GEOLOGY OF BARTHOLOMEW COUNTY.

By Moses N. Elrod, M. D.

PROF. JOHN COLLETT, A. M., *State Geologist:*

DEAR SIR:—I herewith submit a Report of a Geological Survey of Bartholomew County.

Thanking you for valuable aid, many courtesies and suggestions as to the Geology of the drift period, I am, very respectfully,

MOSES N. ELROD, M. D.

Hartsville, Ind., September 4, 1881.

Columbus, the county seat of Bartholomew county, situated near the center of the county, is forty-one miles east of south of Indianapolis, on the main line of the Jeffersonville, Madison & Indianapolis Railroad. The county comprises an area of about four hundred square miles, two hundred and fifty-six thousand acres. In the early history of the State it formed a part of Delaware county, and was organized as Bartholomew county under an act of the Legislature, approved January 9, 1821. Originally it included most of the territory now embraced in the county of Brown. Johnson and Shelby counties bound it on the north, Decatur and Jennings on the east, Jennings and Jackson on the south, and Jackson and Brown on the west.

In addition to the main line of the Jeffersonville, Madison & Indianapolis road, the Madison and Cambridge branches center at Columbus. By these north and south roads the business of the central part of the county is well accommodated with transportation, and from present indications the wants of the other sections will soon be met by the building of a road from Columbus to Greensburg, over some one of the proposed routes.

Columbus is a city of over 5,000 inhabitants, and one of the most active, pushing, business places in the State. It is beautifully located on the west bank of White river, at the foot of the famous "Hawpatch" region; is equipped with a full city government, well supplied with water works and gas, and withal healthful, and has a bright prospect for the future. Jonesville, Walesboro, Taylorsville, St. Louis Crossing, Clifford and Elizabethtown, are all thriving railroad towns. Hope is the first and Hartsville the second largest towns in the county. Azalia, Burnsville, Waymansville and Bethany are prosperous villages.

TOPOGRAPHY.

The monotony of an otherwise generally level country is diversified by many a hill and valley in the west part of the county, especially that portion of the county lying west of Columbus, forming the western parts of Ohio, Harrison and Union townships, and locally known as the "Brown county edge of Bartholomew."

An eastern continuation of the central ridge of the Brown county knobstone enters the county at the southwest corner of Harrison township, and reaches its greatest altitude at Taylor hill, in Sec. 36, T. 8, N. R. 4, E. Taylor hill, the highest point in the county, is 1,003 feet above tide level, and 360 feet above Columbus. From its summit magnificent views of the surrounding country may be had. On a clear day when the air is pure the unaided eye can trace for miles, as a blue line against the horizon, the eastern boundary of the great Driftwood-White river valley. The observer may see Georgetown to the northwest in Brown county, Edinburg in Johnson county, and Columbus and Walesboro in Bartholomew. From Taylor hill the Wall ridge, as Prof. Collett has named it, trends to the north through Union township, thence west through Nineveh township to the Brown county line. It is not a continuous ridge, but a series of high points intersected by numerous valleys and gaps, that fall away to the lower lands of the east and west, north and south. The central and northern parts of Nineveh township, while broken by outliers and foot-hills of the Wall ridge, are generally what may be termed rolling lands. Low hills and ridges, ranging from twenty-five to fifty

feet in height, occupy much of the country between the knobstone summit and the bottoms of Driftwood, White river, and to the south of the ridge in Ohio and Jackson townships. The central portion of the county is level, much of it below and in the vicinity of Columbus being White river bottoms, ranging three to four miles wide. North of the county seat sets in the Haw-patch plateau, extending from White river to the Shelby county line, renowned as an extensive tract of arable land, level and fertile as any prairie, primevally covered with a magnificent forest of great trees, devoid of undergrowth.

The eastern parts of the county are usually rolling, and some parts spoken of as hilly, but the application of the term hill, *i. e.*—an elevated mass of land—is a misnomer. The so-called hills are not elevations above the level of the country, but valleys cut from twenty to seventy feet below the general surface. This distinction is important, as will further appear when we come to discuss the geology of the drift period. Especially are the valleys marked in the vicinity of Hartsville, and in the northeast part of Clifty township, on Fall Fork and Middle Fork creeks.

DRAINAGE.

What is given as the east fork of White river on the State and school maps, is locally, and it is claimed, correctly known as Driftwood from Edinburg down to the mouth of Flat Rock creek, from that point south as White river; but as the term "Driftwood" is indiscriminately applied to any portion of the river in the vicinity of Columbus, and is not used generally outside of the county, we shall drop the name Driftwood and use the name White or East White for all parts of the east fork of White river below Edinburg. Above Edinburg the same misapplication of terms recurs in calling East White river Blue river.

White river crosses the northern boundary of the county near Edinburg, and bears thence in a general course east of south through the central part of the county. From Edinburg the river follows and runs through the foot hills of the wall ridge of Knobstone till it reaches the sand and gravel bottoms below the mouth of Catharine's creek. Above this the river flows through a stony bed of black shale, and is not

subject to great overflows; below the banks are low, the bed gravelly, shifting and frequently overflown. According to the table of altitudes of the main line of the J., M. I. railroad, the bed of the stream, Blue river, is fifty-three feet higher at Edinburg than the bed of White river at the Columbus bridge. From the same tables we find the fall in the river from Columbus to the Rockford bridge to be thirty feet, showing that the fall per mile is 100 per cent. more above than below the city. Advantage has been taken of this fall and utilized to run the extensive flouring mills at Lowell and the Valley Mills west of Taylorsville. The permanent banks and swift current of the upper river invite further investments in manufactories. Messrs. Stansberry and Williams give the mouth of Flat Rock creek at 602 feet above the level of the ocean, and that of Clifty creek at 596 feet above, making the fall six feet in five miles as compared with a fall of fifty-three feet in fifteen miles of the river above the mouth of Flat Rock. The fall in the Ohio and Mississippi rivers from Louisville to the Gulf of Mexico is less than four inches to the mile. The difference between high and low water at Columbus is given at fifteen feet.

A few rivulets and brooks that rise west of the Wall ridge flow into an arm of Salt creek that cuts the northwest corner of Harrison township, and finally unites with East White river below Bedford, in Lawrence county. With this exception all the streams of Bartholomew county empty into White river within the county or soon after it enters Jackson county. The general course of the creeks is east and west, with the surface of the country, and to the south of the center of the greatest depression of the White river valley. White creek, and its tributaries, leave the county in a more southern direction, and unites with White river below Seymour. The creeks of the west side of the river, beginning in the northwest, are Big Nineveh creek, Muddy branch, Catharine's creek, Wolf creek, Denois creek, and White creek and its tributary the East Fork of White creek; on the east are Flat Rock river, Haw creek, Clifty creek and Little Sand creek and their tributaries, Little Haw creek, Fall Fork, Middle Fork, Otter creek, Brush creek and Bear creek, together with other small streams, named and not named on the map. The banks of the creeks on the west side of the valley, after reaching the low lands, are cut in the

clay and mud without proper first or second bottoms, in appearance very much like artificial ditches, and hence overflows are common. The creeks flowing through the Hawpatch have low banks in the gravel with well marked second banks. Those of the limestone region of the east are deep and rocky, and the present beds are never filled by rain storms to their full carrying capacity.

GENERAL GEOLOGY.

QUATERNARY AGE.

Recent and Drift Periods.

The recent and drift periods, aside from the inquiries aroused in the mind of the most casual observer of nature, as to the origin of the soil, clay, sand, gravel and bowlders that go to make up these periods of mixed materials, out of which order comes, when closely studied, are the most interesting from a practical point of view as the base of all agriculture, the source of all wealth.

MATERIALS OF THE DRIFT PERIOD.

In order to a proper understanding of the wonderful forces that came into play during the glacial and terrace epochs of the drift period, we will first consider the clays, sands, gravels and bowlders that go to make up the mass of these groups, and their distribution over the surface of the stratified rocks, and then discuss the theory and dynamics of their origin. In general terms we may say that the whole of the surface of the county is covered with drift materials, except the top of the wall ridge, and the hills to the west of it in Harrison and Union townships, and doubtless these high hills have been subjected to the action and influences of the waters of the terrace epoch, that have so greatly modified and rearranged the ancient glacier deposit.

