GEOLOGY OF INDIANA.

GEOLOGICAL MAP.

The accompanying geological map of Indiana gives a fair exhibit of the surface geology of the State. It is a compilation of all the labors of my distinguished predecessors and their assistants, as Owen, Lawrence, Brown, Cox, etc., etc., also of myself and assistants. To all workers in the State and amateurs the fullest credit and acknowledgments are given.

Much of the geology of the northern and northwestern areas is given, not accessible before the surveys of Newton and Jasper counties. The map comprises over one hundred years of labor and study of these devotees to science, but as well the results of thousands of miles of travel with pick and hammer.

In every dividing line between formations, outliers will be found to the east and north on the hill tops; to the west and south denuded areas will be found of lower strata.

The map is the best that can be prepared on so small a scale now; in the future, with better facilities and on a sectional scale, more finished work may be expected. It is believed that it will be appreciated by our citizens as a chart giving years of study and labor, condensed in a single sheet, and invaluable to teacher, student and citizen.

The sections on the borders of the map exhibit a large amount of labor and observation. The vertical sections are an average of studies along each line of outcrop and the deep bores in all divisions of the State. The horizontal section, from Vincennes to Lawrenceburg, shows the railway lines of the Ohio and Mississippi road, the surface rocks, etc. The dip is at the conventional rate of 30°, as the dip of each stratum is rapid near the rim of each basin—from 40 to 100 feet to the mile, but afterward ranges at 10 to 20 feet to the mile.

OUTLINE GEOLOGY OF INDIANA.

LOWER SILURIAN.

The rocks of the Lower Silurian age, known as the Hudson River or Cincinnati group, are found in the southeastern division of the State, extending also throughout large areas in Ohio and Kentucky. They are well exposed in the bluffs of the Ohio River, extending west to the mouth of Fourteen-mile Creek, in Clark county, and form the surface rocks in the counties of Wayne, Union, part of Fayette, Franklin, Dearborn, Ohio, Ripley and Switzerland. In several of the adjoining counties to the west are exposures of Lower Silurian in ravines and deep cuts, as on the extreme east side of Clark, Jefferson, Decatur and Rush. The rocks of this formation are filled with well-preserved fossils, and, by decomposition, form a rich and highly productive soil.

UPPER SILURIAN.

Strata of the Upper Silurian formation form the general surface rocks of the counties immediately west and northwest of those in the Lower Silurian, including Adams, Wells, Huntington, Wabash, Miami, part of Jasper, White, Cass, part of Carroll, Jay, Blackford, Grant, part of Howard, Delaware, Madison, Tipton and Hamilton, Randolph, Henry, Hancock, Rush, Shelby, Decatur, the eastern part of Marion, Bartholomew, Jennings, Jefferson, and the eastern part of Clark county. The Upper Silurian strata also extend north and northwest from these counties to the northern boundary of the State, at many points being capped by uneroded areas of Devonian age, but so deeply covered with bowlder drift as to be rarely seen, and its presence is more known by test bores than by outcrops in the drift district.

Soils derived from the disintegration of rocks of this age are, as a rule, cold, heavy clays, which, when drained, produce good crops of wheat and the grasses.

DEVONIAN.

The Devonian rocks are exposed in a narrow band, commencing, on the south, at the Ohio River in Clark and Floyd counties, and extend, thence, north and west through the counties of Scott, Jackson, Bartholomew, Johnson, Marion, Boone, Clinton and Carroll, with local exposures in Tippecanoe, Cass, White and Jasper, Miami, Wabash, parts of Shelby, Jennings, Jefferson and Jackson. From fossils collected in the drift area, to the the north and west and from test bores, it is known that Devonian rocks have been more or less eroded, but once covered much of the northern third of the State, and at many points they are still in place.

LOWER CARBONIFEROUS OR MOUNTAIN LIMESTONE.

Rocks of the Lower Carboniferous series form the surface strata in a wide belt west of the Devonian and east of the Coal Measures, and these, for the most part, constitute the rocky exposures of the counties of Harrison, Crawford, Orange, Washington, Lawrence, Brown, Monroe, Owen, Morgan, Putnam, Hendricks, Montgomery, Tippecanoe and Benton, with parts of Perry, Floyd and Jackson. The eastern line of this belt is composed of shales and sandstones of the Knobstone group, while adjoining on the west are the great cavernous limestones of the State, so well exhibited in the southern counties, but which thin out to a few feet at the north. The soil of this district is remarkable for its growth of cereals and grasses.

COAL MEASURES.

The rocks of the Coal Measures are found in the counties of Posey, Vanderburg, Warrick and Spencer, the western parts of Perry and Crawford, in Gibson, Pike, Dubois, Knox, Daviess, Martin, Sullivan, Greene and Clay, the western part of Owen, and in Vigo, Parke, Vermillion, Fountain and Warren, with a projection in a narrow band of Coal Measure rocks (Conglomerate sandstone), underlaid by thin beds of Keokuk limestone and Knobstone shales of the Lower Carboniferous group, extending from the northern part of Warren county, in a northeasterly direction across Benton, and terminating near Rensselaer, in Jasper county, where the Conglomerate is massive. It is probable that this projection is not continuous, but interrupted at intervals.

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

STONE COALS OF INDIANA.

Humanity, in its progress, has passed its infancy—the Age of Stone; its boyhood—the Age of Bronze; its young manhood—the Age of Iron; and, with wondrous achievements, its ripening manhood—the Age of Gold and Silver. To-day, armed with all the glories of the past, its cycles of thought and labor, and advancing with the momentum of all the Ages, we stand upon the summit of these thoughts and works, and, boldly invading the future, achieve the Age of Steel—of quick, exact thought and realizations. Every work of forest, farm, field and commerce requires this adjutant, grander and greater than gold or silver, and welcomes the aids of science and steel.

Steam is the soul and spirit of our past advancement; at every step its voice, tame as the sigh of love, terrible as the cyclone, is heard, but the food, the nerving fire that drives the great advances of progress, civilization, Christianity and happiness, is Coal.

I am indebted for arrangement and compilation of many succeeding facts to favor of Oscar F. Mayhew, to whom thanks are returned.

COAL.

The Coal period was the grand culmination of the earth's existence. Long ages were required to reach it, and ages upon ages to pass it. From what is known, coal is the result of slow chemical action upon vast bodies of vegetable growth, accumulated under conditions favorable to the condensation of its carbon and hydrogen into solids embodying more or less of the latter element, and forming the anthracite, or pure carbon, and the bituminous, or hydro-carbon, coals as we find them—though the anthracite is the result of subsequent elimination of the volatile matter from previously formed bituminous coal. As a hint of the vast period of time and immense quantity of vegetation required for the formation of the Coal Measures, "all the forests of the Mississippi Valley could not furnish to the sea from their river spoils, during a hundred thousand years, one of the anthracite beds of Schuylkill county, Pennsylvania."—*Lesley.*

The great economic value of coal to man can not be estimated, and is the justification for repeated attention to it in these Reports. Until something better (electricity perhaps) shall be controlled and made subservient to the production of light and heat, coal must rank as only second to the food we eat in its relation to man's necessities. It has made ocean steam navigation not only a possibility but a grand success. It has rendered practicable the building and profitable operation of vast systems of railways, until they ramify into every civilized quarter of the globe, in the more densely populated parts, forming a network of connections and establishing stations in close proximity to the homes of millions of people, cheapening transportation, diffusing and equalizing the benefits of manufactures and traffic, opening up vast tracts of new country to settlement and cultivation, and reaching out to newer and cheaper sources of iron, timber, stone and hundreds of other raw materials that contribute to man's progress and enjoyment. It makes the steam that operates millions of machines, facilitating and lightening labor, and increasing and cheapening billions of mechanical productions. It makes the iron that enters into all these. It furnishes the light for the streets and business places of hundreds of towns and cities and thousands of homes. It cooks the food and warms the abodes of millions of people. And when inventive genius shall have devised appliances for its perfect combustion and consequent better utilization, its already immense value will be more than doubled.

Anthracite coal, of which none exists in this State, is, when free from impurities, a pure carbon, very hard, difficult to ignite, burns slowly, under a moderate draft, with a light bluish flame, evolving carbonic-oxide gas. Its waste in burning in the stoves and furnaces in common use is 67 per cent. of its heat value, in the uncombined gas that is carried off by the smoke flue.

Bituminous coal, of which Indiana has 7,000 square miles, is, when free from impurities, nearly pure hydro-carbon in varying combination, easily ignited, evolving nearly pure carburetted hydrogen gas, that burns with a luminous and more or less ruddy flame. The bituminous coals are utilized for illuminating as well as heating purposes. On account of the volatile matter contained in them, they are wasted, even in the best constructed furnaces, at the rate of more than 75 per cent. of their heat-producing capability.

Although there is considerable variety in the coals found in Indiana, ranging from the non-caking block, or splint, through all the grades of caking up to the most highly bituminous, including cannel, affording, in abundance, varieties best adapted to steam and gas making and domestic and metallurgic purposes, yet, for some of these and other purposes, it becomes necessary or advantageous to convert it into coke. Since the discovery and development of the bituminous or caking coals, and before the discovery of the block or non-caking coal, coke was principally used in the blast furnace and cupola of the iron founder, and, except in this State, is still generally so used. Block coal is used in the cupola here. The principal object of coking is to get rid of the sulphur that is contained in most coals, and to provide a fuel that will not cake, or become packed, under the weight of the superincumbent mass, so that the heat may freely permeate every part. Sulphur, whether in the coal or the ore, destroys the tenacity and malleability of the iron.

Coke is the solid carbon and ash of coal, and is produced by driving off the volatilizable constituents, as the water, hydrogen, sulphur, etc. This is done by heat, in ovens built for the purpose, though the primitive, wasteful method of coking in pits made of earth is still in use in some places. The volatile matters driven off are nearly one-half by weight, but their expulsion does not lessen, materially, the volume, though this varies with the method of coking. Under pressure, with a slow fire at beginning and until the the sulphur is driven off, followed by a brisk fire, the product will be a hard, heavy, bright coke that has a ring when struck, while a smouldering fire, without pressure, yields a dark, spongy product.

Indiana is highly favored in having many hundreds of square miles of the best natural fuel in the world for the reduction of iron ore in the blast furnace, in her non-caking block coal, as well as in the vast area of coal adapted to making excellent coke.

COAL PRODUCTS.

"The readiness shown by the elements of coal to enter into new combinations where it is exposed to an increase of temperature, and the great variety of combinations obtained under different degrees of heat, or by the admission or exclusion of air, indicate the close relation of coal to the elements of the vegetable kingdom. It consists of carbon, hydrogen, oxygen and nitrogen, which make up the great bulk of vegetable matters, and these show the same disposition as in the plants themselves to separate from existing combinations and enter into new. The number of new products thus formed is almost unlimited. They differ from one another and from the original substance from which they are generated, as do those obtained in the processes of vegetable fermentation. When heat is applied without access of air, the vapor of water, set free, acts on the existing combinations of the elements. These are broken up, and hydrogen and oxygen are evolved under the most favorable circumstances, in their nascent state, to form new compounds with the carbon present, the characters of which vary greatly with the temperature. The process is called dry distillation. By keeping the retorts in which it is conducted at a cherry-red heat, the gases used for illumination are most copiously evolved, the tar itself being decomposed and converted into gaseous matters. But if the object is to obtain the coal oils, parafine, benzole and other hydro-carbons of this nature, care is taken that the retorts are heated very gradually, and do not acquire more than a low, red heat. The tarry matters thus escape decomposition, and, by repeated distillations, afford crude naptha and its secondary products. Coal tar was, for a long time, a troublesome product of the gas works, no useful application of it, to any great extent, being known. It was employed as a covering to protect iron work exposed to the weather, and the pitch obtained by distilling it was found, when mixed with earthy matters, to be a good substitute for the natural product, asphaltum, used for artificial pavement, water-tight covering for roofs, etc. Finally, the tar came to be an object of purchase by tar distillers, who learned to extract from it the crude naptha and also the light oily fluids. The pitch, too, by repeated distillations, was made to yield more oily matters, which are useful for lubricating machinery and other purposes. The crude naptha is now purified by mixing it with a tenth its bulk of concentrated sulphuric acid, adding, when cold, five per cent. of peroxyde of manganese, and distilling off the upper portion. A rectified naptha is thus obtained, which readily dissolves caoutchouc, and, mixed with wood naptha, produces a powerful solvent of various resinous substances useful in making varnishes. Still further purified, the liquid benzole is obtained, which has been applied to many useful purposes. The light essential oils, as also the heavier qualities which come over after these, are found to possess antiseptic properties, which render them of value for preserving wood from decay. From the essential oils, the tar creosote or carbolic acid is obtained, which possesses extraordinary antiseptic properties, and is used in the preparation of a valuable dye-stuff, carbazotic acid. The heavy oil yields a substance called aniline, which gives, with bleaching powder and other agents, a magnificent blue color, and is employed in dyeing. Napthaline, also (which is a solid white substance, obtained in large quantities in the distillation of the tar), yields two coloring matters—one called napthalic acid and the other chloro-napthalic acid, the latter of which is nearly identical with the coloring principle of madder, and gives, with alkalies, a beautiful red color. Instead of napthaline, by conducting the distillation at a lower temperature, may be obtained the waxy substance of parafine, which is now used for the manufacture of candles and the parafine oils. * * * By oxidizing aniline with bichromate of potash, a bronze-colored substance is produced, dissolving in alcohol with a beautiful purple color. In concentrated sulphuric acid its solution is green. On adding water, and precipitating with an alcoholic solution of potash, the coloring matter is precipitated unchanged. It is of intense hue, and considered as good, if not better, than archil. It is very stable, not being decomposed at a temperature of 482° Fahr. One pound of the solid substance will dye 200 pounds of cotton a moderately dark lilac, the color standing well the action of light and heat, acids and alkalies."—*Amer. Cycl., Vol. 4, page 752.*

Coal oils have been made from the cannel and other fat coals, and also from the bituminous shales, which, until late years, were considered worthless; but the wonderful production of petroleum renders their manufacture unprofitable.

LOCOMOTIVE USE OF COAL.

The world, in an economic sense, is made up of little things. Like building a house, it is only one brick on another. As an illustration of the importance of detail in all the affairs of life, the following is copied:

HOW GREAT THINGS ARE DONE.

Success in great things generally depends upon the care and faithfulness with which all the little details are done. This is true, whether it be a sermon or a shoe factory, a play or a printing house, a picture or a war.

The fact is strikingly illustrated by a description of the manner in which the fastest railroad train on the continent is run between New York and Philadelphia, as described in the American Machinist:

"To accomplish the distance in the time requires the most minute supervision—the engine, even down to the oil cans, must be in perfect order, the brake air-pump working, the valves, joints and reservoirs in exact condition. To pass over what would be obviously necessary in the skill and judgment of the engineer, there is the skill of the fireman alone, whose neglect would cause a serious difference in the time which the train is obliged to make. His coal is all broken into lumps of equal size; it is to be pitched, while the engine rocks and leaps, to the right spot in the fire-box ten feet long; only one shovelful is thrown in at a time, so the fire is not choked with fuel, as it would be by an unskillful fireman; but every two minutes in goes the right quantity at the right spot, and the door closed quickly.

"When the engine arrives at its destination there are only a few inches of glowing coals left, so accurate is the calculation by which the steam in the boiler is kept to an exact and steady degree of temperature, and the very highest service got of the engine in consequence. It is in this way invariably that great and substantial achievements in every department of life are gained."

CONNECTED SECTION OF THE COAL MEASURES IN INDIANA.

0 to 20 feet.	Buff, brown, mottled, flaggy sandstone.
5 to 20 "	Merom sandstone, upper division shaly.
5 to 40 "	Merom sandstone, massive.
10 to 24 "	Gray or buff shales and flaggy sandstone, ripple marked.
1 to 6 "	Hard, clinky, gray limestone, sometimes flinty; to the west a calcareous shale.
0 to 34 "	Argillaceous shale and shaly sandstone.
0 to 2 "	Black slate with fish spines and fossils.
0 to 1 "	SECOND RASH COAL.
0 to 2 "	Fire clay.
0 to 6 "	Gray shales.

3 to 12 feet.	Yellow, ferrugineous limestone, passing to calcareous shale or clod, in the west.
10 to 25 "	Gray shale.
0 to 2 "	FIRST RASH COAL and black slate.
1 to 2 "	Fire clay.
40 to 110 "	Flaggy, blue, buff and gray sandstone, with much gray shale and beds of clay iron-stones.
15 to 28 "	Yellow and gray sandstone quarry beds.
0 to 1 "	Black slate, or clod, with fossils.
0 to 2 "	COAL N. Choice, gassy, caking.
1 to ·5 "	Fire clay, shaly at bottom, with pyrite.
2 to 8 "	Brown or gray limestone, with *Chætetes*.
30 to 40 "	Gray or white shale, with bands of sandstone.
40 to 70 "	Siliceous shale, passing to massive sandrock at the south and west. "Anvil Rock," of Dr. Owen.
2 to 4 "	Black slate and clod, with many animal and vegetable fossils.
3 to 6 "	COAL M.
2 to 4 "	Fire clay.
3 to 14 "	Shale, with balls of pyrite.
2 to 4 "	Brown, compact limestone.
2 to 20 "	Argillaceous sandstone.
20 to 84 "	Gray shale and soapstone.
1 to 2 "	Soapstone crowded with plant remains.
3 to 11 "	COAL L.
2 to 5 "	Fire clay.
20 to 120 "	Siliceous shale and coarse, massive ferruginous sandstone.
2 to 8 "	Bituminous limestone and black slate.
2 to 8 "	COAL K.
2 to 10 "	Fire clay.
16 to 22 "	Gray shale and soft sandstone. } Block coal (local.)
3 to 4 "	COAL I. Main "Block." } Block coal (local.)
6 to 10 "	Fire clay. } Block coal (local.)
0 to 2 "	Dark shales. } Block coal (local.)
0 to 2 "	COAL H. } Block coal (local.)
16 to 24 "	Fire clay and shale. } Block coal (local.)
0 to 1 "	COAL G. } Block coal (local.)
15 to 23 "	Shale and sandstone. } Block coal (local.)
2 to 4 "	COAL F. Lower "Block." } Block coal (local.)
30 to 80 "	Sandstone and gray shales. } Block coal (local.)
0 to 3 "	COAL B. Part "Block" and splinty cannel.
2 to 4 "	Fire clay.
10 to 22 "	Siliceous shale and coarse, soft sandstone.
60 to 125 "	Massive conglomerate gritstones.

2 to	30 feet.	Black, aluminous, pyritous shale, highly ferruginous.
0 to	2 "	Black slate.
0 to	2 "	COAL A. Impure.
2 to	4 "	Fire clay.
10 to	40 "	Dark pyritous shale, with ferruginous clays. Kaskaskia limestone, Chester group Lower Carboniferous period.

FUEL VALUES OF COAL.

HEAT UNITS—STEAM VALUES.

The State Geologist is indebted to Dr. G. M. Levette for the preparation of the following tables of the heat units and steam values of the coals of Indiana and other competing regions.

Prof. John Collett, State Geologist:

SIR—Herewith you will find a compilation of all the analyses of Indiana coals given in the reports of Dr. David Dale Owen, Prof. Richard Owen and Prof. E. T. Cox, comprising, in the aggregate, 390 examples; also two analyses of peat from the north end of the State. In addition, for comparison, are given fifty-six examples of coal analyses from Ohio, Pennsylvania, Kentucky, Illinois, Missouri, Iowa and other States and Territories, not forgetting the widely known Newcastle coal of England and the Albertite of New Brunswick. In all cases the authority is given in the heading of the tables or in the column under "Remarks."

The figures in the column headed "Units of Heat"* indicate the pounds water one pound of the coal will raise from 39° to 40°. As an example, one pound of coal, No. 1, of the tables (Barnett's mine) will raise the temperature of 8086 pounds of water 1° Fahr., or 4043 pounds 2° or 44.9 pounds from 32° to 212°.

The units of heat in any fuel are calculated from the per cent. of carbon and hydrogen contained in it.

The rules for these calculations are deduced from numerous experiments, through several years, by MM. Scheurer–Kestner and C. Meunier–Dollfuss, who, following the line of investigation instituted by Favre and Silberman, devised a modification of their calorimeter, by which the theoretical and experimental calorific value of fuels were made to coincide so closely that approximately correct multipliers were established for each per cent. of carbon or hydrogen found by chemical analysis in a fuel.

The column headed "Steam Value" gives the gallons of water that one ton (2,000 pounds) of the coal will raise from 100° F. to steam, at atmospheric pressure. For example, 2000 pounds of coal, No. 2, of the table

*A *unit of heat* is the quantity of heat required to raise the temperature of one pound of water from 39° to 40° Fahr., 39° being the temperature of greatest density.

(Garlic & Collins) will convert 1396 gallons of water into steam, starting with the water at 100° F., a temperature at which many heaters deliver water to the boilers.

All the calculations under the head of "Steam Value," and all in black face type, under "Units of Heat," were made specially for this report, while all other figures in the following tables were copied from the authorities given in the headings or in the column under "Remarks."

The first analyses of Indiana coals of which I find any record, were made by Dr. David Dale Owen, in his laboratory in New Harmony, by authority of an act of the Legislature "to provide for a geological survey of Indiana," approved February 6, 1837. Wood being more of a burden than a blessing, at that time, in most parts of the State, its extreme low price rendered coal mining unprofitable and unnecessary; but few coal banks were known, simple outcrops along streams or valleys having attracted the attention of settlers. It was from these few exposures Dr. Owen took his samples and made his analyses.

In 1859, the Legislature of Indiana authorized "a geological reconnoissance of the State." Dr. D. D. Owen was again made State Geologist. His death occurring soon after the appointment, his principal assistant, Professor Richard Owen, made the report in which is found analyses of twenty-two examples of coal.

In 1869, the Legislature provided for a geological survey. Professor E. T. Cox was appointed State Geologist, and served in that capacity until the spring of 1879, during which time all the important coal banks or mines in the State were visited, samples selected and analyses made, 363 of which are given in the following tables.

All of which is respectfully submitted by

Yours truly,

G. M. Levette.

Analyses of Coals, Clay County, Indiana. Geological Report of Indiana, 1869, *E. T. Cox.*

	NAME OF MINE OR OWNER.	Specific gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam value. See page 10.
1	Barnett's mine	1.250	78.12	57.0	1.5	....	58.5	37.5	4.0	41.5	8086	1500.
2	Garlic & Collins	1.230	76.87	57.5	3.0	....	60.5	31.0	8.5	39.5	7523	1396.
3	Knightsville No. 1	1.176	73.50	59.8	0.3	....	60.1	30.9	9.0	39.9	7725	1433.
4	Knightsville No. 2	1.167	72.93	57.0	2.0	....	59.0	33.0	8.0	41.0	7668	1423.
5	McClelland's No. 1	1.279	79.93	54.7	1.5	....	56.2	38 8	5.0	43.8	8023	1489.
6	McClelland's No. 2	1.279	79.93	53.0	2.5	....	55.5	40.0	4.5	44.5	7994	1481.
7	Star Mine, Harmony	1.242	77.62	61.5	2.5	....	64.0	32.5	3.5	36.0	7985	1483.
8	Newburg mine	1.327	82.93	47.3	6.0	....	53.3	39.7	7.0	46.7	7550	1400.

Clay County Coals—Continued. *Geological Report of Indiana,* 1870, *E. T. Cox.*

9	Carbon Block Coal Company	1.296	81.00	55.25	1.5	White.	56.75	39.85	3.40	43.25	8176	1517.
10	Garlic & Collins, Otter creek	1.244	77.75	57.90	3.5	White.	61.40	35.85	2.75	38.60	8027	1489.
11	Otter creek, lower seam	1.232	77.00	57.95	2.6	White.	60.55	37.35	2.10	39.45	8166	1515.
12	Niblock & Zimmerman	1.231	76.93	55.63	0.75	White.	56.38	40.62	3.00	43.62	8243	1529.
13	Morris Coal Company	1.244	77.75	52.00	1.00	White.	53.00	43.50	3 50	47.00	8238	1528.
14	Markland Mining Company, 1873	1.211	75.69	52.00	2.0	White.	54.00	41.50	4.50	46 00	8053	1494.

15	E. Cooprider, Middlebury, top	1.280	80.00	44.00	4.50	Pink.	48.50	47.50	4.00	51.50	7924	1469.
16	E. Cooprider, Middlebury, middle	1.533	95.81	45.00	8.50	Brown.	53.50	44.00	2.50	46.50	7673	1423.
17	E. Cooprider, Middlebury, bottom	1.211	75.88	50.50	4.00	Yellow.	54.50	42.50	3.00	45.50	7980	1480.
18	J. Cooprider, Middlebury, middle	1.271	79.44	44.50	5.50	Purple.	50.00	47.00	3.00	50.00	7808	1448.
19	J. Cooprider, Middlebury, bottom	1.274	79.62	41.50	7.50	Purple.	49.00	47.50	3.50	51.00	7711	1431.
20	Kennedy, Centre Point, top	1.354	84.62	46.50	15 50	Brown.	62.00	35.00	3.00	38.00	6968	1292.
21	Kennedy, Centre Point, middle	1.204	75.25	49.50	9.00	White.	58.50	39.00	2.50	41.50	7575	1405.
22	Kennedy, Centre Point, bottom.	1.188	74.25	52.00	4.50	White.	56 50	40.50	3.00	43.50	7917	1468.
23	Knickerbocker Coal Company, top	1.167	72.93	55.00	5.50	Buff.	60.50	37.00	2.50	39.50	7838	1454.
24	Knickerbocker Coal Company, middle	1.184	74.00	52.50	6.00	White.	58.50	39.50	2.00	41.50	7774	1442.
25	Knickerbocker Coal Company, bottom	1.241	77.56	50.50	6.50	White.	57.00	40.00	3.00	43.00	7750	1438.
26	Kress, Middlebury, top	1.318	82.37	44.00	13.00	Red.	57.00	39.50	3.50	43.00	7179	1332.
27	Kress, Middlebury, middle	1.287	80.43	40.50	10.50	Brown.	51.00	44 50	4.50	49.00	7355	1365.
28	Kress, Middlebury, bottom	1.432	89.40	38.50	13.00	Gray.	51.50	44.50	4 00	48.50	7194	1335.
29	Limited Liability Coal Company	1 231	76.93	57.00	3.00	White.	60.00	37.00	3.00	40.00	8000	1484.
30	Lodi	1.303	81.43	43.00	13.50	Red.	56.50	40.50	3.00	43.50	7190	1334.
31	Markland Coal Company, top	1.202	75.12	58.00	4.00	White.	62.00	36.00	2.00	38.00	7989	1482.
32	Markland Coal Company, middle	1.145	71.56	63.50	0.50	White.	64.00	35.50	2.50	36.00	8205	1522.
33	Markland Coal Company, bottom	1.221	76.31	59.00	2.50	White.	61.50	36 00	2.50	38.50	8070	1497.
34	Morrison's, Centre Point, top	1.233	77.06	52.50	7.00	Flesh.	59.50	37.00	3 50	40.50	7637	1417.
35	Morrison's, Center Point, middle	1.253	78.31	58.50	4.50	White.	63.00	34.00	3.00	37.00	7846	1455.
36	Morrison's, Centre Point, bottom	1.209	75.56	57.00	3.50	Flesh.	60.50	36.00	3.50	39.50	7909	1467.
37	Muir & Free, top	1.269	79.31	52.00	3.00	White.	55.00	42.50	2.50	45.00	8101	1503.
38	Muir & Free, middle	1.167	72.93	48.50	6.00	White.	54.50	41.50	4.00	45.50	7727	1433.
39	McClelland & Zeller	1.285	80.31	56.50	2 50	White.	59.00	32.50	8.50	41.00	8005	1485.
40	J. McCrea, Hoosiertown, top	1.196	74.75	56.50	2.00	White.	58.50	39.50	2.00	41.50	8189	1519.
41	J. McCrea, Hoosiertown, middle	1.229	76.81	56.00	5.50	White.	61.50	36.00	2.50	38.50	7828	1452.
42	J. McCrea, Hoosiertown, bottom	1.227	76.06	58.00	2.50	White.	60.50	37.00	2.50	39.50	8080	1499.
43	Niblock & Co., "Chicago mine"	1.251	78.19	50.50	2.00	White.	52.50	41.50	6.00	47.50	7888	1463.

Clay County Coals—Continued. *Geological Report of Indiana*, 1875, *E. T. Cox.*

	NAME OF MINE OR OWNER.	Specific gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.
44	A. Phipps, Middlebury, top	1.303	81.43	52.00	5.50	Brown.	57.50	39.50	3.00	42.50	7826	1452.
45	A. Phipps, Middlebury, middle	1.266	79.15	48.50	4.50	Pink.	53.00	44.50	2.50	47.00	8002	1484.
46	A. Phipps, Middlebury, bottom	1.333	83.31	40.00	10.50	Red.	50.50	47.00	2.50	49.50	7544	1400.
47	J. Roush, Middlebury	1.239	77.42	49.50	7.00	Flesh.	56.50	40.00	3.50	43.50	7670	1423.
48	Stedman's, Centre Point, top	1.208	75.50	57.50	4.00	White.	61.50	35.50	3.00	38.50	7903	1466.
49	Stedman's, Centre Point, middle	1.216	76.00	50.50	8.00	White.	58.50	39.50	2.00	41.50	7904	1466.
50	Stedman's, Centre Point, bottom	1.220	76.25	60.00	5.00	White.	65.00	32.00	3.00	35.00	7784	1444.
51	J. Storm, Middlebury, top	1.204	75.25	52.50	7.00	White.	59.50	38.00	2.50	40.50	7728	1434.
52	J. Storm, Middlebury, middle	1.257	78.56	59.00	2.50	White.	61.50	36.00	2.50	38.50	8070	1497.
53	J. Storm, Middlebury, bottom	1.230	76.87	55.50	7.00	White.	62.50	35.50	2.00	37.50	7731	1434.
54	Wagstaff, Clay City, top	1.319	82.43	61.00	3.00	Red.	64.00	33.50	2.50	36.00	8003	1484.
55	Wagstaff, Clay City, middle	1.231	76.93	59.00	2.50	Pink.	61.50	36.00	2.50	38.50	8070	1497.
56	Wagstaff, Clay City, bottom	1.214	75.87	54.50	2.50	Pink.	57.00	40.50	2.50	43.00	8120	1506.
57	Ward & Perry, Oakland, bottom	1.165	72.81	57.00	3.50	Red.	60.50	36.50	3.00	39.50	7955	1476.
58	Ward & Perry, Oakland, top	1.162	72.62	58.50	3.00	White.	61.50	36.00	2.50	38.50	8030	1489.
59	Ward & Perry, Oakland, top	1.222	76.37	58.00	5.00	White.	63.00	34.50	2.50	37.00	7851	1456.
60	Woodruff & Fletcher, Hoosiertown, middle	1.221	76.31	55.50	6.50	White.	62.00	36.00	2.00	38.00	7787	1447.
61	Woodruff & Fletcher, Hoosiertown, middle	1.216	76.00	59.00	3.50	Flesh.	62.50	35.50	2.00	37.50	8024	1489.
62	Woodruff & Fletcher, Hoosiertown, bottom	1.188	74.12	58.00	1.50	White.	59.50	38.50	2.00	40.50	8218	1524.
63	Woodruff & Fletcher, near Brazil	1.142	71.37	59.00	1.50	White.	60.50	35.50	4.00	39.50	8024	1489.

Analyses of Coals, Daviess County, Indiana. Geological Report of Indiana, 1870, *E. T. Cox.*

64	Allen, Joseph, coal	K	1.293	80.81	56.00	6.50	Brown.	62.50	30.50	7.00	37.50	7355	1364.
65	Aikman's coal	L	1.270	79.37	56.50	3.00	N'rly white.	59.50	35.50	5.00	40.50	7860	1458.
66	Berry,s, Walter, coal		1.288	80.50	59.00	5.50	Brown.	64.50	28.50	7.00	35.50	7412	1375.
67	Cox's coal	L	1.259	78.68	57.50	3.50	White.	61.00	35.00	4.00	39.00	7894	1465.
68	Clark's coal	I	1.277	79.81	57.30	3.50	White.	60.80	34.70	4.50	39.20	7848	1456.
69	Dutch Bank	L	1.264	79.00	61.50	2.00	White.	63.50	34.50	2.00	36.50	8171	1515.
70	Gregory's coal	K?	1.276	79.75	60.50	2.00	Drab.	62.50	30.50	7.00	37.50	7719	1432.
71	John Gregory's coal	K?	1.275	79.68	49.50	2.00	Lilac.	51.50	42.00	6.50	48.50	7897	1465.
72	McCord's coal	K	1.245	77.81	54.00	2.00	Flesh.	56.00	40.00	4.00	44.00	8075	1498.
73	O'Brian's	K	1.270	79.37	56.50	1.50	Salmon.	58.00	35.50	6.50	42.00	7860	1458.
74	Odell's coal	A	1.262	78.87	53.00	2.00	White.	55.00	36.50	8.50	45.00	7670	1423.
75	Raymond's coal	X	1.200	75.00	50.75	1.75	Cream.	52.50	46.50	1.00	47.50	8416	1561.
76	Spink & Cable, main shaft	L	1.294	80.87	60.00	4.50	Fawn.	64.50	30.00	5.50	35.50	7632	1416.
77	Sulphur Spring Bank	L	1.280	80.00	58.30	6.00	Brown.	64.30	31.20	4.50	35.70	7650	1419.
78	Spicer's Mill	L	1.268	79.25	48.50	1.00	Blue.	49.50	44.00	6.50	50.50	8002	1484.
79	Stone's coal		1.264	79.00	54.30	2.00	Red brown.	56.30	35.20	8.50	43.70	7652	1419.
80	John Shaffer's coal	A	1.308	81.75	58.00	3.50	Brown.	61.50	30.50	8.00	38.50	7517	1395.
81	Turner's coal	A	1.278	79.75	55.50	1.50	White.	57.00	35.50	7.50	43.00	7779	1443.
82	Ward's coal	A	1.261	78.81	55.00	2.50	White.	57.50	36.00	6.50	42.50	7785	1444.
83	Wilson's coal	L	1.268	79.25	59.20	2.50	White.	61.70	34.90	3.40	38.30	8915	1489.
84	Buckeye Cannel Coal Company, Cannel coal		1.229	76.87	42.00	6.00	White.	48.00	48.50	3.50	52.00	7894	1465.

Daviess County Coals—Continued. *Geological Report of Indiana*, 1875, *E. T. Cox.*

85	J. S. Morgan, top, No. 1	1.277	79.81	56.00	5.50	Red.	61.50	32.50	6.00	38.50	7507	1393.
86	J. S. Morgan, bottom, No. 2	1.252	78.25	53.50	5.00	White.	58.50	36.00	5.50	41.50	7626	1415.
87	J. S. Morgan, lower seam, No. 3	1.239	77.44	53.00	2.50	White.	55.50	39.50	5.00	44.50	7906	1466.

Analyses of Coals, Dubois County, Indiana. Geological Report Indiana, 1871, *E. T. Cox.*

	NAME OF MINE OR OWNER.	Specific gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.
88	Burnham coal . . . . A	1.306	81.62	53.00	3.50	White.	56.50	39.00	4.5	43.50	7902	1466.
89	Elkin . . . . A	1.295	80.93	50.50	4.00	Brown.	54.50	39.00	6.5	45.50	7700	1429.
90	Harbison . . . . A	1.198	74.87	23.50	10.00	Pink.	33.50	60.50	6.0	66.50	7513	1394.
91	Hay, upper part . . . . A	1.289	80.56	51.50	3.50	White.	55.00	40.50	4.5	45.00	7920	1469.
92	Hay, middle part . . . . A	1.264	79.00	49.50	3.00	White.	52.50	40.50	7.0	47.50	7758	1439.
93	Hay, bottom part . . . . A	1.271	79.43	51.50	2.00	White.	53.50	40.00	6.5	46.50	7873	1461.
94	Kesler, upper part . . . . A	1.333	83.31	40.00	11.50	Blue.	51.50	41.50	7.0	48.50	7083	1314.
95	Kesler, middle part . . . . A	1.268	79.25	40.50	8.50	Gray.	49.00	45.00	6.0	51.00	7448	1382.
96	Kesler, bottom part . . . . A	1.260	78.75	40.50	9.00	Brown.	49.50	44.00	6.5	50.50	7356	1365.
97	Fest . . . . A	1.305	81.56	48.00	5.50	Faun.	53.50	41.00	5.5	46.50	7682	1425.
98	Bridenbaugh, upper part . . . . K	1.273	79.56	52.50	4.00	Red.	56.50	37.00	6.5	43.50	7676	1423.
99	Bridenbaugh, middle part . . . . K	1.265	79.06	51.50	3.50	Red.	55.00	40.50	4.5	45.00	7920	1469.
100	Bridenbaugh, bottom part . . . . K	1.246	77.87	52.50	3.50	Red.	56.00	39.00	5.0	44.00	7861	1458.
101	Rudolph . . . . K	1.361	78.81	48.50	4.00	Red.	52.50	42.00	5.5	47.50	7816	1450.
102	J. Stein	1.260	78.75	48.50	3.50	Brown.	52.00	43.50	4.5	48.00	7955	1476.
103	M. Wilson . . . . K	1.416	88.50	53.00	2.50	White.	55.50	40.50	4.0	44.50	8041	1491.
104	M. Wilson, another part of mine . . . . K	1.286	80.37	44.50	5.00	Red.	49.50	44.50	6.0	50.50	7725	1433.
105	Adam Smith, upper part . . . . K?	1.256	78.50	43.50	3.50	White.	47.00	46.00	7.0	53.00	7783	1443.
106	Adam Smith, middle part . . . . K?	1.335	83.43	49.00	2.50	White.	51.50	43.50	5.0	48.50	7996	1483.
107	Adam Smith, bottom part . . . . K?	1.261	78.81	44.50	4.50	Gray.	49.00	45.50	5.5	51.00	7818	1449.
108	Bretzville . . . . A?	1.275	79.68	49.00	3.50	White.	52.50	43.00	4.5	47.50	7950	1475.

Analyses of Coals, Fountain County, Indiana. Geological Report Indiana, 1869–'70–'75, E. T. Cox.

109	Norbourn Thomas, semi-block coal	1.277	79.81	59.80	4.5	. . . .	64.30	32.70	3.0	35.70	7818	1450.
110	W. B. Coates, top, coal . . . N	1.249	78.06	51.80	2.6	Brown.	54.40	42.60	3.0	45.60	8146	1511.
111	W. B. Coates, bottom . . . N	1.301	81.31	49.00	7.2	Gray.	56.20	40.20	3.6	43.80	7671	1423.
112	Hatfield's Mill, cannel coal	1.195	74.68	47.50	1.0	Red.	48.50	47.00	4.5	51.50	8199	1521.
113	Barker's	1.195	74.68	54.50	4.5	White.	59.00	36.00	5.0	41.00	7707	1429.
114	Judge Coates	1.220	76.25	47.50	3.0	White.	50.50	44.00	5.5	49.50	7875	1461.
115	Kirtland, top	1.203	75.18	47.50	2.5	Red.	50.00	46.00	4.0	50.00	8058	1493.
116	Kirtland, bottom	1.211	75.68	39.00	4.5	Brown.	43.50	53.00	3.5	56.50	8014	1487.
117	J. W. McKee, top	1.205	75.31	55.00	4.0	White.	59.00	35.00	6.0	41.00	7655	1420.
118	J. W. McKee, bottom	1.225	76.56	47.50	5.5	White.	53.00	41.50	5.5	47.00	7646	1418.
119	S. Thompson, top	1.239	77.43	52.50	4.5	White.	57.00	37.50	5.5	43.00	7682	1425.
120	S. Thompson, bottom	1.207	75.43	51.50	4.0	Flesh.	55.50	41.50	3.0	44 50	7969	1478.

Analyses of Coals, Greene County, Indiana. Geological Report Indiana, 1869, E. T. Cox.

121	Babbitt	1.238	77.30	59 90	1.5	. . . .	61.40	35.60	3.0	38.60	8142	1510.
122	Bledsoe	1.251	78.20	63.00	0.5	. . . .	63.50	29.50	7.0	36.50	7828	1452.
123	Harrell	1.263	78.31	48.10	2.5	. . . .	50.60	42.40	7.0	49.40	7822	1451.
124	McKissick	1.189	74.37	62.50	2.0	. . . .	64.50	32.00	3.5	35.50	8020	1488.
125	Templeton	1.238	77.37	59.30	4.5	. . . .	63.80	28.70	7.5	36.20	7499	1391.

Analyses of Coals, Gibson County, Indiana. Geological Report Indiana, 1873, E. T. Cox.

126	Finney	1.307	81.68	51.50	6.5	Brown.	58.00	36.00	6.0	42.00	7502	1391.
127	McGregor, coal . . . N	1.249	78.06	52.50	3.5	Yellow.	56.00	39.50	4.5	44.00	7908	1467.
128	Oakland City . . . L?	1.391	86.93	43.50	18.5	Red.	62.00	32.00	6.0	38.00	6484	1200.
129	G. S. Vanada	1.275	69.68	54.00	5.5	Red.	59.50	35.50	5.0	40.50	7658	1421.

Analyses of Coals, Knox County, Indiana. Geological Report Indiana, 1873, E. T. Cox.

	NAME OF MINE OR OWNER.	Specific gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam value. See page 10.
130	Curry, coal L	1.319	81.87	57.00	4.5	White.	61.50	34.50	4.0	38.50	7807	1447.
131	John Hooper. . . . . M	1.261	78.81	51.50	6.5	Red.	58.00	38.50	3.5	42.00	7734	1435.
132	Dr. Keith, upper . . . . K	1.292	80.75	49.50	5.0	Gray.	54.50	39.50	6.0	45.50	7665	1422.
133	Dr. Keith, middle . . . . K	1.311	81.93	49.00	6.0	Gray.	55.00	39.00	6.0	45.00	7578	1405.
134	Dr. Keith, lower . . . . K	1.305	81.56	49.00	6.5	Brown.	55.50	39.00	5.5	44.50	7578	1405.
135	McKenna	. . .	. . .	57.50	4.0	White	61.50	35.00	3.5	38.50	7894	1465.
136	Sanborn . . . . K	1.287	80.43	48.00	3.5	Brown.	51.50	44.50	4.0	48.50	8000	1484.
137	Sanborn, cannel coal . . . . K	1.601	100.07	38.50	25.0	Brown.	63.50	33.00	3.5	36.50	6173	1146.
138	Shepard & Hazlet . . . . K	1.304	81.50	49.00	6.5	Blue.	55.50	39.00	5.5	44.50	7578	1405.
139	A. Simonson, upper L	1.250	78.12	47.00	2.5	Faun.	49.50	47.00	3.5	50.50	8159	1514.
140	A. Simonson, middle L	1.244	77.75	49.50	3.5	Faun.	49.00	47.50	3.5	51.00	8408	1559.
141	A. Simonson, lower L	1.253	78.31	48.50	3.0	Pink.	51.50	45.50	3.0	48.50	8048	1493.
142	Simonson & Hulan, upper . . . . K	1.281	80.06	45.50	3.0	White.	50.50	45.50	4.0	49.50	7899	1465.
143	Simonson & Hulan, middle . . . . K	1.276	79.75	49.00	3.5	White.	52.50	43.00	4.5	47.50	7950	1475.
144	Simonson & Hulan, lower . . . . K	1.286	81.00	52.00	7.0	Red.	59.00	37.50	3.5	41.00	7682	1425.
145	Swick . . . . M?	1.276	79.75	46.00	5.5	Red.	51.50	46.50	3.0	48.50	8032	1490.
146	James D. Williams . . . . M?	. . .	. . .	54.00	4.0	Brown.	58.00	38.50	3.5	42.00	7936	1472.
147	Weaver Coal Company (borings) . . . . M?	. . .	. . .	59.00	3.5	White.	62.50	34.00	3.5	37.50	7969	1478.
148	Weaver Coal Company, mine . . . . M	1.277	79.81	52.00	4.5	Brown.	56.50	38.50	5.0	43.50	7774	1442.
149	Weaver Coal Company, mine L	1.286	81.00	53.00	5.0	Red.	58.00	38.50	3.5	42.00	7855	1457.

Analyses of Coals, Martin County, Indiana. Geological Report, Indiana, 1870, *E. T. Cox.*

150	Baker, upper part	A	1.238	77.37	51.25	1.5	White.	52.75	44.75	2.5	47.25	8294	1539.
151	Baker, lower part	A	1.239	77.43	48.75	0.8	White.	49.50	47.50	3.0	50.50	8367	1551.
152	Horn & Co	A	1.246	77.87	42.50	2.5	Brown.	45.00	52.00	3.0	55.00	8259	1532.
153	P. Hultz	A	1.262	78.87	47.50	2.5	White.	50.00	46.50	3.5	50.00	8153	1512.
154	Munson's Ridge, upper	A	1.270	79.37	50.00	1.5	Brown.	51.50	45.50	3.0	48.50	8262	1532.
155	Sampson's Hill, upper	I	1.588	99.25	28.50	41.0	Gray.	69.50	25.00	5.5	30.50	4228	892.
156	Sampson's Hill, middle	I	1.232	77.00	53.00	1.0	White.	54.00	44.00	2.0	46.00	8365	1551.
157	Sampson's Hill, bottom	I	1.252	78.12	47.00	1.5	Red.	48.50	48.50	3.0	51.50	8298	1539.
158	Sampson's Hill, carbon markings				83.40	0.8		84.20	13.30	2.5	15.80	7963	1477.
159	Turner, Sampson's Hill	A	1.359	84.31	45.50	9.0	Red.	54.50	41.50	4.0	45.50	7528	1396.
160	Willow Valley	A	1.286	86.37	48.00	2.5	Lead.	50.50	46.75	2.8	49.50	8240	1529.

Analyses of Coals, Montgomery County. Geological Report, Indiana, 1875, *E. T. Cox.*

161	B. Clover, near Waveland		1.254	78.37	52.00	3.5	White.	55.50	41.50	3.0	44.50	8010	1486.
162	H. S. Burford, near Waveland		1.202	75.12	49.00	5.0	White.	54.00	43.50	2.5	46.00	7950	1475.

