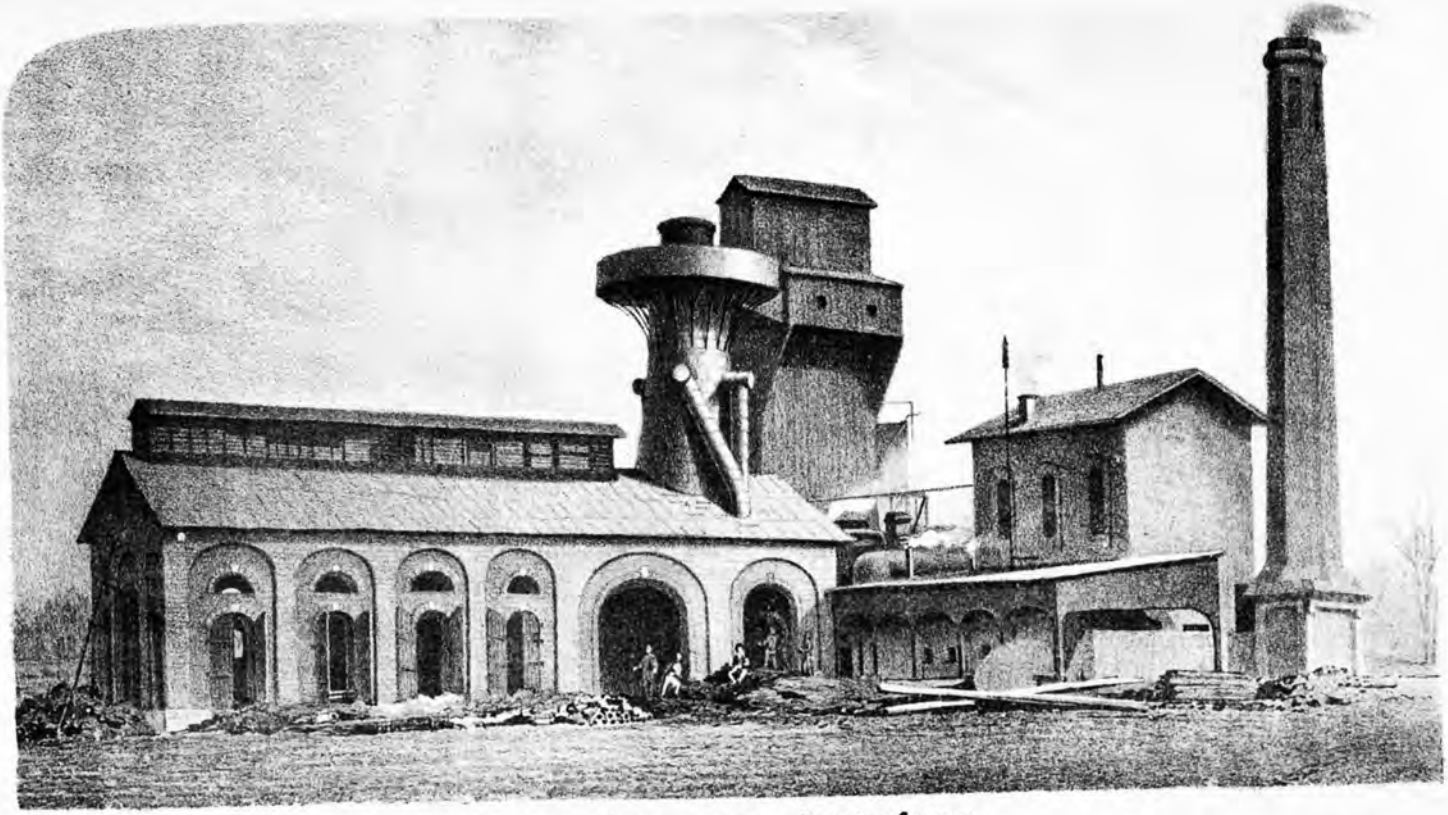

BRAZIL FURNACE.
Garlick & Collins, BRAZIL, CLAY CO., IND.

FIRST

ANNUAL REPORT

OF THE

GEOLOGICAL SURVEY

OF

INDIANA,

MADE DURING THE YEAR 1869,

BY

E. T. COX,

STATE GEOLOGIST,

ASSISTED BY

PROF. FRANK H. BRADLEY, DR. RUFUS HAYMOND,
AND DR. G. M. LEVETTE.

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1869.

OFFICE OF STATE GEOLOGIST,
January 1, 1870.

To the Honorable the President and Members
of the Indiana State Board of Agriculture:

SIRS: In accordance with my duties as State Geologist, I take pleasure in submitting to you herewith my report of progress for the year 1869.

Very respectfully yours,

E. T. COX,
State Geologist.

INTRODUCTION.

The law passed at the Forty-sixth Regular General Assembly of the State of Indiana creating the office of State Geologist places him at the head of a Geological and Scientific Department, to act in connection with and under the control and management of the Indiana State Board of Agriculture, for the purpose of collecting information designed to promote the interests of agriculture, arts, manufactures and mining.

The law not only requires of the State Geologist that he shall institute a geological survey to make known the mineral resources of the State, but that he shall likewise establish an analytical laboratory at Indianapolis, fitted up with all the necessary chemical apparatus for analyzing such ores and substances as may be deemed useful to the State, and to build up a Geological and Natural History Cabinet, and to publish the results of his labors in the annual reports of the Indiana State Board of Agriculture.

Soon after receiving the appointment of State Geologist from his Excellency, Conrad Baker, Governor of Indiana, I proceeded to pack my large and valuable collection of minerals, fossils, shells, and other objects of natural history, also my chemicals and chemical apparatus, etc., etc., preparatory to making my residence in Indianapolis, and with a view to arranging them in the rooms of the Geological Department at the State House.

On arriving at the Capitol with this collection, it was soon made manifest that the room set apart for the use of the State Geologist was totally inadequate to hold the na-

tural history specimens and chemical apparatus, and to be used, at the same time, as office and laboratory.

From a high appreciation of the importance of the labor to be performed, the State officers, with one accord, decided to have a small addition, suitable for a chemical laboratory, built on the east side of the State House, adjoining the rooms of the Indiana State Board of Agriculture.

The erection of this addition, together with the time necessarily spent in arranging the office, testing and purifying the chemical reagents, greatly delayed the chemical work, and will account for the limited number of analyses given in this report. But, through the hearty coöperation of our appreciative and energetic State officers, Indianapolis can now boast of one of the best arranged and most completely equipped analytical laboratories in the West. I trust soon to be able to commence a series of elaborate investigations of the iron smelting coals, iron ores and fluxes used in the blast-furnaces of Indiana, that will, it is confidently believed, prove of great utility to the iron-masters, and materially advance the manufacturing interests of the State.

In addition to the delay caused by arranging the office and laboratory, a considerable portion of my time has been taken up in receiving visitors and imparting geological information to capitalists, from various parts of the country, who are desirous of investing their money in the coal lands and in blast-furnaces, and other branches of manufactures in this State. To collect and furnish such information has always given me pleasure, and appears to be strictly in accordance with my duties.

As some of the fruits of the Geological Bureau, already made manifest, it may be stated that it has been the means of drawing the attention of wealthy manufacturers from Pennsylvania, Ohio, and other States, to Indiana, inducing large investments in coal lands, and the taking of decided steps for the erection, at different points, of several new blast-furnaces for smelting iron; also for the building of glass works at Indianapolis.

The gentlemen engaged in the latter enterprise were desirous to learn of the Geological Department if they could find, convenient to Indianapolis, suitable material for the manufacture of glass. Their attention was at once called to specimens of sand suitable for the purpose, from various localities in the State. One of the best samples, a soft, white sandstone, from Pendleton, in Madison county, on the Bellefontaine railroad, about twenty-five miles northeast of this city, was tested in the laboratory and a glass made from it that proved to be as clear as crystalized quartz. The result was entirely satisfactory, and I have been informed that several barrels of the Pendleton sandstone were subsequently shipped to Pittsburgh, Pennsylvania, where similar results were obtained in a practical way in the glass works of that city. Thus, being fully satisfied of the excellence of the sand, fire clay for glass pots, lime, coal, and other material essential to the manufacture of glass, that are to be found here in close proximity, ground has been broken and the glass works are now being rapidly pushed forward to completion. It is but fair to presume from the railroad facilities that give assurance of low freights, and the proximity of Indianapolis to a coal field which furnishes an abundant supply of the best bituminous splint coal for manufacturing purposes to be found in the country, that this pioneer establishment will soon be followed by others.

From the information which has been furnished and the encouragement given to manufacturers, it is believed that the State has already been benefitted more than tenfold the cost of sustaining the geological survey. The above explanation of the duties which have devolved on the State Geologist, outside of field explorations, will serve as an apology for any apparent dereliction of duty or want of finish in the published results of the department for the year 1869.

The limited amount of funds at my disposal would only admit of the employment of a small corps of assistants, who were kept at work but a small portion of the season.

Dr. G. M. Levette, of Indianapolis, has been engaged to collect information on the natural history of the State, and otherwise assist in the laboratory, office, and field work, and I take pleasure in acknowledging the valuable aid which the geological department has received from his labors.

Dr. Rufus Haymond, of Brookville, Franklin county, Indiana, was employed to make a survey and report on Franklin county. Although neither valuable metaliferous ores nor coal are to be found in this county, the law contemplates a complete survey of the entire State, and it was therefore deemed necessary to pay some attention to the resources of such counties as well as those more favored with mineral wealth. Franklin county was selected on account of being the home of the assistant, who was thus enabled to accomplish the same amount of work at a less cost than if sent to some distant county.

Prof. Frank H. Bradley, late of Hanover College, Ind., was engaged to make a survey of Vermillion county, he having previously acquired an extensive knowledge of the geology of that county from examinations made while surveying the adjoining counties in the State of Illinois.

The reports of these gentlemen are herewith respectfully submitted.

My first desire, on commencing the survey of the State, was to confine my own researches in the field, this season, to Clay and Greene counties, on account of the large amount of capital invested in mineral lands and blast-furnaces within their limits. But the great interest manifested, and intense excitement which continues to prevail in the country with regard to the developments of the iron-smelting coal known as "block-coal," subsequently determined me to push my investigations to the northern limits of the coal field in Warren county.

On my first visit to Brazil, in Clay county, the general impression seemed to prevail that the peculiar variety of coal familiarly known as "*block coal*," or "*Brazil coal*," was confined to a small basin, isolated from the great bitu-

minous coal fields of Indiana and Illinois, and limited to an area of a few square miles.

Indeed I found, at Brazil, those who were presuming enough to stand in the door of Rigby's Hotel and point out to me the extreme limits of the "Block coal" field in every direction. Of the fallacy of this prevailing opinion, regarding the coal fields of Indiana, I felt it to be my first duty to disabuse the public mind, and to do so it became necessary to extend the line of observations beyond the bounds first laid down. By thus increasing the field of labor, the survey of Clay and Greene counties has not been made as thorough as desirable, but on the other hand, from the fact that splint, or "block coal," has been traced from the southern limits of Greene county to Warren county on the north, a more extended knowledge of the iron-smelting coal has been acquired, and the mining and manufacturing interests of the State has been more fully advanced.

As the survey progresses, it is my intention to publish maps of each county, on which will be marked the boundaries of geological formations, and the location of coal mines, ore banks, stone quarries, etc., the county maps to be finally collated into a geological map of the entire State. In the present report will be found maps of Greene, Clay and Vermillion counties.

It affords me great pleasure, before closing these introductory remarks, to return my sincere thanks to the citizens of the districts surveyed, for the uniform kindness and attention that has been everywhere received at their hands, and for the deep interest which they manifested in the geological developments of the State.

To the following-named gentlemen I am under special obligations for favors:

Garlick & Collins, Brazil Furnace; William Watson, Superintendent Western Iron Company's Furnace; E. Jones, Superintendent Planet Furnace; John Andrews, Superintendent of Coal Mines at Brazil; John H. Masten, Superintendent Otter Creek Coal Mines; Captain Morris,

Superintendent Clay Coal Company's Mines; Henry Ashley, Brazil; David N. Barnett, Barnett's Mine; McClelland & Son, of Brazil; Major W. W. Carter, E. Teter, Esq. Elkins, T. J. Cromwell, of Bowling Green; Hon. J. Cooprider, Middleberry; James Ferguson, Major Morse, Ashboro; Dr. Gilfillan, Centre Point; Alfred West, Cloverland Station, Clay county.

Dr. J. A. Minnick, Esq. Andrews, Worthington; Captain M. H. Shryer, Colonel E. H. C. Cavens, A. G. Cavens, Mr. Clark, Judge Burns, Mr. H. S. Slinkard, Colonel Smith, Dr. Connelly, O. T. Barker, Bloomfield, Greene county.

Dr. Keith, J. R. Madden, and Mr. Armstrong, Edwardsport.

Mr. A. Raney, Bloomington, Morgan county.

Calvin Fletcher, Judge Franklin, Reuben H. Warder, Spencer, Owen county.

Colonel Edwards, W. J. Ball, Jacob Hagar, Terre Haute.

D. C. Donnohue, E. D. Andrews, Greene Castle.

Dr. D. W. Layman and son, W. B. Williams, Putnamville; Hon. A. D. Hamrick, Hamrick's Station, Putnam county.

John Collett, Joseph Collett, Jr., Hon. B. E. Rhoads, Samuel Groenendyke, Vermillion county.

General G. H. Steele, Judge Maxwell, Dr. Rice; Hon. Thomas Rice, William H. Nye, A. Darroch, Rockville; Hon. W. C. Danaldson, Montezuma, Parke county.

Joseph Poole, Secretary Indiana State Board of Agriculture, Marshall M. Milford, Alexander A. Rice, Attica; James McManamy, Mrs. E. M. McDonald, Covington; Norman B. Thomas, Silver Island, Fountain county.

Mrs. Debrow, Williamsport, Warren county.

John Sutherland, La Porte, La Porte county.

John M. Lord, John Thomas, Charles B. Parkman, officers of the Indianapolis Rolling Mill and Planet Furnace; V. Butch & Dickson, White River Valley Rolling Mills; E. J. Peck, John R. Elder, Colonel Harper, Indianapolis.

Also to the officers of the following railroads, for material aid in the way of free passes: Terre Haute & Indian-

apolis Railroad, Evansville & Crawfordsville Railroad, Indianapolis & Vincennes Railroad, Indianapolis, Cincinnati & Lafayette Railroad; Indianapolis, Peru & Chicago Railroad; Chicago, Cincinnati & Louisville Railway.

GEOLOGY.

The coal measures of Indiana form a portion of what is sometimes called the "Great Illinois Coal Field," a name given to the western coal measures by the late Dr. D. D. Owen, one of the very earliest of our pioneers in geology. This name not only applies to the coal area of Illinois and Indiana, but likewise to that of Western Kentucky, Arkansas, Missouri, Iowa, Kansas and Nebraska, from the fact that, they were all considered as parts of one great basin. The area of the coal measures in Indiana, which, in advance of a computation to be made from an actual detailed survey, may be stated to approximate (6,500) six thousand five hundred square miles, or one-fifth part of the entire State. Insignificant as this coal area may appear when compared to that of the whole United States, which has been estimated at 130,000 square miles, it is, nevertheless, more than half as large as the entire coal area of Great Britain and Ireland.

There are, perhaps, no phenomena connected with the changes to which the surface of this planet has been subjected, that appear so inexplicible and well calculated to fill the mind of the student of geological history with wonder and astonishment, as the occurrence of extended beds of mineral fuel, alternating with shale, sandstone and other rocks, through a great depth of strata. For so vast an accumulation of carbonaceous matter, at first view, there would appear to be no solution found in the causes now in action on the globe. But it is now, however, generally conceded that the deposition must have taken place

in water, from the fact of finding associated with the coal plants that grew in swamps, and the carbon of the plants in such a perfect state of preservation; the latter could not have been the case had the plants, like the forests of the present time, been exposed to the decomposing influences of the atmosphere.

Still further argument in favor of the theory that the plants of the coal grew in large marshy lakes, somewhat similar to the peat-bogs of the present time, is afforded by the characteristic beds of clay (fire clay), more or less plastic and arenaceous, which forms the under-stratum to all coal seams—leading to the inference that it formed the soil on which the plants of the coal period grew, being everywhere filled with the roots of trees, whose trunks and branches are found preserved in the roof-shales, and sometimes in the coal itself. It is not uncommon to find, in the entries of coal mines, the roof-shales beautifully ornamented with a continuous sheet of the compressed carbonized trunks of *sigillaria lepidodendron*, and other plants, with their surface-marks perfectly distinct and well preserved.

The plants of the coal period were not sub-aqueous, but required the influence of the sun's rays to promote their growth, just as we see in the great peat-bogs of the present time. By long continued subsidence, and subsequent elevation of the surface, the necessary conditions were obtained for the production of the coal.

The carboniferous age occupies a position about midway in that portion of the earth's crust which is accessible for study.

It has been divided into three periods. The lower is largely composed of limestone, and is known as the sub-carboniferous period—mountain limestone of the English geolgists. The middle division forms the true carboniferous period, from the fact of its being the great repository of mineral carbon—stone coal. It is estimated that ninety-nine hundredths of all the coal that is mined comes from this geological period. The permian epoch forms the up-

per division of the carboniferous age; but, at present, it is a matter of some doubt in the minds of many of our geologists—after considerable strife among them to establish claims to priority of discovery—whether the evidence, so far furnished, will justify its recognition as distinct from the carboniferous period.

The carboniferous period is usually divided into two epochs: millstone grit, or conglomerate, and coal-measures; the latter being again, sometimes, subdivided into lower and upper coal-measures, but I can find no necessity for or evidence to sustain this sub-division, either in Kentucky, Illinois, or Indiana. The upper or barren coal-measures of Owens' Kentucky Reports being nothing more than a repetition of his lower coal-measures seen at localities where, from local causes, the coals are of less thickness, or are entirely wanting, and their places are occupied by shale or other mineral matter. The millstone grit epoch lies at the base of the coal-measures, and is usually represented by a massive sandstone that is nearly always charged wtth quartz pebbles varying in size from a buckshot to that of a quail's egg. Though good thick beds of workable coal are found below this conglomerate in Indiana, Kentucky, and elsewhere in the United States, they are of rare occurrence in England, and the miners of that country have consequently given to it the name of "farewell rock." From the geological position of the millstone grit, it becomes necessary that we should give it our especial study, from the fact of its forming an important horizon to guide the miner in his search after coal—a task that is by no means so easy as at first view might appear, for the massive sandstone, which forms its principal feature, is not everywhere a conglomerate—that is, charged with pebbles—and at very many localities its lithological character appears in no respect to differ from the massive sandstones which are to be found at a higher geological level in the coal-measures. Nor will the proximity of a sandstone to the underlying carboniferous limestone, in the absence of other evidence, serve at all times for its identity, as the millstone grit may be en-

tirely wanting, and its place represented by superior strata, resting on rocks of a much greater age. An example of the latter condition may be seen at La Salle, in Illinois, where the coal-measures are resting on rocks belonging to the lower Silurian age.

The investigations I have made during the last three years in the Western coal fields have led to the discovery of great errors that exist in the reports of previous surveys made in the same district, at least so far as they relate to the coal-measures of Indiana, Western Kentucky, and Southern Illinois.

In the third volume of the Geological Report of Kentucky, pages 18 to 24, the coal-measures are divided into two epochs, designated as *upper* and *lower* coal-measures. The vertical section of the coals given in the above report is adopted entire in the subsequent report of a Geological Reconnoisance of the State of Indiana by Prof. Richard Owen, and an effort is made therein to have all the coal beds of Indiana conform to the arrangement of the coal beds as laid down in the Kentucky section above referred to.

Now, from the best of evidence, I feel authorized to say that this classification of the coals can no longer be retained, neither as regards the division of the strata into epochs, nor in the number and order of the coal beds. What has been designated by Owen and other geologists, in the district above referred to, as *upper* coal-measures, turns out to be merely a repetition of the *lower* coal-measures of the Kentucky section, seen where the shales have an increased thickness; and the beds of coal elsewhere referred to as the *lower* coal measures are either entirely wanting, or are reduced to a few inches in depth. Indeed, all the investigations I have so far been able to make go to show that it is only around the rim or margin of the western coal basin, and not throughout its *central area*, that we are to look for a succession of thick beds of coal. As we approach toward the central part of the basin, the coal beds which surround it are either entirely absent, or have dwindled down to seams that are only a few inches in thickness, their

places being occupied by a preponderance of argillaceous shale, some sandstone, and an occasional stratum of limestone.

The increased thickness and lithological character of the strata forming the central area of the Great Illinois Coal Field, with their paucity of coal, appears to point to the fact that their deposition took place in deep and quiet water, where the favorable conditions which prevailed so fully for the accumulation of carbonaceous matter in the shallower waters along the margin, were here, not such as would admit of a luxuriant growth of plants so essential for the formation of thick beds of coal. From numerous irregularities to be found in the coal measures, in many localities, we are further led to conclude that the bottom of the large marsh, or peat bog, in which coal beds were formed, was not an entirely level surface, but was subject to the same changes and inequalities that are to be found in the great peat bogs of the present day; and that it was traversed by streams, both large and small, in such a manner as to cause an accumulation of carbonaceous matter in one locality, and cut it away in others.

From this view of the subject, it is not at all strange that we should find coal absent in strata at some localities which are coal bearing at others.

The conglomerate, and likewise other massive sandstones, are often seen charged with fragments of coal and stems of trees, as though the currents which transported the sand and gravel of which the rock is composed had, in some places at least, cut away underlying coal seams; and it may be observed, as a general rule throughout this coal field, that wherever the usual argillaceous or bituminous roof shales are absent, and the sandstone is found resting immediately on the coal itself, the latter will seldom show its normal depth, from the fact that a portion of the top part of the bed was swept away by the forces which brought in the sand, and, in such cases, it is not at all unusual to find in the sandstone an abundance of plant remains, such as *Lepidodendron*, *Sigillaria*, *Calamites*, etc.

In the chronological arrangement of the western coal beds, published in the third volume Geological Report of Kentucky, and subsequently adopted in the Report of a Geological Reconnoissance of Indiana, published in 1859, there is, in addition to the error of separating the productive and barren coal strata into separate epochs, a further misplacement of strata and duplication of coal-beds below the "*Anvil Rock*" *sandstone*, which forms an important geological horizon in western Kentucky and Southern Illinois. Commencing with No. 1, B, of the Kentucky section, which is seen at Cannelton, Indiana, at Hawesville on the opposite side of the river, and at Bell's and Casey's mines on Tradewater river, a few miles to the eastward of Caseyville, on the Ohio river, in Union county, Kentucky, we have a generally recognized synchronism over a broad area of the coal measures, for the first bed of coal above the conglomerate that is of sufficient thickness to be economically worked.

Now, assuming this coal bed to be correctly placed, there is, thirty or forty feet above it, a thin seam, No. 2, that is nowhere over the district mentioned thick enough to work. But the "*Ice-house*" coal, No. 3, is the equivelant of No. 1, B, it having been mistaken for a higher coal. And the "*Curlew coal*," No. 4, is the equivalent of No. 11. Being seen in the Curlew hill, near Caseyville, it was mistaken for a lower coal.

The massive sandstone above the "*Curlew coal*," designated as the "*Mahoning sandstone*," in the reports above referred to, is consequently nothing more nor less than the "*Anvil Rock*" *sandstone* seen at another locality.

In consequence of the magnitude of these errors, the usefulness of the Kentucky section is completely destroyed in so far as regards the synchronism of coal beds, and its adoption, long unquestioned in this State, has been productive of much confusion.

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 be able to construct, after completing the detailed survey of the coal measures, a general vertical section that will prove harmonious in all its parts.

Notwithstanding the amount of study that has already been given by geologists to the coal measures of the West, we are just beginning to clear away the errors of preconceived notions, and instead of building conclusions upon speculative theories, the theories themselves are being made to rest upon *bona fide* examinations and well authenticated facts.

In tracing a seam of coal, it must be borne in mind that the quality of the coal in any given seam will seldom serve for its identity over any great extent of country, as in this respect it is subject to great variation. The same seam may be a free burning, hard, bituminous splint coal in one place, and a caking highly bituminous soft coal at another; nor will it do to rely upon the thickness of a bed of coal as a sure means of identity over any great extent of country, as in this it is also subject to great changes.

A single coal bed seldom exceeds five or six feet in thickness; when of greater thickness than this it is apt to contain a parting of fire-clay, which tends to show that it is a double seam, and liable, in other localities, to be separated by many feet of strata.

The efforts that have been made to identify the coal seams by the organic remains found in the roof shales, have also proved equally uncertain.

In consideration of the above facts, we are led to the conclusion that the only sure way of tracing the identity of a coal seam over a great extent of country, is to pay strict attention to the study of all the accompanying strata.

CLAY COUNTY.

This county is bounded on the north by Parke, on the east by Putnam and Owen, on the south by Greene, and on the West by Sullivan and Vigo counties. Its topography is marked by no very great diversity of surface; the hills are low, and present but few mural precipices where cut by the streams, being for the most part composed of argillaceous and arenaceous shales, rarely flagstones and thick bedded sandstones; they are capped with a thick deposit of glacial clay and gravel, with some boulders. A large portion of the county may be termed level, and from the tenacity with which the clay soil retains water, it is, for a part of the year, inclined to be wet. The principal watercourse is Eel river, a branch of the west fork of White river; it crosses the southern part of the county from east to south-west, and thence in a south-east direction in such a manner as to form a large triangular shaped bend; and contains throughout this part of its course a succession of remarkable horseshoe-like crooks; Birch creek and Croy's creek are tributaries of Eel river; the source of the former is near the town of Brazil, and with its tributaries drains the middle part of the county. The latter heads in the northern part of Putnam county, and flows through the north-eastern corner of Clay. The headwaters of north and south Otter creeks flow through the middle and western portions of the northern townships, in a westerly direction, forming, at their junction in Vigo county, Otter creek, a tributary of the Wabash river. Jordan and Six-mile creek are tributaries of Eel river, the former forms its junction at Bowling Green, and the latter at Belleair.

The Wabash and Erie Canal, (now abandoned south of Terre Haute,) passed through the south-west corner of the county. The supply of water for this part of the canal was obtained from the great reservoirs fed by Eel river and Birch creek. Splunge creek reservoir contained four

thousand acres, and the Birch creek reservoir, fourteen hundred.

When these immense reservoirs were constructed, the ground was covered by a dense forest growth, but the stagnant water killed the trees and caused the vegetation to decay, thus loading the air with miasmatic poison to an extent that jeopardized the health of the county for many miles around; therefore, considering themselves aggrieved, and seeing no chance for redress in the courts, the citizens of that part of Clay county bordering on the reservoirs resolved to take the law into their own hands, and, assembling in force, cut the embankments and let out the water. Troops were sent out by the Governor of the State to bring the guilty parties to justice, but resistance on the part of the citizens seemed so determined, and the impracticability of keeping up the canal having become apparent to most persons, it was finally concluded to let the matter rest, and the reservoirs no longer exist except in name, so that we could not even, at this time, find the exact locality of the one fed by Birch creek, in order to mark its original outline on the map.

The Terre Haute & Indianapolis and the Indianapolis & St. Louis railroads cross the "*block coal*" field in the northern part of the county, running nearly parallel with each other, and only about five miles apart. The former is one of the best managed railroads in the West. The track is always kept in the best of order, and the officers furnish every facility in their power to promote the large mining and manufacturing interests along the line of their road. Branch roads or switches have been built to the blast furnaces and to the most important coal mines now opened, both to the north and south of the main line, as shown on the map accompanying this report, making, in the aggregate, about fifteen miles of additional railroad facilities. Four passenger and six regular freight trains run daily each way over this road, and when it is borne in mind that nearly every regular freight train "flags" another, and that fully one-half of this business is derived from a very small part of the

coal lands of this county, some idea may be formed of its vast mineral resources, which are just beginning to be developed.

The Indianapolis & St. Louis railroad is not yet completed, but the work of construction is being rapidly pushed forward, and it is confidently believed that trains will be running through on this road early next summer. As this road also crosses the "block coal" belt in Clay county, some five miles north of the Terre Haute & Indianapolis railroad, there is every reason to believe that it will furnish along its line equal facitities for coal mines and blast furnaces.

Besides these two roads, a charter has been obtained for a railroad to run from Newburg, in Warrick county, on the Ohio river, in a northerly direction to Attica, in Fountain county. This road will run through the central part of Clay county, passing on its way through Bowling Green, Center Point, Brazil, and Carbon. Being located in the heart of the coal field, it will, when completed, afford fine mining facilities from one end of the line to the other. As nearly all the counties through which it will pass have voted liberal donations to aid in its construction, there is, consequently, a fair prospect that it will be built.

GEOLOGY OF CLAY COUNTY.

Clay county is situated on the eastern margin of the Illinois coal field, and contains within its area rocks belonging to the following geological divisions, namely:

Subcarboniferous limestone.
Millstone grit.
Coal measures.
Glacial or drift.

The subcarboniferous limestone formation embraces the oldest stratified rocks found in the county. The only outcrop of this limestone, which I saw, is exposed in the bank of Jordan creek, where it cuts through a ridge, one and a quarter miles northwest of Bowling Green, in the northeast quarter of section eighteen, town eleven, range five

west. At this point of exposure it is about ten feet thick, and contains characteristic fossils. *Productus cora*, *Pentramites pyraformis*, *Say*. *Sprifer incrassatus*, *Athyris subtilita*, and some fragments of unrecognized shells were seen. Above the limestone, at this locality, there is about thirty feet of arenaceous shale, with a considerable quantity of hydrated brown oxide of iron. This ore occupies the same geological horizon as the heavy deposits of iron ore found to the south, in Greene county, and being on the "line of strike," or outcrop, from the latter locality, it may prove to be extensive and valuable; at least the indications are sufficiently favorable to warrant me in recommending further search by sinking a few shallow shafts along its out-crop. The millstone grit epoch follows immediately above this limestone in regular sequence, and is very variable in its lithological character, and carries two or more coal beds. It is sometimes represented by a massive, coarse-grained rock, sixty to seventy feet thick, specked with peroxide of iron, and is usually separated into two beds by a parting of shale, with six to twelve inches of coal. At other points the massive rock is entirely replaced by a great depth of arenaceous shales, containing no coal. This massive rock is quite soft when first quarried from the bank, but soon becomes very hard on being exposed to the influence of the air. It varies in color from light buff to brownish red, and can be quarried in blocks of large dimensions. At most quarries it presents the character of a fair building stone.

Around Bowling Green the millstone grit is largely composed of arenaceous shales, with here and there a layer of very good building stone, specimens of which may be seen in the jail, which is built of sandstone, quarried a short distance south of the town. On the opposite side of the ridge in which the sub-carboniferous limestone is exposed, and in the same section, town, and range, the following section is seen, the lower coal of which belongs, apparently, just above the shales over the limestone. The connected section for the locality of Bowling Green is therefore:

Drift, gravel, and clay,	20 ft.
Shale and schistose sandstone,	15 ft.
Coal B.,	1 ft.
Fine potter's clay,	3 ft; 6 in.
Bluish-black argillaceous shale and rash-coal,	7 to 8 ft.
Coal A. ("block coal,")	1 ft. 3 in.
Fire clay with stigmaria,	? ft.
Arenaceous shale,	30 ft.
Subcarboniferous limestone,	10 ft.
Low water of Jordan creek,	0 ft.
	88 ft. 9 in.

Coals A. and B. were opened and worked to a small extent, for neighborhood use, by Esquire Elkins, of Bowling Green. The quality of the coal is good, but the seams are too thin to prove remunerative. The fire clay under B. is light colored and very plastic, and is adapted for the manufacture of stoneware. The shales above A. are filled with beautiful coal plants, that are difficult to preserve, on account of the friable nature of the shale. *Neuropteris Loschii, N. hirsuta, Sphenophyllum Schlotheimii, and Pecopteris arborescence;* large fruit, flattened trunks of *Sigillaria, Lepidodendron, and Calamites.*

Descending the hill on the east side of Bowling Green, the road cut exposes the following section:

Soil and drift,	30 ft.
Whitish-gray flagstones (place building stone,)	20 ft.
Coal B,	1 ft.
Fire clay,	2 ft.
Silicious shale,	13 ft.
	66 ft.

A quarter of a mile beyond, in a ravine, there is to be seen below this section three feet of coal-rash, resting on hard, arenaceous fire clay. On going up this ravine, the

coal-rash rises rapidly with the hill, and before reaching the top, it is united with the thin coal B., which is here overlaid by a thin, schistose, rough weathering sandstone, with marks of false bedding in places. Here, in the coal-rash, we also find an abundance of compressed trunks of coal-measure trees belonging to the same genera above noted.

Near Eel river, in the north edge of the town of Bowling Green, some time before my visit to the place, a shallow bore was made, which passed through a thin coal, (probably B.,) and the coal-rash of the above section. I was unable to learn any further particulars regarding the strata passed through in this bore, or the depth of it, but it is generally conceded that it is of but little depth. Sixty or seventy feet would surely have reached the subcarboniferous limestone, making a reasonable allowance for the thickening of the siliceous rocks to the westward of the exposure of this limestone on Jordan creek, in section eighteen, town ten, range five west. The ridge of millstone grit on which Bowling Green is situated, bears away to the south, touching Eel river just below Belleair, where it forms an abrupt escarpment on the east bank of the stream. The upper part being a heavy bedded, rough sandstone, the lower part shaley, with five or six bands of ironstone, in all from four to six inches thick. The latter is underlaid by shales and a thin coal. This coal was covered with water at the time of my visit, it being in the bed of the river, and is only exposed at low water. It is reported to be twenty inches thick, and is probably the equivalent of coal A. The section made of the rocks in the bank of the river, immediately above the coal, which is in section thirty-four, town eleven, range six west, and several hundred yards below the bluff of bedded sandstone, is here given. (Three feet of the lower part is given from report):

Soil and drift, ...	6 ft.
Blue argillaceous shale, with four to six inches of ironstone, . .	5 ft.
Schistose sandstone, with marks of false bedding, ...	8 ft.

Coal A.,	1 ft. 8 in.
Bed of Eel river,	0 ft. 0 in.
	20 ft. 8 in.

Coals A. and B. outcrop, also, in a ravine, near Mr. Kincaid's house, in section twenty-one, town eleven, range five west, where I obtained the following section:

Drift,	8 ft.
Coal dirt, (B ?),	– ft.
Siliceous shale, fissile,	10 feet.
Siliceous shale, compact,	2 ft.
Coal (A?) "block coal,"	1 ft.
Very white fire clay,	2 to 3 ft.

Two hundred yards further down the branch, into which the waters of this ravine run, the siliceous shale of the above section is replaced by a compact sandstone, from the base of which—and probably from off the coal—there breaks up in the bed of the branch a spring of mineral water, charged with carbonate of protoxide of iron, sulphate of protoxide of iron, and other mineral salts, most likely derived from the pyritic shales which form the roof of the coal.

From Bowling Green the millstone grit passes southward in the direction of Hausertown, in Owen county, and strikes White river at Point Commerce, in Greene county. Another branch of the main ridge, which starts off from the neighborhood of Hausertown, passes to the westward of Worthington, in Greene county, and crosses White river at the point known as "the Ripple," a few miles above Fairplay ferry; and to the northward of Bowling Green it skirts along the entire eastern boundary of the county, and in places extends in tongue-shaped points far out into Putnam county. At the base of the millstone grit is the great repository of limonite iron ore, not only in this State, but likewise in Ohio, Kentucky, Tennessee, Illinois, Missouri, Arkansas, and the territory of New Mexico. And in Clay county we find more or less iron ore all along its outcrop, but the main deposits yet seen lie to the southward in Greene county.

When argillaceous shales predominate at the base of this formation, the iron ore partakes of the character of an earthy carbonate, and lies in bands stratified with the shale; where sandstone forms the base, the iron ore is a silicious brown oxide.

The first variety of ore has been mined to a considerable extent south of Eaglesfield, in the western border of Putnam county, and smelted at the Planet furnace, but the expense of mining and transporting the ore to the furnace was too great to prove remunerative, and the mines have been abandoned.

The ore band is only four to six inches thick, and could only be mined by removing a large amount of worthless material, after which it had to be hauled two and a half miles to the railroad. The silicious oxide of iron is found in vast quantities in Greene county, and still further to the southward, which leads me to infer that it will yet be found abundant to the northward of that county, along the outcrop of the millstone grit.

At no place along the line of my survey has the millstone grit been represented by a conglomerate, or sandstone charged with quartz pebbles, but it varies in its lithological features from a thick bedded sandstone, of various colors, to silicious shale; its total depth is very irregular, also, being much greater at some places than at others.

This frequent variation in the depth and character of these strata, renders the study of the millstone grit epoch very difficult, especially in this region, and it is therefore quite possible that I have, in some places, along the margin of the basin, committed the error of mistaking its shales for coal-measure strata, and *vice versa*, especially where the country is level, and no well marked characters can be found to serve as a guide; for it must be borne in mind that in this part of the carboniferous basin the millstone grit is coal bearing, and the quality of its coal appears to differ, in no respect from the true coal measure beds, being, like them, "block," or non-caking coal.

COAL MEASURES.

In order to show more clearly the position of the coal strata and subordinate formations in Clay county, a vertical section is given, which represents the geological order of the strata between Greene Castle on the east and Terre Haute on the west, constructed from outcrops along the line of the Terre Haute and Indianapolis railroad, and from the record of deep bores. (*See colored section.*)

In the city of Terre Haute, at about the level of the crossing of the Terre Haute & Indianapolis and the Evansville & Crawfordsville railroads, a bore was made for Mr. Chauncey Rose, which went to the depth of seventeen hundred and ninety-three (1793) feet, passing through the carboniferous, and stopped in the subcarboniferous rocks, just above the Marcellus shale, as I propose to show, by the comparison of its section with that of other bores.

At Terre Haute, three horizons of salt water are noted in the carboniferous strata, and there are probably others, still lower down, that are not recorded, for the reason, possibly, that the brine above was not stopped out but allowed to fill the bore for some depth below.* A "show of oil" and two oil-veins were passed, from the lower of which there was a considerable flow of oil. The sulphur-water which is found in the lower one hundred feet, rises to a considerable elevation above the surface, with an irregular pulsating flow, and is mixed with gas emitting a strong odor of sulphuretted hydrogen, and leaves on the reservoir a deposit of sulphur. The analysis made of this water, for Mr. Rose, by J. G. Pohle, M. D., indicates that it possesses fine medicinal properties. From one gallon of the water he obtained 365.067 grains of solid matter, composed of

Chloride of Sodium,	316.000	grains.
Chloride of Magnesium,	6.428	"
Chloride of Calcium,	4.816	"
Chloride of Potassium,	1.232	"

* Since writing the above I have been credibly informed that good brine was reached at several horizons in this space, and that at thirteen hundred feet a brine was struck which indicated 13° on Baume's Saltometer. Fifty gallons of brine of this strength will make one bushel of salt, fifty-six pounds.

Bicarbonate of Soda,	.520	grains.
Sulphate of Lime,	2.325	"
Bicarbonate of Magnesia,	6.420	"
Bicarbonate of Lime,	25,026	"
Silicic Acid and Alumina,	1.200	"
Nitroginous organic matter,	1.100	"
Bromide of Magnesium,	trace.	
Sulphate of Calcium,	trace.	
Phosphates of Lime,	trace.	
Also, Sulphuretted Hydrogen, and Carbonic gas.		
	365.067	grains.

For the record of the bore at Reelsville, on the Walnut Fork of Eel river, in Putnam county, I am indebted to Mr. David N. Barnett, who lives a few miles south of the well. This bore is twelve hundred and forty (1240) feet deep, and notwithstanding it commences by the railroad levels, one huudred and seventy-six (176) feet above Terre Haute, it starts in strata that are geologically seven hundred and fifty-four (754) feet below the surface at that place, and penetrates strata that are two hundred and fifty (250) feet below the bottom of the Terre Haute artesian well.

This difference in the geological horizons of the two places is readily accounted for, by a very slight dip of the strata to the west. At Reelsville four horizons of salt water are passed, one in the subcarboniferous limestone, two in the subcarboniferous sandstone, and the fourth below the Marcellus shale, and probably in the Devonian. Near the bottom of the well, and in silurian strata, artesian sulphur-water is reached, that appears, from the taste, to be very similar, in its mineral constituents, to the artesian water at Terre Haute. It rises in a copious stream to the height of twenty feet, or more, above the surface.

Another great well was bored for oil, at Lodi, in the south-west corner of Fountain county, which passed through five distinct horizons of salt water, one in the

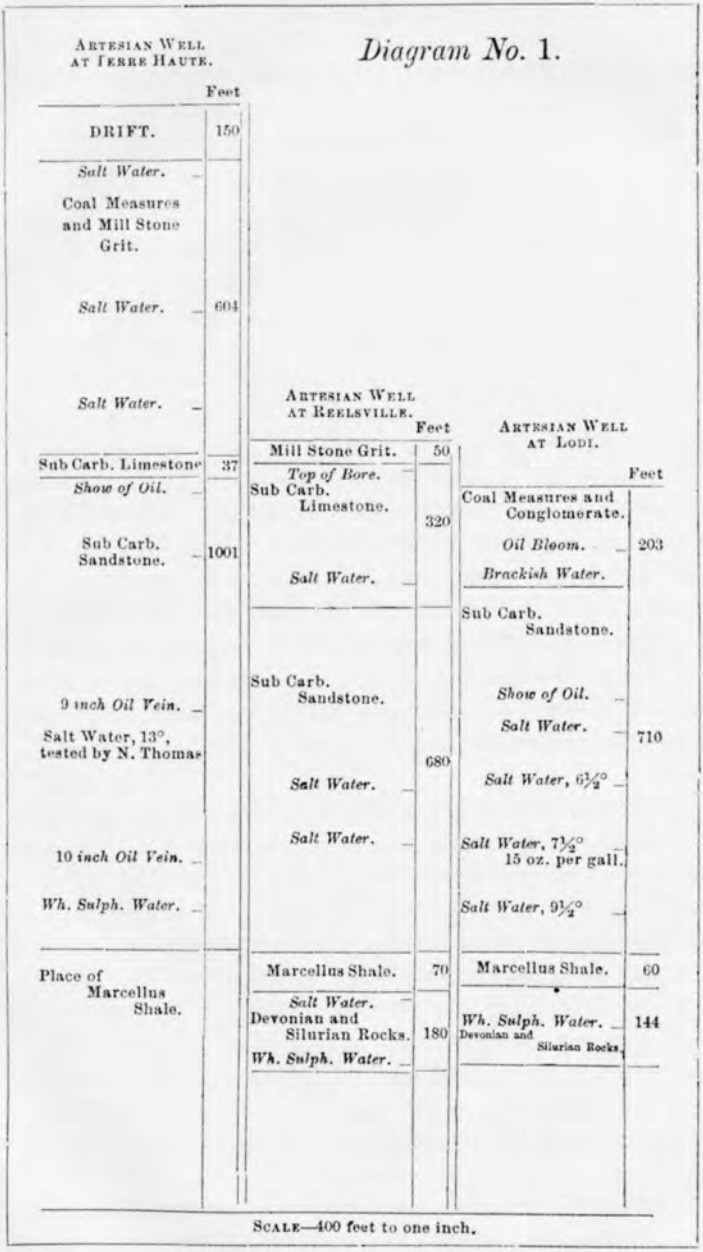
coal-measures, another at the base of the millstone grit, and three in the subcarboniferous sandstone; the lower brine, marked seven and a half degrees of Baumé, being equal in strength to the brine at Kanawha.