The upland gravel beds are collections of pure sand, clean gravel and small bowlders, found only on the high grounds and ridges, that I believe to be identical "hog's-backs" of the Ohio survey, and the *kames* and *eskers* of the authors; especially are these beds of gravel identical in only being found on the high lands, and in being much less modified and re-

arranged by the action of water subsequent to the glacial epoch. In stratification the beds are very irregular and seldom conformable one with another; more frequently no indications of stratification are seen, the beds when opened showing sand at one end and coarse gravel at the other; the strata frequently interlock and alternate in cross sections without reference to the underlying beds. This want of uniformity of stratification is in marked contrast with that of the low land gravel as seen in the Hawpatch. The town of Hartsville is built on a rolling elevation, ranging from forty to fifty feet above the valleys and facing to the southwest. It is bounded on the west by the deep bed of Clifty creek, and on the south by the gorge, through which flows Boner's branch. In the south part of town, capping the bluff that forms the north bank of the Boner's branch gorge, there is a typical bed of upland gravel. It has a steep, rounded head at the east end, on which the Hartsville University building stands, and trends thence west in a low ridge that slopes to the north, terminating in an abrupt bluff at the west, with a spur to the south. The high bluff west of Jackson street is also capped with gravel that, in an irregular way, is connected with the bed found in the University campus. The gravel beds that occur on the farm of William J. Herron, near the Tarr hole of Clifty creek, and that on the farm of R. B. Kent, near Hartsville, are very similar in structure to the one above described, and are all peculiar in presenting on one side at least, a very bold, abrupt face. The upland gravel found on the farm of Mrs. Amy Wiley, west of Anderson's Falls, in Clifty township, is another extensive bed that, like the preceding examples, seem to be in some way connected with the drainage of the country at the close of the drift period. The occurrence of these beds on the immediate bluff banks of streams, now small, it is true, but once great, is not accidental. In thickness they range from ten to twenty-five feet, but seldom reaching the last figure. Whenever cut through to the bottom, it has been found to rest directly on the underlying corniferous limestone. Nowhere has it been found mixed with any but the surface clays, and in these instances the mixing seems to have been accidental. Near the surface masses of cemented gravel, conglomerate are not infrequent, in which the cementing element, or matrix, is carbonate of lime, deposited by the hard

waters that percolate from above through a calcareous soil. Other beds of upland gravel are those on the farm of Mrs. E. Jones, near the Haw Creek Baptist church; on the farm of Mrs. M. Marlin; on the farm of E. Reed, near the village of St. Louis, in Haw Creek township, and the "back-bone" ridge, as it is called, on the farm of J. Remy, west of Burnsville, in Rock Creek township.

The Hawpatch glacial gravel and sand, one of the most extensive and peculiar beds of gravel in the State, is roughly bounded by Flat Rock river on the northwest, and Haw creek on the southeast, and reaching from the White river bottoms to the Shelby county line, a continuous bed of gravel covered with a gravelly black soil, twelve miles long by three miles in average width. On the Columbus and Greensburgh pike a typical view of the surface features of the Hawpatch may be had, and it will be seen that Haw creek does not form any special boundary on the east, but cuts through the gravel, that the immediate, first banks of the creek are from six to eight feet below the second banks that mark the true level of the bed, and that the banks of Clifty creek define the eastern edge. What is true of this cross section will be found true of other places. The actual limits of the Hawpatch gravel are to be found in the range of foot hills of the Knobstone on the west of White river, extending from below the Lowell mills to the northeast of Taylorsville, and the sand ridges and dune like hills on the east, running north from the Clifty creek bridge. Another element that has entered into the formation and largely determined the uniformity and evenness of the surface of this gravel plateau has been the smooth top of the underlying black shale; the shale unlike the other strata of Indiana, is a stony formation of great uniformity of structure that does not weather into rough escarpments of valleys and ridges. An exemplification of this may be seen in the bed of White river, in the vicinity of the Valley mills. The top of the bed is mixed with a strong dark calcareous soil, except where the soil has been washed away in the bed of the creeks, where the gravel is left in purity. Under the soil, generally, comes a bed of adherent gravel and sand, locally known as "hard pan." This conglomerate is due to the cementing together of the particles of sand and gravel by carbonate of lime in the same manner as the

conglomerate of the upland gravel, as has already been pointed out. In short, it is the same chemical process that under other circumstances would result in the formation of tufa and stalactites, the interstices between the gravel in the one case acting as the larger cavernous openings do in the other.

Water dissolves carbonate of lime under pressure, and deposits it under opposite conditions. These conditions have occurred in many instances, and, continued for long periods, have cemented the gravel and sand in an impervious stratum of "hard pan," so that we have the apparent anomaly of a pond or marsh covering a gravel bed. Below the "hard pan" and soil is found clean, fine gravel and sand. In many places the sand, or rather very fine gravel, presents a white or ash-blue color. An examination of the white and blue sand, with a magnifier shows the first to be quartzite, and the second, the blue particles derived from the decomposition of the gray granite-like bowlders, all much worn and rounded by attrition. Occasionally mixed with the gravel are pebbles and small bowlders. All the beds, whether upland or lowland, have a large per cent. of chert and limestone fragments, not so much worn as the other materials, of a brownish color on the outside from staining with oxide of iron. The bowlders are frequently in a state of decomposition, and specimens measuring more than a few inches in diameter are seldom or never found. The following section, taken south of Columbus and Greensburg pike, on Haw creek, is very characteristic:

Section on Webber Smith's Farm, Columbus Township.

Soil mixed with gravel	3 ft.
Stratified sand and gravel, with pebbles at the top	6 ft.
Larger pebbles stratified	2 ft.
Fine sand	1 ft.
Stratified gravel to the bed of Haw creek	4 ft.
Total	16 ft.

The top of this section reaches the surface and includes the soil of the second bank of the creek. On the west of the point at which the section was taken, the strata have a uniform thickness; on the other hand the stratification dips slightly to the

east, but is everywhere conformable. The following section in the second bank of Clifty creek north of the pike shows the same general arrangement of the strata as the preceding:

Section near Clifty Creek Bridge, Columbus Township.

Soil with gravel	2 ft. 0 in.
Sand and gravel, stratified	1 ft. 0 in.
Coarse gravel and large pebbles in a continuous stratum	0 ft. 6 in.
Stratified sand and gravel	4 ft. 6 in.
Total	8 ft. 0 in.

What is seen at these sections will be found true for the balance of the Hawpatch. Wherever examined on the banks of Flat Rock river, or in digging wells the same evidence of stratification was found, and it will be noticed that while there is occasional evidence of stratification in the upland gravel, such is not by any means the rule, thus placing the two in marked contrast. An excavation for a cellar, No. 414 west side of Washington street, in Columbus, showed that the surface of the gravel was not perfectly level, but marked by hillocks, slight ridges and pocket-like depressions, as if formed by currents of water running in different directions. On the gravel rested a bed of clay, overriding the elevations and dipping down into the depressions. The two strata were very distinct, as if formed under very different conditions. No gravel was noticed in the clay, but its absence may be due to the near vicinity of the river, and is alluvial rather than of the drift period. We can form no very correct estimate of the actual thickness of the Hawpatch gravel as the underlying stone was not seen, nor has it been reached in sinking wells in the deeper parts. Wells have been put down to the depth of fifty and sixty feet in the vicinity of Columbus, and no stone struck. That the bed was once much deeper than now is shown by the mound on the farm of Judge Tunis Quick, one and a half miles west of Clifford, and the Tipton mound in the city of Columbus. The first is twenty-five feet above the surface of the surrounding plain and the second twenty feet. They are the monuments left by the currents of the Terrace epoch, and meters by which we can in part measure what was once the thickness of this great gravel

bed. The soil of the Hawpatch has an average thickness of five feet, is dark or black in color, and free from admixture with any but alluvial clays—no glacial clay intervenes between the soil and gravel.

The following section east of the broad ford on Clifty creek shows the stratification and arrangement of the gravel, sand and pebbles of the gravel beds that form the connecting link between that of the uplands and lowlands:

Section at Sarah Bush's Farm, Clay Township.

Soil free from gravel	... ft. 10 in.
Soil and gravel mixed	2 ft. 2 in.
Coarse gravel and pebbles	..... 5 in.
Fine gravel and sand	..... 2 in.
Coarse gravel	..... 5 in.
Fine gravel	..... 4 in.
Coarse gravel and sand	1 ft. 3 in.
Fine clean gravel	..... 3 in.
Coarse gravel and sand	1 ft. 2 in.
Clean gravel	..... 2 in.
Coarse gravel and sand	2 ft. 0 in.
Total	9 ft. 2 in.

Here the stratification is very marked and distinct, and the strata more largely mixed with limestone fragments and chert, than at other places. East of this section on the south bank of Clifty creek a backbone of gravel, above any overflow of the present day, extends for a mile or more. South of Columbus, in Sand Creek and Wayne townships, the gravel and clay is covered with sand to such an extent that no opportunity was had to study the bed, but is doubtless much like that of the last section, and the same range is struck in digging wells in Clay, German and Haw Creek townships. The clay of the Hawpatch region has been washed away, while that of the adjacent beds was left undisturbed, or covered with sand.