Analyses of Coals, Owen County. Geological Report, Indiana, 1875, *E. T. Cox.*

163	Arney's, top		1.212	75.75	49.50	2.5	White.	52.00	45.00	3.0	48.00	8129	1508.
164	Arney's, middle		1.206	75.37	49.50	2.0	White.	51.50	45.00	3.5	48.50	8129	1508.
165	Arney's, bottom		1.271	79.44	51.50	5.0	Red.	56.50	40.50	3.0	43.50	7877	1461.
166	Reuben Barton		1.267	79.18	44.00	4.5	Red.	48.50	49.00	2.5	51.50	8051	1493.
167	James Beaman		1.240	77.50	52.50	3.0	Red.	53.50	41.00	3.5	44.50	8004	1485.
168	J. Brammer, Patricksburg, top		1.192	74.50	46.00	1.5	Yellow.	47.50	48.50	4.0	52.50	8167	1515.
169	J. Brammer, Patricksburg, middle		1.204	75.25	53.50	3.5	Red.	57.00	41.00	2.0	43.00	8085	1500.
170	J. Brammer, Patricksburg, bottom		1.277	79.81	46.00	4.5	Pink.	50.50	47.00	2.5	49.50	8029	1489.

Analyses of Coals, Owen County—Continued. *Geological Report Indiana*, 1875, *E. T. Cox.*

	NAME OF MINE OR OWNER.	Specific Gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.
171	T. Burger, middle	1.191	75.68	54.00	1.5	White.	55.50	42.50	2.0	44.50	8262.	1532.
172	T. Burger, bottom	1.223	76.44	58.00	3.5	White.	61.50	35.00	3.5	38.50	7897.	1464.
173	Chambers, top	1.230	76.87	49.00	3.0	Brown.	52.00	45.50	2.5	48.00	8134.	1509.
174	Chambers, middle	1.237	77.31	56.50	2.0	White.	58.50	39.00	2.5	41.50	8143.	1511.
175	Chambers, bottom	1.248	78.00	50.00	8.5	Brown.	58.50	39.00	2.5	41.50	7618.	1413.
176	D. C. Cress	1.248	78.00	55.00	2.5	Yellow.	57.50	39.50	3.0	42.50	8068.	1496.
177	G. Croft, middle	1.214	75.87	57.50	2.0	White.	59.50	38.50	2.0	40.50	8178.	1516.
178	G. Croft, bottom	1.250	78.12	57.00	4.5	White.	61.50	36.00	2.5	38.50	7909.	1467.
179	Joel Dillon	1.243	77.68	53.00	4.5	White.	57.50	39.50	3.0	42.50	7906.	1467.
180	A. Fiscus	1.362	85.12	45.00	19.5	Gray.	64.50	33.00	2.5	35.50	6664.	1237.
181	C. Fletcher, top	1.219	76.18	60.00	3.0	White.	63.00	35.00	2.0	37.00	8059.	1495.
182	C. Fletcher, middle	1.206	75.37	58.00	2.5	White.	60.50	37.50	2.0	39.50	8126.	1507.
183	C. Fletcher, bottom	1.241	77.56	44.00	8.5	Red.	52.50	45.50	2.0	47.50	7638.	1416.
184	Louisa Hester, cannel slate	1.333	83.31	47.00	12.5	Gray.	59.50	36.00	4.5	40.50	7101.	1317.
185	James Jackson	1.222	76.31	32.50	9.5	Pink.	42.00	54.00	4.0	58.00	7580.	1406.
186	McCreary, top	1.280	80.00	53.50	5.5	Brown.	59.00	38.00	3.0	41.00	7809.	1449.
187	McCreary, bottom	1.276	79.76	51.60	4.5	Red.	55.50	42.00	2.5	44.50	7974.	1479.
188	W. S. Norris	1.282	80.12	45.00	5.0	Red.	50.00	48.00	2.0	50.00	8040.	1491.
189	Oberholtzer, middle	1.242	77.62	57.00	4.5	Yellow.	61.50	35.00	3.5	38.50	7817.	1450.
190	Oberholtzer, bottom	1.292	80.75	53.00	9.5	White.	62.50	34.50	3.0	37.50	7447.	1381.
191	Jesse Reagan, top	1.261	78.81	52.50	7.5	White.	60.00	37.00	3.0	40.00	7555.	1402.

192	Jesse Reagan, middle		1.230	76.87	52.00	5.0	White.	57.00	40.50	2.5	43.00	7918	1450.
193	Jesse Reagan, bottom		1.250	78.12	52.50	5.5	White.	58.00	39.50	2.5	42.00	7866	1441.
194	J. Rowe, middle		1.235	77.18	56.00	5.0	White.	61.00	36.00	3.0	39.00	7828	1433.
195	J. Rowe, bottom		1.213	75.81	53.50	4.5	White.	58.00	39.00	3.0	42.00	7901	1466.
196	Wm. Royer, top		1.260	78.75	55.50	4.0	White.	59.50	38.00	2.5	40.50	7970	1479.
197	Wm. Royer, middle		1.193	74.56	55.00	3.0	Pink.	58.00	39.00	3.0	42.00	8022	1488.
198	Wm. Royer, bottom		1.219	76.18	51.50	4.0	White.	55.50	41.50	3.0	44.50	7969	1478.
199	J. C. Stahl		1.203	75.18	58.00	3.0	White.	61.00	36.00	3.0	39.00	7989	1482.
200	White		1.216	76.00	55.50	2.5	Pink.	58.00	39.00	3.0	42.00	8062	1495.

Analyses of Coals, Parke County. Geological Reports Indiana, 1869–'70–'71–'75, *E. T. Cox.*

201	Batty's Mine	I	1.231	76.93	56.00	2.5	....	58.50	38.50	3.0	41.50	8097	1502.
202	Buchanan's Mine	I	1.232	77.00	62.50	2.0	....	64.50	31.00	4.5	35.50	7927	1470.
203	Judge Maxwell		....	....	48.75	2.5	White.	51.25	45.50	3.25	48.70	8182	1518.
204	Cannel slate, near Rockville		....	....	34.50	26.0	Dark.	60.50	32.00	7.5	39.50	5757	1066.
205	Sand Creek coal		1.296	81.00	45.50	4.5	Light.	50.00	45.50	4.5	50.00	7899	1465.
206	Beard's coal		1.191	74.43	48.50	1.0	White.	49.50	42.50	8.0	50.50	7863	1459.
207	Moore's Mill		1.228	76.75	46.50	3.5	Brown.	50.00	46.00	4.0	50.00	7977	1479.
208	Bethany, cannel? coal		....	....	43.00	4.5	White.	47.50	47.00	5.5	52.50	7836	1453.

Analyses of Coals, Perry County. Geological Report Indiana, 1871, *E. T. Cox.*

	NAME OF MINE OR OWNER.	Specific gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam value. See page 10.
209	Everard's, coal . . . . A	. . . . . .	. . . .	54.00	1.5	Red.	55.50	37.00	7.5	44.50	7797	1446.
210	Rock Island Seam, top . . . . F	. . . . . .	. . . .	52.50	2.0	White.	54.50	41.00	4.5	45.50	8047	1493.
211	Rock Island Seam, middle . . . . F	. . . . . .	. . . .	58.00	11.0	Red.	69.50	27.50	3.0	30.50	7461	1384.
212	Rock Island Seam, bottom . . . . F	. . . . . .	. . . .	50.00	8.5	White.	58.50	37.00	4.5	41.50	7473	1386.
213	Rock Island Seam, slaty bottom	. . . . . .	. . . .	49.50	12.5	Lemon.	62.00	34.00	4.0	38.00	7155	1328.
214	Rock Island Seam, cannel . . . . F	. . . . . .	. . . .	45.50	6.0	White.	51.50	42.00	6.5	48.50	7574	1405.
215	Cannelton, upper . . . . F	. . . . . .	. . . .	51.50	4.0	White.	55.50	41.00	3.5	44.50	7966	1478.
216	Cannelton, middle . . . . F	. . . . . .	. . . .	48.50	2.0	Brown.	50.50	43.00	6.5	49.50	7909	1467.
217	Cannelton, bottom . . . . F	. . . . . .	. . . .	45.50	3.5	Red.	49.00	46.00	5.0	51.00	7945	1474.
218	Clarke Brothers, upper . . . . F	. . . . . .	. . . .	48.50	2.0	White.	50.50	42.50	7.0	49.50	7863	1459.
219	Clarke Brothers, middle . . . . F	. . . . . .	. . . .	49.50	3.5	White.	53.00	40.50	6.5	47.00	7758	1440.
220	Clarke Brothers, bottom . . . . F	. . . . . .	. . . .	48.50	4.0	White.	52.50	41.00	6.5	47.50	7724	1433.
221	Heck's Mine, upper . . . . F	. . . . . .	. . . .	49.50	6.0	Blue.	55.50	40.00	4.5	44.50	7712	1430.
222	Heck's Mine, lower . . . . F	. . . . . .	. . . .	45.00	8.5	Red.	53.50	43.00	3.5	46.50	7626	1415.
223	McMahon, upper	. . . . . .	. . . .	48.50	4.0	Blue.	52.50	41.50	6.0	47.50	7770	1441.
224	McMahon, lower	. . . . . .	. . . .	50.50	5.5	Brown.	56.00	39.50	4.5	44.00	7746	1437.

Analyses of Coals, Pike County. Geological Report, Indiana, 1871, *E. T. Cox.*

225	Thomas Case . . . . L ?	1.280	80.00	45.50	4.0	Faun.	49.50	47.00	3.5	50.50	8038	1491.
226	Bennett . . . . K	1.268	79.25	45.50	3.5	Brown.	49.00	45.00	6.0	51.00	7852	1457.
227	Alexander's Seam . . . . N	1.284	80.25	49.50	3.0	White.	52.50	41.50	6.0	47.50	7851	1457.
228	Alexander, another part of seam . . . . N	1.259	78.69	52.00	4.0	White.	56.00	36.00	8.0	44.00	7542	1401.
229	Dr. Posey, upper . . . . K	1.288	80.50	48.00	5.5	Blue.	53.50	40.00	6.5	46.50	7590	1408.
230	Dr. Posey, middle . . . . K	1.275	79.68	48.00	4.0	Faun.	52.00	41.00	7.0	48.00	7683	1425.
231	Dr. Posey, bottom . . . . K	1.244	77.75	50.50	6.0	Brown.	56.50	38.00	5.5	43.50	7607	1412.
232	Shandy's, upper . . . . K	1.279	79.94	51.50	5.0	White.	56.50	37.00	6.5	43.50	7595	1409.
233	Shandy's, lower . . . . K	1.270	79.37	49.00	3.5	White.	52.50	41.50	6.0	47.50	7810	1449.
234	DeBruler, upper . . . . K	1.294	80.87	42.00	5.0	Blue.	47.00	45.00	8.0	53.00	7569	1404.
235	DeBruler, middle . . . . K	1.271	79.43	44.50	5.5	Brown.	50.00	44.00	6.0	50.00	7679	1425.
236	DeBruler, bottom . . . . K	1.268	79.25	50.00	3 5	Blue.	53.50	40.00	6.5	46.50	7752	1438.
237	Crowe's, upper L	1.274	79.62	52.50	3.5	Faun.	56.00	35.50	8.5	44.00	7536	1398.
238	Crowe's lower L	1.262	78.87	47.90	8.5	Gray.	56.40	35.10	8.5	43.60	7086	1315.
239	T. Smith's . . . . N	1.279	79.93	53.50	2.5	White.	56.00	38.50	5.5	44.00	7896	1465.
240	Hawthorn & Gleason L	1.269	79.31	45.50	14.0	Gray.	59.50	32.00	8.5	40.50	6646	1233.
241	Barrs . . . . M	1.260	78.75	57.00	3.5	White.	60.50	32.50	7.0	39.50	7622	1414.
242	Falls, upper . . . . N	1.274	79.62	47.00	5.0	Faun.	52.00	42.50	5.5	48.00	7742	1436.
243	Falls, lower . . . . N	1.268	79.25	51.50	4.0	White.	55.50	37.00	7.5	44.50	7595	1409.
244	Owner unknown . . . . K	1.268	79.25	48.00	3.0	White.	51.00	44.50	4.5	49.00	8008	1486.
245	DeTar, upper . . . . A	1.444	90.25	41.50	14.0	Red.	55.50	37.00	7.5	44.50	6787	1259.
246	DeTar, lower . . . . A	1.288	80.50	49.50	5.0	Red.	54.50	40.00	5.5	45 50	7712	1431.
247	Bees, coal . . . . K	1.269	79.31	44.50	14.0	Brown.	58.50	37.00	4.5	41.50	7529	1378.
248	Moulton, upper . . . . K	1.244	77.80	48.00	3.5	Blue.	51.50	43.00	5.5	48.50	7869	1460.
249	Moulton, middle . . . . K	1.257	78.56	50.50	8.5	Red.	59.00	36.50	4.5	41.00	7468	1385.
250	Moulton, bottom . . . . K	1.257	78.56	49.50	3.0	White.	52.50	41.50	6.0	47.50	7851	1456.
251	Thomas . . . . K	1.280	80.00	48.50	4.0	White.	52.50	40.50	7.0	47.50	7677	1425.
252	Wells & Whitman, upper L	1.294	80.87	52.50	2.5	White.	55.00	37.00	8.0	45.00	7676	1425.
253	Wells & Whitman, middle L	1.278	79.87	50.50	2.0	White.	52.50	41.50	6.0	47.50	7932	1471.
254	Wells & Whitman, bottom L	1.275	79.68	50.50	2.5	White.	53.00	42.00	5.0	47.00	7978	1480.

Analyses of Pike County Coals—Continued. *Geological Report of Indiana*, 1871, *E. T. Cox.*

	NAME OF MINE OR OWNER.		Specific Gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.
255	Massey, upper	L	1.268	79.25	53.50	3.5	Gray.	57.00	34.50	8.5	43.00	7524	1396.
256	Massey, lower	L	1.279	79.93	55.00	1.5	White.	56.50	36.50	7.0	43.50	7831	1453.
257	Martin, upper	L	1.258	78.62	52.00	3.5	Gray.	55.50	37.00	7.5	44.50	7635	1416.
258	Martin, middle	L	1.269	79.31	57.00	3.0	Gray.	60.00	33.50	6.5	40.00	7724	1433.
259	Martin, bottom	L	1.275	79.68	55.00	2.5	White.	57.50	35.00	7.5	42.50	7692	1427.
260	Tevault	K	1.245	77.81	49.50	3.0	White.	52.50	40.50	7.0	47.50	7758	1440.
261	Wood	K	1.272	79.50	45.00	3.0	White.	48.00	47.50	4.5	52.00	8044	1492.
262	Ingham, upper	K?	1.280	80.00	49.00	2.0	White.	51.00	41.50	7.5	49.00	7810	1449.
263	Ingham, lower	K?	1.311	81.93	50.50	2.0	White.	52.50	41.00	6.5	47.50	7885	1463.

Analyses of Coal, Spencer County. *Geological Report of Indiana*, 1870–'71, *E. T. Cox.*

264	Priest coal		1.282	80.12	51.90	1.5	Cream.	53.40	43.10	3.5	46.60	8192	1518.
265	W. L. Barker	I	1.317	82.31	43.50	6.5	Brown.	50.00	47.50	2.5	50.00	7923	1470.
266	Brashear & Howard	I	1.281	80.06	52.50	1.0	White.	53.50	43.00	3.5	46.50	8232	1527.
267	Barr & Bro., upper	L	1.274	79.62	46.00	2.5	Brown.	48.50	48.00	3.5	51.50	8171	1515.
268	Barr & Bro., middle	L	1.282	80.12	48.50	2.5	Brown.	51.00	45.00	4.0	49.00	8095	1502.
269	Barr & Bro., lower	L	1.278	79.87	48.50	3.0	Light red.	48.50	47.00	4.5	51.50	8280	1536.
270	R. L. Crosley	L	1.267	79.17	47.50	4.0	Red.	51.50	45.00	3.5	48.50	8014	1487.
271	Lewisport	I	1.294	78.06	47.50	1.0	White.	48.50	47.50	4.0	51.50	8246	1529.

272	Rockport		1.275	79.68	49.50	4.0	White.	53.50	40.00	6.5	46.50	7712	1431.
273	L. G. Smith		1.232	77.00	45.50	1.5	White.	47.00	47.00	6.0	53.00	8038	1491.
274	Staal's coal	I	1.237	77.31	47.20	3.5	Gray.	50.70	44.30	5.0	49.30	7927	1470.
275	Staal's coal (Col. J. W. Foster)	I	1.243	77.68	54.00	1.6	White.	55.60	42.60	1.8	44.40	8307	1541.
276	Stocking's coal		1.267	79.18	46.60	3.0	Brown.	49.60	47.90	2.5	50.40	8212	1523.
277	Woods' coal	I	1.289	80.56	48.00	3.5	Brown.	51.50	45.50	3.0	48.50	8101	1503.
278	H. B. Kittaen	A	1.244	77.75	46.50	2.0	White.	48.50	47.00	4.5	51.50	8119	1506.
279	Kathman, upper	A	1.250	78.12	45.50	2.0	White.	47.50	48.50	4.0	52.50	8084	1500.
280	Kathman, lower	A	1.251	78.18	47.50	2.5	White.	50.50	45.00	5.0	50.50	8014	1487.
281	Abbott of St. Meinrod	F	1.265	79.06	50.50	5.0	Brown.	55.50	39.00	5.5	44.50	7690	1427.

Analyses of Coals, Sullivan County. Geological Report of Indiana, 1870, *E. T. Cox.*

282	Chambers	N	1.206	75.37	48.50	2.0	Brown.	50.50	45.00	4.5	49.50	8095	1502.
283	B. & L. Burk	M	1.210	75.62	51.00	1.5	White.	52.50	44.00	3.5	47.50	8204	1522.
284	Dicks, upper	M	1.258	78.62	50.50	1.5	White.	52.00	43.50	4.5	48.00	8117	1505.
285	Dicks, middle	M	1.252	78.25	55.80	0.5	White.	55.30	39.20	4.5	44.70	8144	1510.
286	Dicks, lower	M	1.278	79.05	52.00	2.5	Red.	54.50	42.00	3.5	45.50	8099	1502.
287	Hanna, Standard	L	1.281	80.06	54.00	2.5	Gray.	56.50	40.50	3.0	43.50	8122	1506.
288	Pigg's coal	M	1.271	79.43	49.00	2.5	Red.	51.50	42.50	6.0	48.50	7903	1466.
289	St. Johns	M	1.287	80.43	49.00	2.5	White.	51.50	45.00	3.5	48.50	8135	1509.
290	Henry K. Wilson	M	1.228	76.75	51.60	0.8	White.	52.40	45.25	2.35	47.60	8360	1551.
291	H. Wilson, Cass Tp.	M	1.249	78.06	52.00	2.0	Blue.	54.00	43.00	3.0	46.00	8192	1520.
292	Curryville Shaft	L	1.282	80.12	51.50	1.0	Red.	52.50	43.50	4.0	47.50	8198	1521.
293	Richards & Buckley, top	L	1.278	79.05	51.50	2.5	Red.	54.00	43.00	3.0	46.00	8152	1513.
294	Richards & Buckley, middle	L	1.284	80.25	50.25	2.0	Cream.	52.25	44.75	3.0	47.75	8213	1505.
295	Richards & Buckley, bottom	L	1.296	81.00	53.70	2.8	Red.	56.50	39.75	3.75	43.50	8011	1486.
296	Standard Coal Company	L	1.333	83.31	55.20	2.9	White.	58.10	40.10	1.8	41.90	8155	1513.

Analyses of Coals, Sullivan County. Geological Report of Indiana, 1871–'75, E. T. Cox.

	NAME OF MINE OR OWNER.	Specific Gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam value. See page 10.
297	Curryville, upper part	. . . .	. . . .	56.50	2.50	White.	59.00	36.50	4.5	41.00	**7952**	1475.
298	Curryville, middle	. . . .	. . . .	53.50	1.50	White.	55.00	40.00	5.0	45.00	**8035**	1490.
299	Curryville, lower	. . . .	. . . .	52.50	3.00	White.	55.50	40.00	4.5	44.50	**7954**	1476.
300	Dicks' coal, five years out of mine	1.239	77.43	55.00	1.5	White.	56.50	40.00	3.5	43.50	8114	1505.
301	Dicks' coal, fresh from mine	1.258	78.62	50.50	1.5	White.	52.00	43.50	4.5	48.00	8071	1497.

Analyses of Coals, Vanderburg County. Geological Report of Indiana, 1875, E. T. Cox.

302	Ingleside . . . L	1.275	79.68	53.50	4.0	Red.	57.50	39.00	3.5	42.50	7901	1466.
303	Ingleside, top . . . M	1.273	79.56	44.00	13.5	White.	57.50	39.50	3.0	42 50	7179	1332.
304	Ingleside, middle . . . M	1.275	79.68	48 50	6.0	White.	54.50	42.00	3.5	45.50	7772	1442.
305	Ingleside, bottom . . . M	1.336	83.50	46.00	11.0	White.	57.00	39.50	3.5	43.00	7341	1363.

Analyses of Coals, Vermillion County. Geological Reports of Indiana, 1869–'75, E. T. Cox.

306	Grove's mine . . . L	1.289	80.50	47.70	4.5	. . . .	52.20	44.30	3.5	47.80	**7965**	1478.
307	Charles Moore	1.258	78.62	46.00	4.5	Flesh.	50.50	44.00	5.5	49.50	7751	1438.

Analyses of Coals, Vigo County. Geological Reports of Indiana, 1870–'75, E. T. Cox.

308	Foote's coal, Honey Creek	1.217	76.06	50.10	1.8	Brown.	51.90	44.40	3.7	48.10	8168	1515.
309	Titcomb's coal, Grant. L?	1.257	78.56	46.50	2.5	White.	49.00	48.00	3.0	51.00	8212	1523.
310	Roof of Titcomb's coal	1.493	93.50	39.00	32.0	Fawn.	71.00	25.00	4.0	29.00	5471	1013.
311	Arbuckle & Budd, Seelyville, top	1.211	75.68	48.00	3.5	White.	51.50	45.00	3.5	48.50	8007	1485.
312	Arbuckle & Budd, Seelyville, bottom	1.250	78.12	50.00	3.5	White.	53.50	43.50	3.0	46.50	8031	1490.
313	Barrick & Sons	1.192	74.50	48.20	4 3	Red.	52.50	44.50	3.0	47.50	8000	1484.
314	H. Brayton, Grant	1.216	76.00	44.00	8.5	Red.	52.50	44.00	3.5	47.50	7592	1409.
315	Foote's bore.	1.217	76.06	50.10	1.8	Brown.	51.90	44.40	3.7	48.10	8123	1507.
316	P. H. Holloman	1.242	77.62	42.00	12.5	White.	54.50	42.00	3.5	45.50	7247	1344.
317	G. W. Mooreland	1.195	74.70	47.50	4.5	Red.	52.00	43.50	4.5	48.00	7829	1452.
318	A. McPherson	1.239	77.43	56.50	4.0	White.	60.50	37.00	2.5	39.50	7959	1477.
319	McQuilkins	1.210	75.62	47.50	3.5	White.	51.00	44.50	4.5	49.00	7921	1469.
320	F. Rhyan	1.226	76.62	48.50	6.0	Flesh.	54.50	43.50	2.0	45.50	7910	1467.
321	Somerset Coal Co	1.210	75.62	51.00	1.5	White.	52.50	43.00	4.5	47.50	8066	1496.
322	Webster & Bramwell, top	1.197	74.81	48.00	3 0	Purple.	51.00	46.00	3.0	49.00	8098	1503.
323	Webster & Bramwell, bottom	1.210	75.62	47.50	4.0	Red.	51.50	45.50	3.0	48.50	8013	1487.
324	Wyeth, Hartford, top	1.237	77.31	49.00	7.5	White.	56.50	41.00	2.5	43.50	7721	1432.
325	Wyeth, Hartford, bottom	1.216	76.00	51.00	4.5	White.	55.50	42.00	2.5	44.50	7974	1479.

Analyses of Coals, Warrick County. Geological Reports of Indiana, 1870–'75, E. T. Cox.

326	Locust Grove, No. 1 I	1.300	81 25	47.50	14.0	Brown.	61.50	34.50	4.0	38.50	7040	1306.
327	Locust Grove, No. 2 I	1.279	79.93	50.50	2.0	White.	52.50	44.50	3.0	47.50	8210	1523.
328	Locust Grove, No. 3 I	1.313	82.06	46.00	7.0	Brown.	53.00	45.00	2.0	47.00	7893	1465.
329	Locust Grove, No. 4 I	1.282	80.31	50.50	2 5	White.	53.00	44.50	2.5	47.00	8210	1523.
330	Chandler's, top. M	1.274	79.62	47.50	9.0	White.	56.50	40.00	3.5	43.80	7508	1392.
331	Chandler's, middle. M	1.282	80.12	49.50	5.5	White.	55.00	41.50	3.5	45.00	7808	1449.
332	Chandler's, bottom. M	1.283	80.18	45.00	16.5	White.	61.50	34.50	4.0	38.50	6801	1262.
333	Millersburg, middle N	1.242	77.62	53.00	2.5	Blue.	55.50	41.50	3.0	44.50	8090	1501.
334	Millersburg, bottom N	1.243	77.68	49.00	2.0	Brown.	51.00	45.50	3.5	49.00	8042	1492.

· *Analyses of Coals, Warren County. Geological Report of Indiana,* 1873, *E. T. Cox.*

	NAME OF MINE OR OWNER.		Specific Gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.
335	John Briggs, coal	K	1.212	75.75	48.50	2.0	Flesh.	50.50	44.75	4.75	49.50	8071	1497.
336	J. T. Briscoe, upper	L	1.223	76.44	57.50	7.0	Gray.	64.50	32.00	3.50	35.50	7616	1413.
337	J. T. Briscoe, middle	L	1.267	79.18	54.70	8.0	Blue.	62.70	33.80	3.50	37.30	7559	1402.
338	J. T. Briscoe, lower	L	1.350	84.37	52.25	16.0	Blue.	68.25	28.75	3.0	31.75	6890	1278.
339	R. W. Claypool, upper	L	1.246	77.87	48.50	10.0	Red.	58.50	38.50	3.0	41.50	7491	1390.
340	R. W. Claypool, middle	L	1.204	75.87	55.50	2.5	White.	58.00	38.00	4.0	42.00	8011	1486.
341	R. W. Claypool, lower	L	1.205	75.31	54.50	8.5	Brown.	63.00	34.00	3.0	37.00	6751	1253.
342	R. W. Claypool	M	....	....	48.00	3.5	Brown.	51.50	45.00	3.5	48.50	8050	1493.
343	Goodrick	M	1.343	83.93	45.00	9.5	Red.	54.50	39.50	6.0	45.50	7302	1355.
344	Goodrick, upper	L	1.304	81.50	46.50	8.5	Purple.	55.00	42.00	3.0	45.00	7655	1420.
345	Goodrick, lower	L	1.262	78.87	46.00	4.5	Flesh.	50.50	46.50	3.0	49.50	8032	1490.
346	Hooper & Barringer, upper	L	1.238	77.37	59.00	2.5	White.	61.50	34.50	4.0	38.50	7967	1478.
347	Hooper & Barringer, lower	L	1.236	77.35	56.00	2.5	White.	58.50	35.00	6.5	41.50	7773	1442.
348	Harold & Co., upper	L	1.282	80.15	54.00	6.5	Red.	60.50	36.00	3.5	39 50	7704	1429.
349	Harold & Co., middle	L	1.290	80.62	49.50	7.5	White.	57.00	38.50	4.5	43.00	7572	1405.
350	Harold & Co., lower	L	1.252	78.25	56.00	3.5	White.	59.50	31.00	9.5	40.50	7401	1373.
351	Jarvis, upper	K	1.243	77.68	50.50	6.5	Red.	57.00	38.00	5.0	43.00	7607	1411.
352	Jarvis, middle	K	1.251	78.18	53.50	3.0	White.	56.50	40.75	2.75	43.50	8104	1504.
353	Jarvis, lower	K	1.348	84.25	51.50	12.0	White.	63.50	33.00	3.5	36.50	7183	1333.
354	Luppoldt, upper	L	1.222	76.37	49.00	9.5	Red.	58.50	37.00	4.5	41.50	7386	1370.
355	Luppoldt, middle	L	1.254	78.37	52.50	9.0	Red.	61.50	33.50	5.0	38.50	7351	1364.

356	Luppoldt, lower	L	1.256	78.50	57.00	4.5	White.	61.50	35.50	3.0	38.50	7900	1465.
357	Schoonover, upper	K	1.284	80.25	49.40	9.5	Red.	58.90	37.60	3.5	41.10	7480	1488.
358	Schoonover, lower	K	1.229	76.81	55.25	6.25	Red.	61.50	34.00	4.8	38.50	7640	1417.
359	John Thomas	M	1.415	88.43	49.50	12.5	Red.	62.00	33.50	4.5	38.00	7108	1318.
360	Tinker & Co., upper	L	1.257	78.56	50.00	3.5	Red.	53.50	43.50	3.0	46.50	8077	1405.
361	Tinker & Co., middle	L	1.282	80.12	47.00	3.0	Blue.	50.00	44.50	5.5	50.00	7927	1278.
362	Tinker & Co., lower	L	1.244	77.75	50.50	5.0	Red.	55.50	42.50	2.0	44.50	8024	1489.

Analysis of Coals, Posey County. Geological Report of Indiana, 1875, *E. T. Cox.*

363	G. Heldfert, St. Wendells	1.327	82.93	51.00	5.5	Brown.	56.50	39.50	4.0	43.50	7745	1437.

Analyses of Peat, Northern Counties. Geological Report of Indiana, 1869–'70–'71, *E. T. Cox.*

364	Peat from St. Joseph county	....	....	26.50	9.5	Yellow.	36.00	55.50	8.5	64.00	7292	1353.
365	Peat from Lake county	....	....	21.50	23.0	Buff.	42.50	51.25	6.25	57.50	6493	1202.

Analyses of Indiana Coals, by Dr. David Dale Owen, in 1838.

								Car.	Bit.			
366	Fountain County, Sugar Creek Foundry	1.219	76.18	43.90	3.5	White.	47.40	75.00	20.00	52.60	7916	1468.
367	Fountain County, Coal Creek	1.260	78.75	44.60	15.0	Brown.	59.60	60.00	25.00	40.40	7168	1330.
368	Vermillion County, Brouillet's Creek	1.270	79.37	42.00	9.0	Yellow.	51.00	52.00	39.00	49.00	7821	1451.
369	Sullivan County, Lick Fork	1.240	77.50	54.90	2.0	White.	56.90	70.00	28.00	43.10	8254	1531.
370	Vigo County, Honey Creek	1.240	77.50	46.10	2.5	White.	48.60	70.00	27.50	51.40	8208	1523.

Analyses of Indiana Coals by Prof. Richard Owen in 1859–'60.

	NAME OF MINE OR OWNER.	Specific Gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.
371	Clay County, Brazil shaft			44.0	3.0	White.	47.0	48.0	5.0	53.0	8010	1486.
372	Clay County, Staunton			55.0	1.0	Gray.	56.0	39.0	5.0	44.0	8063	1496.
373	Dubois County, Portersville			50.0	5.0	Gray.	55.0	39.0	6.0	45.0	7659	1421.
374	Dubois County, Celestine			53.0	3.0	Gray.	56.0	39.0	5.0	44.0	7902	1466.
375	Dubois County, S. H. Jacobs			55.0	3.0	Gray.	58.0	34.0	8.0	42.0	7599	1410.
376	Fountain County, N. Thomas			51.5	4.5	....	55.0	37.0	8.0	45.0	7595	1409.
377	Greene County, T. Hays			53.0	2.0	Gray.	55.5	36.0	8.5	44.5	7623	1415.
378	Harrison County, M. Smith's			54.5	4.0	Gray.	58.5	31.5	10.0	41.5	7327	1359.
379	Harrison County, A. Rosenberg			41.2	10.0	Red.	51.2	46.8	2.0	48.8	7674	1423.
380	Harrison County, Houghton's			48.7	12.0	Red.	60.7	30.3	9.0	39.3	6749	1252.
381	Harrison County, Leavenworth			40.0	20.0	Red.	60.0	29.0	11.0	40.0	5923	1100.
382	Orange County, Powell's			50.4	7.0	Gray.	57.4	35.6	7.0	42.6	7375	1368.
383	Parke County, W. G. Coffin			49.0	3.0	Gray.	52.0	42.0	6.0	48.0	7857	1457.
384	Parke County, J. W. Campbell			49.0	2.0	Brown.	51.0	42.0	7.0	49.0	7857	1457.
385	Perry County, Cannelton			50.0	3.0	Light.	53.0	39.0	8.0	47.0	7659	1421.
386	Pike County, Hughes			51.0	5.0	Dark.	56.0	38.0	6.0	44.0	7647	1418.
387	Pike County, Rhodes			54.5	1.0	Red.	55.5	30.0	14.5	44.5	7187	1333.
388	Posey County, Priest			42.0	19.0	....	61.0	36.0	3.0	39.0	6734	1250.
389	Spencer County, Woods			48.0	3.5	....	51.5	45.0	3.5	48.5	8054	1494.
390	Vermillion County, Bell & Groves			54.0	3.0	Red.	53.0	33.0	10.0	47.0	7426	1278.
391	Warren County, Burr's Mill			40.0	15.0	Gray.	55.0	40.0	5.0	45.0	6944	1289.
392	Warren County, Kiester's			51.5	6.5	White.	58.0	40.0	2.0	42.0	7873	1461.

Analyses of Ohio Coals by Prof. Womley. Geological Report of Ohio, "Vol. III, Geology."

393	Hocking Valley, Stallsmith Seam	1.254	....	51.85	4.14	....	55.99	36.41	3.8	40.21	**7566**	1403.
394	Straitsville, "Great Seam"	1.270	....	59.61	3.04	....	62.65	31.37	5.98	31.37	**7727**	1433.
395	Keith's Mine, Coshocton County	1.339	....	54.70	5.10	....	59.80	32.20	4.00	36.20	**7408**	1375.
396	Steubenville, Jefferson County	1.308	....	65.90	1.80	....	67.70	29.50	1.40	30.90	**8062**	1496.
397	Briar Hill or Mahoning Valley coal	1.284	....	62.66	1.16	....	63.82	32.58	3.60	36.10	**8086**	1500.

Jackson coal, Star shaft (Womley), specific gravity, 1.267; water, 7.50; ash, 4.10; volatile matter, 30.90; fixed carbon, 57.50; heat units, 7513.5; gallons of water from 100° to steam at atmosphere pressure, 1391.

Jackson coal, Star shaft (Levette), specific gravity, 1.270; coke, 64.50; volatile matter, 35.50; ash, 6.00; fixed carbon, 58.50; gas, 30.00; water, 5.50; heat units, 7510.8; gallons of water from 100° to steam at atmosphere pressure, 1391.

Analyses of Kentucky Coals by Dr. Peters. Geological Report of Kentucky, Vol. 1, 1875.

398	Boyd County, Buena Vista Furnace	1.328	....	52.78	6.82	....	59.60	33.90	6.50	40.40	**7408**	1375.
399	Carter County, Star Furnace, bottom	1.288	....	54.64	4.40	....	59.04	34.36	6.60	40.96	**7634**	1416.
400	Greenup County, Amanda Furnace	1.335	....	53.34	9.00	....	62.34	33.62	4.04	37.66	**7424**	1278.
401	Muhlenburg County, Airdrie Furnace	1.278	....	58.50	6.50	....	65.00	31.40	3.60	35.00	**7650**	1419.

Analyses of Pennsylvania Coals by A. S. McCreath. Pa. 2d Geol. Survey, Vol. M.M.

	NAME OF MINE OR OR OWNER.	Specific Gravity.	Lbs. Weight of 1 Cubic Foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.
402	Washington County, "Pittsburg bed"	...	...	51.46	8.89	Gray.	60.35	36.77	0.77	37.54	7569	1404.
403	Westmoreland County, "Pittsburg bed"	...	...	65.52	5.76	Gray.	71.28	25.20	1.27	26.47	7630	1415.
404	Tioga County, "Blossburg Coal"	...	...	71.69	5.34	Gray.	76.03	20.75	1.19	21.94	7718	1431.
405	Greene County, "Pittsburg bed"	...	...	59.05	2.60	Cream.	61.65	36.49	1.03	37.52	8151	1512.
406	Fayette County, "Pittsburg bed"	...	...	61.84	4.56	Gray.	66.40	31.84	1.20	33.04	7951	1475.
407	Westmoreland County, gas coal	...	...	59.29	2.89	Cream.	62.18	35.36	1.78	37.14	8066	1496.
408	Bedford County, "Broad Top Coal"	1.330	...	74.65	7.50	...	...	17.55	0.30	...	7660	1421.
409	Lehigh, anthracite	...	...	88.05	6.66	...	94.71	2.94	2.34	5.28	7387	1400.

Analyses of Missouri Coals by R. Chauvenet. Geological Survey Missouri, Broadhead.

410	Barton County, H. Flack's	...	...	58.71	5.36	Purple.	64.07	34.04	1.89	35.93	7902	1466.
411	Vernon County, Cassell's	...	...	53.91	5.12	Gray.	59.03	38.39	2.58	40.97	7917	1469.
412	Bates County, Hecadon's	...	...	49.72	2.78	Pink.	52.50	44.93	2.57	47.50	8149	1511.
413	Sullivan County, Sodder's	...	...	50.03	4.92	Brown.	54.95	37.37	7.68	45.05	7507	1393.
414	Adair County, Williams	...	...	49.69	6.19	White.	55.88	38.99	5.13	44.12	7675	1423.

Analyses of Iowa Coals by Rush Emery. Geological Report, Iowa, White, 1869.

	NAME OF MINE OR OWNER.	Specific Gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.	
415	Monroe Co., Miller's mine	....	....	51.30	6.15	....	57.45	37.84	4.71	42.55	7556	1402.	
416	Marion Co., Bousquest's mine.	....	....	47.54	3.32	....	50.86	43.25	5 89	49.14	7854	1457.	
417	Mahaska Co., Burtis' mine	....	....	48.00	4.50	....	52.50	42.27	5.23	47.50	7801	1447.	
418	Wapello Co., Inskeep's mine.	....	....	49.15	4.02	....	53.17	42.96	3.87	46.83	7969	1478.	
419	Hardin Co., Buckner's mine	....	....	44.72	4.82	....	49.54	42.54	7.92	50.46	7559	1402.	
420	Average of sixty-four samples (Prof. White)	....	....	45.42	6.77	....	....	39.24	8.57	....	7341	1362.	

Analyses of Illinois Coals.

	NAME OF MINE OR OWNER.	Specific Gravity.	Lbs. Weight of one cubic foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value.	
421	Jackson Co., "Big Muddy" coal.	....	....	60.80	1.50	....	62.30	31.20	6.50	37.70	7808	1448.	James Macfarlane.
422	Vermillion Co., Danville	1.357	84.81	46.78	8.64	Brown.	55.42	40.58	4.00	44.58	7545	1400.	Geo. Rep. Ind., 1870.
423	Peoria Co	1.243	77.68	58.60	2.80	Gray.	61.40	25.80	12.80	38.60	7202	1337.	Blaney, Econ. Geo. Ill., vol. 1.
424	LaSalle Co	1.243	77.68	55.00	7.60	Fawn.	62.60	27.40	10.00	37.40	6989	1297.	Blaney, Econ. Geo. Ill., vol. 1.
425	Grundy Co	1.259	78.48	58.20	1.80	Gray.	60.00	29.20	10.80	40.00	7412	1375.	Blaney, Econ. Geo. Ill., vol. 1.
426	Randolph	1.278	79.68	58.20	5.20	Lilac.	63.40	26.60	7.00	36.60	7171	1331.	Blaney, Econ. Geo. Ill., vol. 1.

Analyses of Coals from Other States and Territories.

	NAME OF MINE OR OWNER.	Specific Gravity.	Lbs. Weight of 1 Cubic Foot.	Fixed Carbon.	Ash.	Color of Ash.	Coke.	Gas.	Water.	Total volatile matter.	Units of Heat.	Steam Value. See page 10.	
427	Alabama, DeKalb Co	....	....	57.42	6.31	....	....	35.51	0.76	....	7935	1472.	Alabama 2d Geo. Rep.
428	Michigan, Eaton Co	....	....	45.00	2.00	....	....	49.00	2.00	....	8183	1518.	
429	Arkansas, Yell Co	....	....	80.40	5.20	....	....	11.40	3.00	....	7555	1402.	Dr. D. D. Owen.
430	North Carolina	....	....	70.48	6.46	....	....	21.90	1.16	....	7727	1434.	
431	Colorado, Golden City	1.320	....	45.57	3.85	Gray.	....	37.15	13.43	....	7129	1323.	W. P. Blake.
432	Colorado, Boulder Co	1.330	....	49.72	5.20	Gray.	....	33.08	12.00	....	7087	1315.	W. P. Blake.
433	Colorado, Canon City	1.279	79.23	56.80	4.50	Yellow.	61.30	34.20	4.50	38.70	7763	1441.	Geo. Rep. Ind., 1870.
434	Colorado, Fair Play	1.254	78.37	55.58	2.00	Fawn.	57.58	37.92	4.50	42.40	8010	1486.	Geo. Rep. Ind., 1870.
435	Colorado, San Miguel, Ouray Co	1.314	82.12	39.50	10.50	Brown.	50.00	40.50	9.50	50.00	6950	1290.	G. M. Levette, 1881.
436	Colorado, LaPlatte Co	1.296	81.00	45.75	5.25	Orange.	51.00	37.50	11.50	49.00	7177	1331.	G. M. Levette, 1881.
437	Utah Territory, Evanston	1.300	....	49.90	6.30	....	....	35.22	8.58	....	7300	1354.	W. P. Blake.
438	Wyoming Territory, Carbon	1.330	....	49.72	8.00	....	....	35.48	6.80	....	7310	1356.	W. P. Blake.
439	West Virginia, Coalburg	1.257	78.56	56.00	1.50	White.	57.50	40.50	2.00	42.50	8283	1537.	Ind. Geo. Rep., 1870.
440	West Virginia, Campbell Cr'k	1.290	80.62	57.00	2.50	Red.	59.50	38.00	2.50	40.50	8131	1508.	Ind. Geo. Rep., 1870.
441	West Virginia, Peytona, cannel	1.322	82.62	59.50	3.50	White.	63.00	34.50	2.50	37.00	8009	1486.	Ind. Geo. Rep., 1870.
442	Texas, Robertson Co., lignite	1.232	77.00	45.00	4.50	White.	49.50	39.50	11.00	50.50	7260	1347.	Ind. Geo. Rep., 1875.
443	California, Mt. Diablo, lignite	....	....	46.84	4.58	....	....	33.89	14.69	....	6929	1286.	Dr. J. S. Newberry.
444	Oregon, Coos Bay, lignite	....	....	41.98	5.34	....	....	32.59	20.09	....	6417	1188.	Dr. J. S. Newberry.
445	Alaska, Cook's Inlet, lignite	....	....	49.89	7.82	....	....	39.87	1.25	....	7731	1434.	Dr. J. S. Newberry.
446	Vancouver's Island, Naminn.	....	....	46.31	18.55	....	....	32.16	2.98	....	7712	1430.	Dr. J. S. Newberry.
447	Newcastle, England	....	....	61.70	3.75	....	....	33.55	0.99	....	8090	1501.	
448	New Brunswick, Albertite	....	....	42.00	1.00	....	....	57.00	....	....	8683	1608.	
449	Crude Petroleum, Pa	Carbon, 84 per cent.; Hydrogen, 13.75 per cent.; Water, 2.25									11526	2134.	H. Wurtz.

COMPARISON OF INDIANA BLOCK COALS WITH ILLINOIS COALS.

The following exhibit of fuel values of Indiana coals and those of Illinois, prepared by Prof. E. T. Cox, in 1876, has never been officially published. The present State Geologist has pleasure in availing himself of the labors of his efficient predecessor:

H. G. Sleight, Indianapolis:

DEAR SIR—The following is the result of the analyses, made in the laboratory of the State Geologist, of the three samples of coal which you brought to me for that purpose:

No. 1. Block coal. Taken at random from a car load, shipped from Brazil, Clay county, Ind.

No. 2. From Wilmington, Ill., on the Chicago & Alton R. R. Sample taken from the delivery at Chicago.

No. 3. Minonk Coal, Ill., on the Illinois Central R. R. Also taken from the delivery at Chicago.

No. 1 is an ordinary sample of block coal. No. 2 is a glossy, jet-black caking coal, with specks and scales of pyrites. No. 3 is a very brilliant black caking coal, which, when broken, shows numerous markings of sulphide of iron.

A large lump of each sample was reduced to fine powder and kept, well stoppered, in separate bottles. From these bottles, which contained proper average samples of the coals, the quantities were taken necessary to complete the separate processes to which a coal must be subjected in order to point out its commercial value. For convenience, these coals will now be referred to by the numbers given above. The results are given in 100 parts of coal:

NO. ONE. INDIANA BLOCK COAL.

Specific gravity, 1.285. A cubic foot weighs 80.31 lbs.

Ash, white	2.50	Coke, 59.00 per cent.
Fixed carbon	56.50	
Volatile matter	32.50	
Water	8.50	
	100.00	

Iron	0.82
Alumina	1.20
Silica, lime and magnesia	0 48
Ash	2.50

Total sulphur. 1.43. The iron is combined with 0.947 of sulphur, leaving 0.483 of sulphur combined with the other constituents of the ash and carbon. This coal contains 7424 calculated heat units, and one pound will convert 11.4 pounds of water from 0° Cent. (32° Fahr.) into steam at 100° Cent. (212° Fahr.).

NO. TWO. WILMINGTON COAL.

Specific gravity, 1.248. A cubic foot weighs 78 lbs.

Ash, red	6.50	Coke, 52.50 per cent.
Fixed carbon	46.00	
Volatile matter	37.00	
Water	10.00	
	100.00	

Total amount of sulphur in this coal, 4.74 per cent. Iron 4.34 per cent.=9.298 of pyrites; this would be in excess of the sulphur, so that all the iron does not exist as sulphide. The ash is composed of iron 4.34; silica, 2.16.

This coal contains, by calculation, 6762 units of heat. One pound will convert 10.4 pounds of water from 0° Cent. (32° Fahr.) into steam at 100° Cent. (212° Fahr.).

NO. THREE. MINONK COAL.

Specific gravity, 1.232. A cubic foot weighs 77 lbs.

Ash, brown	5.50	Coke, 53.50 per cent.
Fixed carbon	48.00	
Volatile matter	35.00	
Water	11.50	
	100.00	

Total sulphur, 3.63 per cent. Sulphur combined with iron, 2.719. Sulphur combined with other mineral matter, 0.911.