For a detailed, highly interesting and accurate record of the bore at Lodi, I am under obligations to Mr. John Collett, of Eugene, in Vermillion county, Indiana, who 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. At about the same geological level as in the well at Reelsville, a most remarkable stream of sulphur-water was reached, which rushed with tremendous force up a ten-inch tube to the height of forty-three feet above the level of the ground, and discharges about one hundred thousand barrels of water per day. An analysis of this water was made by Dr. Pohle, from which it appears to be one of the most remarkable and valuable medicinal waters found in the world. Around the well sulphur is deposited in solid flakes on every substance which is reached by the spray from this gigantic fountain, and the odor of sulphydric acid may be readily perceived, under favorable conditions, at a distance of half a mile from the well.

The Marcellus shale, which is also found in the Lodi bore, being everywhere a black bituminous rock, that will burn when thrown on the fire so long as the bitumen lasts with which it is charged, but its stony substance remains unchanged, and though often mistaken by the uninitiated for coal, on account of its color and limited inflamability, it is entirely worthless for fuel; but, on account of its marked features and great depth, being seventy feet at Reelsville and sixty feet nine inches at Lodi, as shown by the bores; it is of special importance as a guide to the geologist, from its forming a conspicuous horizon that is readily recognized by the well-borer.

Now, taking this Marcellus shale as an established base, and arrange accordingly the sections of the three bores,

Diagram No. 1.



SCALE—400 feet to one inch.

just spoken of, side by side, as shown in the accompanying diagram, No. 1, and assuming that the bore at Terre Haute stopped near the top of the Marcellus shale, a remarkable correspondence of the strata is perceived in the two bores, the agreement being almost as close as one could expect to find in two bores at a much less distance apart.

As we go westward the subcarboniferous limestone appears to have given place to shale and sandstone.* The former is three hundred and twenty feet thick at Reelsville, but is only thirty-seven feet thick at Terre Haute, and was not found at all at Lodi—though a few feet of limestone, equavalent to the Keokuk limestone, is seen at the base of the millstone grit at Williamsport, about twenty-five miles a little east of north, from the former place.

In the record of the bore at Lodi, Mr. Collett, for whose opinion I have great respect, marks the base of the conglomerate at five hundred and sixty-five feet; but in this I must differ from him, and place it as shown in Diagram No. 1, at the depth of two hundred and three feet and nine inches. In justification of this correction, it may be well to state, that the millstone grit is found a few miles to the northeast and south of Lodi, and is universally along the margin of the basin, overlaid by coal seams, with no great space intervening, and very often coal is found below it.

The horizons of salt water correspond so completely in the two bores that we are at once led to conclude that throughout Clay county, and the entire coal field of this State, deep wells are likely to reach good salt water, equal in strength to the brines on the Kenawha river in Virginia at about the levels indicated on the section of the bores in the preceding diagram.

On account of the great development of the subcarboniferous sandstones and shales in which petroleum is found so abundant in Pennsylvania, Ohio, and West Virginia, our

*This is not shown on the colored section. The depth of the limestone at Reelsville is carried through to Terre Haute. The limestone, as we go west, appears to be displaced by sandstone and shales that are synchronous with the limestone at Reelsville.

prospect for oil in this part of Indiana is not so discouraging as geologists have, heretofore, been led to believe. In fact, from the present evidence, there is strong probability that oil may be found in sufficient quantities to pay for working. The few unsuccessful wells that have been bored in Indiana serve by no means to definitely settle the question with regard to the possibility of finding oil in paying quantities, nor to discourage further efforts in its search. In Pennsylvania, and elsewhere, we find numerous wells bored that fail to reach oil; indeed, it is a well established fact that barren wells are more numerous than productive ones in the most highly favored oil territory. Measuring from the Marcellus shale (on Diagram No. 1) upwards, the space between it and the millstone grit, at Reelsville, is one thousand feet; at Lodi, seven hundred and ten feet; and at Terre Haute, (assuming that the bottom of the bore at that place is near the top of this shale,) one thousand and thirty-eight feet. Now, since the *colored section* is made to a scale of two hundred feet to the inch, in vertical height, the depth to which a bore will have to go to strike the oil or brine horizons, at any given point between Greencastle and Terre Haute, may be readily determined with a remarkable degree of accuracy.

From Reelsville, in Putnam county, the strata dip to the westward at the rate of about thirty feet to the mile of horizontal distance. This low rate of dip is not rendered perceptible unless followed to some distance, when the changes it brings about in the strata are made wonderfully manifest. The subcarboniferous limestone and millstone grit are carried below the surface; the former seven hundred and fifty-four feet below the crossing of the Terre Haute & Indianapolis and the Evansville & Crawfordsville railroads at Terre Haute, which point is four hundred and eighty-three feet above high tide of the Gulf of Mexico, and about fifty-two feet above the low water of the Wabash river.

The coal measures make their appearance along the line of this section, in Clay county, increasing rapidly in thick-

ness as you proceed toward the Wabash river, and for some distance beyond that stream in Illinois. As the strata increase in depth, the beds of coal disappear, and are replaced by shale and other rock. Their absence being first noticed in the lower strata in Marshall county, Illinois, not more than twelve miles west of the Wabash river, where, notwithstanding a still greater development of the coal measures, by the acquisition of superior strata, we see they are, nevertheless, barren of coal beds of a workable thickness, from the upper to the lower strata.

The following diagram (No. 2) exhibits a connected section of the coalmeasures and coal beds in Clay and Greene counties, extending down to the base of the millstone grit, which contains two or more coal beds, one of which is of good workable thickness. The short time that has yet been given to the survey of the coal field in this State renders it highly probable, as I make no pretensions to infallibility, that some errors may still exist in regard to the placing of the seams of coal in this section. It is, therefore, only provisionally given at this time, in order to facilitate their study.

The space between coals B and F appears to be barren of coal seams in the counties examined, and a skip in the order of lettering has been made, with the expectation that coal-beds will be found to fill out some of the blanks, at least in other parts of the State.

Coals A and B are to be seen along the eastern border of Clay county, and in places some miles beyond, and within the limits of Putnam county; but here, so far as yet discovered, they are too thin for profitable working, especially while thicker beds can be had close by. The quality of the coal is generally good but variable, being, at some places, non-caking, or "block," and at others "caking-coal."

Where the former character prevails, these coals will answer for making iron in blast-furnaces.

On the east side of Bowling Green, and at the foot of a ravine, the space between coals A and B is twelve to fifteen

feet, which gradually diminishes as you ascend to its head, where they unite in one seam from one and a half to two feet thick. Coal A ranges from one and a half to three feet in thickness, but B seldom exceeds one foot. As these coal seams have already been alluded to in connection with the millstone grit, and the horizon at which they may be found being clearly set forth in the connected section, I will now proceed to speak of the more important coals, from a manufacturing point of view, to be found within the entire limits of the *great western coal field.*

These coals are marked F, I, and K, on the connected section, and may be referred to as "lower block," "main block," and "upper block-coals."

The main "block-coal," I, ranges from three feet eight inches to four feet four inches in thickness, and the lower and upper coals from one foot six inches to three feet six inches. They were first mined in the vicinity of Brazil, and are found occupying a belt that, in Clay county, is from three to ten miles in width, and in length extending from the northern limits of the coal basin, in Warren county, as far south as the present limits of my survey, in Greene county; and it is my opinion that it will be found still farther south.

"Block-coal" is a name used by miners to designate a variety of non-caking bituminous coal, which was first discovered on the western border of the Appalachian coal-field, along the Mahoning valley, in the State of Ohio, where it is also extensively used in blast-furnaces, direct from the mine. In many respects it closely resembles the Scotch "splint" coal; it is free burning, contains a small amount of white ash, is remarkably free from sulphur, has a splinty fracture, and emits a dull ringing sound when struck with the hammer. The beds of this coal are traversed by narrow vertical fissures, that are, nevertheless, quite distinct, the main system of which run a little east of north, and being crossed at right angles by others, they separate the coal strata in such a manner that the coal may be mined in large cubes or blocks, which exhibit the whole depth of the bed—hence the probable origin of the name

Diagram No. 2.

CONNECTED SECTION OF COAL MEASURES IN CLAY AND GREENE COUNTIES, INDIANA.

Spaces. Feet	In.	Feet	In.	
		23		*Drift.*
43	6			
		19		*Hard-Pan.*
		1	6	Sandstone with Iron Ore.
		4		*Coal N.*
		7	6	*Fire Clay.*
		1	6	*Sandstone.*
31	4	12	9	*Shale.*
			6	Fossiliferous Iron Ore.
		7	7	*Shale.*
		1	6	Bituminous Shale.
				Coal M.
		5	8	*Fire Clay.*
		4		*White Sandstone.*
30		5		*Dark Sandstone.*

CONNECTED SECTION OF COAL MEASURES—*Continued.*

Spaces. Feet	In.	Feet	In.	
		14	6	*White Sandstone.*
			10	Bituminous Shale.
		7		*Coal, L.*
		4		*Fire Clay.*
		4	6	*Sandstone.*
14	2	1	6	Bituminous Shale.
		2	6	Fossiliferous Limestone.
		1	8	Bituminous Shale.
		1	10	*Coal K, (Upper Block).*
		5		*Fire Clay.*
14	6	9	6	*Shale.*
			7	Coal, J.
		4		*Sandstone.*
11		7		*Fire Clay.*
		4	4	**Coal I, Main Block.**
12	6	10	6	*Fire Clay.*
		2		Bituminous Shale.
		1	5	Coal, H.
		3	9	*Fire Clay.*
25	2	4	6	*Slate.*
		5		*Fire Clay.*

CONNECTED SECTION OF COAL MEASURES—*Continued.*

Spaces.		Feet	In.	
Feet	In.			
		2	9	Shale.
		3	1	Sandstone.
		5	6	Shale.
			7	Bituminous Shale.
			5	Coal, G.
		1	6	Shale.
		4		White Sandstone.
		1	4	Dark Sandstone.
		7		*Shale.*
24	6			
		2		*Sandstone, Dark.*
		6	2	*White Sandstine.*
		2	6	Bituminous Shale.
		3	8	*Coal, F, (Lower Block).*
		7		*Sandstone.*
		1	3	*Fire Clay.*
		5		*Gray Shale.*
				Argillaceous and Silaceous Shales bored into at Harmony, Clay Co,
		109		
263	9			

CONNECTED SECTION OF COAL MEASURES—*Continued.*

Spaces. Feet	In.		Feet	In.	
			150		*Millstone Grit, Shales and Massive Sandstone.*
			2		*Coal, B.*
20			20	4	
			3		*Coal, A.*
			3		*Argillaceous Shales.* *Heavy Deposits of Iron Ore.*
					Sub-Carboniferous Limestone.

RECAPITULATION.

Feet	In.	
43	6	
4		Coal, N. (Perring).
31	4	
	6	Coal, M.
30		
7		Coal, L. (Staunton).
14	2	
1	10	Coal, K. (Upper block).
14	6	
	7	Coal, J.
11		
4	4	Coal, I. (Main Block).
12	6	
1	5	Coal, H.
25	2	
	5	Coal, G.
24	6	
3	8	Coal, F. (Lower Block).
263	3	
2		Coal, B.
20	4	Millstone Grit.
3		Coal, A.
3		
522		Total.

Aggregate Thickness of Coals---28 9-12 Feet

"block coal." The sides of the blocks are regular, and usually stained with oxide of iron, which is probably caused by the infiltration of ferruginous waters along the joints. When entries are driven across the main joints of the block-coal beds, the face of the mine presents the zig-zag, notched appearance, of a Virginia worm fence.

Block-coal has a laminated structure, and splits readily into sheets, that have their surfaces covered with a dull-black, soft, fibrous, carbonaceous matter resembling charcoal; while, on the other hand, it is difficult to break in the opposite direction to the laminæ; and this fracture exhibits a splinty structure marked by alternate layers of dull and shining black coal. In coking, it scarcely swells or changes form, and never cakes or runs together. It is this latter character which gives to the "block-coal" its peculiar value as a fuel for smelting iron ores, while it has sufficient bitumen—in the form of gaseous matter—to render it highly inflammable; and the blocks retain their shape until burnt to ash, in such a manner as will admit the ready passage of the blast and flame through the entire mass of fuel, ore and flux.

On the other hand, the bituminous, caking-coals, of which the Pittsburg coal may be taken as the type, swell and run together, so that the blast cannot force the flame through the contents of the furnace, and the whole mass becomes chilled for want of sufficient heat to melt the ore.

By reference to the map of Clay county, which accompanies this report, the outcrop, and mining-shafts, and all coal-beds, are designated by a black square (■), and the equivalency of the coal-beds by letters, corresponding with those of the continuous section.

In the northern part of the county, and in the vicinity of the Terre Haute & Indianapolis railroad, numerous shafts are sunk, and a great many bores have been made for the purpose of determining the extent and limits of the main "Block" coal-bed (I). My researches go to show that that portion, at least, of the coalmeasures in which this coal is found, is much disturbed by horsebacks and other

irregularities in the strata; hence the manifest necessity of making frequent bores over level tracts of land, where no outcrops are to be seen, in order to ascertain the best location for sinking a mining shaft, and to acquire the assurance that a wave in the rocks has not brought up the strata of coal to a position that left it liable to be cut away by the disintegrating forces which covered this county with debris during the glacial epoch.

The spaces between the *upper*, *middle* and *lower* "block" coal beds, (K., I. and N.,) are subject to great changes, as will be shown by the sections which are to follow, and I have reason to believe that, in some places, two of these coals are united in one bed. Then again, on going west from Brazil these spaces are seen to contain one or more intercalated seams of coal. East of the Planet furnace, on section twenty-two, town thirteen, range six west, the sandstone, which locally overlies coal I, outcrops in a small branch of Croy's creek. The coal below it is worked by a shaft at the furnace, and also by another shaft (the Star mine) one and one-quarter miles northwest of the former, on the northeast quarter of section twenty-one, in the same township and range. Both of these mines are owned and worked by the Indianapolis Rolling Mill Company, and I am indebted to Mr. E. Jones, foreman at the furnace, and to Mr. Haggert, superintendent of the mine, for much information and valuable assistance in obtaining an accurate detailed section of the shaft at the "Star Mine," which is eighty-seven feet six inches in depth; seventy feet to the bottom of the coal.

SECTION OF STRATA IN "STAR MINE."

Red clay, ...	14 feet 7 inches.
Hard pan, ...	4 ft.
White sandstone, ...	23 ft. 6 in.
Silver-gray sandstone, . . .	15 ft.
Blue argillaceous shale, . . .	1 ft.
Light-gray sandstone, with carbonaceous markings in the seams, . .	2 ft. 11 in.

Blue argillaceous shale, . . .	3 feet 3 inches.
Block coal, I, ...	4 feet 8 inches.
Soft, dark fire clay, containing roots of plants, ...	3 feet 6 inrhes.
Light-gray sandstone, in the bottom of shaft, ...	15 feet.
	87 feet 6 inches.

This shaft is located in a small basin, as the coal appears to rise from it in all directions. The mine is reached by a switch from the Terre Haute & Indianapolis railroad, and the coal is used for making iron at the Planet furnace, which is owned by the same company as above mentioned.

For manufacturing iron, this coal is not surpassed by any in the county, as may be seen by the following exhibit of its anaysis:

Specific gravity, 1.264; weight of a cubic foot, 79 lbs.

Coke, ...	64.00.	Ash, white, . . .	2.5.
		Fixed carbon, . .	61.5.
Volatile matter, .	36.00	Water, ...	3.5.
		Gas, ...	32.5.
	100.00.		100.0.

The structure of the coke shows but little change from that of the coal. It is not swollen and puffed out, but lamellar, dense, and without lustre. The large amount of fixed carbon, and the small quantity of ash and water which this coal contains, gives it a higher rank for heating purposes than is possessed by the caking coals brought to Indianapolis from Pittsburg. An analysis was made of a picked specimen of Pittsburg coal, obtained from one of the Indianapolis coal dealers, and is here given for the sake of comparison:

Specific gravity, 1.189; a cubic foot weighs 74 lbs.

Coke, ...	57.9.	Ash, white, . . .	1.0.
		Fixed carbon, . .	56.9.
Volatile matter, .	42.1.	Water, ...	1.0.
		Gas, ...	41.1.
	100.0.		100.0.

Coke very much swollen and puffed out; form of the coal quite changed. It contains 4.6 per cent. less carbon than the Star mine coal, but has less ash and less moisture. The latter quality adds to its value, while the loss in carbon depreciates it.

The superiority of the Star mine coal for fuel is due, mainly, to the fact of its being an open, free-burning coal, that ignites readily, and will reach the initial heating point in a much shorter space of time than the Pittsburgh coal, which property renders it of great value as a steam producing coal, and incomparable for locomotive use.

Going south from the Planet furnace, and before reaching Harmony, a village on the Terre Haute & Indianapolis railroad, the coal strata outcrop or have been removed by denudation, as a bore made at that place to the depth of one hundred feet—after passing through the drift or glacial depost—was in argillaceous shales to the bottom, and passed no coal.

At Knightsville, two miles west of Harmony, on the Terre Haute & Indianapolis railroad, the main "block" coal, I, is mined by the Western Iron Company to supply their two blast-furnaces. The following analyses were made of two specimens of coal taken from these mines, that possessed the general appearance of all the coal taken from this bed:

(a.) Specific gravity, 1.176; a cubic foot weighs 73.5 pounds.

Coke,	60.1	Ash, white,	0.3
		Fixed Carbon,	59.8
Volatile Matter,	39.9	Water,	9.0
		Gas,	30.9
	100.0		100.0

Form of coal but little changed in coking, and it does not cake and run together.

(b.) Specific gravity, 1.167; a cubic foot weighs 72.93 pounds.

Coke,	59.0	Ash, white,	2.0
		Fixed Carbon,	57.0
Volatile matter,	41.0	Water,	8.0
		Gas,	33.0
	100.0		100.0

Character of coke same as in the preceding.

At the Western Iron Company's Furnaces, the sandstone over the main coal is not so thick as it is at the star mine, and the shaft is only forty feet deep, and the coal averages three feet nine inches in thickness. Going to the northwest of these furnaces, the coal strata rises, so that in two hundred and seventy yards from the shaft, it may be reached at the depth of eighteen feet.

I am under obligations to Mr. William Watson, superintendent of the Western Iron Company's works at Knightsville, for the following instructive sections of bores made under his supervision on the Bahan farm, in the south-west quarter of section 21, township 13, range 6, west:

(No. 1.)—

Surface, soil and clay,	7 ft.
Soft clay and sand,	2 ft.
Hardpan,	13 ft. 10 in.
Hard clay and sand,	13 ft. 2 in.
Soft brown clay, with driftwood,	2 ft. 0 in.
Soapstone,	1 ft. 8 in.
Coarse gravel and sand,	ft. 4 in.
Hard clay and sand,	8 ft. 6 in.
Sandstone,	0 ft. 2 in.
Soapstone,	6 ft. 5 in.
Coal K (top seam),	0 ft. 1 in.
Fire Clay,	1 ft. 1 in.
	59 ft. 3 in.

(No. 2.)—Section of bore on same farm:

Surface and Clay,	7 ft. 6 in.
Soft clay and sand,	7 ft. 0 in.
Hardpan,	1 ft. 0 in.
Hard brown sandstone,	5 ft. 2 in.
Potters' clay, probably the under clay to coal K,	1 ft. 2 in.
Blue slate,	2 ft. 2 in.
Iron ore,	0 ft. 3 in.
Blue slate,	2 ft. 2 in.
Iron ore,	0 ft. 1 in.
Blue slate,	1 ft. 5 in.
Iron ore,	0 ft. 1 in.
Blue slate,	0 ft. 7 in.
Slate, with thin sandstone,	1 ft. 3 in.
Soapstone,	5 ft. 3 in.
Sandstone,	26 ft. 1½ in.
Slate,	0 ft. 1 in.
Coal I,	4 ft. 3 in.
Fire clay,	0 ft. 0 in.
	65 ft. 9½ in.

The fire-clay, 43 feet 9½ inches above coal I, is probably the under clay to coal K.

(No. 3.)—Section of bore on same farm:

Surface-soil and clay,	8 ft. 6 in.
Soft clay and sand,	7 ft. 0 in.
Hardpan,	2 ft. 0 in.
Hard sandstone,	6 ft. 1½ in.
Soft, bluish sandstone,	7 ft. 6 in.
Coal K, top seam,	2 ft. 2½ in.
Rash coal,	0 ft. 6 in.
Fire-clay, good quality,	4 ft. 9 in.
Sandstone,	0 ft. 2 in.
Light-blue sandstone,	9 ft. 6½ in.
Rotten limestone (?)	3 ft. 8 in.

Blue shaly sandstone,	9 ft.	2 in.
Sandstone,	10 ft.	5½ in.
Coal I, main "Block,"	4 ft.	2 in.
Fire-clay,	0 ft.	0 in.
	72 ft.	9 in.

The space between I and K, in this bore, is 42 feet 5 inches—very nearly what it is in bore No. 2, assuming its place to be above the potters' clay.

(No. 4.)—Section of bore on the same farm, near the outcrop of coal I:

Surface soil and clay,	6 ft.	6 in.
Soft clay and sand,	8 ft.	6 in.
Brown hardpan.	6 ft.	6 in.
Bluish hardpan,	5 ft.	6 in.
Soapstone,	8 ft.	4 in.
Coal I, main "Block,"	2 ft.	6 in.
Rotten coal,	1 ft.	1 in.
Fire-clay,	6 ft.	5 in.
Sandstone,	3 ft.	3 in.
Pale blue slate,	1 ft.	9 in.
Arenaceous shale,	2 ft.	2 in.
Blue sandy shale,	12 ft.	8 in.
Coal F,	1 ft.	7½ in.
	66 ft.	9½ in.

At "Weaver's Switch," half a mile west of Knightsville, a shaft was sunk, in 1862. by Mr. John Andrews, who superintends the mines of Andrews, Butch & Dickson, and passed through the following material:

Drift,	18 ft.	0 in.
Dark-gray sandstone, lower part soft, and mixed with coal,	6 ft.	0 in.
Coal I,	0 ft.	6 in.

Fire-clay and argillaceous shale, .	12 ft. 0 in.
Sandstone, ...	4 ft. 0 in.
Coal F, ...	1 ft. 8 in.
Hard arenaceous fire-clay, . .	4 ft. 0 in

The shaft ends here; but a bore was made which passed through strata as follows, viz:

Very white sandstone, coarse grained, and excellent for building purposes, may answer also for making glass, .	12 ft. 0 in.
Bluish, argillaceous shale, . .	16 ft. 0 in.
Argillaceous shale, soft, and easily bored, . . .	65 ft. 0 in.
	143 ft. 2 in.

The coal in the "Weaver-Switch" shaft dips one foot in twelve to the east, and thirty rods in that direction, from the above described bore, Mr. Andrews put down another, which passed through the following strata, viz:

Drift, ...	12 ft. 0 in.
Coal I, ...	4 ft. 0 in.

A few yards from this he sunk a shaft to coal I, which he found at the same depth as indicated by the bore, and from the bottom of this shaft he bored sixteen feet, to coal F, passing through the same material found in the "Weaver-Switch" shaft.

As coal I has no substantial roof above it at this place, it could not be worked economically, and the shaft was abandoned.

At Brazil, and to the eastward and northward of that city, and along South Otter creek, coal I is mined in many places. The following list comprises the most prominent of the coal mining companies of that section: Garlick & Collins, three mines—one in south-east quarter of section

25, township 13, range 7 west, and two others in the south-east quarter of section 24, township 13, range 7.

The following is the result of an analysis of a characteristic specimen of coal from the first named mine.

Specific gravity, 1.230; a cubic foot weighs 76.87 lbs.

Coke,	60.5	Ash, lead color,	3.0
		Fixed carbon,	57.5
Volatile mater,	39.5	Water,	8.5
		Gas,	31.0
	1.000		1.000

The structure of the coal was but slightly changed in coking, and the coke was brilliant, dense and brittle; the large amount of water found in this coal, may be owing, in part, to the fact that, the specimen analyzed was fresh from the mine, and had been exposed to a rain storm the night previous.

Andrews, Butsch and Dickson, three mines; all on the east half of section 30, town 13, range 6.

Strain & Schurmann, one mine in the north-west quarter of section 31, town 13, range 6.

Jane Ernhart, one mine in the north-east quarter of section 30, town 13, range 6.

Otter Creek Coal Company, one mine in the south-west quarter of section 19, town 13, range 6.

—— Jones, one mine in the north-east quarter of section 26, town 13, range 7 west.

Dr. Mansur Wright, two mines in the north-east quarter of section 25, town 13, range 7 west.

Clay Coal Company, one mine in the north-west quarter of section 19, town 13, range 6.

Niblock Coal Company's mines in the north-west quarter of section 19, town 13, range 6.

McClelland and Son, one mine in the north-west quarter of section 17, town 13, range 6.

Indiana Coal Company's mines, in the north half of section 17, town 13, range 6.

Indianapolis Rolling Mill Company, two mines; one at the Planet Furnace, in the south-east quarter of section 22, town 13, range 6, and one in the north-east quarter of section 21, town 13, range 6.

The above list, I think, comprises all the points at which the "Block" coal is being worked north of the Terre Haute and Indianapolis Railroad. A list of the openings south of the railroad will be given in due order.

The *Upper*, *Middle* and *Lower* "Block" coal seams all out-crop between the house of Mr. John Andrews and Mrs. Jane Ernhart's mine, on a small tributary of South Otter Creek. The upper seam, K, is overlaid by a fossilferous limestone, in which I found *Productus cora*, *P. semireticulatis*, *P. Wabashensis*, *Spirifer cameratus*, *Chonetes mesiloba*, *Athyrus subtilita*, and large *encrinite* stems.

In the following section, obtained at Andrews, Butsch and Dickson's shaft, just back of Mr. Henry Ashley's residence, this limestone is eleven feet thick.

Section of strata, passed through in the shaft just named, on Mr. Ashley's land, one mile east of Brazil:

Soil and drift,	20 ft.	0 in.
Fossiliferous limestone,	11 ft.	0 in.
Blueish soapstone,	6 ft.	0 in.
Coal, K, (Upper "Block,")	1 ft.	6 in.
Gray shale,	16 ft.	0 in.
Thin bedded, light-colored sandstone, containing reddish bands colored with protoxide of iron,	18 ft.	0 in.
Stiff blueish, argillaceous shale,	1 ft.	4 in.

This shale varies in thickness from 0. to eight feet.

Coal I, main "Block,"	3 ft. 10 in.
Good fire clay for pottery,	1 ft. 6 in.
Hard siliceous clay, mixed with iron balls,	6 ft. 0 in.
The shaft ends here, and from this point they bored into Hard blueish shale	6 ft. 0 in.
Soft sandstone, with layers of yellowish clay,	20 ft. 0 in.
Coal, F,	0 ft. 3 in.
Fire clay, ?	
Argillaceous and siliceous shale,	60 ft. 3 in.
Gray shale, with iron balls,	6 ft. 0 in.
	177 ft 8 in.

This section carries us down to the shales that were bored into at Harmony, and proves, I think, the absence of coal seams in this part of the basin between coal F, and the heavy sandstone of the millstone grit.

The section of the shaft on the railroad, in Brazil, is reported as follows:

Soil and drift,	10 ft. 0 in.
Limestone,	4 ft. 0 in.
Argillaceous shales,	28 ft. 0 in.
Coal, K,	0 ft. 10 in.
Sandstone,	28 ft. 0 in.
Shale,	2 ft. 0 in.
Coal, I, main "Block,"	3 ft. 3 in.
Fire clay,	6 ft. 0 in.
	82 ft. 1 in.

A bore was made to a considerable depth below the bottom of the shaft, finding no coal, and passing through noth-

ing but argillaceous shale. The depth of this bore could not be ascertained exactly, but is supposed to be about one hundred feet.

In many of the shafts and bores made in this part of Clay county the limestone above coal K, and the sandstone between K and I are wanting, their places being filled by shales.

Along the Indianapolis & St. Louis railroad, and on North Otter creek, the "block" coal bed I is seen in many places where it is of as good quality for manufacturing pig iron as any found on South Otter creek, or along the Indianapolis & Terre Haute railroad; and the building of the former road will enable the proprietors of coal lands to open up and develop the mineral resources of a large area of the "block" coal field now locked up from market for the want of transportation.

The town of Carbon, recently laid off, on the Indianapolis & St. Louis railroad, is situated about the middle of the northern tier of townships in Clay county, and occupies a position in the very heart of the "block" coal belt that is most favorable for mining operations and the erection of blast-furnaces for making pig-iron. The coal mine of McClelland & Sons is reached by a switch or branch road from the Terre Haute & Indianapolis railroad, and is now one of the most northerly mines worked in the county; and in order to show the persistent good quality of the "block" coal, as you go north from Brazil, a characteristic specimen from this mine was subjected to analysis, and gave the following result:

Specific gravity, 1.279; a cubic foot weighs 79.93 lbs.

Coke, ...	56.2	Ash, white, . . .	1.5.
		Fixed carbon, . .	54.7.
Volatile matter, .	43.8.	Water, ...	5.0.
		Gas, ...	38.8.
	100.0.		100.0.

The form of the coal is but slightly changed by coking; coke lamellar and semi-lustrous. This coal is on section

17, town 13, range 6 west, about one and a half miles south of Carbon, and has been successfully used for making pig-iron, in the furnace of the Lafayette Iron Company and in the Brazil furnace.

South of the Terre Haute & Indianapolis railroad, the main "block" coal bed has been opened at the following places, viz:

Ormsley Coal Co., on sec. 12, town 12, range 7 west.
General Pierce, on sec. 18, town 12, range 6 west.
Crawford & Co., on sec. 7 and 8, town 12, range 6 west.
David N. Barnett, on sec. 10, town 12, range 6 west.
Western Iron Co., on sec. 28, town 13, range 6 west.
V. Raab, on sec. 11, town 12, range 6 west.
Lucas, on sec. 16, town 12, range 6 west.
McCullough, on sec. 15, town 12, range 6 west.
B. Payne, on sec. 14, town 12, range 6 west.
Steadman, on sec. 4, town 11, range 6 west.
Gillfillan, on sec. 10, town 11, range 6 west.
J. Moss, on sec. 9, town 11, range 6 west.
G. Moss, on sec. 16, town 11, range 6 west.
C. Moss, on sec. 9, town 11, range 6 west.
Ashboro, on sec. 17, town 11, range 6 west.
J. Fisher, on sec. 11, town 11, range 6 west.
Ely, on sec. 11, town 11, range 6 west.

SOUTH OF EEL RIVER.

Goshorn, on sec. 10, town 10, range 6 west.
Rowe, on sec. 10, town 10, range 6 west.
Cole, on sec. 10, town 10, range 6 west.
Kilmer, on sec. 21, town 10, range 6 west.
Croft, on sec. 33, town 10, range 6 west.
Leisty, on sec. 28, town 10, range 6 west.
P. Barrick, on sec. 34, town 10, range 6 west.

South of the Terre Haute & Indianapolis railroad, the main "block" coal bed averages about the same thickness as it does north of the road.

The Ormsby Coal Company were not ready to begin operations at their mine south of Brazil at the time of my visit, but they have since laid a railroad track from their mines to the main trunk at Brazil, and their mines are now in complete working order. Their coal has a good reputation, both at home and abroad—being, for the most part, shipped to Chicago, where it is used for manufacturing iron.

Coal from Barnett's mine, three and a half miles southeast of Brazil, on section ten, town twelve, range six west, is hauled in wagons to the furnaces at Knightsville and Brazil, and is considered the best coal yet used in this part of the basin for making pig-iron. At Barnett's mine the main "block" coal bed I, and the lower seam F, appear to be separated by only five inches of fire-clay and seventeen inches of rash-coal, as shown in the following section:

Drift, clay and gravel,	19 ft. 8 in.
Gray Shale,	5 ft. 0 in.
Sandstone,	1 ft. 5 in.
Gray slate,	0 ft. 7 in.
Sandstone,	0 ft. 2 in.
Gray slate,	1 ft. 4 in.
Dark sandstone, with black seams,	1 ft. 0 in.
Shale,	0 ft. 9 in.
Coal I, main "Block,"	3 ft. 10 in.
Fire-clay,	0 ft. 5 in.
Rash coal,	1 ft. 7 in.
Coal F, lower "Block,"	2 ft. 0 in.
Fire-clay,	3 ft. 0 in.
	30 ft. 9 in.

The coal at this mine is worked by a drift, or entry, driven in from the outcrop of the bed, on the north face of a low ridge.

A bore made fifty rods south of the opening to Barnett's mine, furnished the following section;

Drift, clay and gravel,	11 ft. 0 in.
Hardpan,	10 ft. 6 in.
Gray slate,	4 ft. 0 in.
Arenaceous slate, with small balls of iron-stone,	3 ft. 0 in.
Black Slate,	1 ft. 6 in.
Coal I,	3 ft. 6 in.
Fire-clay,	0 ft. 0 in.
	33 ft. 6 in.

Another bore was made a short distance from the above, and to the north-west, which passed through the same material, and found the coal four and a half feet thick.

A specimen of coal from Barnett's mine gave, on analysis, the following result: Specific gravity, 1,250; a cubic foot will weigh 78.12 pounds.

Coke,	58.5	Ash, white,	1.5
		Fixed carbon,	57.0
Volatile matter,	41.5	Water,	4.0
		Gas,	37.5
	100.0		100.0

Coke, dense and brilliant, and form of coal slightly changed.

This may be taken as a type of the "Block" coals to the south, at Centre Point and Ashboro, and to the south of Eel river.

"Block coal" is spread over fully one-half of the county, and we may estimate a depth of four feet of this coal on at least one hundred square miles, or sixty-four thousand acres; each acre, therefore, contains seven thousand tons, of two thousand pounds or one hundred and seventy-five thousand bushels, which, at the extremely low estimate of one cent per bushel, gives one thousand seven hundred and fifty dollars as the value of the coal on each

acre, or *one hundred and twelve millions dollars* for the sixty-four thousand acres.

A short distance west from Brazil, the "Block" coal beds K and I, are brought up by a slight wave in the strata, and are cut out by the drift. At Newburg, two miles west of Brazil, the general westerly dip from the axis of the wave has again carried these coals to a considerable depth below the surface at the railroad level, and they are so much reduced in thickness as not to have been recognized in the bores made in search of them at various points between Brazil and Terre Haute.

At Newburg, Root, Price & Co. are mining coal L, from a shaft made by the side of the railroad track. This shaft passes through coal M, which is too thin to mine, and reaches coal L at the depth of forty feet. The latter coal is six to eight feet thick, and has one, and sometimes two fire-clay partings; here there is but one parting, about forty-three inches from the top. This is a bituminous, caking coal, and will not answer for the manufacture of pig-iron unless coked. The upper six inches of the bed is quite sulphurous, and should be rejected in mining. The remainder of the bed is a shining, black, cube coal, often displaying the much-admired peacock colors.

Coals M and L outcrop at a number of places in the vicinity of Newburg, and L. is opened and mined by Mr. Armstrong on the north-east quarter of section 10, town 12, range 7; Mr. Keneda, south-east quarter section 3, town 12, range 7; Mr. Fortner, north-west quarter section 10, town 12, range 7; Mr. Williams, south-west quarter section 10, town 12, range 7.

At Staunton, on the Terre Haute and Indianapolis railroad, four miles west of Brazil, coal L is reached by shafts, thirty-six to forty feet deep; both on the north side of the railroad, and in the town. Bailey and Company's shaft is thirty-eight feet deep, and passes through the following strata:

Clay and gravel, ...	9 feet.
Hardpan, ...	10 "
Sandstone, ...	12 "
Coal L, ...	7 "
	38 feet.

A characteristic specimen of coal, from the above-named mine was analyzed, and gave the following result:

Specific gravity, 1,327; a cubic foot will weigh 83 lbs.

Coke, . .	53.3	Ash, light gray, . .	6.0
		Fixed Carbon, . . .	47.3
Volatile matter,	46.7	Water, ...	7.0
		Gas, ...	39.7
	100.0		100.0

In the water-sump below the coal, there is from eight to twelve inches of rash-coal, underlaid by four to five feet of fire-clay. Coal M. was not found in this shaft, and was probably removed by the drift. Coal L. ranges from six to eight feet in thickness, and has here, as at Newburg, a thin parting of fire-clay, three to three and a half feet from the top. In quality the coal is the same.

At Mr. Somers' shaft, one-half mile east of Bailey & Co.s' mine, coal M. lies about fifteen feet above coal L; the former is eighteen inches, and the latter seven feet five inches in thickness, has a clay parting, and is of the same quality as that seen at Bailey's and elsewhere. On the south side of Staunton, coal M lies very close to coal L, where they outcrop in the side of a ravine, and are exposed in the cut of the creek branch. Coal M is overlaid by a black shale that may be readily split into great sheets like roofing slate, but, unlike the latter, is rich in bitumen, and crumbles to pieces on being exposed to the action of the atmosphere. This shale is highly fossiliferous, and contains spines and teeth of fish, and a variety of marine

shells. Of the latter I recognised *Orthoceras rushensis*, *Nautilus decoratus*, *Productus wabashensis*, *Chonetes mesoloba*, *Athyris subtilita*, *Spirifer cameratus*, *Cardenia fragilis*, *Arca carbonaria*, *Aviculopecten rectilateraria*, very abundant, *Myalina pernaformis*, *Pleurotomaria Grayvillensis*, and *Bellerophon carbonarius*.

At some of the outcrops of this shale, south of Staunton, I saw mixed through it large concretionary boulders of dark limestone. On the land of Mr. Modisett, one mile south-west of Staunton, section 17, town 12, range 7 west, coal L has two clay partings, and is eight feet thick. The partings are about one inch thick, and coal M, 18 inches thick, is seen a few feet above it.

At Harding's mine, a few hundred yards south of Staunton, coal L. is mined from an entry which penetrates the ridge on which it outcrops.

John Andrews, an intelligent and experienced mining-boss, who lives at Brazil, put down a bore, some years ago, about a quarter af a mile north-west of Bailey's shaft, and went ninety-six feet below the mammoth bed L, and passed through the following strata:

Coal L,	7 ft. 0 in.
Fire-clay,	3 ft. 0 in.
Commencement of bore—	
Shale, with iron balls,	20 ft. 0 in.
Coal K, upper "Block,"	1 ft. 8 in.
Soft sandstone,	20 ft. 0 in.
Shale I, here a caking-coal,	4 ft. 0 in.
Coal,	2 ft. 6 in.
Shale,	46 ft. 0 in.
Coal F?	2 ft. 6 in.
	96 ft. 8 in.

At Cloverland, two miles west of Staunton, we find the same succession of coals outcroping in the ravine on the south of the railroad, where the following section was obtained, starting at the top of the hill at Mr. Alfred West's:

Surface-soil and drift,			27 ft. 0 in.
White sandstone,			11 ft. 0 in.
Shale,			20 ft. 0 in.
Hard, blue limestone, which breaks with conchoidal fracture,			2 ft. 0 in.
Shale,			0 ft. 6 in.
Coal M,			1 ft. 2 in.
Fire-clay,			3 ft. 0 in.
Bluish shale, with iron-stone,			2 ft. 0 in.
Coal,	2 ft. 0 in.		
Fire-clay,	0 ft. 1 in.		
Coal,	2 ft. 0 in.		
Fire-clay, with thin band of coal,	0 ft. 5 in.	Coal L,	7 ft. 6 in.
Coal,	3 ft. 0 in.		
Fire-clay, with iron-stone,			4 ft. 0 in.
Black shale, with fish remains,			4 ft. 0 in.
Coal K, caking-coal,			1 ft. 10 in.
Low water, head branch of Lost creek,			0 ft. 0 in.
			84 ft. 0 in.

The following persons own mines at Cloverland, that are now being worked by stripping off the surface earth:

Alfred West, Miss Kate Brittain, and Mr. Wright.

Coal L, here averages seven feet in thickness, and when properly and carefully selected from the pyritiferous bands, which are more or less common in this bed, it is a very good article of bituminous, caking-coal; excellent as a fuel for household and steam purposes.

Going west, the dip carries the Cloverland coal below the drainage surface; and coal N, which lies about sixty feet above it, outcrops in a ravine on the south side of the railroad, about one mile west of that place, where there is an abandoned coal mine.

At Seelyville, in Vigo county, the Indianapolis Rolling Mill Company is working coal L, from a shaft that is one

hundred feet down to the bottom of the coal; and a few hundred yards west is Perring's mine, where they are working coal N, from a shaft that is forty-three feet to the bottom of the coal, which is here four feet thick, and has a thin slate parting about one foot from the top. This coal contains fewer sulphur bands, and is a very good bituminous caking-coal.

Though the general dip of the strata, at this place, is to the west, this coal outcrops in the hills about two and a-half miles east of Terre Haute, and is not seen again from thence to the latter place, or to the State line and beyond, at least not of sufficient thickness to justify working. The first coal bed reached in the artesian well at Terre Haute is undoubtedly L; likewise the coal which is mined by shafts thirty to sixty feet deep, one and a-half miles a little north of west from Terre Haute, and the coal at St. Mary's, in the woods, one hundred feet below the road-bed of the Terre Haute & Alton railroad. The synchronism of these coals, as designated above, from Newburg, on the Terre Haute & Indianapolis railroad, to St. Mary's, five miles northwest of Terre Haute, is, in my opinion, well established by the numerous shafts and bores made between the two points, the uniform character of the coal, and its characteristic accompaniments.

The line of eastern outcrop of coal L runs from Newburg with a northerly curve, passing through Roseville and Rosedale, to Clinton Lock, in Parke county: thence northward in Parke county, curving to the east, and passing five or six miles west of Rockville, it crosses the Wabash river a few miles south of the mouth of Sugar creek, and continues to the west of Newport, in Vermillion county, Indiana, where the continuity of the line is broken by a wave in the strata—the strike, or bearing, of which is northwest and southeast, and breaks the connection of the outcrop line with the equivalent coal bed on Coal creek, in Wabash township, Fountain county. In Vermillion county the outcrop of this coal may be traced along the Little and Big Vermillion rivers, and it is the equivalent of the seven-

foot seam of coal mined by Col. Chandler, at Danville, Illinois.