Bowlders, or erratic rocks, locally known as "nigger heads" and "blue heads," of the largest size and in greatest numbers are found on the eastern boundary line of the county. A line of bowlders extending from the vicinity of Milford, south into Jennings county, was noted in the early history of the country,

and was supposed by some to have been the work of the Indians, who had placed them as some sign or memorial. The largest one seen was on the land of Knox Smiley, just over the Decatur county line. It is of gray granite, and measures six by eleven feet on the surface, and is bedded deep in the earth. Another, on the farm of Henry Mobley, in Clifton township, measures 8x10x6 feet. Bowlders two and three feet in diameter are common, but grow less frequent toward the west, but are rather common in Nineveh township and in the clay banks of White river down to Lowell mills. In composition they are identical with the mass of stones found strewn over the Drift regions of Indiana, Ohio, Illinois and the northwest, the various varieties of granite, syenite, gneiss, etc., metamorphic and plutonic rocks from the Laurentian highlands of Canada, north of the great lakes. The larger ones are usually angular, showing no signs of having been rolled or eroded. The smaller ones are rounded and water worn, and occasionally one is found with a smooth surface and lines of striation.

The glacial; yellow or ferruginous clays of Haw Creek, Clay, Clifty and Rock Creek townships, are light yellow in color, friable when dry and inclined to be sticky when wet. Internately mixed with the clay are fragments of chert and limestone, torn from the underlying Niagara and corniferous strata, together with a large per cent. of metamorphic pebbles of northern origin. In the banks of the creeks and bluffs the clay never shows evidence of stratification, but not infrequently beds of sand and fine gravel are pierced in digging wells and cisterns. A bed of sand two feet thick was found in the Paul Sheets well in Columbus, below forty-five feet of white and bluish clay. These beds of sand are local, occurring in pockets that soon thin out, or are replaced by clay and gravel. The average thickness of the glacial clay, as determined from the average depth in a number of wells, is put at twenty-five feet, and varies from a few feet to many. The top soil, free from gravel, ranges from one to five feet in thickness. The clay is thinnest when subjected to the wash and action of the currents of the terrace epoch, as in the vicinity of Otter creek where the water once flowed across the creek south.

The terrace clays that cap the Knobstone foot hills west of White river, are largely made up of the fine, impalpable sands

and alumina arising from the decomposition of the adjacent and underlying aluminous shale. Frequently underlying the terrace clay are beds of glacial origin; especially may they be noticed in the bluffs and hills west of Columbus. Seven feet of red or yellow clay, containing quite a number of specimens of glacial gravel, was exposed in a well at Henry Gross' farm, in Harrison township, at an elevation of one hundred feet above Columbus, and glacial clay has been found near the top of the Wall ridge, but, as a rule, the clay of this region is of a much later date. The terrace clays are white, sticky and form a retentive cold soil, known as "crawfish land."

The blue bowlder clay, recognized everywhere as of glacial origin, has not been seen by us in the county. Perhaps the conditions favorable to the formation of a blue clay did not exist in this immediate vicinity. The yellow glacial clays of Bartholomew county are doubtless in the main the result of the disintegration of the Niagara and corniferous group rocks and the black shale, together with the materials of a foreign origin, without the usual admixture of the products of the blue shales, so common in the lower silurian and sub-carboniferous formations, neither one of which is crossed by the line of denudation that has formed our clays. Blue clays are said to be found south of this county, and probably owe their origin to the base of the Knobstone.

Yellow sand—Molders or ferruginous sand forms an important feature in the surface geology of the county, not only on account of the quantity, which is considerable, but more particularly as the cap of the extreme outlying bluffs on the east and west of the White river valley, and as being the most recent formation and deposits in the succession of time of the Terrace epoch. This deposit of sand marked the close of the Drift period. In physical appearance, where pure as left by the receding waters, and unmixed with humus, carbonaceous clay and other foreign matter, it is always loose and mellow, with a rough feel to the touch—not impalpable—in the vast majority of instances of a yellowish or ochery color, with occasional pockets of white sand, so clean that a shovel full of it will not render a pail of water turbid. The clean yellow sands are those that cap the bluffs and form the higher sand ridges, that have not been disturbed since they were deposited. Examined

under the microscope, the fine particles show that they are of metamorphic origin, identical with the coarser sands of the Hawpatch, but without sharp points of crystallization, indicating that they have been water worn and rolled as the other glacial sands have. On the low lands and bottoms, where mixed with the products of the soil and mud of the flood plains and overflows of the rivers, they are dark, in many places after cultivation, black; in others, where much washed, of a light color.

The central line of sand ridges of the county commence at the northwest corner of Clay township, and trend thence south to the north bank of Clifty creek, following the bluffs of the south and west bank as a mantle over the clay to the bridge on the Columbus and Burnsville pike, southeast to the Lutheran church, thence in a general course south between Elizabethtown and Azalia, crossing the county line and connecting with the chain of sand ridges and hills of Jackson county. Through Sand creek township are found parallel ridges ranging north and south, with a spur to the west that is cut by the Azalia and Mineral spring road. By barometric measurement this spur was found to be twenty-five feet above the river bottoms, and is probably forty feet above high water in White river; Elizabethtown by railroad level is seventeen feet above Columbus. The top of the bluff north of the Clifty bridge on the C. & H. pike is by the barometer seventy-five feet above the bed of the creek. These sands modified form the surface soil of Sand creek, and a large part of Wayne township. An isolated, and apparently an anomolous accumulation of yellow sand unmodified is found on the east bluffs of Fall Fork creek, and on both faces of the valley locally known as the "no-head-hollow," a sharp gorge running north and south from the banks of Middle Fork to Fall Fork, above their junction. These bluffs are estimated to be at least one hundred and twenty feet above the bed of the White river valley. A branch of the "no-head-hollow," is known as "fox hollow," here with little labor the fox and ground hog dig their habitations, safe places of retreat in the loose sand. On the farm of Dr. Biddinger, south of David Anderson's mill is a low sand ridge in the bottom, showing that at one time overflows must have been much higher than any of the present day. In the bends of Clifty creek

below Fall Fork, especially below Newbern, in the vicinity of Bush's mill, are points and broad accumulations of mixed sand and soil. On the west side of the great White river valley the range of hills between Taylorsville and the Valley mills are covered on the west with yellow sand; in the vicinity of the Lowell mills the same range of hills show only a deposit of clay and clay gravel. The foot hills of the Knobstone west of Walesboro, and again in Wayne township, are sandy.

BURIED TIMBER.

In digging wells all over the eastern townships of the county at an average depth of twenty feet a bed of black earth is pierced. In appearance it is indentical with a productive surface soil. This *soil bed* is found as a rule, not always, and rests generally on the underlying limestone, but occasionally, as in the neighborhood of Hope, is reported to have a substratum of sand and gravel. In thickness it ranges from one to six feet, and is not so much mixed with gravel and pebbles as the overlying clay. Where this black soil is penetrated, quite frequently pieces of wood, roots, masses of decayed leaves, and a thick muck are found. A large piece of timber was taken from a well on the farm of John E. Galoway, just east of Hartsville; from the well of Francis Galbraith, on the county line east of town; from the well of Prof. Lewis Mobley; from the well of Mr. John Chisler, in Hartsville, and from a number of other wells in Clifty and Rock Creek townships. So common are the remains of an ancient forest that an inquiry in any neighborhood will elicit the fact of leaves and wood being found buried near by. A root is reported to have been taken from the Taylor well, in Columbus, fifty feet down, but such things are not common in the central valley region. No fact connected with the history of the Drift has more indelibly fixed itself on the minds of the masses, and no fact more conclusively convinces the average mind that the whole country on the east line of the county has been subjected to the violent action of water or some other force, at a time long past.

COLLETT GLACIAL RIVER VALLEY.

Commencing at the head waters of Blue river in Henry county, on the long southern slope of the divide that determines and gives direction to the sources of the Great Miami,

White Water and the east and west forks of White river, at an elevation of more than 1,200 feet above the mean tide level of the ocean, sets in a broad valley that connects with the valley of the Ohio at Louisville. For this great central Indiana valley, Prof. John L. Campbell, of Wabash College, has suggested the name of Collett Glacial River Valley. Prof. John Collett having been the first to point out the extension of the valley below Jackson county, the honor has been well earned and well bestowed. As the terms Blue river, Driftwood and White river valleys have a local signification only, parts of a grand whole, and all three combined do not convey to the mind the extent of the valley in length or vastness in breadth, there seems to be a real necessity for a more general term. To fill the want we shall apply to the region under consideration the name, Collett Glacial River Valley.