Composition of ash.	Iron	2.38
	Alumina	0.80
	Silica	2.32

This coal contains 6756 calculated heat units. One pound will convert 10.3 pounds of water from 0° Cent. (32° Fahr.) into steam at 100° Cent. (212° Fahr.).

From this it will be seen that one ton of the Indiana block coal will convert into steam, from 0° Cent. (32° Fahr.) to 100° Cent. (212° Fahr.) 22,800 pounds of water, while the Illinois coals will only convert into steam, under the same conditions, 20,800; a difference of 2,000 pounds in favor of the block coal, or nearly eight barrels.

In addition to its superior heat-producing properties, the Indiana block coal contains a minimum quantity of sulphur and ash, while the other coals contain these injurious diluents in great excess.

I need hardly dwell upon the injurious effect which the sulphur exerts upon grate-bars, fire-boxes and boilers, where it is used for generating steam, since it is well known to all intelligent engine drivers that when sulphur is brought in contact with red-hot iron it causes it to fuse or lose its tenacity; thus, the sulphur from coal will destroy the grate-bars, fire boxes, and, sooner or later, the boilers themselves.

The pyritiferous ash of the Illinois coals will also give great trouble, since it will fuse into clinkers, which, by their rapid accumulation, stop the draft, and otherwise derange the perfect combustion of the coal, so that frequent stops must be made, or favorable moments taken, to remove them from the fire-chamber. On passenger trains, using such coals, much inconvenience is also experienced by the passengers, who are compelled to inhale the sulphurous fumes which escape from the smoke-stack and are wafted back into the coaches by the motion of the train.

No inconsiderable part of the commercial value of a coal depends upon its strength and resistance to atmospheric agencies, which cause it to crumble and waste when stocked. In this respect, again, the Indiana block coal will endure stocking for years without deterioration or loss from crumbling, while the Illinois coals will crumble into dust from the decomposition of sulphide of iron which it contains in such large quantities. It is given in Trautwine's "Engineers' Pocket Book," that 4.47 tons of water will carry a passenger train twenty to thirty miles, or even more if the grades are light. Then, assuming for the sake of comparison that the evaporation of 4.47 tons of water will run a given train twenty-five miles, one ton will run it 5.7 miles. Now, a ton of Indiana block coal will convert into steam one ton more water than the Illinois coal; consequently, it will, under like conditions, run a train 5.7 miles further than the Wilmington or Minonk coals—a difference of more than twenty per cent. in favor of Indiana coal. Indeed, so different is the Indiana block coal from the Illinois coals here reported on, chemically and physically, that they can not rightly come in competition for steam and house purposes, where a due regard is paid to economy of fuel, safety to machinery, comfort and health.

E. T. COX, *State Geologist.*

INDIANAPOLIS, March, 1876.

ECONOMIC GEOLOGY OF THE STATE.*

Indiana has been bounteously endowed by nature. In other regions rich in ore, coal and stone, the soil is usually thin and unproductive, or, *vice versa*, fertile lands are not rich in mineral treasure: but here in Indiana, a bountiful and inexhaustible supply of mineral wealth is overlaid by the richest of soils; and with cheap and abundant food, cheap homes, cheap wood and coal for fuel, and good clays, sands, and the finest of building material, she offers to the farmers, laborers, mechanics and manufacturers a share of her abundant blessings, resources richer and more useful to humanity than gold or silver or precious stones.

BUILDING STONE.

The rocks of the State contribute largely to her wealth, for they contain some of the finest building stone in the country, and the supply, comparatively undeveloped yet, is practically inexhaustible. The excellent qualities, durability and beauty of these Indiana stones are just beginning to be recognized for building purposes throughout the country, and the quarrying interests promise to become an important feature in the products of the State, in the near future. This stone is being extensively used in some of the most expensive and imposing buildings throughout the country, and the demand is increasing as it becomes better known. During the year 1880, the capital invested in the operation of quarries was $613,500, and the output of material was 8,413,827 cubic feet, worth $633,775, or about $20,000 more than the total capital employed. To effect this result required the labor of 1,788 men and 545 horses, and the use of 13 steam channellers in quarrying; 107 derricks and cranes in hoisting; 14 saw mills and 42 gangs of saws (3 per mill), in dressing; while 5,727,225 cubic yards of space were excavated, in doing which $2,300 worth of powder and dynamite was used.

As to the geographical division of the quarrying interest, Southeastern Indiana supplies a large quantity of stone for foundations and rubble masonry, from the bluffs along the Ohio River, and extending through Wayne, Union, Fayette, Franklin, Dearborn, Ohio and Switzerland, west to Clark county; besides being found to some extent in the counties adjoining these to the west, which are included in the Lower Silurian geological range.

*Republished from my Report of 1882, by frequent request.

The close-grained, compact, magnesian limestones are largely quarried in the counties bordering the above on the west, forming a belt extending northward from the Ohio to the Wabash River in Carroll, Cass, Miami, Wabash and Huntington, and to some extent in the counties north and west of these. This stone, which belongs to the Upper Silurian age, lies in even beds, having a thickness of from a few inches to two or more feet, and is especially adapted to work in foundations, piers, abutments, and massive range work where great strength is required. The thinner strata of this stone furnish, at a low cost, excellent slabs, flags and curbstones, etc., since it comes from the quarries with bed and top ready dressed by nature. The economy in its use is apparent.

A very popular stone among engineers and bridge builders is the North Vernon blue limestone, a good sample of which, as a bridge building material, may be seen in the new bridge of the C. & I. Air Line across Broad Ripple, north of Indianapolis. This stone is quarried extensively in Jennings and Jefferson counties.

Quantities of blue and buff Oolitic stone of superior quality for building purposes are quarried in Monroe county. These strata are from six to twenty feet thick, from whence one firm alone, Messrs. Dunn & Dunn, has been shipping their entire output to Chicago and Joliet, Ill. It is there sawed into thin slabs, matched and polished, and finds a large and growing demand for mantels, table-tops, pilasters, wainscots, and interior ornaments and decorations where handsome neutral tints are required.

From Warren county, on the north, to the Ohio River, in a widening range, the valuable limestones of the Keokuk group, the sandstones of the Chester, and Oolitic limestones of the intermediate St. Louis group, are quarried; while the basal conglomorate sandrock, found in a wide belt from Warren county to the Ohio, contains an unlimited supply of strong, fire, water, and frost proof stone, very suitable for piers, foundations, etc.

But by far the most beautiful and valuable stone for architectural purposes is the Oolitic limestone of Lawrence, Monroe, Owen, Crawford, Harrison and Washington counties. The supply is simply inexhaustible, as it lies in massive strata of from twenty to seventy feet thick, over an area of more than fifty square miles.

These strata are homogeneous, equally strong in vertical, diagonal or horizontal sections. The stone comes from the quarry so soft as to be readily worked by saw, chisel or planing machine, while on exposure it hardens to a strength of from 10,000 to 12,000 pounds to the square inch—a strength amply sufficient to sustain the weight of the largest structure in the world. In use it presents a handsome, creamy brown appearance, gradually whitening with age. It is of almost unprecedented purity, containing an average of 96.8 per cent. of carbonate of lime, a purity rarely, if ever, surpassed, and scarcely equaled, in the world. Hence its advantage over the magnesian limestones, as it is not affected by decay in an atmosphere charged with the gases of burning stone coal. In natural outcrop it presents bold perpendicular faces to the elements, showing every scratch and mark, unaffected after the exposure of thousands of years, as no other stone or rock does.

It is quarried by steam channelers, which carve it out in prisms six by ten, fifty or one hundred feet long, putting to shame the boasted prodigies of Egyptian story and effort. It is then rapidly sawed into blocks and dimension forms, and steam-planers carve, mold and smooth it like clay or wood, and more accurately than mallet and chisel. It is now fit to be carved and polished into the freest kind of sculptured and ornamental work.

Ready for the mason or sculptor, it is alive and resonant, answering with a clear metallic ring each touch or blow. This resonance is an excellent test of the perfect unity of its particles, and as a result it is highly elastic, bending under pressure and rebounding to place when relieved from it. This elasticity enables Indiana Oolitic limestone to adapt itself without cleavage or disintegration to our changeable climate, where material will be frequently subject to a change of from 20° to 60° of temperature in a few hours; as in large buildings, the outside will be subject to a temperature of 25° below zero in winter, or 120° above it in summer, while the inside will remain at 60° or 70°—differences of 50° to 80° in the extremities of the same stone—with their accompanying effects in expansion or contraction. The strains of heat and frost will tear down buildings and sides of mountains, with their great expansive forces, and even steel and iron will give way before them. Here, then, is presented to the builder and architect a new and wondrous element in an "elastic stone," a potent quality which, united with its other sterling excellencies of strength and beauty, makes Indiana Oolitic limestone *the best in the world* for exposed work in buildings in localities subject to great climatic changes. It has been and is now being used in many of the finest public structures in the country—the new $2,000,000 court house at Indianapolis, the new Indiana State House, the postoffice, and many churches in that city; the custom house at Louisville; the city hall and the water-tables of Lincoln park in Chicago, many fine structures in St. Louis, the Cotton Exchange in New Orleans, and many public and private buildings in New York and Philadelphia, and the exposed parts of the new State House of Illinois.

The sandstones of Indiana occur in a broad belt from the Illinois line, in Warren county, south and southeast through the counties of Fountain, Vermillion, Montgomery, Parke, Putnam, Clay, Owen, Greene, Martin, Pike, Dubois, Orange, Perry, Crawford and Harrison, to the Ohio River. This is the conglomerate sand-rock, forming the base of the Coal Measures, and the same as the sandstones so famous in Scotch and English architecture; and, although irregular in color and physical characteristics to some extent, presents a great bed of building material, frost, fire and water proof, and of practical value for permanence and solidity. In these beds, in Warren, Orange, Lawrence, Crawford and Harrison counties, are found extensive and valuable bands of grit stones, of great utility for grindstones, as well as quarries of the "Hindoostan" whetstones, so favorably known in all the markets of the civilized world.

The sandstones of the Coal Measures proper, while not fully up to the above, are yet extensively used for foundations, piers, and hammered masonry. In the Sub-Carboniferous formation, the sandstones of the Chester and Knobstone groups are well developed, easily accessible, and merit the local favor and reputation they sustain.

During the year 1882, there were quarried in Indiana nearly 1,000,000 cubic yards of sandstone.

COAL.

The Indiana coal fields are embraced in an area of about 7,000 square miles, and are entered from all directions by railroads, thus insuring a steady and inexhaustible supply of the best fuel at a low price. There are in all twelve seams at varying depths, from the surface to three hundred feet below, averaging a depth of eighty feet. Five of these seams are almost constantly workable wherever met, varying from one-half to eleven feet, and averaging four feet in thickness. The small seams are worked for local use by "stripping."

These coals range in quality from "fair" to "superior." The "block coal," pre-eminent as a metallurgic agent, is found in an area of about 600 square miles. Remarkably free from sulphur and phosphorus, it is rich in carbon, and admirably adapted to the manufacture of "Bessemer" steel, and for refining, as well as for rolling mill and locomotive use. It burns free, without caking, to a minimum of white ash, and with a ruddy flame.

Mr. J. J. Turner, Superintendent of the Indianapolis & Vincennes Railroad, made for some weeks a careful test of the comparative merits of Indiana coal (from Greene county) and the celebrated Pittsburgh coal, with especial reference to locomotive purposes, with the following results:

	Pittsburgh.	*Indiana.*
Wheels hauled one mile per ton coal	.97	.99
Gallons of water evaporated per ton coal	.53	.52
Average temperature during test	39°	39.9°
Total consumption	.40	.35

The enormous amount of power stored up in coal is thus set forth by Prof. Rogers: "The dynamic value of one pound of good steam coal is equivalent to the work of one man for one day, and three tons are equal to twenty years' hard work of 300 days to the year. The usual estimate of a four-foot seam is that it will yield one ton of good coal for every square yard, or about 5,000 tons per acre. Each square mile will then contain 3,200,000 tons, which, in the total capacity for the production of power, are equal to the labor of over 1,000,000 able-bodied men for twenty years."

Of course this contemplates that period in the future when inventive genius shall develop processes by which the full power of coal shall be economized, now so wasted in smoke and imperfect combustion.

During the year 1881 the coal mines of Indiana employed 5,000 men, to whom were paid wages amounting to over $1,500,000. In the mines was invested a capital of $2,500,000, while the product was 1,500,000 tons of coal, worth at the mines $2,500,000, a sum equal to the capital invested.

From a small beginning in a region where wood fuel was so abundant as to be a drawback, the excellent quality of our coal has promoted Indiana to the place of sixth in the coal-producing States of the Union, with a gain of 231 per cent. in the past decade, or over 23 per cent. per annum, while the future promises still larger outputs and triumphs.

How much influence the State Geological Department has had in producing the above results may be inferred from the fact that since 1869, when the first full report of the coals of Indiana was made by my predecessor, Prof. E. T. Cox, the business has increased about 250 per cent.

GLASS SAND.

Extensive beds of sand and friable sandstone occur in the counties of Madison, Parke, Clark and Harrison. It is of ocean-washed purity, frequently white as snow, and so pure as to cause the plate-glass of our State to rival, and in some respects to excel, the best European products. With fair encouragement Indiana can supply the nation with glass cheaper and better than foreign manufacturers, and can at the same time give employment to thousands of skilled and unskilled laborers, and bring additional capital within her borders.

GRAVEL.

This is so bountifully present over nearly all the State that it is as common as air *and as unprized.* Other countries make costly highways with broken stone; here nature presents the best of granite, imported during the great "Ice age," ready prepared for use. This is the best possible material, and in the future, with ordinary enterprise, our State will have the best roads in the world, with the consequent blessings of comfort, enjoyment and profit. During the year the sale of gravel in the State amounted to about 200,000 cubic yards, but probably ten times that amount was used without cost.

LIME AND CEMENT.

These necessaries of life are so abundant in the State as to escape attention. The whole northern, central drift regions and eastern and middle parts are underlaid with good limestone, suitable for calcining. The very best quality of lime is produced from these rocks, and in quantities not only sufficient for home consumption, but for an extensive trade in exportation also. To-day it is only used for mechanical purposes, but its full value will be appreciated when, in the near future, it becomes more generally used in agriculture for fertilizing purposes. The lime of the Upper Wabash, Central and Southern Indiana is unrivaled; the Delphi and Huntington and Utica limes are of a very superior quality.

Cement that meets all the requirements of the market is prepared from the native beds of Clark county, and is of fine quality; while large beds still undeveloped exist in Harrison county, waiting to reward him who will turn his attention to and bestow his labor upon them. From the lacustral clays and chalks of St. Joseph county is made, at South Bend, a fine "Portland cement," which is not rivaled even by the best European brands. During the year 1882 there was produced in the State 836,628 bushels of lime and 82,938 barrels of cement.

CLAYS AND KAOLIN.

Brick clay is as common as water throughout the State. Owing to the presence of iron, the clays of Delphi, Carroll county, offer a product of extra beauty, smooth and ruddy, and with colors so fixed that buildings which have stood for twenty or twenty-five years present the same cheerful, bright appearance as those erected last year. Our builders would do well to consider the color and quality of this material, permanently painted by nature.

Underlying all our coal seams are great beds of excellent fire clay. Good fire bricks are made in Clay and Vermillion counties, and the raw material is abundant in the southwestern regions. When the coming man builds, not for to-day, but for all time, he will require permanent fire-proof edifices, and will then avoid disastrous conflagrations by cheaply furnishing from this clay, window and door frames, roofs, cornices, etc., and ornamental brackets of terra cotta ware. The supply is sufficient to furnish the world, and, when common sense prevails, the clays of Indiana will be richer than the mines of Colorado and the golden sands of California. During 1882, 2,769 tons of fire clay were produced.

The kaolin mines of Owen and Lawrence counties have lately opened a new and prosperous field of labor. The product of these mines is used by the "Encaustic Tile Works" at Indianapolis, where are being produced tiles of rare beauty and excellence, rich in design, perfect in form, equally vitrified, and unrivaled by the best factories of England and France, over whose products they take precedence in the great public buildings in eastern cities. Large beds of kaolin, still undeveloped, invite exploration and examination in Owen and Harrison counties. The discovery of these kaolin beds has already resulted in the importation of large amounts of capital, and numbers of foreign skilled workmen.

NATURAL GAS.

In Harrison and other counties considerable areas present, from the deep bores, a flow of gas distilled by the internal heat of the earth from the bituminous beds of the Devonian age. This flow has been utilized for concentrating brine, and is of great economic value for driving engines, burning lime, crockery, etc., as well as for illuminating and culinary purposes. It invites and deserves attention.

SOIL.

The soil of Indiana is composed of materials from all the geological horizons. It contains the elements of all, spread as a broad alluvial plain along the ancient glacial bed. Being deep, it holds like a sponge the excess of winter and spring moisture to alleviate with dews, or water by springs, the surrounding country, avoiding excessive drouth. Posey county has shown to the State Board of Agriculture her great crop of corn, while Vermillion county comes to the front with 64.78 bushels of wheat and 110 bushels of oats to the acre. Other regions are equally rich, showing results in grains and grasses which rival these. Such crops are not accidents, but are the legitimate and natural results of a superior soil and its mineral constituents. When we consider that a soil composed of the decomposition of local rocks only is lean and soon needs manure, we can appreciate the effects of the deposition of the glacial drift over Indiana in the almost fabulous fertility of its soil, as instanced by the above examples.

GEOLOGY OF POSEY COUNTY.

Posey county is the extreme southwestern part of Indiana. The seat of justice, Mt. Vernon, is 198 miles, and the farthest point, at the mouth of the Wabash, over 200 miles southwest from Indianapolis.

It was organized in 1814, contains 420 square miles, or 268,000 acres, and is bounded on the north by Gibson, east by Gibson and Vanderburg, south by the Ohio River and State of Kentucky, and west by the Wabash and State of Illinois.

These boundary streams are stately rivers, of nearly equal size at low water. The Wabash comes from the rich alluvial loams and clays of Northern Indiana, and the prairies of Illinois, loaded with manurial sediment; the Ohio, at overflow, brings the calcareous washings of its tributary streams, and is red with angry waves. At ordinary stages the latter is the "Belle riviere" of the French—the beautiful river of the early traveler; bright and blue in its clear almost crystal waves and royally crowned by a swan-like fleet of steamers trailing their smoky banners against the clear sky, it is attractive. From the hill tops it is a scene of active beauty, clearer, brighter and fuller of progressive energy than even the "Silver Rhine." Each of these rivers is belted with broad, alluvial plains, ranging from a narrow strip to five or more miles wide, with a soil of unrivvaled fertility, excelling the boasted granaries of Egypt by the diversity of its productions. Corn, wheat and oats are cultivated, and produce crops never elsewhere equalled. All the fruits of a temperate clime are abundant, and textile plants have been and may be successfully grown. The forests comprise black and white walnut, red, white and burr oak, red and white elm, white and black gum, cottonwood, hickory, maple, willow, sycamore, cypress, pecan, etc., with many shrubs and vines.

The drainage of the northern parts is by Black River. This stream, almost insignificant in its present volume, shows evidence that once it was a mighty river, broad alluvial bottoms bordering its sides, so much wider than a stream of its volume required, that it is plain at some early time—probably about the close of the Lacustral period, Patoka, or creeks(?) tributary to Pigeon, were discharged by this way. Big Creek drains the central parts and was formerly a mill stream of importance. Small streams flow from the southern areas to the Ohio. Many of these creeks flow through flat level plains, and have the muddy beds characteristic of the Loess soils.

From the creek and river valleys we pass, sometimes by gentle ascents, along the tributaries, but often by abrupt bluffs, to the table lands. The latter, in the central and northern parts, attain an elevation of from 100 to 200 feet, and average a height of 125 feet above low water in the Ohio River; and being formed, as a rule, from lacustral fine sands or loam, the soil is compact and to a degree impervious to air and moisture, unless drained or well intermixed with vegetable matter. The flat areas are wet and predisposed to prairies or "openings," but the slightly uneven surfaces are clothed with a thick growth of timber. Of this, post-oak, persimmon and sweet gum are characteristic, if not peculiar. White, red and Spanish oaks, black gum, maple, white and black hickory are common. The rolling uplands, containing a generous admixture of red calcareous material, imported by fluviatile action, is richer, and has a corresponding growth of sugar trees, poplars, black walnut and ash, added to the former list. Both varieties of upland, when properly cultivated, produce fair to good crops of corn, wheat, oats and meadow grass. The hills and high ridges, by the modifying influence of their elevation, are exempt from the destroying effects of sudden changes of temperature, and admirably adapted to the growth of tender fruits and vines. Advantage has been taken of this situation by progressive farmers and gardeners, and the many extensive and profitable orchards and vineyards of this county are regarded sure sources of income by their prosperous owners. These areas, entirely elevated above the malaria of the valleys, are remarkably free from fevers attributed to that cause. Good cisterns for filtering and containing rain water for family use, would furnish an ample supply of purer water than can be obtained from wells or springs in this soil, and would probably, in a considerable degree, avert inflammatory diseases.

Dr. D. D. Owen describes this lacustral loam as a silico-calcareous earth, of pale, reddish gray, or ashen flesh tint, and says that, when in part composed of decomposed material of Coal Measure rocks, it gives rise to some of the best tobacco land. He gives the following analysis:

Combined moisture	1.35
Soluble organic matter	.30
Insoluble silicates	73.30
Carbonic acid	10.00
Lime	6.80
Magnesia	3.78
Alumina and peroxide of iron	2.80
Chlorine	.12
Loss and alkalies	1.55
	100.00

An analysis of water leached through this material is found to contain an excess of magnesia, and observation shows that it has a deleterious effect on the health of those who habitually employ it for domestic and drinking purposes. During the presence of cholera, Owen observes that those who habitually used this kind of water were apt to be more frequently and seriously attacked. In such localities, at times of drought, erysipelas and typhoid fevers are liable to prevail. Magnesia and its metallic combinations, rendered deliquescent by exposure to atmosphere, are not acute poisons, perhaps, in the small quantity which exists, but long continued use produces a chronic irritation which may tend to incite disease. Hence the use of pure, filtered rain water is earnestly urged.

RECENT GEOLOGY.

ALLUVIUM.

The "river bottoms," or alluvial "meadow lands," bordering the rivers and streams are due to causes now in action. Solid rocks, laminated or crystalline, compose the rock-ribbed crust of the earth. These, on exposure to frost, air and water, decompose or disintegrate, or, broken from their beds, are rounded, rolled, and, by the mills of nature, ground into clays, sands and pebbles by rushing water and waves. The finer particles, as clay and sand, combined with rich organic matter, form here the productive alluvial bottoms of a delta outrivaling the famous delta of Africa. This deposit is always found above or against the sides or excavated edges of older beds.

In deep shafts at Evansville, and at Henderson, Kentucky, a bed of fluviatile shells was found, at a depth of forty to seventy feet from the surface, so deposited as to indicate an era when the Ohio flowed at a bed that much below its present level; but, more wondrous, it showed an early period in the river's existence, reaching back to tell the story of life, and climate and time. These mollusks, then abundant here, were such as now are common in streams bordering the northern shore of the Gulf of Mexico; and as they could only exist in a sub-tropic climate, they prove that such climate prevailed here. They may be intimately connected with the following epoch.

LUCUSTRAL EPOCH.

The Loess or lacustral loams succeed in age. It was the epoch of great lakes or slow-flowing lagoons, with a warm climate succeeding the glacial time. These loams are an ash gray or brownish buff color, exhibiting, principally, an impalpable sand, with a small amount of clay. Sir Chas. Lyell, on his visit to this county, identified this deposit as the equivalent to the Loess of the Rhine, and he was enabled to know of the thermal conditions by the shells found abundantly at New Harmony as equivalent to that of Cuba or Mexico. These shells are listed in my report for 1870, on

Sullivan county, but here repeated for the benefit of those not having that report, viz.: *Macrocyclas concava*, Say; *Zonites arboreus*, Say; *Hyalina indentata*, Say; *Patula perspectiva*, Say; *Helicodiscus lineatus*, Say; *Pupa armifera*, Say; *P. fallax*, Say; *Strobila labyrinthica*, Say; *Stenotrema hirsuta*, Say; *S. monodon*, Rack.; *S. monodon var. fraterna*, Say; *Vallonia pulchella*, Muell.; *Succinea avara*, Say; *Valvata tricarinata*, Say; *Pomatiopsis lapidaria*, Say; *Helicina occulta*, Say.

Of these shells, *H. occulta* is of tropic life, and belongs to the latitude of Cuba and Mexico. Prof. Swallow remarks: "These lacustrine fluviatile and land species of mollusca indicate a deposit formed in a fresh-water lake, surrounded by land and fed by rivers; and refer back to a time when a large portion of this valley was covered by a vast lake, into which flowed various rivers and streams." The climate was tropic or sub-tropic.

The low, rounded hill-tops, constantly recurring, appear like tumuli, and are occasionally shaped by the Mound Builders for funeral purposes. The red, marshy clay, fat with shells of that epoch, forms a fertile soil along the shore line of the lagoon-like lake, characterized by a heavy growth of poplar, walnut, sugar tree, ash and post-oaks of giant size; the lower and more sandy member of the Loess, impervious to air and moisture, bears a growth of oak, hickory, gum, beach, dogwood, symbolic of the cold, close soil.

DRIFT.

Next in order of time succeeds the great ice age; a stratum of sand and gravel resting below the Loess, but upon or against the sides of older formations. It represents the sorting and sifting power of water in motion, each deposit being placed where the velocity of the current could no farther carry it; thus a ripple deposited gravel and bowlders, a slower current left banks of coarse sand, and, finally, slow eddy-currents made banks of clay and fine sand. At the base of the hills at New Harmony are beds of glacial material, indicating the sorting powers of the Wabash in its youthful vigor.

GENERAL GEOLOGY OF POSEY COUNTY.

The rocky formations of this county are classed as of the Upper Coal Measures. The surface outcrops exhibit two or three coal seams, with intercalated beds of limestone; above is the Merom sandstone, which, unconformable with the Coal Measure rocks, lies above them, and its coarse material demands a shore line of a mighty, surging sea for its formation. This rock is of later date and apparently of different conditions, and, perhaps, indicates that future students may find evidence to connect it with

Mesozoic times and possibly with the Triassic period. Cretaceous beds occur in adjoining regions of Kentucky and Missouri. Outliers are to be expected, and should be sought for, in Indiana.

GENERAL SECTION OF POSEY COUNTY.

The following general section is combined from the shafts, bores and explorations made from outcrops in eastern and northern parts or adjoining regions, and probably gives the unexplored strata of this county:

		Ft.		Ft.	In.
1.	Buff, brown, red and mottled shales	2	to	0	00
2.	Merom sandstone, soft, shaly, upper div.	20	to	25	00
3.	Merom sandstone, massive in quarry beds	10	to	30	00
3½.	Dark gray or buff shales and flaggy sandstones, with clay iron stones	10	to	20	00
4.	BROWN IMPURE COAL, 3d rash coal	1¼	to	00	00
4½.	Flaggy or thick-bedded sandstone, ripple-marked	9	to	4	00
5.	Hard, clinky, gray limestone, at bottom irregular and sometimes flinty, passing to the west to a calcareous shale	2	to	6	00
6.	Argillaceous shale and shaly sandstone	34	to	0	00
7.	Black slate, with fish spines and fossils	1½	to	0	00
8.	SECOND RASH COAL	0	to	0	03
9.	Fire clay	1	to	0	00
10.	Gray shale	6	to	0	00
11.	Limestone, yellow ferruginous	3	to	12	00
11½.	Gray shale	98	to	0	00
12.	FIRST RASH COAL and black slate	0	to	0	08
13.	Fire clay	1	to	2	06
14.	Soft, flaggy, blue, buff and gray sandstone, with much gray shale and beds of clay ironstone and nodules	60	to	121	00
15.	Yellow and gray sandstone, often giving good quarry beds	15	to	29	00
16.	Gray and buff alluminous, arenaceous or shaly, flaggy sandstone, with ironstone nodules and shaly concretions	29	to	8	00
17.	Black slate or clod, with fossils			1	00
18.	COAL N. Choice, gassy, caking			2	03
19.	Fire clay, at bottom shaly, with iron balls			5	08
20.	Buff or gray limestone, with *Chætetes*	8	to	5	00
21.	Gray or white shale, with nodules of ironstone and bands of sandstone	30	to	40	00
22.	Siliceous shale, passing to massive sandrock to south and west; Anvil rock? of Lesquereux and Owen	60	to	71	00
23.	Black slate and clod, with many animal and vegetable fossils	2	to	1	08
24.	INGLESIDE COAL M: Laminated coal, 1 ft. 4 in.; parting, 2 in. to 0; solid cubic coal, 2 ft. 8 in.			4	00
25.	Fire clay			4	00

26.	Fire clay, with pyrite balls			3	08
27.	Siliceous shale			11	09
28.	Argillaceous sandstone			5	00
29.	Gray shale and soapstone			64	05
30.	Soapstone, with plant remains			0	03
31.	COAL L: Impure cannel coal, 1 ft. 6 in			1	06
32.	Fire clay			2	06
34.	Siliceous shales and coarse massive ferruginous sandstone	90	to	120	00
35.	Bituminous limestone and black slate	2	to	8	00
36.	COAL K. Caking, pyritous	0	to	1	06
37.	Laminated fire clay	2	to	1	04
38.	Siliceous and black aluminous shales, with rich bands and pockets of nodular iron ore	10	to	30	00
39.	Conglomerate sandrock	110	to	180	00
40.	COAL A	3	to	0	00
41.	Dark or black shale, with iron ore	30	to	5	00
42.	Chester sandstone and Lower Carboniferous limestone.				
				833	11

PALEOZOIC TIME.

CARBONIFEROUS AGE.

Upper Coal Measures.

The following remarks (made after a careful and protracted study of the mines, outcrops, bores and shafts of Vanderburg county) are given here as the fullest show the writer has of the deep strata of Posey county, where, from the depth of the coal seams, extensive explorations have not been made. The section and deductions apply with full force to Posey county.

The beds Nos. 3 to 14 of the general section, including two or three thin seams of rash coal and two strata of limestone, each from two to eight feet in thickness, occupy the hill-tops in the eastern parts, and thence, dipping to the southwest, are found at or near the level of the streams in that part of the county. These beds are a notable horizon. Besides the advantage of the stone, which is burned for the lime, they form an unmistakable directrix from which to measure down to the probable level of the lower workable coals. The limestones Nos. 5 and 11, at their southeastern outcrop, are hard and clinky, and are frequently brought close together or found in contact. Going westward, they first become more plainly calcareous, are separated by a parting which widens at some points to a space of nearly fifty feet, and allows the introduction of a Rash Coal, becoming persistent to the west, but only represented by fire clays in the eastern parts. Persistent in the eastern parts they become somewhat inconstant in the western, and pass into calcareous shales. In all adjoining regions, these limestones contain a multitude of fossils in great variety, which have given rise to bitter personal quarrels and disputes between eminent scientists. Some of these fossils, as *Meekella*, *Syntrielasma*, a *Myalina*, *Bellerophon crassus*, *Pleurotomaria turbiniformis*,* etc., are closely allied to Permian forms of Europe. These fossils, with many others are not found, in my knowledge, below the Upper Coal Measures included by the numbers (5 to 14) under consideration. So many new fossils from this horizon have been described as of "the Coal Measures," that, deciding from such determination, the rocks, notwithstanding the introduction, in part, of a new fauna, are Coal Measures. As a compromise, equivalent beds in Kansas and Nebraska have been termed by eminent geologists "Permo-carboniferous," a designation which seems properly applied.

In this county, these limestones, often crowded or almost wholly composed of fossils, as *Athyris*, *Spirifer lineatus* and *Lophophyllum proliferum*, offer many and good cabinet specimens. The coals (Nos. 3, 8, 12) are generally absent and never persistent over considerable areas. Impure and thin, they are consequently of no great economic importance. The thin fire clays (Nos. 9, 13) are of even more value, for, generally unctous and plastic, they afford, as a rule, a clay which, purified by exposure to atmospheric agencies, will work well for crocks, coarse pottery and terra-cotta ware.

No. 14, a soft, flaggy, blue, buff and gray sandstone, interchanging with gray shale, carrying iron stones, is found in the eastern parts.

The yellow and gray sandstone (No. 15) is found well down in the Evansvlle shafts, and is not exposed in the county.

The black shale or clod (No. 17) is pretty constant, and differs from the slate usually found covering coals in the predominance of aluminous matter, rendering it soft. It usually carries a considerable number of fossils, most of which are pyritized, as *Productus cora*, *P. costatus*, *Athyris subtilita*, *Macrocheilus*, several species, *Bellerophon*, two species, etc., etc.

Coal N (No. 18 of the general section) is a choice, gassy coal, of excellent quality. From appearances it is believed that this is equal to the best western coal for gas and coking, and, although the seam will average but little over two feet, yet the purity and richness in volatile matter will justify removing the fire clay for potteries, and thus secure this valuable coal. It is passed in the Ingleside shaft, and was formerly worked by a shaft not now in use, on Stevens' land, northwest quarter section 7, township 6, range 9.† It is also pierced by Priest's bore, at West Franklin, in

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† These fossils have not been found west of the Wabash River, but are abundant in equivalent beds in Illinois, adjoining to the west.

* In Vanderburg county.

the extreme southwest corner of Vanderburg county, and by the Kentucky shafts at Henderson—in fact at every point at which this horizon has been explored. These facts indicate a general persistence throughout this region of Coal N., a seam that is characteristically inconstant and unreliable in all the basin, to the north and east. It is locally known as the "Little Newburg coal."

Below the fire clay of N. is found a buff or gray limestone (No. 20). This is not exposed in the county, but is met in all the shafts in regular position, and outcrops at Newburg. It contains a few specimens of *Productus* and *Spirifer*, but is remarkable for the wonderful size of *Lophophyllum proliferum* (some of the cups were seen from three-fourths to one and one-fourth inches in diameter), and a great profusion of the coral *Chætetes milleporaceus*. Next succeeds a gray or white shale, carrying bands and nodules of iron ore of good quality, but not in sufficient quantity to be of any great value.

The siliceous shale and sandstone, passing into massive sand rock along Green River and generally to the north and west, is a marked horizon at stations where exposed, forming quarry beds of economic importance and bold river bluffs. In this county, it is entirely below the surface and can be seen only in shafts.

The black slaty clod (No. 23) is generally persistent throughout this region,* and carries a large number of beautiful and well preserved fossils. Generally pyritized, they form desirable cabinet specimens, viz.: *Productus cora*, *P. longispinus*, *P. punctatus*, *Bellerophon carbonarius*, *B. Montfortianus*, *B. percarinatus*, *Macrocheilus inhabilis*, *M. fusiformis*, *M.* (sp?) *Pleurotomaria carbonaria*, *P. sphærulata*, *P. Grayvillensis*, *Orthoceras Rushensis*, *Nautilus decoratus*, *Aviculopecten rectilateraria*, *A.* (sp?) *Nuculana bellistriata*, *Nucula inflata*, with crinoid stems. These are only a partial list of its marine life. Comb-like spines of fishes and dermal plates, named *Petrodus occidentalis*, are not uncommon; while bones and corprolites are frequent, though crushed and fragmentary.

The Ingleside coal M., locally known as "Main Newburg" (No. 24 of the general section), is the probable mineral resource of this region. This seam has been pierced, by shaft or bore, at a great many different points in this county* and in regions immediately adjoining. At every station, with the single exception of the "Crescent City Park" bore, it has shown a thickness of not less than four feet. It is a strong coking coal, burns to a gray or red ash, and is an excellent fuel for steam or grate use, and commands, as it deserves, a ready market. It drives the wheels of commerce, pulls mighty railway trains, and gives energy to the thousand arms and fingers of iron which manufacture, with the strength of a million giants, the wealth of the city of Evansville. From absence of faults or barren places, indicated by bores conducted up to this time, we may infer

* In Vanderburg county.

that it underruns southern and eastern parts, at least two-thirds of the area of the county, with a possibility, if not a probability, that it may be found in the remainder. A coal of such continuity is unusual, not often met in our coal field, and combining so many good with but few bad qualities, it may be looked upon as a grand source of wealth for ages, and assures for this region an enviable prosperity and progress for the future. This coal has long been worked at Ingleside shaft, in Evansville, and at Newburg, Henderson and Green River, of Kentucky; a new shaft has been put down at Chandler Station, on the Boonville road; all of which find the seam regular in thickness, and differing but little in quality, as may be seen in the chemist's report of analysis.

The usual fire clay, below Coal M. (Nos. 25 and 26), in its upper member, is plastic, and in the future demand for fire-proof buildings, will be extensively used in terra cotta. Usually, it will be necessary to remove the diffused particles of pyrites by aeration. Strata of limestone are not reported in the sections to which access was had below N. and immediately above M., as was found to be the case in Gibson county; but in the new shaft at Henderson and in the bore at Ingleside, beds are found confirming the unexpected phenomenon of massive limestones in the Coal Measures, so unwillingly admitted in my report on Gibson and Knox counties.

The space represented by Nos. 27, 28 and 29 has been pierced only by the lower shaft, in Ingleside mine. It is highly argillaceous, hardly rising above the grade of clay shale; even the tough blue sandstone readily yields to air and moisture. This was to be expected, as similar material, in eight cases out of ten, characterize the horizon between Coals M. and L., in the counties I have visited in Indiana. Similar outcrops were seen at the same horizon, along Green River, especially at and near Cromwell Landing. A thin bed of soapstone (indurated clay) is ordinarily found succeeding, which is rich in leaves and stems of carboniferous plants, and is known as the "fern bed." Sometimes the soapstone is replaced by gray shale, full of kidney iron-stones, enclosing plants and fruits.

Coal L (No. 31 of section) offers the characteristic physical form and qualities usually presented throughout the Indiana coal field. It is a laminated semi-caking or free burning coal, rich in carbon, and yielding a gray or white ash, with little or no cinder. It is the most persistent coal of the Wabash basin in thickness, regularity and good qualities. In this vicinity it has been pierced by three bores, showing an average thickness of only about two feet, which may be regarded as the probable thickness of the seam along the southern and eastern part of the county. This will hardly justify mining at present.

Below Coal L., a hard ferruginous, laminated sandstone, passing into siliceous shales, has been pierced by bores, and occurs at adjoining regions in outcrops, filling a space of from 90 to 120 feet, at the base of which the limestone superimposing Coal K. is found; sometimes flinty, but on the

Kentucky side of the river carrying the usual fossils as *Productus costatus*, *P. longispinus*, *Lophophyllum proliferum*, *Spirifer cameratus*, *S. Lineatus*, *Athyris subtilita*, *Chonetes mesaloba*, *C.* (sp. ?) and *Crinoid* stems.

Coal K. is not seen in this region. In bores along the Ohio River it never develops a thickness of two feet and is generally thinner or barren. Typically, it is a strong caking coal, containing some sulphur, and burns to red or brown ash. A short distance below the horizon of K., beds of black shale occur, which are often, in bores, reported as coal. No thick or workable seams may be expected at this depth. The space usually presenting the block coals is here barren, as it is generally in the southern part of the State. It seems probable that at the central extreme depths of the basin the vegetable material, which if preserved pure would suffice for a coal seam, was largely intermixed with clay and argillaceous matter, and thus diffused and scattered, is represented by a black shale, and the ironstone (No. 38).

The conglomerate sandrock (No. 39) forms the bottom rock or bed of the Coal Measures. It is a coarse, red sandstone, heavy bedded or massive, containing, often, a few red and white quartz pebbles, conglomerated, but the latter are generally absent in the Indiana coal field. This sandrock is only pierced by the Crescent City Park bore in Vanderburg county, and in neighboring wells, but is typically exhibited in adjoining regions to the northeast and south.

The sub-conglomerate Coal A is only known by report. Its existence in this region is, to say the least, problematical, and certainly of no economic importance. The deepest bores report beds of limestone and sandstone, which are referred to the Chester beds of the Sub-Carboniferous period. These bores were put down during the oil excitement, and are not very reliable for minor details, but their steady concurrence, as to the underlying limestone, is regarded reliable.

The foregoing gives a connected view of the surface phenomenon and rocky structure of the county, as before stated almost wholly studied from out-crops, bores and shafts in Vanderburg and Pike counties, and in the Greene River regions of Kentucky. Details will be added for local information.

LOCAL DETAILS.

With low water in the Wabash, the following section was observed, following down the cut-off:

SECTION AT NEW HARMONY CUT-OFF.

	Ft.		Ft.	In.
1. Alluvium (river bottoms)	30	to	10	00
2. Loess	20	to	10	00
3. Clay, sand, gravel, etc., sorted from glacial drift	30	to	13	00

4.	Merom sandstone; massive in eastern parts, to the west laminated	50	to	20	00
5.	Limestone, with fossils	4	to	12	00
6.	Black shale				
7.	UPPER RASH COAL	10	to	0	00
8.	Shaly sandstone	10	to	40	00
9.	Concretionary iron balls	1	to	2	00
10.	Calcareous shale, with fossils	1	to	2	00
11.	Black, sheety shale, with coprolites and fossil remains.	1	to	2	00
12.	LOWER RASH COAL	0	to	1	06
13.	Gray shales, with plant remains to low water in river	2	to	4	00
				116	06

The lower sandstones of this locality present fossil casts of strong growing plants of the Permo-Carboniferous age, *Calamites*, *Sigillaria* and numerous beautiful ferns. A *Sigillaria* preserved by Mr. Sampson was of wondrous size. A part of the fossils seen in his collection were: *Lophophyllum proliferum*, *Bryozoans*, *Productus longispinus*, *P. punctatus*, *P. costatus*, *Orthis Pecosi*, *S. lineatus*, *Athyris subtilita*, *Myalina Missouriensis*, *Entolium aviculatum*, *Bellerophon carbonarius*, *B. percarinatus*, *B. Montfortianus*, *Peurotomaria carbonaria*, *P. tabulata*, *P. spherulata*, *P. Grayvillensis*, *Orthoceras Rushensis*, etc., etc.

This section does not reach down to the bottom of the Upper Coal Measures, and indicates that the horizon of the workable coals M., L. and K. are from 200 to 500 feet below.

Continued rains directed attention to the eastern part of the county. A section was taken near the county line, at M. Gluck's, southwest quarter section 32, township 6, range 11, where the upper limestones were well developed.

SECTION AT GLUCK'S.

	Ft.	In.
Loess loam	20	00
Red sand, Loess	4	00
Soft Merom sandstone	26	00
Shaly sandstone	12	00
Blue limestone . . . 3 feet to	1	00
Calcareous argillite, with plates of chert of 2 inches to 8 inches, and containing *Spirifer Lineatus*, *Orthis Pecosi*, *Bellerophon*, *Athyris*, *Productus*, and crinoid stems and arms	3	00
Gray and buff limestone, crowded with a crushed mass of above fossils	8	00
Gray shale in brook	2	00
	76	00

An outcrop of this flinty (hornstone) limerock was seen further on in the West Franklin road, which has been a noted curiosity with geologists who have made this region famous by their labors. At this point, although not well exposed, it would seem from the sloping outcrops that the whole thickness of this limestone had passed into clinky hornstone (flint). At southeast quarter section 6, township 7, range 11, the Merom sandstone is seen along the top of the hill, indicating a thickness of twenty to thirty feet.

On the slope of the hill, near the residence of F. Finney, are three sink holes, such as are so common in the region of the subcarboniferous limestone, from ten to thirty feet in diameter. Their size indicates an unusual development of limestone of this locality. These are the only sinks seen in our Coal Measures. A large spring discharges the water collected by them. At the southeast corner of the county, about a mile east of West Franklin, the bluffs expose a bold, precipitous face to the river. The limestones, here parted by a slight layer of slate and thin plates of the second rash coal, are elevated, with the Merom sandstone, by a local anticlinal ridge, with strike from northeast to southwest, and dipping slightly to the east, but rapidly, for a short distance, in the normal western direction. Much stone was formerly burned here, and at the village below, for shipment to the southern market, but this lime contained so much color and foreign ingredients that it could not successfully compete with the purer article from Subcarboniferous. At this bluff, Mr. George M. Priest (to whom I am indebted for section in bore and other favors), in November, 1859, put down a test well, which, with the outcrops, gives a good exhibit of strata, viz.:

PRIEST'S BLUFF SECTION, WEST HALF SECTION 19, TOWNSHIP 7, RANGE 11.

		Ft.	In.
Outcrop.			
Covered		22	00
Yellow ferriferous Merom rock		15	00
Pyritous clay shale, with plates of sandstone		19	00
Black carbonaceous slate	1 ft. to	0	00
Blue limestone	1 ft. to	4	00
Parting, 2d rash coal			06
Buff clinky limestone		5	06
Blue and black shale, 1st rash coal	1 ft. to	0	00
Siliceous shales, with iron nodules		27	00
Bore—High-water mark.			
Siliceous shale, with good iron ore in bands and nodules		36	06
Siliceous shales, with nodules		30	00
Hard concretions		2	00
Sandstone		44	03
Laminated sandstone and shale		13	00
Blue shales		27	00
Very dark shales		3	06
Coal (N?)		3	06
Fire clay		1	06
Total		254	03

By this it is seen that a coal of workable thickness exists at a depth of 157 feet below high water mark. Just across the line, in Posey county, the rash coals are better exhibited, although of no great importance. They are, at no locality in the State, of workable extent. Near this point, and below, the tops of the hills, 130 feet above the valley, afford a magnificent view, embracing a large extent of river and bottom fields, and have been employed as "look-outs," or residences, by the Mound Builders and other pre-historic races.

Going north along the county line, the Merom sandstone was noted at several localities, generally in Posey county, rising to the northeast and dipping to the west southwest. Much diagonal or false bedding was observed, with wave faces to west. At Andrew Keck's quarry (northwest quarter section 36, township 7, range 12), half a mile west of the county line, the massive member of the Merom sandstone is well exposed, and yields an excellent quarry stone, in large blocks, one of the best quarries in the vicinity. In the lower strata *Calamites* and worn trunks of coal plants were seen. Below the quarry is a band of black shale, with, locally, a thin seam of coal, from six to ten inches thick.

