface, made of finer material than is exposed in the townships north of this—sand generally taking the place of gravel. But a single surface outcrop of stone was observed in this township. This occurs at Dobe's Mill, on Coal creek, in section 10, town 20, range 7. This exposure extends along the stream but about forty rods. It is, however, clearly exposed and the strata well defined. We obtained the following section:

Dobe's Mill Section.

Drift	8 ft.
Sandstone (Chester).....	10 ft. 4 inches.
Argillaceous Limestone.....	2 ft.
Total.....	20 ft. 4 inches.

Though but two feet of the lowest member is exposed above the bed of the stream, yet it has been penetrated by a boring to the depth of sixty feet in the immediate vicinity. Fossils are rather rare in this rock, but we obtain well preserved specimens of *Fenestella shumardi* and *Alorisma subcuneata*, which mark it as belonging to the Keokuk group. The stratification is parallel and quite uniform, both in the sandstone and limestone; the strata ranging from six to ten inches thick. The limestone is used in the neighborhood for cellar walls and house foundations. It contains too much clay, colored with iron proto-sulphide, to be reliable in exposed situations. The sandstone overlying it, though softer, is a more durable building material. This outcrop of stone marks the eastern shore of the great glacial erosion. In the southwestern part of Newtown, on elevated ground, a boring reached sandstone (Chester?) at the depth of thirty-nine feet. A singular phenomenon occurred at this well. The sandstone was penetrated five feet,

when a copious stream of water, strongly impregnated with iron, was struck, having a temperature of 59°, while the water obtained in the drift above has a temperature of 54°. We are unable to say why the chalybeate water should be warmer than that in shallower wells; unless it may be that it rises from a great depth.

Richland township has generally a level surface, and the northern part is embraced in Shawnee prairie. The township, as its name indicates, is very fertile; but its productiveness and its health will be greatly improved by underdrainage. In its early settlement, this township was noted for the prevalence of "milk sickness," but since cattle no longer run on wild pastures, the disease has entirely disappeared.

VANBUREN TOWNSHIP

Occupies the central position in Fountain county. It is traversed in nearly its whole length from north to south by Coal creek, and two large tributaries, east fork of Coal creek and Dry run, enter it from the east. Though coal has been mined to a considerable extent near Stone Bluff, in section 24, town 20, range 8, yet we may not consider any point as being fairly within the coal field if it lies north of the line dividing towns 19 and 20. Local deposits of block coal of a good quality will be found west of Coal creek and north of this line, but being on the margin of the coal field, these will be found in detached pockets, and mining can be carried on with certainty only by borings in advance of the entries. Moreover, the deep erosions of the glacial currents have, in many places, cut out the coal where it was originally deposited in a workable seam. Several borings have been made on section 36, town 20, range 8, but these investigations were made by private parties, and in these cases the person employed to make the boring is always charged to keep the register of the work entirely private, so we found it impossible to obtain definite sections of these borings. This much, however, we learned from a source that we deemed reliable. The borings were from 100 to 150 feet deep, but no coal was found in any of them. At this we were not surprised, as section 36 lies directly in the track of the great erosion—the ancient river bed. Near the southeast corner of this section, at the foot of the hill, is a surface outcrop of block

coal of good quality. The seam, for some distance, ranged from thirty to thirty-six inches thick. After being worked for several years, the enterprise was abandoned on account of the seam thinning, and in some of the entries entirely disappearing, and in many places the roof was defective.

In 1872 a shaft was sunk a few rods west of the Veedersburg cemetery, for a section of which we are indebted to Riley Helm, who was one of the workmen engaged in sinking it.

Shaft near Veedersburg.

Drift.....	30 ft. 0 in.
Soft sandstone.....	10 ft. 0 in.
Compact sandstone.....	15 ft. 0 in.
Bituminous shale (black slate)	5 ft. 0 in.
Block coal.....	2 ft. 3 in.
Fire clay.....	1 ft. 6 in.
Fine grained white sandstone.....	12 ft 0 in.
Bituminous shale (black slate).....	4 ft. 3 in.
Block coal.....	4 ft. 2 in.
Total depth.....	84 ft. 2 in.

At the bottom of this shaft there was a heavy inflow of water, from which the proprietors had no pump of sufficient power to relieve it. Subsequently it passed into the possession of the I. B. & W. R. R., and was used as a water station. About 150 feet south of this and on the opposite side of a branch, a boring has been made, revealing substantially the same section. Another boring was made near the west line of section 12, and above 200 yards west—a little south—of which we obtained the following, rather indefinite, section:

Drift.....	20 ft.
Sandstone and clay shale.....	48 ft.
Black slate.....	2 ft.
Block coal.....	4 ft.
Total depth.....	74 ft.