This valley is roughly bounded on the east by the high ridge of the western outcrops of the Hudson river groups of the lower Silurian, and on the west by the eastern outcrop of the Knobstone groups of the Sub-carboniferous period. By the natural drainage of the country its upper part above the Bartholomew and Jackson county lines, embraces all the territory drained by East White river. In Jackson and Scott counties the valley is cut at right angles by the Muscatatuck river, and its tributaries flowing west through the Knobs. To a proper understanding of the wonderful forces in action during the Glacial period, it will be well to first get an idea of the amount of erosion and denudation that has taken place since the emergence of the rocks of our country from the bed of the ocean, beneath which they were formed. To do this some idea of the depth of the valley may be had by a comparison of the height of Columbus and other points above tide level, with the ridges on the east and west. This can be done by a study of the railroad elevation on the C., I., St. L. & C. R. R., published in Indiana Geological Report for 1878, the J., M. & I. and branches, published herewith. According to the survey of the main line of the J., M. & I. road, in round numbers, the base of the rail at the Columbus depot is 643 feet above tide level and the bed of White river 34 feet less, or 609 feet above the ocean. Starting with these data we find the summit between the West White river and Sugar creek on the

C., I., St. L. & C. road, 227 feet above Columbus and 109 above the surface of Blue river at Shelbyville, the summit between Flat Rock creek and Clifty creek 273 feet, the surface of Flat Rock at Rushville 323 feet, at St. Paul 176 feet, Clifty creek at Adam's Station 258 feet, and the ground in Greensburgh 323 feet above Columbus. The summit between Sand creek and Salt creek is given as the highest point on the C., I., St. L. & C. road at 1079 feet; 436 above Columbus. The altitude of Pierceville station on the O. &. M. Ry. is given at 1009 feet above tide level, which is 564 feet above the bed of the Great Miami river bridge, 404 feet above Seymour, 442 feet above the bed of White river at Rockford, and 366 feet above the depot at Columbus. The Knobstone ridges on the west, range in altitude from 300 to 400 feet above the bed of White river and at the highest point in Brown County, the Weed Patch Knob is 1173 feet above the ocean (Prof. Collett), and 510 feet above Columbus. The Knob west of New Albany is given as 500 feet above high water of the Ohio river, (Prof. R. Owen). From the above elevations, that may be relied upon as approximately correct, an idea may be formed of the extent of the Glacial river valley. It has a width of over 40 miles measuring on an east and west air line through Columbus, from the Wall ridge of the Knobstone to the Lower Silurian ridge north of Pierceville, in Ripley County, and a depression of over four hundred feet below an air line in the lowest parts of the White river bottoms. In this valley we find nearly the whole of Bartholomew County and fully one-third, through the center of the county north and south, a broad level plain at the very bottom of the old Glacial valley. That the trough of this ancient river was once at a lower level than it is now is shown by the present river flowing over the sand and gravel, and at no point below Catfish Falls cutting through to the underlying rock north of the Jackson County line. It is not probable that the thickness of the gravel and sand below the present river bed is very great, or has been silted up as the Ohio at Louisville and points above; where the filling up with sand, gravel and clay has been to such an extent as to warrant the assertion that the Ohio, throughout its entire course, runs in a valley that has been cut nowhere less than 150 feet below the present level of the river, (Prof.

Newberry). It is proven that the old channel of White river, at some period of its history, cut the Black Shale at a lower level than it now does at Rockford, by borings for water at Seymour, that have been sunk in the gravel below the present bed of the river, and 25 feet below at Columbus, and no rock found. The extent of the Glacial river valley at the close of Paleozoic time is largely a matter of speculation; but that a valley of considerable depth existed in the pre-glacial period, and gave direction to ice currents, is proven by the mass of drift material found far down the valley south of and below that stopped by the Knobstone barrier of the west.

DYNAMICS OF THE DRIFT.

In the presentation of the dynamical geology of the Drift period, I shall adopt and apply those theories of the authors that seem best to explain and agree with the phenomena presented by the facts detailed above.

At a period of time long past and variously estimated at 200,000 to 4,200,000 years ago, when the surface of the continent was elevated from 500 to 2,000 feet above the present ocean level, the ice cap that now covers the frozen regions of the far away Arctic zone, was extended south in a general sheet to the Highlands of Canada. From the foot of the glacier of the Laurentian hills, prolongations flowed south, southwest, and southeast. That flowing across northern and central Indiana from the striæ left on the rocks, over which it passed, seems to have had a southern or southeastern course. The primary glacier of Indiana was, doubtless, continuous with that of Ohio, if not in direction of the flow, at least in action, and covered the Lower Silurian ridge as far south as Ripley county. On the west Collett Glacial river valley, the Bean Blossom ridge of the Brown county Knobstone, and the northern side of the Wall ridge in Nineveh township, were the barriers, beyond which the central portion of the Indiana glacier never passed. Here against the everlasting hills the ice piled up in mass over 400 feet thick (Prof. Collett*); but found a depression to the east and south, across and down which a lobe extended in force, scoring and planing the face of the under-

* Ind. Geol. Rep. 1874—Brown County.

lying limestone and shale. Down the preglacial valley the ice flow reached nearly, if not quite, to Louisville, and that this great extension of the glacier was of long duration is shown by the thickness of the glacial clay and immense amount of chert gravel and pebbles contained in it, derived from the Corniferous and Niagara limestone over which it passed, grinding and pulverizing the face of the earth. Some idea of the immensity of time, during which the glacier was in action and of the amount of denudation that took place, may be formed when it is remembered the chert gravel and pebbles that form so large a per cent. of the Drift clay and other materials, existed only in a small per cent. in the rocks, from which they were derived. During this long period the Glacial valley was deepened and extended, scooped out of the solid rock by the mighty power of moving ice. At the bottom of the icy river was borne the rounded pebbles and striated bowlders of metamorphic rocks torn from their home north of the present great lakes, constantly were added to these, the fragments of the sedimentary strata, over which the glacier glided, on its top rode huge masses of angular stones, unworn bowlders.

In the fullness of time came a change, the climax of the Glacial epoch had been reached, heat began to displace the frozen mantle, and fogs that hung like a pall over the face of nature, the land began to subside and the ice disappeared from the Silurian ridge on the east. The line of numerous large, angular, unworn bowlders, unmodified beds of upland gravel and abundance of glacial clay, found in greatest force along the eastern boundary of the county, and continued into Jennings, are proof of their accumulation at the edge of a local glacier, that they are the remains of a lateral moraine. The terminal moraine is found in the line of bowlders and sand south of the Muscatatuck river in Scott county, in the vicinity of Scottsburgh, Vienna and Lexington, and on the head waters of Pigeon Roost creek. (Prof. Borden). The lateral moraine in Bartholomew county is elevated from one hundred to one hundred and twenty feet, and the terminal moraine is shown by the survey of the J., M. & I. railroad, at the water divide below Vienna, to be ninety-five feet above Columbus. The water divide south of the Muscatatuck, in a large measure, determined the foot of Collett glacial river. Another explana-

tion suggested for the great abundance of bowlders seen on the east side of the county, is that the glacial clay subsequent to its deposition, with bowlders buried beneath the surface, has been washed away and the bowlders left lying on the surface. But this explanation does meet the facts in the case; while there is evidence of the long continued action of water, there is no evidence that the clay in the bowlder region has been washed away, but is as thick, if not thicker, than at other points. The strongest proof of the existence of a lateral moraine is that bowlders of a large size are rare on the east in the vicinity of Greensburg, and especially on the west in the west part of Clay township, where the land is found at the same or a lower level, and the clay as much or more liable to have been washed than any other beds in the valley. If ever imbedded in the clay in like proportion, the wearing away of the gravelly banks and beds of the streams and rivulets would have unearthed them.

The lateral moraine on the west of the valley can only be traced to the foot hills west of Columbus. Bowlders of medium size are found near the Dowell hill quarries in Harrison township, and specimens of larger size are not infrequent above, and common at the Valley mills. In digging for an extension of the race at the Valley mills, several bowlders of large size were removed. Some of them were found resting on the black shale and the others bedded in the terrace clay. That there is a line of buried bowlders on the west, the remains of a lateral moraine covered by the terrace clays of a later epoch, is not impossible, but improbable. In the southwest part of the county, at points where the clay was thin and washed, a careful search and inquiry failed in finding them. At Rockford the clay is cut through to the bed rock in the same manner as the Lowell mills and above, and is in the line of the western moraine, if one ever existed. Yet, Prof. E. T. Cox says, (Ind. Geol. Rep., 1874): "I saw no erratics more than a foot in diameter in Jackson county, and such specimens are very rare." The theory that best agrees with the observed facts, is that the course of the ice-flow of the general glacier as it came down from the regions of Lake Superior and Lake Michigan, continued in the same southeast direction, across the State and across the glacial valley, and that for a time the foot of the glacier rested against the east side of the valley. The piling

of the mass of ice against the Bean Blossom and Wall ridges, at an angle with the direct line of the glacier flow, would have the effect to stop and cut off the detritus of the lateral moraine. On the south and west, the great mass of bowlders would accumulate at the foot of the piling ice and but few reach the valley from that side. Another result of the accumulation of ice on the Brown and Johnson county line, would be to deflect the flow to the east and increase its velocity. The cross flow of ice and that down the valley to the south, was shorn of its western and lateral moraine by the Knobstone hills; hence no bowlders on that side of the valley below Columbus.