The same sandstone outcrops on the farms of Charles Keck, Lewis Hauschild and George Roseman (sections 30 and 31, township 6, range 11), soft and incoherent at the top, but presenting massive ledges, ten to twenty feet thick, in the ravines. A short distance east of this locality, the sandrock ascends to the summit of the hills, and the double limestone and rash coals are exposed in the valleys. Massive beds of sandstone are seen along the southern bluffs of Big Creek, some of which have been quarried for rough masonry. At Wm. Fauquher's, and vicinity (section 6, township 6, range 11), the Merom sandstone caps the tops of the hills, and a band of black carbonaceous shale, twelve to eighteen inches thick, is seen in the ravines, representatives of the second rash coal of general section, the limestones apparently being absent or having passed into a calcareous shale. A thin coal was formerly worked, for blacksmiths' use, on the Dow farm (northwest quarter section 1, township 6, range 12).

On the dividing ridge between east and west branches of Big Creek, on the farm of Henry Schift, 2½ miles southwest from St. Wendell, the Merom sandstone has not been eroded, and crowns an almost knob-like elevation. The lower strata is soft, micaceous, and readily yields to the action of the atmosphere and running water; the middle or massive member, more compact, often stands out 10 to 15 feet, overhanging the brook which rushes past its base, forming "rock houses" like those so often seen in the conglomerate hills. These have been used for shelter in storms by Indians, as well as wild animals. St. Wendell is a German village (section 7, township 5, range 11), and presents many characteristics of the fatherland, novel to Americans. The industry, thrift and prosperity of the citizens is proverbial. Well appointed farms, good gardens and comfortable or luxurious houses, filled with means for social comfort, enable them to enjoy life somewhat independent of the outside world. Coal has been stripped to a very small extent at several openings near the village, but it is impure, thin, and will not justify expensive work. On the farm of John Tenbarge (west half section 6, township 5, range 11), the second rash coal is found, eleven inches thick, of fair quality. At George Helfert's (southwest quarter section 7, township 5, range 11), several loads have been mined.

SECTION AT HELFERT'S, ST. WENDELL.

	Ft.	In.
Slope, Merom sandstone	70	00
Calcareous shale (limestone)	1	06
Black sheety shale	2	00
Coal, second rash	1	06
Laminated fire clay, in brook	1	00
	76	00

In the black slate covering this coal was seen dermal tubercles and spines of *Petrodus occidentalis*, *Nucula inflata*, *Cardiomorpha Missouriensis*, etc. The fish specimens above are probably termed "comb-like teeth of sharks" in former Reports.

The northeast part of the county is a prime agricultural region; perhaps, considering all the surroundings, the best in the country. The tableland is a broad, gently undulating or nearly level plateau, and offers the characteristics of a prairie opening. The soil produces good crops of grass, wheat, and a fair yield of corn in its natural condition; but many farms have been enriched by under-draining, which assures good crops in spite of unpropitious seasons, by fortifying plant life against flood or drought. In this vicinity, the valley of Big Creek proper is from two to three miles wide, and several of its branches have valley plains from one to two miles wide, with only brooks or wet weather streams flowing through them, in no way commensurate with the erosion necessary to excavate such water-ways, all pointing back to the time when temporary sluice-ways, discharging floods of ice-water from the northern and northeastern glaciers, swept across here to the Wabash, by way of Big Creek, now an insignificant stream. The rocks are deeply covered, and the only outcrop noted is a quarry of Merom sandstone on the farm of John Klaser (northwest quarter section 23, township 4, range 11). Well improved farms, comfortable houses and a thrifty people characterize this vicinity.

Continued rains and overflows concealed the beds of the stream, justifying the recall, condensed, of some of such sections, by Dr. D. D. and Prof. Richard Owen, given in their Reports.

Six miles north of New Harmony, near the residence of Jos. Calvin, a coal seam is exposed, about nine inches thick.

CALVIN SECTION.

	Ft.	In.
Covered top of hills	70	00
Limestone, without fossils	2	00
Shaly sandstone	5	00
Soft shales, with plants and shells	21	00
Coal	0	09
Fire clay	2	00
	100	09

On Mackadoo Creek, eight miles northeast of New Harmony, two thin seams of coal are seen.

On Big Creek, near the road from New Harmony to Mt. Vernon, a bed of coal eight, to ten inches thick, is exposed, and was worked for burning lime. The roof shales contain plant and fish remains, as well as fossil mollusca.

At the mouth of Rush Creek there is a thin bed of coal, ten to eighteen inches thick, overlaid by a bank of sandstone, four to six feet thick; and on the border of the Wabash, at low water, a bed of soft shales is exposed, containing a great abundance of plants. The black, slaty shales, here, contain many fossils.

SECTION AT BLAIRSVILLE.

		Ft.	In.
1.	Alluvial soil and Loess	5	00
2.	Shales and shaly sandstone	15	00
3.	Coal—rash	0	03
4.	Fire clay, with broken plants	6	00
5.	Sandstone	6	00
6.	Fire clay and trace of coal	0	03
7.	Shales and shaly sandstone, to Creek	0	00
		32	06

In the sandstone (No. 5 of this section), remarkable fossil remains of standing trees were discovered by Dr. D. D. Owen. One of the largest specimens, preserved in the cabinet of this distinguished geologist (afterward destroyed at the fire of the State University), was two feet three inches high, perfectly cylindrical, and thirteen inches in diameter at the top, where it was broken off. A similar specimen was secured, and sent to the State Museum by the writer, in 1875.

Graysville, Illinois, opposite the northwest corner of the county, gives the following expose of the limestone and first rash coal:

SECTION AT GRAYSVILLE.

	Ft.	In.
Covered space	8	00
Bituminous fossiliferous shales	4	00
Fossiliferous limestone	1	00
Black, bituminous shales	0	03

Rash coal—plant remains	0	03
Slaty coals	0	03
Fire clay	1	00
Shaly sandstone—plant remains	12	00
	26	09

Many fine fossils have been found in the calcareous beds here, and some described by Norwood and Pratten.

The State Geologist is indebted to kindness of Prof. E. T. Cox, his able and meritorious predecessor, for the following facts on the "Geological Features of Posey County." Prof. Cox's long study of this vicinity, aided by the corps of distinguished laborers in this science, who rallied at New Harmony as the central home of geology, gives them high value.

LOCAL GEOLOGICAL FEATURES OF POSEY COUNTY.

The geological features of Posey county, though presenting many points of extreme interest to the paleontologist, are correspondingly uninteresting to the peterographic geologist, on account of the very uniform character of the rocks which present themselves to the view of the explorer.

We find the sandstone, which caps the hills in the northern part of the county and extending into Gibson and Vanderburg counties, spreading over the whole county where the land is elevated enough to catch it. This sandstone is sometimes thin-bedded, but is generally massive, has a reddish-brown color and coarse, granular structure, and is most probably a portion of the great sandstone so well pronounced in the Bluffs at Merom, Sullivan county, Hanging Rock, above Mt. Carmel, on the Wabash River at the latter city, and at Carnie's Bluff, below Mt. Carmel, on the Wabash. It is also seen as a massive rock, but not so thick, as found in the above mentioned localities, in the hills that border the western bottoms of Fox River, in Illinois, six miles west and almost opposite New Harmony, Indiana. A portion of this rock forms the Grand Chain, in the Wabash River, nine miles by land and twenty-two miles by water below New Harmony. The lower part of this sandstone also crosses the river at the Little Chain. At the latter locality, the reef across the stream is formed of a thin-bedded, bluish-gray, highly micaceous sandstone, with here and there impressions of stems of coal plants.

At the time of my visit the United States River Improvement engineers, under the direction of Major J. A. Smith, were engaged in dredging up this sandstone and building a breakwater or cribbed wall of rock, jetting down the stream for a distance of 4,000 feet or more. This dangerous obstruction had been removed for a width of fifty feet, which is as wide as the excavation could be made by once going over, it being the intention, next season, to take out fifty feet more and to make the channel one hundred feet wide, with a depth of six feet of water at the lowest stage. Captain Huston was in charge of this important work, and entertained us most hospitably on his dredge boat, the "Kwasind." I was surprised to see the lower Wabash River, from Mt. Carmel down, such a large and important stream. At New Harmony it is twelve hundred feet wide, and increases this width to the mouth, where, according to the engineer's report, this river discharges more water in time of drought than is found in the Ohio at its embouchere, ten miles above Shawneetown.

SECTION OF FORMATIONS AT NEW HARMONY.

	Ft.		Ft.	In.
Soil and sub-soil	1	to	6	00
Loess	6	to	30	00
Drift, yellow clay, with small crystalline bowlders	10	to	20	00
Hard, blue clay (hard-pan)	½	to	1	00
Merom sandstone; sometimes thick-bedded, yellowish red color and spotted with iron stains; often friable, and seldom suitable for building purposes	10	to	50	00
Argillaceous and siliceous shales	5	to	10	00
Coal	½	to	1	00
Fire clay	1	to	3	00
Limestone; earthy, and of accretionary structure, and without fossils	0	to	2	00
Argillaceous, jointed, bluish-gray shale	20	to	30	00
Thin-bedded and schistose sandstone, highly micaceous, and carrying stems and trunks of *Sigilliria Oweni* and *Asterophycus Coxii*	3	to	6	00
Banded limestone, with *Palæophycus Milleri*	0	to	0	02
Calcareous shale and limestone, full of fossils (West Franklin limestone)	2	to	25	00
Argillaceous shales, with some coal plants, black, bituminous, sheety shales, with fish teeth and *Coprolites*	0	to	2	00
Coal	0	to	0	06
Bluish underclay, full of fossil plants	0	to	3	00
Low water, Wabash River.				

Underneath the sandstone (which I have traced from Merom to the Ohio River, and which, for the purpose of convenience, and fixing the continuity in the mind of the reader, has been designated as the Merom sandstone), there is a massive bed of siliceous and argillaceous shales, with intercalated beds of fossiliferous, calcareous shales and earthy limestones. At West Franklin, opposite Diamond Island, the limestone is of very great thickness.

Prof. E. T. Cox is of the opinion that the West Franklin limestone has its counterpart in the Carthage limestone, which crops in the bank of the Ohio River, about one mile below Uniontown, Union county, Ky. On Big Creek, near the road from New Harmony to Mt. Vernon, this limestone is not so thick, and is of a black color, very close grained, breaks with irregular fracture, and has a strong fœtid odor. It contains a few characteristic Coal Measure fossils, very perfectly preserved, but difficult to procure on account of the hardness of the rock. The fossils are white and, when the rock is polished, they show white on a black background. If the stone could be had in dimensions free from cracks, it would be valuable as a marble for mantles, table tops and other decorative purposes.

At the Lower Hills, in Bethel township, the limestone seen in the shales above alluded to, is of an earthy, accretionary character, not at all resembling the West Franklin, and is without fossils. On the road from New Harmony to Evansville, and about five miles east of the Posey county line, the West Franklin limestone is seen in great force, cut through by the drainage ravines, and is extensively quarried for lime.

At the cut-off, in the edge of New Harmony, there is a beautiful exposure of the lower part of the Merom sandstone and the upper portion of the underlying shales. About ten feet of the sandstone, of a coarse-grained, friable nature, and reddish-brown color, has under it five or six feet of argillaceous shale, containing a seam of poor coal, eight inches thick, underlaid by a bed of fire clay that will answer well for coarse pottery; and, beneath the latter, is an earthy accretionary limestone of a reddish-brown color, and wholly barren of fossils. Under this limestone is a massive bed of bluish-gray, jointed, argillaceous shale, improperly called soapstone. Under this shale, there is a bed of sandstone, about thirty feet thick, in layers from two inches to twelve inches thick. The total thickness of this bed varies, and is best seen at the mouth of the cut-off, where it was quarried by the Old Harmony society for the foundations of its hall, and for the ornamental doorway, the lintels and other portions of the building. This doorway was carved by Frederick Rapp. It can not be considered a durable stone, though the blocks for the above purpose appear, so far, to have withstood the test of fifty-one years. Under this sandstone, at the site of the lower dam, in the cut-off, there is exposed, in the bed of the river and along its shores, another mass of shales, containing a band of flat ironstones, rich with remarkable fossilized ferns that are in bold relief. Some of the most remarkable have been figured and described by Prof. Leo Lesquereux, in the Report for 1875. The best preserved specimen was found on Brouillet's Creek, in Vermillion county, and obtained from the cabinet of Mr. J. F. Miller, Superintendent of the Pan-Handle Railroad, Richmond, Indiana. While on a visit to this place with Mr. James Sampson, of New Harmony, he found and gave to the State Museum some of the very best and most interesting specimens that have yet been discovered. The name given by Prof. Leo Lesquereux is *Palæophycus Milleri*.

These shales and schistose rocks are found throughout the county, and may be seen in most of the streams in times of drought or extreme low water. On Macadoo Creek, near the road leading from New Harmony to the Hume settlement, they are quite siliceous, and contain casts of many fossil shells, conspicuous among which is seen *Monopteria longispina*, Cox.

At Blairsville, on Big Creek, they contain upright trunks of trees, *Sigillaria Oweni*, Lesq. From this famous locality Dr. David Dale Owen obtained many specimens, from six inches to a foot and more in diameter and three feet high from the branching roots to the top of the broken body. Sir Charles Lyell, when on his second visit to this country, accompanied by Dr. Owen, made a careful examination of this locality. Not only has it been examined by the above mentioned parties, but during the years before it had received the attention of William Maclure, Thomas Say, C. A. Leseuer and Dr. Troost; subsequently by Norwood, Shumard, Pratten, Worthen, Lesquereux, Cox, and many others. Below the roots of these standing trees is a bed of argillaceous shales, containing some fossil ferns, and other coal plants, and a thin seam of coal.

The calcareous beds which underlie this member of the general section were best exposed on the bank of the Wabash, just above the mouth of Rush Creek, but they had been so extensively worked for fossils by the very many geologists who congregated at New Harmony, that the subsequent freshets of the Wabash have filled up the excavation to such a depth that it would be a vast and expensive undertaking to excavate it so as to again expose the fossil bed. At the cut-off the fossil bed is not so thick; but it was crowded with fossils that have gone to enrich the cabinets of the country.

I should have stated that the two massive blocks of limestone, above alluded to, in the cut-off and the Rush Creek locality, furnished the fossils for the excellent monograph on carboniferous fossils published by Norwood and Pratten, also a subsequent publication by J. H. McChesney.

Any one wishing to study the fossils of these famous localities must visit the extensive collection made and owned by Mr. James Sampson, of New Harmony. Every available part of his residence contains cabinets that are filled with fossils and other objects of natural history. But it is when you enter what he calls his "sanctum sanctorum" that one is bewildered with the vastness of his labors in bringing together the natural history of this renowned region of the State. There are two rooms to this temple of science. The first one you enter contains his work bench, around which is to be found a multitude of tools suitable for all kinds of work. In the center is a round table for books, papers, etc. The ends are filled with cabinets and shelves, crowded to their utmost capacity with choice specimens. The ceiling overhead is completely covered with prepared specimens of fishes, cheloniæ, snakes, etc., etc. The next room has its sides and ends filled with cabinets from top to bottom, and in the central space, leaving a narrow walk on each side, is also a string of cabinets. Here are to be seen Indian relics of all kinds, among which are a great many that are rare and precious. In others are the prepared skulls of all the birds and quadrupeds of the district, feet of birds, etc. There are rows of bottles filled with reptiles. Here, again, every available spot on the ceiling is covered with heads and skins of animals.

When you have finished looking through this vast museum, you will not fail to be impressed with the amount of labor required, through the single exertions of one man, to hunt them up and clean the fossils from their rock matrix, more or less difficult to remove, and place everything away in admirable order. Mr. Sampson is now 77 years old, and is still a hale and hardy man, and just as full of enthusiasm for collecting as in his younger days. He walked with me to visit many localities and, on returning in the evening, showed no signs of the least fatigue—in fact, was not nearly so tired as I found myself.

Mr. Sampson is not the only collector and naturalist at New Harmony, for this is also the home of Prof. Richard Owen, the former State Geologist of Indiana, and for many years Professor of Geology and Natural History in the State University, at Bloomington. At the time of my visit, this distinguished scientist and author was absent, with his wife, on a visit to the Southern Exposition, at Louisville. I met him on the cars as they were returning home, but, being on the way to Griffith Station, I was sorry that I could not accept his kind invitation to pay him a visit.

I found that Mr. John Chappelsmith had, on the death of his wife, returned to England. He lived for many years in New Harmony, and drew all of the fossils that were described by Prof. E. T. Cox, and figured in the 3d Kentucky Report. He was a skilled artist and engraver. I spent an afternoon at Mrs. Thomas', looking over several scrap books that contained specimens of drawings and steel-plate engravings. They were admirably drawn and showed great skill.

The calcareous shales of the cut-off and Rush Creek are also seen in the bank of the Wabash River, at Grayville, Illinois, twelve miles above New Harmony. At the latter locality, it is highly fossiliferous, and there is a band of ironstone just above it, which has furnished a large number of remarkable *Cephalopoda*, *Lamellibranchiata*, *Brachiopoda*, *Gasteropoda*, *Pteropoda*, *Bryozoa*, and corals. Like Rush Creek and the cut-off, this also has been a place of great resort for the New Harmony naturalists, and has furnished specimens that were new to science.

William Maclure, who purchased one-half of the town of New Harmony from Robert Owen, in 1825, for the purpose of promoting a love for natural history, was, himself, one of the earliest workers in geology, and, indeed, might properly be classed as one of the founders of the science. He crossed the Alleghany Mountains many times on foot, to study their rocky structure, and lived long enough to see his conclusions, which were published in book form, verified by the research of modern students. Associated with him at New Harmony was Thomas Say, styled the great American naturalist; C. A. Leseuer, the great artist and ichthyologist of the expedition of La Peruse, fitted out under the auspices of Napoleon I, to explore Australia; D. Troost, the eminent geologist and mineralogist, who afterwards moved to Nashville, where he died, leaving a cabinet of great scientific value. These eminent men were followed by the late David Dale Owen, M. D., and his brother, Prof. Richard Owen, who came to New Harmony in 1832, fresh from the schools of Europe. Dr. D. D. Owen commenced at once to arrange a chemical laboratory and museum of natural history on a scale that, in those days, had no superior in this country. William Maclure turned over to him his vast collection of rocks and minerals that had been made in Italy, Spain, Portugal, West Indies, Mexico and France, at a great cost. So vast was this valuable collection that many boxes remained unopened up to the time of their removal to the State University at Bloomington. In 1837, D. D. Owen was appointed United States Geologist, with headquarters at New Harmony. He was instructed to make a reconnoisance of what was then the Great Northwest, now Minnesota, Wisconsin, Iowa, and the northern part of Illinois, in order to point out, for preservation by the Government, the salt springs, lead and other mineral-bearing rocks, previous to offering the lands for sale. This herculean task was accomplished in two months, and the report laid before Congress at the opening of the next session. Several hundred men were employed in making the survey. They were divided into companies, having an intelligent head to look after the work, and each company was allotted a district, in which every section was to be visited and samples of the rocks collected. At stated points, Dr. Owen would meet each camp, and study the work accomplished. The country was almost without settlements, and each camp had to be supplied with hunters, whose duty it was to furnish game for subsistence.

In looking over Dr. Owen's report, one can not fail to appreciate the skill and fidelity with which this great geologist performed this survey under immense difficulties and in such a short time. He carried with him on the trip up the Mississippi a suite of rocks and minerals, which were exposed on a table in the cabin of the steamboat, and he would daily give his men instruction in geology and point out the characteristic rocks of the leading formations and the minerals that it was likely would be found in them. In this way, by the time they reached the place to disembark, they had been made acquainted with the first principles of geology. In after years, this great region was more systematically surveyed by Dr. Owen.

The headquarters of the United States Geological Survey continued at New Harmony up to 1856. Among the geologists connected with these surveys, who spent more or less time at New Harmony, were Dr. J. G. Norwood, B. F. Shumard, Dr. Litton, Col. Charles Whittlesy, the veteran geologist, Dr. Locke, F. B. Meek, the eminent paleontologist, and others.

After the completion of the Smithsonian Institution building at Washington, the headquarters of the Government surveys were established in that city.

Dr. Owen was placed in charge of the Kentucky survey and the Arkansas survey, with Dr. J. G. Norwood in charge of the Illinois survey, and Prof. Richard Owen in charge of the Indiana survey, all of whom had headquarters at New Harmony, where the advantages of comparison could be found in the extensive cabinets of the Owen collection. New Harmony, then, became the resort of a great many geologists, some of whom made it their home. I may mention among these, as connected with the Kentucky survey, Maj. Sidney Lyon, Prof. E. T. Cox, Leo Lesquereux, Mr. Nicholson, civil engineer and topographist. In the Arkansas survey, E. T. Cox, Leo Lesquereux, Dr. Elderhorst (author of "Elderhorst on the Blowpipe"), and Joseph Lesley; on the Illinois survey, J. G. Norwood, chief; Henry Pratten, J. H. Wolfers, Dr. Varner, A. H. Worthen and J. H. McChesney. In the Indiana survey, Richard Owen and Leo Lesquereux. From this, it will be understood why New Harmony became a kind of Mecca for geologists and naturalists. Subsequently, A. H. Worthen became State Geologist of Illinois, and the headquarters was moved to Springfield. Prof. E. T. Cox was appointed State Geologist of Indiana in 1869, and the headquarters of the survey was established at Indianapolis.

ECONOMIC GEOLOGY.

The survey is indebted to the favor of Gen. Alvin P. Hovey for the following paper on the common sense interests of Posey county, and it is so reliable and pointed that it is given verbatim:

Posey county was organized in 1814 and named in honor of one of our Territorial Governors, Gen. Thomas Posey.

It lies in the extreme southwestern part of the State, and is bounded, on the south and west, by the Ohio and Wabash Rivers, for the distance, by their sinuosities, of at least one hundred and forty miles.

The topography of this part of the State is but very imperfectly known abroad. The great body of the county is gently undulating. Large tracts of rich black soil are found in level lands or flats of Black River, Big Creek and Point townships, which are above all overflows of the Ohio and Wabash Rivers.

There is a general misapprehension as to the "bottom land" of the rivers. Commencing where the southeastern line strikes the Ohio River, following it down to the Wabash, and, thence, up the Wabash, to the northwestern corner of the county, near Grayville, Illinois, a strip of land on the margins, not exceeding a half a mile in general width, forms the celebrated "bottoms," or corn lands, of Posey. These bottoms have given the travelers on the river the general idea that the whole of the county is a level swamp. Commencing at Mt. Vernon, and running north to Cynthiana, it can be safely said, that no finer or better land can be found in this State, or any other part of the United States. The best of water is found in every locality, and a failure of any crop is unknown to the oldest inhabitant. There are many fine fields of wheat which have been cultivated for fifty years, and producing more now than they did in former years. It has a rejuvenating subsoil, that seems to be exhaustless and improves on continued cultivation. In wheat, it is the banner county of Indiana, the "Banner State," and produces over 4,000,000 bushels of corn, or maize, with a capacity, when fully developed, of almost doubling its present productions. Below is given an abstract taken from the office of the Auditor, for 1883—that for 1884 is not yet complete, and may be increased by at least ten per cent.

1883.

Acres of wheat	60,693
Acres of corn, up-land	79,641
Acres of corn, bottom land	13,372
Acres of oats	3,615
Acres of barley	101
Acres of rye	104
Acres of Irish potatoes	760
Acres of sweet potatoes	99
Acres of timothy hay	5,042
Acres of clover	12,087
Acres of blue grass	1,234
Drain tile, rods	89,346

I will only observe that our wheat averaged about eighteen bushels per acre, which would amount to about 95,000 bushels; corn land at least forty-five bushels per acre, or over 4,000,000 bushels; besides other grain. There are probably about 20,000 acres of good land held by their owners out of cultivation as timber land, which is of the best quality.

There are outcroppings at West Franklin, ten miles above Mt. Vernon, and on the Grand Chain, on the Wabash, of sandstone and bastard lime-rocks, but of no considerable quantities. There can be but little doubt that the whole county is made land, with the usual coal formation in this locality; and vein M., worked at Evansville, Shawneetown, Henderson, and other surrounding localities, clearly prove the existence of the same formations here. There are eight or more spots in the county, at different points, where coal, in the upper or thinner veins, crop out. The working vein at Mt. Vernon will, probably, be found at about 200 feet below the surface, and a company is about to be formed to sink a shaft on the Ohio, near Mt. Vernon. The highlands, commencing at the upper part of the city of Mt. Vernon, and extending about eight miles below, are above the highest water of the Ohio River, and are destined, at no distant day, to be covered with manufacturing establishments. There is no other locality on all the banks of the Ohio River, from Pittsburgh to its mouth, where eight continuous miles of high banks, above all high water, can be found. It will be the foundation for a future great city; for as the drainage of all the table lands of the Ohio valley are speedily thrown into the river, by the hundreds of thousands of miles of tiling and artificial ditches, the river will be annually subject to increasing overflows, until manufacturers will be compelled to abandon all overflowed localities and seek positions above the swelling waters.

Without doubt, there is a bright future for Posey. No other county of the same number of square miles has the same agricultural advantages. Every part of her one hundred and forty miles of river, and her eighty miles of railroad running through her lands, offer to the agriculturist markets for the vast quantities of grain grown upon her soil. The rivers compete with the rail, and the rail with the rivers, for low freights, and the agriculturist, instead of being at the mercy of one kind of transit for his produce, has his option to select another.

ARCHÆOLOGY.

Posey county was the center of mechanical skill in the time of the Mound-Builders. Copper was beaten into thin plates, for buttons, gorgets and tiny bells; obdurate flint was polished as are Danish flints; shells from the ocean were pierced and polished for ornaments; beautiful vases and vessels were made in perfect symmetry; and the native pearls of the Wabash were prepared and pierced to serve as beads.

Several good-sized mounds were seen on the bluff, one hundred and seventy feet above the Ohio, at West Franklin, giving a wide out-look over the beautiful river and its rich valley lands.

A clump of mounds on the bluff overlooking New Harmony attracted the attention of our early scientists. One was opened and described by Leseuer. At the same town the old German burial ground is dotted with mounds, showing the taste of our predecessors for beauty in aspect and situation.

TABLE OF ALTITUDES AND DISTANCES,

With Elevation at Low Water above the Level of the Sea, on Wabash River between Terre Haute and Mt. Carmel, and on White River between its mouth and Hazelton. Distances taken in steamboat channel at low water from maps made from recent surveys.

WABASH RIVER.

LOCATIONS.	Miles from Wagon Bridge at Terre Haute.	Miles from Wagon Bridge at Vincennes.	Elevation of Low Water Above the Sea in Feet.
Main Street Bridge, Terre Haute	0.00	90.00	447.73
Foot of Island	1.60	88.40	446.32
Sugar Creek	2 50	87.50	445.88
Old Terre Haute, Ferry	4.55	85.45	445.41
Musgrave's Ripple (head) (Fall, 1.04 ft.)	7.20	82.80	444.12
Eight Mile Island (head)	7.80	82.20	442.93
Eight Mile Island (foot)	8.10	81.90	442.49
Hawk's Creek	10.95	79.05	442.11
Goose Nest Island (head)	12.70	77.30	441.92
State Line, Corner Stone	14.65	75.35	440.60
Strain's Ripple (head) (Fall, 1.20 ft.)	16 35	73.65	440.27
Turkey Reach, Ferry	18.10	71.90	438.71
Big Creek	18.70	71.30	437.70
Creek at Head of Aurora Bend	20.95	69.05	436.55
Foot of Aurora Ripple (Fall, 1.16 ft.)	21.70	68.30	434.75
Darwin Ferry	23.60	66.40	433.78
Darwin Landing	23.80	66.20	433.60
Bowen's Ripple (head) (Fall, 0.66 ft.)	25.50	64.50	432.68
Prevo's Landing (warehouse)	26 45	63.55	432.00
Little Sycamore Bend (head of bar)	27.90	62.10	431.57
Bridge Piers, Chenowith's Reach	29.15	60.85	431.26
Prairie Creek	30.40	59.60	430.95
Niles' Landing	32.10	57 90	430.15
Devil's Elbow Ripple (head) (Fall, 1.54 ft.)	35.40	54.60	429.56
Mill Creek, at York	36.40	53.60	427.71
Green's Ripple (head) (Fall, 0.66 ft.)	38.10	51.90	427.29
Raccoon Creek	39.35	50.65	426.46
High Water Cut-off, Hackberry Bend	41.10	48.90	425.84
Foot of same	43.20	46.80	424.69
Hutsonville Ferry	43.50	46.50	424.63
Hutson Creek	44.10	45.90	424.30
Head of Island	45.25	44.75	423.77
Turman's Creek	46.20	43.80	422.68
Harney's Landing	47.80	42.20	422.17
Merom Island (head)	50.05	39 95	420.88
Merom Ferry	51.00	39.00	420.81
Eagle Island (head)	53.00	37.00	419.41
Narrow Gauge Bridge	53.80	36.20	418.78
Greer's Ripple (head) (Fall, 1.08 ft.)	55.20	34.80	418.43
Palestine Landing	57.75	32.25	416.71
Turtle Creek	60.75	29.25	415.10
Hite's Ferry	61.85	28.15	414.71
McCutcheon's Slough	63.45	26.55	414.00
Shaw's Landing	65.70	24.30	412.70
Longtown Landing	67.70	22.30	411.42
Foot of Cut-off, Johnson's Ripple	70.30	19.70	409.49
Horse-shoe Cut-off (head)	71.20	18.80	409.79
Doe Creek	71.60	18.40	409.69
Swan Island	74.00	16.00	407.46
Goose Bar	75.15	14.85	406.75
Russellville Sawmill	77.20	12.80	405.28

WABASH RIVER -Continued.

LOCATIONS.		Miles from Wagon Bridge at Terre Haute.	Miles from Wagon Bridge at Vincennes.	Elevation of Low Water Above the Sea in Feet.
Belgrade Landing		81.50	8.50	403.42
Seven Mile Island (foot)		84.00	6.00	401.96
Massey's Bend Ripple (foot)	(Fall, 0.35 ft.)	85.00	5.00	401.32
Fort Knox		86.30	3.70	401.09
Soap Creek		88.40	1.60	399.81
R. R. Bridge, Ohio & Mississippi		89.55	0.45	398.97
Wagon Bridge, Vincennes		90.00	0.00	398.81
Embarras River		95.75	5.75	394.85
Nine Mile Island (head)		98.45	8.45	394.61
Nine Mile Ripple (head)	(Fall, 1.40 ft.)	98.85	8.85	394.45
R. R. Bridge		99.50	9.50	392.83
St. Francisville Landing		102.90	12.90	391.46
Raccoon Creek		106.90	16 90	389.91
River Deshee, Head of Cat-fish Bend		109.30	19.30	387.96
Little Rock Ripple (head)	(Fall, 1.80 ft.)	112.00	22.00	387.66
Beadle's Dam Ripple (head)	(Fall, 1.30 ft.)	114.75	24.75	385.40
Buchannan's Ferry		116.40	26.40	383.40
Hanging Rock	(Fall of Ripple, 1.25 ft.)	118.75	28.75	382.55
Grand Rapids Dam	(Fall of Ripple, 4.50 ft.)	121.10	31 10	378.68
Hurd's Ferry		121.50	31.50	376.76
White River, "The Point"		122.55	32.55	376.55
R. R. Bridge, Louisville, New Albany & St. Louis		123.70	33.70	. . . . .

WHITE RIVER.

LOCATIONS.		Miles from Mouth of White River.	Miles from Hazelton Ferry.	Elevation of Low Water Above the Sea in Feet.
Mouth		0.00	18.30	376.55
Ferry		2.95	15.35	376.73
Kelley's Ripple (foot)		3.30	15.00	378.07
Kelley's Ripple (head)	(Fall, 1.80 ft.)	3.70	14.60	379.95
Bingham Place		5.05	13.25	379.46
Outlet Spring Lake		7.00	11.30	379.72
Slough, Foot of Bar		9.00	9.30	380.16
Field's Ferry		10.75	7.55	380.94
Ripple (foot)	(Fall, 0.20 ft.)	14.00	4.30	383.34
Worth's Ripple (head)	(Fall, 0.80 ft.)	16.00	2.30	385.69
Hazleton Ferry		18.30	0.00	387.05
R. R. Bridge, E. & T. H.		20.80?	. . . . .	388.82

NOTE—The first three of the low water elevations given above for White River, are taken from a survey made in 1879; the others from a survey made in 1880. Distance from mouth of White River to Mt. Carmel R. R. Bridge is 1.15 miles.

The above distances and elevations have been carefully compared and corrected by Jared A. Smith, Major of Engineers, U. S. Army, to whom thanks are returned.

GEOLOGY OF MORGAN COUNTY.

BY RYLAND T. BROWN, A. M., M. D.

GEOGRAPHICAL AND HISTORICAL NOTES.

Morgan county covers an area of 409 square miles, lying in an irregular square, the eastern and southern boundaries being unbroken section lines, while the northern line has an offset of two miles, and the western one an offset of three miles, and an irregularity at its northern extremity caused by Mill Creek forming a part of the line. Morgan county is bounded on the north by Hendricks and Marion, on the east by Johnson, on the south by Monroe and Brown, and on the west by Owen and Putnam counties. It was organized in the spring of 1822 by the appointment of Benjamin Hoffman, Jonathan Williams and Larkin Reynolds, County Commissioners, George H. Beeler, Clerk, and Benjamin Cutler, Sheriff. These appointments were made by the Governor, and the commissioners proceeded to divide the county into civil townships and complete the organization by ordering an election for the remaining county and the township officers.

The first permanent settlement of white inhabitants in Morgan county was made in the spring and summer of 1819, on the southeast side of White River, between the mouth of Crooked Creek and the bluff, where the village of Waverly now stands.

Soon after the ratification of the treaty of St. Mary's (in the autumn of 1818), extinguishing the Indian title to all the land lying in the central portion of the State, an idea became prevalent that the four sections of land donated to the State for a capital by the act of Congress admitting it into the Union, would be located near the bluffs of White River. This brought a number of adventurers into the wilderness, even before the land was surveyed. This settlement before the close of the year 1819 had swelled to the number of about a dozen families, which served as a kind of center of distribution for subsequent immigration.

Cyrus Whetzel, who located his cabin near the mouth of Bluff Creek, had opened a trace through the forest from the older settlements on White Water, and for several years afterward "Whetzel's trace" was an institution familiar to all emigrants from the east to Central Indiana. Hiram

T. Craig and James and Robert Stott, who settled at the mouth of Crooked Creek, two miles below Whetzel's, had also opened a trace from Vernon, by the mouth of Flat Rock, now Columbus. This opened a communication with the southern settlements of Indiana, and gave this early pioneer colony a prominence, and, indeed, made it the parent of numerous other backwood settlements.

The county, at present, is divided into fourteen civil townships, arranged in four tiers, north and south, beginning at the north end of the eastern tier, as follows: First, Madison, Harrison, Greene and Jackson; second, Brown, Clay and Washington; third, Monroe, Gregg, Jefferson and Baker; fourth, Adams, Ashland and Ray. These are quite irregular, both in size and form, several of them having White River for one boundary, which gives a very irregular margin.

The principal towns are Martinsville, in Washington township, the county seat; Mooresville, in Brown; Brooklyn and Centerton, in Clay; Waverly, in Harrison; Morgantown, in Jackson; Paragon, in Ray; Alaska, in Ashland; Eminence, in Adams; Hall, in Gregg, and Monrovia, in Monroe.

DRAINAGE AND TOPOGRAPHY.

White River traverses Morgan county diagonally from northeast to southwest, and, with its tributaries, furnishes ample drainage for the whole county, with the exception of Adams and a part of Ashland townships in the northwest corner of the county, which are drained by tributaries of Eel River. On the southeast side, White River receives Bluff Creek, Crooked Creek, Stott's Creek, Clear Creek, Indian Creek, Little Indian Creek and Bryant's Creek. From the opposite side, it receives White Lick, Sycamore Creek, Highland Creek, Lamb's Creek, Burkhart's Creek, Fall Creek and Butler's Creek. Running westwardly into Eel River, we have Lake Creek, Mud Creek and Rhoades' Creek. These complete a most perfect system of drainage, and, at the same time, supply the country with water from numerous springs which break out along their several courses. White River is a large stream, having been declared a public highway for navigation by act of Congress before the land was surveyed.

In the early years of the settlement of this county, flatboats loaded with produce, were occasionally floated to New Orleans, at the time of spring freshets in White River, and in the spring of 1824 a stern-wheel steamboat made its way up this stream as far as Indianapolis. But since the forests have been cleared away, the streams have greatly diminished in size and persistence of volume, though, if there was a demand for it, White River could still be used for flatboat navigation at the time of spring floods; but railroads having supplied the demand for transportation, the river is no longer used for that purpose. The general course of White

River through Morgan county is more direct than it is above this, and a number of short curves and "horse-shoe bends," which existed when the bottom lands were covered with timber, have been relieved by the wâter making a new channel or "cut-off" since the forests were cleared away. A cordon of rocks form rapids in the river in section 32, range 1 east, township 12 north, in which the river has a fall of four feet in half a mile.

Several of the tributaries of White River, above named, were, formerly, regarded as valuable mill streams, but at present they are nearly dry during the summer and fall months, and are, therefore, practically worthless for mill purposes.

In its general surface, Morgan county is more diversified than most other counties in the State. A belt of country along the northern border of the county, embracing Madison, Brown, Monroe and Adams townships, is quite level, or, at most, not so broken as to materially interfere with cultivation. It is covered with a deep deposit of drift material, forming a soil more largely mixed with sand than the clay soil of the regions further north. It is, therefore, a friable, mellow soil, easily cultivated and very productive. Adams, and the western half of Monroe township, present large tracts of black-muck swamp lands, that were originally covered with water a great part of the year; but ditching and underdrainage is converting these swamps into the best of farm lands, especially adapted to the production of corn. This region was originally covered with a heavy forest of white oak, burr oak, ash, beech, sugar maple, black walnut, yellow poplar (tulip tree), hickory, etc. But little of this, however, remains. Much of it was displaced to make room for cultivation, and the recent demand for walnut, poplar, ash and oak lumber has thinned out most of the choice timber from the forests that remain.

Directly south of this belt, and embracing the greater part of Clay, Gregg and Jefferson townships, lies a region of knobs, but little of which is level enough for profitable cultivation. The hills, in some places, rise to the altitude of three hundred feet above the level of the river, and are frequently so steep as to make the ascent difficult, even on foot. The surface soil of these knobs is generally clay, with but a very thin coat of vegetable loam covering it. It, however, produces a good growth of grass, and both peach trees and apple trees make a vigorous growth on it, and appear to be long-lived. These knobs, therefore, may be utilized for pasturage and fruit culture. The forest on these hills was originally a rather small growth of white oak, jack oak, black hickory, with an occasional grove of sugar maple. Much of this timber has been sold—the oak for railroad ties and the hickory for wagon timber.

West and southwest of these knobs lie Ashland and Ray townships, the uplands of which consist of an elevated plain of clay lands, interspersed with an occasional spot of very rich loamy soil. In places it is broken by numerous funnel-shaped depressions, familiarly known as sink-holes.

Some of these are thirty feet deep and embrace half an acre of surface. The hills bordering the streams are in many places abrupt bluffs of limestone. The timber here very nearly answers to that on the northern tier of townships, with the absence of the burr oak. Some of this land will be improved by underdraining, when it will produce well.

The uplands in the townships of Harrison, Greene, Jackson, Washington and Baker, lying on the southeast side of White River, are more uniform in their character than those on the opposite side of the river. In the vicinity of White River, the surface in many places is quite hilly and the general elevation of the country is about two hundred feet above the level of the river. But these hills are seldom so steep as to materially interfere with cultivation. The soil on them is generally a sandy loam.

After passing back from the river hills two or three miles, the surface becomes gently undulating, and in many places quite level, while the soil changes from a sandy loam to a compact clay loam, resting on a rather hard clay subsoil. These lands will require tile drainage to develop their full producing capacity. Under proper treatment there are but few soils that will be more productive or more pleasant to cultivate than the land on the eastern border of Morgan county.

White River, in its course, developes a very wide margin of bottom land, about two-thirds of which lies above the reach of freshets, and that which is subject to overflow is seldom visited by this catastrophe except in the spring months, and the crop on these lands being generally Indian corn, can be planted after the freshet has subsided, and a heavy yield secured, for these lands are inexhaustively productive. While the bottom lands are distributed pretty uniformly along the river (for the hills are seldom less than a mile apart), yet the large districts of bottom lands may be considered in three groups, to-wit:

The Centerton, or White Lick, bottom, is about five miles long, and in several places, more than two miles wide. Lamb's bottom extends from the rapids of White River, nearly opposite to Martinsville, to a point some distance below Paragon, giving an area of about twenty-five square miles, most of which is above high water. Indian Creek bottom, on the southeast side of the river, extends from Martinsville to the west line of Washington township, a distance of about six miles, with a width of from one to three miles. In this bottom, in section 17, range 1 east, township 11 north, there occurs the curious phenomenon of a "lost hill," as it is familiarly called. This consists of a hill about one hundred feet high, nearly a mile long and a quarter of a mile wide, detached from the main upland by a strip of bottom land half a mile wide, more or less. The hill consists chiefly of a mass of heavily stratified sandstone. Indian creek bottom is much of it subject to overflow—more, however, from the freshets of Indian Creek than from the floods of White River. Like all other alluvial lands, these bottoms are generally built on a substratum of gravel, which gives perfect underdrainage to these broad, level plains, that renders them exceeding productive. I observed a spot in the Centerton bottom, and one or more in Lamb's bottom, that were exceptions to this rule. These are composed of a sedimentary deposit of a very fine, light-colored clay. The bricks used in the construction of the new State Capitol are made from this Centerton deposit and it proves to be an excellent material for the purpose. The manner in which these large districts of bottom land were formed, and the nature of the forces operating in their formation, will be considered in their proper place; at present we speak of them only in their economical relation, as furnishing an area of more than fifty square miles, in this county, of land which has no superior in points of productiveness, durability and adaptation to a variety of crops.

GEOLOGY.

The underlying rock of nearly the whole of Morgan county is the knob sandstone, which is now generally regarded as the lowest member of the Carboniferous formation. Measuring its outcrop from its junction with the Devonian shale on Bluff Creek, in Johnson county, along the line of strike to the point of its disappearance under the Keokuk limestone, near the corner of Owen county, and allowing it a dip of twenty feet to the mile, we may assume the thickness of the knob sandstone at this point to be about five hundred feet. This corresponds very nearly to the register of the boring at Reelsville, in Putnam county, where a thickness of four hundred and eighty-eight feet was reported. The base of this formation consists of a clay shale, thinly laminated but not distinctly stratified. This shale, when moist, has a pale blue color, but when dry it is ash colored. When exposed to the weather, it crumbles into a mass of sandy clay, with scarcely enough iron in its composition to tinge it red when burned. This shale has occasional bands of a hard, blue rock, from three to ten inches thick, interposed at irregular distances. These rocks are siliceous, though they have not the mechanical structure of sandstones. They are generally smooth and parallel on their faces, but, lacking elasticity, they endure change of temperature badly. Their hardness and firm appearance have often misled builders to use them in preference to the softer but more durable sandstones. The entire absence of fossil remains is a rather remarkable feature of this shale, for though it had, probably, neither lime nor silica in a proper state to produce petrifactions, yet it appears to have been an excellent material to receive impressions and retain them in the form of moulds or casts; but a diligent search revealed no such marks of organic remains. A few crinoid stems and an indistinct impress of a coral, found near Waverly, was the only evidence of life which I observed in this extensive deposit of shale. This is the more remarkable as it is in a shale corresponding to this, and nearly on the same horizon, that the noted crinoid beds of Crawfordsville are found. At a point, however, five miles below this, on the southeast side of the river, near the mouth of Clear Creek, a bed of argillaceous sandstone occurs, which abounds in fossils, though the species are not numerous. We obtained *Taonurus Colletti*, *Zaphrentis Dalei*, *Spirifier Carteri*, *Productus semi-reticulatus*, *Productus costatus*, and fragments of several unidentified species were also observed.

The upper members of this formation present a distinctly stratified sandstone, generally of a gray, or light drab color, sometimes showing a distinct shade of buff. The lower members of this series are often so largely mixed with clay as to destroy their value as a building material. This clay gives a more or less distinct blue shade to the stone; and though it is generally harder than the purer sandstone, yet, on exposure to the weather it disintegrates rapidly. In selecting building stone from this formation *it will be safe to reject all that have the blue or lead colored shade.* Higher in the series, and generally crowning the highest elevations, we find a fine-grained sandstone, in strata ranging from one foot to five feet thick. This stone is quite soft in the quarry, and this feature of its character has deterred architects from adopting it as a building stone. But when it loses its quarry moisture, and is once thoroughly seasoned, it becomes very firm and hard, and absorbs but little water when exposed.

The chief defect I observed in this rock, as a building material, is the occasional occurrence of small specks of oxide of iron that may produce unsightly stains; but these are small, and, in the thicker strata, of rare occurrence. Care must be observed in quarrying this rock. Like most sandstones, the grains cohere with but little force in the quarry condition, and even a very moderate blast will shatter the firmest rock in these quarries for a distance of fifteen feet or more, so as to render it practically worthless. Blocks may be taken out very rapidly and neatly with a channeling machine, or with steel wedges, even without drilling.

The outcrop of this rock occupies the summit of the hills on the southeast river front, from the mouth of Bluff Creek to Martinsville with but two or three interruptions, the widest of which is at the mouth of Stott's Creek. But few quarries, however, have been opened, and these have not been worked to any considerable extent, and generally with but little skill or science.

Mr. S. J. Mandeville has opened a quarry at Peach Orchard Hill in section 6, range 2 east, township 11 north, and is taking out a good quality of stone, and exhibiting both science and skill in the operation. The strata in this quarry now exposed range from two feet to five and a half feet thick, and the stone is very uniform in its texture. It shows but few iron specks and no petroleum stains that disfigure many of the Ohio and Pennsylvania sandstones.

This is the only point in the county where the working of the quarry gave me a fair opportunity to judge the quality of this stone as a building material, and, after examining it, both in the quarry and in its dressed and seasoned condition, I have no hesitancy in saying that it will fairly compete with the best Ohio sandstone, both in point of beauty and durability. Mr. Mandeville's quarry is eight hundred and sixty-two feet above tide water and two hundred and sixty-five above Martinsville.

It is not improbable that stone of a quality equally as good as this at the Peach Orchard quarry may be found at other points in the county, and more convenient to railroad transportation than this is; but the quarries are not opened, or have been so imperfectly worked that it is difficult to form such a judgment of the stone as if it were exhibited under more favorable circumstances.