To the south of Newburg, in Clay county, the eastern outcrop of coal L bears in a southeasterly direction to Middleberry—but, through this portion of the county, it has been but little developed, for want of facilities for getting the coal to market. At Middleberry, Mr. J. Cooprider has opened a mine on the outcrop of coal L, where it is seven feet thick, with two clay partings, as at Cloverland. Though outcrops of this coal are to be seen at various points around Middleberry, very little effort has been made to work it. About half a mile southeast of Mr. J. Cooprider's, coal K has been worked by stripping. It is from four to five feet thick, and has a black sheety slate roof containing fish remains. Above the shale is an earthy, cream-colored limestone, that will make a handsome building stone, and has been used in this neighborhood for walling wells and building chimneys.

From Middleberry south, coals K, L, and N, where the measures are thick enough to contain them, are of good workable thickness, and may be traced through the western part of Greene county to the limits of the present survey on the south.

GLACIAL OR DRIFT EPOCH.

The material comprising this geological epoch, consists of irregularly arranged beds of sand, gravel, tough bluish clay with gravel, the so-called hardpan, and yellowish and more or less plastic clay, with gravel and small boulders; the latter are principally of metamorphic origin, but occasionally we find one from the sedimentary rocks, and a few have been found containing fossil shells of Silurian and Devonian date. Trunks and branches of co-existing trees are sometimes met with in sinking wells to the lower stratum of sand and gravel. The total thickness of the drift, in Clay county is from 0 to 40 feet, and in some instances even more.

The impervious clay called hardpan, constitutes the horizon of the fresh water supply for household purposes, and

is usually reached by wells at a depth of fifteen to twenty-five feet. The temperature of the water from this stratum is from 60° to 65° Fahr., being cool, healthful and pleasant to the taste; it contains small quantities of mineral salts, namely: bicarbonate of lime, bicarbonate of magnesia, a trace of protoxide of iron, chloride of sodium (common salt) and sulphates. This is termed a *hard water*, because it cannot be used for washing clothes. The acids of the salts contained in the water unite with the alkali of the soap, causing decomposition by setting free the grease, and thus destroying its detergent properties.

Many persons hold the opinion that the habitual use of hard water for slaking thirst is injurious to health, and recommend in its stead the use of rain-water. This, in my opinion, is in most cases a mere fancy, as the very mineral salts which are supposed to be injurious, are, unless found in such quantities as will give to it medicinal properties, beneficial to the living body, and supply it with some essential constituents. On the other hand, rain-water, as collected from the roofs of houses, is more or less contaminated with ammonia and poisonous gases absorbed from the atmosphere, soluble matter from the smoke and soot thrown out from the chimneys, and the microscopic organic matter washed from the roofs, much of which is of questionable benefit to the human system.

Small pieces of native copper, fragments of lead ore, and some other minerals, have been found at various places in the drift of Clay county, but they are of rare occurrence, being far removed from their native beds, which lie to the northward.

ECONOMICAL GEOLOGY.

The entire coal area of Clay county comprises about three hundred square miles, or 192,000 acres; and the total depth of coal over this area, including all the seams from N, at the top of the measures, to A, at the base of the millstone grit, is twenty-eight feet nine inches; but as some of

the seams comprising this grand total are not thick enough to mine over the entire area, a reasonable deduction is made on this account; also, for loss from outcrops, horse-backs, waste, etc., etc., and the available depth of "Block" and caking coals is placed at the low average of six feet. This depth of coal strata will give, as the product of one acre, 10,500 tons, or 294,000 bushels of coal, which, if estimated at $2.50 per ton, the present market value of coal delivered on the railroad cars in Clay county, will make the sum of $23,250 as the value of the average product of an acre of coal land.

If estimated at this rate for the entire area of 192,000 acres, we have four thousand four hundred and sixty-four millions ($4,464,000,000) of dollars as the probable value of the coal of this county alone.

For want of suitable transportation and a ready market, only a small portion of the three hundred square miles of coal-lands can be made available for mining purposes for many years to come; therefore, the commercial importance of the coal is not so readily realized, and the above figures may at first appear startling to those who have not fully contemplated the subject. Let us, therefore, make an estimate from another point of view. The area of the iron-smelting, or "Block" coal in Clay county, which is included in the above estimate, cannot be less than one hundred square miles, or sixty-four thousand acres, under which the coal may be averaged at four feet in thickness, being much less than the combined thickness of the five beds, A, B, F, I, and K, and we have seven thousand tons as the product of one acre, worth, at $2.50 per ton, (the market price on the cars in Clay county,) $17,500 per acre. At this rate of calculation, the 64,000 acres will give one thousand one hundred and twenty millions ($1,120,000,000) dollars as the present value of the available "Block" coal of Clay county.

The price per ton at which the "Block" coal is herein estimated, cannot be looked upon as above its value, when we take into consideration its convenience to market and

superior quality as a fuel for smelting iron. Each succeeding year its value must be enhanced, and mine owners had better let it remain in the ground than dispose of it at a less price. In fact this coal should be used only for making iron, notwithstanding that, for heating purposes, and for generating steam, it stands unrivaled in the West, even by the famous Youghiogheny coal of Pennsylvania; and for the use of locomotives it has no superior. As a blast-furnace coal to smelt iron ores, it has been amply tested in the five furnaces that are now using it in Clay county, and leaves nothing to be desired. The pig-iron made at the Clay county blast furnaces, from Iron Mountain and Lake Superior iron-ores, by the use of block-coal as a fuel, commands from two to three dollars more per ton, at the furnace, than the same grade of pig-iron made in Kentucky and Ohio will command in Indianapolis.

With regard to the exact cost of making a ton of pig-iron at any particular locality, very little reliance can be placed on the various published statements that have been collected from blast-furnace managers. We have no right to expect from iron-masters an exhibit of the exact cost of producing iron, or the profits arising from their business; but it may in reason be said, that with a superior article of coal, and her proximity to the ore, Indiana affords highly favorable facilities for manufacturing pig-iron, and will soon take her position in the front rank as an iron-producing State.

Coal and iron, next to agriculture, forms the basis of a country's wealth. England, to-day, owes her greatness as a nation more to the coal-fields that lie within her borders than to any other cause. Without cheap fuel what would become of her vast workshops, that have made her mistress of the markets of the world? All civilized nations fear her competition, and a tariff only can protect our infant manufactories from her blighting competition.

But England is now in the zenith of her manufacturing strength; her warehouses are filled with goods, and all the markets of the world are glutted with the products of her

skill and enterprise. Still, with her vastly superior natural resources, America can look ahead to the time when the failing coal-fields of England will mark the decline in her manufactures, and place the former in the ascendency.

The six to eight foot bed of bituminous caking-coal L, that is mined at the various railroad stations west of Brazil, is, if freed by careful selection from the bands of iron-pirites with which it is more or less contaminated, an excellent coal for fuel and for generating steam, and will make, in properly arranged coking-ovens, a hard, metalic-looking coke that will answer for smelting iron. As yet, the value of this mammoth bed of coal is hardly realized.

The following is an exhibit of the quantity and value of "Block" and bituminous caking-coals mined daily in Clay county:

"Block" coal, shipped daily from Clay county, 410 tons. Value, at $2 50 per ton,	$1,025 00
"Block" coal used daily in blast-furnaces in Clay county, 300 tons, at $2 50 per ton,	750 00
"Block" coal mined daily in Clay county, 710 tons, at $2 50 per ton, ...	1,775 00
Bituminous caking-coal mined daily in Clay county, 60 tons, at $2 00 per ton, .	120 00
Total coal mined daily in Clay county, 770 tons. Total value, ...	$1,895 00
Approximate yield of coal for one year, 230,000 tons. Value, ...	$366,000 00

BLAST FURNACES.

There are five blast-furnaces in Clay county, that are making pig-iron with raw *block-coal.* They all run upon the hot-blast principle, and the blast is heated in gas-ovens by the waste gas brought from the top of the stack. The total working capital employed at these furnaces is about six hundred thousand dollars. Combined, they consume daily:

300 tons of "Block" coal.
150 tons of Lake Superior and Iron Mountain ore.
50 tons of limestone for flux.

The daily make of iron is about 110 tons, worth, on an average, at the furnaces, forty dollars per ton; this includes all grades. The total value of each days' run of iron is, therefore, four thousand four hundred dollars, or about one and a half millions dollars per annum, after allowing a large margin for mishaps and loss from accidents. The number of men employed at these furnaces, not including coal-miners, is about two hundred.

All the furnace companies own collieries, and give employment to a great many more men who are engaged in mining "block" coal for the furnaces, and also for market, but the accounts for each branch of business are kept separate.

The view which forms the frontispiece to this Report is taken from a photograph of the magnificent blast-furnace at Brazil, now run by Messrs. Garlick & Collins.*

The Brazil furnace was built in 1867, and "blowed-in" on the 8th of December of that year, and is one of the largest and best conducted blast-furnaces in the West. At my request, Messrs. Garlick & Collins very obligingly furnished me with statistics in regard to this furnace, which it is thought may prove of general interest to the public. It

*It was my intention to have published views of all the blast-furnaces of this county, but the promised photographs were not received from the other proprietors.

is what is termed a cupola furnace, and is formed by joining at their base two truncated cones of solid brick work, the upper cone being supported on iron columns. Both are formed internally of good refractory fire-brick, and have a shell of boiler-iron one-quarter of an inch thick.

Height of furnace, - - - - - -	60 feet.
Diameter across the boshes, - - - - -	14 "
Diameter of hearth, - - - - -	5 "
Diameter of trunnel-head, - - - - -	6 "

The engine and blowing cylinder are upright. The former is eight hundred horse power. The steam cylinder is six feet long, and thirty-three inches in diameter. The blowing cylinder is six feet in diameter, and has a six foot stroke. Ranged on each side of the engine-house, and used alternately, there is a nest of four boilers, thirty-six feet long and forty inches in diameter. The arrangement for heating the blast consists of two large gas ovens, that are divided into two sections, each of which contains eighteen pipes, making, in all, seventy-two "Pollock" pipes. The blast is heated from 750° to 900° Fahr., and is driven into the furnace under a pressure of three to four pounds to the square inch, through seven tuyers, with nozzles three and a half inches in diameter. The cast-house and engine-house are constructed of brick, and have iron roofs. When completed, the coal-shed, or stock-house, will hold enough coal to run the furnace about four months. The ore, fuel and flux are hoisted to the tunnel-head or throat of the furnace by a water balance.

Cost of construction, - - -	$150,000.00.
Amount of capital employed, including cost of furnace, railroad, real estate, working capital, etc., etc., - - - - -	250,000.00.
Daily consumption of fuel, (*block coal,*) -	70 tons.
Daily consumption of ore, - - -	45 "
Daily consumption of limestone, - -	16 "
Daily yield of pig-iron, - - - -	28 "

Number of persons employed, including miners of furnace coal and coal for market, - - 150.

Red hematite and magnetic oxide of iron, from Lake Superior and Missouri, are the ores used at this furnace, the native ore being more expensive in proportion to the quantity of iron it contains than the ore from either of the former localities.

For the week ending September 18th, 1869, the average daily run of the Brazil furnace was 62,046 pounds of pig-iron per diem. The highest yield was 73,610 pounds, and the lowest, 47,628 pounds. Total make for the week, 434,-322 pounds, or 191½ tons (of 2,268 lbs to the ton, the selling weight of pig-iron,) of the highest grade of No. 1 foundry iron. Samples of this iron were obtained from the furnace, and are now to be seen in the State collection, at the office of the State Geologist in Indianapolis.

The average quantity of "block" coal used per ton of iron, during the stated period, was 4,042 pounds, only a little more than two short tons.

Owing to the great interest manifested in the manufacture of iron in this State, it is thought that a brief account of the mode of starting, or "blowing-in," as it is called by furnace men, a blast-furnace, may not prove uninteresting to the general reader.

If the furnace is a new one, it is first dried gradually by kindling a fire upon the hearth. After being thoroughly dried, it is filled well up into the boshes with good seasoned cord-wood. Upon the wood is thrown about ten tons of coke, the quantity being regulated by the size of the furnace. Above the coke the furnace is filled with evenly distributed charges of "block" coal, limestone, and a small burden of ore—say about four hundred and fifty pounds of ore, one thousand eight hundred pounds of "block" coal, mixed with coke, and occasionally some sticks of wood, and one hundred and eighty pounds of limestone. The wood is added to prevent the contents from "hanging," or sticking to the sides of the furnace. After the furnace has

been filled in this manner, to the top, the wood at the bottom is ignited. The fire ascends very slowly to the top, and the contents of the furnace gradually settle down as the wood at the bottom is being consumed. After the contents have settled down to the space that was occupied by the wood, and the surface has reached a bright glow, the charging is resumed, and the furnace kept supplied with a full burden of ore and other material requisite to make No. 1 foundry iron. Only a portion of the blast is turned on for a day or two, after which it is blown with full force.

The usual charge for making No. 1 foundry iron, at the Brazil blast-furnace, consists of: 1545 pounds of a mixture of Iron Mountain specular iron ore, Lake Superior red oxide and magnetic iron ore, scrap and mill cinder, 425 to 475 pounds of limestone, (obtained from Hamrick Station or Greencastle Junction,) 1800 pounds of "block" coal, (obtained from the mines of the company and Barnett's mine).

The ore yields about 68 per cent., and the furnace is ordinarily tapped three times in twenty-four hours.

No. 1 *foundry iron* is made when the furnace is worked with the above charge at its maximum heat.

B. 1 *and No.* 2 *foundry iron* is made from the same charge when, by some little irregularity, the heat is decreased in the furnace.

To make mill iron, the quantity of ore in the charge is increased, leaving the burden of coal and flux the same as before.

Pig-iron made from Lake Superior and Missouri specular and magnetic iron-ores, is always *red-short;* that is, the metal, made into bars, is easily broken when hot, but it is very strong when cold; *cold-short* iron possesses the opposite properties, and is made from silicious carbonates and the hydrated brown oxides. The dye-stone ores of Tennessee yield a cold-short iron. Silica, phosphorous, manganese, and titanic acid, when present in sufficient

quantities in ore, will produce the cold-short properties in the obtained metal.

Neutral-iron is made in the furnace, by mixing in proper quantities, the *cold-short* and *red-short* ores, and is the most valuable metal for general purposes.

The general character of the iron made in Clay county is *red-short*, but a *neutral* iron may be made by using the proper mixture of ores.

No 1 *foundry iron*, made in Clay county, is of a gray color, very soft, and highly crystalline; it possesses a high character for foundry purposes, on account of its uniform rate of shrinkage, and the large amount of scrap it will carry, say fifty to sixty per cent., which is from two to three times as much as can be used with either the Hanging Rock or Kentucky iron of the same grade.

B, 1, *gray foundry iron*, is not so soft as No. 1, but makes a stronger casting; scrap cannot be used with it.

N. 2, *bluish-gray foundry*, is both a harder and stronger metal than either of the others, but like the latter will not admit of being mixed with scrap.

No 1, *mill-iron*, bluish-gray, fine-grained pig, used for making bar-iron, nails, etc.

No. 2, *mill-iron*, inclined to be mottled, is also used for making bar-iron and nails.

White iron is made from the same stock as the latter, but results from a higher heat in the furnace; this is the best iron for making nails, cast-iron bells and railroad frogs. It is a very hard metal, and wears better than the other grades.

Red-short iron loses more carbon, and will shrink more in castings than cold-short iron, and in the mill the muck-

bars will crack on the edges in rolling, whilst bars made from neutral iron will be smooth and perfect on the edges.

The market demand for red-short pig is rapidly increasing, owing to its superior strength when cold, and the various uses to which it is applicable. By mixing it in the puddling-furnace with proper proportions of cold short pig, a neutral iron can be made.

Lafayette Blast Furnace, owned by the Lafayette Iron Co., is situated on a branch of South Otter Creek, one and a half miles north of Brazil, on the south-west quarter of section 19, town 13, range 6 west; this is also a very excellent furnace, built on the most approved plan, and is very similar to the Brazil furnace, except in regard to size, being smaller; it is quite new, having "blowed-in," for the first time, on the 20th of May, 1869.

The following statistics of the operation of this furnace, were, at my request, very obligingly furnished by Mr. B. F. Masten, one of the proprietors:

First cost of furnace when completed, not including lands, houses and railroad, ...	$70,000 00
Capital stock, ...	80,000 00
Daily consumption of fuel, "Block" coal, from the company's mines, .	45 tons.
Daily consumption of iron ore, .	37½ "
" " " limestone, .	10 "
" yield of pig-iron, . . .	18 "
Number of hands employed at the furnace, ...	30.
Height of furnace, ...	45 feet.
Diameter of boshes, . . .	10½ "
" " hearth, ...	4 "
" at tunnel-head, . .	5 "
Temperature of blast, . . .	600° Fahr.

The side of the ridge which forms the divide between South Otter creek and the furnace branch, is cut down to a vertical face, in order to locate the furnace in such a position that the tunnel-head is on a level with the table-land above. By this excellent arrangement the throat of the furnace is brought on a level with the railroad switch and coal-shaft which is near by, and the filling of the furnace is accomplished, direct from the fuel and ore-sheds, without the use of the ordinary hoisting arrangement. At the time of my visit to this furnace, it was in most excellent running order, and making, under its able management, No. 1, or best quality foundry iron. The ore used is from Missouri and Lake Superior, and the fuel was obtained from the Otter Creek Coal Co.'s shaft, only a few rods from the furnace; in fact, the excavation that was made for the foundation of the furnace cut through the coal bed.

The Western Iron Co. owns two furnaces, located at Knightsville, two and a half miles east of Brazil, on the H. & I. railroad, in the south-east quarter of section 29, town 13, range 6 west. Both of these furnaces are run with one engine, by which arrangement a considerable saving is made, not only in machinery but in the outlay for hands. They are under the able management of Mr. William Watson, an experienced superintendent from Canada, and have been highly successful in making good iron. One of these furnaces went into blast in the fall of 1867, and the other in December, 1868. I have been informed that the furnace last constructed cost about seventy thousand dollars*, and paid for itself in seven months' time; and during the first twelve months' running it made a ton of pig-iron for every hour of the time. The stacks are each fifty feet high, twelve feet across the boshes, six feet across the hearth, and four and a half feet in diameter at the tunnel-head.

The ore used is from Lake Superior and Missouri, and the fuel is "block" coal, obtained from the company's mines near at hand.

* No information was received from the superintendent on this point.

The average daily run of pig-iron is forty-five tons of 2240 pounds to the ton. The pig-ron is sold at 2268 pounds to the ton.

Daily consumption of ore,	60 tons.
Daily consumption of "block" coal,	100 "
Daily consumption of limestone,	24 "

The limestone is obtained from Hamrick's Station and Greencastle Junction, on the T. H. & I. railroad.

The Western Iron Company, also, have in connection with their blast-furnaces a mill for making muck-bars. The running of this mill is governed somewhat by the relative market value of the pig-ron and the muck-bars. At the time of my visit this mill was not in operation.

Planet Furnace, owned by the Indianapolis Rolling Mill Company, is situated one mile northeast of Harmony, on a switch of the Terre Haute & Indianapolis railroad, and on the southeast quarter of section twenty-two, town thirteen, range six west. Its construction is similar to the furnaces already described, but is the smallest of the number.

Height of stack,	40 ? feet.
Diameter across the boshes,	10½ "
Diameter across the hearth,	4 "

The top is closed by a cup-and-cone arrangement, and the gas is taken off through pipes, and conveyed to the oven for heating the blast. This furnace was built in the summer of 1867, and went into blast in November of that year.

Daily consumption of ore, about	25 tons.
Daily consumption of "block" coal, about	40 "
Daily consumption of limestone, about	10 "
Daily yield of pig-iron,	15 "

The coal is obtained from the company's mines—one situated at the furnace, the other one mile to the northwest. The latter is known as the "Star Mine."

Most of the iron made at the Planet furnace is worked up into rails at the Indianapolis rolling-mill, which is owned by the same company.

Fire-Clay.—This clay is found at the bottom of every coal-bed, and also in places where there is no coal; but it is not everywhere sufficiently refractory to admit of its being used in manufacturing fire-brick. The fire-clay in Clay county, which underlies the main "block"-coal bed I, though not as refractory as the celebrated Mt. Savage fire-clay, will, nevertheless, resist a high degree of heat, and brick made from it are quite good enough for the lining of all parts of blast-furnaces, except the boshes, where the greatest heat is encountered, and where none but the most highly refractory brick can withstand it.

Dr. Mansur Wright has established works for manufacturing fire-brick and terra-cotta work from this clay, on South Otter creek, on the southwest quarter of section 24, town 13, range 7 west, one and a half miles north of Brazil. The clay is mined on the land, in connection with the "block" coal which supplies the necessary fuel for running the machinery and burning the brick and terra-cotta ware. The color of the clay is light-gray. It contains specks of white mica, and is quite hard when first mined, but crumbles and falls to pieces after being exposed to the weather for a few days. Before being ground and tempered for the moulds, the clay is piled in heaps and roasted, in the same manner that iron-ore is roasted. This roasting of the clay destroys the organic matter and noxious gas, which would otherwise cause the clay to shrink and crack, and thereby spoil the manufactured articles, when subjected to the heat of the kiln.

The bricks are moulded by hand, five thousand being the daily average of one hand, and subsequently pressed in a Carnell hand-press, and stamped "*Brazil.*" From forty-five to fifty-five thousand brick are made daily, and meet with a ready market in the various parts of the country to which they are shipped.

Potters' Clay.—This county is abundantly supplied with a variety of fire-clay, that is admirably adapted for manufacturing pottery, such as common stoneware, terra-cotta ornaments, and even a better class of ware known as Rockingham or Troy ware.

Three potteries have been established in Clay county, for making stoneware; one at Brazil, owned by Torbet & Baker; another, one mile north-east of Brazil, owned by Isaac Cordray; and the third at Harmony, owned by S. H. Brown. These potteries obtain their clay from the stratum under the upper seam of "Block" coal, K, and on the south-east quarter of section 17, town 13, range 6, on the property of the Clay Coal Co., and close to Mr. Morris' house. This locality is said to furnish the best article of clay in the county for terra cotta ornaments, statues, pottery, etc., etc. It is the principal clay used by the Terra Cotta Co. of Chicago, for making statues. At the time of my visit, wagons were loading with this clay for Marshall county, Illinois. It is sold at the mine for one dollar and sixty-five cents per ton, and delivered on the cars at three dollars and fifty cents per ton. The stratum is two and a half feet thick, and is mined in connection with the coal, which is twelve to eighteen inches thick.

The commercial importance of this branch of manufacture, yet in its infancy, may be seen from the following exhibit of the amount of ware made at the three establishments now at work:

Torbet & Baker, . .	80,000	gallons	per	annum.
Isaac Cordray, .	50,000	"	"	"
S. H. Brown, . . .	70,000	"	"	"
	200,000	"	"	"

The stoneware made at these potteries presents a fine appearance, is very strong, of a bluish-gray color, quite smooth and free from cracks in the glazing; it meets with a ready market, and is sold at eight cents per gallon de-

livered on the cars, producing to the county an annual revenue of about sixteen thousand dollars.

Salt Brine.—I am not aware that any brine springs have been found as yet in this county, but it is made quite manifest, by the bores at Reelsville, in Putnam county, at Lodi, in Fountain county, and at Terre Haute in Vigo county, that a brine can be had by boring to the depth of one thousand to fifteen hundred feet below the level of the railroad, quite as strong as the brine at Kanawha.

I have been informed by Mr. N. Thomas, of Silver Island, in Fountain county, Indiana, who formerly lived on the Kanawha river, and is a practical salt-maker, that he was present in Terre Haute when a brine was struck in the artesian well at that place, at the depth of thirteen hundred feet; and, at the request of Mr. Rose, he made a test of this brine, and found its strength to be 13° of Baume's saltometer, which is equal to fifty (50) pounds of solid saline matter in forty-seven and six-tenths gallons brine. It might, therefore, be safely estimated that fifty gallons of this brine will yield one bushel, (fifty pounds,) of good salt.

When coal is abundant and cheap, as in this county, it is needless to add that such a brine is of great value for the manufacture of salt, to supply a large and increasing market, and for the manufacture of soda-ash, caustic soda, bicarbonate of soda, etc.

The amount of salt made annually in the United States is estimated at about eighteen millions of bushels, and the consumption is about thirty-four millions of bushels—or nearly double the quantity produced. So there can be no danger of an over-production of salt from home manufactures, for some years to come.

A good brine in Clay county can be made doubly profitable in connection with the iron pyrites and pyritiferous shales found in the upper part of the mammoth coal-bed L, by manufacturing, through the means of a chemical

interchange of their elementary constituents, in addition to common salt, bicarbonate of soda and soda.

Building-Stone.—The sandstone which overlies the main "Block" coal I, is, in places, an excellent building-stone, and is extensively used in Brazil for making foundations, lintels, steps, and other parts of buildings.

The principal quarry of this rock now opened, is owned by Mr. Simonson, on section 7, town 12, range 6, one and a half miles south of Brazil. It is a bluish-white, hard, micaceous, coarse-grained, durable sandstone, and presents a handsome appearance in buildings. On Dr. Wright's property, and at quite a number of localities on South Otter creek, there are fine exposures of this sandstone, but as yet very little attention has been paid to opening quarries for market.

The limestone that overlies the upper seam of "Block" coal K, was quarried on Mr. Henry Ashley's place, about a half mile south-west of Brazil, many years ago, for building the abutments to bridges and culverts on the national road; It ranges from two to ten feet in thickness, and may be found at a number of places on the Ashley land, on Garlick & Collins' land north of Brazil, and on the property of Mr. Grimes, in the neighborhood of the village of Ashboro. It cracks and falls to pieces after some years' exposure to the action of the weather, and cannot be considered a durable building stone.

The subcarboniferous limestone exposed on Jordan creek, near Bowling Green, may, when opened up, furnish good stone for building purposes, and will serve to make a good article of quicklime.

Iron-Ore.—The shales at the base of the millstone grit contain, everywhere, more or less clay iron-stone, and siliceous hydrated brown oxide of iron, but as yet no locality is known in Clay county where it is in sufficient quantity to supply a blast-furnace; however, if suitable transportation could be had, it might be used advantageously at the

present furnaces, to mix with the Lake Superior and Missouri ores.

At Mr. Thomas Cromwell's, on section 3, town 10, range 6 west, there is a deposit of excellent bog iron-ore. The exact extent of this ore can only be determined by instituting borings at a number of places, as it lies buried, for the most part, beneath the superimposed soil along the margin of a level, wet prairie. Mr. Cromwell informed me that he had dug into the ore to the depth of four to five feet, at several places on his land, without reaching the bottom, and that he has traced it for more than a mile in an east and west direction, on the south side of Eel river. The width of the deposit is about sixty feet at Mr. Cromwell's.

Mineral Waters.—At Mr. James Ferguson's house, on on the south-west quarter of section 21, town 11, range 6, there is a good cool spring of chalybeate water. The iron is both in the state of a bicarbonate and sulphate of protoxide of iron, along with a small quantity of saline sulphates, carbonates of lime, magnesia, and chloride of sodium; its properties are slightly diuretic, aperient, and alterative. There is another spring of chalybeate water, which apparently possesses similar properties to the Ferguson spring, at Mr. Kincaid's, on northeart quarter of section 21, town 11, range 5.

In boring for coal, on section 25, town 13, range 7, at the depth of thirty feet the bore struck a horseback, and got a flowing well of good, cool drinking water, with no more mineral matter than is found in the water of the neighboring wells.

Agriculture.—In an agricultural point of view, Clay county cannot be said to stand in the front rank. The upland soil is principally derived from the *drift*, and is a cold, wet, clay soil, varying in color from ash-gray to yellowish-red. The tenacity with which it holds water renders underdraining indispensible to good culture. A top-dressing of lime, wood-ash, or even coal-ash, would prove highly beneficial to this character of soil. The soil in the

bottom, along the streams, is, for the most part, a clay loam with subsoil of clay. In the small prairies there are two kinds of soil, one a dark blackish muck, and the other a black sandy loam; the former is wet and unproductive, unless drained by ditches and exposed by deep plowing, for a considerable length of time, to the decomposing action of the atmosphere. A heavy dressing of lime would prove very beneficial to this soil. The sandy-loam soil of the prairies is decidedly the best in the county, and is well adapted to the growth of the serials, clover and grasses; orchards, also, do well on this land.

The upland, where attention has been paid to dressing and cultivation, and especially in favored localities, produces good crops of wheat, clover and grass, and here and there might be seen fine orchards, with a variety of choice fruits, such as apples, peaches, pears, cherries and plums.

Timber.—On the upland, the principal growth of timber is white, red, and black oaks, smooth shellbark and mocker-nut hickory, some ash, sugar-tree and beach; on the bottoms, water, white and burr oaks, gray ash, shellbark hickory, redbud, sassafras, dogwood and pawpaw; along the streams, sycamore and cottonwood, and on the higher banks large black-walnuts, three to five feet in diameter, and large burr-oaks. There are at least five sawmills on Eel river, in this county, cutting walnut lumber.

GREENE COUNTY.

This county is bounded on the north by Clay and Owen counties; on the east by Monroe and Lawrence counties; on the south by Martin, Daviess and Knox counties, and on the west by Sullivan county. In shape, it is a parallelogram, and contains five hundred and forty square miles.

The principal stream of water is the west fork of White river, which runs in a southeasterly course through the county, and divides it into two, nearly equal, parts. The main tributaries of White river, in this county, are Eel river, Latta's creek, and Black creek, on the west side; and Richland creek, Doan's creek, and First creek on the east side. Indian creek, with its tributaries, waters a portion of the eastern border of the county, and empties into the east fork of White river.

This county, east of White river, is quite broken, with hills from one hundred and twenty feet to three hundred feet in height; whereas, to the west of the river, with the exception of a ridge running from Eel river, on the north, to White river, on the south, near Fairplay, and passing a short distance to the west of Worthington, the county is generally level, or slightly undulating—a considerable part of it being prairie.

Latta's creek marsh, Bee-hunters' marsh, and Goose-pond contain, in all, about nine or ten square miles of land, subject to overflow during freshets. These marshes can be drained, and thus, by aeration, furnish to agriculture a large body of very fertile land.

Previous to the completion of the Indianapolis & Vincennes railroad, (first run in the autumn of 1869,) this county was without a direct and practicable means of communication with the distant centers of trade; consequently, up to that time there was no incentive or inducement offered to its citizens to attempt any development of its mineral resources. For this reason, the geologist has, as yet, but

little to guide him in his investigations, beyond the obscure natural outcrops of the strata, and a few imperfect openings of coal and iron mines—the former of which are only occasionally worked to supply the limited and uncertain wants of the immediate neighborhoods. It is not, therefore, to be expected that I can, at this time, have as much to say, in detail, regarding its vast mineral resources as of Clay county, where so much progress has been made in the work of development.

The geological formations represented by the succession of strata in this county are:

Subcarboniferous limestone period.
Millstone grit epoch.
Coal measures epoch.
Glacial epoch.

The continuous vertical section of the coal and subordinate limestone formation, given on page 37, in the report of Clay county, is alike applicable to Greene county, in so far as it relates to the sequence of the strata; and the coal beds and other strata found here will be referred to it accordingly.

Subcarboniferous Limestone.—At the mouth of Fish creek, in the northern part of the county, limestone belonging to the Chester group of the subcarboniferous limestone formation, outcrops in the bluff bank of the creek, and is exposed to the depth of fifteen to twenty feet, and is at this place overlaid by drift, but at a short distance to the southwest it is increased by the addition of two to five feet of shale, with an irregular bedded, thin seam of coal A and the millstone grit. Some of the layers of this limestone contain a few fossils, but they are difficult to obtain sufficiently perfect for cabinet specimens. The following comprise all that could be recognized: *Orthis umbraculum*, *Archimedes Wortheni*, *Athyris subtilita*, *Pentramites obesus*, *P. pyriformis*, *Spirifer incrassatus*, *Productus carbonarious*, *P. cora*, and an abundance of *encrinite* stems. It belongs to the upper mem

ber of the subcarboniferous limestone, and is designated by Prof. A. H. Worthen, in the Geological Report of Illinois, as the Chester group.

The greatest development of this limestone, seen in Greene county, is on Beech creek, a branch of Richland creek, on section 12, town 7, range 4, where it forms a great mural precipice, capped with a massive sandstone of the millstone grit series. The following section was obtained at this locality:

Brownish-gray sandstone, in thick beds, which has the appearance of being most excellent building stone, -	25 feet 0 inches.
Shale, which thickens up to many feet, and in some places contains coal A,	1 in.
Buff-colored limestone, in which I saw *Pentramites obesus*, *P. pyriformis*, and *Archimedes Wortheni*, - -	20 ft.
Gray siliceous shales, partly covered,	25 ft. ?
Blueish limestone, (in which I saw no fossils,) with intercalations of sandstone, mostly covered by talus, -	50 ? ft.
Total, - - - - -	120 ft. 1 in.

At the junction of the sandstone and limestone, at this locality, there gushes forth a mammoth spring of good cool water, which was, at one time, utilized to run an overshot wheel that propelled the machinery of a grist mill.

The subcarboniferous limestone makes its appearance at the base of the hills along this creek, for a distance of several miles, and is overlaid by a few feet of shale and the massive sandstone at the base of the millstone grit. It also makes its appearance at the ore banks on Ore branch of Richland creek, in section 28, town 7, range 4, and on the eastern border of the county, near the "Virginia" blast-furnace, (now abandoned,) and south from the furnace along Indian creek.

Millstone Grit.—This epoch follows the subcarboniferous in regular sequence, and is principally represented by a massive sandstone, usually in two benches, and separated from each other by a bed of shale, varying from a few inches to four feet, or more, in thickness, and at some places carries a thin coal B. This massive sandstone is, apparently, in the position occupied by the conglomerate sandstone most usually found at the base of the coal measures, yet in this part of the State it is, so far as I have been able to discover, entirely free from the admixture of quartz pebbles which gives rise to the latter name.

The millstone grit covers fully three-fourths of the county. Its boundary on the west may be approximately laid down as passing from Johnstown, on Eel river, across the county in a southwesterly direction to Marco, on the Indianapolis & Vincennes railroad, while the irregular margin of its eastern outcrop is in Monroe county, some miles east of the Greene county line.

Between this massive sandstone and the subcarboniferous limestone there is interposed a bed of argillaceous shale, varying from a few inches to thirty feet, or more, in thickness, that contains, in many places, a bed of good "block" coal A. (*See vertical section of the coals, page* 37.)

Above the sandstone are argillaceous and siliceous shales, with benches of flags and other stones of good dimensions for building purposes. In all, this group may attain a depth of three hundred feet, or more, in Greene county.

The massive sandstone, or conglomerate as it may be called for convenience, gives to the scenery of this county, on the east side of White river, a marked character. Near the tops of many of the ridges that skirt along the streams it forms conspicuous benches, and the slopes below are strewn with cyclopean blocks that have broken off and fallen from the parent mass above. In places it has a portion of the lower part worn away by the combined action of the frosts and running water, so as to form deep caverns with projecting roofs of stone, that afford an excellent protection in time of storms to wayfaring men and farm stock,

for which reason, I suppose, they have received the common name of "rock houses." In the more secluded parts of the county the "rock houses" constitute the abode of a variety of wild animals, that seek in them a friendly shelter from the inclemency of the weather.

It is at the junction of the conglomerate with the subcarboniferous limestone that we find the great repository of limonite iron ore in this county; and, in fact, it forms the common horizon of this variety of iron ore in most of the Western States. The ore lies in pockets of various dimensions, and owes its orgin, in most cases, to a metamorphism of the surrounding rocks, produced by the permeating of mineral water that is strongly charged with protoxide of iron.

On Ore-branch of Plummer's creek, section 22, town 7, range 4 west, on Mr. Heaton's land, the base of the conglomerate has been completely changed by this process into a siliceous ore that is rich in iron to the depth of ten or twelve feet. Similar ore was seen on sections 21 and 28 of the same township and range; also, in the greatest abundance at Mr. Law's place, on sections 4 and 9, town 7, range 6, where it cannot be less than twenty-five to thirty feet in thickness, and great blocks lie scattered over the side of the ridge; it is in abundance, also, on section 12 of the same township and range, and in the neighborhood of Owensboro in the south-east part of the county.

The old Virginia blast-furnace, on Indian creek, in the western edge of Monroe county, has been out of blast for many years, but when in blast the ore was obtained close at hand from large deposits, fifteen to twenty feet thick, covering several acres.

The Virginia blast-furnace cannot be more than five or six feet across the boshes, and twenty to twenty-five feet high. It is poorly constructed, and the only wonder is that it made any iron at all. However, fragments of pig-iron that were picked up around the stack, give evidence that it made a very fair quality of iron, and was abandoned only in consequence of the great expense incurred in getting the metal to market—the nearest being Louisville, on

the Ohio river, to which point the pig-iron was hauled in wagons. A characteristic specimen of ore, from the ore-banks half a mile north-east of this furnace, was analyzed, and the following result obtained:

Specific gravity, 2.56.

Loss by ignition, water and organic matter,	10.00
Insoluble silicates, - - - - -	31.50
Sesquioxide of iron, with some protoxide, and a little alumina and manganese,	58.50
Total, - - - - -	100.00

Giving 40.95 per cent. of metallic iron.

This ore will give over 45 per cent. of iron after being roasted, and will make an excellent quality of cold-short pig-iron.

The principal ore used at the Richland blast-furnace, near Bloomfield, in Greene county, from Ore-branch of Plummer's creek, forms a bench on each side of a ravine, and appears to lie between the massive ore and the sub-carboniferous limestone, which shows itself in the bottom near by. An excavation was made during my stay in the county, to show the thickness of this ore-bed, which went to the depth of six feet, at which point the work was stopped, without reaching the bottom of the deposit.

Capt. M. H. Schryer, of Bloomfield, who frequently saw this bed of ore at the time it was being worked for the blast-furnace, assures me that the deposit is fully nine feet in thickness. It lies in kidney-shaped masses in a matrix of ferruginous clay, and contains less silica than the massive ore. Characteristic samples of this "kidney-ore," and of the massive siliceous "block-ore," from the Richland furnace ore-banks, were analyzed, and the following result was obtained:

"Kidney-ore" (limonite), specific gravity 2.583.

Loss by ignition, water and organic matter mostly water,	11.50
Insoluble silicates,	17.00
Sesquioxide of iron, with some protoxide, and a trace of manganese,	56.00
Alumina,	2.00
Carbonate of lime,	10.00
Magnesia,	3.50
	100.00

Giving 39.20 per cent. of iron.

This ore contains a large amount of lime, and will make an excellent quality of metal; and when roasted the percentage of metal will be increased to 45.42 per cent. Specimens of pig-iron made from this ore were found at the furnace, and have every appearance of being the best quality of mill-iron.

An analysis of the siliceous "block-ore," gave the following result:

Specific gravity, 2.585—2.694.

Loss by ignition, water,	7.50
Insoluble silicates,	34.00
Sesquioxide of iron,	54.73
Alumina,	2.50
Manganese,	1.14
Lime,	.12
Magnesia,	.03
	100.02

Giving 38.31 per cent. of iron.

It was tested for sulphur and phosphorus, but found no trace.

200 grains of this siliceous ore, mixed with 50 grains of limestone, were fused in a Hessian crucible, and a button

of iron was obtained that weighed 76 grains—equal to 38 per cent.; very nearly the same result as obtained by the humid analysis. The button indicated a very good quality of iron, slightly malleable, and gave a semi-crystalline fracture. The roasted ore would yield fully 40 per cent. of iron in the blast-furnace; and on account of the manganese which it contains it is admirably adapted for the manufacture of steel, either by the Bessemer process or in the puddling furnace. Iron made from the above ores alone will possess cold-short properties, but by mixing them, in the proper proportion, with the red-short specular and magnetic ores from Missouri and Lake Superior, a neutral iron may be made.

No one of whom I inquired could inform me definitely when the Richland furnace went into blast, but it is thought about the year 1841, and the final blowing-out was in 1858 or 1859. The *stack* was about forty-five feet high and nine feet across the boshes; it was worked with a hot-blast, and used charcoal as a fuel. About nine tons of pig-iron were produced daily. The cause assigned for the stoppage of the furnace was the want of a suitable and economical means of getting the pig-iron to market.

The furnace-stack had been taken down some years previous to my visit, and the stone of which it was constructed used to build a bridge over Richland creek, though the engine, boilers, and blowing-cylinders were still on the ground and in good condition; the blowing-cylinders are forty-two inches in diameter, and six feet stroke.

Good deposits of siliceous and earthy carbonates of iron are seen at quite a number of localities in this county that are not enumerated above, namely, at Gaskils, on the I & V. railroad, on section 36, town 8, range 6; on Black creek, in the south-west part of the county; at Phillips' coal-mine, and immediately around the old blast-furnace.

All the coal-beds on the east side of White river, and over a considerable strip of country on the west side of that river, are either in the conglomerate or are sub-conglomerate. For the most part, these coals are of the

"splint" or "block" variety, and though generally in thin seams, are nevertheless of good workable thickness at some localities, and will answer, in the raw state, for smelting iron.

Coal A, of the vertical section on page 37, is seen at a number of places north-east of Worthington, where it is cut through in the grade of the I. & V. railroad, and lies in close proximity to the subcarboniferous limestone; indeed it is often separated from the latter by only a few inches of fire-clay. Coal B lies from sixteen to thirty feet above coal A, being intercalated between two benches of the conglomerate, and is from four to eighteen inches thich.

At Gaskil's, on section 12, town 8, range 5, coal A lies thirty to forty feet above the railroad track, and has been partially opened, but proved too thin for mining to advantage. At Woodrow's old mill, on section 14, town 8, range 5, coal A outcrops in the bank of White river, and is twenty-eight inches thick; it is a "block" coal, but apparently contains a considerable portion of sulphur.

Immediately above the coal, and forming its roof, is black, bituminous, fissile slate, two feet; then a few feet of siliceous shale, which latter is succeeded by forty to fifty feet of massive sandstone.

About two hundred yards north of this old mill, up a short ravine, this sandstone forms a great cliff, and coal A outcrops at its base, only about ten feet above the subcarboniferous limestone, which shows itself at the foot of the ravine. Coal B, about eighteen inches thick, outcrops in Point Commerce, on the west side of the hill, at Mr. Miller's mill on Eel river, and in the sandstone bluff on the west bank of that stream, near its mouth. In excavating the foundation for his mill, Mr. Miller found beneath the bed of the river several layers of good clay iron-stone. Though rich in metal, it is barely possible that it can be found in sufficient quantity, under such unfavorable conditions for mining, to make it of value at this point.

Two and a half miles northwest of Worthington, on Mr. Joel Adams' farm, on the west half of section 7, town 8, range 4, coal A, three feet thick, is mined in the ravine by stripping off the two or three feet of super-imposed earth. The quality of the coal is good "block." On the hill close by may be seen the conglomerate sandstone, which usually lies above this coal. In digging a well at his dwelling house, on the top of the low ridge to the south of this mine, Mr. Adams passed through:

Soil and drift, - - - - - - -	13 feet.
Coal B, - - - - - - - - -	1 "
Sandstone, in which water was found, and the work discontinued, - - - - -	10 "

Had the well been sunk through the sandstone, he would have reached coal A, which is only twenty or thirty feet below coal B, and is seen again at an outcrop on the south side of the property.