It is a well known geological fact that at the foot of the ice sheet, all over the northwest, great valley and river beds have been cut very much beyond the capacity to accommodate the streams now flowing through them; some of these ancient river beds have been silted by accumulations of sand and gravel, and the rivers flow at a higher level than they once did; others still find their old rocky bed. To the latter class belong Clifty creek and its tributaries, Fall Fork and Duck creek. The Clifty creek valley and bed is cut through from twenty to forty feet of Corniferous, and from ten to twenty-five feet of hard crystalline Niagara limestone, and the same is true of Fall Fork creek. Perhaps nothing connected with the surface geology of the county is more singular than the beds of these creeks, great valleys eroded in the solid stone, through which now flow insignificant rivulets that are dry for almost half the year. The Duck creek valley has a capacity to carry a volume of water as great as that flowing down White river at flood tide. It is evident that the foot of the cross flow or cross glacier, as we may call it, must have rested for a long time on and near the banks of Clifty creek, alternately advancing and receding, with the heat of summer and cold of winter, across Haw Creek, Clay and Clifty townships, while at the foot ran mighty rivers of ice water. No other hypothesis offers an explanation of the vast amount of local erosion and denudation that has here taken place. It is probable that the ice flow down the Glacial valley was continued long after the cross glacier foot ceased to exist, as an ice tongue of the decadent period, shorn of its moraines, but still laden with metamorphic gravel and recent limestone pebbles. It was the long con-

tinued action of the direct valley glacier that cut away from forty to fifty feet of Corniferous limestone down to black shale, west of Clay township, planing and polishing the broad, smooth floor of the valley, now covered by the Hawpatch and lower White river bottoms.

As the general glacial sheet receded to the north, the ferruginous glacial clay and remodified upland gravel beds were left on the higher lands. The decadence of the Valley glacier left vast quantities of gravel that was more or less modified and stratified by the great rivers of ice water, that the increased heat of summer sent down from the melting snow and ice.

Of the various theories that have been proposed in explanation of the occurence of buried soil and timber, "ancient forest beds," found at many places in the western Drift, that one is adopted provisionally by the writer, which seems best to agree with the facts. It is well known that the glacial clay of this vicinity where exposed to the sunlight and air, will soon support vegetable life. The ice sheet receding through the influence of a warmer climate, the exposed ridges were soon clothed with a soil and growth of vegetation, that had continued to exist further south through the climax of the cold period. Along with the forest growth came the mammoth, mastodon, reindeer, great beaver and other animals now extinct. After the general ice sheet had disappeared from a comparatively narrow strip of territory on the southern edge of the Drift region, through changes in the climate, about the exact nature of which it is not necessary here to speculate, there was a recurrence of the extreme cold, the retreat of the glacier was arrested; over the exposed Drift, on which a forest was growing, came an extension of the ice flow of the north, the glacial clay was rearranged, the so-called ancient soil and forest buried in some places, and wholly obliterated in others. A few things connected with the history of the forest bed seem to lend color to the above theory. First, the buried soil and timber is covered with glacial clay and gravel, and is strictly a phenomenon of the Drift period, we have no reports of buried timber outside of the Drift area. Second, the forest beds of Indiana and Ohio, except where possibly buried under the old deltas of Lake Erie, are found only over a narrow strip of country confined to the southern limits of the Drift. These facts militate

the theory of a general submergence. By a submergence all the forest territory south of the Drift would have been buried. A local central lake, devoid of currents, could not have rearranged the glacial clay, and it is hard to comprehend how a local lake was confined to few counties on the southern border of Ohio and Indiana, no barrier has been pointed out sufficient to dam up a lake whose currents and eddies could have swept over the Lower Silurian hills. An inter-glacial period of a general forest growth certainly would have left scattered remains all over the Drift region, so far as Ohio and Indiana are concerned, with the exceptions mentioned, no such remains have been reported.

That the great body of water flowing from the foot of the receding *recurrent* glacier, further modified the lowland gravel beds of the Glacial Valley and washed vast quantities of it further down the valley, is shown by the so called Indian gravel mounds on the farm of Judge Tunis Quick, and Tipton hill in Columbus, gauges that mark what was once the depth and extent of the deposit. The Judge Quick mound having an elevation of twenty-five feet above the general surface of the surrounding country, presents a sharp bluff to the north, a gently sloping talus to the south and a swale for surface drainage on the east, all showing that the eroding power has been water, and that the currents that have cut away the gravel and left the hill standing, came from the north down the Glacial Valley.

When the glacier had retreated to the water divide, six hundred feet above Columbus, of Randolph and Henry counties, and covered the highlands with melting ice, the collected waters found an outlet through the White River valley. Down the valley of the east fork came sweeping currents and floods carrying quantities of yellow sand, that was left on the plains and hills where the flood current was broken and deflected to the right or left. The bluffs of Clifty creek on the Clay township line formed the base of an eddy of slack waters *above*, that gave origin to the ridge of sand hills that extends north from the vicinity of the Columbus and Greensburgh pike bridge. The retardation of the current of the flood caused the deposition of sand on the bluff sides and in the valley of Middle Fork creek, on the hills east and north of the Valley Mills, in German township, and on the bluffs west of and

below Walesboro. But the great mass of sand was carried beyond the points mentioned, by the torrent and left in the hills and ridges of Sand Creek township, in the slack water formed *below* the Clifty creek bluffs. Like influences together with the change in the course of the valley to the west through Jackson county, caused heavy deposits east and south of the more modern bed of White river. Doubtless much of the sand found over Sand Creek and Wayne township has been spread since the close of the Terrace epoch by the rains and floods of more recent times.

The location of the Terrace clay, on the west side of the valley and in the White creek slashes, gives a clue to their origin, and point to the conclusion that they are the products of the impalpable sand and finer materials, deposited from the sluggish waters of the Glacial river, while the coarser materials were carried further to the east, where the main current flowed. This clay has been added to and modified by materials derived from the adjacent Knobstone hills. It is not necessary to invoke the existence of a great lake, the protecting influences of the Wall ridge were sufficient to favor the formation of bayous, great pools, and slashes beneath which the fine, whitish, sticky clay was deposited.

The Glacial period closed with the Terrace epoch. That the deposition of the yellow or ferruginous sand was the last record made by the floods of the Glacial valley that reached from the bluffs of Fall Fork creek to the Knobstone hills of the west is shown by the sand resting on and above the glacial clay. In depth the flood must have exceeded one hundred and fifty feet, and that the flow was from the north to the south, a great rushing torrent, is shown by sand ridges only being left in the retarded current *above* and *below* the bluffs of Clifty creek. Such must have been the closing scene of many winters of ice and snow, the opening of spring that has ever since been followed by a perennial climate of summer as compared with that of the preceding age*.

* The reader in studying Dr. Elrod's valuable and interesting report, will observe that in some cases his observation differs from conclusions heretofore given. The subject of the drift will require much study, years of labor, and a wide area for observation. The opposing deductions are here given to arouse study and investigation.—COLLETT.

RECENT PERIOD.

ALLUVIUM.

The alluvial deposits of the East White river valley are made up of the varied clays, sand and gravel which are further comminuted by the action of the water, together with great stores of organic matter that are swept down by the rain storms and carried by the floods and overflows over the fat acres of the first river bottoms; thus forever adding to their perennial greenness, at the expense of hills and valleys east and west. The alluvium of the creeks of the east part of the county, is unimportant as their rocky banks are seldom or never overflowed; that of the creeks of the west can not be separated from the muddy terrace clay banks through which they flow. An overflow of the mud banks of these creeks is but the addition of another layer of sticky clay and impalpable sand, a rearranging of the old materials and the addition of decaying vegetable matter. The calcareous soil of the hawpatch is of local origin, from the decomposition of the contained limestone pebbles and metamorphic gravel, to which has been added ages of vegetable, growth, carbonaceous matter that has imparted a dark color to the whole mass.

PALEOZOIC GEOLOGY.

DIP AND CONNECTED SECTION.

Starting with the datum, derived from railroad surveys, that the bed of Clifty creek at Hartsville is 112 feet above the mouth; we find the top of the Niagara group limestones 94 feet below the same horizon at St. Paul, eleven miles north, and that the dip to the south is near eight and one-half feet to the mile. We find the level of the Niagara limestone eight miles east, at Adams Station, to be 156 feet above that of Hartsville, which gives the dip to the west at nineteen feet to the mile. From these measurements we estimate the general dip to be to the southwest at the rate of fifteen feet to the mile.

The following connected section of the rocks of the county is made up from measurements made in taking the local sections, and presents at one view the various strata and their average thickness. The numbers in the first column are referred to in the following pages by the abbreviation, C. S., No. —, and will

enable the reader by reference, to see just what age, period, epoch and stratum, where not more fully given, is under consideration in the local details.

Connected Section of Bartholomew County.

CARBONIFEROUS AGE.

SUB-CARONIFEROUS PERIOD.

Knobstone Group or Epoch.

1.	Sandstone, coarse textured with bands of iron ore and shale partings	95 ft.
2.	Sandstone, even bedded, light colored quarry stone	40 ft.
3.	Shale and sandstone in thin beds	50 ft.
4.	Shale and iron ore	90 ft.
5.	Blue aluminous shale and calcareous goniatite bed..	85 ft.

DEVONIAN AGE.

HAMILTON PERIOD.

Genesee Epoch.