As the surface of the ground rises from the shaft in the direction of the boring, and the dip of the strata being in the same direction, it leaves it doubtful whether the coal reached in this boring is the upper or the lower coal of the shaft.

Eighty rods south of Veedersburg and one hundred feet west of the C. B.-C. railroad, a boring was made several years ago, but we could learn no more about it than that ninety feet from the surface four feet six inches of "rotten coal" was found. Whether this was really coal or merely soft bituminous shale, remains in doubt. As it is, however, at the horizon of the coal at the shaft, it is probably coal in some undefined condition.

At the railroad bridge, eighty rods further south, there is an outcrop of thirty inches of very hard block coal, under ten feet of sandstone, with about one foot of shale interposed between the rock and coal. This coal has been mined from under several acres of bottom land, west of the railroad, but the seam proving irregular, and the sandstone roof disappearing, the mining has been abandoned. Entries driven under the hill west of this might reveal more uniformity of seam and a better roof.

One and a half miles southwest of this, in section 11, township 19, range 8, coal has been mined quite extensive by a horizontal drift from a surface outcrop. The seam was in most places three feet thick, but showed great irregularity—sometimes being "pinched" to half that thickness, and on this account the mine is at present abandoned. The coal is a good quality of block. In this immediate vicinity three borings have been made, but all that we could learn was that at the depth of twenty-five feet a coal seam of twenty inches thick was cut, and in each of the borings, at a distance of from eighty-six to 95 feet from the surface, four feet of block coal was found. We regret that we are unable to give a connected section of the strata in these borings, but as the register is private property we were unable to obtain it. Near the north-western line of this section a boring was made to a depth of more than one hundred feet in drift the entire distance, marking the line of the great erosion. The twenty-inch seam of coal in these borings has a layer of compact cannel coal, from four to six inches thick, which is exposed in the bed of Coal creek, a short distance below the bridge of the C. B.-C. railroad, specimens of which are frequently washed out by freshets.

A boring has recently been made by private parties in the interest of the Toledo & St. Louis railroad, in sec. 24, town

19, range 8, which found forty inches of block coal at a depth of eighty feet. This renders it probable that the lower seam of block coal may be mined, generally, in that part of VanBuren township which lies south of Veedersburg and west of the C. B.-C. railroad; but owing to the irregularity in the seams so near the margin of the coal field, we would not advise the sinking of shafts without first making careful explorations by boring.

An outcrop of conglomerate sandstone occurs on Dry run near the north line of sec. 33, town 20, range 8, which, if properly quarried, will furnish an excellent and very durable building material. A similar outcrop occurs at Stone Bluff in section 10, in the same town and range as the above. In neither of these outcrops have quarries been regularly opened, though stone has been obtained, to a limited extent, for house foundations, etc. The people have not yet learned its value.

TROY TOWNSHIP.

This township has a large river front, as it lies in the great bend of the Wabash, at the lower end of which is located the town of Covington, the county seat. Though Troy township lies chiefly within the coal field yet it has but little workable coal. In the southeastern corner the coal is cut out by the great erosion which forms a junction with the Wabash river from three to four miles below Covington.

About one and a half miles south of Covington, and near the line between sections 1 and 2, town 19, range 9, is an outcrop of block coal, which has been worked in former years, but appears now to be abandoned. The seam ranges from twenty inches to three feet thick, but is very irregular, and where it has been worked the roof is defective. This last defect would, probably, be remedied by extending the entries under the hill to the east, but perhaps the irregularity in thickness of seam would render mining unprofitable. The same seam appears in the railroad cut about two hundred yards east of the station, at Covington, where it shows but sixteen inches of coal.

In a ravine but a little distance east of the old canal bed, in section 12, town 19, range 9, there outcrops a seam of bituminous coal three feet thick. When the canal was in operation

this coal was mined quite extensively, but the work is now abandoned. The coal is similar in quality to that so extensively mined near Snoddy's Mill, which will be described hereafter. At the time of the oil excitement some parties made a boring, near this coal drift, in search of oil. At a depth of about one hundred and seventy-five feet they abandoned the enterprise, but left a fine flowing well of very pure water. We were unable to find the parties who made this boring, and therefore could not obtain a section of it.

The elevated ground in the vicinity of Osborn's Prairie may possibly have the lower seam of block coal underlying it, but the near proximity to the margin of the coal field will, probably, render the seam irregular, and the deposit of coal, in pockets, rather than in a continuous seam. Boring in sections 20, 21 and 22 would settle this question.