One mile east of Mooresville a quarry has been worked by an Indianapolis company for the last five years, and a large amount of stone, of a fair quality, has been taken out. This quarry is too low in the formation to yield the best quality of stone. The strata do not exceed eighteen inches thick, and in some of the strata there is too much clay in the composition to be entirely reliable in exposed situations. This quarry is the nearest workable outcrop of rock to Indianapolis; and with a railroad switch to the quarry, and proper care in selecting the rock, this quarry may be very profitably worked. A mile west of Waverly an outcrop of sandstone appears in several places, which gives promise of valuable quarries, but they have not been worked sufficiently to determine fully the character of the rock. The strata, where exposed, are from twelve to twenty inches thick, and generally of a drab or light buff color, and of a very fine grain.

From the exposure of this rock at "The Bluffs" (now Waverly), the material was obtained for the foundation of the former court house, the abutments of the National road bridge over White River at Indianapolis, and the basement of the old state house. In the last, the blue stone was unfortunately selected, and its speedy decay brought the stone into bad repute. The bridge abutments and the court house foundations proved reasonably durable.

Nearly all the higher knobs of Clay, Gregg and Jefferson townships are capped with sandstone, though it does not always appear on the surface, and in many places, no doubt, quarries may be opened and worked with profit. This remark, however, can apply only to localities favored with railroad transportation.

The summit of the high hill (known by the local name of Mount Ætna) about a mile southwest from Brooklyn is worth a careful examination. It is proper to say, in this connection, that the exposed rocks on the northwest side of the river, lying nearer the summit of the formation, are more highly charged with iron oxide than those nearer its middle.

SUB-CARBONIFEROUS LIMESTONE.

At the mouth of Rhoade's Creek, near the northwest corner of Ashland township, the Keokuk member of the sub-carboniferous limestone makes its appearance on the eastern bank of the Mill Fork of Eel River. At this point it is thinly stratified and rather argillaceous in its composition, but near Alaska, three or four miles southeast, it is well developed and presents its characteristic fossils. These are quite numerous in the individuals, but embrace only a few species. (See Appendix.)

Three miles south of this, at Porter's Cave, immediately on the Owen county line, the St. Louis member crowns the hill above the cave, while the gorge below is excavated in the Keokuk. Immediately at the junction of these members of the sub-carboniferous limestone, there occurs a single stratum of dolomite, five feet thick. It is quite soft, and has the peculiar unctuous feel, characteristic of magnesian rocks.

PORTER'S CAVE

Is formed by a considerable stream of water, which has cut away the soft magnesian rock, and has worn its way some two feet into the Keokuk strata which forms the floor.

The opening of the cave looks to the southeast, and is twenty-five feet wide, with an average height of seven feet. The roof, for the first one hundred feet, is smooth, and appears to be composed of a single slab of St. Louis limestone. In this distance, the cave narrows to an average width of sixteen feet, with an elevation of five feet six inches. From this point the roof breaks and is irregular, reaching in some places an elevation of from twenty-five to thirty feet. At the same point the walls abruptly recede, and display a room thirty feet wide, with irregular walls, incrusted with adhering stalactites. For the next reach of one hundred yards, the width gradually narrows to ten feet and the roof becomes a gothic arch by the jutting forward of the strata, which are now, in most places, covered by the stalactite formation. The floor is tolerably smooth, and quite free from loose stones. A brisk current of water, from four to ten feet wide and two or three inches deep, runs on the floor, varying its position from side to side, making the frequent crossing of it a necessity. I extended my observation for about four hundred yards, when the water (covering the bottom from side to side) became so deep as to demand waterproof boots, which I had not with me. As far as I explored, the roof continued so high as to permit of walking upright, though I am informed that, further on, it is, in some places, so low as to require the explorer to stoop. The cave has an opening on the opposite side of an elevated ridge, three-quarters of a mile from the outlet I examined. At the first room, one hundred feet from the entrance, there is exposed several strata of limestone, ranging from one to four feet thick, which show a decidedly ōolitic structure. The stone is much harder than the Bedford or Ellettsville stone, but this may be owing to its having been long exposed. Immediately below the cave, the water coming from it forms a cascade by making a leap of thirty feet from the floor of the cave into a wild and romantic glen.

Porter's Cave is directly on the line between Morgan and Owen counties, five miles northwest from Paragon.

The region of country along Butler's Creek, below the cave, including the ridge between that stream and Fall Creek, on the east, gives a remarkable instance of the influence of the geology of a country on its topography and soil. Passing westward over the knobs of Sycamore Creek, Lamb's Creek, Burnett's Creek, and Fall Creek, we observe the sterile soil, with its stinted growth of white oak and black hickory, but, suddenly, on reaching a hill capped with St. Louis limestone, immediately we enter a forest of sugar maple, black walnut, yellow poplar, blue ash, wild cherry, etc. But these rich hills are badly broken by sink-holes.

GLACIAL PHENOMENA.

The drift deposits of Morgan county, like its topography, is varied and very irregular. On the southeast side of the river, the surface deposit is more uniform than on the opposite side. In a few instances, we find the usual deposit of clay, gravel, and bowlders replaced by a heavy deposit of sand, evidently derived from the denudation and destruction of the knob sandstone of the immediate vicinity. This is not distributed uniformly over the surface, making a level plain, as is common with drift deposits, but it gives a surface broken into rounded hills, from fifty to one hundred feet high, suggesting their deposit, by eddies, on the margin of great currents of water. A good opportunity to study these sand hills occurs a little way east of Martinsville, along the northern margin of the Indian Creek bottom. At a large spring, about three-fourths of a mile northeast of Martinsville, I observed the base of the sand deposit resting on the blue clay which generally constitutes the lowest member of the foreign drift. Beyond this, as we recede from the river hills, the drift resumes its usual appearance of clay plains, with occasional bowlders of granite or gneiss distributed over the surface; though these are neither so frequent in occurrence, nor so large, as they are further north.

On the northwestern side of White River, in the northern tier of townships, the drift is deep and continuous, with its base of blue clay, and its upper member of yellow clay, with water-worn pebbles interspersed and an occasional bowlder of granite on the surface. Some of these are very large. On section 4, range 2, township 12, I measured a bowlder of flesh colored granite, with these dimensions: length, 15 feet 4 inches; greatest breadth, 13 feet; height above ground, 11 feet 9 inches. It is an irregular oblong, with the corners well rounded off. It shows no indications of decay. South of an irregular line from Brooklyn to Eminence, the bowlders almost entirely disappear, and, with them, the upper drift also, leaving an irregular deposit of blue clay, constantly broken by the deep ravines which lay bare the underlying strata and cut the country into knobs.

The glacial period has left its footprints on the surface of Morgan county in a manner that time will hardly efface. Beginning at the Mill Fork of Eel River, a little north of Eminence, there is a valley about five miles wide, extending in a northeasterly direction; crossing the valley of White Lick Creek a short distance north of Mooresville, it passes into Marion county between West Newton and Friendswood, and, thence to the valley of White River. From its western origin, to a point in section 1, range 1, township 13, near Monrovia, the valley gradually narrows to a width of about one mile. Originally, this section of the valley was a continuous lagoon, or swamp, locally known as "The Lake"; but now it is drained westwardly into Eel River, by a public ditch, which has become quite a large creek. On the northern side, the depression of this valley seldom exceeds forty feet below the general level of the country, and the descent is commonly quite gradual. On the opposite side, the country rises from fifty to one hundred feet, and sometimes pretty abruptly. From the water-shed near Monrovia, the drainage is eastward, by McCracken's Creek, to White Lick. In this section, the descent gives a rapid current to the water, though the valley maintains a width of a mile or more, with well defined margins, the south side still maintaining the greater elevation. East of White Lick, the outline of the valley is less distinctly marked, yet, on close observation, its course is plainly visible. The topography west of White Lick indicates that this valley was the southern margin of the ice-field for a long time, and received the drainage floods from the disappearing glacier. South of this, I observed no gravel beds, or other evidence of rapid currents that mark a dissolving glacier.

The valley of Indian Creek gives evidence of having been the bed of a glacial river, bearing the same relation to the knobs in Washington township and Brown county that the one above described does to the knobs of Gregg and Clay townships. Several smaller valleys of erosion, that properly may be referred to this period, were observed, but they are not of sufficient importance to require special notice.

The broad valley of White River, in this county, however, is a geological phenomenon that demands careful study. It is evidently a valley of erosion, for the strata in the hills bordering the valley on either side have their natural dip undisturbed, and the several members correspond correctly on opposite sides of the valley. This lies from 250 to 300 feet below the general level of the drift plain forming the adjacent uplands;

and of this depth, at least 200 feet is cut through the rock strata of the Knob sandstone. The area denuded to this depth in the county is not less than 150 square miles. This amount of erosion since the Carboniferous period, by a stream no larger than White River, would be almost incredible; but there is conclusive evidence that, at the close of the Drift epoch, a volume of water passed down the valley of White River vastly larger than that which now flows there, or than that which filled its channel when Congress declared it navigable.

But there is another circumstance which must be taken into the account when estimating this erosion. From fifty to one hundred feet of the lower portion of this rock is a soft clay shale, easily cut away, and, being very fine material, would be transported by even a very gentle current. A torrent of water would rapidly undermine the overlying sandstone, and, falling into the surging current in its soft state, it would be readily ground to sand and carried away. The sand hills in the vicinity of Martinsville give evidence of the burden of sand which that flood carried.

METALS AND ORES.

The base of the Carboniferous formation is frequently rich in iron ores, but in Morgan county it is peculiarly barren in this respect. A few nodules of iron ore were observed in two or three localities, associated with the clay shale so common here, but in no place is it found in such quantities as would promise valuable deposits of ore. Detached fragments of both lead and zinc ores (sulphide) have been picked up in several places in the knob districts; and, at least, in two localities, I observed specimens of galena, in quartz nodules imbedded in sandstone, but in no place could I find a well defined vein, or lead, of sufficient promise to encourage further search for these metals.

In the year 1850, some returned California gold miners observed the characteristic black sand in the ravines, among the knobs of Brown and Morgan counties, and immediately commenced "prospecting." They found gold in most of the ravines of Bean Blossom Creek, in Brown county, and in the tributaries of Sycamore Creek and Lamb's Creek, in Morgan county. Some of the more skillful miners were able to wash out two or three dollars' worth of gold per day for several weeks. But the excitement of an actual "placer mine" in Indiana brought together so many fortune hunters, that every ravine was directly occupied and the sands were soon washed out, and the "gold fever" subsided. Within the last few years the excitement has been revived, and gold-washing, to a limited extent, has been resumed, paying from fifty cents to a dollar per day. The gold is in very thin scales or in almost invisible grains, and is remarkably free from alloy of any kind.

The origin of this gold is a geological problem of some importance, as the underlying rock is of comparatively recent date and shows no indications of trap dykes, quartz veins, or other geological disturbances. The only rational solution of the problem appears to be that which refers the gold to the blue clay, which is the lowest member of the drift. Where the clay forms the summits or sides of the hills, it is washed into gulches by the rains. The lighter and finer particles are borne onward with the current, while the heavy black sand and gold lodge among the rocks in the bottom. But as the lower blue clay is the ascertained matrix of the gold, still the question, How came gold to be mixed with this particular clay, in this special locality? remains to be answered. Two methods of solving this problem have been proposed. The first assumes that the gold-bearing clay of Brown, Morgan and Montgomery counties, in Indiana, certain localities near the Vermillion salines, in Illinois, and a few local spots on the Des Moines, in Iowa, indicate a line of early drift, from regions of gold-bearing quartz, which, being crushed and broken down in its passage, liberated the gold in the form we now find it. The other hypothesis assumes that the lower blue clay contains minute quantities of gold everywhere, and that it accumulates, in appreciable quantities, only in the sands of ravines where the country is hilly and extensive surfaces are washed into streams that are sufficiently rapid to carry away the lighter material and leave only the gold and heavy sand to accumulate, it may be for centuries, till we can detect the presence of the precious metal. But either of these solutions will involve that more difficult question, From whence came the material that now covers thousands of square miles with a talcose clay to a depth varying from ten to five hundred feet? The discussion of this question would be out of place here; and here for the present I leave it, adding, however, the practical caution, that fortunes will never be made by gold-mining in Morgan county.

OTHER MINERALS.

There is a pretty well authenticated tradition that the Indians made salt from water of a spring, or shallow well, on the border of the lake valley, about two miles north of the village of Eminence. I examined the locality with some care, and though I found a large bog spring of common chalybeate water near the location of the traditional saline, yet I found no traces of any excavation, nor of even brackish water. The occurrence of brine, in this locality, however, is not an improbability. In boring through the Knob sandstone at Reelsville and at Terre Haute, brine of fair strength was found; and as the whole depth of that formation lies below this locality, any deep fissure in the rock would be likely to reveal brine. But salt is now so cheap, that its manufacture could hardly be made profitable here.

On the southern border of the town of Monrovia, is a deposit of magnesian clay of a very fine quality. It is quite free from iron, and when burned has a light cream color, similar to Milwaukee brick. It is at present used in the manufacture of drain tile.

Two diamonds have been found in the drift of the Indian Creek valley. One is now in possession of Mr. Harry Craft, a well-known jeweler of Indianapolis. It is cut and set. It had a weight of three carets in its rough state. It was found near Morgantown. The other is somewhat larger, and is uncut. It is in the possession of Mr. Maxwell, who resides three miles south of Martinsville. It was found on his farm. Both of these stones appear to have had an original connection with the drift of Indian Creek valley.

ARCHÆOLOGY.

The Mound Builders have left no remarkable monuments of their occupancy of the territory now included in Morgan county, yet it is quite certain that the large districts of bottom land did not fail to attract the attention of these primitive cultivators of the soil. That a dense settlement —probably a large town—of this race once existed near the mouth of White Lick, is an inference from the numerous small burial mounds in and near the town of Centerton, and from the stone implements, such as axes, chisels, knives, arrows and spear-heads, etc., that are frequently found in this vicinity. But few specimens of pottery have been detected in this county. A large vase, however, was recently found in a gravel pit near Waverly, by a company of workmen who were constructing a road. It was associated with a male skeleton, buried in the sitting posture. It was finely proportioned, richly ornamented, and had a capacity of two or three gallons. Unfortunately the workmen broke it into fragments so small that it was impossible to reconstruct it. I saw a collection of these fragments, which indicated that the original had been a fine work of art. This discovery proves that the Mound Builders did not always bury, even their distinguished dead, in mounds.

About a mile northeast from the town of Paragon, on the point of a high hill which projects into the bottom land, is a lookout mound, commanding a wide view to the southwest. A beacon fire on this mound could be distinctly seen on the range of hills west of Gosport, ten or twelve miles distant. On a similar hill, two miles due north from Paragon is another lookout mound, commanding an extensive prospect to the southeast. Near Brooklyn, on the east side of the Indianapolis & Vincennes Railroad, is a large mound, constructed on the south end of a gravel ridge one hundred yards long. The mound has a base of about one hundred feet in diameter, and rises twenty feet above the ridge on which it stands. It is constructed entirely of gravel, which suggests a doubt of its artificial character. But its regularity, and the depression in the ridge, indicating the place from whence the material was taken that was used in its construction, confirms the opinion that it is the work of human hands, though it may be more recent than the age of the primitive Mound Builders. Passing over a newly-plowed corn field, about a mile west of this, I picked up a stone axe which weighs seven pounds. It is made of a fine-grained gray stone—perhaps a fine granite.

Morgan county was a favorite hunting ground of the Delaware Indians, a principal town of which tribe was located on the west bank of White River, a few miles above Waverly. Game was abundant in the dense forests that covered the broad river bottoms, and the hills furnished winter food in the acorns, beech nuts and other native seeds. Deer, bears and turkeys were abundant, and White River was well supplied with an excellent quality of fish. These, together, furnished the Indian an easy living, which he left with many regrets.

RAILROADS.

The Indianapolis & Vincennes Railroad traverses the county from northeast to southwest. Its road bed and bridges are permanently constructed, and its trains are run with regularity, safety and comfort.

The Martinsville, Franklin & Fairland Railroad is an auxiliary to the Cincinnati, Indianapolis, St. Louis & Chicago Railroad. It furnishes a direct line to Cincinnati, and makes connection at Franklin with the Louisville line. It is in contemplation to extend this road westward, up the valley of Lamb's Creek, to the coal fields of Owen and Clay counties.

The line of a coal road from Indianapolis to the Eel River coal fields has been located through the great glacial valley in the northern part of the county, but adverse circumstances have hitherto interfered to prevent its construction. However, this is but a question of time, for Indianapolis must, before long, have a direct supply of coal, and this line will reach good coal in the shortest distance, on a line of easy construction and low grades. It will, moreover, open a region of agricultural capabilities second to none in the State, and forests of hard wood, which will be invaluable to the manufactories of Indianapolis.

LIST OF FOSSILS IN MORGAN COUNTY.

I collected the following fossils in the strata of Morgan county:

Taonurus Colletti	Knob sandstone.
Zaphrentis Dalei	Knob sandstone.
Spirifer Carteri	Knob sandstone.
Productus semi-reticulatus	Knob sandstone.
Productus costatus	Knob sandstone.
Plurotomaria (Sp.?)	Knob sandstone.
Spirifer Keokuk	Keokuk limestone.
Spirifer Grimesi	Keokuk limestone.
Productus punctatus	Keokuk limestone.
Productus Cora	Keokuk limestone.
Palæacis cuneatus	St. Louis limestone.
Rotalia Baileyi	St. Louis limestone.
Aulopora gigas	St. Louis limestone.
Zaphrentis spinulifera	St. Louis limestone.
Cyathocrinus (Sp.?)	St. Louis limestone.
Fenestella Shumardi	St. Louis limestone.
Archimedes Wortheni	St. Louis limestone.
Orthis dubia	St. Louis limestone.
Athyris subquadrata	St. Louis limestone.
Athyris hirsuta	St. Louis limestone.
Terebratula formosa	St. Louis limestone.
Euomphalus Spergenensis	St. Louis limestone.
Dentalium venustum	St. Louis limestone.

CONNECTED SECTION.

Alluvial (bottoms)	10 to 20 ft.
Second bottom	15 to 30
Lacustral—Loess	5 to 15
Glacial drift, about	100
St. Louis limestone	30
Keokuk limestone	50
Knob sandstone	500
Devonian shale	00
Total	745 ft.

GEOLOGY OF RUSH COUNTY.

BY MOSES N. ELROD, M. D.

GENERAL DESCRIPTION.

Rush county has an area of twenty-three miles, north and south, by eighteen miles, east and west; equal to four hundred and fourteen square miles; and, according to a recent report of the Bureau of Statistics, has 255,315 acres of land returned for taxation. The aggregate taxable property is given as $12,473,020, which, considering that it has no large city within its limits, ranks it as one of the very wealthiest counties in the State. Its *per capita* wealth of $652.18 is second to but one county.

It is bounded on the west by Shelby and Hancock counties, on the north by Hancock and Henry counties, on the east by Fayette and Franklin counties, and on the south by Decatur county.

The title of the Delaware Indians to the territory comprising Rush county was ceded to the United States, by treaty at St. Mary's, October 2 to 6, 1818. The United States' surveyors completed their work July 23, 1819, and April 29, 1820, and the land was offered to purchasers October 1, 1820, at the Brookville land office. Up to the year 1822, the land embraced in Rush county, was attached to Franklin county for judicial purposes. This year the county was organized and the first County Commissioners' Court convened on the first Monday in March. The county was named, at the suggestion of Dr. Wm. B. Laughlin, Government surveyor, in honor of the famous Dr. Benjamin Rush, of Philadelphia. June 17, 1822, the county seat was located, and, by July 29, following, the town was surveyed and lots offered for sale, thus showing that push and energy of the early settlers which still characterizes their descendants.

Rushville, the county seat, is beautifully situated on the right bank of Big Flat Rock River, near the center of the county, thirty-six miles east, and eleven miles south of the Circle Park of the State Capital, and is thirty-nine and three-tenths miles by rail from Indianapolis. It is a handsome city of 4,000 inhabitants, and is rapidly growing in wealth and population. The south, and business part, of the city, including the court house, is located on the river terrace, above high water mark; the residence part of the city lies to the north, on the low uplands, and contains many fine buildings and highly ornamented front yards. The streets are wide and regular, smoothly graveled, paved, lighted with gas and lined with beautiful maple shade trees. The water supply is drawn from inexhaustible wells. The city government is complete, with a uniformed police force, fire department, and everything to indicate a thriving, vigorous town.

Carthage, on Big Blue River, the second place in point of size in the county, is a good town of 600 inhabitants, surrounded by a fine agricultural region.

Milroy is the third town, in size, and, since the completion of the Vernon, Greensburg & Rushville Railroad, has grown rapidly. Its location, nearly equidistant between Greensburg and Rushville, and a good farming community supporting it, promise well for its future.

Moscow, Richland, New Salem, and Raleigh are thriving, pleasant villages, off the railroad lines. Manilla, Homer, Marcellus, Glenwood, Falmouth, Gings, and Arlington are railroad villages, of three hundred inhabitants and less. They are active trading and shipping marts, the outgrowth of the commercial wants of the finest farming and pasture lands in the world.

Rush county is well supplied with railroads, all centering and crossing at Rushville. The Cincinnati, Hamilton & Indianapolis Railroad runs through the central part of the county, from the east to the northwest; the Cambridge Branch of the Jeffersonville, Madison & Indianapolis Railroad (forming a connecting link in the "Pan-Handle system"), crosses the county from the southwest to the northeast; the Vernon, Greensburg & Rushville Railroad (a branch of the "Big Four," Cincinnati, Indianapolis, St. Louis & Chicago Railway) and the Louisville Branch of the Cincinnati & Fort Wayne Road, traverse the center of the county, from north to south.

All pikes and other roads leading out of Rushville are graveled to the out townships, and many of them to the adjoining county lines. The experiment of building free pikes is being tested in some parts of the county. The ordinary dirt roads are good, especially for Indiana, and in summer nothing could be much nicer, but in winter they are fearfully muddy. I was struck with the almost total absence from the road side of the rank and vile weeds so commonly seen in a neighborhood of slovenly farmers.

TOPOGRAPHY.

TABLE OF ALTITUDES, RUSH COUNTY.

Cincinnati, Hamilton & Indianapolis Railroad.

Miles from Indianapolis	POINTS AT WHICH THE ELEVATIONS WERE TAKEN.	Feet above Ocean.
	Indianapolis, East and New Jersey streets	720
1.21	Cincinnati, Hamilton & Indianapolis shops	751
2.8	Belt Railway crossing	784
4.6	Irvington	832
7.2	Morehouse	871
11.0	Julietta	843
14.8	Palestine	844
18.5	Reedville	847
20.8	Fountaintown	854
22.8	Lardona	865
	Big Blue River bridge, grade level	844
	Big Blue River, bed of stream	822
25.4	Morristown	858
28.3	Gwynne's	924
	Beaver Meadow Creek, bed of stream	895
32.3	Arlington	933
	Little Blue River bridge, grade level	927
	Little Blue River, bed of stream	905
	Mud Creek, bed of stream	945
34.9	Brandon	955
	Summit	1,016
39.3	Rushville, level of grade	983
	Flat Rock River, bed of stream	957
44.3	Farmington	1,045
45.4	Griffin	1,062
47.4	Glenwood (Vienna)	1,092
	Summit, natural level of surface	1,116
51.8	Longwood	1,011
	Summit, natural level of surface	1,059
54.7	Tyner's	936
55.9	Salter's Switch	919
57.1	Connersville	844
	Summit, natural level of surface	951
61.5	Lyons	896
	East Fork White Water River bridge	802
	East Fork White Water River, bed of stream	773
65.3	Brownsville	806
	Summit, natural level of surface	1,020
71.4	Liberty	992
	Summit, natural level of surface	1,043
74.3	Lotus	1,055
	Summit, natural level of surface	1,090
76.5	Cottage Grove	1,054
79.4	College Corner	1,002
	State Line, Ohio and Indiana	998
84.9	Oxford, Ohio	930
98.9	Hamilton, Ohio	839

TOPOGRAPHY—Continued.

Cambridge Branch of Jeffersonville, Madison & Indianapolis Railroad.

Miles from Columbus, Indiana.	POINTS AT WHICH THE ELEVATIONS WERE TAKEN.	Feet above Ocean.
	Columbus Depot, base of rail	642
23.86	Shelbyville crossing Cincinnati, Indianapolis, St. Louis & Chicago Railroad	779
	County line, Shelby and Rush, base of rail	905
32.86	Manilla, base of rail	907
	Mud Creek bridge, base of rail	922
	Mud Creek, bed of stream	908
35.11	Homer, base of rail	923
37.72	Goddard's Station, base of rail	952
39.79	Summit of grade, base of rail	1,002
42.19	Rushville station, base of rail	979
	Crossing Cincinnati, Hamilton & Indianapolis railroad, base of rail	983
	Flat Rock River bridge, base of rail	983
	Flat Rock River, bed of stream	966
	Turkey Creek bridge, base of rail	1,002
	Turkey Creek, bed of stream	976
48.31	Ging's Station, base of rail	1,013
49.68	McMillan's Station, base of rail	1,025
	Plum Creek bridge, base of rail	1,029
	Plum Creek, bed of stream	1,016
52.68	Falmouth, base of rail	1,061
55.12	Highest point on Cambridge Branch, base of rail	1,084
63.20	Cambridge City, junction Pittsburg, Cincinnati & St. Louis Railway	952

Vernon, Greensburg & Rushville Railroad.

Miles from Greensburg.	POINTS AT WHICH THE ELEVATIONS WERE TAKEN.	Eeet above Ocean.
	Greensburg Depot, Cincinnati, Indianapolis, St. Louis & Chicago Railroad	954
8.8	Williamstown, county line	954
	Little Flat Rock Creek bridge	958
	Little Flat Rock Creek, bed of stream	935
11.8	Milroy	963
15.3	Bennett's	982
19.0	Big Flat Rock River bridge	951
19.5	Rushville junction with Cambridge Branch Jeffersonville, Madison & Indianapolis Railroad	955

The striking geological facts bearing on the topography and surface configuration of Rush county, deduced from the above tables and others before published in connection with the Geological Survey of Indiana, is the limitation of a part of the western border or crest of the ancient upheaval of the bed of old ocean that has given origin to the Cincinnati arch of the Lower Silurian rocks. The western border of the Cincinnati arch can be readily traced from the summit, near Pearceville, in Ripley county, north, through McCoy's Station and Clarksburg, in Decatur county, through Richland and Noble townships, Rush county; thence, north on the boundary line, and through the western part of Fayette county. The summit of the crest, one and one-half miles east of Glenwood (Vienna), taken at the natural level of the surface of the country, has an elevation of 1116 feet above tide water, which ranks it in altitude as the second highest point yet reported south of Indianapolis, and second only to the celebrated Weed Patch Knob of Brown county, which has an altitude of 1173 feet above the ocean.

The next highest point (1084) reported in this connection, is taken at the base of the rail on the Cambridge Branch Railroad, two and a half miles northeast of Falmouth. This line of elevation is not a high ridge in the sense of an abrupt elevation above the common level of the country; the so-called hills of Fayette, Union and Franklin counties are really not hills, the unevenness of the country being due to valleys cut below the surface. The top of the Lower Silurian outcrop in Indiana, in its early history, was a level plain. From the western border of this arch or plain the land falls away in a gradual slope to the west, and so gradual is the descent that it is not noticed by the casual observer. A reference to the table of altitudes, however, shows a marked difference in the elevations on the east and west sides of the county. The Glenwood summit, it will be seen, is 159 feet above the bed of Flat Rock River, at Rushville, and more than 100 feet above the common level of the country in the central part of the county. From Rushville, west, to the bed of Beaver Meadow Creek, the descent is eighty-eight feet, equal to a difference of 221 feet between the summit and the bed of the creek last mentioned. The Falmouth summit is 101 feet higher than Rushville, and 179 feet higher than the base of the rail at the point where the Cambridge branch crosses the Shelby and Rush county line. The elevations on the Vernon, Greensburg & Rushville Railroad show that there is but one foot difference between the level of Williamstown, at the Decatur county line, and the junction with the Jeffersonville, Madison & Indianapolis Railroad, and that the highest point on the road (Bennett's Station) is twenty-seven feet above Rushville. Two and a half miles west of the Rushville depot, on the Cambridge Road, the top of the grade is twenty-six feet higher than at the depot, and on the Cincinnati, Hamilton & Indianapolis road the difference is twenty feet.

Stretching away to the west, on a gentle slope, rests the broad and fertile acres of Rush county. Over the surface of an otherwise level expanse of country are short, low ridges, and slight mounds of gravel and sand, intermingled with a greater per cent. of clay. None of these elevations exceed twenty feet above the common level, and very few of them reach that figure—there is just enough rise and fall of ridge or mound to relieve the eye of the monotony of a dead sameness. An apparent exception to the above is seen in Anderson and Orange townships, where portions of the country are cut into bluffs and valleys by Big Flat Rock River and its tributary creeks and branches.

DRAINAGE.

The western border of the Lower Silurian (Cincinnati arch), besides its bearing on the topography of the county, determines the course of its rivers and creéks, causing those east of the border, or divide, in Richland and Noble townships, to flow into the White Water River, and those of the rest of the county to unite, as tributaries, with the east fork of White River. With the exception of Big Blue River (which flows through Ripley township, in the northeast corner of the county), all the rivers and creeks of the county have their origin within its limits or near the boundary lines. From this fact, it is manifest that the greater number of its streams are small. Flat Rock River is the most important stream of the county, and, with its many tributaries (the largest of which is Little Flat Rock Creek), drains the northeast, central and southwest portions of the county. The northwest and western portions of the county are drained by Big Blue River and its branches, Little Blue River and Mud Creek.

The flow of its streams to the west and southwest is determined by the general lay of the land already described and the increasing depth and lower level, from the north to the south, of the Collett Glacial River valley, of which Rush county forms an integral part.

In all drift regions, especially where the drift is heavy, as is the case in the north half of Rush county, the rivers and creek channels seldom reach down to the country rock. Below Hungerford's dam, section 4, township 12, range 9, the bed of Big Flat Rock River is generally rocky, and the same is true of Little Flat Rock Creek, below Milroy. With these exceptions, and appearance of stone in the bed of the river, four miles below Rushville, and in Little Blue River, below Arlington, the bed and banks of the streams are clay, gravel, or sand. Flat Rock River, where its bed lies wholly in the drift, has well-marked, level terrace banks, or second bottoms, ranging in width from one-half to one mile, with an average width of three-fourths of a mile in the vicinity of Rushville. The average width of the river-bed, or first bottom, is about 300 feet; height of bank is 10 feet; and the difference between low and high water is 8 to 11 feet. The bluff banks of the second bottoms vary in height from 10 to 50 feet, and, in a few places, may reach even 80 feet. The second bottoms of Big Blue River at Carthage, vary in width from one-half to one mile, with bluffs from 20 to 50 feet high. Here, the river banks average 10 feet in height, and the difference between low and high water is 10 to 12 feet. In the early history of the county, most of the streams, having their origin in the ponds and swamps of the flat lands, were everlasting brooks and branches, which wound their sluggish way beneath the protecting shadows of a dense forest, but, under the improving hand of man, many of them have been changed into artificial ditches that are dry one-half the year. In this fast age, even the creeks and rivers are required to do their work in a hurry; the barriers that once held back the waters have been removed, the very soil, by tilling, deprived of its superabundant moisture, and the floods sent rushing down to the ocean.

GENERAL GEOLOGY.

All the native stone, found in place, in Rush county, belongs either to the Niagara epoch of the Niagara group, Upper Silurian division of the Silurian Age, or the Corniferous epoch of the Corniferous group of the Devonian Age.

CONNECTED SECTION.

QUATERNARY AGE.

ALLUVIAL EPOCH.

Black soil and river deposits . . . . 4 ft.

DRIFT PERIOD.

Bowlders, gravel, sand, yellow and blue clays . . . . 60 ft.

PALÆOZOIC TIME.

DEVONIAN AGE.

CORNIFEROUS PERIOD.

Buff-colored magnesian limestone, lower division of the Corniferous epoch, used for making lime . . . . 30 ft.

UPPER SILURIAN AGE.

NIAGARA PERIOD.

Waldron shale	2 ft.
Gray or blue limestone, building rock	25 ft.
Total	151 ft.

The thickness of each stratum, as given above, is an average of several measurements, made at different points. At some places, the Corniferous group stone has a thickness of less than one foot, at others it exceeds that given. In *time* but two ages are represented, and the country rock underlying the drift forms but a small part of the great geological series. The top members of the Devonian, the whole of the Carboniferous, Reptilian and Tertiary ages are wanting; either they were never deposited over the surface of Rush county, or they have been removed by agencies that have worn away and comminuted their rocky substance to coarse gravel, sand and impalpable clay.

A practical inference from the absence of the rocks of the Carboniferous age, is that no true coal bed will ever be found within the limits of Rush county.

PALÆOZOIC GEOLOGY.

UPPER SILURIAN TIME.

NIAGARA PERIOD.

Commencing with the Niagara group, this limestone is, geologically, the oldest rock seen in the county. I found it an even bedded, crystalline stone, of a drab blue, or gray color, outcropping along the banks of Big Flat Rock River, below Moscow, and from Milroy, south, on Little Flat Rock Creek, in Orange and Anderson townships. It does not seem to form an exposed part of the bluffs on either side of the valleys, and, if it is ever discovered in them, will be found at their base, covered by a heavy stratum of the Corniferous group. As the drift, gravel, sand or clay covers all the stone of the rest of the county, with but a few exceptions in Posey and Rushville townships, it is not possible to exactly define the surface and boundary of the Niagara stone. From the reported results of borings made in the vicinity of Rushville, and the outcrop seen in Flat Rock River, below the city, it is safe to say that wells sunk through the drift in Richland, Noble, Union and Washington townships, will reach the Niagara limestone.

In the central tier of townships—Anderson, Rushville, Jackson and Center—the prevailing stone will depend largely on the irregularity of the surface underlying the drift. The Niagara will probably be found in the low places, and the Corniferous capping the higher, with a preponderance of the latter. Mr. Geo. C. Clark, of Rushville, reports that three-quarters of a mile from the city, up the mill-race, the freshets have exposed a gray limestone, on a level with the bed of Flat Rock River, that is referred to the Niagara group. Driven and other wells, put down in the central part of the county, have struck a similar, if not identical, stone.

No outcrop of the Hudson River group, Lower Silurian, was seen, nor has any been reported, but, possibly, it may be found in some of the ravines or creek bottoms, on the east side of Richland township, under the thinned edge of the Niagara.

No opportunity offered to measure the dip, but the general topography of the county clearly indicates that it is to the southwest, at a rate of not less than sixteen feet to the mile.

In the region of St. Paul, Decatur county, the Niagara limestone has a thickness of not less than forty feet, and, in places, more; but it seems highly probable that, on the south line of this county, it thins out as it approaches the Cincinnati arch. Near the western crest of the arch, the lithological characters of the top members are changed from cherty rubble to an even-textured stone, or the cherty portion has been eroded away; the former is the case with the outcrops seen in Rush county.

Chemically, the Niagara limestone is a carbonate of lime and magnesia, in variable proportions, together with alumina, silica, and oxide of iron in much smaller quantities. The reddish color of weathered specimens of the stone is due to a change of the oxide of iron from a lower to a higher oxide, by exposure. The percentage of silica is greatly increased in the flinty or cherty portions of the top strata, and is aggregated into irregular masses, nodules, and rough tables, that cause the stone, on exposure, to break into fragments. The Rush county stone seen by me is comparatively free from cherty matter, as I have before mentioned; and, hence, the upper ledges are more valuable than the outcrops at some other places. Uniformity of structure is an important element in a durable limestone for building purposes—hard and soft places differ widely in the amount of water the stone will absorb, and so, by freezing, subject it to very unequal strains and cause it to shell and break. Mr. Geo. C. Clark called my attention to the gradual crumbling, to fine fragments, of the court house foundation in Rushville, where, frequently, as much as an inch has been worn away. Whether this erosion was due to atmospheric waste, acting on a stone deficient in the cement that holds the particles together, or irregularity in density, it was not possible to say with certainty, but probably the former; and it may be that the durability of a limestone, aside from the homogeneity manifest to an ordinary quarryman, can be thoroughly tested only by time and exposure. And while but few ledges of this stone seen in Rush county will come up to the high standard required of a first-class building rock, for use in expensive structures, all of it will be found valuable for the thousand-and-one uses to which stone is now applied. It can be economically worked in road-making, to form a base on which to spread gravel. This experiment is being made on the Milroy and Andersonville pike with every prospect of it proving a success. In time, the south part of the county will be fenced with stone walls taken from the Niagara beds of Big and Little Flat Rock; and, but for its nearness to the quarries just south of the Decatur county line, it would now be in demand for fence posts and bases. At present what stone is taken out is mainly used for foundations and other purposes about light buildings.

It is evident that the Niagara limestone was formed at the bottom of a sea free from sediment, but subjected to currents sufficiently strong to reduce the crinoidæ and other organic remains found in it to fragments; and as corals do not flourish below the influence of the waves, their presence in the top ledges indicate a shallowing of the waters near the close of the period.

In this State the base of the Niagara is made up of shale, in strata ranging from a few inches to eight or nine feet in thickness. None of these beds are exposed in Rush county, but, as they outcrop northeast of Clarksburg, in Decatur county, they may be found near the surface in the southeast corner of Rush county.

The upper Niagara shale (or soapstone, as it is frequently called) is seen at Moscow and Milroy. This formation is generally known as the Waldron shale, for the reason that the outcrop, on Conn's Creek, in Shelby county, is largely made up of magnificent fossils that have given the locality a world-wide reputation. It does not seem to have an exact equivalent in any of the adjoining States, and in Indiana, so far as reported, the outcrops are confined to Flat Rock River, Clifty Creek and their tributaries. It is seen frequently from Moscow and Milroy, south, to Hartsville, and from Milroy and Sandusky, west, to Waldron. Aside from the fossils found in it and its marking the junction of the Upper Silurian and Devonian Ages, it has no special geological import on economic value. In this county, the Waldron shale contains more than the usual per cent. of argillaceous matter, nowhere showing imbedded nodules and flat pieces of limestone. Perhaps it was due to a want of carbonate of lime that no fossils were found in it, aside from a few fragments. In structure, the beds are made up of thin laminæ of friable shale and indurated clay. When not exposed the color is some shade of blue that weathers to yellow or ochrey, and the broken-down, disintegrated beds are scarcely distinguishable from the overlying yellow clay of the Drift period.

The conditions under which the Waldron shale was formed were in part a continuation of those of the shallow sea of the cherty Niagara limestone. The essential change in the conditions was the addition of currents loaded with a clay sediment. It has been suggested that, to the northward, the Waldron area was a more shallow sea, but, so far as yet reported, these beds are local, and, as indicated above, of no very great area, and it seems possible that the clay sediment also may have been of local origin. At this time in geological history the Lower Silurian limestone and shale of Indiana and Ohio, on the southeast, was either dry land or a wave-washed bank that may have furnished the alumina of the Waldron shale.

DEVONIAN AGE.

CORNIFEROUS PERIOD.

Geologists teach that the Devonian Age is the record of an invasion of the dry land, then in existence, by the sea. The Devonian sea was bounded on the southwest by the islands of the emerging Cincinnati anticlinal; on the west, the nearest land was the Lower Silurian mountains of Missouri; away to the north, the highlands of Canada were a part of a great and growing continent; on the east, in the States of New York and Pennsylvania, an extended area of dry land was exposed. Doubtless changes in the relative level of the land and sea were more frequent and well marked in their influence on the east, where the Devonian shales and sandstones have a total thickness of more than 15,000 feet, than in Central Indiana, where the formation is for the most part limestone of an aggregate thickness of 300 feet or less. But over all the interior space a warm sea prevailed, even its northern margin being studded with coral reefs and islands, and its shores having a tropical vegetation (Newberry).

The surface, extent and limits, east and west of the Corniferous group stone in Rush county, may be defined by reference to the description already given of the area covered by the Niagara epoch. Roughly stated, if all the drift materials were removed from the west half of the county, the exposed surface would be found to be buff-colored, magnesian limestone of the base or lower division of the Corniferous. Exceptions to this general rule are found in the valleys of the creeks and rivers. The stone exposed in the mound southwest of Rushville, section 24, township 13, range 9, and near Swayne's mill, on Little Blue River, and in the vicinity of Arlington, are all outcrops of the Corniferous stone.

In the banks of Big Flat Rock, near Moscow, it has the same general character as the strata further south. It is a coarse, argillaceous stone, having much the physical appearance of a sand-rock, and is frequently so called by the quarrymen; but the ease with which it is burned to lime proves that it is not a sandstone. Near the bridge over Little Flat Rock Creek, just west of Milroy, the Corniferous is the only stone seen in the outcrop, and has the same earthy color and appearance, but is in thinner strata that break into wedge-shaped pieces with feather edges. In general appearance it is identical with the outcrops of the same formation in the vicinity of Greensburg, and contains a higher per cent. of carbonate of lime than the equivalent beds on Big Flat Rock. In its western exposure, at Moscow, the bedding is from medium to heavy massive, breaking into angular blocks that are rounded at the corners by weathering, and under certain conditions of constant moisture, disintegrate to a fine powder. One mile below Milroy, on Little Flat Rock, the Corniferous outcrops above the Waldron shale and has local characteristics that distinguish it from either of the two varieties before described. Here it is a thin-bedded, shelly, blue or drab, crystalline limestone apparently free from admixture with earthy matter. In lithological appearance, it is the equivalent of the middle division of the Corniferous group that lies just under the North Vernon stone in many other parts of the State. Nowhere in the adjoining counties have I seen a stratum of so highly crystalline stone as this at the base of the group. These varieties, occurring within a radius of a few miles, indicate that they were formed under local conditions acting near the margin of a surf-beaten coast.

LIST OF FOSSILS FOUND IN RUSH COUNTY.

UPPER SILURIAN.

NIAGARA GROUP.

Favosites Forbesi (var. *occidentalis*) . . . . Hall.
Favosites spinigerus . . . . Hall.
Streptelasma radicans . . . . Hall.
Streptelasma borealis . . . . Nicholson.
Cyathophyllum radicula . . . . Rominger.
Eucalyptocrinus crassus . . . . Hall.
Eucalyptocrinus cœlatus . . . . Hall.
Lyriocrinus melissa . . . . Hall.
Lichenalia concentrica . . . . Hall.
Anastrophia internascens . . . . Hall.
Retzia evax . . . . Hall.
Rhyncotreta cuneata (var. *Americana*). . . . . . . Hall.
Rhynchonella Whitii . . . . Hall.
Rhynchonella Indianensis. . . . . Hall.
Meristina Maria . . . . Hall.
Meristina nitida . . . . Hall.
Atrypa reticularis. . . . . Linneus.
Spirifera crispa . . . . Hall.
Platyostoma Niagarensis . . . . Hall.

Strophostylus cyclostomus	Hall.
Gyroceras Elrodi	White.
Orthoceras annulatum	Hall.
Orthoceras crebescens	Hall.

DEVONIAN AGE.

CORNIFEROUS GROUP.

Cyathophyllum corniculum	Rominger.
Cyathophyllum rugosum	Edwards & Haime.
Acervularia Davidsoni	Edwards & Haime.
Favosites hemisphericus	Yandell & Shumard.
Favosites limitaris	Rominger.
Favosites epidermatis	Rominger.
Stromatopora tuberculata	Nicholson.
Zaphrentis gigantea	Rafenesque.
Athyris vitata	Hall.
Atrypa reticularis	Linneus.
Spirifera Oweni	Hall.
Spirifera euruteines	Hall.
Spirifera mucronata?	
Strophodonta demissa	Conrad.
Conocardium trigonale	Hall.

All the sedimentary stone of Rush county is fossiliferous, but not highly so; and no localities are known that offer attractions to the professional specimen collector. Just below the Decatur county line, on Big Flat Rock, Mr. Shaw showed me several fine fossils, found in the Niagara limestone of his quarry. One of them is, probably, an *Eucalyptocrinus* of very large size; another appears to be a large cystidian. He, also, has a fine specimen of *Orthoceras strix*, the only one I have seen from any of the Indiana beds. This locality is mentioned, with the hope that some good collector may visit and give it a thorough examination. The Waldron shale, so far as seen, is nearly destitute of good specimens, and fragments by no means common. The Corniferous fossil beds present nothing specially different from those of other localities. Mr. Geo. C. Clark has some nice specimens of *Spirifera mucronata* (?) and corals, found in the Drift gravel near the Little Flat Rock Christian Church. I visited the locality, but did not find anything of interest.

LOCAL DETAILS.

Following the banks of Big Flat Rock, north from St. Paul, the height of the bluffs gradually grows less, until, at Moscow, they are less than twenty feet. Generally, after crossing the county line, but one side of the stream shows a full bluff outcrop, the other side having been eroded away by the forces that, in ages gone by, excavated a valley many times greater than the rain storms of this day ever fill. Underlying some of these low bottoms, quarries can be opened and worked economically; the quarrymen will find but little stripping necessary, nature having done this part of the work for him.

SECTION AT MOSCOW, ORANGE TOWNSHIP.

Covered space	
Corniferous limestone, massive earthy stone	2 ft. 0 in.
Waldron shale (clay), Niagara group	0 ft. 10 in.
Flag, even-bedded Niagara limestone	0 ft. 2½ in.
Flag	0 ft. 3 in.
Flag	0 ft. 3 in.
Flag	0 ft. 4½ in.
Flag, or dimension stone	0 ft. 10 in.
Flag, or dimension stone	0 ft. 9 in.
Flag	0 ft. 5 in.
Flag	0 ft. 4 in.
Flag	0 ft. 3 in.
Flag	0 ft. 4 in.
Flag	0 ft. 2 in.
Flag	0 ft. 2 in.
Flag	0 ft. 4 in.
Dimension stone	0 ft. 5 in.
Dimension stone	0 ft. 4 in.
Dimension stone	0 ft. 6 in.
Dimension stone	0 ft. 10 in.
Stone to the level of river bed	6 ft. 0 in.
Total	15 ft. 7 in.