6.	Black slate	80 ft.

CORNIFEROUS PERIOD.

Corniferous Group.

7.	Blue crystalline quarry stone, North Vernon stone, Upper Corniferous	10 ft.
8.	Light blue crystalline limestone, middle corniferous	12 ft.
9.	Gray or earth colored limestone, soft at the top, locally hard and ochery in color, lower corniferous	40 ft.

SILURIAN AGE.

UPPER SILURIAN DIVISION.

NIAGARA PERIOD.

Niagara Group or Epoch.

10.	Calcareous shale, fossil beds	6 ft.
11.	Blue quarry stone, locally brownish in color at the top	30 ft.
	Total	538 ft.

LOCAL DETAILS.

NIAGARA GROUP.

In lithological characters the blue quarry stones of the Niagara group vary from massive to thin bedded crystalline magnesian limestone with local bands of chert. Wherever it is exposed, it has been found very free from shaly or clay-partings and breaks with a square angular fracture. In physical appearance and composition, it is subject to change, in some localities being an even bedded homogeneous rock, and at others, only a few hundred feet removed, irregular, and the mass made up of chert bands and nodules. At the top of the Niagara limestone the beds change in most places by imperceptible degrees, and at others, abruptly into a hard refractory ochery-colored pseudo-limestone that occurs in thin or massive layers, generally shelly, with a conchoidal fracture. In color or structure, it seems to be persistent, showing in all the outcrops, in appearance it is very much like the base of the lower member of the Corniferous group overlying the calcareous shale, nodules of calcite, crystallized carbonate of lime, of great beauty are common to both. The calcareous shales, No. 10 C. S., is not always found in place, is very variable in thickness, and composition. Where not too much exposed to the air the color is blue, where mixed with the surface soils and weathered, is a yellowish clay. It is thin bedded, splitting into thiner laminæ, uniform in structure, where non-fossiliferous sometimes a sticky plastic clay, and at other places intercalated with plates of fossiliferous limestone and nodules and cubes of pyrites, ferrum sulphide. The surface of the blue limestone is not a uniform level; at the foot of the Farr and Stucker holes in Clifty creek, the top of the outcrop is just above low water mark, while at the bend of the creek between the two, below Hartsville, a ridge is cut through twenty-five feet in thickness. There is no evidence that these irregularities are synclinal or anticlinal axes, but slight ridges left at the bottom of the ocean before the overlying Corniferous was deposited, hence there is probably a slight want of conformability between the two groups of stone.

The Niagara group stones were formed from the sediment of

an interior ocean, whose eastern shore line was formed by the hills of Franklin and Ripley counties, hills that were then and have ever since reared their heads above the tide level. The nearest outcrop of the lower Silurian is seen in the vicinity of Westport, a few miles east of the Bartholomew county line. As the average thickness of the strata decrease as we go east, thinning out to a knife blade deposit, we have evidence that the waters of the ocean were shallow, but must have been very pure and quiet to favor the formation of crystalline rocks; the process of formation must have been slow and long continued to allow the growth of life, the fragments of whose remains are here found entombed in the living rocks. As the Niagara group limestone emerged from the shallow seas, a change in the purity of the water and irregularity of the limestone bed caused deposits of argillaceous clay sediment to take place in the pockets and depressions, hence the calcareous shale is variable in thicknes within a few feet and occasionally wholly wanting, where the conditions were not favorable to the accumulation of a muddy sediment. A very perfect specimen of *Eucalyptocrinus crassus* found in the calcareous shale, lying horizontally with the root and stem of another individual growing at right angles from the calyx, a *Platyostoma niagarense* covered over with the delicate tracery of *Paleschara*, and on this the roots of a crinoid, together with the great numbers of fossils taken from these beds, show that the accumulation was very slow and that more than one generation of animal life passed before the last was covered by sediment.

All the members of the Niagara group are fossiliferous and the calcareous shale, highly so. The cephalopod shells, *Orthoceras crebescens*, H., *O., annulatum*, Sow., and *Gyroceras elrodi*, White, by their size, form and members are the most conspicuous, and are characteristic of the Niagara blue limestone. They are found in greatest abundance near the top of the group in the thin flagging stone. Occasional specimens of *Atrypa reticularis*, Linn., *Strophostylus cyclostomus*, H., *Meristina nitida*, H., *Eucalyptocrinus crassus*, H., and a few very small *Stephanocrinus gemiformis*, H., are found in the upper members, but not in abundance, nor are the corals or trilobites common; *Calymene niagarensis*, H., has been found. No attempt will here be made to give a list of the fossils of the calcareous shale, suf-

fice it to say that all the above named species are common, except the cephalopods and stephanocrinus.

The Niagara group limestone outcrops in the bed and banks of Clifty creek from the southwest corner of section 2, township 9 north, range 7 east, to the Decatur county line at Possum Glory, up Fall Fork creek to Anderson's falls, up Middle Fork to Long's falls, in Boner's branch to the cemetery road east of the college, up Hiner's branch to the bluffs on the south, and up the valleys and ravines for a short distance on either side of Clifty creek. No other outcrops are to be seen on Duck creek or Haw creek, and but for the valley of Clifty creek all the members of the Niagara group would be buried out of sight by the superincumbent corniferous limestone.

As the Oriskany sandstone period has been referred to the upper Silurian rather than the Devonian age by most modern geologists, perhaps a word may not be out of place as to its occurrence or non-occurrence in Bartholomew county. If it occurs it should be found between what has been recognized universally as the Niagara and Corniferous groups of limestone. On lithological grounds it is excluded if we look for it as a sandstone. No sandstone occurs on Clifty creek where the two groups are in contact, the one above the other. In Southern Illinois the Oriskany is described as a "silicious limestone," in Ohio as a "coarse saccharoidal sandstone," neither of which can apply to any of our rocks. The presence of the calcareous shale settles the age of the limestone below it. The stone above is used down to the very base, at the Arbuckle Kiln, near Hartsville, as a lime rock, good specimens of *Conocardium trigonale*, H. *Zaphrentis gigantea*, Raf., and other well known Corniferous corals have been found in the stone resting immediately on the calcareous shale. It is true the lower member of the Corniferous group has a "rough and hard dirty look, especially after weathering" (Dana), but no other characters in common with the Oriskany.

Section at Jesse Mobley's Quarry, Clifty Township.

Gray, soft limestone, lower division of the Corniferous group, heavy bedded..... 2 ft. 2 in.
Hard, ochery, colored stone, No. 9, C. S., with calcite nodules, breaking into wedge shaped shelly pieces 3 ft.

Even bedded, bluish quarry stone, Niagara group, in ledges from 2 to 4 inches thick, readily splitting into good flagging	2 ft. 4 in.
Massive quarry stone ranging from 4 to 6 inches in thickness, good building stone, No. 11, C. S.	2 ft. 9 in.
Dark blue stone, soft when first quarried, hardening on exposure	6 in.
To bed of Clifty creek	4 ft.
Total	14 ft. 9 in.

In the above section the calcareous shale is wanting, and it is with some doubt we refer the ochery colored limestone to the Corniferous group, but as it is identical in lithological characters with the base of No. 9 of the connected section, this is probably its true place. No fossils of any kind were seen.

Section at Turn Hole, Clifty Creek, Clifty Township.

Soil and covered space, estimated	40 ft. 0 in.
Massive soft limestone, lower division of the Corniferous group	2 ft. 2 in.
Massive soft limestone, lower division of the Corniferous group	0 ft. 7 in.
Massive stone at top, shelly at the bottom, No. 9, C. S.	1 ft. 9 in.
Calcareous shale, fossil bed	5 ft. 8 in.
Massive brownish pseudo limestone, No. 11, C. S.	0 ft. 11 in.
Massive blue limestone, No. 11, C. S.	0 ft. 9 in.
Massive limestone, flagging at bottom	0 ft. 11 in.
Massive bed with chert, No. 11, C. S.	1 ft. 5 in.
Niagara group limestone to creek bed	2 ft. 6 in.
Total	56 ft. 8 in.

The quarry stone at this place has frequent bands of chert that very much increase in the outcrop above on the east side of the bend of the creek. By the following section taken on the west side of the creek, the changeable character of the stone is seen in a few hundred feet.

Section at Lower End of Tarr Hole, Clifty Creek, Clifty Township.

Soil	00 ft. 00 in.
Massive soft stone, lower division of the Corniferous group	2 ft. 0 in.
Gray stone, bedding irregular, No. 9, C. S.	0 ft. 9 in.
Gray stone, bedding irregular, No. 9, C. S.	0 ft. 6 in.
Gray stone, bedding irregular, No. 9, C. S.	0 ft. 5 in.
Gray stone, bedding irregular, No. 9, C. S.	0 ft. 8 in.
Gray stone, bedding irregular, No. 9, C. S.	0 ft. 4 in.
Gray stone, bedding irregular, No. 9, C. S.	0 ft. 6 in.
Gray stone, bedding irregular, No. 9, C. S.	0 ft. 7 in.
Gray stone, bedding irregular, No. 9, C. S., brownish at bottom	0 ft. 7 in.
Calcareous shale, fossiliferous beds of the Niagara group	6 ft. 0 in.
Ochery-colored pseudo-limestone, hard and shelly, No. 11, C. S.	1 ft. 5 in.
Massive blue quarry stone, very even bedded, splendid building stone, free from chert, No. 11, C. S.	1 ft. 10 in.
Quarry stone to bed of creek	1 ft. 0 in.
Total	16 ft. 7 in.