Troy township has a productive soil, adapted to a wide range of crops, and the northern part of the township lies admirably for cultivation. The southern part is somewhat broken by the deep valleys of the tributaries of Coal creek and the Wabash; yet there is but little land in the township that can not be conveniently plowed.

WABASH TOWNSHIP

Lies directly south of Troy, and has a river front of five miles. Coal creek cuts the township diagonally from northeast to southwest; and Graham's creek, a large tributary, which has its source in Osborn Prairie, traverses the northern part of the township. These, with the hills along the river front, render the surface of the country somewhat broken.

In section 31, town 19, range 8, in section 6, town 18, range 8, and in section 1, town 18, range 9, are located the rather celebrated "Stringtown" coal mines. These mines were opened by Brown, Barbee & Co., as early as 1845, and the succeeding year a tram railroad was constructed over the ridge, to the Wabash and Erie Canal; and coal was furnished from this point to supply the demand of all the towns along the canal to Toledo. The abandonment of the canal suspended mining here and the work lay idle until 1870, when the C. & Eastern Illinois railroad constructed a branch to this point, and mining

was commenced chiefly in the interest of the North Chicago Iron and Steel Works. At present (June 20, 1881) three horizontal drifts and three shafts are in active operations. The coal is a semi-block, but too bituminous to work in smelting iron without coking, but makes an excellent article of coke, and is quite free from sulphur. We regard it as the equivalent of coal K of Prof. Cox's classification. The seam ranges from five to six feet thick, and is quite uniform. On section 31, Soliday & Co. are working thirty hands in two drifts, with five feet of coal. The shale roof of these entries are very rich in well preserved fossils of the coal vegetation. Of these we obtained specimens of the *Pecopteris lonchitica*, fronds of *Sphenopteris crenata*, *Neuropteris hirsuta*, and fragments of stems and fronds of calamites (species undetermined). On section 6, Ogden Bros. are working a drift in a seam five feet thick of coal K. On section 1, Trunky, Purdee & Co. work a shaft forty feet deep, mining a seam of K six feet thick. This company works fifty hands. S. W. Phelps & Co. have a shaft fifty feet deep on section 1. The coal is six feet thick and similar in quality to the neighboring mines. This shaft employs one hundred hands in summer and two hundred in winter, and raise from one fifty to three hundred tons of coal daily. On the same section, and three hundred yards southwest from the last named shaft, the Fountain County Coal Mining Company are operating in a shaft one hundred feet deep, working six feet of coal K, with a force of one hundred and fifty hands. The entire output of this group of mines is at this season about five hundred tons daily. The North Chicago Iron and Steel Company has just completed and put into operation twenty-five coke ovens for economizing the coal slack from these mines. The cost of these ovens with the machinery necessary to operate them was \$150,000. The experiment is working satisfactorily.

On sections 4 and 5, township 18, range 8, there is an outcrop of coal K, about 4 feet thick, which has been mined to a limited extent for neighborhood use. This outcrop is on the bluff south of Prairie creek. We found no indications of this coal seam between Coal creek and Prairie creek, the general level being below its elevation. Near the north line of section 5, and in section 3, township 18, range 8, are outcrops of block coal in seams from thirty to thirty-six inches thick; and on sections

33, 34, 27 and 23, are outcrops of block coal, the seams ranging from three feet to three feet ten inches in thickness. The coal is of good quality, and the general uniformity in the outcrops in the ravines on the east side of Coal creek from above Cade's Mill to a point nearly opposite Snoddy's Mill, gives ground to infer that this upper block coal seam has lost much of the irregularity which marked it in the neighborhood of Veedersburg. At Cade's Mill (section 27) there are indications that the lower block coal lies but a little distance below the bed of Coal creek, but no borings or excavations have yet been made to ascertain that matter.

In 1830 Mr. Jarred from the Kanawha salt regions in Virginia, made a boring on the north side of Prairie creek in section 4, township 18, range 8, for the purpose of obtaining brine for the manufacture of salt. No very definite register of the boring was kept, but we were fortunate in obtaining from Jesse Jarred (a son of the proprietor, who assisted in the boring) the following general notes:

Section at Jarred's Well.

Drift.....	40 ft.
White sandstone.....	10 ft.
Black slate and coal.....	10 ft.
Fire clay and soapstone.....	12 ft.
First brine at.....	72 ft.
Total.....	144 ft.

This brine not being satisfactory, either in quantity or strength, the boring was subsequently continued to the depth of 1,004 feet, tapping several veins of brine in that distance. Salt, to a limited extent, was made here for several years, but the proprietor lacked capital to compete with Thomas & Co., who were operating a salt furnace about eight miles south of this, near the mouth of Coal creek. The only point of importance in this boring is the demonstration of a coal seam below that in section 3, one mile east of this. But in those early days the notes of boring did not discriminate between bituminous shale and coal, and how much of the ten feet in the above section was the one, and how much the other, it is impossible to determine without repeating the boring.