This quarry is opened in the east bank of Flat Rock River, on the point of an angle formed by a ravine. The amount of work done has not been sufficient to develop the exact quality of the stone, that taken out being changed by exposure and atmospheric waste. So far as the quarry has been developed, the stone is very free from chert, so common in the top strata of the Niagara at other places. The bedding is loose, even, and generally free from vertical seams, and of sufficient thickness to make excellent flag and general-purpose building stone. The facilities for working the quarry are confined to an ordinary outfit of drills, bars, hammers, etc. At the time of my visit, Mr. J. H. Jones, lessee of Jos. Owens, the owner of the quarry, and two employes, were engaged in prospecting and preparing to take out stone in quantities. With a good gravel road from Moscow to Milroy, a local demand, at least, might be developed that would pay good returns on a quarry investment. That the citizens of Milroy and vicinity are a wide-awake, enterprising people, is shown by the money they have spent in building the Milroy and Andersonville free pike; a continuation of the same spirit will macadamize a road west to Big Flat Rock. Let the proprietors of the quarries show what they have on hand, and those in need of stone will get it away.

SECTION ON LITTLE FLAT ROCK CREEK, ONE MILE SOUTH OF MILROY, ANDERSON TOWNSHIP.

Covered space, drift, clay and gravel		
Thin-bedded, crystalline limestone, lower division of the Corniferous group, fossiliferous	3 ft.	0 in.
Waldron shale, Niagara group, weathered to ochery-colored clay, and thin calcareous plates, very sparingly fossiliferous	1 ft.	6 in.
Thin-bedded Niagara group limestone, to the bed of the creek	3 ft.	0 in.
Total	7 ft.	6 in.

This section was taken in the bend of the creek, on the east side, where the wash of the stream has removed the crumbling Waldron shale, and left the Corniferous limestone projecting over the bank. Quite a number of fossils were seen in the overhanging rock at this point, and in the equivalent stone further down the creek. The Waldron shale is here intercalated with very thin calcareous laminæ that, when found thicker, as is the case at other points, are invariably fossiliferous. Here, the amount of carbonate of lime and magnesia appears to have been insufficient to preserve the organic remains buried in it. Only fragments and crinoid stems of the species general to this horizon were found. The underlying Niagara limestone is in thin strata, so far as could be seen, and much less massive than at the Moscow quarry. The same remark applies to the quarry of Captain Rice, located a little lower down the creek. That better stone could be had by opening back into the bank or bluff, is very probable, but, from what I have seen of this stone further south, it is not likely that the bedding will be heavy. The Niagara beds in this vicinity will yield good, light flagging, fence posts, bases, and light building-stone. Nowhere, in hundreds of examinations of the base of the Corniferous, where it forms a junction with the Waldron shale, have I found the stone so highly crystalline and so nearly a pure limestone as here. Doubtless it will make excellent "hot" lime, but, on account of its tendency to shell, will not prove of value for any other purpose.

QUATERNARY AGE.

DRIFT PERIOD.

In Rush county, covering alike the Upper Silurian on the east and the Devonian on the west, to a depth ranging from ten to one hundred feet, and thus largely concealing them from view, is found a mixture of clay, sand, gravel, pebbles, angular, subangular, and rounded stones, generally unassorted, unstratified and unfossiliferous. Out of this apparently heterogeneous mixture, a careful study evolves a degree of order that, in its history, has been governed by the same invariable laws of antecedents and sequences as in the other domains of nature. The general arrangement of the drift materials is illustrated in the following sections:

SECTION IN FAIR GROUND WELL, ON THE LOW BLUFF ONE MILE EAST OF RUSHVILLE.

Soil	6 ft. 6 in.
Hard, yellow, gravelly clay, with hardpan at the bottom	38 ft. 0 in.
Hard stone	16 ft. 0 in.
Total	60 ft. 6 in.

SECTION OF MR. J. C. PARKER'S WELL, NORTH OF THE C., H. & I. RAILROAD DEPOT, RUSHVILLE.

Soil	9 ft. 0 in.
Clay and black carbonaceous soil (?)	25 ft. 0 in.
Black sand, slightly water-bearing	8 ft. 0 in.
Mixed gravel and clay, no water	16 ft. 0 in.
Total	58 ft. 0 in.

SECTION IN MR. GEORGE C. CLARK'S WELL, ON THE EAST BLUFF ADJOINING RUSHVILLE.

Yellow hardpan, similar to the blue clay hardpan only in color	36 ft. 0 in.
Bed of fine gravel and water	6 ft. 0 in.
Stone	9 ft. 6 in.
Total	51 ft. 6 in.

AVERAGE OF ARTESIAN CHALYBEATE WELLS, WEST END OF RUSHVILLE.

Soil, yellow clay, and gravel	6 to 8 ft.
Blue clay, hardpan	14 to 15 ft.
Fine white sand and water	..
Total	20 to 23 ft.

SECTION IN THE WELL OF JOHN F. MOSES, TWO MILES NORTH OF RUSHVILLE, IN JACKSON TOWNSHIP.

Soil, yellow clay, and blue clay hardpan	91 ft. 0 in.
Stone, probably Corniferous group; whitish, soft, sandy clay, Waldron shale (?); stone, probably Niagara group; total of stone	15 ft. 0 in.
Total	106 ft. 0 in.

This bore, one of the deepest reported in the county, was put down on the table-land back of the highest bluff. Water was found in the lower stratum of stone, and rose about sixty-seven feet in the bore.

AVERAGE OF WELLS IN CARTHAGE, RIPLEY TOWNSHIP.

Soil and yellow clay, mixed with large gravel	5 ft. to 5 ft.
Gravel	4 ft. to 6 ft.
Blue clay hardpan	10 ft. to 25 ft.
Quicksand and water	.. ..
Total	19 ft. to 36 ft.

SECTION IN THE WELL OF LOUIS J. OFFUTT, SECTION 21, TOWNSHIP 14, RANGE 9, POSEY TOWNSHIP.

Soil	6 ft. 0 in.
Yellow clay, and very little gravel	32 ft. 0 in.
Hardpan, blue clay	18 ft. 0 in.
Stone	0 ft. 10 in.
Total	56 ft. 10 in.

AVERAGE OF WELLS IN ARLINGTON, POSEY TOWNSHIP.

Soil, free from gravel	2 ft. 6 in.
Yellow clay, free from gravel	8 ft. 0 in.
Blue clay, hardpan	25 ft. 0 in.
Total	35 ft. 6 in.

SECTION IN WELL AT MANILLA, WALKER TOWNSHIP.

Soil	3 ft. 0 in.
Yellow, loamy clay	7 ft. 0 in.
Loamy sand	10 ft. 0 in.
Blue clay	47 ft. 0 in.
Fine quicksand	3 ft. 0 in.
Snow-white sand	1 ft. 0 in.
Gravel and sand	2 ft. 0 in.
Total	73 ft. 0 in.

AVERAGE OF WELLS AT MOSCOW, ORANGE TOWNSHIP.

Soil	1 ft. to 2 ft.
Yellow clay, slightly mixed with gravel	10 ft. to 10 ft.
Blue and hardpan clay	10 ft. to 20 ft.
Fine sand and water	.. ..
Total	21 ft. to 32 ft.

AVERAGE OF WELLS AT MILROY, ANDERSON TOWNSHIP.

Soil	1 ft. to 2 ft.
Yellow clay, uniformly found in the village and surrounding country	10 ft. to 10 ft.
Blue clay, sometimes replaced by a stratum of sand	8 ft. to 10 ft.
Gray clay and hardpan, usually mixed with fragments of chert and pebbles	6 ft. to 8 ft.
Gravel, sand, or muck, water-bearing, and, from two wells, fair specimens of peat	3 ft. to 5 ft.
Total	28 ft. to 35 ft.

In one well dug at Milroy, 150 yards from Little Flat Rock, sand was reached five or six feet from the top; after going through ten feet of sand water was found, which filled the well so it could not be walled. In one of the village wells a bowlder fifteen inches in diameter was found in the muck stratum, and they are reported as of frequent occurrence in other wells. Along the southern border of Anderson township there is a stratum of red clay that seems to replace the lower blue clay, as it comes from the bottom of the wells. The average of the wells above given is taken from wells dug on the uplands, above the first terrace or second bottom of the creek.

Sections taken in the wells at Richland, Richland township, and at New Salem, Noble township, show very nearly the same strata and thickness as the average of the wells at Milroy.

From the foregoing sections, it will be seen that there is an orderly succession of strata, from the bottom to the top of—(1) sand, quicksand or gravel; (2) blue plastic clay or gray hardpan, and, occasionally, buried timber, muck or peat; (3) yellow or red clay; and (4) soil. Another conspicuous member (5) of the Drift, not mentioned above, is the frequent occurrence, in places, of bowlders—exotic stones, derived from the Archæan rocks found native in the high land of Canada and on the south shore of Lake Superior. In some of the sections it will be noticed that one or more of the generally found strata are wanting; either they were never formed, or, by the action of local causes, they have been removed, or altered and blended, until it is impossible to identify them as the equivalent of any particular stratum; but however altered and changed, the *order* of succession remains the same in the Rush county Drift.

In the southern townships, Orange, Anderson and Richland, the average thickness of the Drift will not vary much from thirty feet. On the east side of the county, in Richland, Noble, Union and Washington townships, near the water-shed, the deposit grows thinner, and will not generally exceed twenty feet. At Rushville, Henry Ormes & Co., who have made many borings and wells, give forty-eight to fifty feet as the average depth of stone. North, northwest and west of Rushville the general depth will reach sixty feet and over. At Manilla, the well above reported passed through seventy-three feet of Drift; and another, bored on an adjoining farm, is said to have been put down one hundred and twenty-three feet before reaching the bottom of the blue clay.

The sand, glacial sand or gravel stratum resting on the country stone is not alike constant over high and low ground, but seems to occur in greatest force in the surface depressions. Its component materials range in size from fine siliceous sand to gravel and angular chert fragments; in color, from snow-white to dark or black quicksand. Generally it is a water-bearing bed of fine sand, but is occasionally replaced by dry, hard pieces of stone, that, from lithological and fossil evidence, are probably the debris of the eroded Carboniferous and Niagara group limestones. It is suggested that the agencies that reduced the flinty portions of the stone in one case to fine particles or sand, and in the other to coarse gravel, were not uniform in their action. Occasionally, as in some of the wells at Milroy, this and the next succeeding stratum are blended together.

The blue, plastic clay, bowlder clay, glacial clay, or hardpan, is a very generally diffused member of the Drift, occurring universally, except in the valleys south of Rushville, where the rivers and creeks reach down to, or near, the bed-rock. Wells and borings sunk in the first river terrace on Big Blue River, at Carthage, and on Big Flat Rock, at Rushville, pass through the blue clay, showing that the forces which have excavated the valleys ceased to act at these points before reaching the bottom of the blue hardpan. Taking the average depth to stone of the Rushville wells at forty-eight feet, and comparing it with twenty feet, the average height of the bluff part of the city above the bed of Flat Rock, it will be seen that many of the wells go twenty-eight feet below the river channel before reaching stone. The exposure of stone, before mentioned, on the west bank of the river, at the head of the millrace, on a level with the bottom of the stream, shows that Flat Rock does not reach down to the bed of the ancient valley. During the Drift period, the valley was filled with clay and gravel, and the channel of the present river subsequently formed near the close of the period. The well at the northeast corner of the court house yard (dug eighteen feet in the surface clay and gravel without striking the blue clay), indicates that the bed of the river may have shifted from the north to the south at a still later date in geological history, or the bed of the modern Flat Rock may formerly have been much wider and gradually contracted, by silting, to its present limits. In physical appearance it is a blue or lead colored clay, where protected from atmospheric change; where exposed, of a lighter shade. It usually occurs in compact beds, ranging from a soft, laminated, plastic, putty-like mass, to a dry, impervious hardpan, that can only be excavated with a pick. That these differences in consistency are largely due to moisture may be shown by subjecting different specimens to the same drying process. Chemically, it is an alumina silicate, mixed with fine, impalpable sand and salts of iron; its color is due to the latter. At Rushville, Mr. Geo. C. Clark describes this stratum, by saying that "It is not properly blue clay, but a hardpan of dark bluish cast, very gritty, filled with coarse sand and pebbles or gravel, intermixed like grouting. It has a very disagreeable smell, and, when it forms the wall of a well or the well is walled inside of it, the water has an offensive smell and taste for some months, but, finally, becomes palatable. In some places this bluish hardpan is forty feet thick, but generally less." "Southwest of the city, four or five miles, a well, bored sixty feet deep, did not strike stone, but found real blue clay, tough and resisting the drill by elasticity." In some places, fair-sized bowlders of northern origin are found in this stratum, but, as a rule, they are small, worn, and occasionally striated. Not infrequently it contains intercalated beds of sand.

The occurrence of buried timber, or a bed of soil and carbonaceous matter, is intimately connected with a description of the blue clay. In this portion of Indiana it usually occurs at the top of the stratum, but at Milroy was found at the bottom. Buried soil or timber is reported in nearly every neighborhood in the southern townships of the county. The soil bed, where it forms the top of the blue clay, is frequently overlooked in digging wells, or only remarked as a bed of black earth or clay, while the finding of a stick of wood or the root of a tree twenty or thirty feet below the surface, is something out of the usual line, and is reported; and the same is true of the muck beds. I am thoroughly convinced that the less conspicuous soil bed is of much more frequent occurrence.

The yellow or orange colored clay is found everywhere overlying the blue clay, except in the valleys and upland gravel ridges. Over the east side of the county, and in the vicinity of New Salem and Richland, it is so intimately associated with the top soil that it is not possible to separate them. Near the Fayette county line, the color is a reddish orange, and especially so in parts of Washington township. Generally, it is comparatively free from gravel in the uplands on the east and north sides of the county. Isolated points, low mounds and slight ridges, are not infrequent in which the proportion of gravel and sand is increased. This increase is, in part, due to the clay having been dissolved out by the rains. The gravel, pebbles, and bowlders distributed through the mass are identical in composition with those of the blue clay, but are less worn; especially is this true of the bowlders that are larger, seldom sub-angular, striated or flattened on one side by attrition. In structure it is a heterogeneous, friable clay, much more pervious to water than the blue clay, and yet so tenacious as to be improved by tiling. The percentage of lime is quite large, as indicated by a vigorous growth of sugar maple. The calcareous matter and very fine sand incorporated with the orange clay, in parts of Richland, Noble, Union and Washington townships, give it many of the physical characters of loess. Ten feet will cover its average thickness in Anderson township, that gradually grows heavier on the north, until it will measure thirty feet or more. Near the southeast corner of the county, the yellow clay is very thin; and over the line in Franklin county it fails as a factor of the Drift period, and leaves the blue clay exposed as the surface clay.

On the crest of the river bluff, west of Big Flat Rock, for five miles below Moscow, is a continuous ridge of imperfectly stratified gravel unmixed with clay. The stratification is seldom parallel with the horizon, but more nearly conforms to the surface slope of the ridge. A transverse section shows the alternating strata of sand, gravel, sand and gravel, or sand, gravel, and pebbles, running in irregular, increasing, and vanishing lines, that may or may not be conformable. The composition of a stratum is not uniform. It may be made up of sand in one place, that gradually changes to gravel within a few feet. Here and there, pockets are found, filled with clean, unstratified sand, or well-rounded metamorphic pebbles and bowlders. Occasional blocks of water-worn Niagara limestone occur, that seem to increase in size and number below the Decatur county line. By infiltration of water charged with carbonate of lime, in favorable localities, the thin beds of polished gravel and pebbles are cemented into a mass of conglomerate. This ridge contains enough good road gravel to macadamize Rush county. Other beds of upland gravel are reported as occuring east of Moscow, but were not examined; and it is probable that some of the low gravel beds on the east side of the county are similar in origin and structure to that described.

Along the banks of the principal streams, as already shown, are terraces or bottoms, averaging something over one-half mile in width. These terraces are the direct result of the wash or scouring action of the river flow that has removed the previous deposit of yellow clay.

Borings made in the bottoms pass through what is left undisturbed of the original Drift series, and show the same general section or borings on the uplands, minus a part of the yellow clay bed. In other places, the erosive action has been carried down to the blue clay, and sections show a partial replacement of the yellow clay by gravel or coarse sand. The terrace gravel beds are usually stratified, but not always so, and present the same alternating strata of fine and coarse materials, with increasing and vanishing layers, as the upland beds, but differ from the latter in having the strata nearly horizontal, more continuous, and showing less evidence of having been acted on by currents coming from two or more directions. The stratified terrace beds, when unmixed with large fragments of Niagara or Corniferous stone, yield good road gravel. Frequently, however, a few feet away from the channel of the stream, the gravel does not show stratification, and is too fine for macadamizing purposes. Well-marked second terraces were not observed in Rush county, but something of that kind shows near the southern boundary line, above the confluence of Big and Little Flat Rock, where the latter stream cuts across the ancient flood plain. These terraces are supposed to be evidence of a greater flow of water, some time in the past, together with a gradual elevation of the land on the north, that gave greater velocity to its rivers and, hence, more power to scour deep channels.

The extension of the yellow clay and gravel layers over the summit of the divide between the White Water and White River valleys, east of Rushville, and much above the level at which the equivalent beds are wanting in other places not many miles distant, is suggestive of some curious speculations on the geology of Indiana. If the yellow clay deposit is due to a submergence, it seems probable that these high lands must have been relatively lower than at present. Observations bearing on the history of the Cincinnati arch of the Lower Silurian, and the geological period or epoch in which its western border was uplifted to the present level, are omitted as too technical for presentation here.

Bowlders are scattered throughout the mass of the yellow clay and gravel beds, but the vast majority seem to lie on or near the surface. In size, they range from a few inches to two or three feet in diameter. In shape, they are angular and very seldom show a worn surface; especially is this true of the isolated specimens. On the side of the bluff bank, below Moscow, lies much the largest one I have seen in Southeastern Indiana; it will probably weigh over twenty-five tons. They are not common over the whole county, but are principally found in the southeast and west parts, and seem to occur as the continuation of a line of bowlders that reaches south, nearly to North Vernon. They are Archæan rocks, generally of the gneissoid variety.

RECENT PERIOD.

SOIL AND ALLUVIUM.

The soil of Rush county is almost wholly derived from the Drift deposits. Scarcely any of it is due to decomposition of the country stone found *in situ*; it is the combined result of the Quaternary Age acted on by the fertilizing agency of animal and vegetable life. In color, it ranges through various shades from black to pale yellow; the former is locally known as the black land, and the latter as the clay land. The black loamy soil covers the greater part of the surface of the county, and is general over the central and western parts. The great body of the black lands were formerly wet and swampy, and the dark color is due to the humus and carbonaceous matter derived from the decayed vegetation that grows luxuriantly over its surface. The yellow clay beds form the subsoil, except in the terrace bottoms, where the clay is sometimes replaced by gravel or sand. Outside the black lands, the distinction between the top and subsoil is not marked; the pale yellow surface clay grows brighter as it gradually grows deeper, and has more the character of a true tenacious clay. The tenacity of the subsoil explains why all the lands of the county are improved by tiling. A happy blending of calcareous matter, sand and clay in the subsoil, renders it peculiarly susceptible to the aerating influences of under-drainage. Exposed to the fertilizing influences of air and rain, charged with carbonic acid, the calcareous matter locked up in the clay and fine limestone gravel is unloosed, the salts of potash and soda set free, organic matter taken up, and, directly, it supports a vigorous growth of vegetation. The yellow clay subsoils of Indiana universally contain all the inorganic and a large per cent. of the organic elements of fertility; those of Rush county, in consequence of their fine state of division, readily yield their elements in a bountiful harvest, the substantial foundation of all wealth. Practically, they are inexhaustible; they may deteriorate under continuous cultivation and non-rotation of crops, but rest soon restores them to pristine productiveness.

ECONOMIC GEOLOGY.

AGRICULTURE.

The wealth of Rush county is essentially agricultural, together with such commercial relations as necessarily grow out of the wants of a great farming community. Originally covered with a dense forest, and, in places, wet, the husbandman has nobly done his work of turning an unbroken wilderness into splendid farms. The virgin soil, without a rival, has been constantly growing more productive. The bountiful gift of nature has been carefully utilized, until, to-day, instead of a wild waste, the eye wanders over well-inclosed farms of growing grain, pasture fields dotted with blooded horses and cattle, huge barns and fine residences. A moment's attention directed to agricultural statistics and land drainage will more forcibly and eloquently show, than mere words, what has been done for the farming interests of the country.

In 1882, the assessors of Rush county reported 446,000 rods of tiling against 442,000 rods in Shelby, 477,000 rods in Marion, and 693,000 rods in Decatur; giving to Rush the third place in the State in the number of rods of tile put down. Before a people can expend money in improvements they must first produce a surplus. That surplus is easily accounted for. In the number of bushels of corn produced per acre, Rush outranked any other county in the State, and was third in aggregate yield, with 2,223,414 bushels grown on 57,669 acres. The two leading corn counties were Tippecanoe and Benton, both including extensive tracts of Wabash bottoms within their limits. With 55,070 acres sown in wheat, producing 997,772 bushels, it ranks fifth in the State, and is led by Gibson, Daviess, Posey and Shelby counties. In clover lands, it had 20,369 acres against 21,310 acres in Wabash county. No more direct proof could be adduced than the last item, of the attention paid to the rotation of crops and keeping the land up to its high state of fertility. In 1881, 59,891 hogs were fatted for market, which is nearly thirty per cent. more than was produced in any other county in Indiana. The number of horses, mules and cattle owned in the county is well up with the best. In the leading farm products and stock raising, Rush is found at the head of the list. A very few counties may exceed it in a single farm product; but, when the whole list is taken into consideration, it stands without a rival. The mines of California may be exhausted, manufacturing may be overdone, banks may break and securities decline in value, but, with proper care, the Rush county farmer need not have any fears for the future. The peculiar adaptability of its soil to the growth of any of the cereals or to stock raising gives a variety of resources, that, in all human probability, render a total failure an impossibility.

The general remarks of Prof. Collett on the soils of Indiana are especially applicable to the black land, clay soil and yellow clay subsoil of Rush county. A heavy forest of sugar maples and walnut, supported by experimental evidence, is proof of its calcareous nature and adaptability to the growth of blue grass.

"The surface of the drift was left nearly level, but has since been modified by fluviatile and lacustral agencies, sorting the clays, sands, etc., so as to form, generally, a loose calcareous loam, deeply covering the gently undulating wood lands, plains and valleys. The great depth of the Drift deposit allows it to act as a gigantic sponge, absorbing excess of moisture in the spring or winter, until the long sunny days of summer, thus insuring against any prolonged drouth, and constituting a superior grazing district. For the perfect growth of grasses, a rich soil and perennial moisture is required, conditions which do not prevail in many other States. Indiana is the native home of "Blue Grass," *Poa pratensis*—the glory of our rich calcareous soils—an infallible gold-finder. It forms a permanent sward, thickening with age, so that, within ten or twenty years, the sod will withstand the hoof of heavy bullocks, even in wet weather. It grows slowly under the snow of a cold winter, but bursts into new life with the first genial day of spring, carpets the earth with productive beauty through the summer, and, if reserved for winter, cattle, horses, sheep, etc., may be well kept, except in time of deep snows, on this food alone."*

"Among the blue grass trotters," America over, is understood to mean more than the accidental relationship of the queen of native grasses to the fast horse. Muscle is necessary to the thorough development of the horse; "blood will tell," and the blue grass wood lands tell on the blood. The elastic sward, over which the high-steppers range, gives ease and grace

*First Annual Report of the Bureau of Statistics and Geology, Indiana, page 9.

to his proud movements, while he is protected from the blazing sun in "pastures green" that are charmingly undulating and invite trials of speed. Everything in nature and the loving care of man conspire to give life and strength to the noble animal. The Blue Bull and Jim Monroe farms of the late James Wilson, of Noble township, attest what can be done. These farms have turned out trotters and pacers that take rank with the best in America. The Blue Bull strain has second place in the trotting list for horses that have made better than 2:30; and Monroe Chief, from the Monroe farm, has a trotting record of 2:16$\frac{3}{4}$.

It has been remarked that the possession of a fast horse curiously gives a kind of vicarious merit to his proprietor; he is esteemed as something of a high stepper and flyer, and as likely to run his factory, his newspaper, or his farm, or whatever it may be, a little better than other people. It is the best advertising medium known. And, in a degree, the same is true of the breeders of all kinds of pedigreed stock. Of the many proprietors who prove the truth of the above in Rush county, that are engaged in stock raising, and especially interested in producing improved strains of horses, cattle, etc., only a few can be mentioned here. Mr. Richard Wilson, of Rushville, and Mr. Samp. Wilson, of Noble township, as breeders of trotting horses, maintain the well-merited reputation of their father. Mr. John T. McMillan and Mr. Cal. Bates are well known owners of thoroughbred Norman horses. Mr. S. Frazee, of Noble township, breeds, and exhibits at the State and county fairs, complete herds of full-blooded short-horn cattle. Mr. George W. Thomas, of Homer, is another breeder of short-horn stock; and Mr. J. H. Beabout, of Rushville, of Jerseys. Mr. Leonard McDaniel, of Posey township, and Geo. W. Mauzy, of Union township, are well-known producers of full-blooded Cotswold, South Down, Canada, and Merino sheep Of course, in a county so largely engaged in hog-raising, especial attention is paid to the production of all the leading varieties.

FRUIT.

All the various kinds of orchard and small fruits are successfully grown, but not so extensively as in some of the adjoining counties. A rich sugar tree soil will undoubtedly produce the very best kind of orchard products. Winter-killing seems to be the great draw-back. With care in selecting varieties of trees that are known to be hardy, and good under-drainage, this trouble might be obviated. Wheat, corn, and stockraising chiefly occupy the attention of farmers, but some fine orchards were seen, showing what might be done for the whole county.

LIME AND SAND.

The soft magnesian stone found at the base of the Corniferous group, at Moscow and Milroy, makes a lime that is highly prized by masons and plasterers, and especially by the latter, on account of its working easily and smoothly under the trowel. The Moscow stone, having a considerable percentage of earthy matter, will yield a "cool" lime that slacks slowly; while that produced from the Milroy stone, on account of its more crystalline character, will rank as intermediate between a "cool" and "hot" lime. Typical "hot" lime is produced from the hard Niagara stone. It was formerly thought that the dark, rotten, Corniferous rock, having much the appearance of a decomposing sandstone, that occurs abundantly on the banks of Flat Rock and its tributaries, was utterly worthless for making lime. Experience shows that the darkest stone will burn perfectly white, and that the alumina, or earthy matter, mixed with it, adds greatly to its value for builders' use. The equivalent of the stone under discussion is used in making lime at Adams and Greensburg, in Decatur county, and at Geneva, in Shelby county. The ease with which the Flat Rock stone can be quarried, and the less amount of fuel required to reduce it than the hard Niagara stone, are questions of expense that indicate that the business might be made to pay in this county.

Sand for masonry and plastering, of the best quality, is common in the bars and banks of the rivers and creeks. No beds of bluff sand, free from gravel, were seen.

BRICK AND TILE CLAY.

Any of the yellow or blue clay of Rush county, when free from gravel, can be readily moulded and burned into brick or tile. Brick buildings are common in the towns and country; and farmers usually make what they need out of the clay found on the farm. Messrs. Patten and Caldwell, of Rushville, have a steam tile factory and kiln, with a capacity to turn out from 18,000 to 20,000 tile at a burn. There are a number of other factories of less note in the county.

GRAVEL.

Road gravel is found in the terrace bottoms of all the creeks, but not abundantly on the smaller streams. In Orange, Anderson, and Noble townships, upland gravel ridges occasionally occur that are free from clay, but the main supply for the county comes from the banks and bars of Big Blue and Flat Rock Rivers.

BOG IRON ORE.

Bog iron ore, in considerable quantity, has formed on the borders of the marshy tracts of land five miles east of Rushville. These deposits of ore are the result of the organic acids, derived from decomposing plants, acting on the salts of iron that occur in the drift clay, thereby rendering them soluble. By exposure to the air oxidation takes place, generally at the margin of the marsh, and the iron, in the form of hydrated peroxide, is again thrown down. Such accumulations are not infrequent, and some day may have a commercial value.

VEGETATION.

In 1879 and 1880, the assessors for this county reported more gallons of maple syrup made than were reported from any other county in the State. A soil that supports a mighty growth of sugar maple, *Acer saccharinum*, will abound in majestic specimens of black walnut, *Juglans nigra;* yellow poplar, *Liriodendron tulipifera;* white oak, *Quercus alba;* white ash, *Fraxinus Americana;* shellbark hickory, *Carya alba;* dogwood, *Cornus Florida*; red bud, *Cercis Canadensis;* iron wood, *Carpinus Americana;* paw-paw, *Asimina triloba*, etc. Beech, *Fagus ferruginea;* burr oak, *Quercus macrocarpa;* elm, *Ulmus Americana;* swamp maple, *Acer dysacarpum*, etc., are the most common varieties of timber growing on the wet, black lands. On the east side of the county, huge yellow poplar were once common; and one cut a few years ago, growing in Union township, is said to have been the largest reported in the State. The great body of the primitive forest has been removed in preparing the land for the plow, and the wood lands left have been culled of their best trees. A casual examination of a Rushville saw-mill yard, containing over three hundred logs, showed only beech, maple and elm.

MINERAL SPRINGS.

The artesian chalybeate wells of West Rushville have attracted attention for years, and are curious examples of subterranean streams or sheets of mineral water, held down by the impervious blue clay. The wells are dug in the usual manner, or dug a few feet, and then bored through the clay. The water is found in the fine gravel or white sand overlying the bed rock. Pump logs were placed in some of the wells and tamped with clay until the water was forced to flow through the log. The quantity of water discharged was never great, and additional wells seemed to weaken the flow of those previously dug, indicating that the water probably comes from a compact, saturated bed of sand that slowly gives up its superabundant moisture. Other mineral springs of note are found in the vicinity of Homer, and at the Soldiers' Home, south of Knightstown. Small ferruginous springs are rather common in all parts of the county, and, so far as I could learn, are nearly identical in composition. Their chemical nature is shown by the brown or ochery deposit of hydrous peroxide of iron seen near the spring. Before reaching the surface, the iron is held in solution as a ferrous carbonate, that is rapidly changed to the insoluble peroxide by oxidation on exposure to the air; hence, to get the medicinal effects of the water it should be used fresh from the spring. It will be found beneficial in all diseases where a mild preparation of iron is indicated.

WATER SUPPLY.

There is a wide-spread belief among physicians as well as the laity, that sheets of water found in or confined to the sand or gravel beneath the clay are continuous, and that the pollution of one well will contaminate many. That there is some truth in this, I am free to admit, but not to the extent generally believed. That the water supply of the city of Rushville has nothing to do with the level of Flat Rock River has already been shown. The varying depth of wells to water, and failures to find water, are proof that the water-bearing sand under the city is not continuous, nor on a common level. Two wells were put down just west of Main street and north of Ruth street, respectively twelve and eighteen feet to water; and two others near by, one on the west twenty-seven feet deep, and the other on the east thirty-seven feet deep, and no water. Southeast of the latter well, in court-house square, water was found at eighteen feet. Mr. J. C. Parker's well, north of the Cincinnati, Hamilton & Indianapolis depot, was put down fifty-eight feet, no water; another, near the point where the Jeffersonville, Madison & Indianapolis road crosses Main street, failed to find water at eighty-seven feet; while water was found in the triangle formed by the Jeffersonville, Madison & Indianapolis Railroad, Main street, and the Cincinnati, Hamilton & Indianapolis Railroad, at thirty-eight feet. These differences in depth are not due to inequalities of the surface, as the city is built on comparatively level ground.

Throughout the county, potable water for culinary and drinking purposes is almost wholly obtained through wells, and, as might be expected, springs rarely occur in a country so uniformly level. Wells sunk to the gravel or sand stratum, under the blue clay, reach an abundant supply of water; in localities where the clay rests on the country stone, a vein has to be found in the rock, or the well proves a failure—failures, however, are not common. Well water contains more or less mineral matter, even where it percolates through sandstone, and the water found in or beneath the calcareous drift deposits is universally "hard." That this hardness is not wholly due to calcic and magnesic carbonates is shown by its not being rendered "soft" by boiling, that changes the bicarbonates held in solution into insoluble carbonates, with consequent precipitation. The hardness remaining after boiling is probably due to calcic sulphate. Notwithstanding a hard water does not answer for all kinds of household use, it is perfectly healthful, sparkling and delicious.

The Rivers' Pollution Commissioners of England, in their sixth report, make the following classification of water in respect of wholesomeness and general fitness for drinking and cooking: *Wholesome*—(1) Spring water; (2) deep well water; (3) upland surface water. *Suspicious*—(1) Stored rainwater; (2) surface water from cultivated land. *Dangerous*—(1) River water to which sewage gains access; (2) shallow wells. In this county wholesomeness and safety lie in the use of water from deep wells that reach the glacial sand or gravel or a vein deep in the stone. Some facts have come to my attention indicating that the well water may be unwholesome that has percolated through the ancient forest bed or buried muck and carbonaceous soil. Especially does this seem to be true where the stratum rests on the native stone, and the water supply comes from it or from the stone just beneath. Organic matter in water, no difference what the source may be, supplies the conditions necessary for the development of microzymes. Every source of organic contamination should be rigidly excluded by digging deep, and protecting the mouth of the well from surface wash or soakage. A supply of soft water is had by storing rain and snow water in cisterns that are easily made in the clay.

ARCHÆOLOGY.

Burial mounds of a race of people who lived prior to the advent of the modern Indians not infrequently occur, and, so far as reported, are most common in the southern part of the county. I visited the site of a large mound on the farm of Mr. Louis J. Offutt, northeast quarter of section 21, township 14, range 9, that, in the early settlement of the country, is said to have been one hundred and six feet in diameter and fifteen feet high, and connected with a smaller mound, on the northeast, by a ditch. Fifty-three years ago, the large mound was covered with a heavy growth of beech timber, some of the trees measuring eighteen inches in diameter. Since the timber has been cut away and the mound plowed into, it has been nearly leveled with the ground. A few years ago Mr. Offutt dug into the larger one, near the center, and found parts of several skeletons, copper bands encircling the bones of the arms, wrists and ankles, bone beads, and two curiously perforated pieces of jawbone with a single, tusk-like tooth. The perforations were cut through the bone into the hollow of the tusk, and gave it somewhat the appearance of a whistle, but its use is not very evident.

Dr. S. H. Riley, of Milroy, has assisted in opening several mounds in the county, and reports that they all contained ashes, charcoal, and red or burnt clay. Relics were found in three of them. In one (section 12, township 13, range 9), were found an arrow point, copper needle, beads, and block of mica of an oval shape, seven by eleven inches in diameter and three-eighths of an inch thick. Two nearly perfect skeletons and parts of a third were found in another (section 27, township 12, range 9), buried with the heads turned toward a common center; also copper and bone beads. Some bones and copper bracelets were found in the third one (section 12, township 13, range 9). A large mound in section 27, township 12, range 9, about ten feet high and forty feet in diameter, has not yet been explored. From the fact that shells peculiar to the Atlantic ocean, copper from the shores of Lake Superior, and mica from the mines of South Carolina have been found in the mounds along the banks of Little Flat Rock Creek, it is presumed that the commercial relations of their builders were much more extensive than their limited means of travel would seem to indicate.

THANKS.

I am under obligations to all whom I met for favors and information, and especially so to Mr. George C. Clark, of Rushville, for information bearing on the history of the Drift period, etc.; to Messrs. Henry Ormes & Co., for depth of wells, etc., in Rushville and vicinity; to Dr. Henry Charles, of Carthage; Mr. J. Morton Clark, of Arlington, and to Dr. S. H. Riley, of Milroy.

GEOLOGY OF JOHNSON COUNTY.

BY DAVID S. M'CASLIN, A. M.

Johnson county lies south of the geographical center of Indiana. It comprises an area of 320 square miles, or 211,206 acres of land. In form it is a true parallelogram, measuring, from east to west, sixteen miles, and, from north to south, twenty miles. This county is bounded, on the north, by Marion; on the east, by Shelby; on the south, by Bartholomew and Brown, and on the west, by Morgan county. Franklin, the county seat, is twenty miles south of Indianapolis.

The county organization was effected in 1822, the territory previously having been a part of the extensive tract known as Delaware county, the original purchase from the Delaware Indians, which was effected at St. Mary's, Ohio, in 1818. It was known as the "New Purchase," and included nearly all the land now comprised in the central counties of Indiana.

Previous to 1818, the influx of population had been mainly to the southern portion of Indiana Territory. The organization of the State of Indiana, in 1816, was followed by a great increase of population—from 63,897, in 1816, to 147,178, in 1820. This tide of immigration flowed rapidly into this newly opened territory, coming in from both the south and the east. As early as 1817 pathways had been made through the unbroken forest—from the east, it was known as "Whetzel's trace," and from the south, the old Indian trail, running north to the villages on the Wabash, was the highway of the pioneers of Johnson county. The pathway previously trod by herds of buffalo and wild red men became the chosen highway of commerce, traveled by the iron horse on his path of steel. Southern and eastern people were thus early mingled and united. This social amalgam has produced a citizenship of more than usual excellence and stability. Virginia, North Carolina, Massachusetts and New Jersey are, here, all blended into an organic structure of morality and culture that flowed into this beautiful region through those humble avenues of civilization, "Whetzel's trace" and the old Indian trail.

Originally, the whole county was an unbroken forest, with a dense undergrowth, much of it regarded as worthless, being wet and swampy.

Other portions were supposed to be so broken as to prevent successful cultivation. Under energetic and progressive agriculture, these difficulties have been annihilated; every marsh has been made a marvel of fertility, and every hillside a mine of wealth.

The river bottoms and the higher plateaus are unsurpassed in the production of corn and wheat. The clay uplands and the higher ridges of the southern part afford a great variety of timber and the best capacity for fruit production. This county produced, in 1880, 582,469 bushels of wheat, 1,315,283 bushels of corn, and 143,697 bushels of oats. Great numbers of cattle, horses, hogs and sheep are raised. These statistics are large, as might be expected from the production of grain and grass. There were in the county, in 1880, horses, 8,760; cattle, 11,670; sheep, 11,865. In other lines of production, the figures are proportionately large, making very favorable comparison with any other county in the State, indicating fertility in the soil and intelligent agriculture.

Franklin, the flourishing county seat, located a little east of the center of the county, has a population of 3,116, according to the census of 1880. It lies on level land, at the junction of Hurricane and Young's Creeks. It is beautifully laid out, with well-paved streets, having excellent drainage in two directions. The streets are shaded with majestic maples, two or three species having been planted, both the white and red varieties. In many places their branches meet over the thoroughfares, making an arch of living green. The homes of the people are handsomely and substantially built, and many are surrounded with beautiful lawns. The business houses and public buildings are commodious and convenient. The court house is an elegant structure, occupying a square in the central part of the city. The city school building is large and well arranged. Several handsome churches adorn the city, their capacity and costliness indicating the Christian character of the citizens.

Two railroads intersect at this point—the Jeffersonville, Madison & Indianapolis and the Cincinnati & Martinsville—giving direct commercial contact with the great centers of trade—Indianapolis, Louisville and Cincinnati. The Cincinnati & Martinsville Railroad does a very large freight business. Passing, as it does, through a region as yet without good roads, it carries to market the produce of a wide extent of territory. It furnishes transportation for the southwest part of Johnson county, the southeast of Morgan, and is nearly the only railroad accessible to Brown county, as yet entirely without a railroad. Large quantities of timber, hoop-poles, grain, and fruit are brought to Morgantown, and shipped thence by way of this road.

A study of the map shows the fact that a wide region of very productive land in the western part of Johnson county is without a railroad. It has had many promises, but, as yet, none have been realized. Should the line be built from Indianapolis to Evansville, as recently proposed, it will pass through this county, and be of immense advantage to the people and of untold profit to the railroad. Such a railroad is one of the urgent needs of both Brown and Johnson counties, and it will, doubtless, be built at no distant day.

Edinburg, in the southeast part of the county, is located in the sandy valley of Blue River, and surrounded by a magnificent farming country. It has an energetic, enterprising population of about 2,000.

Other towns and villages of importance are Greenwood, Trafalgar, Wheatland and Nineveh, all of which present evidence of thrift and culture among its citizens.

The population of the county in 1880 was 19,537, being a little more than sixty-one to the square mile.

TOPOGRAPHY.

The surface features of Johnson county are very simple. A bird's-eye view of its whole extent would reveal a general outline as follows:

A broad, high ridge, beginning in the northern part and gradually growing higher as it extended to the south, would be observed in the central part of the county. It would appear to be a sort of flattened ridge, in a crescent form, with the convex side westward. From this elevated center, a gentle slope would be observed on both sides, in the northern part of the county; but, as it extended towards Brown county, the slope would appear more abrupt and precipitous. On the eastern side, this descent, in places, as in Nineveh township, would be quite abrupt, making the boldly escarped hills of that township. On the western side, the descent has caused the streams to cut deep channels, rendering much of the land very broken. To the east and south, would be stretched away, as far as the eye could reach, a broad alluvial plain, covering the whole area of Clark, Needham and Blue River townships. To the west and south, would be seen the bold bluffs of White River, running sheer up to the eroded channel of its waters. West of the northern extremity of this ridge, would be seen a broad valley, extending to the White River, threaded by Honey Creek and Pleasant Run. This surface outline reveals the hydrography of the county.

The ridge is the watershed, and upon its summit all the streams originate. The flattened ridge, in the north, forms broad plateaus that were originally swamps, but now, thanks to thorough drainage, they are so no longer. These swamps are, really, the highest land in the county, and not the lowest, thus facilitating their reclamation. Many of the ditches made to drain them continue to cut deeper channels, instead of filling up. From this summit region the streams all flow either southwest or southeast, emptying into Blue River or White River, according to their relation to the ridge. White River touches the county on the northwest, cutting off about 1,000 acres, and Blue River touches the southeast corner, cutting off about 1,400 acres. It will be seen, thus, that the whole of Johnson county is a watershed, lying between these two rivers.

The streams that flow down its slopes, or plunge down its descents, are numerous and beautiful. Sugar Creek is the main stream of the eastern slope. It receives, in Needham township, through Little Sugar Creek, nearly the whole of the drainage of Clark township. Young's Creek, with its tributaries, Indian, Moore's, Burkhart's and Hurricane Creeks, drain the concave side of the crescent ridge. Gathering, thus, the whole volume of water from this level basin, it finally empties into Sugar Creek, near Amity, in the northwest part of Blue River township. From the southern and highest part of the ridge, Nineveh Creek sweeps down a narrow ravine, excavated by its plowing waters. Its channel is simply a gorge, with high and precipitous clay banks. On the western side of this ridge Indian Creek begins, with its various tributaries. These streams, like all running in that direction, descend to the valley of White River, through deep channels, not all of them, however, of recent origin, for some of them have evidently adopted the channels of ancient glacial streams.

The other streams are Stott's Creek, with its tributaries, and Crooked and Coot's Creeks. These last streams are small; and, indeed, none on the western side of the county are large enough to afford mill power. Occupying, as they do, rocky gorges, they are quite dry during most of the year. Some, at points where there are springs flowing, make a rill, useful only as a supply of water for stock. Sugar Creek is the only stream of the county that furnishes adequate mill power, and along its banks a number of large mills have been erected.

This topographical outline puts before us the various topographical features of this county. We have the form, and are now ready for the structure and constituents.

Observations throughout the county, with measurements of many widely separated exposures and outcrops, give the following:

CONNECTED SECTION.

QUATERNARY AGE.

Alluvium	00 ft. to 40 ft.
Loess	00 ft. to 30 ft.
Lacustral silt	00 ft. to 25 ft.
Bowlder drift	25 ft. to 100 ft.
Total	195 ft.

CARBONIFEROUS AGE..

KNOBSTONE GROUP OR EPOCH.

Knob shales and sandstone	25 ft. to 150 ft.

DEVONIAN AGE.

HAMILTON GROUP.

Black slate (Genesee shale)	00 ft. to 30 ft.
Grand total	375 ft.

RECENT GEOLOGY.

It being the fact that all geological formations are the results of successive depositions of material, the lower deposits, if undisturbed, are the older, and the rocks are later, successively, until we reach the surface, where the latest formations are found. These later deposits, as seen by the section given, are very heavy in Johnson county, and present many features of interest.

All these deposits of recent time are included under the one term, Quaternary. They are, generally speaking, alluvial, lacustral, and glacial. Of these three, the alluvial is latest, and its material is gathered from all the rest, being the deposits along the streams. Sand, clay, and organic matter are mingled together, and, as distributed through the river bottoms, produce soils of great fertility. Some of the low, level lands, above the line of overflow, are covered with from one to five feet of alluvium, almost entirely of vegetable origin. This material, mingled with sand, produces the black loam so valuable for farming purposes. A great portion of the northern and eastern part of the county is covered with this soil. The lacustral deposits are found in the southern and western portions of the county. They, generally, date from the latter part of the Champlain period, an era of surface depression. Bodies of fresh water were then confined in shallow basins, over a great part of Indiana, particularly in the northern and southern parts, the central part of the State seeming to be a sort of high dividing line between two great lake basins. The deposits in these lakes would be, usually, a fine sediment, with very little of sand and gravel. In many instances, the deposits contain fresh-water shells, though but few are observed in the lacustral of Johnson county.

These formations present three varieties in Johnson county. The ridges of the southern part, in Nineveh and Hensley townships, are capped with Loess, a yellow or buff-colored sediment. It has much siliceous material, but little coarse sand, and is easily removed by currents of water. The hills are accordingly cut into gullies and gorges, with abrupt sides. The valleys in many places are filled up with the lacustral from the hills. The Loess bed extends, in a wedge-shaped tract, almost to Trafalgar. In the western point of Hensley and Union townships, a large extent of light gray soil was observed, which is also assigned to this period. Slight changes were observed in several localities, where these fine-grained sedimentary deposits are replaced by silt, a sandy deposit made by slowly moving currents of shallow water. These lacustral deposits are simply fragments of a great area of Loess that covered several counties of Indiana, thus cut up into isolated areas, in later transformations of surface, by erosion and denudation. The ancient lake bed is thus the level of the highest ridges, and the soil that caps them the sedimentary deposit of its quiet waters. Underneath these alluvial and lacustral beds, throughout the county, is found the glacial Drift. It is either obscurely unstratified or modified, and in one form or the other, or both, it covers the rocky substratum of the whole county. The alluvial of Sugar Creek valley rests upon modified drift. But the lacustral deposits of the high southern ridge as far as observed, lie above deposits of undisturbed Drift, the latter being, in general, compact blue clays filled with angular, fragmental rocks. This formation is evidently the foundation of the primeval glacial deposits.