On Mr. Schryer's land, in the southeast corner of the same section, the Adams seam of coal also makes its appearance, and it may be traced to Johnstown mills, on Eel river, where it is struck in the wells, and as far south as Marco, on the Indianapolis & Vincennes railroad.

At Mr. McKissick's, on section 36, town 8, range 6, coal A is three feet thick, and has shale above it. The following result was obtained from an analysis of a characteristic specimen from the above bed:

Specific gravity, 1.189; a cubic foot weighs 74.37 lbs.

Coke, - -	64.5.	Ash, white, -	2.0.	
		Fixed carbon, -	62.5.	
Volatile matter, -	35.5.	Water, - -	3.5.	
		Gas, - -	32.0.	
	100.0.		100.0.	

Twenty to twenty-five feet higher than the coal bed above referred to, there is another opening to a seam of coal that has the same depth of bed, with a roof of

sandstone, four to five feet thick, immediately under the drift which covers the slope of the hill above. The quality of the coal at both these openings is that of a good "block" coal. Notwithstanding the upper coal is in the position of coal B, with regard to relative space, still I feel quite sure that the two openings are in one and the same bed. But the nature of the locality, and the want of proper developments, prevented me from arriving at a positive conclusion. The sandstone above the upper opening has all the appearance of the conglomerate, and the openings being on opposite sides of the ravine, gives ample room for misplacement by a slide or horseback, the traces of which may be covered by debris.

McKissick's mine is one and a half miles north of the Indianapolis and Vincennes railroad, and may be easily reached by a switch from the main road, running the whole distance over a level prairie.

Under the coal at the lower opening there is considerable iron-stone of good quality for making iron. It is here found stratified with the shale.

South of McKissick's, the subconglomerate coals have not been worked on the west side of White river, its presence being known, only, by reaching it in wells at the following places:

Mr. Dixon's, on section 13, town 7, range 6.
Mr. Shelket's, on section 15, town 7, range 6.
Mr. Allison's, on section 14, town 7, range 6.
Mr. Lundy's, on section 21, town 7, range 6.
Mr. Wakefield's, on section 21, town 7, range 6.
Dr. Bennifield's, on section 25, town 6, range 7.
And at Halsted's, just south of the Greene county line, on Black creek, in Knox county.

On the east side of White river, the subconglomerate coal A is generally from thirty to thirty-six inches thick, and is also, in this part of the county, a "block" coal, similar in character to what is found above the conglomerate in

Clay county, and may be used in its raw state for making pig-iron in blast-furnaces.

The following mines have been opened and partially worked, to supply a very limited home demand, in the neighborhood of Bloomfield, between Richland creek and Ore-branch creek:

Templeton's mine, on section 20, town 7, range 4.
D. Heaton's mine, on section 2, town 7, range 4.
W. J. Heaton's mine, on section 28, town 7, range 4.
Cushman's mine, on section 28, town 7, range 4.
Holtzclaw's mine, on section 28, town 7, range 4.
Burcham's mine, on section 32, town 7, range 4.
Channey's mine, on section 32, town 7, range 4.
Ackerman's mine, on section 25, town 7, range 5.

At all the above openings the coal is of good quality, is overlaid by the conglomerate, and in places it is not more than twenty feet above the subcarboniferous limestone. In the immediate roof shales of the coal, impressions of the flattened stems and trunks of *sigillaria* and *calamites* are abundant, but the shale is of too fissile a character to admit of their preservation as cabinet specimens. Neither shells nor fish remains were observed.

Coal A underlies a broad district of country, which stretches out to the south-west from Bloomfield. At T. Hays' mine, on section 16, town 6, range 4, the character of the subconglomerate coal is quite changed, being at this mine a caking coal with two clay partings. The following section was made of the coal in this mine by Mr. R. H. Warder, of Spencer, Owen county, Indiana, who accompanied me on my trip through Greene county, and to whom I feel under many obligations for valuable assistance.

The entrance to the mine was partly filled with water at the time of our visit, but Mr. Warder waded through it, and measured the coal at the far end of the entry.

SECTION AT HAYS' COAL MINE.

Slope, covered space to top of hill,		30 ft. 0 in.
Coarse-grained, buff-colored sandstone,		8 ft. 0 in.
Black slate,		0 ft. 0¼ in.
Coal,	1 ft. 10 in.	
Clay parting,	0 ft. 10 in.	
Coal,	1 ft. 11 in.	5 ft. 7 in.
Fire-clay,	0 ft. 6 in.	
Coal,	0 ft. 6 in.	
Total,		43 ft. 7¼ in.

The total thickness of this bed, including the clay partings, is five feet seven inches; reduced to clear coal, leaves three feet eight inches. This is a fine bed of coal, and is found over a large area of country, which forms the "divide" between the waters of Doan's creek and Plummer's creek. Going south to Phillips' mine, on section 21, town 6, range 4, the same bed of coal seen at Hays' mine is *semi-block* coal, three to seven feet thick, including a five-inch clay parting. Above the coal there is eight inches of a good quality of siliceous limonite iron-ore, containing stems of coal-plants, *sigillaria* and *calamites*. A fine specimen of the *Calamites cannæformis*, obtained from this locality, was presented to me by Capt. M. R. Shryer, of Bloomfield.

The following section will show the position of the coal, which is opened in a shallow ravine near the top of the table land. The bed is worked by stripping off the superincumbent strata of rock:

Soil and drift,		10 ft. 0 in.
Siliceous iron-ore,		0 ft. 8 in.
Sandstone,		1 ft. 0 in.
Blue shale,		1 ft. 0 in.
Coal, semi-block,	2 ft. 4 in.	
Clay parting,	0 ft. 5 in.	3 ft. 8 in.
Coal,	0 ft. 11 in.	
Fire-clay,		0 ft. 0 in.
		16 ft. 4 in.

The same stratum of coal is also mined by W. B. King, on the line between sections 28 and 29, town 6, range 4, where it presents the same characteristics seen at the Phillips' mine.

My first impression on visiting these mines was, that the place of this bed of coal was above the conglomerate, and in the coal-measures proper; but seeing that my friend, Leo Lesquereux, in his report on the coals of Greene county, published in Prof. Richard Owen's Geological Report of Indiana, has referred to it as being subconglomerate, it is therefore thought best to make no change with regard to its position in advance of a more thorough examination.

In the neighborhood of Owensboro, and to the southwest, in Martin county, the subconglomerate coal A has been opened and mined for blacksmiths' use, at quite a number of places; it ranges from thirty to thirty-three inches in thickness, and is, at some openings, good "*block*" coal, while at others it is a bituminous caking-coal.

Owensboro is on the western limit of the subconglomerate coal, the place of the latter being, possibly, represented by an outcrop of excellent fire-clay for potteries, lying near the top of the hill on the west side of the town. Below the fire-clay there are large deposits of iron-ore, similar to that used at the Old Virginia blast-furnace in Monroe county.

A well dug by Mr. John Potter in the eastern part of the town, on a branch of Indian creek, passed through:

Gray argo-siliceous shales, - - -	15 ft.
Sandstone, - - - - - -	3 ft.
Blue argo-shale, - - - -	4 ft.
	22 ft.

The water in this well is, no doubt, obtained from the upper part of the subcarboniferous limestone, which

makes its appearance a short distance farther up the branch.

Coal A, at Babbit's mine, is opened on the half-section line, between sections 28 and 33, town 6, range 3, one and a quarter miles south-west of Owensboro; the bed is two feet thick, and the coal is mined out in fine large cubes from twelve to fifteen inches thick. It is a caking coal, of a beautiful jet-black color, with numerous small cracks lined with scales of *selenite* not thicker than a sheet of paper. This is a remarkably pure coal, and would answer well for making gas and coke. The analysis gave the following result:

Specific gravity, 1.238. A cubic foot will weigh 77.3 lbs.

Coke, -	61.4	Ash, gray, - -	1.5
		Fixed carbon, - -	59.9
Volatile mat'r,	38.6	Water, - - -	3.0
		Gas, good illuminating,	35.6
	100.0		100.0

The coke swells but little; structure of the coal but slightly changed; color dull.

Immediately above the coal, and forming its roof, there are three feet of black bituminous shale, overlaid by five or six feet of conglomerate sandstone, which is again succeeded by a few feet of drift. This same bed of coal is opened at Mr. Baker's, on the south-west quarter of section 20, town 6, range 3, and also at Mr. Amos Dawson's, on the west half of section 23, town 6, range 3. The opening to the coal at the latter locality was filled with water, so that I had no opportunity to personally inspect the depth of the strata, which is reported to be four and a half feet. From samples of coal found at the mouth of the opening, it is here a good quality of "block-coal." The succession of strata are as follows:

Drift, - - - - - - -	30 ft. 0 in.
Sandstone, - - - - - -	3 ft. 0 in.
Shale, - - - - - - -	6 ft. 0 in.
Coal A, ("block,") said to be, - -	4 ft. 6 in.
	43 ft. 6 in.

Another opening is made to this coal on Mr. Foote's land, on the south-west quarter of section 36, town 6, range 4, and the quality is said to be the same as at Babbit's.

Going south into Martin county, coal A is also seen at Mr. Davis', where it has the character of a good "block-coal." The bed is twenty-seven inches thick, and is worked in the bank of a ravine by stripping off the superimposed strata, composed as follows: Of

Soil, - - - - - - -	2 ft. 0 in.
Sandstone, - - - - -	1 ft. 0 in
Bluish argo-shales, - - -	10 ft. 0 in.
Coal A ("block-coal"), - - -	2 ft. 3 in.
Fire-clay, - - - - -	?
	15 ft. 3 in.

Mr. Rollings has opened a mine in the same coal-bed, one and a half miles south of Davis'; the coal is two feet thick, and similar in character to Babbit's coal. It is overlaid, where mined by stripping, with four or five feet of tough, bluish argo-shale, containing an abundance of well preserved coal plants, principally, *Sphenophyllum Schlotheimii*, *Pecopteris Arborescens*, *Neuropteris Loschii*, *N. hirsuta*, *Asterophyllites Sublevis*, and stems of *Calamites cannæformis*. A short distance back from this mine, the shale is overlaid by the conglomerate sandstone, which shows in benches along the tops of the ridges.

Half a mile south of Rollings' mine, is Todd's mine, said to be the same seam and character of coal as the former.

Passing now to the west side of Greene county, we ascend above the conglomerate or millstone grit epoch, to the place of the coal strata proper.

Coal-measures.—The three townships, 6, 7, and 8, of range 7, in the western part of Greene county, are, except where cut out by the flats of Goose-pond, Black creek, Latta's creek, and the bottoms of small streams, underlaid by the mammoth coal-bed, L, which is mined on the Terre Haute and Indianapolis railroad at Newburg, Staunton, Cloverland station, and at the Lost creek mines at Seelyville.

On the north-west quarter of section 18, town 6, range 7, Mr. W. P. O'Haver has opened, in a ravine, a mine to coal L; the bed is here from four and a half to five feet thick, has from one to two feet of black sheety slate in the roof, and no other material above except a foot or two of soil; but on the rise, at Mr. O'Haver's house, in digging his well he passed through thirty feet of siliceous shale without getting down to the coal. At his grist-mill, half a mile to the west, in the edge of Sullivan county, the well which supplies water to the boilers passed through the bed of coal worked at the mine, and is reported as being seven feet thick. In this measurement the two feet of black shale forming the roof must have been mistaken for coal. Judging from specimens of coal found around the mouth of the pit at O'Haver's mine, it is a good article of bituminous caking-coal.

The entry to the mine was not in a fit condition to admit of the coal being seen in place.

Two miles north of O'Haver's, at Mr. Bedwell's, also in the edge of Sullivan county, there had been openings made to a bed of coal that is said to be seven feet thick. On visiting this locality I felt disappointed to find that the walls of the old shaft had caved in and covered up the seam; some fragments of coal, however, found lying at the mouth of the pit, indicate its character to be a caking-coal; and from the topography of the country lying be-

tween this locality and O'Haver's, I am led to believe that the two coals belong to equivalent beds. At Mr. Purcell's, on section 24, town 6, range 7, a coal was struck in his well, that is also, in all probability, referable to the same bed.

In the neighborhood of Linton, coal K has been mined at a number of places; it is from four and a half to five feet thick, and is an excellent quality of caking-coal.

On the map or Greene county accompanying this report, the place which the coal-beds at Linton occupy in the connected section of the coals, given on page 37, is designated by the letter "K?" The accompanying mark of interrogation implies that the coal has been so referred with doubt; indeed the old openings were all filled with debris, and very little opportunity was afforded, in this part of the county, for the examination of the coals in position.

The specimens found at these mines, and left with me since the suspension of mining operations last fall, bear testimony that it is a very firm and good quality of bituminous caking-coal. At two of the openings the coal is occasionally mined for market—one on section 26, town 7, range 7, owner's name unknown; the other is at Barney McClurg's on land owned by Mr. Sharp, on section 23, town 7, range 7. This stratum of coal is said to be from four to five feet thick, and has been struck in wells at Armstrong's mill, one quarter of a mile east of Linton, on section 23, town 7, range 7, and at the residence of Dr. Humphreys, on section 22, same town and range. The country immediately around Linton is quite level, and no rocks are to be seen; but on going northward a few miles the country becomes broken, and in road-cuts along the hill-sides we find, exposed to view, siliceous shales and flag-stones in the upper part, while in the deeper parts, at the base, there lies from two to ten feet of fossiliferous limestone, underlaid by the black bituminous sheety slate, containing teeth and other fish remains, which generally forms the roof of coal K, and occasionally the coal itself is seen.

At Mr. Jonas Hanna's, on section 32, town 8, range 7, coal K outcrops in a ravine, and may be traced along the branch that cuts through it for a considerable distance. It is here divided into three beds by two partings of fire-clay, and the total depth is five and a half feet.

Mr. Hanna dug a well at his house, on the top of the ridge, which passed through this coal at the depth of sixteen feet, and found no roof above it but the drift.

The principal fossils seen in the limestone which usually accompanies this coal, are referable to the following genera and species: *Productus wabashensis*, *P. cora*, *P. semireticulatus*, *Spirifer cameratus*, *Chonetes mesoloba*, *Athyris subtilita*, *Bellerophon carbonaria*, *Nucula inflata*, and large stems of *encrinites*.

Coal K outcrops in a branch at the foot of the hill at Mr. Bledsoe's, and thirty-two feet above it, this gentleman is mining coal L, by an entry driven into the hill, a specimen of which was analyzed, giving the following result:

Specific gravity, 1.251; a cubic foot weighs 78.2 lbs.

Coke, - -	63.5	Ash, fawn-color,	0.5
		Fixed carbon, -	63.0
Volatile matter,	36.5	Water, - -	7.0
		Gas, - - -	29.5
	100.0		100.0

The structure of the coal changes but slightly in coking, is somewhat swollen, and of a dingy, lustreless color.

At Mr. Smith's, one-quarter of a mile west of Bledsoe's, on the same section of land, the Perring bed, or coal N, outcrops, and is also worked by an entry.

The following approximate section will serve to show the relative position of these three beds of excellent bituminous caking-coal:

Soil and drift, - - - - -	18 ft.
Argillaceous shale, - - - -	2 ft.

Coal N,	4 ft.
Potters' clay, white,	2 ft.
Siliceous shale, with flags,	40 ft.
Coal L, equivalent of Staunton coal,	5–6 ft.
Dark fire-clay,	?
Blue argillaceous shale,	4 ft.
Bluish-gray sandstone,	24 ft.
Fossiliferous limestone,	2 ft.
Black bituminous slate, with fish remains,	2 ft.
Coal K,	4–5 ft.
	109 ft.

Here, in the space of about 109 feet, we find three beds of fossil fuel that have an aggregate thickness of from thirteen to fourteen feet.

The sulphur-bands which are of common occurrence in coal L, are, at Mr. Bledsoe's, readily separated from the main part of the bed, which is one of the very best bituminous caking-coals in this part of the county.

This coal is, as a fuel, above the average, and is sought after by blacksmiths, far and near, for forging iron and welding steel.

Gamble's coal, on section 29, town 8, range 7, is the same as the lower coal K, at Bledsoe's.

In the northern part of Wright township, coal K outcrops at the following places, where it is from four and a half to five feet thick, with one or two clay partings, and overlaid by a black shale and fossiliferous limestone;

McBride's,	on section	17,	town	8,	range	7.
White's,	"	8,	"	8,	"	7.
Letsinger's,	"	8,	"	8,	"	7.
Jasonville,	"	4 or 5,	"	8,	"	7.
Lahr's,	"	22,	"	8,	"	7.

Going east it has been struck in wells at a number of places, and underlies all the high land in that direction as far as the line dividing ranges 6 and 7.

The outcrop of coal I—the main "block-coal" bed of Clay county—should be found in the townships in range 6.

GLACIAL, OR DRIFT EPOCH.

The superstrata of clay, gravel, sand, and small boulders of metamorphic rocks which cover the entire county, except where removed by denudation, belongs to this geological formation.

Various metals and ores, foreign to the stratafied rocks of this county, are frequently found in this formation, but usually in such small quantities as to be of no practical value; indeed this "float" mineral of the drift serves too frequently to mislead the uninitiated, who lose both their time and money in the vain search after the parent bed or vein, which lies far to the north of the State.

The stratum of clay commonly known as "hardpan," is generally reached at the depth of fifteen or twenty feet, and forms the horizon from which the supply of well-water is obtained throughout the county.

ECONOMICAL GEOLOGY.

The total depth of all the coal strata in Greene county is fully equal to that of Clay county, which is twenty-eight feet and nine inches, and the area which is underlaid by coal may safely be estimated at three hundred and sixty square miles, or two hundred and thirty thousand four hundred acres. Over this district, after making full allowance for outcrops, horsebacks, loss from mining, etc., etc., there exists fully six feet of coal available for market.

As the mines in this county are only worked to a very limited extent to supply blacksmiths' forges and a few families who find it more convenient and economical than wood as a fuel, there is no data, at present, by which to fix its commercial value. If, therefore, we estimate the product of one acre which, at six feet in depth, will yield—calculating one ton per cubic yard—two hundred and ninety-four thousand bushels, which, at the usual price paid as royalty, one-half cent. per bushel, gives *one thousand four hundred and seventy dollars* as the value of one acre; and

calculated at the same rate for the entire area of two hundred and thirty thousand four hundred acres, gives *three hundred and thirty-eight milllons six hundred and eighty-eight thousand dollars* as the approximate royalty value of the coal in Greene county.

"*Block*" *Coal.*—The area of the "block" coal in Greene county, which is included in the above estimate, is about *one hundred and fifty square miles*, and its average depth may be taken at two and a half feet. In quality it is fully equal to the average run of "block" coal in Clay county, and can be used in the raw state for the manufacture of pig-iron.

Iron Ore.—Greene county is rich in deposits of siliceous hydrated brown oxide of iron and clay iron-stone. Many of these deposits of ore are from ten to twenty feet, or more, in depth, and will furnish a full supply of ore for a large number of blast-furnaces for many years to come. The only thing required to insure the immediate erection of blast-furnaces at these ore-banks, is a railway that will furnish means of transporting its manufactured products to market. Good "block-coal" suitable for fuel, and limestone for flux, are to be found in close proximity to the ore; and there is no quality of metal so much needed at this time, in Indiana, as the cold-short iron which the ores of this county will furnish in great perfection.

Building-Stone.—Excellent quarries of sandstone and limestone are now being opened and worked on Mr. Watson's land, on the line of the Indianapolis & Vincennes railroad, on section 6, town 8, range 4, and on section 14, town 8, range 5.

At the time of my examination, about six feet of rock was exposed at the latter quarry, still leaving a considerable depth of good stone undeveloped. It is a fine-grained, brownish-gray sandstone, with small specks of protoxide of iron, and lies in strata that range from six to sixteen inches in thickness, and may be taken up in slabs of any required length and breadth.

Sandstone quarries have also been opened by Mr. Hamlin, on section 25, town 7, range 4, and at Mrs. Faucett's, on Plummer's creek, on section 4, town 6, range 4.

The stone at the latter quarry is moderately fine-grained, has a cream color, can readily be split to any required thickness, and is mined in large slabs from six to thirty inches thick. Stone from Hamlin's quarry is used in Bloomfield for foundations to buildings, door-steps, door and window lintels and sills, chimneys, copings, etc., etc. In quality and in color it is similar to the stone at Mrs. Faucett's quarry.

Good sandstone for building purposes is also found on Mr. Lahr's land, and at various other localities in Wright township, in the north-western part of the county. In fact there is no scarcity of good building-stone in Greene county.

Quick Lime.—The subcarboniferous limestone along the I. & V. railroad, and in the ridge skirting Richland creek and Ore-branch, will furnish material for an abundance of good white lime. The limestone which overlies coal K, in the western part of the county, will at many places furnish a dark-colored but good strong lime, in every respect suitable for making mortar.

Fire-Clay.—This valuable mineral, which forms the substratum to coal-beds, has received very little attention in this county, and as yet no effort has been made to test its refractory qualities or adaptation to the manufacture of fire-brick. The bed of fire-clay which outcrops in the hill at Owensboro, is of excellent quality for the manufacture of stone-ware, and a pottery has been established by Mr. Reynolds on section 25, town 6, range 2, in which the Owensboro clay is used. This is a small factory, and turns out daily about one hundred gallons of ware consisting of crocks and jugs.

Ochre-Beds.—Beds of clay, colored with oxide of iron, are found at Patterson's near the mouth of Fish creek, on the line of the I. & V. railroad, in the edge of Owen county, also one and a half miles south-east of Salisbury,

at Mr. Law's, on section 4, town 8, range 3. These ochres are of various shades of color, and make a good cheap paint.

Agriculture.—On the west side of White river the country is mostly level, or gently rolling, and there are quite a number of small fertile prairies. On the prairies and the broad bottoms along the streams, the soil is, with a few exceptions, a sandy loam, easy to bring into cultivation, and yields large crops of corn, wheat, oats, and grasses.

In the marshes or wet prairie lands, on Latta's creek, and at other places, the soil is a deep black muck, which is, in its present state, unproductive, but if properly drained and worked by deep plowing, in such a manner as to leave its particles well exposed to the oxidizing action of the atmosphere, will, in a few years, become one of the most productive soils in the county.

On the ridges and table-lands, the soil is, for the most part, a yellowish clay, that is not ordinarily as well adapted for growing cereals as the sandy loam soil; yet it is very productive, and with ordinary culture will yield from twenty to thirty bushels of wheat to the acre. It also produces fine crops of red clover.

That portion of the county lying on the east side of White river is quite broken, and the soil is mostly composed of yellow clay; though there are tracts of sandy loam land in the bottoms along the creeks.

The ridges on this side of the river form highly favorable locations for the cultivation of fruits, and though but little attention has yet been paid to this branch of agriculture in Greene county, some very good orchards are to be seen in the neighborhood of Bloomfield, and both apple and peach trees present a thrifty appearance.

Timber.—On the west side of White river the timber is generally small, comprising a variety of oaks and hickory. The eastern portion of the county is heavily timbered, and contains the usual variety of trees found in this latitude—such as poplar, oaks, black walnut, ash, sugar-tree, hickory, etc., etc.

PARKE, FOUNTAIN, WARREN, OWEN, AND VERMILLION COUNTIES.

In addition to making the survey of Clay and Greene counties, a small portion of the time available for this year's work was taken to ascertain the limits and probable extent of the *iron-smelting* or "*block-coal*" seams in the coal field lying to the northward of Clay county, leaving that portion of the basin which lies to the southward and west of those counties to be examined next season, it being found impossible for me to examine both districts in the few months that could be given to field explorations. Having made only a hasty reconnoissance of the counties named at the head of this section, and which are to be hereafter surveyed and reported upon in detail, my present sketch of their geology will necessarily be brief.

PARKE COUNTY.

In the eastern part of Parke county, and spreading over a belt of country from two to six miles in width, and in length extending from Clay county on the south, to Fountain county on the north, there are from one to three beds of "block-coal." In the southeastern part of the county, in Raccoon township, there are, at least, three beds. The position of these coal seams are designated by the letters F, I, and K, on the vertical section of the coals given on page 37, in the report on Clay county. I is the main "block-coal" at Brazil, F is the lower, and K the upper seam.

On the branches of North Otter creek, in Raccoon township, coal I outcrops at a number of places where it is from four to five feet in thickness, being an excellent quality of iron-smelting or "block-coal." As yet but little effort has

been made, in this part of the county, to develop the coals; but since the commencement of work on the Indianapolis & St. Louis railroad, which will, when completed, furnish an outlet for mineral fuel, public attention has been called to this locality, and the coal lands are rapidly rising in value.

In parts of this district the lower "block-coal" seam F, which lies from twenty-four to thirty feet below coal I, attains a thickness of four feet, and is also a good quality of "block-coal" for smelting iron.

The "block-coal" belt in Parke county is broken into irregular basins by the conglomerate which crosses the belt along the Big and Little Raccoon creeks, and on Sugar creek. After passing beyond the conglomerate ridges on Big Raccoon creek, coals I and K make their appearance in the northwest corner of Raccoon township, and again after crossing the conglomerate ridge on Little Raccoon creek, they are found on Sand creek, in Washington and Adams townships.

The "block-coal" I, at Mr. Buchanan's mine, on Sand creek, is four feet thick. A specimen for analysis was taken from this mine, and gave the following result:

Specific gravity, 1.232; a cubic foot will weigh 77 lbs.

Coke, - -	64.5	Ash, white, - - -	2.0
		Fixed Carbon, - -	62.5
Volatile matter,	35.5	Water, - - - -	4.5
		Gas, - - - -	31.0
	100.0		100.0

The coal is but slightly altered in coking, somewhat swollen, lamellar and semi-lustrous. This coal contains a large amount of fixed carbon, and is well adapted to smelting iron ores.

In Washington township coal K is from thirty to forty inches thick, and, although at most openings a bituminous caking coal, at Mr. Kyles' mine it is a good block-coal. On Sugar Creek this seam is sometimes a cannel coal.

The following section will exhibit the position of the

coals on Sand and Sugar creeks, in Washington and Sugar Creek townships:

Soil and drift	10 feet	0 inches.
Sandstone and shale	8 "	"
Fossiliferous limestone, containing *Productus wabashenses*, *P. cora*, *P. semireticulatis*, *Spirifer cameratus*, *Athyris subtilita*, *Chonetes mesoloba*, *Bellerophon carbonaria*, *B. percarinatus*, *Orthoceras rushensis*, *Cyathaxonia prolifera*, large stems of *Encrinites* and *Eupachycrinus tuberculatus*, M. and W.	2 feet	10 inches.

(Hon. B. E. Rhoads, to whom I am indebted for the name of this new and interesting crinoid, which has been recently described by Professors Meek and Worthen, informs me that it was found in this limestone, on Sand creek.)

Pyritiferous shale	1 foot	0 inches.
Coal K, varying from a bituminous caking coal to a "block-coal"	3 feet	6 inches.
Fire clay	?	
Gray siliceous shale, with iron-stone	20—30 feet.	
Coal I, "block coal	3 feet 6 inches to 4 feet	6 inches.
Fire clay, good quality	3 "	0 "
Sandstone, building stone, containing fucoidal markings that closely resemble the *Fucoides Cauda-Galli*	5 "	0 "
Siliceous shales, with bands of good iron-stone	20 "	0 "
Coal F	0 "	6 "
Soft, reddish, thick-bedded sandstone, conglomerate	15 "	0 "
Bed of Sand creek	0 "	0 "
	100 feet	4 inches.

A specimen of the caking variety of coal K, taken from Mr. Batty's mine, on Sand creek, gave the following result:

Specific gravity, 1,231. A cubic foot will weigh 77 lbs.

Coke, - - - - -	58.5.	Ash, white, - - -	2.5.
		Fixed carbon, - -	56.0.
Volatile matter, -	41.5.	Water, - - - - -	3.0.
		Good illuminat'g gas,	38.5
	100.0.		100.0.

Coke swollen and porous.

This coal is mined in large cubes, and is a good steam and grate coal. Block-coal, suitable for blast-furnaces, is also found on Sugar creek, and its branches, in Sugar Creek township, ten to twelve miles northeast of Rockville, and the seam is here from thirty to forty inches thick.

In the western part of Parke county the southwesterly dip of the coal strata has brought up the higher beds, which in this county belong to the bituminous caking variety of coal, and are not suited for blast-furnaces.

The mammoth coal L, which is the equivalent of the coal at Lost creek mines, Staunton, Cloverland and Highland, on the Terre Haute & Indianapolis railroad, ranges from five to seven feet in thickness, and is opened and mined at the following places: Roseville (Gen. George K. Steele's mine), on the Evansville and Crawfordville railroad; Rosedale, on Big Raccoon creek; Clinton Locks; Jose Butler's, on section 7, town 15, range 8 west; and on Leatherwood creek, about four miles northwest of Rockville. At Jose Butler's mine the lower part of the bed possesses the quality of a "semi-block-coal." In this part of the county the underlying coal seams will rarely be found thick enough to be mined on a large scale with profit.

Section of the strata at Jose Butler's, on section 7, town 15, range 8.

Soil and drift, - - - - - - -	30 ft.	0 in.
Concretionary limestone, containing *Productus costatus*, *P. Rogersii*, *Spirifer cameratus*, *Athyris subtilita*, - - - - - -	0 ft.	6 in.
Black sheety shale, splits in thin laminæ, -	1 ft.	6 in.

Coal M?		1 ft. 0 in.
Fire clay,		3 ft. 0 in.
Greenish argo. shale,		4 ft. 0 in.
Black pyritiferous sheety slate, with fish-teeth. *Petrodus occidentalis*, spines and scales, *Cardinia fragilis* and *Aviculopecten rectilateraria*,		1 ft. 0 in.
Coal L,	Upper part containing irregular bands of iron pyrites, - - - 2 ft. 5 in. Pyritiferous clay parting, - - - 0 ft. 1 in. Bituminous coal - 1 ft. 0 in. Block-coal, - - 1 ft. 6 in.	5 ft. 0 in.
Fire clay,		5 ft. 0 in.
Argillaceous shales,		4 ft. 0 in.
Soft schistose sandstone		10 ft. 0 in.
Shales, covered,		21 ft. 0 in.
Black sheety slate,		0 ft. 6 in.
Coal,		1 ft. 6 in.
Gray shale,		8 ft. 0 in.
Black sheety slate, with fossil shells, of which *Cardinia fragilis*, *Orthoceras Rushensis*, were all that could be recognized,		3 ft. 0 in.
Coal,		0 ft. 6 in.
Gray shale,		6 ft. 0 in.
Black pyritiferous shale, passing into hard gray fossiliferous limestone, containing *Productus cora*, *P. costatus*, *P. wabashensis*, *Spirifer cameratus*, *Bellerophon carbonarius*, *B. Montfortianus*, *Orthoceras Rushensis*, *Chonetes mesoloba*, *Cyathaxonia prolifera*, and large stems of *crinoids*,		1 ft. 6 in.
Bed of branch.		

The limestone forming the lower stratum in this section was also seen at Armiesburg, where it is underlaid by a coal bed that may be seen in Big Raccoon creek at low water, which, in my opinion, is coal K.

The Evansville & Crawfordsville railroad runs in a northerly direction through the southern part of Parke county to

Rockville. At Roseville this road reaches the outcrop of the caking coal L, which is mined by Gen. George K. Steele, and at Catlin Station passes through a portion of the "block-coal" field. From one and a half to two miles east of this station "block-coal" I (?), from three to three and a half feet thick, and of excellent quality, has been opened on Mr. James Knight's land, section 4, town 14, range 7 west, and on the adjoining land to the west, belonging to Mr. Sunderland; and may be found underlying a broad district of country convenient to this road.

The Indiana & Illinois Central railway is located to run on an east and west line through the county, passing through Rockville and Montezuma. It will cross the "block-coal" field between Little Raccoon creek and Rockville; and the bituminous caking-coal field between Rockville and Montezuma.

Papers of association have recently been filed by the Indianapolis & St. Louis railroad company for the purpose of building a road from Brazil, on the Terre Haute & Indianapolis railroad, to run northward through Carbon, and from thence along the valleys of North Otter and Raccoon creeks to Montezuma, on the Wabash river, where it connects with the Evansville, Terre Haute & Chicago railroad, and with the Indiana & Illinois Central railway, under the name of the Raccoon Valley railroad; thus giving a direct route from the "block-coal" field, in the southern part of Parke, and northern part of Clay counties, to Chicago, on the north, and Decatur, on the west. The company having this road in hand has ample means at their disposal, which gives assurance that it will be built, and, when completed, will afford additional advantages for obtaining iron ores from Lake Superior.

Iron-Stone.—Where the creeks and branches cut through the shales that underlie the lower beds of coal, several bands of clay-ironstone are exposed to view, and the beds of the streams are, in such places, covered with ore that have been washed from the banks above. Though the quantity of this ore, at any one locality, may not be suffi-

cient of itself to supply blast-furnaces, it may nevertheless be obtained in sufficient quantity to form an advantageous mixture with the Iron Mountain or Lake Superior ores.

Building Stone.—The conglomerate sandstone, which forms high cliffs on Big Raccoon, Little Raccoon and Sugar creeks, may be quarried in blocks of any required dimensions, and will make a handsome and durable building stone. At Mansfield, on Big Raccoon creek, this rock is of a beautiful reddish-brown color, closely resembling in appearance the brown sandstone of which the Smithsonian Institute at Washington, D. C., is built. It has been used in the construction of the abutments to the bridge which crosses the creek at Mansfield, where it has been exposed to the weather for several years, and gives evidence of being a durable stone.

A similar colored sandstone, from the conglomerate bluff on the Little Racoon creek, was used in the foundation of the large bank building in Rockville, and is highly spoken of as a building stone.

FOUNTAIN COUNTY.

From Parke county on the South, with here and there breaks in the continuity of the strata, the "block-coal" is traced through the central portion of Fountain county, as far north as Big Shawnee creek, in Shawnee township, and is partially opened and worked from outcrops at many places throughout this district.

In Shawnee township the seams of "block-coal" are generally thin, ranging from one and a half to two feet, but the quality is good. The most northerly coal seen in this county is about two and a half miles south of Attica. It lies on the top of the conglomerate sandstone, and is mined by stripping. This coal has not been worked for some time, and the pits from which it was mined by stripping were filled with debris so that I could not see its depth, but was informed that it is about eighteen inches thick. A few pieces of coal were found at the old pits, which

served to indicate that it possessed the character of a good "block-coal." In the shales which overlie this coal, there are numerous nodules of earthy carbonate of iron that contain zinc-blende (sulphuret of zinc). A specimen of iron-stone from this locality, collected by the former State Geologist, Prof. Richard Owen, was at his request examined by me, and found to contain a notable quantity of rose-colored cobalt (*Remingtonite*).

In Van Buren township, on Dry Run, North Fork and East Fork of Coal Creek, "block-coal" has been mined for home consumption at a number of outcrops. The depth of the beds varies from two and a half to four feet, and the quality is equal to that of Clay county for the manufacture of iron.

On Mr. Geo. Lease's land, on the north fork of Coal creek, section 30, town 20, range 7 west, the following section was seen:

Drift, - - - - - - -	2 ft. 0 in.
Soft shale, - - - - - -	0 ft. 6 in.
Coal, - - - - - - -	1 ft. 6 in.
Fire-clay, - - - - - -	1 ft. 0 in.
Buff and gray argillaceous shale, -	8 ft. 0 in.
Coal (I?) good "block-coal," - -	3 ft. 0 in.
Fire-clay, - - - - - -	?
Black bituminous shale, with one to two inches of coal occasionally mixed through it, - - - - -	20 ft. 0 in.
Bed of creek,	
	36 ft. 0 in.

This coal may be traced for a distance of one and a half miles farther up the creek by outcrops. It appears to occupy the position of the middle "block-coal" bed (I) of Clay county, but my hasty examinations in this county will not enable me, at this time, to decide upon its position in the continuous section of the coals given on pages 37 to 45.

Where seen, at Mr. Lease's in the above section, the coal appears to be split up by intercalated shales, and I was shown an opening farther up the creek where the bed is united, and its depth thereby augmented to four and a half feet.

At William Davis' place, on section 31, town 20, range 7, is found:

"Block-coal," - - - -	1 ft. 6 in.
Argo. shale, - - - - -	1 ft. 0 in.
Hard, impure limestone, - -	3 ft. 0 in.

On the south side of Mr. Davis' farm, in the face of a low bluff, a bed of good "block-coal," full three feet thick, outcrops at a number of places, and probably lies from six to eight feet below the limestone of the above section which was seen on the north part of the farm.

At Mr. Davis' the coal has a good-sized hill above it, and may be conveniently worked at the outcrop by a drift.

A thin seam, from eighteen to twenty inches, of "block-coal," is seen on Miller's run, in the south edge of Covington, and may be followed for some distance, by outcrops along the line of the Indianapolis, Bloomington and Western railroad, which follows that creek. A "block-coal" bed, thirty to thirty-three inches thick, is also seen on Neal's branch, in section 2, town 19, range 9, and on Phœbus branch, in section 12, town 19, range 9, which probably belongs to the same horizon as the thin seams on the south side of Covington.

On Graham's creek, a branch of Coal creek, and on Coal creek, at many places, both in Wabash and Fulton townships, there are from two to three beds of bituminous caking coal. The lower bed is, however, in many localities, a *semi*-"block-coal." The places of these coals on Coal creek are provisionally given in the following sections:

Section at Mr. Mercer's mine on a branch of Coal creek, on section 30, town 19, range 8 west:

Covered slope to top of hill,		20 to 30 feet	0 inches.
Black slate,		1 "	0 "
Coal,		1 "	6 "
Gray argillaceous shale,		35 "	0 "
Coal I?	Hard, ringing coal, 2 ft. 2 in.		
	Semi-"block-coal," 10 in.		4 ft. 0 in.
	Caking-coal, 1 ft. 0 in.		
Fire-clay,		? ft.	
		71 feet 6 inches.	

A section was obtained on the Lafayette company's land, section 1, town 18, range 9, about one mile to the southwest of the former, which shows a middle coal that was not observed there:

Drift,	4 feet	0 inches.
Shale,	? "	"
Black slate,	1 "	0 "
Coal,	1 "	6 "
Shale,	8 "	0 "
Coal K?	3 "	6 "
Shale,	14 "	0 "
Coal I?	4.8 to 5 "	0 "
Covered slope to branch,	10 "	" "
	47 feet	0 inches.

On the Wallace place, in Fulton township, close to the Parke county line, in section 36, town 18, range 9, on Coal creek, the following section was seen:

Drift and covered slope,	20 feet	0 inches.
Flaggy sandstone,	6 "	0 "
Black sheety shale,	8 "	0 "
Limestone,	2 "	0 "
Semi-"block-coal," K? (which thickens up to four feet on the place of Jno. and Jas. Allen, on the opposite side of the hill,)	1 "	8 "
Fire-clay, (good potters-clay,)	2 "	0 "

Shale with covered space,	16 feet 0 inches.
Sandstone,	2 " 0 "
Coal I?	5 " 0 "
	62 feet 8 inches.

Close to Mr. Norman Thomas' house, on Silver Island, in the southwest corner of Fountain county, there is a high bluff, which faces the Wabash river, and presents a fine exposure of the coal measure strata. The following section was furnished by Mr. John Collett, of Eugene:

Drift,	20 to 30 feet 0 inches.
Gray argo. shales,	2 to 3 " 0 "
Coarse, black sheety slate,	4 to 5 " 0 "
Coal, brash,	0 " 8 "
Clay shale, place of quarry-rock,	6 " 0 "
Ferruginous, fossiliferous limestone,	0 " 6 "
Black bituminous sheety slate,	1 " 10 "
Coal,	1 " 6 "
White fire-clay,	3 " 6 "
Arenaceous shale with ironstone,	8 " 0 "
Band of nodular ironstone,	0 " 6 "
Black bituminous shale,	2 " 0 "
Fatty-coal,	1 " 6 "
Siliceous fire-clay,	2 " 6 "
Clay shale, with siliceous ironstone,	5 " 0 "
Gray argo. shale, with bands of ironstone,	4 " 8 "
Black band ironstone,	0 " 4 "
Cannel coal(?) slate,	0 " 8 "
Black sheety slate, with fish remains,	1 " 0 "
Coal (choice caking-coal),	1 " 8 "
Fire-clay,	6 " 0 "
Clay-shale, with ironstone,	2 " 0 "
Bituminous, fossiliferous limestone,	4 " 10 "
Coal K(?),	4 " 0 "
Fire-clay,	4 to 5 " 0 "
Soft sandstone,	2 " 0 "
Siliceous ironstone,	8 inches to 1 " 2 "

Flaggy sandstone, - - - -	6 feet 0 inches.
Coal I(?), semi-"block-coal," - -	3 " 0 "
Sandstone in river bed.	
	113 feet 10 inches.

It is my opinion that the second coal from the bottom in this section is coal K, and the mammoth bed L, which lies from ten to fifty feet above it, is here split up and represented by thin coals and beds of black bituminous slate.

The lower coal lies in the river bed, and occupies the position of the middle "block-coal" seam I.

Near the Wabash and Erie Canal, on the east side of Silver Island, (in which direction the county gradually slopes from the river bluff to the bottoms of Coal creek), Mr. Thomas has sunk a shaft to coal K(?), which passes through:

Soil and drift, - - - -	10 feet 0 inches.
Argillaceous shale, with ironstone, -	1 " 0 "
Limestone, - - - - -	1 " 0 "
Calcareous shale, - - - -	4 " 0 "
Coal K(?), - - - - -	4 " 8 "
	20 feet 8 inches.

A few yards farther to the east the coal is mined from the outcrop, and has above it:

Fossiliferous limestone containing *Productus wabashensis*, *P. punctatus*, *Spirifer cameratus*, *Bellerophon carbonarius*, *Chonotes mesoloba*, *Athyris subtilita*, and a variety of other coal measure fossils, - - -		4 ft. 0 in.
Bluish-gray shale, - - - -		0 ft. 6 in.
Cannel coal, local, - -	0 ft. 4 in.	
" Semi-block-coal," - -	3 ft. 6 in.	
Streak of iron pyrites, - -	0 ft. 0⅛ in.	4 ft. 8 in.
" Block-coal," good, - -	0 ft. 4 in.	
Streak of iron pyrites, - -	0 ft. 0⅛ in.	
Caking coal, - - -	0 ft. 6 in.	

I was informed by Mr. Thomas that there is another seam of coal, about twenty feet below this, which corresponds to the bed of coal in the Wabash river at the bluff. Half a mile east of Thomas' mine, on the west bank of Coal creek, in section 36, town 18, range 8, the Wabash Petroleum and Mining Company are mining the same seam of coal, by stripping off the clay roof, where the stratum lies near the surface. The same coal also outcrops in the hills on the east side of Coal creek, and underlies a large area of country.