FULTON TOWNSHIP

Occupies the southwest corner of Fountain county. It has a river front of five miles, and is traversed from north to south by Coal creek, while Wabash Mill creek cuts across the southeast corner for a distance of two miles. These streams render Fulton township the most broken and hilly of any in the county. The northern half of the river front is composed chiefly of drift hills, rising from one hundred to one hundred and fifty feet above the river. At a westward bend of the river, near the southern line of section 22, town 18, range 9, a bayou continues the direction of the river above and cuts off a considerable territory of elevated land, presenting a bold and rocky front towards the river. The bayou or "swale" has a width of from two hundred to four hundred yards, and gives evidence of having once been the bed of the Wabash; and even now it requires but a moderate rise of the river to throw a strong current through it. This detached piece of high land is known as "Silver Island," and was a notable place in the early days of Wabash navigation. It is the highest point on the river shore where coal is observed cropping out. Near low water mark, at the base of a bluff, about forty feet high, at an abrupt bend of the river to the right, there is an exposure of coal, seam K, with its characteristic limestone roof, bearing marine fossils. From this rock we obtained *Productus semireticulatus* and *Productus longispinus*. The coal at this point has an average thickness of about four feet. Above this three other seams occur, ranging from twenty inches down to ten inches thick. These probably represent L and M of the Indiana series. The coal in the lower seam is of a fair quality, though its exposure to the river in high water has injured it at the outcrop. On the east side of the island an outcrop of coal K occurs near the southwest corner of section 26, town 18, range 9, on the land of N. Thomas. This coal was quite extensively worked when the canal was in operation, and gained the reputation of being a superior quality of coal. The works are now abandoned and the entries filled up. The seam is about four feet thick. A shaft was once sunk a few rods west of the line between sections 26 and 27, on the land of H. Randolph, reaching the same seam of coal, but owing to the aban-

donment of the canal, this shaft was not worked to any considerable extent. Extensive borings in search of coal have lately been made on Silver Island, but as these were made in the interest of private parties, we are unable to obtain details. In general terms, we learned that the coal on the island is irregular—in some places reaching a thickness of seven feet. The upper seams, L and M, are not in any place workable. On the northern part of the island there are seven surface outcrops of this coal that have been worked, none of which was less than four feet thick. A shaft, also, was once sunk to four feet of this coal on the upper part of the island. Near the Coal creek bridge, on the Toledo, Cincinnati & St. Louis Railroad, there are several outcrops of coal K where the seam ranges from three to five feet thick. These outcrops are in sections 36, town 18, range 9, and in sections 31, 30 and 20, in town 18, range 8. North of this the eastern erosion has cut out the coal in a belt from half a mile to a mile wide. Beyond this, coal K appears again on sections 7 and 8, town 18, range 8, along the ravines running into Prairie Creek from the south. These mines have not been worked sufficiently to determine the character of the coal, nor the thickness of the seam with accuracy, but both look favorable, and we predict a field of profitable coal mining between Coal creek and Wabash Mill creek, in the three southern tiers of sections in Fulton township. Though there is a considerable space between these creeks in which no coal appears—the streams being superficial—yet at the falls of Mill creek, in section 28, town 18, range 8, coal K appears in a seam four feet thick, and covered with its characteristic roof of silicious limestone. Indications of coal are seen below this on the creek. These circumstances justify the opinion that the same bed extends, with more or less regularity, under the whole intermediate space.

Sandstone of a good quality is found on the river face of Silver Island, at the point where the line dividing sections 27 and 34 strikes the bluff. The quarry is being worked at this time to obtain stone for the railroad bridge over the Wabash at the county line. Some of the strata in this quarry have a decidedly blue tinge. Rocks of this character should not be placed in exposed situations. The lighter colored strata of this quarry are entirely reliable in any situation.

In the year 1865 a boring was made near the north line of section 35, town 18, range 8, for the purpose of determining the presence of salt or other valuable mineral deposits in the strata below. The boring was prosecuted to the depth of 1,155 feet, at which point a very strong flow of mineral water was encountered which arrested the boring. At several points in the progress of the work veins of brine were struck, but none of these proving satisfactory to the company, the boring was continued. We subjoin a condensed report of the strata penetrated by this boring, as the same were noted at the time.

Section in the Lodi Artesian Well.