This glacial Drift varies greatly in thickness, ranging from only a few feet to over a hundred, wells that deep not having reached its base. The probability is that its thickness over this region was quite uniform, and that what remains in place is the undisturbed portion of a great mass of Drift material. As far as seen, this part of the Drift, throughout the county, was quite uniform. The variations of the surface are very marked, being lacustral, fluviatile, or alluvial, but the identity of this blue clay that superimposes the sandstone is clearly apparent. Dig where you will on the great central ridge of the county, this blue clay will be found at varying depths. It, like the others, gets its name from its origin. The alluvial is formed by the wash and overflow of streams; the lacustral by the slow accumulation of sediment in quiet waters; the glacial Drifts were formed by the action of great masses of moving ice.

The dynamics of this period need only an elemental discussion for the benefit of readers unlearned in geological science. All the phenomena of this period have not yet been fully explained, but the fact as to the prevalence of an era of glaciation is an integral part of accepted science. It is the only theory explaining a multitude of problems in physical geography. It answers the questions as to the presence of the bowlders, and explains the discovery of buried timber at the bottom of deep wells and a variety of inquiries originating in the mind of every observer.

Wide investigation has revealed the fact that the glacial Drift does not extend far, on an average, below the 39th parallel. In Indiana, the Drift scarcely reaches to the Ohio River, some of the southern counties having little or none. In many other localities, deep grooves or striations are seen upon the stratified rocks, and many of the bowlders are scratched or grooved, as are some observed in Johnson county. Moving ice alone could leave such a record.

The facts observed show that this moving mass was a mighty glacier, covering vast areas of the northern latitudes. As it accumulated, it moved southward, thus passing, gradually, into lower and warmer latitudes. In its progress over the rocky formations of the north, it displaced, by its weight and motion, vast quantities of material. These substances, in the form of sand, gravel, and bowlders, were carried along in its icy embrace, to be released in other latitudes by the dissolution of the glacier. The broken fragments of metamorphic rocks of the north would lodge in the soil, and remain as bowlders of granite and feldspar that are so familiar to all, yet so mysterious in their origin. The material eroded, by the glacier, from sandstone and limestone formations constitutes a large proportion of the soil, being pulverized and distributed by the waters of the melting glacier. The local details of the Drift in Johnson county furnish a good exposition of glacial phenomena. The primeval glacier extended over the whole of Johnson county, there being evidence that it covered the whole of Brown county, save the summit of "Weed-patch Hill," the northern ridge of Brown county became a great barrier in the pathway of the glacier. The first advance of the ice may have easily surmounted the obstacle, passing on and over, with resistless depth and power, the whole region becoming a glistening expanse of icy solitude. Bye-and-bye, an epoch of spring-time followed this era of wintry cold. The changed climate came on slowly. The melting ice causes the gradual recession of the glacier. Its dissolution sets new agencies into operation. Torrents of water begin the re-assortment of the drift. As the glacier withdrew, its detritus of bowlders, sand, and clay is subjected to the action of these fluviatile floods. The original deposit of the glacier is unstratified bowlder-drift; the foundation is of blue clay or hardpan that underlies the surface deposits.

The glacier did not recede uniformly. Its progress backward was varied with periodical advances. Nor was its retreat equal in every latitude. Surface elevation and the nature of the underlying formations would affect the dissolution of the ice mass. Tongues of the glacial ice would extend southward. Along elevated ridges, waters, rushing down, would conspire in the construction of deep, broad channels where the excavation was the easiest. That would be the locality where the surface was lowest and the underlying formations most susceptible of erosion.

This was the process of glacial action in Johnson county. The great central ridge of the county was covered with ice after it had wholly disappeared in the eastern side of the county. Indeed, it appears, from conditions observed, that the whole valley of Sugar Creek was a portion of what is now definitely known to science as "Collett's Glacial River."

Through this region, comprising three townships, there is evidence of deep erosion. There is no outcrop of the sub-stratum, save one exposure of the black shale. The deposits are all fluviatile, modified bowlder drift, either as a pebbly clay, with pockets of sand, or large and wide-spread deposits of obliquely stratified sand and gravel. Throughout this region, large bowlders are rarely found. The western shore of this ancient channel is well defined. In the southern part of the county are boldly outlined hills of the Knobstone formation. Some of them are plainly terraced, as particularly one on "Montrose farm," in section 34, Nineveh township. From the top of this hill there is a magnificent view of this ancient valley. Its eastern shore, the highest lands in Shelby county, stands out in distant outlines. This hill is one hundred and forty feet above the valley at its base and two hundred and seven feet above Edinburg, six miles to the east, and located on the alluvial and fluviatile deposits in the bed of this ancient river. In the northeastern part of the county, this outline is not less distinctly, though not so abruptly and grandly, defined. On the map, it coincides almost exactly with the course of Hurricane Creek. Observation revealed the striking fact that this stream, with an almost due south course, followed the eastern limit of the modified bowlder drift. This is seen in the fact that the western bluff of the stream is the higher for a distance of seven miles, and that this higher bluff, throughout this whole extent, is full of bowlders, while none were observed on the eastern side. West of Hurricane, the bowlder clays are thick and undisturbed; but on the east, the soil is sandy and loamy, with local gravel deposits, just as observed elsewhere throughout this ancient valley. This shore line, beginning thus in the northern part of this county, continues, with this general southern course, to the southern part of the State.

Prof. John L. Campbell has conjectured that at the time of greatest flow in this channel, the southern terminus of the glacier was not far south of Indianapolis. There is evidence of this, not only in the fact that the western shore disappears in this region, but that the crescent-like ridge of this county sweeps around to the east with a sharp curve, outlining, to the observer, a mighty mass of drift material that is a notable feature in the northern part of Pleasant and Clark townships. It extends from Greenwood, eastward, with its axial line running a little south of east. It is a ridge, well marked by the hundreds of bowlders that are strewn along its surface. Near Greenwood, the railroad crosses this ridge at an elevation of 840 feet above the sea, this being the highest point on the railroad between Indianapolis and Louisville. The eastern terminus of this ridge is in section 4, Clark township, at which it is rounded by Leatherwood Creek. Throughout its course, no deposits of gravel were seen. The bowlders are everywhere thickly studded in a solid matrix of clay. Near Rocklane, a multitude of unusually large ones were seen, sometimes hundreds of them in an area of a few acres, many of them ten to fifteen feet in length and weighing many tons. On the farm of Mr. W. F. Kimuck, in section 36, Clark township, one was measured, showing the following dimensions: Length over top, 18 feet, 1 inch; circumference 41 feet, 10 inches; height above ground, 5 feet. Near this monster were a number of immense proportions.

It was noticeable that there was a striking similarity in the bowlders of this ridge. They were mainly a coarse, gray granite, appearing as though they came from the same locality, as, doubtless, they did. The reason of their exposure so numerously upon the surface is, probably, that the ridge, being much more elevated originally, has been lowered by the washing down of its clays, thus exposing its buried bowlders and leaving them thickly strewn upon its flattened surface. Bowlders are thus a measure, oftentimes, of erosion.

There are a number of localities where a heavy removal of clay is revealed by the abundance of bowlders exposed, notably in Nineveh township, section 16. The whole mass of undisturbed bowlder clays of the central part of this county are more or less filled with these massive, erratic rocks.

Most of them are granitic. Occasionally a feldspathic or schistose bowlder is seen. A few large fragments of limestone, usually filled with Devonian fossils, were noted; one weighing several thousand pounds was seen in a deep ravine, near Barnes' Creek, in Hensley township, section 17. These massive erratics, thus strewn throughout this whole region, suggest the extent of the glacier. The whole region was covered with ice, by which alone these bowlders could have been transported.

Originally, the drift was deeply deposited on the eastern side of the county, also; but, there, it has been subjected to complete modification and erosion. That this re-assortment should take place there, and not in the central part of the county, is explained by the fact that the elevated regions held their ice-coverings the longest; that while the receding glacier's volume of water was deepening its channel northward, defining the course of the great glacial river, this ice-foot extended across Johnson county to the higher lands of Brown county, thus preventing the deep erosion that would have re-assorted the glacial drift, had it not been thus protected. But, in process of time, the whole mass melted, and there came volumes of water, overflowing everything, silting up portions of the old channels, and re-covering large areas of the glacial deposits, with sorted sands, clays and gravel. These floods moved with rapid and resistless current. They cut deep sluiceways through the clay barriers, casting up, in various places, heavy bars of sand, gravel, clays and bowlders. These channels may be traced by the deposits of gravel in many places, notably in a series of sluiceways having a general southwestern direction, found mainly in the southern part of the county. One is observed passing through the southwestern part of Franklin township, and connecting in Union township with the channel in which Stott's Creek now flows. Along the line of the Franklin and the Trafalgar gravel road, it is well defined, being a broad, deep channel, now obstructed with alluvium, and only occupied by a rill wholly unequal to the task of its excavation. Another similar depression passes near Trafalgar, showing an analagous relation to Indian Creek.

Proof that large volumes of water, at one time, flowed through these passage-ways of this glacial ridge, is found in the fact that, in the deep channels of the creeks in Hensley township, deposits of gravel are found. In many places they occupy positions with reference to the clay and sandstone that show the direction of flow as being from the northeast. Two beds of gravel on Barnes' Creek were examined, having the usual oblique and alternating stratification of such fluviatile deposits. Both were on the west bank of the valley, the one in section 17 facing a bluff with an exposure of sandstone capped by about 30 feet of clay. The current that cast up this sand bank came down this valley from the northeast. Similar conditions were observed in other valleys, many of the low points in these deep gorges being simply deposits of the post-glacial streams.

Where the region to the northeast of this central ridge is examined, it reveals the fact that these fluviatile waters wrought wonders in re-assorting the drift. North and east and south of Franklin, extensive deposits of sand and gravel exist. In their arrangement there is a general trend to the southwest. The sand ridge beginning at Franklin runs southwest, without interception, for several miles, where it is intersected by a small stream, but it appears again in the west, in sections 29 and 30, Franklin township. The sand and gravel at Mount Pleasant Church is a continuation of the ridge south of Franklin.

Another conspicuous deposit of sand and gravel, and probably the most remarkable, is the "Donnell Mound," section 8, Franklin township. It is an illustration of the effect of fluviatile waters, and it shows well their southwestern course. The northeast side of this mound is abrupt; and the southwest side, sloping gently toward Young's Creek, presents a talus, showing the direction of the current. The sand and gravel at Hopewell and vicinity is all of the same origin. The "Donnell Mound" presents a section of alternate layers of sand and clay and gravel, showing well the "flow and plunge" structure. The mound is about ninety feet above the bed of Young's Creek. From its rounded summit there is an interesting view of a region of wondrous fertility and beauty. While these floods were re-assorting portions of the glacial drift in the central part of the county, the eastern parts were wholly submerged. Clark township was a broad flood-plain, and in Sugar Creek valley the waters had more current; hence the casting up of the great sand deposits, characteristic of this region. The elevated portions of Needham township, notably on the land of L. Waggoner, in section 18, and of W. Duckworth, in section 15, are excellent examples of these fluviatile deposits. They overlie large areas in Blue River township.

All of these deposits bear a marked resemblance throughout the county, and all are contemporaneous in origin.

The only departure from this rule, that was observed, was a gravel deposit in section 20, Hensley township. This formation is apparently near the base of the glacial drift, being overlaid by from thirty to forty feet of bowlder clay and Loess deposits. From observation, this bed of gravel is present through quite an area of drift, and is not a mere pocket of sand and gravel, as such deposits usually are in unstratified drifts. The formation is, on an average, about ten feet thick, and, as far as seen, shows a regular, horizontal stratification. The alternating layers of fine sand and gravel are from six to ten inches thick, and all are charged with various mineral solutions, that give the whole deposit a variegated appearance. The bands are reddish-brown, ash-gray, blue, and yellow, features of chemical discoloration not seen in any gravel deposits elsewhere in the county. In many, the ordinary coloring of red oxide of iron was seen, but nothing with these features of color and stratification. This deposit, probably, antedates the general fluviatile modifications of the drift, and was formed at the first advance of the glacier, under the action of waters attending its periodic advance and retreat, and, as thus deposited, finally deeply covered with drift, when the glacier reached its culmination. The contrast of condition between this gravel bed and the one on Barnes' Creek, just one mile west, is very striking. The one lies above the drift, with oblique stratifications; and the other below it, with regular layers. The covering of the gravel pit on Barnes' Creek, is black alluvium; of this one, the covering is of the most compact clay, so hard and firm that it could only be removed by blasting. The relative antiquity of these two adjacent deposits is thus suggested. An epoch of geological history probably intervenes them.

Along the bluffs of White River, the peculiar phenomena of the glacial and post-glacial periods are observed. On this side of the central ridge of the county, the fluviatile floods apparently had not the advantage of long continued erosion. Instead of filling up a wide valley, already excavated, the great flood performed the Herculean task of cutting a channel through the sandstone ridge that extended, in bold outlines, across its course. This fluviatile erosion of the ancient valley of White River is thus seen to be a later event in geologic history than the formation of the "Collett Glacial River," which was the product of glacial action previously. This sandstone formation was probably capped with a heavy drift deposit. Through this barrier the water found its way, having, as the shore of its channel, the bold bluffs of White River at Waverly and Far West. The bluffs mark the eastern limit of the Knobstone formation.

Instead of following the outline of the outcrop, as in "Collett Glacial River" valley, the waters are compelled to cut directly across the barrier, because of the ridge on the east. North of Smith's valley there is a broad level plain, covered deeply with alluvium. Parallel with the present channel of White River, there are, in many places, detached ridges of sand and gravel, the axial lines of which lie northeast and southwest, coincident with the course of the ancient river. Some of these sand deposits are very thick. In several places they are piled directly upon the sandstone, all the clay having been removed. The sand and gravel gradually disappear as we go east from Far West, showing that these deposits were limited to that ancient channel. The high lands of section 9, 16, etc., of White River township, are the eastern shore of glacial drift, of superimposing sandstone strata. From the county line, one mile south of Far West, this elevation affords a magnificent view of the ancient valley, now threaded by the comparatively diminutive and meandering channel of White River. Observation and inquiry in various parts of the county reveal the fact that buried timber and leaves are frequently found, under such conditions as to position and distribution as to indicate a glacial and not "forest-bed" origin. The wood was apparently that of cone-bearing species, and found usually imbedded, at irregular depths, in clays. In section 21, Franklin township, at the bottom of a well twenty feet deep, leaves and twigs were found in the clay; and in section 20, three-fourths of a mile west, fragments of wood were taken out thirty-five feet below the surface. These remains all seem to be isolated and fragmentary—not a portion of a buried forest, but particles of wood and debris, dislodged and ground up by the moving glacier, and deposited finally with its detritus.

In section 12, of Hensley township, just south of Trafalgar, on the farm of J. J. Moore, is a formation of tufa that is quite extensive and interesting. There is above it a deposit of gravel, much of it cemented firmly together; beneath it lies a mass of calcareous tufa, or "honey-comb limestone." It contained perfectly preserved outlines of sticks, grass, moss, and leaves. The formation is produced by the filtration of water through the soil, which is highly charged with mineral ingredients, in this instance particularly, calcareous matter. The water becoming thus charged with lime, deposits a thin layer upon any object that it may cover; hence, the leaves and moss lying where such waters issue will, sooner or later, have their material re-placed with carbonate of lime, and, so, perfect casts are preserved and these curious formations are produced. For this reason these tufaceous deposits are usually observed in the vicinity of springs.

PALEOZOIC GEOLOGY.

The substrata of Johnson county comprise two different formations—one of the Carboniferous Age and the other Devonian. The Subcarboniferous period is represented by the Knobstone group or epoch, that underlies the drift throughout the western portion of the county. The Devonian is represented by the black shale of the Hamilton period, which is seen at a single exposure in Blue River township, but, probably, underlies the drift throughout the eastern third of the county.

The first for consideration, in the order of investigation, will be the

KNOBSTONE GROUP OR EPOCH.

As previously intimated, this formation underlies the glacial drift in the western portion of the county. As traced by outcrop, it enters the southern line of the county in the southeast quarter of section 34, where it appears in force, forming the precipitous slopes of Woodruff's Hill, near Nineveh. From this point it extends northwest in a waving line, having a heavy outcrop in section 10, Nineveh township, at Pritchard's Hill; thence, northwest through sections 4 and 5, Nineveh township, and section 31, Franklin township. In all the deep channels of the streams in Hensley, Union and White River townships, there are uniformily exposures of strata of this formation. Generally, the exposures are continuous to the very source of the small streams, showing that this formation lies well up in the central ridge of the county. It was seen at the head-waters of Nineveh, Indian, Stott's, Crooked, and Bluff Creeks. This elevation of strata suggests the possibility of their continuance underneath a portion of the eastern extension of this ridge, through Pleasant and Clark townships. This can only be determined by a deep bore in those regions. The probability of this extension is increased by the consideration that erosion did not occur here so deeply, because of the overlying ridge of compact bowlder drift. This whole region was more or less protected while the denudation of the formations southward was in progress.

Originally, the Knobstone formation extended eastward much farther than at present. Indeed, such an extension is demanded by the present position of the strata. They lie in position with an undisturbed and almost horizontal stratification, and with only a gentle dip to the west, yet, six miles west of Edinburg, they have an altitude of more than two-hundred feet above the level of Blue River. There are no sufficient data to prove that this difference of altitude is produced by oscillations of surface; the ledges show no signs of any sort of disturbance. The main cause of change has, apparently, been the deep erosion of the eastern portion of the Knobstone toward the older and more elevated formations of Shelby and Decatur counties. The precipitous wall of the Knobstone formation in southern Johnson county indicates that it was caused by erosion. The very constituency of the lower portion of the Knobstone group favors the idea of their general denudation in the eastern part of Johnson county.

The characteristic of these ledges is that the lower are the more argillaceous; hence, loose, fine-grained clay shales are found, generally toward the base of this formation, with an increase of sandstone toward the top. The whole group in Johnson county exhibited these features.

The easily disintegrated clay shales are lowest and eastward, and the heavier ledges of massive freestones are found, as we rise, in series toward the limestone of the next formation. This feature indicates not only the probability of extensive erosive action along the eastern outline of the Knobstone, but suggests also the fact that the physical condition of the lower parts of the Knobstone conditioned the course of the Collett Glacial River, and contributed not a little to the formation of this glacial valley. The natural tendency of water is to follow the line of an outcrop, especially when an outlet with the dip is not easily secured, as was the case in this instance. The glacial deposits, westward, overlaying massive sandstone formations, made the natural channel coincide with the outcrop of the soft clay shales of the Knobstone. These favored deep and rapid erosion. All the data have, as yet, not been gathered to establish its depth and extent. It certainly swept away the whole part of the clay shales, and a greater part of the black shale of the next period. It is possible that the drift deposits, in some localities, rest upon the Corniferous limestone — the final bed of the deep flowing river of the misty past.

The Knobstone formation is quite uniform throughout the county. A section from White River township would coincide, in general features, with a section in Hensley.

Everywhere, the blue clay shales are filled with ironstone concretions, of all sizes and shapes. They are particularly abundant in the deep ravines of Nineveh and Hensley townships. They contain a large per cent. of iron, but the quantity is not sufficient to give them economic importance. Near the top of the outcrop at "Pritchard's Hill" (section 10, Nineveh township), two beds appear that are quite rich in iron, the mineral not being in nodules, but mingled with the shale, and, under exposure, showing a reddish-brown color.

The aluminous shale, while persistent through the whole section, nevertheless, varies in appearance. In one locality, on the land of Alfred Vandevier, in section 5, Nineveh township, it was a fine micaceous clay. The outcrop is about ten feet thick, underlying layers of freestone about six inches in thickness. In character, it was very soft and friable, but, on exposure to the air, it soon hardens, and, if it is rubbed, it takes a smooth polish and turns white. The early settlers of the neighborhood used it as a finishing mortar in "daubing" their houses. Its qualities demand some test of its practical value. No other exposures of this aluminous shale were observed, with the peculiarities of this outcrop. Elsewhere, they are more of a drab color, and usually with more or less of arenaceous material.

Along the course of Indian Creek, in Hensley township, the peculiarities of this formation are well displayed. One branch of the stream rises in the northern ridge of Brown county and the other starts from high land south of Trafalgar. Each one passes down a deep gorge, in part the work of its own waters. The South Fork presents the best exhibit of the Knobstones. Along its whole course they present a precipitous bluff, ranging from seventy-five to one hundred feet in height. At the junction of the two branches of Indian Creek, in southeast quarter of section 27, the following section was taken:

Soil	2 ft.	00 in.
Loess	20	00
Clay, about	30	00
Sandstone	00	10
Arenaceous shale	12	00
Freestone	00	06
Clay shale	10	00
Sandstone	00	08
Blue clay shale	12	00
Paving stone (bed of creek)	00	00
Total	88 ft.	00 in.

This alternation of shale and sandstone is very marked as we go down the stream. The sandstone becomes more massive, but the shales are persistent. The floor of the stream, at the point of the section given, is a layer of ferruginous sandstone. It is in broad slabs from three to six inches thick. It quarries easily, is regularly seamed in one direction and breaking with a square fracture in the other, thus being well adapted for pavements. The verticle partings through this layer all trend east and west.

This layer is exposed in Union township, under similar conditions, in the bed of the Middle Fork of Stott's Creek. The dip of the strata is down stream. It was observed that they rapidly thickened as they continued westward; a stratum of freestone, six inches thick, increased to about two and one-half feet in less than two miles. The increase of thickness was very uniform through the whole distance. Its continuous outcrop along this creek is a very noticeable feature of the scenery. The ledge juts out in massive shelves over the water. Where it finally passes below the bed of the stream, it is nearly three feet thick. At this point the overlying deposits are comparatively thin, and the conditions are favorable to the successful removal of this excellent building stone. It is a durable rock, hardening with exposure and not affected by climatic changes. Ledges that had been exposed for an indefinite period preserved the sharp angles of the first fracture.

No fossils were found in any part of this formation, though constant and careful search was made. Ripple marks were occasionally seen, though usually in faint outlines. One slab of brown ferruginous sandstone on "Woodruff's hill" had its surface covered with raindrop-like impressions; another was found in Hensley township, with outlines of "fucoids or seaweed." The absence of fossils is explained by the conditions of the ancient sea in which these shales and sandstones were deposited. The turbulent and shallow water of its shore may have been fatal to their existence, or, if they existed, its deposits were not adapted to their preservation. In some of the ravines of White River township, geodes were found quite numerously, but, generally, smaller than those abounding in Brown county. The hollow concretions are characteristic of the Keokuk beds, the next higher formations, and appearing in outcrop some distance westward. Their presence in this distant and isolated valley may be explained by the decomposition of some outlier of the Keokuk. The calcareous matter of limestone being removed, these siliceous concretions would remain, and would naturally find their way to the beds of small streams.

In the valley of Indian Creek, a geodized goniatite was found by Hiram Porter, who kindly presented it to the State Museum.

THE BLACK SHALE.

(GENESEE SHALE.)

There is but one outcrop of this well-known and much studied formation. It is well exposed in the bed of Sugar Creek, in Blue River township. The outcrop begins just below the railroad bridge, in section 9, and extends down the stream to the iron bridge, over Bradley's Ford, in section 17. It is a fine exposure, the formation composing both the bed and the banks of the stream. The shale is jet black, breaking usually, on exposure, into small pieces, the fracture being quite as ready in one line as another. Other ledges exist in broad slabs that are quite massive; these are usually studded with quantities of iron pyrites in flattened concretions. When broken, the illusive yellow suggests the common name, "fool's gold," and, therefore, is simply sulphide of iron.

This exposure of the black shale seems to be an isolated one, there being no other observed nearer than Valley Mills, in Bartholomew county, nearly seven miles south. It seems to be an island of shale, capped with a heavy deposit of modified drift. If any of this bed exists in any place in this locality it is at a much lower level. In this outcrop, the shale ascends well up on the bluffs of the creek; and in the adjacent regions the alluvial and fluviatile deposits are very heavy, the deepest wells never reaching the shale.

Only one fossil was found in this outcrop. Though this group, in other localities, has furnished quite a number of species, the specimen found was the impression of a fossil plant on a large slab of the shale. It was fully six feet long, and was apparently a rush-like plant, with a jointed stem, which, when growing, must have been a gigantic *Equisetum*, allied to the genus *Calamites* of the Carboniferous Age. It had jointed stems, the joints being from two to four inches apart. In process of preservation these joints seem to have been separated, and, in the interstices, was found a layer of coal that was as hard and irridescent as anthracite. This black shale is full of carbonaceous matter.

The rocks of this period, in other localities, are rich in oil, but these shales contain only about ten per cent. of combustible matter. For this reason, they burn with a bright flame for a few minutes, when placed in a hot fire, but, aside from this they have no other resemblance to coal; nor have they any relation to the coal-bearing rocks, being far below them geologically. These beds probably underlie the most of the surface of the eastern part of the county. It has been subject to great erosion, and, as it readily decomposes on exposure to air and water, it is not unlikely that the broad belt of black loamy land in Clark and Needham townships derive their color and fertility from the decomposition of the black shale. Its clayey, carbonaceous matter, mingling with alluvial deposits of organic material, produces a fertile soil.

ECONOMIC GEOLOGY.

SOIL.

The diversified topography and varied geological structure of this county affords a great variety of fertile soils. They range from the firm compact clays of the central ridges to the loamy alluvium of the level plains.

The clay lands are all susceptible of a high state of cultivation. Even the white clay of portions of Hensley and Union townships is rich in the mineral ingredients that are the basis of a good soil, which constitute the vital elements of plant food—the product of decomposed rocks, mingled with more or less of matter of vegetable origin. These stiff, heavy clays are really not "poor" land. They are rich in the elements of productiveness. A cold, clammy soil only needs to be opened and warmed. This can readily be done, not so much by costly fertilizers; for the soils of Johnson county do not need so much the introduction of plant food as they need the production of the conditions in which they can use what they already have in store as a part of their constitution. Manures might, doubtless, benefit old and worn out soils, but the need of so-called "poor white clays" is not the putting-in, but the bringing-out process. The elements of fertility are inherent in the vast store of phosphates, carbonates, etc., that are held unused in these cold, compact clays. The two agents are clover and drainage; the former, in connection with a judicious rotation of crops, and the latter contemporaneous with thorough subsoiling. These introduce the effects of light and heat. The clover roots penetrate deeply—they tap the store of plant food. The roots and leaves, dying, introduce a new element of fertility. The drains carry off the water that formerly had no outlet. The soil becomes porous and open. In wet weather, it loses its superfluous water, and in dry weather the loosened earth gives the rootlets access to the deeper moisture. This process will develop the capacity of these cold clays. Not only will it develop their capacity, but it will preserve them in increasing fertility.

The greater portion of the soil in Johnson county is a rich, black loam. The only condition of productiveness is thorough under-drainage. This condition has been almost universally met, hence, the almost unequaled fertility of the land. There are numerous tile factories in constant operation, and thousands of dollars are expended annually in this most profitable investment.

The direct benefit of the extensive and thorough drainage is the hygienic blessing of pure water. Malaria was the curse and terror of this county, three decades ago. The shallow, stagnant marshes generated the poison which was introduced into the human system, probably not so much by atmospheric communication as by the infiltration of its impurities into the shallow wells and surface springs from whence the people procured water for potable and culinary use. Drainage dries the swamps that feed the shallow, surface wells. The remedy is a deeper well to the purer waters below, that have not a marsh for a fountain; or, what is better still, the construction of cisterns, and thus securing the purest of all waters, from the clouds. The importance of a pure water supply can not be overestimated. Medical authorities affirm that many epidemics of typhoid fever originate in a contaminated water supply.

Johnson county is naturally well supplied with an abundance of pure water. Numerous springs issue from the hillsides, some of them charged with mineral ingredients. The finest and most noted mineral springs are found in section 7, Nineveh township. They are known as the "Vickerman Springs," after the name of the original owner of the land. They are three in number, all close together and issuing from the base of a boldly escarped bluff of bowlder drift. The springs flow out at the top of the sandstone strata at the base of the clay. They are quite similar in character, though the one farthest to the west exhibits the most decided mineral character. Its analysis was not obtained. The water is said to have medicinal properties, and many have testified as to its efficacy in certain disorders. It has a pleasant taste. The rocks over which it flows are colored bluish black, as is the whole bed of the stream into which it flows, for some distance below. Bubbles issuing occasionally, indicate the presence of a free gas. The "Big Spring," at Hopewell, is well known. Here, the water issues from the base of a sand and gravel deposit overlaying the blue clay. Other springs have been utilized in the arrangement of fish ponds. The supply of German carp has taken fish culture out of the domain of pleasure into the region of practical industry. Fish may be reared as easily as poultry, and are more profitable.

LIVE STOCK.

The abundance of running waters and excellent grass land make this county a great stock region. These natural advantages, coupled with the noted enterprise of the people in securing and breeding to the best breeds of animals, has made this county famous for its fine stock. Herds of short-horn and Jersey cattle are numerous, with horses of the finest character, while flocks of Cotswold sheep and droves of Berkshire and Poland China hogs are found everywhere. To individualize merit would be to discriminate against equal excellence in a myriad of instances.

ROADS.

Johnson county was one of the first counties to move in the matter of improved means of transportation. Under the old gravel road law, numbers of excellent roads have been built, the material being the excellent gravel that abounds in every part of the county, save a narrow strip along the central ridge. This region, however, is not so extensive but that material is accessible in the adjacent more highly-favored localities. The gravel usually cements into a solid mass, and becomes very durable, needing only a fresh coat now and then to keep it in excellent condition.

The provisions of the new road law are stimulating the construction of many free gravel roads, notably in Hensley and Union townships. The distance from any shipping point make them doubly desirable. Difficulty in securing adequate supply of gravel in those localties was anticipated, but closer investigation indicates an adequate amount is accessible. The beds of the larger streams will produce a small amount continually, probably enough to keep the roads in repair. A larger and more reliable supply will be found in hidden deposits along the points of the ridges running down into the deep valleys of Indian, Barnes' and Stott's Creeks. The gravel is found in the "second bottoms," and sometimes under several feet of soil. The efficiency of the new road law will depend upon its proper enforcement, and that will hinge upon election of honest, intelligent and energetic men to the office of road superintendents.

FRUIT.

The "Brown edge" of Johnson is well adapted to the production of fruit of all kinds. The native fruits of this soil are Nature's plain hint as to its capacity. They grow luxuriantly. Persimmons, blackberries, raspberries and grapes all abound. Grape vines of wonderful length and size clamber among the branches of tall trees. Where Nature's suggestion has been followed, excellent fruit is produced in abundance and in the greatest perfection. While the orchards elsewhere in the county were dead and dying, the apple trees on these ridges were thrifty and fruitful. Mr. J. M. Woodruff states that in sixty years his peach trees on this high land have only failed to produce fruit four times, an average of but one failure in every fifteen years! Such success should warrant the planting of this land in all varieties of fruit. Cereals have but a scanty and uncertain growth in these soils, but fruit would be a sure investment, with early profit. The region south of Trafalgar and west of Nineveh could be made the orchard of Central Indiana. Other regions, equally as productive, are too remote from the railroad. This region is near, with excellent facilities for transportation, and could easily distance all competitors.

ARCHÆOLOGY.

Traces of the pre-historic people, while not abundant, are of such a nature as to interest the antiquarian. Only two small mounds are known to exist in the county, and they are small habitation tumuli. They are on the land of William Sanders, in section 10, Blue River township. They are about one hundred yards from each other. The land is under cultivation, and they have been almost obliterated. Some of the sand ridges in the county greatly resemble mounds, as the "Donnell Mound," and many others; but they are natural elevations produced by the fluviatile agency previously described.

The western half of the county is by far the richest in archæological relics. One of two reasons may explain their comparative absence on the eastern side: either the locality was too wet and marshy, or the alluvial deposits have buried all traces of their residence below the present surface. On almost every farm in Hensley, Union and White River townships, the various implements of the pre-historic and aboriginal people may be found. They are generally the grooved axes, pestles of Greenstone, and pieces of pottery. A fine Syenite axe was presented to the State Museum by Mr. Hiram Porter, of Hensley township. This gentleman is an enthusiastic collector of specimens, having in his house many of rare interest. Another handsome grooved axe, or "celt," was presented by George Holman, of Hensley township.

In this township are frequently found slabs of sandstone, having one or both sides full of shallow round holes, about large enough to fit the larger end of an average hen egg. They are smooth and symmetrical, evidently having been fashioned for some purpose. Many conjectures have been advanced as to their probable use. Some have suggested that they were "Anvil stones"; but the character of the stones prohibits such use, being in rather thin slabs and easily broken. One of these stones was seen, having both sides full of holes. On one side there were twenty-three, and on the other twenty-five. Such a number seems to oppose another explanation that has seemed very plausible—that these holes were worn by constant use in cracking nuts for food, which constituted a large portion of their subsistence.

On the land of Calvin Fletcher, in section 18, White River township, a skeleton was found in a gravel pit, having a vessel of pottery closely fitted upon the skull, which was well preserved. Both the skull and the pottery were broken into fragments by the thoughtless workmen. Associated with this skeleton were found a number of flint arrowheads and pieces of fresh-water shells. These specimens are in possession of Mr. W. M. McKinzie, of Waverly, Morgan county.

In section 32 of this township, on the land of Mr. J. H. Throckmorton, portions of an immense pair of antlers were found, in digging a ditch. They were four feet below the surface, lying at the base of the alluvial deposits or at the top of the clay. They were worn, doubtless, by the great post-glacial deer, which ranged this region as a contemporary of the Mastodon. Of this latter animal no relics have been reported in any part of the county.

Flint arrowheads, chisels, bodkins, scrapers, knives, etc., are frequently found. Mr. W. H. Barnett, of Franklin, has an interesting collection from various parts of the county—among them one eight-grooved axe, one flint bodkin three inches long, and a fine flint dagger six inches in length. He has in his possession, also, two iron tomahawks, to which is attached peculiar interest. The smaller one was picked up on the old Indian camp ground on the bluff of Young's Creek, west of Amity, the spot on which the Indians had their last camp-ground within the limits of this county, in 1824; the other is a larger axe, of very hard steel, made in the old Spanish fashion, and was dug up near the buildings of Franklin college.

EDUCATION.

Franklin College is located at Franklin, and is under the control of the Baptists of Indiana. The institution is in a flourishing condition and is doing a grand work in the cause of education. The able and efficient faculty are thoroughly devoted to their work. It is confidently hoped that the endowment of this institution will soon be increased largely, and the college put in position to surpass in usefulness even the grand record of the past. The curriculum of studies is complete in all departments, and the standard of scholarship is high. The surroundings of student life are most delightful and favorable to all the interests of the pupil—moral, mental and physical. The location is a pleasant one. The buildings are commodious and convenient, and the campus extensive and shaded by majestic trees, mainly of native forest growth. The library, laboratory and cabinet are all well supplied with the references, appliances and specimens that enable the successful prosecution of any branch of study.

The public school houses of Franklin, and of all the larger towns, are well constructed and supplied with all the desiderata of first-class graded schools; and, throughout the county, the old-fashioned, barn-like school houses have been almost universally replaced with handsome and well-arranged structures that are a credit to the intelligence of the people.

Large and commodious churches abound in the county as well as in the towns. Some of the rural churches, as Hopewell, Pleasant Hill, and Union, rival the cities, in both the costliness of the houses of worship and size of the congregations.

The population, everywhere, is cultivated and Christian, progressive in spirit, ready for every act of benevolence and every movement for public good.

THANKS.

The personal kindness received from those who aided in this survey has been highly appreciated, special acknowledgment being due the following generous and public-spirited citizens of various townships: Wasson McCaslin, David A. Leach, N. H. Barnett, Herman Porter, J. M. Woodruff, Alfred Vandevier, George Holman, Andrew S. Wood, W. F. Kinnich, Prof. D. A. Owen, W. H. McKinzie, T. J. Byer, John H. McCaslin.

GEOLOGY OF GRANT COUNTY.

BY A. J. PHINNEY, M. D.

GEOGRAPHICAL AND TOPOGRAPHICAL NOTES.

Grant county is situated not far northeast of the center of the State, about midway between Ft. Wayne and Indianapolis. It embraces 418 square miles in its area.

The principal Indian inhabitants of the county, in the early part of the century, were of the Miami tribe; in later years they were reduced to the Meshingomesia band. Their most noted village was Meshingomesia, situated about three miles south of the Wabash county line, near the Mississinewa River. The Indians still hold this land, the title never having passed to the Government.

The first settlers were principally Quakers, who located at and in the vicinity of Jonesboro; and, to-day, fine farms, school-houses, and modest churches are evidences of the thrift, intelligence, and moral status of these people. The northern portion was settled by emigrants from Ohio and the Middle States.

Grant county formed part of Delaware county until February 10, 1831, when the Legislative Act for the organization of the county was approved.

Marion, the seat of justice, is named in honor of Gen. Francis Marion, a noted leader in the Revolution. This city has a population of about four thousand. It is an enterprising place, busy with the various industries that give prosperity and happiness to its people. It is situated in the valley of the Mississinewa River, and is surrounded by high table lands, rendering the scenery quite picturesque. The court house is a magnificent structure, built of Indiana's famous oolitic limestone.

The other principal towns are Jonesboro and Fairmount, each having about one thousand inhabitants. The smaller towns are Upland, New Cumberland, Van Buren, Jalapa, Mier and Sweetser.

The county is crossed by the Pittsburgh, Cincinnati & St. Louis, the Cincinnati, Wabash & Michigan, and the Toledo, Cincinnati & St. Louis Railways, and, as the course of each is somewhat circuitous, ample facility for communication is afforded all parts.

SURFACE CONFIGURATION.

The surface was originally one vast plain, with only occasionally slightly rolling tracts to break the monotony; now, the valley of the Mississinewa River is the most marked topographical feature. On the east, is a slight divide, separating the waters of Black Creek from the Mississinewa, while on the west, is another, which turns the waters of Pipe Creek to the westward. Its course, after leaving the county, is nearly parallel with the Mississinewa. The drainage from Green township is almost due west, Wildcat Creek having its source here. There are no hills, strictly speaking; the broken surface along the river is due to erosion, as the summits of the so-called hills are not higher than the plain a few miles back from the river.

The fall of the Mississinewa is rapid. Throughout its entire course in the county, it has cut its channel from fifty to one hundred feet below the level of the plain; as a result of this, all the small streams tributary to it have excavated deep gorges through the heavy clays, giving a very broken surface. The southern portion of Monroe township is usually considered rolling, especially along Walnut Creek, but this is due, also, to erosion. Walnut Creek may seem totally inadequate for the excavation of so deep and broad a valley as the one it now occupies, but the explanation is easy, after determining that it was crossed by a great glacial river, flowing to the southwest. Overflows from this river, probably, contributed much toward the excavation of the valley and the erosion of the surface of the plain adjacent to it.

The Mississinewa River enters the county near its southeast corner, and, after traversing it diagonally, leaves it on the north side, about six miles east of its western boundary. Its valley is quite broad in places, though, north of Marion, it is narrow, owing to the river having cut its channel through limestone strata. No one, from the present size of the stream, would infer that it was ever navigable, yet such has been the case. In early times it could be crossed at Marion by ferry only, for nearly half the year; flatboats carried the produce of the farmers, by way of the Wabash, to New Orleans, where it found a ready market; but with the clearing of the forests, the draining of the wet lands and the building of dams, the river has dwindled until this is no longer practicable, and the construction of railroads has rendered it no longer a necessity. The river, however, at present, affords valuable water power, which is utilized to its fullest capacity.

Pipe and Grassy Creeks drain the western part of the county, and Black Creek the northeastern portion. The principal tributaries of the Mississinewa, from the east, are Walnut, Lugar's, Hummel's and Lake Creeks, and Barren Back, Deer and Boot's Creeks from the west. These are all small streams, and serve only to furnish a supply for stock.

Water is usually obtained in wells, at a depth varying from ten to forty feet, thirty feet being the average depth in the eastern part of the county, while in the west and south it is frequently obtained within fifteen or twenty feet of the surface.

In the southeastern part of the county, passing through Monroe, Jefferson and Fairmount townships, with direction from north northeast to south southwest, is the partially silted up channel of one of those Glacial Rivers that were once so common in Eastern Indiana. It is marked throughout its course by a series of swamps, lakes, beaver dams, and, near section 18, Fairmount township, by a deep gorge, one-half mile long, unoccupied by any stream. The drainage of the swamps has made many of the prairies. Some of them are of considerable size, as Bird's prairie, in Monroe township. In section 14, Fairmount township, is quite a large lake; its area is now about ten acres, but it formerly covered nearly thirty. This is gradually filling up, but is still a favorite fishing place for people in that vicinity. In section 12, Jefferson township, is another large, but shallow lake, now nearly dry from drainage. Although this lies considerably to the south of the course of the stream as marked on the map, it is probably a part of the old channel, as the Glacial River was, at times during the overflows, a wide stream. This old channel is quite clearly marked, and can be traced into Blackford county on the east and Madison county on the south. The course of the stream was such that it probably passed through Marion county, near the site of Indianapolis, and either joined the Collett Glacial River in Johnson county, or continued on in a southwesterly direction near or in the valley of White River.

The city of Marion is supplied with water from an artesian well, which was sunk on the west side of the river near Boot's Creek. It was commenced twenty-five feet in diameter and carried to a depth of twenty-seven feet, when, not finding water, a drill was sunk forty-one feet, when a vein was reached which filled the well and overflowed at the top.

SECTION IN THE MARION WELL.

Black muck	1 ft.
Blue clay	2
Gravel and sand	9
Blue clay	15
Blue clay, in bore	41
Total	68 ft.

Water works have been built at a cost of about $50,000, and afford ample protection against fire, as well as furnishing the people an abundance of good pure water. From an analysis of the water, given by Prof. Cox in the Geological Report for 1878, it is found to contain twenty-eight grains of mineral matter to the gallon.

ANALYSIS OF WATER FROM THE MARION WELL.

	Grains.
Silica, insoluble in acids	1.610
Alumina	.350
Magnesia	3.705
Lime	9.319
Oxide of iron	.849
Soda	.154
Carbonic acid, combined	9.314
Sulphuric acid	2.298
Chlorine	.236
Loss	.343
Total	28.200

Many people in the adjacent counties think that the well furnishes soft water, but this is a mistake, as shown by the analysis.

The source of the water is a question frequently asked, but difficult to answer positively. The direction of Massey and Hummel's Creeks and the swampy tracts, extending northeast through Van Buren township into Huntington county; a continuation of the same line, embracing Boot's Creek, the upper portion of Pipe Creek, and the chain of swamps, now prairies, extending through the northwest corner of Green township, into and through Tipton county, passing a little east of Tipton, render it probable that this line represents the course of another of those glacial rivers, or, perhaps, one of the pre-glacial lines of drainage, incompletely filled. Marion, besides its situation in the valley of the Mississinewa, is located between two rocky ridges, the one on the northwest about one-half mile from the city and the other, two and one-half miles to the southeast. Between them is a deep valley three miles wide. Wells have been sunk at Marion one hundred feet without reaching the rock, and this may not be one-half its depth. Where the river cuts across the ridge southeast of the city, it may find a passage under the heavy sheet of clay filling the valley, and, the well being sixty-eight feet deep, the fall between this point and the bottom of the well may be sufficient to cause an artesian flow. The subterranean currents of the old valley, probably, come from the northeast, and may be reinforced by veins from the east and southeast, as well as by water from the river. The well is located in a wet, swampy tract, which was once the channel of the Mississinewa River.

GENERAL GEOLOGY.

CONNECTED SECTION.

QUATERNARY AGE.

Alluvium	1 to 10 ft.
Drift	10 to 200 ft.

UPPER SILURIAN.

Guelph, or Cedarville beds, yellowish, massive limestone, with chert.	16 ft.
Springfield beds, bluish limestone, upper portion argillaceous, in places a calcareous shale, variable	25 ft.
Total	251 ft.

QUATERNARY AGE.

These deposits are of vital interest to the farmer, because they have contributed largely to the formation of fertile soils. Without them the farms would not be worth near their present value, and much of the surface would be covered with shallow lakes, to breed pestilence and death instead of yielding, as now, glorious harvests.

At the close of the Glacial epoch, the many slight depressions of the surface were filled with water; but, with the spread of vegetation and the wash from the higher lands, most of these have become swamps, filled with peat, muck, or humus, waiting only for the farmer's bidding to give up their wealth. The prairies are only lakes that have been filled with vegetable accumulations. The aquatic vegetation has only covered the surface of the deeper ones, and beneath the ten or fifteen feet of peat and muck will be found subterranean lakes. This will explain why railroad embankments built across these prairies are frequently swallowed up, as the mass of vegetation gives way. All the townships in the county have more or less of this deposit, but the eastern, western, and southern portions are best supplied. Much has been done, by ditching, to complete the work begun by nature, namely, to render the swampy tracts dry; but more is needed, if an increase of the fields of magnificent corn and wheat is expected. Vegetable mould or humus is found on every farm, as indicated by the rich black soil.

ALLUVIUM.

This deposit is necessarily limited in extent, for the valley of the Mississinewa is deep, but narrow, and none of the tributaries, except Walnut Creek, have alluvial bottoms of any extent. Formed by the material left on the flood-plain during high water, it is composed of fine sand (silica), clay, and vegetable debris, finely comminuted. The uniformly good crops show that this deposit has high rank, judged from an agricultural standpoint.

DRIFT.

This name is given to all those beds of sand, gravel, clay and bowlders which have not been deposited by forces still in action. They are due to causes which have long since ceased to act in this latitude. They cover the whole county, the depth ranging from ten to two hundred feet, the last only found in the pre-glacial valleys.

Gray clay is the principal surface deposit over the eastern portion of the county. Its thickness is about thirty feet. Beneath this is the water-bearing bed of sand and gravel; under this lies the blue bowlder clay, so nicely exposed in the bank of the river east of Marion. The bed of sand and gravel is not as constant as the clays. In the western and southern parts, gravel and sand is found in pockets; as wells, sunk only a few feet apart, show, in one, nothing but clay, while the other may strike gravel within a few feet of the surface, and afford an unfailing supply of water. In places, thin beds of gravel are passed through, in digging wells, at a depth of ten or fifteen feet, but water is obtained principally from deeper beds, and is thus freer from impurities. Many of the swamps, bogs and round sink holes or ponds are underlaid with gravel and sand. A pike was being built in Fairmount township, the gravel for which was taken from a swamp. It was necessary to use a pump to keep the pit free from water. At Jonesboro, the bluffs are composed of sand and gravel; elsewhere observed, they are formed of heavy blue and gray clays. In the southern part of the county, along the river, the gray clays have become yellowish or rusty colored from oxidation or the iron in the limestone, which forms a good portion of the drift, being thoroughly mixed with the clays. South of Marion is a deposit of gravel, below the old bed of the Mississinewa; but this was deposited by the melting glacier, not by the river. It supplies the city and railroads with an abundance of this valuable material.