On Prairie branch of Coal Creek, at Thomas Arrowhood's, on section 4, town 18, range 8, these two seams of coal, K (?) and I (?), come close together, being separated by only two feet of fire-clay, and, at one exposure which I saw, show a combined depth of ten feet. About one and a half miles northeast of Arrowhood's, at the crossing of Coal creek, near Cooper's mill, the conglomerate sandstone forms a conspicuous bluff. The position in the coal measures and the synchronism of the Arrowhood coals with the two lower coals at Silver Island is well established by deep bores that have been made close by the coals at each locality. The artesian well at Lodi, a condensed section of which is given on page 31, is situated about two hundred yards southeast of Thomas' mine, and commenced in the bottom land below the coal, consequently no coal was passed in this bore. As a more detailed account of the strata passed through in this bore may be of interest, it is given as follows:

Drift,	5 feet	0 inches.
Soapstone, with iron nodules	5 "	6 "
Limestone,	2 "	0 "
Shale,	8 "	0 "
Coal,	1 "	0 "
White clay,	3 "	0 "
Coal,	1 "	0 "
Soapstone, with iron nodules,	1 "	6 "
White sandstone,	12 "	6 "
Fossiliferous limestone, with iron nodules,	7 "	6 "

Sandstone, with cannel coal, bituminous coal, charcoal, and an oily substance,	10	feet	0	inches.
Argillaceous sandstone,	8	"	0	"
Argillaceous sandstone, with iron nodules,	16	"	9	"
Sandstone and soapstone,	12	"	7	"
Dark clay,	2	"	5	"
Soapstone, with coal,	3	"	7	"
Dark sandstone,	4	"	0	"
Shale,	4	"	3	"
Argillaceous sandstone, with mica,	2	"	10	"
Sandstone, fine-grained,	5	"	0	"
White sandstone,	15	"	0	"
Bituminous shale, with "oil bloom,"	5	"	10	"
Shale and coal,	6	"	3	"
Black shale,	9	"	0	"
White soapstone,	19	"	6	"
Sandstone, (base of conglomerate?)	31	"	11	"
Shale and soapstone, with thin seams of sandstone, (brackish water),	39	"	8	"
Shale,	15	"	3	"
Hard sandstone,	2	"	3	"
Sandy shale and soapstone,	62	"	5	"
Sandstone, fine-grained,	46	"	5	"
Soapstone with grit,	19	"	2	"
Hard-cap and shale,	12	"	3	"
Gritty soapstone, with shale,	53	"	7	"
Hard sandstone, with "oil bloom,"	10	"	4	"
Gritty shale, with salt water,	102	"	4	"
Sandstone and flint,	8	"	2	"
Soapstone, with iron pyrites,	44	"	11	"
(Salt water 5° Baume), Compact, coarse sand-rock,	64	"	10	"
Unctuous clay,	8	"	8	"
Soapstone, with fine grit,	65	"	5	"
Flint,	1	"	0	"

Gritty soapstone,	32 feet	4 inches.
(Salt water 6.5° Baume),		
Sandstone,	58 "	1 "
Soapstone, with unctuous shale	65 "	7 "
(Lowest salt water 7.5°),		
Brown bituminous shale, which burns freely, and contains specks of iron pyrites, (Marcellus shale),	60 "	9 "
Blue soapstone and sandstone,	20 "	5 "
Red bituminus shale,	25 "	11 "
(Oily matter,) hard, coarse-grained sandstone,	22 "	1 "
White limestone, with coral and shells (Devonian),	12 "	0 "
Magnesian limestone,	18 "	8 "
Sand rock, very hard,	22 "	0 "
Limestone,	23 "	0 "
	1,118 feet	9 inches.

The above well was bored on property owned by the Wabash Petroleum & Coal Mining Company. A quantity of water from this well was sent to Dr. Pohle, of New York, for analysis, and the result obtained shows that it is one of the most valuable medicinal waters in the country. An account of this analysis was given to me for publication, by one of the proprietors of the well, Mr. Nye, of Rockville, Indiana:

"It was found to yield the following dry, saline, and other constituents from the gallon, United States standard:

"Chloride of sodium,	502.464 grains.
"Chloride of calcium,	47.928 "
"Chloride of magnesium,	53.540 "
"Sulphate of lime,	55.553 "
"Sulphate of potassa,	.804 "
"Sulphate of magnesia,	3.260 "
"Sulphate of soda,	2.135 "
"Bicarbonate of lime,	2.904 "
"Bicarbonate of magnesia,	1.104 "
"Bromide of magnesium,	.880 "

" Iodide of magnesium,	- -	trace.
" Silicic acid,	- - - -	.520 grains.
" Phosphate of lime,	- - -	1.200 "
" Sulphur, mechanically suspended,		.500 "
" Nitrogenous organic matter,	-	.800 "
" Total solid matter,	- -	673.937 grains.

" It has a pleasant saline and sulphurous taste, and emits " the odor of sulphuretted hydrogen.

" Specific gravity at 60° F., 1.0112.

" Gaseous matter in one gallon:

" Sulphide of hydrogen,	-	7.94 cubic inches.
" Carbonic acid gas,	- -	undetermined.
" Nitrogen and oxygen,	-	undetermined."

About one quarter of a mile west of Thomas Arrowhood's mine, a well was bored for salt to the depth of seven hundred feet, and passed through five feet of coal (the lower bed) at the depth of twelve feet, and no other coal was found in the well.

South-east of Thomas Arrowhood's, on the same section, the upper part of his great bed—which is generally overlaid by limestone—is seen where it is about four feet thick, and entirely disconnected from the lower bed.

Some of the best bituminous caking-coals in the State are to be found on Coal creek, and when rendered accessible to market by the railroads that are now being built, they will be eagerly sought after for fuel and gas purposes.

The Thomas' coal, K? is for the most part a semi "block coal," and in my opinion will answer as fuel in the raw state, to manufacture pig-iron. A specimen was analyzed, and gave the following result:

Specific gravity, 1,277; a cubic foot weighs 77 lbs.

Coke, . .	64.3	Ash, dark brown, - -	4.5
		Fixed carbon, - -	59.8
Volatile matter,	35.7	Water, - - - -	3.0
		Gas, - - - -	32.7
	100.0		100.0

The coke is light, porous, much swollen, and without lustre.

It is at present mined by a company who pay Mr. Thomas a royalty of a half cent. per bushel. They ship, by the canal, about ten tons daily to Lafayette, where it has a high reputation as a steam and grate coal.

A trial of the relative heating value, and capacity for generating steam, was made of the Danville, Illinois coal, and Thomas' "Silver Island" coal, in a steam mill at Lafayette, last July (1869), with the following result:

4,210 pounds of Silver Island coal kept the steam up to full 60 pounds, for seven hours and forty-five minutes, while 4,260 pounds of Danville coal would only sustain the same pressure of steam for five hours and twenty-five minutes. This test shows a gain of 42.8 per cent. of heating capacity for the former coal; or, in other words, seventy bushels of Silver Island coal are equal to one hundred bushels of Danville coal.

Iron-ore.—In the shale above and below the coal seams on Coal creek, there are to be found numerous bands of ironstone (earthy carbonate of iron), that will go a great ways toward supplying blast-furnaces. In the bluff facing the Wabash river at Mr. Thomas', the bands of iron-stone will, in the aggregate, amount to more than two and a half feet in depth; and similar beds are to be seen on Coal creek.

Salt-Brine.—Good strong brine may be obtained anywhere in the vicinity of Coal creek or its branches, in Fulton and Wabash townships, and in the southern part of Troy township, by wells, at the depth of six hundred to one thousand feet.

Three wells have been bored for salt and oil in the above named district, and they all passed through several veins of brine, varying in strength from 6.5° to 9.5° Baume. The horizon of these brines may be seen by reference to the section of the bore made near Lodi, given on page 37. It

will require from sixty-five to seventy gallons of the best brine to make a bushel (50 lbs) of salt, which is fully as strong as the brine on the Kanawha river in Western Virginia.

Mr. Norman Thomas, of Silver Island, made salt for many years, in this county, from a brine obtained from a well which he bored on Coal creek, and only suspended operations in consequence of not having sufficient manufacturing facilities to compete with the salt works of Michigan and New York, which, at that time, were sending salt to northern Indiana at an extremely low rate of freight by means of the Wabash and Erie Canal.

Some years ago I made an analysis of the brine from the "Thomas salt-well," that was published by Prof. Richard Owen in a report that he made to the Wabash Petroleum and Coal Mining Company, which is reproduced here, together with the remarks made by Prof. Owen in relation thereto:—

"By Baume's scale, the brine sent by you indicated 8⅓°, "(distilled water at 60° F. being zero,) every degree denot- "ing one per cent. of salt, and 36½ being the greatest "amount that water at any temperature can take up. The "specific gravity of the same brine (distilled water at 62° "F. being 1000,) was found to be 1060. To render the "above more intelligible to salt boilers, I may add that the "brine you sent floats an egg, with a portion appearing "above the water. Salt makers are in the habit of saying "that, under ordinary circumstances of cheap fuel and "proximity to market, any brine will pay in which an egg "will float. But as this is a very indefinite standard, the "egg floating higher or lower in different brines, I have com- "pared the egg test with the salt hydrometer of Baume, and "here give the result. In water containing 8⅓ to 9 parts of "salt in 100 (hence indicating 8⅓ to 9° Baume) a fresh egg "will float, but be nearly covered. At anything below 8° "it sinks, but at 10° to 10½° B., (or specific gravity 1075 to "1080,) and in all brines above that strength, an egg will "float high.

"The brine from your 'Thomas well' gave of solid mat-
"ter 84.82616 parts in 1000. That solid matter consisted
"of the materials given below:

"Carbonic acid (free),	0.01615.
"Oxide of iron and silica,	0.02880.
"Carbonate of lime,	1.83850.
"Sulphate of lime,	0.04991.
"Chloride of magnesium,	0.90823.
"Chloride of calcium,	3.68225.
"Chloride of sodium (pure salt,)	78.30232.
"Water, and trace of organic matter,	915.17384.
"Total solid matter in 1000 grains,	84.82616.

"Your well requires 72.4 gallons of water to produce a
"bushel (fifty pounds) of pure salt."

I also copy, from *Kane's Chemistry*, the following "*Table showing the number of gallons of Salt Water producing a bushel of salt, in different parts of the United States:*

Nantucket Salt Water,	350
Boon's Lick, Missouri,	450
Conemaugh, Pennsylvania,	300
Shawneetown, Illinois,	280
Jackson, Ohio,	213
Lockhart, Mississippi,	180
Shawneetown, 2d Saline,	123*
St. Catharine, Upper Canada,	120
Zanesville, Ohio,	95
Kanawha, West Virginia,	75
Grand River, Arkansas,	80
Illinois River,	80
Montezuma, N. Y. (old wells),	70
Grand Rapids, Michigan,	50 to 60
Muskingum, Ohio,	50
Montezuma, N. Y. (new well),	50

* New Saline, 75 gallons.

Onondaga, N. Y. (old wells),	40 to 45
Onondaga, N. Y. (new well),	
Syracuse,	30 to 45

The "Thomas Well" still produces a good flow of brine, which, at the time of my visit, was pumped by hand, and made into salt on a limited scale by a man who was permitted to use the Company's kettles, nine in number, free of charge. He collected the fuel used under the kettles from the fallen forest trees, and carried it to the works upon his shoulders, pumped the water, and in fact did all the work about the establishment himself, and was making about one barrel of good white salt per day. I had no means of testing the strength of this brine at the well, and the small bottle of brine collected for examination at the laboratory, was broken in the transit.

The saliferous strata in this State are reached in the subcarboniferous sandstone formation, which underlies the limestone, and is co-extensive with the coal measures.

Building Stone.—The conglomerate sandstone in this county furnishes an abundance of good freestone for building purposes. In color it ranges from whitish-gray to a brownish-red.

Quarries of this stone have been opened near Attica, on the Toledo, Wabash and Western railroad, in Logan township, and afford a coarse-grained, grayish-brown, durable sandstone, that can be quarried in blocks from one to four feet or more in thickness, and of any required length and width. Other quarries have also been opened at Portland, on the Wabash and Erie canal, where a stone similar to that from Attica is obtained.

WARREN COUNTY.

My examinations in this county were very limited, being made solely with a view of determining the character of the coal-beds on the northern limits of the Indiana coal-field.

The stratified rocks of this county belong, for the most part, to the millstone grit epoch; the prominent feature of this formation being a heavy bedded sandstone, that occupies the geological position of the conglomerate sandstone; but here it contains no quartz pebbles. It is a coarse-grained, durable building-stone, and in color it varies from grayish-brown to reddish-brown. The jail at Williamsport is constructed of rock quarried from this member of the series which forms the Williamsport falls, sixty to seventy feet high, and outcrops in all the hills around the town.

In the road, on the north edge of Williamsport, there is an outcrop of subcarboniferous limestone, of a few feet in thickness, which contains a few fossils characteristic of the Keokuk beds. Half a mile south of the town there is a very good spring of cool chalybeate water, that breaks out from the base of the conglomerate sandstone, from which is deposited a large quantity of calcareous tufa and ferruginous matter.

A qualitative chemical examination of this water was made in the laboratory after my return home, and its principal constituents are:

Sulphate of protoxide of iron.
Carbonate of protoxide of iron.
Bicarbonate of lime.
Bicarbonate of magnesia.
Chloride of sodium (common salt).
Sulphate of soda (Glauber salts), small quantity.
Sulphate of magnesia (Epsom salts), small quantity.
Free carbonic acid.

This is properly a saline chalybeate water, and its medicinal properties are tonic and aperient.

The coal-measure strata which make their appearance in Pine township, contain at least two seams of good "block-coal," from two and a half to four feet thick. The principal mine visited was on a branch of Pine creek, and

was opened and worked to a considerable extent by Alexander A. Rice, of Attica, on section 19, town 23, range 8. The section at this mine is as follows:

Drift,	10 feet.
Buff siliceous shale,	2 "
Coal I? good "block-coal,"	4 "
Fire-clay,	2 "
Gray shale,	18 "
Shale, with bands of sandstone,	8 "
Blue argillaceous shale, with bands of ironstone,	6 "
Bed of Creek,	
	50 feet.

At Dick's mill, on Pine creek, the following section was seen, which underlies the section obtained at the coal-mine:

Drift,	10 (?) feet.
Bluish argillaceous shale, with bands of iron-stone,	60 (?) "
(The lower band of iron-stone is fully six inches thick.)	
Rough, false-bedded sandstone, with stems of plants much broken,	8 "
Bed of Pine creek.	

This section underlies all the coal.

Coal has been mined at a number of other places in Pine township, which I did not have time to visit; but, as the county is to be surveyed in detail hereafter, and the object of my visit having been accomplished in tracing the iron-smelting or "block-coal" to the northern limits of the coal basin in Indiana, further examination was not deemed necessary at this time.

OWEN COUNTY.

My examinations in this county were confined to a very narrow strip along the southwestern border of the county, in Marion and Jefferson townships. In these townships the "block-coal" seam I ranges from three-and-a-half to five feet in thickness, and, in quality, is equal to any in Clay county for manufacturing iron. All that is needed to bring the coals of this district into market and induce the building of blast-furnaces, is the establishment of railroad facilities.

VERMILLION COUNTY.

The survey of this county was made by my assistant, Prof. Frank H. Bradley, whose able and interesting report will be found in this volume, page 136. It only remains, therefore for me to add a few remarks embracing an account of the result of my own observations, made subsequent to the survey of Prof. Bradley, and during a trip hastily undertaken, at the request of a number of the leading citizens of the county.

Previous to my personal examinations in this county, it was not known that "block-coal" could be found within its borders, and its discovery was first made public through the newspapers, immediately after my return to Indianapolis, on the 15th of November, 1869.

The "block-coal" of Vermillion county, so far as known at present, underlies all the ridge land between Highland, on the south, and Newport, on the north. But it is my decided opinion that it will be found still farther to the south, as the same seam underlies the greater part of the county from the Indiana blast-furnace, on the south, to the Horseshoe on the Little Vermillion river, on the north.

Owing to the inclemency of the weather and the want of time, I was unable to determine the width of the field.

The total thickness of the bed ranges from five to seven feet, and is separated into two or more seams by thin partings of shale or fire-clay. The lower part of the bed (from

thirty to thirty-six inches) is good "block-coal," and the upper two to three feet above the clay parting is caking-coal.

On the map of Vermillion county which accompanies this volume, and in Prof. Bradley's report, this bed of coal is marked No. 6, and is, in my opinion, equivalent to the mammoth coal L of the connected section of Clay county coals, given on pages 37 to 45.

I am led to this conclusion not only from stratigraphical investigations, but from the fact that coal L, on the Terre Haute & Indianapolis railroad, in Clay county, and still further south, in Greene county, contains in its lower portion more or less "block-coal." This character of the mammoth seam is also apparent in General Steele's mine at Roseville, in Parke county, and quite marked at Jose Butler's, in the same county, a few miles southeast of Highland. At Mrs. Leatherman's, on section 27, town 16, range 9, and at Mr. Furman's mine, and the Groves' or Mill bank, south of Newport, from thirty to thirty-six inches of the seam is good "block-coal." A sample from the Mill bank was subjected to approximate analysis, and gave the following result:

Specific gravity, 1.289; a cubic foot weighs 80.5 lbs.

Coke, - -	52.2.	Ash, white, -	4.5.
		Fixed carbon, -	47.7.
Volatile matter, -	47.8.	Water, - -	3.5.
		Gas, good illumint'g,	44.3.
	100.0.		100.0.

This is a free-burning, non-caking, white ash coal, contains a small quantity of water, and has a larger quantity of gas than Pittsburg coal. It appears to be free from sulphur, and will undoubtedly make a good blast-furnace coal.

The Evansville, Terre Haute & Chicago railroad, which crosses the Wabash river at Clinton, and runs through the entire length of this "block-coal" field, will afford excellent facilities along its line for the location of blast-furnaces. As this railroad connects at Danville with another railroad run-

ning direct to Chicago, and is crossed at Highland by the Indiana & Illinois Central railway, running west to Decatur, in Illinois, no location in the "block-coal" region of the State can be more favorable for manufacturing iron, and for obtaining the Lake Superior iron ores at a low rate of freightage.

In close proximity to the "block-coal," large quantities of earthy carbonate of iron can be obtained from the shale-beds which underlie it. Bands of this character of iron-stone, that have a total thickness of from six to ten inches, or more, may be seen near the "Mill-bank," where the subordinate shales have been washed bare on the slopes of the ridges, and in the deep cuts made through the strata by the small creeks and branches.

Prof. Bradley, in his report, mentions a number of localities where iron-ore in considerable quantity can be obtained, and there are, no doubt, many others that have not yet been discovered.

The Indiana Blast-furnace, in the southwest part of the county, obtained its ore from this geological horizon, and experienced no difficulty in finding an abundant supply, though it was in blast for a number of years, and consumed daily from thirty to forty tons of ore.

At the time of my visit to the Indiana Blast-furnace, Mr. Sparks, who lives on the property, and is one of the owners, was absent from home, consequently I was unable to learn anything definite regarding its history; and, as yet, no answer has been received to a note which I left at his residence asking for information on this subject. It is reported, however, that it went out of blast soon after the breaking out of the rebellion; and owing to its distance from railroad facilities, and the growing scarcity of timber for charcoal, it has not since been put in blast, but not from any want of ore.

The outer wall of the stack is built of sandstone, and I should judge it to be about forty-feet high, and nine feet across the boshes. It was arranged for hot-blast, and used charcoal for fuel. The daily make of metal would be about

nine tons. The boilers, engine, and blowing cylinders appeared to be in good order.

I had but little opportunity to examine the character of the coal beds in the neighborhood of this furnace, but fully believe that a seam equivalent to the Leatherman and Mill bank coals may be found here of a quality that will also answer for smelting iron ores; in which case the Indiana furnace may be again put in blast, and run with profit, if placed under proper management.

The pig-iron, which is still to be seen at this furnace, bears testimony that the ores yield an excellent quality of metal. As many as three thick seams of coal, with a total depth of twelve to sixteen feet, are found over a large area of this county, and the quality will compare favorably with that of any other coals in the State.

ANALYSIS OF COALS.

County.	Name of Mine or Owner.	Specific Gravity.	Weight of one Cubic Foot.	Fixed Carbon.	Ashes.	Coke.	Volatile combustible matter. Gas.	Water.	Total Volatile Matter.
Clay	Barnett's Mine*	1.250	78.12	57.0	1.5	58.5	37.5	4.0	41.5
Clay	Garlick & Collins' Mine*	1.230	76.87	57.5	3.0	60.5	31.0	8.5	39.5
Clay	Knightsville No. 1 Mine*	1.176	73.50	59.8	0.3	60.1	30.9	9.0	39.9
Clay	Knightsville No. 2 Mine*	1.167	72 93	57.0	2.0	59.0	33.0	8.0	41.0
Clay	McClelland's No. 1 Mine*	1.279	79.93	54.7	1.5	56.2	38.8	5.0	43.8
Clay	McClelland's No. 2 Mine*	1.279	79.93	53.0	2.5	55.5	40.0	4.5	44.5
Clay	"Star" Mine*	1.242	77.62	61.5	2 5	64.0	32.5	3.5	36.0
Clay	Newburg Mine.	1.327	82.93	47.3	6.0	53.3	39.7	7.0	46.7
Greene	Babbitt's Mine	1.238	77.30	59.9	1.5	61.4	35.6	3.0	38.6
Greene	Bledsoe's Mine	1.251	78.20	63.0	0.5	63.5	29.5	7.0	36.5
Greene	Harrell's Mine	1.263	78.31	48.1	2.5	50.6	42.4	7.0	49.4
Greene	McKissick's Mine*	1.189	74.37	62.5	2.0	64.5	32.0	3 5	35.5
Greene	Templeton's Mine*	1.238	77.37	59.3	4.5	63.8	28.7	7.5	36 2
Parke	Batty's Mine	1.231	76.93	56.0	2.5	58.5	38.5	3.0	41.5
Parke	Buchanan's Mine*	1.232	77.00	62.5	2.0	64.5	31.0	4.5	35.5
Fountain	N. Thomas' Mine†	1.277	79.81	59.8	4.5	64.3	32.7	3.0	35.7
Vermillion	Grove's Mine*	1.289	80.50	47.7	4.5	52.2	44.3	3.5	47.8
Roan County, Tennessee	Rockwood's Mine	1.331	83.18	68.9	4.5	73.4	24.1	2.5	26.6
	Pittsburg Coal	1.278	79.75	56.9	1.0	57.9	41.1	1.0	42.1
Lehigh, Pennsylvania	Anthracite Coal.	1.590	99.37	91.0	2.5	93.5	3.5	3.5	6.5

* "Block"-coal. † Semi-"block"-coal.

ANALYSIS OF IRON ORES AND SLAG.

County.	Owner's Name or Title of Company.	Specific Gravity.	Loss by Ignition.	Sesqui-oxide of Iron.	Protoxide of Iron.	Alumina.	Manga-nese.	Lime.	Magnesia.	Sulphur and Phos-phorus.	Insoluble Silicates.	Per cent. of metal-lic Iron.
Greene	Richland Furnace ore bank.....	2.585	7.50	54.73	——	2.50	1.14	.12	.03	none.	34.00	38.31
Greene	Richland Furnace ore bank.....	2.583	11.50	56 00	——	2.00	——	10.00	3.60	none.	17.00	39.20
Monroe ...	Virginia Furnace ore bank.....	2.56	10.00	58.50	——	trace.	——	——	——	none.	31.50	40.95
Marion ...	Slag from Ind'p'lis rolling-mill		Gain .029	——	70.00	2 44	.25	trace.	trace.	——	15.94	62.37

Analysis of Peat from St. Joseph County.....

Coke: Shriveled, earthy, and lustreless.....

Coke.....	36	{ Ash, dirty yellow.....	9.5
		{ Fixed carbon.....	26.5
Volatile matter.....	64.	{ Water.....	8.5
		{ Gas.....	55.5
	100.		100.

GEOLOGY OF VERMILLION COUNTY.

BY FRANK H. BRADLEY.

Vermillion county is bounded on the north by Warren county, on the east by Fountain and Parke counties, with the channel of the Wabash river as a boundary line, on the south by Vigo county, and on the west by Edgar and Vermillion counties, of Illinois. It is thirty-six miles long, and varies in breadth from five to ten miles, with an average of a little less than seven miles, thus including an area of 249 square miles.

Of this area, from one-fourth to one-third consists of the rich bottoms and terraces of the valleys of the Wabash and its affluents, the Big and Little Vermillion rivers and Norton's creek. A study of the details of the terrace-topography would be very interesting, but the time allotted to the survey of this county allowed of only a passing notice of its general features. The main terrace, or "second bottom," is especially developed in the region between Perrysville and Newport, a fact probably resulting from the combined action of the two main affluents which join the Wabash within these limits. The terrace is here from one to four miles wide, furnishing a broad stretch of rich farming lands, and has an average elevation of about forty feet above the present bottoms. Below Newport the bluffs approach the river so closely that the terrace is nearly obliterated, and the bottoms themselves become very narrow. At the mouth of Little Raccoon creek the bottoms are considerably widened, but the terrace has no considerable extent, until we reach the head of Helt prairie, about six miles north of Clinton, whence it stretches southward, with an average width of from two to three miles. It narrows

again, about three miles below Clinton, as we approach the mouth of Brouillet's creek, and the county line.

At the first settlement of the country, the bottoms were heavily timbered, but a large part of the terrace was so-called prairie, being entirely clear of trees. It is probable, however, that this was the result of ancient clearing by the Aztecs, or Mound-builders, whose "mounds" are quite numerous in this region; and that, during the period when the Indians occupied the country, their annual fires prevented the growing up of the clearings.

Rising from the terrace we find more or less abrupt bluffs, which attain a general level of from 120 to 130 feet above the river, and form the slightly-elevated border of Grand Prairie. The most gradual ascent is to the westward of Perrysville, and this has been selected as the best route for the Chicago, Terre Haute & Evansville railroad, although the coal and iron interest would rather favor a location south of the Big Vermillion. South of this stream the bluffs are much steeper, and a moderate grade could be obtained only by following up the valley of one of the smaller streams. The slopes of these bluffs are generally too steep for convenient cultivation, and are, through nearly their whole extent, still heavily covered with timber, principally consisting of oaks, hickories and walnuts, though beech begins to take a prominent place as we approach the southern end of the county. In many of the ravines, and along the foot of the bluffs, there are large groves of the sugar maple, from which considerable quantities of sugar and molasses are annually drawn. Near the principal streams this timbered region extends westward to the State line; but in both the northern and middle portions of the length of the county, considerable portions of its territory form parts of the Grand Prairie, which stretches, with few breaks, northward to the Illinois river, and westward nearly to the Mississippi.

The county is well watered by its numerous streams, and by the strong springs which, especially in its northern half, burst forth at short intervals from below the "boulder-clay" of the drift period.

GEOLOGICAL FORMATIONS.

The alluvium of the river bottoms shows the common characters of river deposits, having animal and especially vegetable remains thoroughly intermingled with the fine sand and mud washed from the drift beds higher up the streams, and occasionally deposits of small stones, derived either from the drift or from the rock formations into which the rivers have cut in various parts of their courses. The only definite knowledge obtained as to the depth of these beds refers to the prairie between Eugene and Perryville, where wells have been sunk sixty feet through alluvial sand, and then encountered six to ten feet of a soft, sticky, bluish mud filled with leaves, twigs, and trunks of trees, locally known as "Noah's barn-yard." The lake-bottom deposits, of corresponding age, which commonly underlie the soil of the Grand prairie, were found in place a short distance west of the State line, consisting of marly clays and brick-clay subsoil, and probably exist equally under such portions of the prairie as extend into this county.

The gravel beds, which commonly form the upper member of the drift formation, have not been noticed within the county, though they may exist in its western portion, where the heavy prairie soil and subsoil prevent a knowledge of the underlying beds.

The "boulder-clay," which forms the mass of the drift formation, is a tough, bluish-drab, unlaminated clay, more or less thoroughly filled with fine and coarse gravel, and including many small boulders. On the bluff west of Perrysville this bed was penetrated to a depth of about one hundred feet before reaching the water-bearing quicksand commonly found beneath it. Outcrops of 110 feet have been measured, and the bed very probably attains a thickness of 125 feet or more, where it has not been subjected to denuding forces. It is much thinner in the southern part of the county. From the difference in character of the included boulders at different levels, we are led to the conclusion that the currents, which brought the materials composing these beds, flowed in different directions at different

times. To illustrate this I will give the following section, observed upon a branch of Johnson's creek, for which I am indebted to John Collett, Esq., of Eugene. (Johnson's creek debouches at the "toe" of the Horseshoe bend of the Little Vermillion, flowing from the east.)

Soil,	0 feet	0 inches.
Boulder-clay, with pebbles of Silurian limestone and trap,	30 "	0 "
Yellow clay, with fragments of coal, shale, sandstone, etc.,	0 "	4 "
Boulder-clay, with pebbles of Silurian limestone,	25 "	0 "
Ferruginous sand,	Streak.	
Boulder-clay from the northwest, with pebbles of various metamorphic rocks and trap, and nuggets of native copper,	50 feet	0 inches.

A considerable portion of the boulders and pebbles of these beds, especially those consisting of limestone and the metamorphic rocks, are finely polished and striated on one or more of their sides, showing the power of the forces which were engaged in their transportation from their original beds. Nuggets of galena (sulphide of lead) and of native copper are occasionally met with, and have had the usual effect of exciting the imaginations of persons who are ignorant that the rocks which contain these metals do not occur nearer than the galena region of Northern Illinois and Southern Wisconsin, and the copper mines of Lake Superior. Well-diggers, in the adjoining part of Illinois, have informed me that they are accustomed to find, near the bottom of boulder-clay, a thin layer of gravel, which contains a small quantity of gold. I have never taken pains to ascertain its outcrop, as the amount is too small to be of any value.

The coal measures furnish the only rock formations to be found in the county. Of these the outcrop at the Horseshoe bend of the Little Vermillion furnishes the highest, and this consideration, with others, leads me to commence the review

of their outcrops at this point, although it is so near the middle of the county.

The section of the rocks exposed at the Horse-shoe is as follows, measuring from the top downward. The numbering of the beds is made continuous as far as the mouth of the Little Vermillion, while the numbering of the coals correspond with the system which Prof. Cox* has adopted, as expressing most correctly the distribution of the different seams throughout the Indiana, Illinois, and western Kentucky coal-field.†

1.	Black slaty shale, with *Discina nitida*,	?
2.	Coal, "No. 8," - - -	2 ft. 6 in. to 4 ft.
3.	Fire-clay,	15 ft.
4.	Soft clay shales, with ironstones,	
5.	Argillaceous limestone, with *Productus longispinus*, - - -	1 ft. 0 in. to 2 ft.
6.	Dark drab clay shale, - -	1 ft.
7.	Soft, nearly black shale, - -	0 ft. 6 in.
8.	Coal "No. 7," - - -	4 ft. 0 in. to 5 ft.
9.	Light colored fire-clay, - -	2 ft.
10.	Dark colored fire-clay, - -	1 ft.
11.	Soft drab shale, with ironstones, *Productus*, etc., - - -	10 ft. 0 in. to 15 ft.
12.	Fossiliferous, black slaty shale, often pyritous, with many large iron-stone nodules, - -	2 ft. 0 in. to 3 ft.

*The system of numbering here referred to by Prof. Bradley, is given in a general section of the coal strata arranged by me for the Geological Report of Illinois, and was compiled principally from information obtained in making a survey of Gallatin and Saline counties, Illinois, and Union county, Ky.

Though the arrangement and numbering of the coal-beds in this section is believed to be accurate, for that region of the coal-field, I have not, as yet, been able to make the coal seams in this part of Indiana agree with it, and have, consequently, in my own report, used letters, provisionally, for the co-ordination of coal-beds, until a thorough study of the coal-measures in this State has been made. E. T. C.

†A letter written by me to John Collett, Esq., of Eugene, on Nov. 26th, 1868, and published in the newspapers of the Wabash valley, used a different set of numbers for the coal-seams, as the result of an attempt to co-ordinate them with the series of numbers adopted by Prof. Worthen, of the Illinois survey, for the coals of the Illinois valley; but finding that certain coals occurring on the Wabash had no place allotted to them in that system, I have been obliged to give it up, and now substitute therefor numbers, which will serve for the present identification of the different seams, but will probably require some change when the completion of the survey of the State shall have enabled us to arrange an accurate system of all its beds.

13. Coal, "No. 6," - - - - 5 ft. 0 in. to 7 ft.
14. Soft, black, shaly clay, - - 1 ft. 0 in. to 3 ft.
18. Fossiliferous, slightly sandy shales, with small ironstones, - 6 ft. 0 in. to 10 ft.
19. Drab shale, bottom concretionary, 20 ft. 0 in. to 43 ft.

Though I have looked carefully for it, I have never succeeded in finding any outcrop of the beds which overlie this section; and of the black shales which appear as its top layer, I have seen only specimens, as its outcrop was covered during the period of my survey of the county. The coal No. 8, as seen by me, had a covering merely of a few feet of soil. The samples of the roof-shales which I have seen are readily distinguished from those of coal No. 6, by their comparative freedom from pyrites, and the great numbers of *Discina* which accompany them, while this shell is only scantily present in the shales of No. 5.

The argilaceous limestone (5 of the section,) is here quite thinly laminated, being mingled with much clay; but the shales between it and coal No. 7 are here rather more solid than at some other points, and make a very fair working roof. About a mile farther up stream, at the upper end of the Horseshoe, the limestone is very solid, but the underlying shales are very soft, and appear likely to fall in the workings. The bed is not now worked at this point.

The section at this point is as follows:

5. Compact argillaceous limestone, 2 ft. 0 in.
6. Greenish shaly clay, - - - 1 ft. 0 in.
7. Soft black shale, - - - - 0 ft. 4 in.
8. Coal, No. 7, - - - - 4 ft. 0 in.
9 and 10. Fire-clay, - - - ?
Covered, - - - - 15?
18. Sandy shales, - - - - 10 ft. 0 in.
19. Dark drab to gray concretionary clay shales, - - 25 to 30 ft. 0 in.

The space marked "covered," evidently includes the

equivalents of Nos. 11 to 14, but no signs of coal No. 6 could be detected upon the outcrop. It is possible that it has locally thinned out and disappeared; but from the constancy of this bed wherever I have looked for it, along a line of outcrop of more than forty miles, I believe that it and the other missing beds, will be found here also when the debris shall have been removed from the slope, with the possible addition of Nos. 15 to 17, which are absent from the locally thinned section at the "toe" of the Horseshoe. It is a little curious, however, that so near to the *only known appearance* of No. 8 in the county, we should meet with the *only apparent failure* of this constant seam. A mistake in identification of seams at once suggests itself; but I believe that no such mistake has been made in this instance.

The sandy ironstones accompanying No. 18 of the section, are interesting to the fossil-hunter, as containing numerous fragmentary remains of fishes, mingled with fragments of *Neuropteris*, *Pecopteris*, *Cordaites*, etc. The last mentioned genus is also frequently present with *Discina* and the long fin-spines of *Petrodus occidentalis*,* in the pyritous ironstones in the roof of coal No. 6.

Upon ascending Johnson's branch, which enters the Little Vermillion at the "toe" of the Horseshoe, we find, upon the first left-hand ravine, an outcrop of coal No. 5, its presence being due to a local disturbance of the strata. As its normal relation to the section already given is better shown elsewhere, I give no section at this point. The disturbance mentioned is plainly indicated along the Little Vermillion by a great thinning of the beds below coal No. 6. This is partially shown by the variation in thickness ascribed to No. 19 of the given section; but a much greater difference is indicated by the dip of the beds at a point where the line of demarcation has passed below the level of the stream.

* I am aware that these long spines, feathered out upon the concave side like a slab of whalebone, and somewhat thickened along the convex edge, have not been described as *Petrodus*; but their universal occurrence, in company with the conical bony scales which are referred to this genus, has compelled me to conclude that they belonged to the same animal.

About a mile below the toe of the Horseshoe, near the so-called "silver-mine" of the "slip-bank," the following section was taken:

13.	Coal, "No. 6," - -	4 to 5 ft. 0 in.
14.	Fire-clay, top dark, bottom light drab, including a band of calcareous iron stone ("silver-ore"), - -	0 to 3 ft. 5 in.
15.	Light bluish-drab gray shale,	8 to 10 ft. 0 in.
16.	Olive colored gray shale, slightly sandy, with bands of siliceous iron stone, -	8 to 10 ft. 0 in.
17.	Nearly black clay shale,	1 ft. 8 in.
18.	Light gray, slightly sandy shale, with fossiliferous bands of calcareous iron stone and argillaceous lime stone, - - - - -	11 ft. 0 in.
19.	Dark drab concretionary shale top fossiliferous, - -	16 ft. 0 in.

Numbers 18 and 19 are especially interesting for their great abundance of fossils, of which the following are the more abundant: *Deltodus*, *Bellerophon percarinatus*, *Nautilus*, *Spirifer cameratus*, *Spiriferina Kentuckensis*, *Productus scabriculus* (very fine interiors often found), *P. punctatus*, *P. longispinus*, *Chonetes*, *Athyris subtilita*, *A. Royissii*, *Terebratula bovidens*, *Hemiphronites crassa*, *Aviculopecten* 2 sp. Along Fall branch, just above the "silver mine," on the opposite side of the river, the calcareous material of the beds equivalent to these bands is concentrated into a heavy compact limestone nearly two feet thick, with comparatively few fossils. In the branch above are numerous small, loose blocks of an impure limestone, perfectly *filled* with *Productus longispinus:* their proper place in the section was not ascertained. About a mile further down stream, near White's Mill, we find the following section, beginning with the bluff at the head of the mill-pond, as seen from the mill,

and running to the bluff below the mouth of Jonathan's creek:

18. Compact and pisolitic iron ore with shales,	2 ft. 0 in.
19. Clay shales, light and dark, hard and soft,	35 ft. 0 in.
20. Black calcareous ironstone,	0 ft. 8 in.
21. Black slaty shale,	2 to 3 ft.
22. Soft black shale,	0 ft. 6 in.
23. Coal, "No. 5,"	4 to 6 in.
24. Dark-drab soft clay shale, with ferns,	2 ft. 0 in.
25. Harder shales with sandy layers,	1 to 10 ft.
26. Quarry sandstone, coarse, ferruginous, with plant remains,	4 to 9 ft.
27. Shaly sandstone and sandy shales, some layers carbonaceous, with ferns, some ripple-marked flags,	15 to 20 ft
28. Dark-drab clay shales,	15 to 20 ft.
29. Clay shales, with thin bands of clay ironstone, full of fossil,	3 to 5 ft.

The black roof-shales of coal No. 5 commonly contain large numbers of the conical teeth (or scales) and long fin-spines of *Petrodus occidentalis.* The overlying black ironstones also contain this species, together with a few Mollusks, of which the most common are *Orthoceras Rushensis* and *Cardiomorpha Missouriensis.*

From the shales, No. 24 of the section, John Collett, Esq., of Eugene, reports the following plants: *Neuropteris hirsuta, Pecopteris, Hymenophyllites, Asterophyllites, Cordaites, Sphenophyllum, Lepidodendron* and *Sigillaria.*

The ironstone bands of No. 29 of the section are crowded with fossils, mostly small, but generally well preserved. The following are the more common: *Orthoceras Rushensis, Pleurotomaria, Loxonema, Bellerophon Montfortianus, Macrocheilus, Spirifer cameratus, Astartella, Leda, Phillipsia.*

Going on toward Newport, we find the beds of the fore-

going section, as high as No. 20, exposed at intervals on the hill-sides, but gradually rising to make room for the lower beds, of which the following is an average section:

30. Clay shales, - - - - - - 6 to 8 ft.
21. Black slaty shales, rich in fossils, 2 to 3 ft.
32. Coal, "No. 4," - - - - 18 to 20 in.
33. Fire clay, dark, shaly, with *Stigmaria*, 4 to 6½ ft.
34. Shales, - - - - - - 30 to 50 ft.
35. Ironstone bands and nodules in shales, 2 to 5 ft.

At Morehead's bank, one mile above Newport, on the south-west quarter of section 28, township 17 north, range 9 west, a local change of dip brings coal No. 4, which at one point had reached an elevation of nearly sixty feet above the river, down again very nearly to water level. Its roof-shales, everywhere quite fossiliferous, are here especially rich in scales, teeth, and spines of fish, including the minute comb-like teeth so frequently mentioned by Lesquereux in Owen's Geology of Indiana (1859–'60), and in nearly perfect specimens of a crustacean closely allied to *Ceratiocaris*.

Below this point no outcrop is visible until we reach the mouth of the river, where a bed of highly fossiliferous, calcareous ironstone, a few inches thick—probably the equivalent of No. 35 of the foregoing section—is exposed at low water. This is especially noticeable for the great numbers of *Serpulæ* which fill the entire mass, sometimes attached to other fossils, sometimes running free, as though the layer had been a calcareous mud, affording support to the thin tubes.

As we go down the bottoms south of Newport, we find, in the numerous ravines and gullies excavated in the bluffs by the small streams, fine sections of the equivalents of the beds noted in the foregoing sections, as high as the roof of coal No. 6, of which an average section is nearly as follows:

Sandy clay shales, with pisolitic ironstone nodules, - - - 5 ft. 0 in.
Soft clay shales, - - - 2 ft. 0 in.

Coal "No. 6," - - - - -	4 ft. 0 in. to 7 ft. 0 in.
Indurated fire-clay, - -	3 ft. 0 in.
Clay shale, partly sandy and micaceous, - - - - -	25 ft. 0 in.
Black calcareous ironstone, -	2 in. to 2 ft. 0 in.
Black slaty shale, - -	3 ft. 0 in. to 4 ft. 0 in.
Coal, "No. 5," - - -	8 in. to 3 ft. 0 in.
White fire-clay, mostly silicious, sometimes changing to sandstone,	2 ft. 0 in. to 6 ft. 0 in.
Argillaceous sandstone, some portions very shaly, others solid ferruginous, lower portion more or less concretionary, with thin irregular ironstone bands, -	70 ft. 0 in. to 80 ft. 0 in.
Light drab clay shales, - - -	10 ft. 0 in.
Black shale, mostly slaty, -	2 ft. 0 in.
Coal "No. 4," - - - -	1 ft. 8 in.
Fire-clay, sometimes very dark and shaly, with a thin band of compact sandstone, containing *Stigmaria*, - - - - -	3 ft. 0 in. to 10 ft. 0 in.
Fossiliferous calcareous ironstone,	1 ft. 0 in.
Black slaty shale, - - -	1 ft. 6 in.
Shaly cannel, fossiliferous, - -	2 ft. 0 in.
Coal, "No. 3," - - -	streak.
Fire-clay, - - - - - -	3 ft. 0 in.