The one foot and ten inches ledge of the above section is a persistent stone of uniform texture and outcrop for a distance of near two miles up the creek, showing in bold and overhanging escarpments where the underlying beds have been less resistant to the action of the weathering process; now appearing on the right bank and again on the left in the bends of the meandering stream. It is evident from the boldness of the square face and sharp angles this stone presents, especially in the bend west of Henry Mobley's place, that it is a building stone that will last for ages without change. At points the ledge increases in thickness and sometimes appears as if divided by seams into thinner strata but is still massive and resistent to atmospheric influences. Most excellent flagging and thin building stone has been taken out of the beds on the farm of Henry Mobley near Hartsville, and its superior quality as a fencing stone demonstrated in the fence east of the pike.

Section at Anderson's Falls, Fall Fork Creek, Clifty Township.

Soil	00 ft. 00 in.
Gray massive stone, lower division of the corniferous group to the bed of creek above the falls..	3 ft. 00 in.
Massive gray limestone hard in appearance.....	5 ft. 00 in.
Calcareous shale, Niagara group, in their *laminæ fossiliferous*	4 ft. 00 in.
Even bedded Niagara group limestone.....	2 ft. 00 in.
Total.....	14 ft. 00 in.

A few yards above the falls the corniferous gray stone, that forms the bed of the creek, thickens in the bank to six and eight feet, and on the outside has a "hard and dirty look" where covered with minute growth of lichens; here the characteristic appearance of the lower division of the corniferous may be seen in the rough bed of the stream caused by the weathered and rounded tops of the square and irregular blocks reminding one of a pavement of huge cobble stones. The Anderson falls are remarkable as being in a small way the geological equivalent of the Niagara falls shale and limestone. Here as well as at the great falls of Niagara may be seen the same processes in action, that in the one case has carried the falls back from Queenstown, Canada, seven miles, and in the other two or three hundred feet by the more rapid erosion of the soft underlying shale and breaking down of the harder superincumbent rock, great blocks of which lie in the channel below the falls, and in both cases the streams cut across or against the dip. From the foot of the falls to the mouth of Middle Fork, the creek runs north and apparently toward a synclinal axis, that is due to an irregularity in the surface of the top members of the Niagara group, that are slightly unconformable with the strata above. At the falls the creek bed is over thirty feet wide with sharp overhanging mural front over which the water pours at flood height with a great roar, falling twelve or thirteen feet into the pool below, presenting a pleasing if not a grand spectacle. All the elements are present, of a first class picturesque resort, especially in summer, when the surrounding valleys are covered with verdure, but one, a lack of water to bring out the beauties of the falls, just at the time people feel most inclined to seek such places.

During ordinary summers, Fall Fork dwindles to a lazy rivulet, playing hide and seek with the rocks of its stony bed, in very dry seasons it vanishes into thin air. But while the *dilettante* pleasure seeker might be disappointed, not so the geological specimen hunter whose work would be favored by the absence of water, and the shale that reaches the bed of the creek left bare. Good specimens of *Eucalyptocrinus crassus*, H., *Glyptaster inornatus*, H., *Rhodocrinus melissa*, H., and very fine crinoid roots are not rare, and an occasional perfect trilobite has been found. All the various species of brachiopods common to the calcareous shale are abundant. Picnic parties will find one of the finest chalybeat springs in the State below the falls in the bed of the creek, where a profusion of the coolest water bubbles up from an unknown depth.

Section at Long's Falls, Middle Fork Creek, Clifty Township.

Grayish and ocher colored shelly stone, lower division of the Corniferous group	4 ft. 00 in.
Calcareous shale Niagara group, non-fossiliferous, weathering further down the creek to a yellowish clay	2 ft. 00 in.
Yellowish shelly stone with chert bands at the top No. 11, C. S.,	1 ft. 6 in.
Massive, even bedded blue quarry limestone, in ledges from two to fifteen inches thick, good building and flagging stone	8 ft. 00 in.
Total	15 ft. 00 in.

These falls are in a small way the counterpart of the Anderson falls, and such cascades, rather than falls, are common to nearly all the valleys and ravines where the calcareous shale forms a part of the outcrop and has weathered so as to leave unsupported the overlying Corniferous rock, that has a tendency to break in huge blocks with a square precipitous front. Examples of the square fracture may be seen on Boner's branch south of the College and on Webber's branch. No better evidence of the resistance, to the action of air and water of the blue limestone can be seen than is here presented, the running water more or less mixed with gravel and sand has scarcely left

a ripple mark on the surface, level as a barn floor or rounded the square edge of the exposed strata.

In the east bank of Fall Fork creek at David Anderson's mill the upper members of the blue Niagara limestone, are replaced by bands and nodules of white chert, that breaks into smaller fragments on exposure, in appearance not unlike an imperfectly slacked lime rock.

Section at Reese Mobley's Quarry, Clifty Township.

Soil and covered space	0 ft.	0 in.
Top ledge, blue limestone, Niagara group	0 ft.	6 in.
Blue massive quarry limestone	1 ft.	7 in.
Blue massive quarry limestone	1 ft.	4 in.
Blue massive quarry limestone	0 ft.	5 in.
Blue massive quarry limestone	0 ft.	5 in.
Blue massive quarry limestone	1 ft.	4 in.
Blue massive quarry limestone	0 ft.	10 in.
Blue massive quarry limestone	1 ft.	0 in.
Blue massive quarry limestone	0 ft.	7 in.
To bed of the creek, thin bedded stone with local bands of chert	6 ft.	0 in.
Total	14 ft.	0 in.

The ten-inch ledge of this section is of remarkably uniform structure, free from hard nodules and "glass seams," and works kindly under the hammer. Mr. Mason, an old experienced quarryman and practical mason, says that it is "one of the best limestones in the world." Only three feet of the front of the ledge had to be discarded in opening the quarry, showing that a building erected from such stone in this climate would resist the ravages of time for ages. A specimen of work from this ledge may be seen in the water tables and window sills of E. D. Weinland's new brick store in Hartsville. All the ledges of this section are most excellent quarry stone for general purposes.

Section at John Graham's Quarry, Hartsville, Haw Creek Township.

Soil and covered space	0 ft.	0 in.
Yellow clay equivalent of the calcareous shale, fossiliferous	3 ft.	0 in.

Ochrey colored limestone with nodules of calcite, No. 11, C. S.	0 ft.	10 in.
Blue quarry stone, massive and even bedded, No. 11, C. S.	1 ft.	3 in.
Blue quarry stone, massive and even bedded, No. 11, C. S.	0 ft.	7 in.
Blue quarry stone, massive and even bedded, No. 11, C. S.	0 ft.	10 in.
Blue quarry stone, massive and even bedded, No. 11, C. S.	0 ft.	10 in.
To the bed of Clifty creek, good flagging and building stone No. 11, C. S.	20 ft.	0 in.
Total	25 ft.	2 in.

The out-crop at the bottom of Boner's branch at the south end of West street shows a continuous section through twelve feet of Niagara limestone and eight feet of the lower division of the Corniferous lying conformable, without the intervening calcareous shale. Four feet of the Niagara is here replaced by chert unmixed with limestone.

Section South of Hartsville University, Haw Creek Township.

Soil and covered space	0 ft.	0 in.
Lower division of the Corniferous group, dirty gray, soft stone in thick ledges, shelly near the base, No. 9, C. S.	17 ft.	0 in.
Calcareous shale, wanting	0 ft.	0 in.
Niagara group limestone, in massive and thin strata ochery-colored, coarse stone near the top, base uniform in bedding and structure, good quarry stone, No. 11, C. S.	6 ft.	0 in.
Total	21 ft.	0 in.

No calcareous shale was here seen, and the same is true of the clay shale, that should be found in the banks below, if the conditions favorable to its formation ever existed. Below this section the gorge opens out into a broader valley from which ten to twelve feet of solid crystalline limestone has been removed, leaving a basin shaped excavation connected with Clifty creek by a narrow outlet. No better example than is here presented, any-

where offers of the powerful local action of some eroding agent, other than water alone; we have already shown that agent was doubtless *ice*.

Section at Arbuckle's Lime Kiln, Haw Creek Township.