Bowlders, although common in the county, are not numerous, except in a belt near Jalapa, where are found many large ones. They are principally granites, gneiss, greenstones and quartzites. They were evidently torn from the under surface of the glacier, as it passed over the ridge of rock exposed in the bed of the river. Limestone bowlders were once numerous along the river, between Jonesboro and New Cumberland, and were burned for lime.

MASTODON.

Some years ago the tooth of one of these extinct animals was found in one of the marshes south of the lake in Fairmount township, showing that the ponds and lakes along the course of the ancient river was frequented by them.

Beaver dams were numerous when the county was first settled, but the beavers had disappeared before the coming of the white man. Whether they were of the giant species (*Castoroides Ohioensis*), and were contemporaneous with the mastodon, or whether they were of existing species, is hard to determine in the absence of their skeletons.

PALEOZOIC GEOLOGY.

The only rocks exposed in the county belong to the Niagara period, Upper Silurian Age. No outcrops occur between Jonesboro, and New Cumberland, though the rock is probably but a few feet below the bed of the river. North of Marion, the Mississinewa has cut its channel through limestone nearly the whole distance north to the county line. It is a magnesian limestone, varying in color, hardness and durability. In places, the argillaceous layers have more resemblance to a shale than to a limestone, and indicate a muddy condition of the seas at the time of their deposition. The better layers produce good building stone, but they must be selected with care, as the strata are subject to great variation — a good layer frequently changing so, in a few rods, that it may be of inferior value. Sufficient stone is quarried to supply the wants of the county, and considerable is shipped away. Near Marion, the quarry of Mr. D. R. McKinney gave the following:

SECTION AT MCKINNEY'S QUARRY.

Gray, argillaceous limestone, charged with iron; strata from 2 to 4 inches thick	4 ft.	00 in.
Bluish gray or light drab limestone; strata 2 to 4 inches	4	00
Blue limestone; lower part resembling a pudding-stone, but due to concretionary structure	0	8
Blue limestone	0	4
Blue limestone	0	10
Blue limestone	0	8
Blue limestone	0	7
Blue limestone; 2 strata	0	6
Blue limestone	0	8
Blue limestone	0	7
Blue limestone	0	6
Total	15 ft.	7 in.

Below the lowest strata worked, the rock becomes argillaceous, of a bluish green color, and rapidly disintegrates upon exposure to the atmosphere. All the strata given in the section become similarly changed, further down the river. The middle layers are the most durable, as the lowest strata are softer, and gradually change until they become worthless. Any of the strata are liable to be split into two or more layers, within a few rods. The dip is to the northwest, and quite marked. Mr. McKinney sells, annually, from 6,000 to 10,000 perch, a portion of which is shipped to other counties.

In the upper portion, specimens of the trilobite (*Calymene Niagarensis*) have been found. In the lower part, large cephalapod mollusks are the prevailing forms of life. The large coiled fossil is a *Lituites* (new species); the curved forms are *Phragmoceras ellipticum.* The larger ones are

Phragmoceras Nestor. The long straight ones are *Orthoceras crebescens* and *Orthoceras strix*—the latter easily distinguished from the first by the longitudinal markings. The short form, with eight or nine transverse septa, is *Gomphoceras subgracile.* Occasionally, the half-coiled *Cyrtoceras Dardanus* is met with. All the above are internal casts. Some of the strata contain calc-spar, chert and crystals of quartz; but it is an idle dream to expect to find silver or any other valuable mineral here. Silica, in one form is soluble in waters slightly alkaline; and its presence here is due to its deposition from solution, either as quartz crystals or as chert, which is only another form of quartz. In some cases, chert and flint, related forms, are probably due to aggregation, around some foreign body as a nucleus, of the solution of the spicula of sponges and the siliceous shells of infusoria. As sponges existed in the seas of the Niagara period, they were probably one of the sources of the chert so abundant in some of the strata.

Across the road, Mr. S. R. Frankbone is working a quarry which gives the following:

SECTION AT FRANKBONE'S QUARRY.

Soil	5 ft.	0 in.
Gray, argillaceous limestone, strata 2 to 3 inches thick	5 ft.	0 in.
Bluish limestone, strata 2 to 3 inches thick	4 ft.	0 in.
Bluish limestone	0 ft.	4 in.
Blue limestone	0 ft.	6 in.
Blue limestone	0 ft.	2 in.
Blue limestone	0 ft.	12 in.
Blue limestone	0 ft.	10 in.
Brownish slate, varying to black or blue calcareous	0 ft.	2 in.
Blue limestone	0 ft.	4 in.
Blue limestone	0 ft.	10 in.
Blue limestone	0 ft.	2 in.
Blue limestone	0 ft.	6 in.
Blue limestone	0 ft.	6 in.
Blue limestone	0 ft.	8 in.
Total	20 ft.	0 in.

About three thousand perch are quarried here, annually. Some of the thinner strata are, in places, quite slaty, and ring under the hammer like a clinkstone. Both these quarries yield some good flagging.

One and one-fourth miles below this point, on the east bank of the river, Mr. S. Secrist quarries about one thousand four hundred perch, yearly. The strata, here, are thicker than at McKinney's but softer, and the argillaceous layers have been removed by erosion.

SECTION AT SECRIST'S QUARRY.

Soil	4 ft. 0 in.
Bluish limestone	0 ft. 8 in.
Bluish limestone, in 4 layers	0 ft. 14 in.
Bluish limestone, argillaceous	0 ft. 12 in.
Bluish limestone	0 ft. 18 in.
Bluish limestone	0 ft. 16 in.
Bluish limestone	0 ft. 18 in.
Total	11 ft. 2 in.

This rock hardens on exposure and becomes a durable building stone. Efforts have been made to produce a hydraulic cement, but without success. It is said, however, to make a very fair firestone.

A short distance below here, Dr. Lewis Williams is working a quarry which corresponds to the one just given, except that the upper layers produce fine flags, their rough surfaces showing nicely the jointed suture.

Three and one-half miles below Marion, Mr. C. W. Bowman is working an outcrop which resembles the one near Marion, but only about four and one-half feet of the lower strata are suitable for buildings. Portions of the upper layers are used for wells. The strata are quite cherty, and the stone from the lower beds hard and refractory. About ten feet is the depth to which this is worked.

A short distance north of here, near the summit of the hill, is an outcrop of a yellowish, massive limestone, very unevenly bedded and overlying the blue rock and argillaceous limestone. It forms the summit of the rocky series exposed in the county, and shows a change from the muddy sea, in which the strata beneath were deposited, to one of clear waters, filled with corals and other forms of life; but, like a coral reef exposed to the waves from a deeper sea, their forms have been reduced to a condition of fine sand, and then cemented, forming a massive lime rock. It is probable that the exposures near Mier and in Franklin township belong to this rock, though differing in color at the place last named. Some lime has been burned from this outcrop, but the kilns are all abandoned. Probably, with care in the selection, avoiding the chert, good lime might be produced. Here were found the trilobites *Calymene Niagarensis* and *Illænus Ioxus*, *Receptaculites hemisphericus*, *Alveolites Niagarensis*, *Eridophyllum rugosum*, *Favosites Niagarensis*, *F. obliquus*, *Halysites catenulatus*, *Heliolites interstinctus*, *Atrypa reticularis*, *Meristina nitida*, *Meristina Maria*.

This place affords a complete section of the rocky series exposed in the county, for, across the river, is the best exposure of the blue limestone seen.

GENERAL SECTION.

Yellowish limestone, unevenly bedded, siliceous	6 ft.
Yellowish-gray limestone, silecious, massive, looking like a sandstone at a distance	10 ft.
Across the river, and beneath the last, a bluish argillaceous limestone, more properly a calcareous shale	15 ft.
Bluish green limestone, strata from 2 inches to 3 feet in thickness .	10 ft.
Total	41 ft.

The lower twenty-five feet, although representing the same strata that are exposed in the quarries near Marion, have their upper portion so heavily charged with alumina that they rapidly disintegrate upon exposure to the atmosphere. No marked line can be drawn separating the upper fifteen feet from the lower ten feet, as the change from the shaly upper strata to the lower harder and more massive beds is gradual. The lower portion has a conchoidal fracture, as shown in the talus. Certain of the strata would, no doubt, be desirable for architectural purposes, if it were not for the thickness of the overlying mass of worthless material. The current of the river is such that the talus is removed nearly as fast as formed, and a vertical face is thus presented.

These beds of blue or bluish-green limestone form one of the most persistent and valuable portions of the Niagara group exposed in Indiana. It everywhere presents nearly the same characteristics—heavy, massive beds below, gradually changing to a calcareous shale or an argillaceous limestone above. The variations observed in the color of the different strata is due, in great part, to oxidation of the iron which they contain. The lower strata have almost invariably a bluish-green color, occasionally changed to a light drab or stained with iron, while the upper layers are of a gray or whitish color, only occasionally bluish. The upper portion has very little economic value, as only occasionally are the beds of sufficient thickness or of such a quality as to render them fit for even the lighter purposes of masonry. In Delaware county, portions of the upper strata are sufficiently free from silica and alumina to make a lime of fair quality; in fact, all the lime burned in that county comes from the upper layers. The lower strata afford nearly all the building stone of Eastern Indiana. They are undoubtedly the western extension of the famous Springfield beds of Ohio, and I have given them, in the General Section, that name, as they are the same strata to which Prof. Orton assigned that name in Ohio. Everywhere throughout Eastern Indiana these beds yield a good building stone, and in some localities in Marion, Decatur and Franklin counties it is hardly surpassed, either in beauty or durability, by Indiana's famous oolitic limestone. It is almost an inexhaustible mine of wealth.

The upper portion of the section last given is the probable equivalent of, at least, the lower part of the Guelph limestone of Canada, or the Cedarville beds of the Ohio geologists. Although cherty at this locality, this portion of the Niagara is as noted for the excellent lime which it produces as the Springfield beds are for building stone. It has not yet been identified south of Delaware and Madison counties. In Decatur and Madison counties, the Devonian rocks immediately overlie the Springfield beds. Throughout Northeastern Indiana, south of the Wabash River, it is the surface rock over a greater part of Randolph, Jay, Wells, Blackford, Grant, Huntington, Miami and Wabash counties. This portion of the Niagara is its only true coral-reef formation. The change from the muddy sea, in which the upper portion of the Springfield beds were deposited, to the clear seas of this coral-reef epoch, is marked. The rock is one mass of broken and pulverized shells and corals. North of Grant county it is probable that this part of the Niagara is thicker, as a white limestone is said to overlie it along the Wabash River, and forms the summit of the Niagara group of Indiana.

So far as at present determined, the Niagara group of Central Eastern Indiana is composed of the following:

Guelph or Cedarville beds	20 ft.
Springfield beds	40
Niagara shale	10 to 15

The last named forms the base of the Niagara group, as determined by Dr. Elrod in his Report of Decatur county, in the Geological Report for 1882. This section would, probably, require some modification in the construction of a General Section of the whole Niagara group of the State, as the character of the strata vary somewhat along the Ohio River, and it is, at present, difficult to tell whether the Waldron shale belongs to the Springfield beds or to the Guelph. No exposure of the Niagara shale occurs in this county, as the bottom of the quarries barely reach the base of the Springfield beds.

It will be of interest to most readers to learn that the quarry rock exposed north of Marion, along the river, is probably the westward extension of the strata over which the torrent flows at Niagara Falls (there ninety feet thick, and the shales, below, sixty feet).

I have thought best to digress somewhat from the Report of this county, in order to give an explanation of the relation the rocks of this county sustain to the Niagara group as a whole.

About one mile below Mr. Bowman's quarry, Mr. John Mellott is taking out a fine building stone. The shaley layers have mostly been removed by erosion, and the thick and valuable beds are easily accessible. Stone from this quarry was used for the abutments of the bridge which spans the river at this point, and it shows no evidence of disintegration as yet. The fossils found here are the same as those at Mr. McKinney's quarry.

SECTION AT MELLOTT'S QUARRY.

Gray argillaceous limestone, uneven bedded, varying from 2 to 8 inches thick; breaks into irregular blocks; worthless	7 ft.	0 in.
Blue limestone	0 ft.	8 in.
Blue limestone	0 ft.	12 in.
Blue limestone	0 ft.	13 in.
Blue limestone	0 ft.	11 in.
Blue limestone	0 ft.	12 in.
Blue limestone	0 ft.	12 in.
Blue limestone	0 ft.	12 in.
Blue limestone	0 ft.	14 in.
Total	14 ft.	11 in.

Below this point, rock is exposed at intervals in the bed of the river, but is not quarried to any extent.

About one-half mile south of Mier is an outcrop, near Pipe Creek. It is, here, a yellowish limestone, in thin layers and unevenly bedded. Some of the lower strata furnish the principal building stone used in this vicinity. Rock is near the surface over quite an area, as it is frequently struck in digging wells. In section 9, Franklin township, is an exposure of a whitish rock, in strata from one to four inches thick. Preparations are now being made to work this quarry on an extensive scale, as the rock has proved durable. Trials show that it produces lime of an excellent quality. This is the purest limestone seen. Being free from silica and alumina, it would probably yield a superior lime, and there need be but little waste, as that not suitable for architectural uses could be calcined, and the quarry thus be very profitable.

Limestone is frequently found near the surface for a number of miles south of here. An exposure occurs about midway between Marion and Jonesboro', but it is the blue rock, and similar to that below Marion.

The drift has brought many Devonian and Niagara fossils here, either from rock which once covered the county or from the destruction of that formation to the north and east. Among them were *Acervularia Davidsoni*, *Cystiphyllum Americanum*, *Diphyphyllum cæspitosum*, *Eridophyllum rugosum*, *Favosites Emmonsi*, and *Lyellia Americana*. These corals are the petrified wasps-nests, honey-combs, roots, etc., of common parlance.

ECONOMIC GEOLOGY.

TIMBER.

In common with all the counties of Eastern Indiana, timber is abundant, and, if the growth of a dense forest is an indication of strength of soil, there need have been no apprehensions on the part of the first settlers. The dense forest has been a detriment, so far as the early settlement of the county is concerned. People would rather go further west, and locate on the prairie, than spend so much time and labor clearing it up. But, now, with the development of the county and the demand for lumber, our forests are a source of profit. All the more common varieties are found here, about equally represented.

LIME.

Very little of this material is burned at present, most of the limestone containing too much silica or alumina; however, with care in the selection of the rock, it may be produced of fair quality. Possibly, some of the argillaceous limestone would make hydraulic cement, if carefully tested.

CLAY.

An abundance of this material is present in every township, suitable for brick and tile. Many kilns are in operation, and miles of tile are already laid, with more in the fields ready. Probably, few counties in the State are doing more in this direction, compared with what is needed.

ROADS.

Pikes are always good highways, and, if this were true of the dirt roads, a great deal of hard labor would be saved. Some of the richest lands are nearly inaccessible during portions of the year. Money spent in the the construction of pikes, here, will be returned in the increased value of the farms. Quite a number have been built, but more are needed. Sufficient gravel can be found in every township, if carefully looked for. Many of the swamps are underlaid with gravel, and, even if pumps have to be used, it will pay better than to haul gravel far, or to go without the pikes.

AGRICULTURE.

The soils are all derived from the alluvial, lacustral, or drift deposits; the latter are mostly clays mixed with vegetable humus (mold), and constitute by far the greater part. The alluvial soils, formed by streams, are principally fine sand and clay, mingled with organic matter. The lacustral soils consist of the black muck and peat of the swamps, with the finer material washed from the higher lands. Every farm has more or less of these different soils.

The principal productions for 1881 were—Wheat, 482,035 bushels; corn, 1,218,049 bushels; oats, 149,499 bushels; flaxseed, 31,907 bushels; potatoes, 24,020 bushels. The prevalence of black soil in the eastern, western, and southern portions of the county, renders corn a profitable crop, as the yield is large.

The county is capable of largely increasing all its productions, but ditches must be dug, and tile laid, in order to redeem the wet lands. The farms most recently brought under cultivation produce the best crops, while many fields, long cultivated, show a marked deterioration in production. There is a reason for this, that ought to be plain to every farmer; for as surely as crops are harvested, and nothing or little returned, so surely will there be a decrease in the fertility of the soils. No skillful rotation of crops, underdraining or subsoil plowing will save the soils of Indiana from deteriorating, unless attention is given to the use of fertilizers. We have only to look to the older settled States and portions of Indiana, where once the soil was equal to our own, to see thousands of acres that fail to yield the farmer a fair remuneration for his labor. The potash, lime, soda and phosphoric acid has been, in great part, removed either in the wheat, corn, oats, rye, potatoes, hay, flax, or as beef, pork, or fine horses, and but little returned to the soil. To-day, in every county, are hundreds of acres that are fast losing their mineral and organic material, and they can not yield more than one-half a crop. Portions of New Jersey was once a barren waste, but a judicious use of marls and other fertilizers has rendered them among the most productive lands in the State. Observations made where dairying or stock raising is carried on, show that even closely pastured lands will lose their strength, and that the attempt to restore lost fertility to worn out soils, by returning them to pastures, is neither very effective nor profitable. The soils of Indiana are a source of immense wealth, and, as yet, we have hardly begun to draw upon their resources, but, as deterioration has already begun, it is time to sound the alarm. Fertilizers ought to be used now, for it is easier and better to maintain fertility than to restore it when lost.

An average of many analyses show that the grain, chaff and straw of one bushel of wheat weigh 136 pounds, but when reduced to ashes, 5¾ pounds, which is mineral matter absorbed from the soil. Every bushel of wheat grown removes nearly three-quarters of a pound of phosphoric acid, nine-tenths of a pound of potash, one-fifth of a pound of magnesia, and one-fifth of a pound of lime. Oats contain a large amount of silicic acid, far exceeding any of the other grains. Potatoes double the amount of potash. Lime, potash and magnesia predominate in tobacco. Flax and buckwheat are the most exhaustive crops raised, as they extract from the soil more potash, lime, magnesia and phosphoric acid than either wheat, corn, oats or grass; hence the fallacy of attempting to redeem poor and worn-out soils by raising a crop of buckwheat simply because it leaves the ground mellow and black. No plant has the power to manufacture any of the elementary substances; it can only select such as are in the soil. And one plant succeeds better than another, other things being equal, because it has greater power of selection, or because the physical condition of the soil is better adapted to its growth. But since plants have the power of selection, in a state of nature, they choose such as are best adapted to their wants; even then, when the soil deteriorates, others less choice in their food will take their place. A familiar example of this may be seen in meadows where the white daisy, fleabanes, *Erigeron annuum* and *strigosum* have run out the meadow grasses.

Most soils have all the elements necessary for the supply of mineral matter for the growth of crops, but the physical condition must be such that heat and moisture find easy access, thus not only favoring chemical change in the soil, but hastening the growth of vegetation. It is of great importance that the ground should be relieved of its surplus water in order for the above conditions to be present. This leads to the subject of underdraining, the beneficial effects of which are no longer doubted, as it has, over and over again, been demonstrated that nearly all soils are benefited by the judicious use of tile. Every farmer realizes the benefits derived from draining the swamps; for no matter how rich a soil may be, it can not produce good crops if saturated with water the greater part of the year. Where the excess of water in the soil finds an easy escape, the season of growth is lengthened (sooner worked in the spring and later in the fall); besides, crops are not so liable to winter-killing, because, without moisture, ice does not form, and cold, without ice, seldom injures the roots of plants.

The principal mineral ingredients of all soils are silicate of alumina, with varying amounts of potash, lime, magnesia, iron, phosphoric acid and organic matter. They may have all the mineral substances necessary, but if they lack organic material they will be unproductive. Carbon dioxide is as necessary for the growth of plants as mineral matter, and the decomposition of organic material produces it. It also renders the soil mellow, and enables the roots to penetrate deeper and give access to the atmosphere, and thus favors those chemical changes in the mineral substances which renders them soluble, besides replenishing the supply by decomposition of the comminuted rocky material, ground in the glacial mill. All soils possess more or less of the proper mineral substances necessary for the growth of plants, but as they are supplied with only a limited amount of each, it is easily seen, where but little is returned and the cropping successive, that the loss is constant, and finally detrimental to the vigorous growth of crops. There are occasionally patches of soil that seem to produce, year after year, with but little diminution of fertility; but they are the exception, not the rule.

Where farmers harvest annually from fifty to one hundred acres of grain, it is not probable, even with the most careful saving of the manures from the barn, that enough can be obtained to supply the waste from the fields, and it is necessary that other means be used to restore lost fertility—plowing under green crops, the use of lime, ashes, or guano. A great part of the value of organic fertilizers depends on the amount of potential ammonia they contain, as produced in their decomposition, but the mineral fertilizers evidently supply deficiencies in the soil, as well as bring into activity chemical actions. In limestone regions, lime can usually be obtained for the burning, at very little expense. Peat or muck is easily accessible in most localities, though, owing to the salts of iron in it, it ought to be exposed to the atmosphere for a while before spreading on the land. Guano or hen manure is one of the most valuable of fertilizers, being rich in phosphoric acid and ammonia. Wood ashes applied to the land show their beneficial effects for years.

ARCHÆOLOGY.

A little north of Jonesboro', on the bluffs of the river, are two or three small tumuli, which contained a few beads, along with the bones, ashes, and charcoal, so common in this class of works. Quite a number of axes, arrow-heads, etc., have been found in the vicinity.

In section 33, Monroe township, and in Van Buren township, near Black Creek, are a number of small mounds similar to those described. One or two small ones are situated on the bluffs, east of the river, near Marion. The largest in the county, however, were situated near where the court house now stands, and in the city cemetery.

Relics are found in nearly all parts of the county, and, through the kindness of Mr. L. A. Wallace, the State cabinet received some fine specimens.

THANKS.

The writer is under obligations to Mr. D. R. McKinney, who allowed him to take such fossils as he wished. Mr. Wm. Neal, County Surveyor, gave information in reference to all parts of the county, such as only an intelligent person, with a life-long experience and familiarity, could give. Mr. L. A. Wallace has already been mentioned as a donor of relics. Mr. E. L. Goldthwait rendered great assistance. Thanks are due to all the people of the county who gave information cheerfully.

A GLOSSARY

OF

TERMS COMMONLY USED IN GEOLOGICAL REPORTS.

SUGGESTED AND LARGELY PREPARED BY

W. T. S. CORNETT, M. D.

ACCRETION. The process by which inorganic bodies grow larger, by the addition of fresh particles from the outside.

ACOTYLEDON. A plant in which the seed-lobes (cotyledons) are not present, or are indistinct, like the fern, lichen, and most of the coal plants.

ACROGENS. Plants which increase in height by additions made to the summit of the stem by the union of the bases of the leaves. The highest tribe of *Cryptogams*, such as *Sigillaria*, *Lepidodendria*, *Calamites*, *Ferns*, etc.

AEOROLITE. A stone or other body which has fallen from the air, or, more correctly, has come to the earth from distant space; a meteorite.

AGATE. A semi-pellucid, uncrystallized quartz.

ALGÆ. Marine plants, comprising the seaweeds and many fresh-water plants.

ALLUVIUM. Earth, sand, gravel, loam, vegetable mould, etc., washed down by streams and floods, and deposited upon formations not permanently submerged.

ALUMINA. A characteristic ingredient of common clay.

ALUMINOUS. Pertaining to or containing alum, or alumina. The clay slates are very frequently impregnated with alum, and are then called alum-slates or alum-shales.

AMMONITE. An extinct genus of *Cephalopoda*, like the Nautilus, found in the Secondary or Mesozoic rocks; so called from the resemblance of its shell to the horns of Jupiter-Ammon.

AMORPHOUS. Bodies devoid of regular or determinate form. A name sometimes used to designate the sponges.

AMPHIBIA. Animals capable of living either in water or on land, like the frogs, newts, lizards, turtles, certain serpents, etc.

AMYGDALOID. A rock in which crystallized minerals are scattered in almond-shaped cavities.

ANTICLINAL. The crest or line in which strata dip in opposite directions.

ARGILLACEOUS. Clayey; composed in whole or in part of clay.

ARTICULATA. Animals characterized by the possession of jointed bodies or jointed limbs.

AURIFEROUS. Containing gold.

AZOIC ROCKS. Rocks formed before the existence of organic life, or, at least, of animal life, consequently destitute of fossil remains.

BASIN. An isolated or circumscribed formation, particularly where the strata dip inward, on all sides, toward the center. Especially applied to the coal formations, called "coal-basins" or "coal-fields."

BATRACHIA. The order of reptiles which includes the frog and related animals.

BELLEROPHON. A genus of *Gasteropoda*, having a univalve shell, found in the Paleozoic rocks.

BITUMINOUS SHALE. Shale impregnated with bitumen; usually of a dark brown or black color.

BIVALVE. Consisting of two plates or valves, hinged together with an elastic ligament.

BOWLDERS. Rocks, rounded or otherwise, which have been transported from more or less distant localities by natural agencies, especially during the Drift period.

BOWLDER CLAY. The stiff, unlaminated clay of the Drift period.

BRACHIOPODA. A class of marine mollusks, characterized by two fleshy arms, continued from the sides of the mouth, and which served to create currents to bring them food.

CALAMITE. Extinct plants, with reed-like stems, sometimes attaining a diameter of fourteen inches and the height of trees, found almost entirely in the Coal Measures.

CALCAREOUS. Consisting of or containing carbonate of lime.

CALCITE. Crystallized carbonate of lime. Common limestone, all the white and most of the colored marbles, calc-sinter, calc-spar, calc-tufa, stalactites, and stalagmites are so classified.

CARAPACE. A protective shield. The upper shell of the tortoise, turtle, crab, lobster and other *Crustacea*.

CARBONATE. A salt formed by the union of carbonic acid with a base.

CARBONIFEROUS. Producing or containing carbon or coal.

CARBONIFEROUS AGE. The one immediately following the Devonian Age, or *Age of Fishes*, and characterised by the vegetables which formed the coal beds. This Age is divided into the Subcarboniferous, the Coal Measure and the Permian epochs.

CARBONIFEROUS PERIOD. The second, or middle, division of the Carboniferous Age.

CARINATED. Shaped like the keel of a ship. Applied to flowers consisting of two petals, either separate or united, inclosing the organs of fructification, and which have a longitudinal prominence like a keel.

CARPOLITE. Petrified fruit. Literal meaning, "stone fruit."

CENOZOIC. Belonging to the Tertiary period, and means "recent life."

CENTIMETRE. A French measure of length, equal to .39368 of an inch.

CEPHALOPODA. A class of the *Mollusca*, comprising the cuttle-fishes and their allies, and characterized by a distinct head, surrounded by a circle of long arms or tentacles, which they use for crawling and for seizing objects.

CHERT. An impure, massive, flint-like quartz, or hornstone, of various dull shades of color.

CHONETES. A genus of fossil bivalve shells, of the class *Brachiopoda*.

CINCINNATI GROUP. The upper division of the Lower Silurian system. Same as *Hudson River Group*.

CLEAVAGE. That peculiar structure in rock which admits of its division into scales or layers.

COAL BASIN. Depressions formed in the older rock formations, in which coal-bearing strata have been deposited.

COAL MEASURES. Strata of coal, with the attendant rocks.

CŒLENTERATA. Proposed by Frey and Lenckhart, in place of the old term *Radiata*, for animals having "hollow bowels," which this term literally means.

CONCHIFERA. A species of the *Mollusca* having shells with a dorsal hinge, like oysters, clams, mussels, and other ordinary bivalves. Literal meaning, "to bear a shell."

CONFORMABLE. Parallel, or nearly so; said of strata which lie in contact.

CONGLOMERATE. A rock, composed of pebbles cemented together by another mineral substance, either calcareous, siliceous or argillaceous.

CONIFERA. The order of the firs, pines and their allies, in which the fruit is generally a "cone" or "fir-apple"; literally, "I carry a cone."

CONTORTED. Strata which have been bent or twisted while in a soft and yielding condition.

COPROLITES. Fossilized excrements of animals.

CORAL. The solid secretion of zoophytes, produced within the tissues of the polyps, and corresponding to the skeleton in higher animals. It consists almost purely of carbonate of lime.

CORALLINE ZONE. That zone of marine life which extends from about 90 feet to 300 feet in depth.

CORALLUM. The coral or solid part of a zoophyte, whether composed of stone or horn.

CRAG. A partially compacted deposit of the older Tertiary formation, consisting of sand and shells.

CRETACEOUS. Having the qualities of chalk; the uppermost or last of the Secondary formation.

CRINOIDEA. An order of lily-shaped marine animals, belonging to the sub-kingdom *Radiata*. They generally grow attached to the bottom of the sea by a jointed stem, though some are free.

CRUSTACEA. One of the classes of the *Articulata*, comprising lobsters, shrimps, and crabs, characterized by the possession of a hard shell or crust, covering the body, legs, etc.

CYATHIFORM. In the form of a cup or drinking-glass, a little widened at the top.

CYATHOPHYLLUM. Cup-shaped, rugose corals, very abundant in the rock formations of Indiana.

DEBRIS. Broken and detached fragments of rocks, taken as a mass or collectively.

DEGRADATION. A gradual wearing down or wasting, as of rocks, banks, and the like, by the action of water, frost, etc.

DENUDATION. The laying bare of rocks by the action of running water, or by removing earth, etc.; also, the excavation of rocks by running waters or by the action of waves.

DEPOSIT. Matter precipitated from suspension in water.

DETRITUS. Small portions of matter worn off from rocks by attrition.

DEVONIAN. Applied to rock strata lying next above the Silurian.

DICOTOMY. Dividing regularly by pairs.

DIP. The downward inclination of strata.

DRIFT. A collection of loose earth, sand, rocks, or bowlders, distributed over a large portion of the earth's surface, especially in latitudes north of 40°, and which have come from the north ward, brought thence, mainly, by glacial action.

ENCRINITE. The lily-shaped radiate; crinoid.

EOCENE. The lowest division of the Tertiary rocks, in which but few specimens of existing shells are found.

EOZOIC. A term used for the oldest fossil-bearing rocks yet known, such as the Laurentian and Huronian of Canada.

EPOCH. The period during which a formation was produced; thus, geologists speak of the Millstone Grit epoch, etc.

ESCARPMENT. The steep face presented by the abrupt termination of strata.

FAULT. A sudden interruption of the continuity of strata or veins in the same plane, caused by a crack or fissure.

FAUNA. The animals of any given area or epoch.

FAVOSITES. A kind of fossil coral, having a prismatic structure closely resembling that of a honey-comb.

FERRUGINOUS. Containing iron; also, partaking of the quality of iron.

FIRE-CLAY. Any clay capable of sustaining intense heat without vetrifying. Abundant in the Coal Measures, beneath each coal seam.

FISSILE. Capable of being split, cleft, or divided in the direction of the grain.

FLORA. The system of vegetable species native in a given locality, region, or period; as the Flora of the Coal Measures, etc.

FLUVIATILE. Belonging to rivers; formed by rivers, as fluviatile strata.

FLUVIO-MARINE. Formed by the joint action of a river and the sea, as in the deposits at the mouths of rivers.

FOLIATED. Having leaves or leaf-like projections, as foliated shells; composed of thin laminæ or layers, as mica schist, schistose, and the like.

FORAMINIFERA. A minute genus of the *Protozoa*, characterized by having a calcareous shell perforated by numerous pores, or foramina.

FORMATION. The series of rocks belonging to an Age, period, or epoch, as the Silurian formation, and the like.

FOSSIL. That which may be dug up; the petrified form of a plant or animal in the strata composing the surface of the earth.

FOSSILIFEROUS. Containing fossils or organic remains, as fossiliferous rocks.

FUCOIDS. Fossils resembling sea-weeds.

FUSIFORM. Shaped like a spindle; tapering at each end.

FUSILINA. A spindle-shaped *Foraminifer*.

GASTEROPODA. A univalve mollusk, having a fleshy ventral disk, which serves to take the place of feet, as the snail.

GEMMATION. The formation of a new individual by the protrusion of any part of an animal or plant, which may then become free or remain connected with the parent stock; budding. Polyps and some other animals reproduce by buds.

GENUS. An assemblage of species possessing certain characters in common, by which they are distinguished from all others.

GEODE. A rounded nodule of stone, containing a small cavity usually lined with crystals, sometimes with other matter; the cavity in such a nodule.

GEOLOGY. A science which treats of the materials which compose the earth, the methods in which those materials have been arranged, and the causes and modes of origin of those arrangements.

GLACIER; GLACIAL RIVER. A field or immense mass of ice, or snow and ice, formed in the region of perpetual snow, and moving slowly down mountain slopes or through valleys, usually bearing along bowlders and fragments of rock.

GNEISS. A crystalline rock, consisting of quartz, feldspar and mica, but, unlike granite, having these materials arranged in planes, so that it rather easily breaks into coarse slabs or flags.

GRANITE. A crystalline rock, of the same materials with gneiss, but differing therefrom in these materials being grainy and not stratified.

GYPSUM. Sulphate of lime. Plaster of Paris is made from this mineral by calcination.

HABITAT. The natural abode or locality of an animal or plant.

HÆMATITE. Sesqui-oxide of iron. So called because of the red color of the powder.

HEMIPRONITES. A fossil bivalve shell, sometimes known as the genus *Streptorhynchus*.

HETEROCERCAL. A fish having the vertebral column continued into the upper lobe of the tail, which lobe, on this account, is larger than the lower one. Literal meaning, "A diverse tail." This form prevailed in Paleozoic times.

HOMOCERCAL A fish in which the vertebral column terminates at the commencement of the tail, the lobes of which are symmetrically equal. Literal meaning, "Common tail."

HUDSON RIVER GROUP. An upper division of the Lower Silurian formation. Same as Cincinnati Group.

HUMUS. A dark brown substance formed in the soil by the action of air on solid animal or vegetable matter. It is a valuable constituent of soils.

ICHTHYOLOGY. The science of the systematic arrangement or classification of fishes.

IGNEOUS ROCKS. Resulting from the action of fire, such as lavas, basalt, trap, and the like.

IMBRICATED. Lying over each other in regular order, like the scales of a fish and those on the leaf-buds of plants.

INFUSORIA. Microscopic animals found in water and other fluids, multiplying by gemmation.

INORGANIC. Devoid of an organized vital structure. Rocks, minerals and all chemical compounds are inorganic substances.

IN SITU. In its original situation. Said of rocks which remain where they were formed.

INVERTEBRATA. Animals without a spinal column.

LACERTIAN. The lizard species.

LACUSTRAL. Pertaining to lakes or swamps.

LAGOON. A marsh, shallow pond, or lake, especially one into which the sea flows.

LAMINATED. Consisting of plates, scales or layers, one over another.

LAND-SLIP. The sliding down of a considerable tract of land.

LENTICULAR. Having the form of a double-convex lens.

LEPIDODENDRON. A genus of fossil cone-bearing trees, belonging to the Carboniferous Age, and so-called from having their stems marked with scars or scales, produced by the falling off of the leaves.

LIGNITE. Mineral coal showing the texture of wood, and found in the Tertiary formation.

LINE OF BEARING. The direction of the strike, or outcrop.

LINE OF DIP. The line of greatest inclination of a stratum to the horizon.

LITHOLOGY. The science which treats of the characteristics and classification of rocks.

LOAM. A soil composed of siliceous sand, clay, and carbonate of iron, with more or less oxide of iron, magnesia, and various salts, and also decayed animal and vegetable matter.

LOESS. A division of the Quaternary System, Lacustral Age. Common along the Mississippi and many of its tributaries.

LOWER CARBONIFEROUS PERIOD. The first, or earliest, division of the Carboniferous Age.

MAMMALIA. Vertebrate animals that suckle their young.

MAMMOTH. An extinct elephant, fossil remains of which have been found on both American continents.

MARL. A mixture of carbonate of lime, clay, and sand in varying proportions. A valuable fertilizer.

MASTODON. An extinct gigantic mammal, resembling the elephant, so called from the conical (nipple-shaped) protuberances on its molar teeth (grinders).

MATRIX. The earthy or stony substance in which metallic ores or crystalline minerals are found.

MESOZOIC. The Secondary period. Literal meaning, "Middle life."

METAMORPHIC. Rocks or minerals which have undergone changes in form or shape since their original deposition; usually applied to changes made by heat.

METEORITE. Same as Aerolite; which see.

METRE. A French measure of length, equal to 39.368 inches. (See, also, Centimetre and Millimetre.)

MICA SLATE. A schistose rock, consisting of mica and quartz, with, usually, some feldspar. The lowest stratified rock except gneiss. It bears no fossils.

MILLIMETRE. A French measure of length, equal to .039368 of an inch.

MILLSTONE GRIT. A hard, gritty, sandstone, a kind of conglomerate, found under the Coal Measures, sometimes containing quartz pebbles.

MIOCENE. The middle division of the Tertiary rocks, in which the minority of the organic fossils are of recent species.

MOLLUSCA. Invertebrate animals, having a soft, fleshy body (whence the name), which is inarticulate, and does not radiate internally. Includes the shell-fish proper.

NAUTILUS. A fossilized and living genus of the Molluscan Cephalopods.

NIAGARA GROUP. A division of the Upper Silurian system.

NODULE. A rounded mass of irregular shape.

NUCLEUS. A kernel; a central mass or point, about which other matter is gathered.

OOLITE. An epoch in the Jurassic Age. A variety of limestone, consisting of round grains like the roe of a fish. Name is derived from two Greek words, which mean "Eggstone."

OOLITIC. Resembling Oolite.

ORGANIC REMAINS. Fossilized remains of animals or plants.

ORTHIS. A genus of *Brachiopoda*, named in allusion to the straight hinge-line.

ORTHOCERAS. A family of the *Nautilidæ*, in which the shell is straight, or nearly so.

OUTCROP. That part of an inclined stratum which shows at the surface of the ground.

PALEONTOLOGY. The science of the ancient life of the earth, or of the fossils which are the remains of such life.

PALEOZOIC. Applied to the older division of geological time and the fossil-bearing rocks of the Silurian, Devonian, and Carboniferous Ages.

PEAT. Accumulation of vegetable matter, on and near the surface of the earth, in moist places. It is intermediate between pure vegetable matter and lignite, 80 parts in 100 being combustible, and is, therefore, often dried, and then used for fuel.

PERMIAN. The epoch following the Coal Measure epoch, and regarded as closing the Carboniferous Age and the Paleozoic era.

PLEISTOCENE. Quaternary. Pertaining to the epoch or to the deposits following the Tertiary, and immediately preceding man. Compounded from two Greek words, meaning "most new"

PLIOCENE. The upper division of the Tertiary period. Meaning, "more new."

PLUTONIC ROCKS. Those deriving form from igneous action.

POLYPI. Radiates, having many feet (whence the name) or feelers.

POLYZOA. The lowest order of *Mollusca*, in which many animals are united in one structure. A compound group among the *Bryozoa*.

PRIMITIVE (OR PRIMARY) ROCKS. Rocks supposed to be first formed, being irregularly crystallized, aggregated without a cement, and containing no organic remains, such as granite, gneiss, and the like.

PRIMO-CARBONIFEROUS. Upper Coal Measures (?). See "Coal Measures," *ante*.

PRODUCTUS. An extinct genus of *Brachiopoda*, in which the shell is "eared," or has its lateral angles drawn out.

PROTOZOA. The lowest division of the animal kingdom.

PTERODACTYL. A winged saurian; a fossil reptile which had the little finger of the hand greatly elongated, for the purpose of bearing a membraneous wing. Meaning, "wing-finger."

PTEROPODA. A class of *Mollusca*, which swim by means of fins attached near the head. Meaning, "wing-foot."

PUDDING STONE. A coarse conglomerate, composed of siliceous or other pebbles, united by a cement.

PYRITES. A combination of sulphur with iron, copper, cobalt, or nickel.

QUAQUA-VERSAL. Dipping toward all points of the compass from a central point, as beds of lava around a crater.

QUARTZ. Pure silex, occuring in pellucid, glassy crystals, having the form of a six-sided prism, terminated at each end by a pyramid. The crystals are usually clear, but sometimes are variously colored, more or less transparent, and even opaque.

QUARTZITE. Granular quartz; sandstone that has been changed, by metamorphic action, to a hard quartz rock.

QUATERNARY. Later than the Tertiary; equivalent to the English Pleistocene.

RADIATA. One of the great sub-kingdoms of animals, in which all the parts are arranged uniformly around the longitudinal axis of the body, such as star-fishes, corals, crinoids, etc.

RASH COAL. An impure coal.

RECENT. Of a date subsequent to the creation of man.

RENIFORM. Kidney-shaped; applied to certain minerals.

RECEPTACULITES. An extinct genus of *Protozoa*. Meaning, "A stone receptacle."

REPTILIA. The class of *Vertebrata* composing snakes, lizards, tortoises, turtles, etc. From Latin verb *repto*, "I crawl."

RETICULATED. Having sets of parallel fibres or lines crossed by others, likewise parallel, so as to form meshes resembling those of a net.

RHYNCHONELLA. A small bivalved Brachiopod, having a *rynchos* (nose or beak).

RHYNCHONELLA OSAGENSIS. Same as *R. Pecosi*.

RHYNCHONELLA PECOSI. Same as *R. Osagensis*.

ROCK. Any natural deposit of stony material.

RUGOSE. Wrinkled; full of wrinkles.

SAURIAN. Any lizard-like reptile.

SEAM. A layer of substance, more or less wide, parallel with the stratification of surrounding material.

SEDIMENTARY ROCKS. Those formed from materials precipitated from suspension in water.

SEISMOLOGY. The science of earthquakes and their characteristics.

SERRATED. Notched on the edge like a saw.

SHALE. A fine-grained rock, having a slatey structure; an indurated clay, deposited in thin layers.

SHELL MARL. A deposit of shells, which have been disintegrated into a gray or white pulverulent mass.

SIGILLARIA. Fossil trees, the bark of which is covered with impressions as if by a seal. Found in the Coal Measures.

SILEX. Silicic acid, generally impure, as it is found in nature, constituting flint, quartz, and most sands and sandstones. Literal meaning, "Flint."

SILICEOUS. Composed of silex.

SILT. Mud or fine earth deposited from running or standing water.

SILURIAN. The earliest of the Paleozoic formations; so called from the country of the Silures, who anciently inhabited a part of England and Wales, because the strata was most plainly developed in that country.

SIPHUNCLE. A tube of a membraneous or calcareous nature, transversing the septa of a chambered shell.

SLATE. An argillaceous stone which easily splits into plates.

SOAPSTONE. A soft magnesian mineral, usually gray, white, or yellow; so called from its soapy or greasy feel; steatite; pot-stone.

SPIRIFER; SPIRIFERINA. Extinct species of *Brachiopoda*, with large spiral supports for their "arms."

STALACTITE. Icicle-like encrustations and deposits of lime, which hang from the roof and sides of caverns hollowed out of limestone.

STALAGMITES. Encrustations of lime formed on floors of caverns hollowed out of limestone.

STIGMARIA. Stem-like, fossilized vegetation, often traversing the under clay of the coal, and supposed to be the roots of *Sigillaria*; which see *supra*.

STRATUM (pl. STRATA). A bed of earth or rock of any kind, formed by natural causes, and usually consisting of a series of layers.

STRATIFIED. Formed in regular beds or layers.

STREPTORHYNCHUS. Often called *Hemipronites*.

STRIKE. The horizontal direction of the out-cropping edges of tilted rocks, which is always at right angles to the dip.

SUBCARBONIFEROUS PERIOD. Same as Lower Carboniferous Period.

SUTURE. The line of junction of two parts which are immovably connected together, like the line where the whorls of a univalve shell join, or the lines made on the exterior of a chambered shell by the margins of the septa.

SYNCHRONISM. Concurrence in time of two or more events; contemporary; simultaneousness.

SYNCLINAL. Formed by strata dipping toward a common line or plane, as a synclinal trough or valley. The opposite of *Anticlinal*; which see, *supra*.

TALUS. A sloping heap of rock fragments lying at the foot of a precipice.

TERRACE. A shelf or bank of earth having an uniformly level surface.

TERTIARY. Third in order. Applied to the first period of the Age of Mammals, or Cenozoic time; also, to the rock formations of that period.

TEST. A shell, as of a mollusk.

TESTACEA. Mollusks are sometimes so called.

THERMAL. Hot, warm. Applied to springs which discharge water heated by natural agencies.

THIN OUT. Applied to beds or strata which grow gradually and continually thinner in one direction, until they entirely disappear.

TRANSITION ROCKS. The lowest uncrystalline stratified rocks, supposed to contain no fossils, and so called because thought to have been formed when the earth was passing from an uninhabitable to a habitable state.

TRAP. A heavy, igneous rock, of a greenish-black or grayish color, generally composed of feldspar, augite, and hornblende; so called because the rocks of this class often occur in large tabular masses, rising above one another like *treppe*, steps.

TRILOBITE. Three lobed. An extinct family of *Crustacea*, and derives its name from its body being so divided.

TUFA. A soft or porous stone, formed by depositions from water, usually lime-bearing, in which case the result is called calcareous tufa. Also, a volcanic sandrock, rather friable, formed of agglutinated volcanic earth or scoria.

UMBO. The beak (the point immediately above the hinge) of a bivalve shell is so called, from its fancied resemblance to the "boss of a shield."

UNCOMFORMABLE. Not lying in a parallel position; applied to rock strata.

UPPER COAL MEASURES. Upper strata of the coal system.

VEIN. A seam or parting of any substance, more or less wide, intersecting a rock or stratum, and not corresponding with the stratification.

VENTRAL. Belonging to the belly, or the surface opposite the back, or dorsal side. Sometimes used to designate the interior surface of the body.

VERTEBRATA. The division of the Animal Kingdom which is furnished with a spinal column.

WHORL. The spiral turn of a univalve shell.

ZAPHRENTIS. A genus of rugose (wrinkled) fossil corals.

INDEX

PART I.

ERRATA.

PART I.

Page 104, twelfth line from top, for *Carboniferous* read Corniferous.

PART II.

Page 127—Note, for *d'Orbigney*, read d'Verneuil.

Page 66, line 15, for *Wolfers*, read Ulfers.

Page 55, for *Peurotomaria*, read Pleurotomaria.