The beds below coal No. 4, lie just at the base of the hills, and are generally more or less covered by debris, so that the exact section is often difficult to obtain; but the thin band of very hard stigmarial sandstone serves as a very reliable landmark. I observed it, either in place or slightly removed, every few rods, for some miles below Jackson's mill. The calcareous ironstone of the subjacent bed is also pretty constantly developed, being the equivalent of the before-mentioned outcrop, at the mouth of the Little Vermillion; but along the lower part of this range it is below the level of the bottoms. It is also interesting for its abundant fossils, beautifully preserved, including *Nau-*

tilus, *Serpula*, *Pleurotomaria*, *Productus*, *Chonetes mesoloba*, *C. punctulifera*, *Hemipronites crassa*, *Spirifer cameratus*, *Crania*, *Aviculopecten rectilateraria*, *Entoliam aviculatus*, *Cyathaxonia*, etc. The *Craniæ* were found attached within the outer chamber of a *Nautilus*. The underlying black shales and shaly cannel contain many *Aviculopectens*, with *Petrodus occidentalis*, *Orthoceras Rushensis*, and occasionally *Cardinia fragilis*.

On Whit. Jackson's farm, about four miles below Newport, wells sunk in the edge of the bottom many years since, but now filled up, are said to have penetrated coal No. 2, at a depth of about twelve feet. An attempt was made, during the past summer, to ascertain the truth of this by digging; but repeated floodings of their pit discouraged the workmen, and the problem is still unsolved.

About three miles below Newport, near the head of Wimsett Hollow, on section 10, township 16 north, range 9 west, one of the small branches, on the right as you ascend, has an exposure of about two and a half inches of "black band" iron ore accompanying the roof shales of coal No. 5, and containing an abundance of *Pleurotomaria*, *Bellerophon*, *Loxonema*, *Productus*, *Chonetes*, *Mytilus*, *Nucula*, *Astartella*, etc.

In the top of the bluff, east of Highland, the heavy bedded sandstone occurring just below coal No. 5, has been considerably quarried, as it here furnishes a very permanent building stone, and attains an extreme local thickness of twenty feet.

On the various branches of Little Raccoon creek, we find essentially the same section exposed piecemeal, here and there.

South of Little Raccoon, following the road under the bluffs, there appears a local rise of the strata, which, within a short distance, brings up coals No. 3 and No. 2. No. 3 is a thin seam, and has not been worked at any point, so far as known; Its level is known to be from twelve to fifteen feet above No. 2, at Wilson's coal bank, one mile above the head of Helt prairie, and in a ravine, a hundred

yards west of that point, it shows twenty inches of coal, with a roof of black slaty shale and calcareous ironstone. No. 2 is here from four to five feet thick, with only a thin covering of soil so far as yet worked. It has been opened, some time since, in the ravine aforesaid, where it is reported to be divided into two seams by a clay parting two feet thick. It appears to be the equivalent of the four foot seam worked just above Thomas's Ferry, on the Wabash, below the mouth of the Big Vermillion.

From this point the rocks dip again immediately, and about a mile farther south coal No. 4 has been opened in the edge of the bluff by the side of the road.

Thus far the heavy band of quarry rock, which holds a tolerably constant position in the shaly sandstones below coal No. 5, has served to keep the hills pretty high by reason of its slow yielding to denuding forces; but below here this band rapidly dips below water level, and there is only a small elevation between the main valley and that of Norton's creek.

[In passing from the valley of the Wabash to that of Little Raccoon, just below Highland, we find, on the contrary that this quarry sandstone is high up in the hill, and that the termination of the dividing ridge is comparatively abrupt.]

In following up the Eastern branch of Norton's creek from the head of Helt prairie, I was unable to find or hear of any outcrop—the boulder-clay covers everything. Small quantities of black shale were noticed in the drift of the western branch of the creek, but it was not traced to its source. Judging from the outcrops lower down the stream, I inferred that No. 6 outcropped on the upper part of this western branch.

Near the head of Helt's prairie, at Hawley & Helt's coal bank, No. 5 shows a local thickness of from twenty inches to two feet, with the usual roof of two or three feet of black slaty shale containing fish remains. In some portions of the mine there occurs a bed of from four to six inches of dark drab, compact clay shale, with *Pecopteris* and *Avicu-*

lopecten rectilateraria, intercalated between the coal and the black shale. This was not met with elsewhere.

A short distance farther down the creek, near the mouths of the ravines upon which are situated Nebeker's and White's coal-banks, this seam, which has kept near the level of the stream all the way, has returned to its usual thickness of from eight to ten inches. Near the heads of these ravines No. 6 is largely developed, and has been extensively worked. Its roof here consists almost entirely of massive concretions of pyritous carbonate of iron, only the *chinks* being filled with the black shale which commonly forms the roof of this seam. A layer of shale, however, overlies the ironstones. Many of these ironstones are rich in fossils, which are most readily obtained after the nodules have been exposed to the weather for some time. Among them we especially note, *Aviculopecten rectilateraria*, *Petrodus occidentalis*, *Productus longispinus*, *Discina nitida*, *Lingula*, *Cardinia? fragilis*, *Edmondia?* and *Solenomya*. The *Cardinia* also occurs in the overlying black shales, sometimes accompanied by *Stigmaria*, all the fossils being rendered noticeable by a brilliant thin layer of iron pyrites. The section of this locality is as follows:

Black shale, some slaty, - -	3 ft. to 4 ft.
Nodular band of pyritous and silicious ironstone, - -	1 ft. to 2 ft.
Coal, "No. 6," - - -	5 ft. to 6 ft.
Fire-clay and soft clay shale, -	4 ft.
Ferruginous sandstone — bottom, hard firestone, - -	6 ft. to 7 ft.
Sandy shales, changing below to dark drab clay shales with ironstones, - - -	40 ft. to 50 ft.
Black slaty shale (and locally calcareous ironstone), - -	2 ft. to 3 ft.
Coal, "No. 5," - -	8 ft. to 10 in.
Shaly clay, with *Stigmaria*,	?

Two and a half miles farther south, near Clinton, at

Van Ness's bank, No. 6 has descended to near high water mark, and soon passes below it as we go southward, making no farther appearance within the county, and showing again on this side the Wabash only at the point opposite Terre Haute, where Prof. Lesquereux reports it as worked near low water mark.*

The mass of the hill between the Wabash and Brouillet's creek, below Clinton, is composed of the shaly sandstones, sandy shales, and clay shales with ironstones, which form the larger part of the sixty or seventy feet of rock between coals No. 6 and No. 7. No section was found exposed in this part of the county which would give the exact distance between these two seams. At Mr. Skidmores place, about 3 miles west-south-west of Clinton, the "dirt" of No. 7 has been seen near the top of the hill, and some traces of No. 6 in the meadows at the foot of the hill. The distance between them was here estimated at seventy-five feet. I was informed by the miller at Hedge's mill, that in diving in the pool under the dam at that point, he had seen the outcrop of No. 6, five or six feet thick, with a black slate roof. A measurement from this point to the outcrop of No. 7 in the hill above, gave the distance at about fifty-five feet.

From near this mill to the Wabash the shales of this division contain numerous ironstone nodules of various sizes, in some of which fine specimens of fossil ferns have been found, though in not nearly so great abundance as at Durkee's Ferry, a few miles farther south in Vigo county.

In ascending Brouillet's creek, above Hedge's mill, we gradually approach the level of coal No. 7. Near the Indiana Furnace we find, upon Coal creek, the following section:

Greenish sandy shales, with ironstones, - - -	20 ft.
Drab clay shales, - -	15 ft. to 20ft.
Slaty coal, - - -	1 ft. to 3 ft.

* Owen's Geology of Indiana, 1859-60, p. 330.

Coal, "No. 7," - -	4½ ft. to 6 ft.
Fire-clay, - - -	6 ft.
Sandy Shales, - -	10 ft. to 12 ft.
Argillaceous limestone, -	1 ft. to 2 ft.
Sandy shales, - -	8 ft. to 12 ft.
Compact sandstone, - -	3 ft. to 6 ft.
Greenish shales, - -	3 ft. to 4 ft.

The limestone here noted is a pretty constant accompaniment of No. 7 in this part of the county, at a slightly variable distance below it. It is here rather farther from the coal than I have seen it elsewhere. It is probably the equivalent of the limestone band found about fifteen feet below the same seam in the neighborhood of Danville, Illinois, though no such bed is present in the section taken on the Little Vermillion.

Going up Brouillet's creek, from the Indiana Furnace, we find No. 7 opened at various places, until within a very short distance of the State line, where it finally dips below water level. Not far above the section taken upon Coal creek, the overlying sandy shales yield, upon disintegration, large numbers of heavy ironstone nodules, which will be more particularly noticed under the head of "economical geology," although the principal source of supply lies beyond the Illinois line. A short distance beyond the line there is a streak of coal, from two to five inches thick, which may be the equivalent of No. 8, though circumstances would indicate that it more probably represents a higher seam, which is not exposed within the limits of Vermillion county. South to the county line No. 7 and its accompanying beds probably underlie the western half of the county, as the lower beds do the portion along the lower course of Brouillet's creek. Starting from the Horseshoe of the Little Vermillion I have followed the natural succession of outcrops, and am now obliged to turn about in order to deal with the northern end of the county.

In going northward from the mouth of the Little Vermillion we find, at various points along the Wabash, nearly

to the mouth of the Big Vermillion, small outcrops of the ironstones and shales below No. 3, with this seam itself sometimes in place. About a mile below the residence of Mr. John Collett, and equidistant from Eugene and Newport, No. 2 has been seen at extreme low water, with a reported thickness of five feet, and the overlying band of ironstone is visible at ordinary stages of water. But, through the whole distance, it was found impossible to get a satisfactory section connecting these two seams.

In ascending the Big Vermillion we find on its south bank, a mile below Eugene, a bluff of banks of from twenty-five to thirty feet of irregularly bedded, highly ferruginous, coarse-grained sandstone, often containing comminuted plant remains, with some large fragments of trees, etc. Some of the beds are sufficiently solid to make good building stone. In quarrying them many fine trunks and branches of *Lepidodendron* and *Sigillaria* have been found, with a few fruits of *Trigonocarpum*. This bed is supposed, from its position, to be the equivalent of the sandstone belonging above coal No. 4, though it is rather more irregularly bedded, and of a coarser structure. Its position, however, is rather peculiar, for it lies in a hollow gullied into the lower strata to such a depth as to have removed both No. 4 and No. 3, and an unknown thickness of rock below them. The edge of this gully passes just below Eugene, where, at the ford, we see this sandstone lying over the edge of coal No. 3 and of from eight to ten feet of the underlying clays and shales. The position of the southern edge of the gully is not known, but the width is probably not very great, since the roof shales of No. 4 have been seen in place about one mile to the southward, in the bed of Tipton branch. (Just above that point a quarry in the overlying sandstone has yielded some fine large stems of the new species *Syringodendron Porteri*, Lsqx.) It would appear probable then that we have here a *fossil river* of carboniferous times, which may have flowed from the hills of conglomerate sandstone which still stand upon the east side of the Wabash, and show, by the position of the later beds about

their bases on all sides, that they were really hills during the deposition of these later beds. Doubtless they were finally buried in the later deposits of the carboniferous age, and have more recently been repeatedly swept over by marine and fresh-water currents, but their relations to these later beds are evidently unchanged, and they stand to-day as they stood then—hills above the surrounding low lands.

On the river bank, back of the tavern at Eugene, the following section occurs:

Dark fire-clay,	2 ft. 0 in.
Soft black shale,	2 ft. 0 in.
Fossiliferous ironstone,	2 to 4 in.
Soft black shale,	0 ft. 6 in.
Black slaty shale and impure cannel,	1 ft. 0 in.
Coal, No. 3,	1 ft. 0 in.
Compact sandstone, with *Stigmaria*,	1 ft. 0 in.
Blue fire-clay,	2 ft. 6 in.
Buff and gray fire-clay, changing to sandy shale,	5 ft. 0 in.

At the sawmill above town four feet of shaly sandstone cap the foregoing section. At S. Groenendyke's mine, above town, the following section occurs, which is an average representation of the condition of No. 4 in this neighborhood:

Dark-drab shale, with bands of ironstone nodules,	12 ft. 0 in.
Black shale	2½ to 3 ft.
Shaly cannel,	1 ft. 0 in.
Black slaty shale,	0 ft. 10 in.
Coal,	0 ft. 14 in.
Black shale, with pyritous nodules,	0 ft. 15 in.
Coal,	14 to 20 in.
Fire-clay,	?

This section is peculiar as regards the shaly cannel in its roof shales, which character does not commonly appear in

connection with No. 4; but I am unable to refer this coal to any other seam.

The section upon Browntown branch is interesting, on account of the disappearance of coal No. 5, (which has been seen nowhere north of White's Mill, on the Little Vermillion,) and for the presence of a valuable band of iron ore. It is as follows:

Black calcareous ironstone, - - -	1 to 2 ft.
Black slaty shale, - - - - -	4 to 5 ft.
Level of No. 5.	
Fire-clay, - - - - - - -	½ to 1 ft.
Shaly sandstone, - - - - -	6 to 8 ft.
Heavy-bedded quarry sandstone, - -	9 to 10 ft.
Shaly sandstone, - - - - -	1 to 2 ft.
Compact ironstone band, changing to nodules, - - - - - - - -	0 ft. 2 in.
Sandy shale, - - - - - -	10 ft. 0 in.
Compact brown ironstone, with fish remains, - - - - - - - -	18 to 20 in.
Sandy shale and shaly sandstone, with some ironstones, - - - - -	40 to 60 ft.
Shales of "No. 4," - - - - -	?

Near this point No. 4 dips below the present level of the Big Vermillion, and comes up again only at the Hanging Rock, and on Coal branch just back of it. Throughout the intervening distance, the roof-shales are seen at low water, proving its presence; and I am informed that it was worked at several points before the building of the dam at Eugene. The upper beds of the foregoing section, however, are very irregular in this neighborhood. Valuable bands of ironstone, and more or less sandstone and sandy shales are everywhere present, but the relative positions and thicknesses of the beds are exceedingly variable, as illustrated in the following section, taken at J. Jones', about two miles from Eugene, and representing the condition of things on an outcrop of about a hundred feet in length:

Blue clay shale-top with sandy streaks,	10 to 15 ft.
Covered, - - - - - - - -	3 to 5 ft.
Light brown ironstone, more or less calcareous, - - - - - - -	1½ to 3 ft.
Drab shales—some places, pure clay; others, becoming sandy and micaceous and even heavy sandstones; with pisolitic compact ironstones, especially at top,	20 ft.

At Hanging Rock, and on Coal branch just east of it, we find No. 4 well developed and considerably worked; but here, even more than is common elsewhere in the county, it is split up into comparatively thin partings, separated by shale and fire clay. I am informed that it has shown here as many as five partings. The following is the section as exposed in 1868, beginning with the capping sandstone, locally known as the "Hanging Rock sandstone," and supposed to be equivalent to the "Mahoning" sandstone of the Ohio coal-field:

Heavy-bedded soft ferruginous sandstone,	20 ft. 0 in.
Black slaty shale, with ironstone nodules,	18 ft. 0 in.
Soft black shale with Productus and fish-teeth, - - - - - - - -	1 ft. 6 in.
Coal, - - - - - - - -	1 ft. 9 in.
Fire-clay and blue shale, with pyrites, -	1 ft. 0 in.
Coal, - - - - - - - -	1 ft. 0 in.
Fire-clay, - - - - - - - -	1 ft. 0 in.
Coal, - - - - - - - -	2 ft. 8 in.
Fire-clay, - - - - - - - -	4 to 6 ft.
Black shale, - - - - - -	0 ft. 6 in.
Coal, - - - - - - - - -	1 ft. 6 in.
Indurated fire-clay, - - - - -	2 ft. 0 in.

One of these partings, said to be the third from the top, has been worked on Coal branch, with a thickness of from three to four feet.

The Hanging Rock itself projects considerably, in consequence of the disintegration of the softer, somewhat

pyritous shales beneath it, forming a small shelter for cattle who frequent the place both for shelter and to lick up the copperas and alum which form in small quantities upon the surface of the decomposing shales.

Above the Hanging Rock no outcrop of No. 4 occurs, and the banks are composed of the overlying sandstones and sandy shales, with the black roof-shales of No. 5 forming a prominent feature, until we pass beyond the State line, where they are about thirty feet above the river. No. 5 itself is represented by from six to ten inches of soft drab clay shale. The roof-shales show an adundance of their usual fossils, *Petrodus* and *Aviculopecten*.

In going north from Eugene, I have, thus far, been unable to connect the sections of the south part of the county with the outcrops found at and above Perrysville. Below Perrysville the only outcrops known belong to the conglomerate or millstone grit, which is so largely developed on the east side of the Wabash; and the relations of this, even to the higher beds on that side of the river, are still undecided.

The Perrysville section is as follows:

Coal (reported, as found in wells), No. 1,?	8 in. to 1 ft. 6 in.
Fire-clay,	2 ft. 0 in.
Soft blue clay shale,	12 ft. to 15 ft. 0 in.
Bluish drab shaly limestone,	2 ft. to 3 ft. 0 in.
Blue limestone, bottom rich in fossils,	3 ft. 0 in.
Light blue and drab shaly clay,	1 to 2 in.
Soft, black, shaly, calcareous clay,	4 ft. to 6 ft. 0 in.
Black slaty shale,	3 ft. to 4 ft. 0 in.
Soft, black, shaly, calcareous clay,	3 ft. to 4 ft. 0 in.
Light drab calcareous argillite, rich in fossils,	1 ft. to 4 ft. 0 in.
Soft, black, shaly, calcareous clay,	1 ft. 0 in.
Black slaty shale,	5 ft. to 0 ft. 6 in.
Soft black shale,	12 ft. to 15 ft. 0 in.
Dark drab shale, with ironstones at top,	27 ft. 0 in.

Exactly the same section occurs on Rock creek, in Warren county, where the beds lie directly, and apparently conformably, upon a set of shaly sandstones, which are continuous with the conglomerate sandstone of Williamsport, only becoming more purely quartzose and more solid as we descend the section. These shaly sandstones include a thin bed of very impure brash coal, about sixty feet below the limestone, which may represent "No. 1 A," but more probably belongs to an unnumbered seam commonly known as the "conglomerate" coal. Three or four miles below Rock creek, near Evans's coal mines, we find another band of limestone of very similar character, from thirty to forty feet above the equivalent of the Perrysville bed, and marks of one or more coal seams between them. Above this upper limestone are the two beds now worked, which considerably resemble Nos. 3 and 4. I believe that, by a little careful work in that neighborhood, one could find a section which would settle the doubtful points.

Wells sunk below the limestone at Perrysville, to a reported depth of ninety feet, are said to have encountered no coal, and it appears doubtful, at present, whether any valuable seam, at least, exists there.

The old limekiln just above Perrysville, on the bank of river, was dug in the soft clay shale of the base of the foregoing section, and shows no disturbance of the layers; yet within fifteen feet of this kiln we find a small quarry of sandstone, which extends from the base to the top of the bluff, cutting off even the limestone. Judging from observations on the east side of the Wabash, I conclude that this is an extension of the conglomerate sandstone, which either stood as an island or projected as a promontory in the old sea whose mud composed these shales and limestones. Just north of this point, the limestone is thicker than at any point south of it, and a slight difference has been noticed in the fossil contents upon the two sides, although, for half a mile to the southward, this feature is constant. On the north side the limestone runs only a few rods, giving no opportunity to ascertain whether the more

southern characters would obtain at a suitable distance from the obstacle. On the north side, close to the sandstone, some thin streaks and patches of coal have been observed, none of which appear to the southward. The lower shales, also, upon the north side, contain a few ferns and other coal-measure plants, none of which have yet been detected upon the south side. As the appearance and contents of these beds, as seen upon Rock and Redwood creeks, in Warren county, seem to be identical with their appearance and contents on the south side of this sandstone hillock, I am disposed to assume that these are the normal conditions of rocks deposited at that period in the open sea, and that the changed conditions on the other side have resulted from special local influences.

Along all the small streams which fall into the Wabash, between Perrysville and Covington, there are beds of fern-bearing shales, accompanied by thin seams of coal, which *appear* to belong *below* the Perrysville beds; but I have been unable to find any certain clue to their exact position. Their fossils indicate that they are *low* in the series, but cannot help us to any more definite conclusion. *Neuropteris hirsuta*, *Alethopteris Serlii*, *Cordaites borassifolia*, and *Gyromices ammonis*, are the most abundant fossils of these beds, while *Lepidodendron*, *Lepidophyllum*, *Trigonocarpum*, *Asterophyllites*, *Hymenophyllites*, *Filicites*, and fragments of bivalve crustaceans are occasionally met with.

As the Perrysville beds contain a very interesting group of fossils, I give here a complete list of the forms thus far collected at that point. From the limestone: *Phillipsia scitula*, *P. Sangamonensis ?*, *Bellerophon*, *Naticopsis* n. sp., *N. nodosa*, *Euomphalus rugosus*, *Loxonema* 2 or 3 sp., *Spirifer cameratus*, *S. lineatus*. *Spiriferina Kentuckensis*, *Athyris subtilita*, *Rhynchonella Osagensis*, *Productus semireticulatus*, *Chonetes mesoloba*, *Hemiphronites crassa*, *Discina nitida*, *Lingula*, *Placunopsis*, *Aviculopecten*, *Fusulina cylindrica*, Crinoid stems and Bryozoans: from the black shales: *Orthoceras Rushensis*, *Nautilus*, *Euomphalus?*, *Productus*, *Chonetes mesoloba*, *Discina nitida*, *Edmondia?*, *Aviculopec-*

ten rectilateraria, *Spirifer planoconvexus*, *Petrodus occidentalis:* from the calcareous argillite: *Nautilus latus?*, *Goniatites*, *Macrocheilus* (large), *Pleurotomaria carbonaria*, *Spirifer cameratus*, *Rhynchonella*, *Athyris subtilita*, *Productus*, *Chonetes mesoloba*, *Aviculopecten Coxanus*, *Solenomya radiata*, *Cyathaxonia prolifera.*

All of the rock strata here described have a general dip toward the southwest, at a rate of from fifteen to twenty feet to the mile, but this is modified greatly by various causes, so that it were possible to find local dips in almost any direction, and sometimes with quite a rapid pitch. Starting, then, from the eastern side of the county, where we stand upon the lower beds, we pass, on level ground slowly, on rising ground more rapidly, to higher and higher beds; until, when we reach the State line, if upon moderately high ground, we stand upon or above beds higher than any which we have crossed in our trip. The *principal* irregularities of dip have been pointed out as we went along; but the accurate delineation of these irregularities would require far more careful and expensive examinations than could be afforded.

Having thus sketched, as much in detail as seemed advisable, the distribution of the rock formations of the county, though with the omission of multitudes of interesting details, I will now proceed to that part of my report which should treat of

ECONOMICAL GEOLOGY.

The first subject to which the seeker for mineral wealth, in this county, would turn his attention is the coal supply. The first impression of the superficial observer would be that there is a great abundance for all demands; and the final conclusion of the scientific explorer must be that good coal can *now* be mined profitably under at least *one-half* of the area of the county, and *ultimately* under probably *two-thirds* of the remainder. A thickness of eight feet would probably be a small enough estimate for the coal underlying every square foot of the county. This would give, at

the usual estimate of one million tons to the square mile for every foot of thickness, the amount of 1,950,000,000 tons, or 48,750,000,000 bushels, as the supply of the county.

The highest workable seam is No. 8. This makes its only appearance in the county, and, indeed, in this whole region, at the Horseshoe bend of the Little Vermillion, where it shows a thickness of from two and a half to four feet, with a roof of black clay shale. It is a fat caking coal, rich in gas, and very sooty; good for blacksmithing or for grate fuel. Ash gray. This seam was formerly dug to some extent, but is at present neglected, in consequence of the large development of No. 7 and No. 6 at the same point.

At this locality, also, we find one of the only two localities within the county where No. 7 is worked. In the immediate neighborhood of the Horseshoe there are quite numerous openings into this seam, but only three or four of them are now worked. This is the equivalent of the main coal at Danville. It is a fat caking coal, good for engine or house fuel, and fair for blacksmithing if picked; but it is rather apt to be somewhat sulphurous. Ash reddish-brown. At the upper end of the Horseshoe, on Mr. Patrick's land, it has been considerably worked, with an average thickness of four feet; but the mines are now deserted. The shale between the coal and the heavy limestone roof appears to be rather soft, and the difficulty of supporting it has probably assisted in causing the desertion of the mines. At the "toe" of the Horseshoe the shale seems to be more compact, and stands very well in the two mines now open in this seam.

A barrel of coal, said to have been taken from this seam at Hibberly's bank, was sent by Josephus Collett, Jr., Esq., of Newport, to the rolling mill at Indianapolis, which, upon trial, proved to be fit for smelting iron. This is far better than the common coal of this seam; and I am rather inclined to believe that a mistake was made regarding the source of the coal sent, its character closely resembling that of the coal of No. 6.

As already stated, No 7 has not been seen north of this

place within the county; but there is reason to believe that it occurs on the highest part of the ridge east of the Little Vermillion, nearly or quite continuously, to its outcrop near Georgetown, Illinois. Below the Little Vermillion it is undoubtedly in place along all the western boundary of the county, and can be reached by shafts sunk in the prairie whenever any considerable demand may arise for coal.* It does not, however, run far enough east to outcrop along any of the streams in the lower part of the county, until we reach Brouillet's creek, along which it is worked, at short intervals, all the way from the State line to Hedges' Mill, and also on Coal creek, in the adjoining part of Vigo county. In this southern extension we find the seam thickened up to nine feet in some places; but, of this, the upper one to three feet consist generally of a very impure "brash" coal, which is rejected in mining, under the false name of "slate." These openings supply a large demand through the adjoining part of Grand prairie. The outcrops are conveniently located, and the supply seems inexhaustible.

Along the Big Vermillion No. 6 is nowhere seen, east of the Illinois line; but it undoubtedly underlies a considerable portion of the space between that stream and the Little Vermillion, along which latter its outcrop is continuous from a point three miles below Georgetown to the "silver mine" below the Horseshoe. Throughout this distance openings are frequent, and large quantities of coal have been taken from them, but none are now extensively worked. It has been recently reported, also, upon W. Eggleston's land, about one and a half miles southeast of the "silver mine."

This seam also underlies the entire western portion of the county, but runs farther east than No. 7, outcropping in the higher hills along every stream between Newport and Clinton, just below which latter place it passes below the level of the Wabash. Where it first enters the county, along the

*Serious difficulty can arise, in attempting to mine the coal at points upon the prairie, only from the possible presence here of the thick bed of water-bearing quicksand, which underlies the boulder-clay in the western parts of Edgar and Vermillion counties of Illinois.

Little Vermillion, this seam has a roof of soft dark-drab clay shale, containing fragments of ferns and the shells of the small Crustacean, *Leaia tricarinata*. But, as we descend the stream, this gradually becomes darker and harder until, at the Horseshoe, it is changed to or replaced by black slaty shales containing *Discina*, *Petrodus*, and other marine fossils, and accompanied by many large, black ironstone nodules, more or less sulphurous. This latter character is still more largely developed near Clinton, where the roof consists almost entirely of spherical nodules of sulphurous ironstone, two to three feet in diameter, closely packed together, and only the small interstices filled with black shale. The thickness of the seam is variable, ranging from four to seven feet. Through the northern part of the county, at least, it is generally a very pure coal, with the lower thirty to thirty-six inches—below the clay parting—a free-burning "block-coal," every way suited for smelting iron in the raw state. The upper portion of this seam swells some in burning, but makes a choice fuel for engine or house use. Ash white. The coal brought to Clinton from Nebeker's bank (No. 6) was observed to contain much of the "block," but circumstances prevented me from ascertaining how large a portion of the seam shows that character. Coal from this mine has displaced, for steamboat use, the product of mines nearer to Clinton.

No. 5, in the immediate neighborhood of so much larger seams of better coal, is not a very important source of fuel, and has been dug from only for local use except at two points, viz.: at Burns' bank, east of Highland, and at Hawley & Helt's bank, near the head of Helt Prairie. At Burns' bank, the seam is locally thickened to an average of about thirty-three inches, but yields only a rather coarse coal which burns with much flame and smoke, and leaves considerable cinder. Both here and at Hawley & Helt's bank, the coal was well spoken of as house fuel. At the latter place, the local thickness of the coal is about twenty-two inches. At all other points where this seam was encountered, it showed only from six to twelve inches of

rather impure coal, and is entirely wanting at all points north of White's mill. At Burns' bank, and at two or three points along Jonathan's creek, the ordinary black roof-shales are wanting, and a rather solid sandstone takes their place; and at Hawley & Helt's bank, as previously stated, a few inches of dark drab compact shale are found between the coal and its roof. It has been observed that where the fire-clay of this seam is not silicious, the coal is apt to be more impure and less in quantity. I have not yet ascertained whether this law holds good where the coal is entirely wanting, as in the northern part of the county.

No. 4 takes a rather more prominent place among the sources of fuel, but is still in the background when compared with the higher seams. This is a very irregular seam, and the amount of fuel which it would yield at any unexplored point, could not be calculated with any certainty. Its different partings vary greatly in thickness, and often in character. As a general rule, the upper portions are composed of a good blacksmithing coal, rich in bitumen, while the lower parts are more splinty. It is liked for house use, but is not extensively mined on account of the thinness of the partings. The principal openings are at and near the Hanging Rock, on the Big Vermillion, about four miles above Eugene, on section 28, township 18 north, range 10 west. Ash reddish-gray, some clinkers. These are among the oldest workings in the county. At S. Groenendyke's mine, near Eugene, this seam has been considerably worked for house fuel. Just below Eugene, as already stated, No. 4 and No. 3 are both cut off by the previously described channel, now filled with sandstone: but its disappearance is only for a short space, since it appears again within a mile of town and continues southward, though it is nowhere worked until we reach Morehead's mine, a mile above Newport. In the ravines below Newport, and upon the branches of Little Raccoon, this seam has been frequently opened in a small way for local supply, but is nowhere of much importance. Its last appearance is about a mile below Wilson's bank, near the head of Helt prairie.

No. 3 makes no prominent show in the county. At Eugene it is too thin to be worked. In the ravine back of Wilson's bank, it is about twenty inches thick, but is neglected for the thicker and purer No. 2.

Wilson's bank is the only place where No. 2 shows above the ordinary level of the river. It is said to have been seen on the bank of the Wabash at low water mark, about a mile below Mr. John Collett's, with a thickness of about five feet. There is every reason to believe that it is continuous under nearly the entire prairie from Newport to Eugene, and beyond towards Perryville, and can be mined by shafts of moderate depth at any convenient point. Above Eugene, its outcrop, beneath the alluvium, probably holds a general north-north-westerly course from the mouth of the Big Vermillion, parallel to the outcrops of the higher seams.

I am also of the opinion that the coal, from two to three feet thick, which outcrops near low water mark on the east side of the Wabash at Thomas' ferry, and which is one of the partings of No. 1, probably runs under the same region, and will be found of workable thickness; but there are no *certain* data for this opinion.

To the northward of Eugene, these lower seams are nowhere visible: in fact, no rock is seen upon the surface between the floor of No. 4, on the upper part of Coal branch, and the fire-clay above the limestone at Perrysville. But, from the general regularity of the outcrops, wherever exposed in this region, it appears probable that after the completion of the Terre Haute and Danville railroad, it will be found profitable to bore for these lower seams, at some point or points upon the prairie west of Perrysville. A boring of two hundred feet would reach the lowest workable seam anywhere in that region, and, over a considerable part of it, one hundred and fifty feet would probably be sufficient.

Although the thin seams to the northward of Perrysville have not been co-ordinated with the beds of the connected section, yet there is reason to account them partings of

No. 1. Coal, from twelve to eighteen inches thick, occurs at several points hereabouts, and has occasionally been dug from the outcrop for local use. The seams will never be of any considerable importance.

Iron.—Accompanying the coal-measure rocks in this county, we find several valuable deposits of iron-ore. The principal ore is an impure carbonate of iron, occurring in nodules and irregular layers or "bands." Such nodules, accompanying the sandy shales above coal No. 7, furnished, for several years to the Indiana Furnace, on Bouillet's creek, an abundant supply of ore, yielding, on an average, thirty-three per cent. of iron. The ore varies much, however, some specimens yielding as high as forty-five per cent. while others would barely give twenty-five per cent. The principal source of this ore lies west of the State line, but much of it also occurs east of the line, along the branches of Brouillet's creek, both above coal No. 7 and between it and coal N. 6. At the latter level, the greatest abundance of ore was seen about a mile below Skidmore's place before-mentioned, in the ravines upon the east side of the creek. A few of these nodules are somewhat pyritous, but these could readily be detached in preparing the ore for the furnace. An attempt was once made here to use the coal of No. 7 in the furnace, and a number of kettles were cast from the iron produced; but the metal proved brittle, probably from the presence of sulphur, and the attempt was not renewed. No iron has been made here since 1859.

Coal No. 6, which, in this part of the county, generally furnishes a good "block" coal from its lower benches, apparently lies about fifty feet below the creek-bottom at this place; it would probably pay to open it and use the coal in the furnace, which is now lying idle, principally, it is said, in consequence of the scarcity of charcoal.

Small quantities of this ore were seen at two or three points, near the Horseshoe of the Little Vermillion, coming from the shales above No. 7; but the supply is limited

Just west of the Illinois line, the shales above No. 6 yield large quantities of this ore.

Similar nodules were noticed along the Wabash, near the mouth of Spring creek above Perrysville; but the amount appeared to be too small to be of any practical importance.

The heavy ironstones mentioned as forming the roof of No. 6 in the vicinity of Clinton, generally contain so much pyrites as to render them valueless as ores, considering the present state of our knowledge upon the subject of freeing iron from sulphur.

The "black band" ore above No. 5, mentioned in the section taken upon Wimsett Hollow, three miles below Newport, although a very valuable ore, is probably not sufficiently abundant to be of any economical importance when taken alone; but if the nodules of pisolitc oxide of iron above No. 6, at the head of the main branch of that ravine, should prove to be sufficiently abundant for mining, this band might probably be used to advantage at the same time.

A coarse irregular band of calcareous ironstone, a few inches thick, often containing pisolitic iron "shot" through semi-crystalline calcite, with small quantities of zinc blende, accompanies the fire-clay of coal No. 6 at the "Silver mine" on the Little Vermillion, but the amount seems to be not large enough to make it of any importance.

The black calcareous ironstone which almost constantly accompanies the roof shales of coal No. 5, ought to be a valuable ore for use with the richer ones of Marquette, which are now largely shipped to Indiana for reduction. Its specific gravity, at some points, indicate a considerable percentage of iron, combined with lime suitable for fluxing. It sometimes contains silex, but this impurity is not common. The bed averages about a foot in thickness, but frequently thickens to three feet. The most favorable localities for examining it would be along the Big Virmillion, from the State line to within a mile of Hanging Rock, near the head of More branch, on Browntown

branch, and at White's Mill on the Little Vermillion. At all these points it could be very easily mined. On the branch next east of Tipton Hollow, two miles below Eugene, large irregular concretions, ten to twelve feet in horizontal diameter, and two or three feet thick, occur in this bed. This structure is not common in the bed, but the sort of roughly conchoidal fracture, which generally characterizes it, may be semi-concretionary in its nature. This structure may well be called "shucky."

Upon Browntown branch, and along the Big Vermillion, as far as More Branch, there is a heavy band of quite pure light-brown calcareous carbonate of Iron, which is of considerable value. At some points the lime largely predominates, but the whole bed would probably average twenty-five per cent. of iron. The combination of this considerable amount of iron, with limestone suitable for fluxing, renders this, also, a very valuable ore for mixing with the richer oxides in the smelting-furnace. The seam varies from eighteen inches to three feet in thickness, and deserves more attention than it has yet received. On Browntown branch, it was observed to contain rather numerous rhomboidal fish scales, and it is possible that, upon analysis, it will be found to contain too much phosphorous to be fit for the furnace. Large quantities could be mined with very little trouble.

The shales lying between No. 4 and its heavy sandstone cover, frequently contain small quantities of ironstone nodules, as at Hanging Rock, where many of them contain fossil plants. But at no point do we find any considerable amount of ore at this level.

Near the top of No. 3 we find, pretty constantly, a band of a few inches of compact ironstone, filled with fossil shells of numerous species, as at the mouth of the Little Virmillion, and in the numerous ravines along the edge of the bluffs between Newport and Highland. At Zener's saw-mill it is a foot thick, and easily mined.

Close above No. 2, along the bank of the Wabash, about four miles below Eugene, we find a heavy bed of com-

pact limonite (hydrated oxide of iron), which promises to be of considerable importance. The outcrop was covered with water at the time of my visit, but masses a foot thick, lying upon the bank, showed its character, and its full thickness was reported at from two to three feet. It would probably yield from forty to forty-five per cent. of iron. Except in times of freshet, it could be easily mined by stripping.

On Thomas Helt's land, along the bottoms of Norton's creek, near the head of Helt prairie, a bed of bog iron ore, said to be three feet thick, covers from six to eight acres. It was dug into some years ago, but none of it is now exposed.

On the whole, the county is abundantly supplied with iron ore of good quality, and the near neighborhood of the beds to the seams of "block" coal, will soon make this one the most important centers of iron production in the West.

Zinc blende (sulphide of zinc) frequently occurs, in small quantities, in the cracks and cavities of the ironstone nodules which accompany the shales above coal No. 6, and in the ironstone band which is found just above coal No. 4, along the Little Vermillion; but the amount is too small to be of any value. It was the scanty presence of this mineral in the pisolitic calcareous ironstone locally accompanying the under-clay of No. 6, which gave rise to the so-called "Silver-mine" at the "Slip-bank" of the Little Vermillion, on section 32, township 17 north, range 10 west. To geologists, it were needless to say that no silver bearing rocks occur in this region.

It is said that minute fragments of galena (sulphide of lead) have been seen in some of these nodules; and here, as everywhere else, "the Indians" have the credit of having mined lead in large quantities. Possibly they did "mine" it here; but, if so, it was only after they had first brought the ore from the Galena region, and buried it. Chunks of galena and of the native copper of Lake Superior are occasionally found in the drift. One of the small streaks of gravel, which occur in the "boulder-clay," is said to yield

minute quantities of gold, through all this region, but not in sufficient quantities to pay fair days' wages for washing it.

Clays.—Next to coal and iron, the under clays of the coal seams take the most important place among the mineral resources of the county. The bed which underlies coal No. 5 seems to be, both from its character and extent, the most valuable one of all, being generally of a lighter color than the underclays of the other seams. At Burns' bank, east of Highland, it was especially noticed as being nearly pure white, and from two to six feet thick. At some parts of its outcrop, as at certain points on Jonathan's creek, the clay, which is everywhere quite silicious, is locally changed to a very compact, semi-crystalline sandstone, full of the rootlets of *Stigmaria*, similar to that before mentioned as marking the level of No. 4, below Newport. This clay is continuous through the whole outcrop, though of varying thickness. In the southern portions of the county it was noticed that the thinner and more "brash" portions of the seams had the more silicious fire-clay. The material seems especially well fitted for the manufacture of tiling, both useful and ornamental, as well as for fire-brick. For the latter purpose the under clays of No. 6 are also suitable, though likely to make a darker brick. On Trosper branch of the Big Vermillion, perhaps a mile west of the State line, and four miles northeast of Georgetown, Illinois, these clays, including some thin intercalated beds of limestone, are over sixteen feet thick, and show a considerable variety of colors. At no point within the county was so great a thickness observed, from two to six or eight feet being the ordinary thickness; but it is not improbable that, at some of the openings of this seam which will certainly be made upon the ridge between the Big and Little Vermillions, clay of similar thickness and coloring may be met with.

Building Materials.—In a letter from Mr. John Collett, of Eugene, dated 3d of January, 1870, he says:

"Bricks have been manufactured at about forty-five different localities in this county, embracing every variety of

material. Those manufactured from the 'boulder-clays' of the table-lands adjoining the Grand prairie, especially when made of materials unexposed to oxidation of the air, are of light color, somewhat approaching the brownish cream color of the 'Milwaukee' brick; in other respects are a fair article. Bricks have often been made from the sandy loam of the creek and river bottoms, sometimes adding a small proportion of 'terrace' or 'boulder-clay.' This material requires more care in burning, as the alkaline potash, etc., held in solution by the water, is set free by access of air, and this, with the great amount of vegetable matter, readily forms, in connection with the sand, a coating of glass. Experiments have been made at Perrysville, and at Newport, resulting in the manufacture of good fire-brick from the 'under clays' and decomposed shales and soapstones so abundant throughout this county."

Of stone suitable for building purposes there is no lack. Some of the more heavily bedded, slightly ferruginous sandstone layers of the sandy shales between coals No. 7 and No. 6 have been quarried, on a small scale, along the hill between Clinton and the mouth of Brouillet's creek. The heavy bedded sandstone, which commonly lies from ten to thirty feet above coal No. 4, has yielded more stone for building purposes than any other bed in the county. Along the Little Vermillion, just below White's Mill, it generally varies from four to nine feet in thickness, and is a fine building stone, but some of the accompanying layers, though looking quite solid in the quarry, will not resist the disintegrating action of the weather, and must be rejected. From this layer considerable rock has been quarried, along the Big Vermillion, below Eugene; on Tipton branch, south of Eugene; along the Little Vermillion, as just stated; and in the bluffs east of Highland. At the latter place the face of the quarry, twenty feet thick, shows well as viewed from the river. Among the shaly sandstones just below the quarry rock we frequently meet with large, thin flagstones, often showing ripple-marks. At all the quarries we find the stone

containing more or less plant remains, of the genera *Lepidodendron*, *Sigillaria*, *Syringodendron*, *Calamites*, *Cordaites*, etc.

From the upper beds of the Millstone grit small quantities of rock have been quarried, between Perryville and Covington. Some of these contain sufficient mica to make it probable that they will prove suitable for furnace hearths. When furnaces shall be established in the county, it will be worth while to test these fairly before going further for hearthstone. Some portions of the Hanging Rock sandstone also appear suitable for this use.

In the section at Nebeker's coal-bank, north of Clinton, a band of sandstone, marked as a "firestone" in the section given, has been used in fireplaces in sugar camps in the neighborhood, and found to stand well.

The limestone at Perrysville is not suited for building purposes, since its argillaceous character renders it peculiarly liable to be broken up by the frost, as is plainly shown along its outcrop. It would make a valuable lime for agricultural purposes. Another thick seam of limestone is the one described as existing on Fall branch, just below the Horseshoe of the Little Vermillion, which appears to be a pretty solid rock; but its position and thinness prevent its being of much practical value. Still another occurs above coal No. 7, above the Horseshoe, and the same remarks will apply equally well to this as to the previous one. At two or three points, as at Perrysville, lime was formerly burnt for masons' use, but the stone used was found loose in the wash of the "boulder clay." The lime now used in this county is entirely imported.

Of black bituminous calcareous shales, such as have been much used for "patent roofing," there seems to be no limit to the amount, occurring, as they do, constantly above No. 3, generally above "No. 4," abundantly covering "No. 5," forming a considerable part of the roof of No. 6, and the roof of "No. 8," so far as seen.

