GEOLOGY OF JOHNSON COUNTY.

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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 town-

ship, 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.

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