Drift.....	5 ft. 0 in.
Sandy shale.....	1 ft. 3 in.
Shale, with iron nodules.....	2 ft. 3 in.
Clay	2 ft. 0 in.
Fossiliferous limestone	2 ft. 0 in.
Shale	8 ft. 0 in.
Coal.....	1 ft. 0 in.
Fire clay.....	3 ft. 0 in.
Coal.....	1 ft. 0 in.
Shale, with iron nodules.....	1 ft. 6 in.
White sandstone	12 ft. 6 in.
Sandstone and limestone	7 ft. 6 in.
Argillaceous sandstone and thin coal seam	10 ft. 0 in.
White clay sandstone.....	8 ft. 0 in.
Thinly stratified sandstone.....	13 ft. 6 in.
Sandstone, with iron ore.....	3 ft. 3 in.
Sandy shale.....	12 ft. 7 in.
Dark unctuous clay.....	2 ft. 5 in.
Shale, with thin coal.....	3 ft. 4 in.
Brown sandstone and shale.....	10 ft. 1 in.
Cream colored sandstone.....	5 ft. 0 in.
White mica sandstone.....	6 ft. 0 in.
Fine grained sandstone.....	9 ft. 0 in.
Shale.....	2 ft. 8 in.
Clay shale	3 ft. 2 in.
Compact shale.....	6 ft. 3 in.
Black shale	9 ft. 0 in.
Soft clay shale	5 ft. 0 in.

Compact shale	14 ft. 6 in.
Sandstone.....	31 ft. 11 in.
Sandy shale.....	39 ft. 4 in.
Hard quartz sandstone.....	2 ft. 3 in.
Sandy shales	60 ft. 0 in.
Fine grained sandstone	31 ft. 2 in.
Hard sandstone.....	10 ft. 3 in.

(Brine 2° B.)

Fine grained sandstone.....	5 ft. 0 in.
Sandy shale.....	7 ft. 1 in.
Unctuous shale.....	12 ft. 1 in.
Hard shale, with iron ore	12 ft. 3 in.
Sandy shale.....	53 ft. 7 in.
Hard sandstone	10 ft. 9 in.
Sandy shale.....	43 ft. 0 in.
Sandstone and shale	9 ft. 10 in.
Sandy shale.....	49 ft. 1 in.
Flint nodules in sandstone.....	8 ft. 2 in.
Sandy shale.....	45 ft. 9 in.

(Brine 5° B. 610 ft.)

Compact sandstone	10 ft. 3 in.
Fine grained sandstone.....	54 ft. 7 in.
Clay shale	11 ft. 2 in.
Fine grit shale	60 ft. 9 in.
Compact silicious rock	1 ft. 0 in.

(Brine 6½° B.)

Soft clay shale	7 ft. 3 in.
Fine grit shale	5 ft. 3 in.
Compact sandstone	3 ft. 0 in.
Soft sandstone	16 ft. 10 in.
White sandstone	6 ft. 0 in.
Sandstone, with thin layers of quartz.....	35 ft. 7 in.
Soft sandstone	9 ft. 4 in.
Shale and clay	19 ft. 4 in.

(Brine 8½° B 880 ft. 2 in.)

Tenacious clay.....	8 ft. 7 in.
Shale, with thin bands of sandstone—Knobstone...	26 ft. 7 in.
Lingula shale (black slate)—Devonian.....	90 ft. 1 in.
Hard, crystalline limestone—Devonian.....	20 ft. 1 in.

Coraline limestone—Devonian.....	12 ft. 0 in.
Magnesian limestone, with chert—Devonian	18 ft. 8 in.

At this depth (1051 feet) struck a flow of sulphur water that discharged with great force at the rate of 1500 barrels per day. Boring was continued through—

Hard silicious rock—Upper silurian	45 ft. 10 in.
Soft fine limestone—Upper silurian.....	5 ft. 0 in.
Compact limestone—Upper silurian.....	10 ft. 0 in.
Yellowish gray limestone—Upper silurian.....	6 ft. 0 in.
Hard blue limestone—Lower silurian.....	14 ft. 6 in.
Drab crystalline limestone—Lower silurian.....	14 ft. 6 in.