I cannot conclude the report of the survey of this county without returning my hearty thanks to the many citizens

thereof who have, in all cases when called upon, rendered most efficient assistance; but these are especially due to William Gibson, Esq., of Perrysville, for guidance and repeated assistance in my attempts to ascertain the truth regarding the distribution of the rocks in that part of the county, and, above all, to John Collett, Esq., of Eugene, to whose frequent hospitality and constant assistance I have been greatly indebted, from the day on which I first entered the county until the present time, his letters having followed me up, and supplied the occasional "missing links" always to be sought for in completing the report of such work.

GEOLOGY OF FRANKLIN COUNTY.

DR. RUFUS HAYMOND'S REPORT OF A GEOLOGICAL SURVEY OF FRANKLIN COUNTY, INDIANA, MADE DURING THE SUMMER AND FALL OF 1869.

To Professor E. T. Cox, State Geologist:

SIR—In your letter, dated May 26, 1869, you suggest the following plan of survey and report upon the geology, etc., of Franklin county:

"1. Boundary of county, surface, configuration, streams, etc.

"2. Geological formations and descriptive geology, economical geology, ores, building stone, and all minerals of use.

"3. Timber and agriculture."

These instructions I have endeavored to carry out, and herewith respectfully submit for your consideration the following report:

PHYSICAL GEOGRAPHY.

Franklin county is bounded on the east by the State of Ohio; on the south, by Dearborn and Ripley counties; on the west, by Decatur and Rush counties; and on the north, by Fayette and Union. It contains about four hundred square miles. At least half the county is very much broken up into ridges and hills, separated by deep ravines and valleys of denudation, usually narrow upon the smaller streams, but occasionally spreading out to half a mile in width.

The principal rivers are, the main White Water and its two branches, the East and West Forks, which unite at Brookville, the county seat, in latitude 39° 28′ north, longitude 85° 05′ west—approximately.

The valley of the main river will average rather more than a mile in width, bounded throughout its whole course by beautiful sloping hills, ridges, promontories and rounded eminences, in many cases covered with forest trees and shrubbery, presenting a scene of unusual beauty throughout its whole course in the county.

The principal tributaries of the West Fork are Pipe creek, Salt creek, Sein creek, Garrison creek and Duck creek, all in the western part of the county. Pipe creek is about fifteen miles in length, and heads in Ripley county; Salt creek is probably twenty miles long, and heads in Decatur. The other streams are small.

The tributaries of the East Fork, within the bounds of the county are two—Templetons creek and Wolf creek—both small and unimportant streams.

The principal branches of the main river are Big Cedar, Little Cedar and Blue creek.

Several of these streams furnish a considerable amount of water in their upper course, but usually become entirely dry near their mouths in the latter part of summer, the water disappearing among the gravel and sand.

I am informed by Hon. John H. Farquhar, who was formerly engaged as an engineer upon the White Water Canal, that the amount of water furnished by the river at a medium stage was, for the East Fork 2,700, and for the West Fork 4,300 cubic feet per minute. The river, at the time the canal was constructed, afforded considerably more water than at present.

White Water is a very rapid stream, having, upon the average, a fall of six feet to the mile, from Hagerstown, in Wayne county, to Elizabethtown, in the State of Ohio. Of the amount of water power it is capable of furnishing, something may be said hereafter.

GENERAL GEOLOGY.

The greater number of rocks within the county belong to the lower Silurian system, the balance to the upper Silurian and Devonian formations. These rocks have evidently been "deposited at the bottom of a deep primitive ocean," and consist of alternate layers of semi-crystaline rocks and other sedimentary deposits, mostly in thin strata, varying from an inch to twelve or fifteen in thickness. These subcrystaline rocks are mostly composed of carbonate of lime, divided by beds of indurated bluish or gray clay, regularly stratified and divided by cleavage planes. This clay, properly a clay marl, contains a large amount of lime, and effervesces freely with sulphuric acid; upon exposure to the air, it slowly decomposes and crumbles to dust. The rocks contain millions of marine fossils, in great variety, many of them being a mass of shells cemented together with lime.

BLUE LIMESTONE REGION.

The blue limestone is the lowest rock which has been exposed at the bottoms of our streams. It underlies the whole region, and is the only rock found in the southeastern third of the county, except hypozoic boulders, which are found in all situations, from the highest to the lowest grounds.

This limestone, with its accompanying marls, is about four hundred feet thick in the southeastern part of the county, and three hundred and fifteen at Brookville, a mile and a half north of which it disappears, under a drab colored limestone, which is from six to twenty-two inches in thickness—the blue belonging to the lower Silurian, and the drab to the upper Silurian group.

In the blue limestone the following fossils were found, that are referable to the Trenton Period:

Petraia corniculum, *Columnaria alveolata*, *Chætetes lycoperdon*, *Asaphus gigas*, *Calymene senaria*, *Orthis Lynx*, *O. occidentalis*, *O. testudinaria*, *Strophomena rugosa*, *Leptæna sericea*, *Rhynchonella increbescense*, *Pleurotomaria lenticularis*, *Murchisonia bicincta*, *M. bellacincta*, *Bellerophon bilo-*

batus, *Endoceras proteiformes*, *Cyrtoceras annulatum*; and to the Hudson Period: *Ambonychia bellastriata*.

In the buff colored stone, which is dolomitic, I found the *Calymene Blumenbachii*, which leads me to infer that it belongs to the Niagara Period.

The surface of the county was originally almost a level plain, which is now varied and cut up by the valleys which the streams have worn for themselves during past ages. Beyond the heads of the streams, where the table land has not been changed by running water, the highest land is so flat as almost to deserve the name of marsh or swamp; yet these flats are not so wet as to prevent the growth of forest trees. Thus it will be apparent that we really have no such thing as hills or mountains, yet, to a person in the valleys or ravines, the rapid slopes, ridges and spurs, give every appearance of his being in a hilly country. Such is the appearance along the valley of White Water and its tributaries. When, therefore, the term hill is used in this report, I wish it to be understood as applicable to the slopes bordering the valleys, and not to hills, properly so called.

The blue limestone, so far as I have observed it in Franklin and neighboring counties, is found in strata varying from less than an inch to twelve or fourteen in thickness. These layers seem to the eye to be nearly horizontal, and occasionally can be traced for half a mile, the inclination only becoming apparent when the out-crop is found bordering streams which run parallel to the dip. I have found it impossible to satisfy myself as to the *exact* amount of inclination. The dip of the blue limestone rocks is to the southeast, at the rate of four feet to the mile, according to the best estimate I can make, after having examined them from the southeastern to northwestern angle of the county. One great difficulty in making a correct estimate of the dip, is the fact that the layers occasionally run out, and are replaced by other strata slightly different, or by the blue marl, so that the identification becomes difficult, and often impossible; all are, however, geologically identical.

The several strata are separated by the blue marl, which

varies from a few inches to one or two feet in thickness. The proportion of stone to the clay varies in different localities, but the stone in Franklin county I think preponderates over the clay marls. The rocks are all divided by vertical fissures into irregular fragments, from twelve inches or less to eight or ten feet in diameter.

There are, however, a few strata in the hills of a smooth, very hard fissile stone, which is often divided into rhomboidal forms—one set of vertical fissures running from southeast to northwest, the other from west of south to a little east of north. This fragmentary arrangement of the rocks accounts for the rounded contour of the hills, points and ridges. When by floods or other causes the rock becomes exposed, the marl crumbles to pieces by the action of the atmosphere; the strata fall successively, and slide down with the unctuous mud, and are never left standing out in mural cliffs, or producing cascades, as is the case with the "cliff limestone," of which I shall speak hereafter.

It is a curious fact that, notwithstanding the immense number of rocks, from the lowest point we can observe to near the tops of the highest levels, comparatively few loose stones are found at the surface. The hills and slopes of the valleys are covered with clay and other diluvial matter, in all respects identical with that found upon the uplands; and strangely enough, though so near the lime rock, the soil of the hillsides, as is the case in all the uplands and flats, seems to be devoid of lime—a fact scarcely credible when we consider the immense amount of this mineral immediately below the surface. If lime ever existed in any quantity in our upland soils (which is doubtful), it has been *leached* out during the lapse of ages by the constant percolation of water, charged with destructive chemical agents, ever since their deposition. The probability is that those lands which are deficient in lime, would be benefitted by the application of the marls found everywhere between the rocks—and that those which have been exhausted by cultivation might, by a proper application of lime and manures, be restored to their original fertility.

The blue clay or marl found between the strata of blue limestone, it was said, by Dr. Locke, contains thirty-five or forty per cent of lime. It effervesces as freely with acids as the rock itself.

These marl strata generally contain no fossils. There are, however, exceptions to this rule in those found near the summit of the hills. During their deposition, animal life, in many instances, seems to have ceased, to be renewed again in the next succeeding stratum, which abounds, as do most others, with marine shells, nearly all as perfect as during the lifetime of the animal; and in almost every rock the great mass of shells show all their convex surfaces upon one side, and the concave surface upon the other. Occasionally stones are found composed almost wholly of shells standing perpendicular to the surface, and fitting into each other as though they had been so placed by design.

I have found it impossible to determine the number of strata with absolute certainty which our valley slopes contain, for in no place is there more than fifty feet in perpendicular height exposed, except at a cut through a ridge two miles west of Brookville, made in the construction of the White Water Valley railroad, which is about eighty feet in depth. In this cut I have counted about one hundred strata, varying from half an inch in thickness to one foot. From the lowest outcrop at Brookville to the point where the blue limestone disappears beneath another formation, it is three hundred and fifteen feet, which at the rate of one hundred for eighty, would give for the whole elevation upwards of three hundred and ninety strata, which I think may be relied on as nearly correct—if any difference, rather under than above the true number.

The blue limestone is very valuable, being a good building stone, good for burning into quicklime, and for Mc-Adamizing roads. Every rock which has sufficient firmness to bear hammer-dressing, makes a good and durable building material. When free from cavities, much of it is susceptible of a very high polish. By Dr. Locke's analysis of the same character of rock, made some years ago, he

found it to contain 90.93 per cent of carbonate of lime, a trace of iron, magnesia, etc.

In consequence of the fact that this rock is always broken up into fragments, and the layers separated by unctuous blue clay marl, which decomposes and crumbles to pieces upon exposure to the atmosphere, thereby causing the fragments to fall, as I have before stated, there are no cliffs. But in the ravines, where the loose stones and other *debris* have been washed away by floods so as to clearly expose the rocks, they are found overlapping each other like shingles upon the roof of a house. The only exception to this arrangement is at their junction with the lowest member of the Upper Silurian group, which is a rock of superior thickness to any of the blue stones, and longer resists the action of air and water. Where this rock crosses the ravines, having small running streams, cascades are formed from six to twelve or fifteen feet in height.

UPPER SILURIAN.

Two miles north of Brookville, upon a ridge running north and south, and at a height of three hundred and fifteen feet above low water mark at the river, there is the first outcrop of a rock of very different appearance from any below it. Externally, it is of a drab or cream color for one-third of its thickness, both upon the upper and lower surfaces, the center third being of a pale blue color. This is the character of those near the surface. After the rock has been stripped below all atmospheric influences, it is entirely blue. This is a hard, compact limestone, which "spawls" with conchoidal fracture, and probably contains magnesia. It is sufficiently hard to work well to sharp edges. It contains but very few fossils. This rock is used extensively for building purposes, and mostly bids fair to be sufficiently durable.

In most situations where it is found, there are above it several strata of nodular bituminous limestone, in the aggregate occupying a space of from five to ten feet in perpendicular altitude. The strata are separated by beds of

yellow clay. This clay abounds in fossils, and in some situations above the bituminous layers, are vast numbers of bivalve shells and *cyathophylla*, the latter in greater numbers than I have ever observed them elsewhere. Specimens of these fossils will be forwarded to you, marked as occurring above these rocks, as well as those from the rocks immediately below.

This rock appears near the surface on the farm of Dr. Peck, four and a half miles northeast of Brookville, and is there three hundred and fifty-two feet below the level of the river; a mile and a half west of Peck's we find it on the farm of Josiah Allen, at a height of three hundred and twenty-four feet; two miles west of Allen's, at H. H. Schrichte's quarry, it is found to be three hundred and fifteen feet in height, showing a westward dip of nearly five feet to the mile. Six miles west of Schrichte's quarry, on the farm of C. T. Gordon, we again find it at an elevation of two hundred and ninety-seven feet; and a mile and a half farther west, on the farm of M. C. Gordon, it is found at the height of two hundred and fifty-two feet—a descent of forty-five feet, or thirty feet to the mile.

The dip of this formation is almost exactly opposite to that of the blue limestone strata, and for ten miles nearly at the same rate of inclination. From Gordon's farm the descent is much greater.

In all situations I have found this rock near the tops of the hills, with little above it except the nodular limestone, and with the further exception, that west of the West Fork, in Laurel township, it dips down and under thirty or forty feet of thin limestone strata, similar in most respects to blue limestone, which underlies it at other places, except that here they are *comparatively* devoid of fossils. Immediately upon this formation, two miles west of Laurel, and near the northwestern part of the county, we find the rock, called by the older Ohio geologists "Cliff limestone." It belongs partly to the Niagara epoch of the Silurian period, and the upper members probably to the Devonian.

Heretofore it seems to have been the opinion of our geologists that this formation was wanting in Franklin county—and indeed I was not aware myself that it existed here until I examined that section of the county. I find it very near the Fayette county line; but whether it is to be found north of that line, I am at present not prepared to say. It is confined to a belt of country about two and a half miles wide, beginning near the north line of the county, partly in Laurel and partly in Posey townships, and running south, probably into Ripley and Jefferson counties.

The lower member of this "Cliff-rock," as it appears in most places, is exceedingly rough, irregularly stratified in layers usually three or four inches thick, divided by vertical seams, which, upon exposure to the atmosphere, open, and the rock splits up into small angular fragments; this is particularly the case in the central parts of the cliff, leaving the upper and firmer parts of the rock overhanging like a projecting roof. The limestone of these cliffs is regularly interstratified with hornstone or chert.

The cliffs vary in height from ten to twenty-four feet, the latter being the highest I have measured.

Immediately upon this formation we find our best building stone, one or two being cream-colored; the latter are very hard, and contain silex, being what is termed "cherty limestone." Some of these courses make as fine flagging as can be found anywhere, and can be quarried of any desired dimensions. They are rough upon both surfaces, being full of protuberances and indentations, the protuberances of each fitting into the indentations of those above and below, there being no clay or other substance between them. The layers, though fitting very closely, in most cases are easily separated. As they lie in the quarry, they present the appearance of regular range-work, having a perpendicular face with narrow seams, which are as straight and true as a mason could put them up.

The district in which this formation is found being so narrow, I have not been able to ascertain the amount or direction of the dip, or, indeed, whether it has any. All

the locations in which I have found the "Cliff" rock seem to be very nearly of the same height.

About three miles southwest of Laurel, on the lands of Mr. Derbyshire, there is a miniature Niagara, a perpendicular fall of forty feet over the coarse irregular rock above mentioned. The shelving rock is in the shape of a horse-shoe, the semicircle being forty or fifty yards in circuit, the rock overhanging about twenty feet. Beneath the fall there is a slaty, calcareous, crumbling rock (probably hydraulic cement rock), twenty feet thick, which, from atmospheric influences, is constantly crumbling and falling out, leaving a tolerably dry cavern. About half a mile northeast of this there is another fall, of thirty-five feet, in every respect similar to the former except in height. Above both of these falls, for some distance back, all the strata, of the same character as those taken from the neighboring quarries, have been worn away by the action of the small streams which form the cascades. During a visit to Logansport, in Cass county, the past summer, I observed a rock of the same character, and of the same geological formation, as that found at Derbyshire's falls, occupying the bed of the Wabash river, in front of that town—hence I infer that the "Cliff limestone" of Indiana has but little, if any, inclination in a northern or southern direction, for there cannot be much difference in the height of our quarries and that of the rock at Logansport. Upon Sein creek, which empties into the West fork a mile below Laurel, there are a number of cliffs varying from ten to twenty-four feet in height. In several places the rock has been precipitated into the creek in large blocks weighing many tons, and though apparently so loosely stratified, and divided by so many seams, they still retain their original firmness and show no signs of disintegration. This Niagara group, and the others mentioned above as belonging to the upper Silurian, do not altogether make more than a hundred feet in perpendicular height. The balance of the formation, if it ever existed in the neighborhood of Brookville, and I presume it did, has been worked away by some great denuding flood, evidences of which may be

seen everywhere. In Schrichte's quarry, two miles north of Brookville, which occupies the top of a narrow ridge, running north and south, we find that one-half of the original formation has been worn off down to the magnesian rock, and subsequently filled up with gravel and clay very distinct from the other half with its nodular limestone and diluvial clay.

In the Sein creek cliffs on the farm of Mr. Bowers there are thirty-two strata of limestone, varying from an inch to three feet in thickness, interstratified with which there are fourteen of hornstone or chert, generally about three inches in thickness.

The Niagara Group, as well as the first rock above the blue "Cincinnati limestone," where they exist separately, are always near the tops of the hills, and are generally, though not always, covered with clay, gravel and broken limestone. The "Cliff" rock is covered with yellow ferruginous clay and fragments of hornstone.

DILUVIUM OR DRIFT.

The superficial material resting upon the rocks above described consist mostly of yellow clay, mixed more or less with small pieces of broken limestone, gravel from primitive rocks, and, in a few localities, almost pure gravel is found, in others sand, and frequently sand and gravel mixed. In no instance upon the uplands or tops of the hills do the rocks penetrate through these materials, and we find them only where the drift has been worn away by the action of the streams. The drift varies from four or five feet to forty or fifty in thickness upon the uplands. The slopes of the valleys and side-hills seem to be covered with drift similar to that upon the high grounds, but not of equal thickness. In digging wells upon the uplands the roots and bodies of trees are frequently found at various depths from ten to thirty feet; and, occasionally, limbs and leaves are found, with vegetable mould at various depths.

BOULDERS.

Boulders of granite, hornblende, greenstone, syenite, gneiss, and, in fact, of almost every species of metamorphic rock, are found all over the county, upon the highest as well as the lowest grounds. They are always found upon the surface and never beneath, except under slides or where gravel in the terraces has been washed over them. I have seen a few granite boulders that would square five or six feet; they are, however, generally much smaller, and are usually worn and rounded by attrition.

CALCAREOUS TUFA, ETC.

This deposit is found in many situations in the county, but more frequently in the gravelly terraces along the river, where the water of springs has percolated through the gravel, frequently forming large, rough, conglomerate rocks by cementing the gravel into a mass. In other places we find leaves and sticks mixed up in these formations, so perfect that we may even recognize them and determine upon what trees they grew. Around certain springs, the waters of which contain iron, ferruginous tufa is occasionally found in small quantities, containing, I apprehend, not more than five to ten per cent of metal.

TERRACES.

Upon the side-hills parallel to the course of the main river, and upon all its branches, there are benches or ancient terraces—upon the river slopes usually but two or three, but upon the smaller streams there are more. I have counted as many as ten upon a side-hill bordering Blue creek. Upon these ancient benches or beaches, we find no gravel or sand, nothing but soil, clays and rocks in *situ*. On the main river, throughout its course in the county, there are from two to four terraces composed of gravel, sand, broken limestone and small boulders of metamorphic rocks. The first terraces, or lowest bottoms, are usually not more than ten or twelve feet above the water; the

highest vary from seventy to eighty feet, and are often, at the same location, found upon both sides of the river. Where the highest terraces occupy the points just above the junction of the main river and its branches, we find the lower ends composed, usually, of fine sand drifted in strata, first to the east, then to the west, as though they had been washed up by the waves and heaped upon each other as the wind changed from east to west, when the land was slowly emerging from or sinking below the surface, during the last submergence of the continent. These gravelly terraces have evidently been deposited since the valley was excavated to its present depth for they rest upon the rocks *in situ*, in some cases below the present bed of the river, and as they could only have been formed *under* water, it follows that the valley has been submerged since its excavation to at least the height of this formation.

MINERAL SPRINGS.

No mineral springs of a medicinal character are known to exist in the county, with the exception of a few which contain a small percentage of iron, with possibly a small amount of saline sulphur. If springs exist having valuable medical qualities, I have not been able to discover them. Springs, of any kind, are much fewer than we would be led to expect from the configuration of the country. I think the limited number may be accounted for by the fact that all the rock strata, as well as the marl-beds, are divided by vertical seams, which allow the water to pass through them. It is true there are in the county quite a number of springs, but they are not by any means so numerous as I have observed them in other hilly sections. The water of all our springs contains a quantity of carbonate of lime, and is therefore familiarly called "hard water."

BLUE CLAY MARL.

Everywhere between the strata of the blue limestone, there are beds of clay marl, varying from an inch to two feet in thickness. In many instances it has nearly the

hardness of stone, and is regularly stratified; it effervesces as freely with sulphuric acid as the limestone above and below it, showing that it contains lime in abundance. Near the mouths of all the small tributaries of the river, and at a height equal to the gravelly terraces, there are large accumulations of marl, which has evidently been ground up or dissolved by water, which has transported it from the higher grounds to near the mouths of the streams, where its course has been checked up by the waters under which the terraces were formed. In these situations it contains some gravel and abundant angular fragments of limestone, identical with that in the surrounding hills. In some situations this marl is soft and plastic, having very much the color and consistence of putty. The marl-beds are so numerous and common all along Whitewater and its branches, that it seems unnecessary to point out particular localities.

In one locality, on the lands of Mr. H. C. Kunkle, in Laurel township, there is a bed of whitish or cream colored marl about eighteen inches thick, lying immediately upon the "Cliff," or Devonian rocks.

PALÆONTOLOGY.

Fossils in great abundance are found in almost every rock of the blue or Lower Silurian limestone.

The lowest rock which shows at the water's edge, near Brookville, is almost a mass of broken and prostrate corals, cemented together by lime. In this rock, standing perpendicular to its surface, are numerous stems of *encrinites*, which appear to have grown up through the corals after they had been broken and prostrated. Corals are found in most of the rocks, but nowhere so numerous as in this stratum, and in others found at an altitude of three hundred and twenty-five feet. The latter differ from the former in several respects, but particularly in being flat in many instances, while the former are nearly round. I send samples of both kinds.

Besides these we have—

Strophomena rugosa, in great profusion.
S. planœanvoxa, " "
S. deltoidea, " "
S. alternata, very numerous.
Orthis testudinaria, very numerous.
Orthis subquadrata, "
Orthis occidentalis, "
Orthis biferatus, Va. Lynx, "
Spirifer, not numerous.
Halysites, of Niagara group.
Favosites, of the Devonian.
Petraia, very numerous in Silurian rocks.
Maclurea, rare.
Encrinites, of several species.
Calymene Blumenbachii, and several other trilobites.
Astrea rugosa, rare.
Rhynchonella Wilsoni, rare.
Cyathophyllum turbinatum, rare.

In addition to these there are many other varieties which I am not able to identify.

IRON ORE.

Nodules of iron ore are occasionally found among the drift and gravel of the river banks, bearing evidence of having been water-worn, and doubtless were brought here with the other drift materials. The quantity is too small ever to be of any value. Pyrites, or sulphide of iron, is generally diffused among all the rocks, but in very small quantities; it is found between the layers, adhering to their surfaces, and occasionally crystals are found in the blue clay. The most beautiful specimens I have seen were found in the Niagara rock in Posey township. It has the color of gold.

LEAD.

There is a tradition that lead was once found upon a small tributary of the East fork, one mile from Brookville.

It is still the belief of some people that lead exists there, yet no man has been found who has *himself* seen the ore. The opinion is founded upon the old story, that an Indian had communicated the secret to some of the early settlers.

I have never been able to find it, and have no idea that lead will ever be found there, or indeed in any other part of the county, unless it be in very small quantities in the Devonian group.

COPPER.

A single piece of native copper has been found in the county, weighing about six pounds. It was no doubt transported with the drift from Lake Superior, as it was rounded, and bore other evidences of attrition.

GOLD.

In the northwest part of the county, in Laurel and Posey townships, upon Sein creek and its branches, gold is generally disseminated in very small particles. A common panfull of gravel and sand, when washed out, generally shows from two to three particles of gold in thin scales. None has ever been found larger than a grain of wheat. Though so generally disseminated, it is doubtful whether the quantity is sufficient to pay the expenses of washing it out. Gold has also been found upon Little Duck creek, and in other places in the county. The yellow clay in the neighborhood where gold is found, is mixed with quartz or chert, and whether the gold belongs to this formation, or has been transported in the drift, it would be difficult to say. Hornstone, in horizontal strata, is abundant in the neighborhood of the localities where the gold is ound. Gold is here, as elsewhere, found associated wita black sand.

SALT.

From forty to fifty years ago salt was made at four different places in the county. It has been so long ago that it has almost become traditional that salt was once produced here. A few of the older inhabitants, who were then

very young, remember the fact, but I have yet found no one who can tell me what amount was made, or how many gallons of the water it took to make a bushel of salt. Three of the salt wells were on Salt creek, two on the farm of George and David Hawkins, section 4, township 11, range 12 east, and one on the farm of Alexander Hawkins, of the same section. The latter is the well at which the largest amount of salt was made. The fourth well was on Pipe creek, section 8, township 10, range 13 east, northeast quarter, in Butler township. These wells are all situated in the blue limestone and clay marls of the Lower Silurian group. On the hills near them is found the magnesian and bituminous nodular series, which, as I have before stated, occupy but a very few feet in perpendicular height, and belong to the Upper Silurian. It is not probable that the water of these wells is of such a character, or in quantities sufficient to render the working of them profitable.

COAL.

Many people have an idea that coal may be found in Franklin county, and it has heretofore been impossible to convince them that there is none. Next in importance to knowing what a district of country *does contain*, is a knowledge of what it *does not contain*. If I could convince those persons who believe in its existence here, that it does not belong to our formation, and that any search for it will be utterly hopeless, I should feel that some good had been accomplished.

The semi-crystalline rocks of the upper and lower Silurian system were formed in the early ages of the world's history, when there was no vegetation upon the earth, except a very few and widely separated sea-weeds. Coal is universally admitted to be of vegetable origin, and its immense quantity points to a period for its formation, when the earth was densely covered with vegetation, tropical in character, such as tree ferns, gigantic rushes, etc., similar to those now found in some parts of Central and South America. The rocks of Franklin, and adjoining counties, were

deposited at a period long anterior to that in which coal was formed, and long before the earth was prepared to produce land plants, except a few, of the most insignificant character—this being the fact, it was impossible that coal could have been formed here at that early period. This should be sufficient to convince every one that it need not be sought for in this county. Fragments of black bituminous shale, which will burn feebly, are occasionally found here. This, no doubt, has been the cause of misleading people as to the existence of coal in this locality.

BUILDING MATERIALS.

Clay of a good quality for the manufacture of bricks is found in every part of the county. They are made on the uplands of the fine-grained yellow and whitish clay of first rate quality. Many are also made near Brookville, from the arenaceous loam of the river bottom lands, of very good quality, but occasionally contain fragments of lime, which slacks after exposure of the brick to the air, causing them to break, and rendering them unfit for outer walls. With care to exclude the lime, these bricks are as good, if not better, than those made from the upland clays.

Stone, known usually as the "blue Cincinnati limestone," is abundant everywhere, and is the surface-rock, as has been said elsewhere, in the southeastern third of the county. It is a valuable and very durable stone, but, unfortunately, there are but few strata, of sufficient firmness to work well, which exceed six inches in thickness. The thinner layers are used in walling cellars, and all other rough work where beauty is not essential. Many of the thicker strata are so shelly, and composed of broken corals and fossil shells, that they are not suited to ordinary stonework. Every stone which is sufficiently firm to bear hammer-dressing, may be relied upon as being sufficiently durable for any description of masonry. The thin strata are extensively used for flagging the sidewalks in the town, and have proved to be durable, and will, no doubt, outlast several successive pavements of brick.

The localities where this rock is found are so numerous, and so generally known, that to point them out would be superfluous. North of Brookville, one mile and a half in a direct line, the rock of which we have been speaking disappears under a stratum of (probably) magnesian limestone, which varies from six to twenty inches in thickness. This stone is extensively used for heavy masonry, and range-work of various kinds; its qualities have been mentioned in a former part of this report, and need not be repeated here. It is extensively quarried by Mr. Schrichte, on the south-east quarter of section 17, town 9, range 2 west; also an the lands of Jane McCarty, sections 8 and 9; on W. W. Butler's, section 8; on the farm of W. J. Peck, sections 13 and 14; on Josiah Allen's, and James Gavin's section 15; on the lands of John Skinner, Wm. Brier, and Samuel Shepperd, section 7; William Frank's, section 18; on lands of Z. B. Reed and J. P. Shiltz, sections 17 and 18; also on the lands of C. T. Gordon, section 32; and those of M. H. Gordon, section 30, town 12 north, range 13 east. It is also found on H. H. Seal's farm, section 36, town 10, range 2 west. South of Brookville it is found on the lands of Hon. A. B. Line, J. H. Lanning and John Althero—all in section 28, town 11 north, range 13 east; also on lands of E. Krause and P. Conrad, section 17, town 10 north, range 13 east. It is found in and around the town of Oldenburg, in great abundance, section 4, town 10 north, range 12 east; also on H. Schwegmann's farm, section 1, same town.

Besides the localities already mentioned, there are many others which might be named; but to enumerate them all would render this report tedious and unnecessarily long.

The most valuable building-stone in the county, or probably in the State, is found in Laurel and Posey townships. It is of the same character, and belongs to the same formation as the Dayton stone so extensively used in Cincinnati and other places, and the same as that found at Greensburg and St. Paul. This group has generally been referred to the Niagara series, and probably correctly so,

but I am of opinion that the upper strata, at least, belong to the Devonian formation. The few fossils I have been able to find in them (the upper members) are referable, in my opinion, to that group. Let this be as it may, the rocks are without doubt of great value as a building material, and when they come to be generally known will be extensively used.

Two miles north-west of Laurel, D. H. Mook owns a valuable quarry, which has been extensively worked. The strata are generally blue, especially the lower series, are hard, easily worked to a fine edge, are durable, and may be obtained of any required size or thickness. It is situated on the south-east quarter of section 5, town 12 north, range 12 east. Immediately west, in the same section, there is a fine outcrop of the same rock upon the land of Wm. Depperman; this has not been worked to the same extent as Mook's, but it contains a vast amount of valuable *material.*

On section 17, town 12 north, range 12 east, Messrs. Kemble & Payne own a quarry of very fine quality of stone. In this quarry the upper members are cream-colored cherty limestone. Stone of any desirable thickness may be obtained there.

John H. Faurot has a fine quarry on the southwest quarter of section 18, town 12, range 12; it has been but little worked. James Murphy also has a fine quarry in the same section. Thomas B. and William D. Adams, whose farm is on section 1, town 12, range 11 east, have a good quarry of the same character of stone. It is upon this farm where gold has been found in greater quantity than in any other locality in the neighborhood.

To these gentlemen, and especially to Thomas B. Adams, Esq., I am greatly indebted for assistance in prosecuting my examinations in that section of the county; and to the Rev. Wm. B. Adams my acknowledgments are due for hospitable treatment and entertainment at his residence.

Martha Plow owns a quarry in section 6, town 12, range

12, which promises well, but has not been worked to any considerable extent. J. A. Derbyshire has a fine quarry on section 20, town 12, range 12, and G. W. Kimble another in section 19.

Alfred Deter has, adjoining the village of Bulltown, in Posey township, a good quarry in section 13, town 12, range 11 east. This is the most western quarry I have seen.

One of the finest quarries in this formation belongs to Jesse Cloud, and is situate in the south-west quarter of section 7, town 12 north, range 12 east. The strata vary in thickness from two inches to ten. The thin flags are yellow, very hard, and upon being struck with a hammer give out a clear sharp ring, similar to glass; they are very durable, notwithstanding their argillaceous character.

Flagging, or stone for any other purpose, may be obtained here, or at any of the neighboring quarries, of uniform thickness and of any dimensions.

Besides these quarries there are a number of others in the vicinity which might be mentioned, but I deem it unnecessary to name them all, as they may be found in a belt two and a half miles in width by five or six in length.

TIMBER.

Franklin county was originally covered with a magnificent forest, comprising most of the hard timber trees common to the latitude. A little more than one-half of all the lands have been cleared, and are now under cultivation; and in the remaining half a large amount of the best timber has been sawed into lumber or made into staves, so that good timber in the county is *comparatively* scarce, and is becoming more so every day.

The principal timber trees are:

White oak (*Quercus alba*). This is, and always was, the most abundant tree in the county.

Burr oak (*Quercus macrocarpa*). Found in various parts of the county, but nowhere abundant.

Chestnut oak (*Quercus Castanea*). Two miles north of Brookville, upon a poor point, there is a grove of about

thirty chestnut-oak trees. These are all I have ever seen in Southeastern Indiana.

Red oak (*Quercus rubra*). Very common.

Black oak (*Quercus tinctoria*). Common upon the hills.

Red beech (*Fagus ferruginea*)), and white beech (*Fagus Sylvestris*). The most numerous of all trees except white oak.

Shellbark hickory (*Carya alba*). Very abundant.

Thick shellbark (*Carya sulcata*). Quite common.

Pig-nut hickory (*Carya glabra*). Common.

White ash (*Fraxinum Americana*). A very common and valuable timber tree.

Blue ash (*Fraxinum quadrangulata*). Rather abundant, and the most valuable of all ash timber.

Hoop ash (*Celtis Mississippiensis*), and hackberry (*Celtis occidentalis*). Quite common, the latter tree the most numerous.

Sycamore (*Platanus occidentalis*). Plentiful along the borders of all our streams.

Butternut (*Juglans Cinerea*). Quite common.

Poplar (*Liriodendron tulipifera*). Once very abundant, now becoming scarce.

Black walnut (*Juglans nigra*). Formerly abundant, but now becoming scarce.

Sugar maple (*Acer saccharinum*). Abundant.

White maple (*Acer dasycarpum*). Common.

Red or swamp maple (*Acer rubrum*). Common.

Wild cherry (*Cerasus Virginiana*). Not abundant

Sweet gum (*Liquidamber Styraciflua*). Common in the southern part of the county; occasionally found in northeast part.

Cottonwood (*Populus angulata*). Quite common along our streams.

Linden-basswood (*Tilia Americana*). Very common.

Buckeye (*Æsculus glabra*). Very abundant.

Coffee-nut (*Gymnocladus Canadensis*). Not very abundant.

Honey locust (*Gleditschia triacanthos*). Quite common

Gum (*Nyssa uniflora*). Common.

Slippery elm (*Ulmus fulva*). Common.

White elm (*Ulmus Americana*). Abundant.

Mulberry (*Morus rubra*). Rather abundant.

Red cedar (*Juniperus Virginiana*). A few small groves in the county.

In addition to the timber trees above named there are many smaller varieties, but as they are seldom used for building or mechanical purposes I have thought it unnecessary to name them.

WATER-POWER.

Our streams do not furnish, upon the average, more than one-third the amount of water they did thirty or forty years ago. There were then many water-mills upon the small tributaries of Whitewater that are now abandoned on account of the failure of water. This failure is caused by the destruction of the forests, and by draining the flat uplands. Whilst the surface was covered with trees, brush and leaves, the water, after rains, was prevented from flowing rapidly into the streams, so that the rises were gradual, but since the side-hills have been cleared and set in grass, and the level lands drained, the water rushes rapidly into the streams, causing great floods, which wash the banks, overflow many of the bottoms, and as quickly subside, leaving a deficiency of water as compared with former years. These floods have greatly marred the beauty of the river by washing away the banks, and leaving great accumulations of gravel and sand in its widened bed. Formerly the stream was bordered by trees, and the water was so transparent in the fall and winter that the bottom could be seen at a depth of twenty feet. It is still a very clear stream, but by no means equal to what it was formerly. The fall upon the average is six feet to the mile—some places more, some less—but everywhere ample power may be had to propel almost any amount of machinery.

The Whitewate canal, now abandoned for purposes of navigation, is still used for hydraulic purposes, and fur-

nishes a very large amount of valuable water-power which is used to some extent, but there are still a number of locks unoccupied which are capable of furnishing almost any necessary amount of power.

ANCIENT EARTH-WORKS.

There are few earth-works, except mounds, found in this county. Three miles north of Brookville, and immediately west of the East fork, upon the top of a hill near three hundred and fifty feet high, there is a semicircular wall of earth three hundred yards in length. It is built across a narrow ridge which is formed by two deep ravines, one on the south, the other on the north, which, with the river on the east, isolate the flat on top of the hill (containing fifteen or twenty acres,) from the level country to the west, and was built, probably, to protect the inhabitants from any enemy approaching from that direction.

There are quite a number of earthen mounds in the county, but none of large size; I have seen none more than ten or twelve feet high; many of them are not above three or four feet in height. Those on the highlands bordering the river are uniformly upon the highest places, and always in view of the river and its valley.

These mounds are so situated with reference to each other that a person standing on a mound in the most northern part of the county, overlooking the valley of the river, could see the next mound below him, and from the second the third was in view, and so with all the others, thus forming a chain of observatories, from which the approach of an enemy could be telegraphed with great celerity from one to the other, either by smoke or some other intelligible signal. Though these mounds were used as burial places, I have no doubt they were also used as signal posts; and very probably the signals were made by fire, for the clay of which they are composed in some cases has been burned to near the color of common brick.

The Mound Builders were a people posssessing rare good taste, which is evidenced by the situation of their mounds.

These were always built in picturesque positions—either on the highest grounds, or, if in the valleys, upon the edges of the highest river terraces, overlooking the water and the lower portions of the valley.

Two miles below Brookville, upon the farm of Mr. Roberts, there are, within the distance of two furlongs, upon the edge of the highest river terrace, nine small mounds. Besides these nine, which appear to have been completed, there is one barely commenced and abandoned. The commencement was made by digging up the earth to the depth of about twelve inches, which was then thrown out from the center and heaped up around the circumference, forming a circle within which the superstructure was to be erected, and which has very much the appearance of a shallow basin. It was in these basins that the dead were burned, or rather partly burned, for they were not usually entirely consumed. Not many mounds in this neighborhood have been thoroughly explored; and, in such as have, few contain anything more than bones and charcoal. In two of them bracelets of copper were found, and, in some others, a pipe or two; one of these, found in a mound eight miles below Brookville, was said, by those who found it, still to have retained the scent of tobacco; if this be true, it conclusively proves that these people used tobacco as well as their successors, the modern Indians. There are upon many of the high points mounds of stone, which have been erected by a different people from the Mound Builders. These contain vast quantities of human bones, both of adults and children, as well as the bones of squirrels, skunks, and other small animals. These were not probably the burial places for the dead, but a collection of their bones brought together from many places for final sepulture.

FOSSIL BONES OF MASTODON, &C.

Parts of skeletons of three mastodons (*mastodon maximus*) have been exhumed in the neighborhood of Brookville; one of them about a mile below, and the other three and a half miles; both found among the gravel in the up-

per river terrace, some eight or nine feet below the surface. This conclusively proves that these animals existed previously, if not at the time, of the formation of the terraces. They were most probably destroyed by the flood which transported the drift. The third skeleton was found three and a half miles north-east of Brookville, on the farm of Mr. David Barnard, in a piece of marshy ground which he was ditching. A tooth or two, and some other bones of the mammoth (*Elephas primigenius*) were found some years ago in Saltcreek township; one of the grinders, which I once had in my possession, was thirteen inches wide, six inches deep, and four inches thick, and weighed, when found, fourteen pounds, but after being thoroughly dried weighed but eleven. Only about half the tooth had been used in mastication, the balance not having, at the death of the animal, appeared above the integuments of the jaw.

SOIL AND AGRICULTURE.

There is considerable variety in the soil of Franklin county. The Whitewater bottoms are, or at least once were, as productive lands as could be found anywhere; they contain a large per cent. of vegetable matter, or humus, with clay, sand and lime—in fact all the elements of fertility. Some of these lands have produced pretty fair crops of corn for fifty successive years without the use of any kind of manures. This constant cropping in corn, however, is perceptibly exhausting them, and points out the necessity of a rotation in crops, and the application of fertilizers, if we expect them to maintain their fertility.

Forty years ago wheat could not be profitably produced in the alluvial bottoms on account of the great amount of vegetable matter which the soil contained. This has to a considerable extent been exhausted by the growing of corn and these lands now produce good crops of wheat. In the eastern part of the county, Bath, Springfield, and Whitewater townships, there is a large amount of level and very productive land. Many parts of this section were formerly considered to be of little value on account of their swampy

character, but, since they have been cleared and drained, hey are considered, taken all in all, to be the most desirable lands we have. The soil is largely composed of vegetable matter with a subsoil of yellow clay.

I will forward a specimen of the soil from Springfield township, which will give you an idea of the character of the soil in that section. Lands there range from forty to eighty dollars per acre.

In Blooming Grove township the soil is gray, and in many cases nearly white, with a yellow argillaceous subsoil found at about fifteen inches below the surface. This clay, when brought up and mixed with the superficial soil greatly enhances its productiveness. I have no doubt that if these lands could be subsoiled, and this clay mixed with the soil, the result would be a great improvement in their productiveness.

In the southern part of the county the soil is also grayish, with a subsoil of arenaceous yellow clay. This soil is not so productive as that in some other parts of the county, but produces fine apples, peaches, and other fruits. In the western part of the county, the soil is gray, with a subsoil of ferruginous-colored clay. This clay abounds in fragments of hornstone. The soil is more productive than its appearance would lead us to expect.

In the surface diluvial soils I have been unable anywhere to find even a trace of lime. None of them effervesce in the slightest degree with acids. If they ever contained lime (which will admit of doubt), it has been *leached* out by the constant percolation of water during past ages. I have found it a hard matter to convince our farmers that their lands contain no lime, and in many cases have entirely failed to do so.

I have no doubt that lime could be beneficially applied to these lands, provided the precaution be taken at the same time to apply manure, muck, or to plow in a crop of green clover.

Our farmers are generally well situated, but little in debt; most of them have good houses, and many even

elegant residences. There is a great amount of substantial comfort and wealth among them. The county is remarkably healthy, and nothing seems to be wanting that is necessary to render them happy and contented.

HYDRAULIC LIMESTONE.

Interstratified with the "Cliff" rock, there are strata of a crumbling impure limestone, having every external appearance of the Louisville cement rock. It has not been tested, but there can be but little doubt that it will prove to be of this character. I have sent specimens to Mr. Speed, of the Louisville Cement Co., to be tested, but as yet have not heard the result.

RUFUS HAYMOND,
Assistant Geologist.

BROOKVILLE, IND., Nov. 22, 1869.

MAMMALS FOUND AT THE PRESENT TIME IN FRANKLIN COUNTY.

FAMILY SORECIDÆ—SHEWS AND MOLES.

Genus Sorex—The Shrews. There are one or two species of shrews in the county, which I have not been able to identify.

FAMILY TALPIDÆ—MOLES—GENUS SCALOPS.

Scalops aquaticus—Common Mole. These animals are very numerous, and are the only species I have observed here. If the star-nosed mole exists here, I have never met with it.

GENUS VESPERTILIO.

Vespertilio noveboracensis—Red Bat.

V. pruinosus—Hoary Bat.

V. rufus—Brown Bat. Bats are numerous here, and belong mostly to the species named above.

CARNIVORA—FAMILY FELIDÆ THE CATS—GENUS LYNX.

