

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.

	<i>Grains.</i>
Silica, insoluble in acids	1.610
Alumina350
Magnesia	3.705
Lime	9.319
Oxide of iron849
Soda154
Carbonic acid, combined	9.314
Sulphuric acid	2.298
Chlorine236
Loss343
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 boulders 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 boulder 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.

Boulders, 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 or rock exposed in the bed of the river. Limestone boulders 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 cephalopod 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.
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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 *Illanus Iorus*, *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, siliceous, 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 caespitosum*, *Eridophyllum rugosum*, *Favosites Emmonsii*, 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 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, $5\frac{3}{4}$ 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.