The flow of water increasing, the boring was suspended at a depth of 1155. The temperature of the flowing water at the surface of the earth is 70° F. It emits a very strong odor of hydrogen sulphide, and has a brackish, not unpleasant taste. The flow of the water continues with little or no abatement to the present time. It has made a deposit of calcium sulphide around the well, and on everything with which the water comes into contact. An analysis of the water was made by J. C. Pohle, M. D., Analytic Chemist, 489 Broadway, New York, which we give below :

One gallon of Lodi water contains 7.94 cubic inches of hydrogen sulphide gas, and 673.937 grains of solid substance, consisting of—

Chloride of sodium.....	502.464 grs.
Chloride of calcium	47.928 grs.
Chloride of magnesium.....	53.540 grs.
Sulphate of lime.....	55.553 grs.
Sulphate of potassa804 grs.
Sulphate of magnesia.....	3.260 grs.
Sulphate of soda.....	2.135 grs.
Bi-carbonate of lime.....	1.104 grs.
Silicic acid520 grs.
Phosphate of lime345 grs.
Sulphide of lime.....	1.200 grs.
Nitrogenous matter (organic).....	.500 grs.
Sulphur, mechanically mixed.....	.500 grs.
Bromide of magnesia	a trace.
Total.....	673.937 grs.

The character of this water and that of the celebrated White Sulphur Springs of Virginia, is nearly identical. The water of the Lodi well contains a little larger per cent. of chloride of sodium (common salt) than the Virginia Springs. This is, perhaps, owing to the copious flow of salt water found above the sulphur vein. When the railroads now in process of construction are completed, this well will certainly become a noted resort for invalids affected with chronic diseases of the glandular system, or affections of the skin.

In section 18, township 18, range 8, on the farm of J. Burnside, a boring was made in May, of the present year, for the purpose of obtaining a supply of stock water. The boring penetrated drift material to the depth of 100 feet, where a soft clay shale was struck, and coal was found at the depth of 110 feet. On penetrating the coal two feet a strong flow of inflammable gas took place, which continues to the last advices.* The gas, when we examined it (July 22, 1881), was flowing in a strong jet through an aperture three-eighths of an inch in diameter, giving a hissing sound. It burns with pale yellow flame, and gives an intense heat with no odor, neither in burning nor before. It is evidently carbide of hydrogen, the much dreaded "fire-damp" of the miners. So far as our knowledge extends, it is a rare occurrence in connection with our coal seams in Indiana. It may be economized for lighting and heating purposes.

MILL CREEK TOWNSHIP.

This is a district of level, rich soil, with defective drainage. The southern part of the township depends on Wabash Mill creek, and the northern on Prairie creek, for drainage, and both these are surface streams. It was originally covered with a dense forest of oak, beech, ash, hickory and elm timber, and much of it remains in the same condition yet. When cleared of its forest and properly drained, this soil will be very productive.

Coal appeared at the surface but at three points in this township, though it is quite probable that, with the exception of three or four square miles in the northeast corner of the town-

*NOVEMBER 10—The accumulation of water in the tube has arrested the flow of gas.

ship, and a narrow belt of erosion passing nearly along the line of Prairie creek, coal will be found underlying the township generally.

At a point one mile west from Harveysburg an outcrop of coal K makes its appearance at the foot of the hill on the east side of Mill creek. Coal has been taken out here, to a limited extent, by stripping, but as it has not been worked far enough to develop a permanent roof, we were unable to determine the thickness of the seam or the quality of the coal.

From this point to section 7, township 18, range 7, a distance of five miles, the stream nowhere cuts through the drift so as to expose the underlying rock. In section 7, at a point about eighty rods east of the new railroad town of Yeddo, coal K appears, covered by its limestone roof. Within the last year extensive explorations for coal have been made in this vicinity. These borings, chiefly on sections 7 and 18, reveal the coal at depths ranging from forty to seventy-five feet, and in seams from three to five feet thick. A shaft has been sunk eighty rods north-east from Yeddo, of which we obtained from Col. Beach the following section:

Section in the Yeddo Shaft.

Drift.....	13 ft. ... in.
Silicious limestone.....	15 ft. 5 in.
Bituminous shale.....	10 ft. 10 in.
Coal (K).....	4 ft. 10 in.
Fire clay.....	1 ft. 8 in.
Total	45 ft. 9 in.

The coal is of excellent quality, being well preserved by its double roof of limestone and shale. The limestone of this roof is packed with an abundance of marine fossils, though representing but a few species. Of these we obtained *Productus nebrascensis*, *P. longi spinus*, *P. semireticulatus*, *Spirifer cameratus* and *Athyris subtilita*. Several inquiries have been made in regard to using the heavy limestone roof of this coal, as a building material. To these we reply: It is intensely hard, and, therefore, has but little elasticity, and will not endure sudden changes of temperature, the expansion and contraction consequent on such changes will fracture the surface, and these cracks will admit water, which, on freezing, will break the rock into fragments. For use in unexposed situa-

tions, such as cellars or wells, it will answer a good purpose. Its silicious character will prevent it from slaking readily to lime, when burnt.