Lynx rufus—American Wild Cat. Occasionally there is a wild cat seen in the county, but they are rare.

SUB-FAMILY VULPINÆ—THE FOXES—GENUS VULPES.

Vulpes fulvus—Red Fox. It is only within the last ten or fifteen years that the red fox has been observed in this county. Previously to that time we had none but the common gray variety.

Vulpes Virginianus—Gray Fox. These foxes are numerous; probably as much so as they ever were.

FAMILY MUSTELIDÆ—WEASEL FAMILY—GENUS PUTORIUS.

Putorius noveboracensis—Common Weasel. The common weasel, probably the most rapacious, blood-thirsty and cruel of all carnivorous animals, is still found here, though in small numbers. When they make an attack upon the poultry or rats of a barn they continue to stay as long as anything is left with life, unless prevented by fatigue or the approach of daylight.

Putorius vison—The Common Mink.

Putorius nigrescens—Little Black Mink. These minks are both common—the former the most numerous. These animals are very destructive to poultry, and therefore very unpopular with our good housewives.

SUB-FAMILY LUTRINÆ—THE OTTERS.

Lutra Canadensis—The Otter. It is barely possible that a few of these animals still linger along White Water, though I have seen none for many years.

SUB-FAMILY MELINÆ—THE SKUNKS—GENUS MEPHITES.

Mephites mephitica—Skunk—Polecat. Of the nine species of skunk in America, we have but one; this one, however, is universally conceded to be sufficient. The skunk, notwithstanding its horrid odor, is really a pretty animal; but I apprehend will never be very popular. They are much more numerous in this region than formerly, and seem to be increasing yearly. The young kittens are very pretty little animals, and make pleasant pets, provided they are not *kept too long*.

FAMILY URSIDÆ—THE BEARS—GENUS PROCYON.

Procyon lotor—Raccoon. It is the general opinion of our people that the raccoons are as numerous as they ever were, probably more so; but as their skins are of little

value, they are not hunted as much as formerly, which may account for their abundance.

GENUS URSUS.

Ursus Americanus—Black Bear. The last black bear was seen here about thirty years ago. They were once very numerous. The prints of their claws are yet plainly to be seen upon the smooth bark of hundreds of beech trees in the forests.

FAMILY DIDELPHIDÆ—THE OPOSSUM—GENUS DIDELPHIS.

Didelphis Virginiana.—Opossum. The opossum is still abundant. There are but two species of opossum in the United States; one southern, the other northern.

ORDER RODENTIA—THE GNAWERS—FAMILY SCIURIDÆ—THE SQUIRRELS—GENUS SCIURUS.

Sciurus vulpinus.—Fox Squirrel. About thirty years ago the fox squirrel made its first appearance in the neighborhood of Brookville, and has gradually increased in numbers until it has become the most numerous of the larger varieties. It will not live in dense forests, but prefers the points where there are but few trees, and the fields with scattering trees having suitable cavities in which to make their nests. These squirrels, if left unmolested, would become very tame, and probably even make their homes about our houses and barns.

Sciurus Carolinensis.—Gray Squirrel and Black Squirrel. My friend Prof. Baird, of the Smithsonian Institute, believes the gray and black squirrels to belong both to the same species. I have more respect for the opinions of Prof. Baird than any other naturalist with whom I have had communication, and his opportunities have been much greater than mine for forming a correct judgment in relation to this subject. Still I am inclined to think he is mistaken. His opinion was made up by comparing a large

number of *dried* skins—mine by comparing fresh specimens of gray and black squirrels. This comparison has led me to believe that there is a difference in form between the black and gray. The black squirrel is shorter and stouter than the gray, and it has seemed to me that their ears are also shorter. Tney do not seem to be disposed to associate with the gray. Between thirty and forty years ago, there were about one-sixth of the squirrels in south-eastern Indiana black; in north-eastern Indiana nearly half of them were black. At this time there are no black squirrels to be seen in southeastern Indiana, neither has there been for several years. Occasionally gray squirrels are very abundant here; why then is it, if the gray and black be the same, that we no longer find among them the latter? Four years ago the gray squirrels migrated eastward, passing near Brookville, still I neither saw or heard of a black one.

I have always believed the black to be a much wilder squirrel than the gray—and this will account for their having abandoned the densely populated districts, while the gray still remains. It has been generally understood that the farther north a particular species of an animal is found, the lighter its color becomes; but if the *black* be a *gray* squirrel this order of nature has been reversed, for the farther north I have gone in this State the more black squirrels I have seen.

Sciurus Hudsonius. — Mountain Squirrel — Chickaree. But a single specimen of this squirrel has ever been observed in the county.

GENUS PTEROMYS.

Pteromys volucella.—Flying Squirrel. This beautiful little squirrel is very numerous—but, being nocturnal, is not often seen unless it be sought in the holes of old rotten trees and stumps, where it lies concealed during the day It is easily tamed.

GENUS TAMIAS.

Sciurus (tamias) striatus.—Ground Squirrel—Chipmunk. Very numerous all over the woods and fields; it is probably more numerous than in the early settlement of the country.

GENUS ARCTOMYS.

Arctomys monax.— Woodchuck — Ground-Hog. The ground-hog is very numerous in the Whitewater valley; the gravelly terraces, wherever covered with brushwood, they seem to prefer to all other situations. They have been accused of preying upon domestic fowls, but I apprehend unjustly.

GENUS MUS.

Mus decumanus.—Norway Rat. The brown or Norway rat is here, as elsewhere, extremely numerous. It is one of the hardiest and most energetic animals, constantly increasing in number notwithstanding the utmost exertion of all its enemies, man inclusive. They first appeared at Brookville in the summer of 1827. At that time the black rat was numerous; it was, however, but a year or two after the Norway rat appeared, until they were all gone—all eaten up by this predatory stranger.

The brown rat has been wrongly named Norway rat; they came originally from Persia to Europe, from whence they have spread to the uttermost ends of all civilized countries.

Mus rattus.—Black Rat. As above stated, these have all been destroyed by the Norway rats.

Mus musculus.—Common Mouse. The common house mouse is familiar to every one, and is common everywhere.

GENUS HESPEROMYS.

Hesperomys leucopus.—This mouse is very common in the woods. They feed upon cockle-burs, stores of which

they often lay up in the deserted nest of the song-sparrow and other small birds.

GENUS ARVICOLA.

Arvicola riparius.—Meadow Mouse. Common in the fields and meadows.

GENUS FIBER.

Fiber zibethicus.—Musk Rat. Very common along the rivers, creeks and canal. It is the fur of this animal which is sold to the ladies under the name of "French Mink."

GENUS HYSTRIX.

Hystrix Hudsonius.—Porcupine. Now very rare.

FAMILY LEPORIDÆ—THE HARES—GENUS LEPUS.

Lepus sylvaticus—Gray Rabbit, or Hare. Of the twelve or thirteen species of hare in the United States, we have but a single one, the common gray rabbit, or more properly, hare, for there are no rabbits natives of America; those we have here were imported from Europe, and are domesticated.

ORDER RUMINANTIA—FAMILY CERVIDÆ—GENUS CERVUS.

Cervus Virginianus—Virginia Deer, Red Deer. Formerly very abundant, but I presume there is not now a single one living in the county.

The above list I think comprises all the Mammals now to be found in the county.

BIRDS OF FRANKLIN COUNTY, INDIANA.

FAMILY VULTURIDÆ—THE VULTURES—GENUS CATHARTES.

Cathartes Aura—Turkey Buzzard. Numerous during the warmer parts of the year; never seen in very cold weather. Two or three warm days during the winter, happening in succession, scarcely ever pass without a visit from these vultures. This is the only vulture I have ever seen in the county.

SUB-FAMILY FALCONIDÆ—THE FALCONS.

Falco columbarius—Pigeon Hawk. Occasionally seen following the flight of pigeons in their migrations; very rarely seen at other times.

Falco sparverius—The Sparrow Hawk. This beautiful little hawk is very abundant, and a constant resident.

SUB-FAMILY ACCIPITRINÆ—THE HAWKS.

Accipiter Cooperii—Cooper's Hawk. Probably the most numerous of all the hawks. They destroy more young chickens and quails than all the other hawks together. They fly with amazing rapidity, and scarcely ever miss taking their prey.

Accipiter fuscus—Sharp-shinned Hawk. These little hawks are quite common, but, like the sparrow hawk, are too small to do much mischief in the poultry-yard.

SUB-GENUS BUTES.

Buteo borealis—The Red-tailed Hawk. Very numerous here, as well as throughout the wooded districts of the western country. They prey upon domestic fowls, hares, squirrels, the tufted grouse, and quails.

Archibuteo Sancti Johannis—The Black Hawk. I have seen but two or three of these birds; these I think were not residents, but strangers.

Nauclerus furcatus—The Swallow-tailed Hawk. I have seen but a single specimen of this hawk. It is a remarkably beautiful bird, looking something like a gigantic swallow.

GENUS AQUILA.

Aquila Canadensis—The Golden Eagle. Frequently seen. More numerous in fall and winter than at other seasons.

GENUS HALIETUS.

Haliætus Washingtonii—The Washington Eagle. This magnificent bird has been seen along White Water almost every winter for fifty years. I have myself seen them very frequently.

Haleætus leucocephalus—The Bald Eagle. Very common in fall and winter.

PANDION.

Pandion Carolinensis—The Fish Hawk—Osprey. This beautiful eagle is often seen in the spring and fall. They do not breed here.

GENUS BUBO.

Bubo Virginianus—The Great Horned Owl. This powerful and rapacious bird is numerous, probably as much so as any other owl.

Scops Asio—The Screech Owl. This pretty little owl is abundant.

GENUS SYRNIUM.

Syrnium nebulosum—The Barred Owl. This is a very common owl in all the western country; usually most numerous in densely wooded districts, but I have seen two of them in prairies, miles from any tree.

GENUS NYCTALE.

Nyctale acadica—Saw-whet Owl. I have seen but a single specimen of this owl in the county, but have heard of others having been seen.

GENUS CONURUS—PARROT FAMILY.

Conurus Carolinensis— Parakeet — Carolina Parrot. I have seen but a single flock of these birds, in June, many years ago. There were in the first settlement of the county, were are told by the old inhabitants, very numerous.

GENUS COCCYGUS.

Coccygus Americana — Yellow-billed Cuckoo. This curious bird is very numerous, arriving late in May. Its strange hammering or pounding note may frequently be heard in the woods both day and night. These birds should be sacredly protected, because they feed principally upon the caterpillar. of which they destroy immense numbers.

FAMILY PICIDÆ—THE WOODPECKERS—GENUS CAMPEPHILIS.

Campephilus principalis—Ivory-billed Woodpecker. A former resident in the county. None have been seen for many years.

GENUS PICUS.

Picus villosus.— The Hairy Woodpecker. Resident. Very abundant. There are two or three varieties of this woodpecker, varing slightly in size.

Picus pubescens—Downy Woodpecker. Resident. This is a very abundant species. Often seen in our orchards, as well as among ornamental trees around our residences. This and the former species are erroneously called Sap-suckers. Neither of them is the bird which bores holes in the bark of living trees for the purpose of drinking the sap. The only holes they bore are made in searching for worms

mostly in dead limbs or decaying wood. They should be protected as friends, and not destroyed as enemies.

GENUS SPHYRAPICUS.

Sphyropicus varius—Yellow-bellied Woodpecker. Quite numerous. Resident.

GENUS HYLATAMUS.

Hylotomus pileatus—Black Woodpecker. Resident. This large woodpecker was once numerous, but is now rarely seen.

GENUS CENTURUS.

Centurus Carolinus—Red-bellied Woodpecker. The true Sapsucker. This woodpecker is very common in spring and autumn. This is the bird which bores holes in the sugar maple, apple trees, etc., for the purpose of drinking the sap. These holes, when bored in the bark of the apple tree in October, fill up with a viscid sweet sap, which the bird collects from day to day; and so with the sugar maple, hickory, and some other trees. They are very quiet birds, and not so often seen as many other less numerous species. They have a peculiar squealing note when frequenting the orchards, which is often heard when the bird itself is not to be seen without considerable search. Resident.

GENUS MELANERPES.

Melanerpes erythrocephalus— Red-headed Woodpecker. This is the most numerous and showy of all the woodpeckers, and the most universally known. In seasons when there is no mast, acorns and beechnuts, they all migrate to warmer regions, but when there are plenty most of them remain. They lay up sufficient stores of these to support themselves during the winter. They deposit beechnuts in holes in decaying trees—the acorns they generally hull, split into two parts, and drive them into the cracks of dry trees. During the whole time they are laying up these

stores, and, in fact, during the whole winter, there is constant turmoil, strife and fighting going on amongst them, caused by a universal propensity to rob their neighbors, which, of course, is resisted, hence the noise and strife everywhere heard in the woods upon the ripening of the mast. When they migrate they never return until the weather becomes settled and warm—about the first of May.

GENUS COLAPTES.

Colaptes auratus—Flicker, Yellow-hammer, High-holder. This is a very common bird. It feeds mostly upon worms and insects, and is especially beneficial to the farmer from the millions of larvæ, etc., which it destroys during the year. A constant resident.

GENUS TROCHILUS.

Trochilus colubris—Ruby-throated Humming Bird. This beautiful little bird is very numerous. Though so small and apparently frail it arrives early in the spring—about the 10th to 15th of April. Migratory.

GENUS CHÆTURA.

Chætura pelasgia—Chimney Swallow. Migratory. This is a very numerous species. They arrive late in May, behind all other swallows, but remain some six weeks longer in the fall than the others.

GENUS ANTRASTOMUS.

Antrastomus vociferus—Whip-poor-will. This noisy bird always has been numerous here. They make no nest at all, simply laying their two eggs on a leaf or the ground. The young are beautiful, little downy creatures before the wing and tail feathers have become visible.

GENUS CHORDEILES.

Chordeiles Americanus—Night Hawk, Bull Bat. The night hawk is very numerous in the month of May, re-

maining some time before passing on to their usual breeding-places farther north. A few breed here. Many persons confound this bird with the whip-poor-will. They belong to the same family, but there is a very great difference in the appearance of the two birds. On their return from the north in September, their number seems to be much greater than in the spring.

GENUS CERYLE.

Ceryle alcyon—Belted Kingfisher. Resident. The Kingfisher is very numerous along all our streams, winter and summer. This is the only kingfisher we have.

GENUS TYRANNUS.

Tyrannus Carolinensis—King Bird. Migratory. Very common; arriving late in the season, and departing early in autumn. They are the most courageous of all the smaller birds (except the Parus atricapillus), fearlessly attacking eagles, hawks, ravens and crows indiscriminately.

GENUS MYIARCHUS.

Myiarchus crinita—Great Crested Flycatcher. Very numerous; arriving about the first of May. They build their nests in hollow trees. Migratory.

GENUS SAGORNIS.

Sagornis fusca—Pewee. Migratory. This bird is familiar to every one, and is numerous; arriving usually in March, and remaining until the weather begins to get cold.

GENUS CANTOPUS.

Cantopus virens—Wood Pewee. Migratory. Very numerous; arrive about the first of May.

GENUS EMPIDONAX.

Empidonax Traillii—Traill's Fly-catcher; migratory. Rare. I have seen probably not to exceed a dozen in a residence of forty years.

Empidonax acadica—Green-crested Flycatcher; migratory. Very common in thickly wooded districts; more common among beech timber than elsewhere. Nearly always build their nests upon the lower branches of beech trees, from four to fifteen feet from the ground, in caves or near ravines, where the nest is protected from the winds. The nest is hanging, suspended from the two branches of a forked limb, very similar in form and material to the nest of the Red-eyed Flycatcher, but not so deep.

GENUS TURDUS.

Turdus mustelinus—Wood Thrush; migratory. Numerous here, and all over the wooded districts of the western country. The male and female sit by turns during incubation. Of all the thrushes, its notes are the most beautiful, clear, and full, varying through many tones impossible to describe, ending in a metallic vibratory sound, which to be appreciated must be heard.

Turdus Pallasi—Hermit Thrush; migratory. Occasionally, though rarely, seen.

Turdus fuscescens—Wilson's Thrush; migratory. Have seen a few specimens; does not breed here.

Turdus Swainsonii—Olive-backed Thrush; migratory. Have seen but a single specimen.

Turdus migratorius—Robin; semi-migratory. This is by all odds the most numerous of the thrushes. Most of them go south during the winter, but it is not uncommon to see large numbers of them during that season. In the latter part of the winter these birds occasionally roost at a given place in vast numbers, as pigeons are in the habit of doing. I have known this to be the case in two instances in the neighborhood of Brookville. Thousands of them were killed by ruthless "pot-hunters."

GENUS SIALIA.

Sialia Sialis—Blue Bird; resident. This popular and familiar bird is very abundant; seen at all seasons.

GENUS REGULUS.

Regulus Calendula—Ruby-crowned Wren; migratory. These diminutive birds are common in fall and winter.

Regulus satrapa — Golden-crested Wren; migratory. Common in fall and winter. About as numerous as the ruby-crowned wren.

GENUS MNIOTILTA.

Mniotilta varia—Black and White Creeper. Very abundant. Its note may be heard at any time in the woods during spring and early summer. They build their nests on the ground.

GENUS GEOTHLYPSIS.

Geothlypsis trichas—Have seen but a few specimens.

GENUS ICTERIA.

Icteria viridis—Yellow-chested Chat. Very common upon all brushy points where there are but few forest trees. Never found in deep wooded solitudes.

GENUS HELMINTHOPHAGA.

Helminthophaga pinus—Blue-winged Yellow Warbler. I have seen but a single bird of this species, at least that I recognized as such. Migratory.

GENUS SEIURUS.

Seiurus aurocapillus—Oven Bird, or Golden-crowned Thrush. This is a very common bird, arriving about the first of May. In passing through the woods, one is scarcely ever out of the sound of their voice. Migratory.

Seiurus noveboracensis — Water Thrush; migratory. These noisy little thrushes are heard along all the smaller streams in early spring, usually arriving in March.

GENUS DENDROICA.

Dendroica virens—Black-throated Green Warbler; migratory. Occasionally seen as they pass to and from their breeding grounds in the North.

Dendroica coronata—Yellow-rumped Warbler; migratory. Quite common.

Dendroica æstiva—Yellow Warbler; migratory. These pretty little birds are quite common, and build their nests in rose bushes and other trees and shrubs, close to our dwellings in the town.

Dendroica superciliosa—Yellow-throated Warbler. Common.

GENUS MYIODIOCTES.

Myiodioctes mitratus—Hooded Warbler; migratory. The most numerous probably of all the warblers. This bird most always attracts the attention of all who see it, from the curious contrast of intense black and deep yellow which mostly characterize its plumage. Builds its nest upon low shrubs.

GENUS LETOPHAGA.

Setophaga ruticilla—Red Start; migratory. This beautiful little bird is very numerous, and may be seen any day in warm weather, pursuing gnats and flies, in catching which they are very expert. It builds its nest, usually, in the forks of bushes from eight to fifteen feet from the ground. It arrives about the first of May, and departs in September.

GENUS PYRANGA.

Pyranga rubra—Scarlet Tanager; migratory. Arrives last of April. This beautiful bird is very numerous through all our woods. It is the only one of the genus found here. The Summer Red Bird I have never seen here.

FAMILY HIRUNDINIDÆ—THE SWALLOWS—GENUS HIRUN

Hirundo horreorum—Barn Swallow. This bird, so familiar to every one, is very numerous. It arrives early in April, and departs in the forepart of September.

Hirundo lunifrons—Cliff Swallow — Republican Swallow. This swallow has been quite numerous since the summer of 1849. During that year, for the first time, they built their nests in the county. Prior to that time, I had occasionally seen them passing through the county. They are now, probably, as numerous as any other swallow.

Hirundo bicolor—White-bellied Swallow. I have seen a few of these birds as they passed through to their breeding grounds further north. They do not breed here, but in the northern part of the State, near Warsaw, many of them build their nests. They are built in the hollows of trees and the deserted holes of the woodpecker.

GENUS COTYLE.

Cotyle riparia—Bank Swallow. Numerous along all the streams with abrupt sandy banks, into which they burrow and build their nests. They often arrive in March.

Cotyle serripennis—Rough-winged Swallow. Occasionally seen, but hard to distinguish from the former.

GENUS PROGNE.

Progne purpurea.—Purple Martin. These birds are numerous, and a great favorite with our people. I have seen them as early as the 17th of March. They generally all leave by the first week in September.

GENUS AMPELIS.

Ampelis cedrorum.—Cedar Bird, resident. These birds are common. They breed from June to September. I have seen three of their nests in the town, two in June and

one in September. All three were upon shade trees on the principal business street of the town, under which people were constantly passing.

GENUS COLLYRIO.

Collyrio borealis.—Shrike—Butcher Bird. Frequently seen in autumn and winter. In 1854, I saw a Butcher bird flying with a Goldfinch, which it had just caught. Going in the direction it flew, a short time afterwards, I found it upon a small elm tree eating the bird, having suspended it in the cleft of a small split elm. The idea instantly occurred to me that the habit this bird has of sticking pieces of flesh and insects upon thorns and other sharp substances, is done as a matter of convenience, enabling them to eat at their leisure, and saving the labor of holding them with their feet, which are rather feeble, and not for the purpose of decoying other birds, as many persons have supposed. I have upon one occasion, myself, seen a Butcher bird fly to a thorn bush, and take off a piece of a bird which it had previously stuck upon one of the thorns—showing that this habit, in addition to its convenience, should be considered as one of economy, enabling it to save, for future wants, that which is not necessary for present use.

GENUS VIREO.

Vireo olivaceus.—Red-eyed Flycatcher, migratory. This bird is so numerous that a traveler through our woods, during the summer is scarcely ever out of the sound of their voices.

Vireo noveboracensis.—White-eyed Vireo. These little birds are quite common. Their nests are suspended, like those of the Red-eyed Fly-catcher, from a forked limb.

GENUS MIMUS.

Mimus polyglottus.—Mocking Bird, migratory. This celebrated songster occasionally strays this far north. I

have seen two or three, and have heard the song of a few others here, within the last forty years.

Mimus Carolinensis.—Cat Bird. Migratory. The Cat bird arrives about the first of May. They are numerous all over the west. I have seen them in numbers as far north as St. Paul, Minnesota, in the month of October. It is not popular on account of the habit it has of eating the eggs and young of other small birds. They hatch as many as three broods of young occasionally, though, generally, but two during the year.

GENUS HARPORHYNCHUS.

Harporhynchus rufus.—Brown Thrush, migratory. The Brown Thrush arrives about the first of April. It is very numerous, and the best imitator of all the thrushes except he Mocking bird.

GENUS THRYOTHORUS.

Thryothorus ludovicianus.—Great Carolina Wren. Numerous, and resident throughout the year.

Thryothorus Bewickii.—Bewick's Wren. Occasionally seen. Does not breed here.

GENUS TROGLODYTES.

Troglodytes aeden.—House Wren, migratory. Have seen but two in the county. None breed here.

Troglodytes hyemalis.—Winter Wren. This beautiful little Troglodyte is very common during the winter. I have heard it sing but once—*that* song was beautiful.

GENUS CERTHIA.

Certhia Americana.—American Creeper. Occasionally seen, though not numerous.

GENUS SITTA.

Sitta Carolinensis.—White-bellied Nuthatch. This familiar bird is very numerous, and known to our citizens by the name of Tom-tit. It is a permanent resident.

Sitta Canadensis.—Red-bellied Nuthatch. This bird does not reside or breed here, but is occasionally seen late in autumn and winter.

GENUS POLIOPTILA.

Polioptila cærulea.—Blue-gray Flycatcher. This lively little bird is very little larger than a Humming-bird. It arrives early in April, and proceeds immediately to construct its nest. It chooses for its situation a smooth limb of a tree, from ten to sixty feet from the ground, not horizontal, but inclining slightly downwards; upon this it begins its nest by placing small pieces of lichens in a circle, fastening them down with fibers of spiders' web. This process it continues until the nest is of sufficient height, the whole surface being covered with small pieces of gray lichens. But the most remarkable thing in this fabric, is the fact that every piece of lichen is placed with its proper side out, just as it grew upon the tree—looking to a person not familiar with the nest very much like a lichen-covered knot.

GENUS LOPHOPHANES.

Lophophanes bicolor.—Tufted Titmouse. Very numerous, and seen at all seasons of the year. They build their nests in the hollows of trees and limbs, often in our decaying apple-trees.

GENUS PARUS.

Parus atricapillus.—Black-cap Titmouse. Very numerous, and a constant resident. They build their nests in small holes and in cavities of limbs, fence-rails, etc., if they can find such; if not, they peck out a hole in rotten stems and trees to suit themselves. The nest is always near the

ground. Though so small, they are the most courageous birds I know. If you disturb their young when nearly ready to fly, they will actually dash against your hand if placed in or near the nest.

GENUS CARPODACUS.

Carpodacus purpureus—Purple Finch. Frequently seen in winter and spring. They breed in the north and winter in more temperate latitudes.

GENUS CRYSOMITRIS.

Chrysomitris tristis—Yellow Bird, Thistle Bird. Very numerous and a constant resident. Breed from June to September.

GENUS CURVIROSTRA.

Curvirostra Americana—Red Crossbill. Seen here almost every winter—feeding upon sunflower seeds and seeds of the larch.

GENUS PLECTROPHANES.

Plectrophanes nivalis—Snow Bunting. I have seen these birds occasionally during severe winters.

GENUS PASSERCULUS.

Passerculus Savanna—Savanna Sparrow. I have seen a few of these birds. Rare.

GENUS POOECETES.

Pooecetes gramineus—Bay-winged Finch. Very common in all our fields. Build their nests on the ground.

GENUS ZONOTRICHIA.

Zonotrichia leucophrys—White-crowned Sparrow. They seem to spend the winter here, and are seen until near the first of June, when they disappear, and are seen no more till fall.

Zonotrichia albicollis—White-throated Sparrow. Common in winter and spring.

GENUS JUNCO.

Junco hyemalis—Snow Bird. Very abundant from October to middle of April.

GENUS SPIZELLA.

Spizella monticola—Tree Sparrow. Very numerous in winter, keeping company with the snow birds. The habits of the two birds are very similar.

Spizella pusilla—Old-field Sparrow. Very numerous during summer in old fields, partly covered with briers, upon which they build their nests. They are similar in general appearance and size to the Social Sparrow.

Spizella socialis—Chipping Sparrow. These social birds are very numerous, appearing about the first of April, and remaining in the fall until the appearance of frost.

GENUS MELOSPIZA.

Melospiza melodia—Song Sparrow. Resident. Very numerous both winter and summer; frequently making their nests among the shrubbery of our yards, and raising two or three broods during the summer and autumn.

GENUS GUIRACA.

Guiraca ludoviciana—Rose-breasted Grosbeak. This showy and beautiful bird is frequently met with late in May and early June. I have never met with its nest, and cannot be sure that it breeds here, but, having on one occasion seen the bird in August, I am inclined to believe they occasionally do.

GENUS CYANOSPIZA.

Cyanospiza cyanea—Indigo Bird. Migratory. Quite numerous on the borders of our fields. Like to build their

nest in fields upon isolated bushes, not often more than four feet from the ground. I have seen a nest on a rose-bush within a foot of a front door of one of the residences in the town.

GENUS CARDINALIS.

Cardinalis Virginianus—Red Bird, Cardinal Grosbeak. The Red bird is very abundant here, as it is in all districts of the Western country. The male is a good singer, and on this account is kept in cages by many of our citizens. It is a constant resident.

GENUS PIPILO.

Pipilo erythrophthalmus—Ground Robin, Chewink. Found usually in thickets and about brush piles—keeps mostly upon the ground, and runs much more than it flies. Builds its nest upon the ground. Constant resident.

GENUS DOLICHONYX.

Dolichonyx oryzivorus—Bobolink, Reed Bird, Ortolan. I have occasionally seen this bird in our grassy fields in the last of May and first of June. They occasionally stay a week or two, but never breed here to my knowledge.

GENUS MOLOTHRUS.

Molothrus pecoris—Cow Black Bird, Cow Bunting. This is a very numerous species—seen at all seasons of the year. It never builds a nest of its own, but lays all its eggs in the nests of other and smaller birds than itself. They lay but one in each nest. I have frequently found their eggs in the nests of the red-eyed flycatch, indigo blue-bird, blue-gray gnatcatcher, redstart, etc. When this egg hatches, the young bird, being larger than the legitimate nestlings, it crowds all the latter out of the nest, and remains the sole occupant, and is reared with labor by its foster parents. As soon as it becomes fully grown it joins the first flock of its kindred it meets with. These birds

during the latter part of summer are found following the cows as they feed along in the pastures, keeping close to their heads, usually some on each side, and moving as they move. It is not certainly known why they do this, but most probably they do it for the purpose of catching such insects as the cow may scare up in her progress.

GENUS AGELAIUS.

Agelaius Phoeniceus—Swamp Blackbird. These blackbirds are common about marshy grounds, but, from the scarcity of swamps in the county, they are few in comparison to the vast numbers found in the northern part of the State. A few make their nests here.

GENUS STURNELLA.

Sturnella magna.—Meadow Lark. Resident. This starling is abundant in all our meadows. Its nest is built upon the ground.

GENUS ICTERUS.

Icterus spurius.—Orchard Oriole. Migratory. This very noisy bird is numerous. Arrives about the first of May.

Icterus Baltimore.—Baltimore Oriole. Migratory. Quite numerous; arriving during the first week of May. It breeds here, building a pendulous nest, which it hangs from the drooping ends of long branches of trees, as far from the body of the tree as possible, with a view of protecting the nest from climbing enemys.

GENUS QUISCALUS.

Quiscalus versicolor.—Crow Blackbird. Very abundant, arriving in March, and building their nests in April and May. After rearing their young, they proceed north about the first of August, and return, going south in the month of October.

GENUS CORVUS.

Corvus carnivorus.—American Raven. The raven was once numerous in this section, yet now so rare that I have seen but one during the past twenty years.

Corvus Americanus.—Common Crow. Rather numerous at all seasons of the year except in extreme cold weather, when they are seldom seen. A few days of warm weather in the winter seldom pass without the crows making their appearance.

GENUS CYANUVUS.

Cyanura cristata.—Bluejay. The bluejay is the dandy of the corvidæ family, and seems disposed to show himself on all occasions to the best advantage. For many years they were in the habit of building their nests in the ornamental and fruit trees of the town; but they are not very popular neighbors, for, like the cat-bird, they rob the nests of the social sparrow and other small and helpless birds.

GENUS ECTOPISTES.

Ectopistes migratoria.—Wild Pigeon. Still seen in large numbers, though evidently they have been constantly diminishing in numbers for the last forty years, and are probably not half so numerous as they formerly were.

In the months of January and February, 1854, these birds roosted about two miles from Brookville, notwithstanding the country is thickly inhabited. No one who did not see them, or who has not seen a "pigeon roost," can form any adequate conception of their numbers.

GENUS ZENAIDURA.

Zenaidura Carolinensis.—Turtle Dove. Very abundant. A constant resident throughout the year.

GENUS MELEAGRIS.

Meleagris gallopavo.—Wild Turkey. I can remember when wild turkeys were very numerous, but it is doubtful whether at this time there is even a solitary individual left. This is not the bird from which the stock of our tame turkeys originated. Our species cannot be domesticated. It has often been tried, but finally they all wander off and become wild. The wild turkey has no wattle under its chin and throat as the tame species have, neither do they have any white feathers. The domestic turkey originated most probably in Mexico or some of the West India islands, where there are wild turkeys marked with white.

FAMILY TETRAONIDÆ—THE GROUSE—GENUS BONASA.

Bonasa umbellus.—Ruffed Grouse: Partridge: Pheasant This beautiful grouse, once so numerous, is becoming rare. There are still a few of them lingering among the brush of our uncultivated hillsides. The curious drumming noise which this bird is in the habit of making during the breeding season in the spring, and upon warm days in the latter part of October and first of November, is familiar to all who live near its haunts; but the manner in which this sound is produced seems to have escaped the observation of nearly every one. Even the great Audubon, whose observations were usually so correct, was mistaken as to the manner of its production. He says it "beats its sides with its wings, in the manner of the domestic cock, but more loudly, and with such rapidity of motion, after a few of the first strokes, as to cause a tremor in the air not unlike the rumbling of distant thunder." This is well told, and true, with the single exception that the bird in drumming does *not* beat its sides.

The drumming is produced thus: The pheasant, standing upon the trunk of a prostrate tree, usually surrounded by brushwood, erects his body to its full hight, and produces the drumming sound by striking the *convex surfaces* of his *outstretched wings together behind his back*, just as

we often see boys swinging their outstretched arms behind them, so as to make the backs of their hands meet behind and opposite the spine. This is the truth of the matter. Audubons' idea that the pheasant could produce a louder noise than the domestic cock, nearly four times his size, by beating its small compact body with its wings, is, to say the least, a curious mistake. The *hollow rumbling* sound could *not* be produced in this manner.

GENUS ORTYX.

Ortyx Virginianus.—Quail—Bob White. The quail is still rather common, but not so numerous as formerly. In addition to its other enemies, the red fox has recently made its appearance in this county, and probably destroys more of them than all the others.

FAMILY GRUIDÆ—THE CRANES—GENUS GRUS.

Grus Canadensis—Sand-hill Crane.—I have never seen but three sandhill cranes in the county. They are very numerous in the northwestern part of the State. The white or great whooping crane is seen there also occasionally.

FAMILY ARDEIDÆ—THE HERONS—GENUS GARZETTA.

Garzetta candidissima.—Snowy Heron. Frequently seen along Whitewater in August and September.

GENUS ARDEA.

Ardea Herodias—Great Blue Heron or Crane. Very frequently seen—occasionally even in winter.

GENUS ARDETTA.

Ardetta exilis—I have never seen but two of these beautiful little bitterns in the county.

GENUS BOTAURUS.

Botaurus lentiginosus—Bittern—Stake-driver. This bittern is rare here—have seen three individuals. In the

northwestern part of the State they are quite numerous. Some of the people there call them *Thunder-pumpers.*

GENUS BUTORIDES.

Butorides virescens—Green Heron—Fly-up-the-Creek. This is by far the most numerous of the heron family. They breed here.

GENUS NYCTIARDEA.

Nyctiardea Gardeni—Night Heron. I have seen two of these herons only. They are rare.

GENUS TANTALUS.

Tantalus loculator—Wood Ibis. These large and curious birds occasionally visit the Whitewater valley in the month of August. Some years ago I kept one (which had a broken wing) about six weeks. In that time it became very tame, learned its name, and would come when called. We fed it upon living fish, which it would swallow with amazing rapidity, except catfish, which required labor and time to dispose of. It died from having eaten a mackerel which had been placed in a basin to soak.

GENUS CHARADRIUS.

Charadrius Virginicus—Golden Plover. Have occasionally seen this plover.

GENUS ÆGIALITIS.

Ægialitis vociferus—Killdeer. This noisy plover is very numerous, and a constant resident throughout the year.

GENUS STREPSILAS.

Strepsilas interpres—Turnstone. Have seen a few flocks of these birds passing through the country.

GEEUS PHILOHELA.

Philohela minor—American Woodcock. The woodcock is not, nor never has been, very numerous in this part of Indiana, owing mainly, I apprehend, to the fact that we have but little swampy land of the character which they frequent. They are, however, occasionally seen.

GENUS GALLINAGO.

Gallinago Wilsonii—Wilson's Snipe. Where swampy meadows are found these birds may occasionally be seen in the latter part of March and through the month of April.

GENUS TRINGA.

Tringa maculata—Jack Snipe. The jack snipe is not numerous, though I have occasionally seen it about ponds.

Tringa Wilsonii—Least Sandpiper. Frequent our rivers, though by no means abundant.

GENUS SYMPHEMIA.

Symphemia semipalmata—Willet. This noisy bird is frequently seen along Whitewater in early spring and autumn. It is is a fisher, and catches small minnows by running them down in shallow water, all the while uttering its shrill discordant notes, which may be heard at the distance of half a mile.

GENUS RHYACOPHILUS.

Rhyacophilus solitarius—I have frequently observed this bird, though they are by no means numerous.

GENUS TRINGOIDES.

Tringoides macularius—Spotted Sandpiper. This noisy restless sandpiper is much the most numerous of all the family in this region. They build their nests near the banks of the river, in a bunch of reeds or under a small

bush. Their eggs are much larger in proportion to its size than those of any other bird I have ever known.

GENUS ACTITURUS.

Actiturus Bartramius—Bartram's Sandpiper—Field Plover. I have seen but two of these birds in the county. In southern Illinois they are numerous all over the prairies.

GENUS NUMENIUS.

Numenius longirostris.—Long-billed Curlew. Very rare only one or two have been seen.

GENUS PORZANA.

Porzana Carolina.—Sora. Common Rail. Frequently seen in spring on their way north. They breed in Kosciusko and other northern counties.

GENUS FULICA.

Fulica Americana.—Coot. Mud Hen. When overtaken by storms these birds frequently stop in our streams and remain a few days. They do not breed here.

GENUS GALLINULA.

Gallinula galeata.—Florida Gallinule. I have seen two gallinules which had been caught in the neighborhood. They seem to have very little fear of man, and are easily tamed.

GENUS ANSER.

Anser hyperboreus.—Snow Goose. Occasionally seen flying over in their migrations.

Anser Cærulescens.—White-headed goose. I have seen one flock containing four of these geese.

GENUS BERNICLA.

Bernicla Canadensis.—Wild Goose—Canadian Goose. Seen in large flocks every fall and spring in their semi-annual migrations. They rarely ever stop, except they become bewildered during dense fogs.

Bernicla Brenta.—Brant. Occasionally seen flying over when migrating.

GENUS ANAS.

Anas boschas.—Mallard—Green-head. This duck is probably more numerous in our waters than any other species.

GRNUS DAFILA.

Dafila acuta.—Pintail—Sprigtail. Has rarely been seen within the past ten years.

GENUS NETTION.

Nettion Carolinensis.—Green-winged Teal. This beautiful little duck is regularly seen here in the spring and fall.

GENUS QUERQUEDULA.

Querquedula discors.—Blue-winged Teal. This diminutive duck appears here about the first of October, usually remaining several days. They are very unsuspecting birds, and easily approached by the gunners, and are therefore much sought after by "pot hunters."

GENUS SPATULA.

Spatula clypeata.—Shoveler Duck. This very curiously marked duck is common late in April, when most other ducks have disappeared.

GENUS MARECA.

Mareca Penelope.—Widgeon. In the year 1855 a few widgeons were shot here. This is the only instance known of their appearance here.

GENUS AIX.

Aix sponsa.—Summer Duck. Wood Duck. This, decidedly the most beautiful of all the ducks, is very common along Whitewater. They always build their nest in hollow trees, and never upon the ground, as is the custom of all other ducks.

GENUS FULIX.

Fulix marila.—Big Black Head Duck.

Fulix affinis.—Little Black Head. Both these ducks are occasionally seen, though by no means abundant.

GENUS AYTHYA.

Aythya Americana.—Red Head. Pochard. But a single instance known of their having appeared here—1855.

Aythya vallisneria.—Canvas Back Duck. This far-famed duck made its appearance here for the first and only time, to my knowledge, in the month of March, 1855. One of them was shot by a friend, which I had a chance to examine and afterwards to taste. It was very tender and juicy, but had such a fishy flavor that it could scarcely be eaten. I supposed they had come from the southern sea-coast, where they had fed upon shell-fish instead of eel-grass, which seems to be necessary to perfect their flavor.

GENUS BUCEPHALA.

Bucephala Americana.—Golden Eye. Quite common in spring.

Bucephala albeola—Butter Ball. Quite numerous through the fall and winter.

GENUS MELANETTA.

Melanetta velvetina—Velvet Duck. Numerous in winter.

GENUS MERGUS.

Mergus Americanus—Sheldrake. These birds are very numerous in Whitewater during the whole winter, which they visit for the purpose of fishing. The stream is remarkably clear, and, being very rapid, seldom freezes over, but the water becomes cold enough to benumb the fish, which thus fall an easy prey to these expert divers. I have known one of them to hatch and rear its brood in this vicinity.

GENUS LOPHODYTES.

Lophodytes cucullatus—Hooded Merganser. This handsome little merganser is very numerous during the colder periods of the year.

GENSS LARUS.

Larus argentatus—The Silvery Gull. Occasionally seen in autumn and spring.

GENUS CHROICOCEPHALUS.

Chroicocephalus Philadelphius—Bonaparte's Gull. Frequently seen all over the State. A small but beautiful bird.

GENUS STERNA.

Sterna paradisea—The Roseate Tern. I have frequently seen this tern along the river and canal.

GENUS PELECANUS.

Pelecanus onacrotalus—Rough-billed Pelican. The pelican occasionally visits us, but its visits are like those of the angels, "few and far between."

GENUS GRACULUS.

Graculus carbo—Common Cormorant. I have seen a single specimen in the winter.

GENUS COLYMBUS

Colymbus torquatus—Loon, Great Northern Diver. The loon is frequently seen in our waters in the fall and spring. Those I have seen in the water were great divers, but could not be forced to take wing. The solitary cry or wail of the loon is, to my ear, the most melancholy sound I have ever heard, conveying to the mind the idea of utter hopelessness and despair.

GENUS PODILYMBUS.

Podylimbus podiceps—Didapper. Grebe. Very common in our waters in October and November. They generally remain about three weeks.

This concludes the list of all the birds of the county which I have observed and been able to identify. Doubtless many others visit this section which I have not observed, and I have seen many which I have not been able to identify.

INDEX.

ERRATA.

Page 36, 8th line from top, for "more" read "most."

" 48, 10th " " for "N" read "F."

" 56, 17th " bottom, for "*semireticulatis*" read "*semireticulatus.*"

" 64, 8th " " for "Coal" read "Coal I."

" 64, 9th " " omit letter "I."

" 80, 3d " " for "thousand" read "hundred."

" 182, 11th " top for "below" read "above."

" 184, 2d " bottom, for "worked" read "worn."

" 188, 18th " top, for "Kunkle" read "Kemble."

" 189, 2d " " for "*planœanvoxa*" read "*planoconvexa.*"

" 193, 15th " bottom, for "Althero" read "Alther."

" 204, 6th " top, for "Stay" read "Slay."

" 204, 13th " bottom, for "*Mephites*" read "*Mephitis.*"

" 205, 8th " " for "Institute" read "Institution"

" 209, 5th " " for "*Butes*" read "*Buteo.*"

209, bottom line, for "tufted" read "ruffed."

" 211, 8th line from top, for "there" read "they."

" 211, 9th " " for "were" read "we."

" 212, 6th " bottom, for "there" read "these."

" 214, 10th and 11th lines from bottom, for "*Sagornis*" read "*Sayornis.*"

" 215, 5th line from top, for "caves" read "coves."

" 217, 13th " bottom, for "*Letophaga*" read "*Setophaga.*"

" 120, 5th " top, for "Norman" read "Norborne."

" 10, 9th " top, for "Norman B." read "Norborne."