We confidently predict that, in the near future, when the entire line of the Chicago Block Coal road shall be finished to the lake, that a heavy coal mining business will be developed on this broad plain lying west and south of Yeddo. North of this, coal K will not be found to any considerable distance, nor would we expect it to extend east more than a mile from Yeddo, though at the county line south, it reaches three miles east, where we have a third exposure of coal K in the township. This is in section 33, township 18, range 7, being near the southeast corner of the township. This outcrop is extended for eighty rods along a tributary of Sugar Mill creek. The seam ranges from four to six feet thick and the coal is of good quality. This "bank" has been worked for more than forty years. In the early settlement of the country coal was hauled from here to Crawfordsville and other points east for the use of blacksmiths, and as a forge coal it is even now quite extensively used. Appearances indicate that at one time or another a large amount of coal has been removed from this place, though the mining has been chiefly done by stripping. Several entries, however, have been driven into the bank for a short distance, and one or two of them have been lately occupied by miners. Until quite recently the nearest railroad to this mine on a direct line was eleven miles, and much further by any accessible route. North of Prairie creek, the probability of reaching block coal at any point on the railroad, as far as to the township line, is such as will justify investigation by boring. The outcrop of block coal at "Hankin's bank," in Wabash township, is but three miles below the railroad bridge on Prairie creek, and this is evidently the upper seam of block coal, and if the lower coal is persistent and lies at the same horizon as at the Jarred salt well, it should be found about sixty feet below the upper seam, or about one hundred feet below the surface at the railroad crossing of Prairie creek. That the lower block coal passes entirely under the heavy development of K, south of Yeddo, is rendered probable by the outcrop of a four feet seam of it in Green's creek, a short distance south of the

county line. But this does not rise above a probability, for it must be admitted that the block coal, at least in this northern part of the field, is neither uniform nor persistent; but the excellent quality of the coal will justify the expense of the borings necessary to place this question on a basis of certainty.

JACKSON TOWNSHIP

Lies in the southeastern corner of the county, and is drained by Sugar Mill creek and the head waters of Green's creek. The southern part of the township is quite hilly, being cut by deep ravines that are tributary to Sugar Mill creek. From the village of Wallace, for the distance of two miles southwestwardly, that stream has worn itself a channel through the conglomerate sandstone. About a mile below Wallace, the stream passes through a deep, narrow gorge, generally known as the "Narrows of Mill creek." Here, as elsewhere, this conglomerate will furnish an almost inexhaustible supply of cheap and durable building material.

In section 34, township 18, range 7, there is an outcrop of coal that may be seen in the bed of Mill creek at low water. It being covered with water and fragments of rock at the time of our examination, we were unable to determine the thickness of the seam, or with certainty, the character of the coal. From fragments that have been washed out, and from its near proximity to the conglomerate base of the coal measures, we are disposed to refer this seam to the block coal group. At several points north of Wallace thin seams of sub-conglomerate coal appear in the bed and banks of Mill creek; but, as in other places, this seam is not workable. It is probable that coal in workable seams will be found underlying the first tier of sections on the west side of Jackson township, and, perhaps, locally in the second tier.

At several points on Mill creek north of Wallace, the Keokuk member of the sub-carboniferous limestone appears, presenting well-preserved fossils of that age, among which we observed *Productus punctatus*, *P. semireticulatus*, *P. magnus*, *P. cora*, *Philipsia bufo*, *Spirifer pseudolineatus*, *Aviculopecten Indianensis*, and *Actinocrinus lowei*.

This township was originally covered with a heavy forest, and lying beyond the reach of railroad markets, heretofore,

much of the timber remains on the ground. With the exception above made, the surface of the township is level and much of it will be improved by artificial drainage. The soil is a rich clay loam, with a considerable mixture of sand, and in places strongly colored with iron. Scott's prairie touches this township in section 2, town 18, range 7.

CAIN TOWNSHIP

Rests on formations, geologically too low to furnish seams of workable coal. Thin layers of sub-conglomerate coal may be found in the East Fork of Coal creek, above Hillsboro, but they will prove of no value, and borings, or other researches for coal at a lower level will be labor lost. The surface rock is already below any workable coal seam.

At Snider's mill dam, near the line between sections 16 and 21, township 19, range 6, there is an outcrop of the sub-carboniferous limestone, with abundance of characteristic fossils, fair samples of which we were able to procure. The upper ten feet belongs to the St. Louis group, and below this is a blue shaly limestone, with Keokuk fossils less liberally distributed than are St. Louis fossils above, but both are characteristic and well marked. Of the St. Louis fossils we obtained *Spirifer keokuk* var. *Athyris hiruta*, *Aulopora gigas*, *Archimedes* (Species?) *Bellerophon sublevis*, *Eumetria verneuillanum* and a *Cyathocrinus*. We were unable to determine the depth of this Keokuk bed, as immediately above the dam the drift covers the rock, and it appears no more. Near the western line of section 16 this formation dips under the conglomerate sandstone which, for the distance of six miles, forms the bed and bluffs of the east fork of Coal creek. These bluffs, in some places, rise to the height of sixty feet. The sandstone in this locality is highly charged with peroxide of iron. Indeed, in some places the iron constitutes twenty-five per cent. of the rock, giving it the character of a silicious iron ore. These highly charged iron sandstones will be found of great service in making roads. The iron and sand, uniting with the clay, will form a very compact cement. The large proportion of iron in most of the sandstone in the vicinity of Hillsboro will impair its value as a building material. Quarries of this rock, however, may be

MOLLUSCA

BRYOZOA.

<i>Fenestella acmea</i>	Hall.
<i>Fenestella parvulipora</i>	Hall.

BRACHIOPODA.

<i>Atrypa reticularis</i>	Linneus.
<i>Pentamerus oblongus</i>	Sowerby.
<i>Pentamerus nysius</i>	Hall.
<i>Pentamerus knappi</i>	Hall.
<i>Rhynchonella indianensis</i>	Hall.
<i>Rhynchonella neglecta</i>	Hall.
<i>Rhynchonella stricklandi</i>	Sowerby.
<i>Rhynchonella cuneata</i>	Sowerby.
<i>Rhynchonella whitii</i>	Hall.
<i>Rhynchonella acinus</i>	Hall.
<i>Spirifera radiata</i>	Sowerby.
<i>Spirifera niagarensis</i>	Hall.
<i>Spirifera crista</i>	Hall.
<i>Strophomena rhomboidalis</i>	Wahlenburg.
<i>Strophomena striata</i>	Hall.
<i>Streptorhynchus subplana</i>	Conrad.

PTEROPODA.

<i>Tentaculites niagarensis</i>	Hall.
---	-------

GASTEROPODA.

<i>Platystoma niagarensis</i>	Hall.
<i>Strophostylus cyclostomus</i>	Hall.

CEPHALOPODA.

<i>Gomphoceras septore</i>	Hall.
<i>Gyroceras elrodi</i>	White.
<i>Lituites marshi</i>	Hall.
<i>Orthoceras crebescens</i>	Hall.
<i>Orthoceras annulatum</i>	Sowerby.
<i>Orthoceras trix</i>	Hall and Whitfield

CRUSTACEA.

<i>Calymene blumenbachi</i> , (var. <i>niagarensis</i>)	Hall.
<i>Phacops limulurus</i> Sp.	Hall.

ECONOMIC GEOLOGY.

COAL.

Next in importance to knowing what a district of country does contain, is a knowledge of what it does not contain. The question is frequently asked, have we coal in Delaware County? to this question we would reply that coal never has, and *never will be* found here as a deposit; pieces of coal have been found in the drift deposits in the northern part of the county; these

evidently came from the coal fields of Michigan, brought here by the glacier. Mr. Jacob Newberger of Grant County found a few pieces in the bed of the Mississinewa River, and mistaking the dark colored boulder clay for a coal showing, he endeavored to get some one to open a mine but without success.

Coal as a deposit is always found in certain groups of rocks; in this State the Carboniferous is characterized wherever found by the fossils which it contains, and the Carboniferous rocks of this State are only found in the south-western part; the rock which underlies this county, the Niagara Limestone, is many hundreds of feet below the true coal bearing rocks. A knowledge of this fact would have saved many hundreds of dollars to the parties who made a boring at Eaton some years since, with the expectation of finding coal or oil.

LIME.

Lime of an excellent quality is burned here, principally to supply the local demand. This industry might be increased so as to become a source of great profit as the rock about Muncie is easily obtained, and is convenient to a shipping point.

MINERAL SPRINGS.

These springs are quite numerous. The most notable ones are the "Inlow Springs," four miles southeast of Muncie, on White River. Here are two large springs which issue from the top of the boulder clay; one of these springs is heavily charged with iron and sulphur, as shown by the deposits around it. Both, however, are chalybeate, and possess tonic and alterative properties. Numerous springs of like character were observed throughout the county. The water from the wells is hard, owing to the presence of lime and magnesia. I have failed to find either a well or spring of soft water in the county.

CLAYS.

Good clay for the manufacture of bricks can be had in abundance in every township, and is easily obtained, as the surface clays are among the best found in the county. Numerous kilns, both for brick and tile were observed; the principal ones, however, are found near Muncie. Mr. E. P. Smith