Soil and covered space	0 ft.	0 in.
Weathered gray stone, lower division of the Corniferous group, massive and even bedded, quarried and used for burning to lime	1 ft.	4 in.
Weathered gray stone, lower division of the Corniferous group, massive and even-bedded, quarried and used for burning to lime	1 ft.	4 in.
Weathered gray stone, lower division of the Corniferous group, massive and even-bedded, quarried and used for burning to lime	1 ft.	1 in.
Weathered gray stone, lower division of the Corniferous group, massive and even-bedded, quarried and used for burning to lime	1 ft.	8 in.
Weathered gray stone, lower division of the Corniferous group, massive and even-bedded, quarried and used for burning to lime, with calcite and corals	2 ft.	10 in.
Weathered gray stone, lower division of the Corniferous group, massive and even-bedded, quarried and used for burning to lime with calcite and corals	0 ft.	10 in.
Covered space, place of the calcareous shale that shows as yellowish calcareous clay in the south bank of the quarry, No. 10, C. S.	3 ft.	0 in.
Flagging ochery colored on the outside, Niagara group	0 ft.	1 in.
Flagging ochery colored on the outside, Niagara group	0 ft.	2 in.
Flagging ochery colored on the outside, Niagara group.	0 ft.	2 in.
Blue building stone	0 ft.	9 in.
Blue building stone with chert band	1 ft.	2 in.
Blue building stone homogeneous	0 ft.	10 in.
Blue building stone homogeneous	0 ft.	10 in.
Total	13 ft.	9 in.

The weathered members of the Corniferous are here true rotten stones of a dirty earthy appearance, in which many of the corals are replaced by calcite, especially in the lower beds. The whole out-crop above the calcareous clay, is soft, easily quarried, and makes a most excellent lime. The Niagara building stone is a beautiful blue heavy stone, apparently very even in structure. Across the creek is a bold escarpment of "cliff-rock," Niagara group below, and Corniferous above, from which a little stone has been quarried.

On the east bank of Clifty creek just below the mouth of Hiner's branch is an out-crop that shows the finest flagging any where seen, great yellowish slabs, smooth as a board, of any desirable thickness.

Section at Stucker Hole, Clifty Creek, Haw Creek Township.

Soil and covered space to top of the bluff, estimated..	30 ft. 0 in.
Lower division of the corniferous group, weathered soft, massive stone, fossiliferous.....	6 ft. 0 in.
Calcareous shale No. 10, C. S., highly fossiliferous at the base and upper end of the outcrop.....	4 ft. 0 in.
Blue Niagara group limestone, in ledges ranging from one to four inches in thickness to bed of the creek.....	2 ft. 0 in.
Total.....	42 ft. 0 in.

Above the Stucker hole good quarry stone can be had at many points, notably in a little ravine just above Critzer's mill. A peculiarity not noticed at other places was here seen, in one of the ledges fracturing at right angles to the plane of stratification into wedge shaped pieces; aside from this ledge, good stone can be had for all general uses.

Section at 'Possum Glory, Haw Creek Township.

Soil.....	0 ft. 0 in.
Flagging stone, even bedded, No. 11, C. S.....	0 ft. 1 in.
Flagging stone, even bedded, No. 11, C. S.....	0 ft. 2 in.
Flagging stone, even bedded, No. 11, C. S.....	0 ft. 1 in.
Flagging stone, even bedded, No. 11, C. S.....	0 ft. 2 in.
Flagging stone, even bedded, No. 11, C. S.....	0 ft. 3 in.
Building stone, No. 11, C. S.....	0 ft. 4 in.

Buliding stone, No. 11, C. S.	0 ft. 5 in.
Building stone, No. 11, C. S.	0 ft. 3 in.
Building stone, No. 11, C. S.	0 ft. 4 in.
Building stone, No. 11, C. S.	0 ft. 7 in.
Building stone, No. 11, C. S.	0 ft. 4 in.
Building stone, No. 11, C. S.	0 ft. 5 in.
Building stone, No. 11, C. S.	0 ft. 6 in.
Building stone, No. 11, C. S.	0 ft. 8 in.
Total	4 ft. 7 in.

Here the stone has some whitish chert nodules, but is free from bands and can be quarried with the greatest facility. The top flagging members have a yellowish color that changes to a blue lower down in the bed. On the farm of Samuel Stroups, the flagging, fencing and light building stone is very fine. A deeper opening will doubtless develop thicker ledges and it would seem that Hope and vicinity, with a good pike to the quarry, should get their stone at this place. Excellent specimens of *Orthoceras annulatum* Sow., and *Gyroceras* were found in the upper strata. The calcareous shale outcrops in the vicinity, across the Decatur county line.

DEVONIAN AGE.

CORNIFEROUS PERIOD.

Corniferous Group.

The Corniferous group limestones form the surface stone and underlie the Drift of nearly the whole of the eastern upland portion of the county. It is the stone struck in digging wells in Rock Creek, Clifty, Clay and Haw Creek townships. It is the bed rock and stone exposed in the banks of Beaver creek, Little Sand creek, Duck creek, Otter creek, Haw creek, and their tributaries, and on top of the bluffs on Middle Fork, Fall Fork and Clifty creeks. From its lithological characters, we have divided it into three subdivisions, upper, middle and lower Corniferous. In relative thickness they stand in the proportion 10: 12: 40, but the outcrop in the county is not in the same ratio. The upper division, blue limestone, equivalent of the North Vernon quarry stone, was seen at but three places; James Manley's limekiln or Little Sand creek, and at the Ev-

errode and Yaley quarries in Clay township. In thickness it is variable; at Manley's kiln it does not exceed three feet, and at the other outcrops scarcely reaches ten feet. The middle division is only found in force on Little Sand creek; other exposures of thin plates were seen on the bluffs east of Robert Ketner's place in the road from Hartsville to David Anderson's mill, and at John E. Robbin's farm. The lower member near Hope has a much greater surface exposure and thickness from having been protected by the others from the general denudation to which they have been subjected.

In lithological characters the upper Corniferous, North Vernon stone, is a hard, sometimes refractory, dark blue crystalline, massive, even bedded, magnesian limestone, of uniform structure that weathers well. The middle is a light blue, crystalline massive or thin bedded, shelly magnesian limestone, of variable structure, banded and mixed with amorphous chert-geodes and weathers to thin plates and shelly fragments. The lower Corniferous is a grayish, dark, dirty colored rock, never truly crystalline to the unaided eye, but showing, under a magnifier, very fine sand like specks, massive or thin, even bedded limestone of tolerably uniform structure, except where mixed with or replaced by chert or pockets of calcite, that weathers into large angular blocks and rotten stone. At many points the lower division might be termed a true argillaceous limestone and is everywhere mixed with a considerable per cent of alumina, and the manner in which it resists the action of water, and atmospheric influence is variable; where covered by a thin soil or kept damp the outside crust is a dirty rotten stone in appearance like sand, that tested with mineral acids and the microscope is found to be free from silex, at other places where exposed to air and rains alone, the face of the bluffs and detached block are eroded into holes and crannies, as if long subjected to the action of waves and running water. That such has been the case seems probable from many of the blocks standing alone and away from the adjoining bed rock. On the west side of Clifty creek north of John Graham's land are isolated masses with perpendicular fronts that measure from 19 to 26 feet in height. On the outside these blocks and bluffs present to the eye a hard, gray, or bluish appearance in contrast with the soft and lighter colored interior. On the north side of

Hiner's branch, a hundred yards or more above the mouth, the lower division limestone is replaced by a coral reef in which the fossils are not only silicified, but are imbedded in a silicious matrix, the counterpart of what is mentioned by Professor Borden, in his report on Jennings County, as a buhr stone, locally called "millstone grit," from its very great resemblance to genuine French buhr. Whether the bed reaches down to the top of the Niagara group stone it was impossible to tell as the lower part was covered, but that such is the case, is probable. The cellular buhr stone was seen at a number of places, and is doubtless peculiar to the lower division of the Corniferous group. At the base of the Corniferous, overlying the calcareous shale or Niagara limestone, frequently occurs hard, refractory, ochery-colored stone, that in appearance and lithological characters is identical with the top strata of the Niagara, both are equally persistent, and one or both may not show in the outcrop. Careful testing with acid and examination with the microscope fails to detect the presence of silex in either.

All of the Corniferous group members are fossiliferous, especially the silicious cherty portion, in this last respect differing from the chert of the Niagara that seldom contains organic remains. Scattered all through the upper and middle divisions of the crystalline stone, fragments and occasional perfect specimens are found, and abundantly, in the chert. We have not found any of the Brachiopods and only one Conchifer, *Conocardium trigonale*, II., that is common, and seems to be peculiar to the lower Corniferous division. At many places a part of the corals are replaced by calcite, but as a rule the stony frame work of carbonate of lime has been replaced by silex, hard and durable as the everlasting hills, that, resisting the weathering process, are found mixed in the glacial clay and gravel, and scattered over the soil; geological records and monuments that have been torn from their settings, all that remains of the once massive stone that has yielded to the ravages of time. From the short time given to the study it is not yet possible to say with certainty what fossils are peculiar to each of the divisions, but enough is known to indicate in a general way the range of some of the more common species. No perfect specimens of crinoids could be had, but fragments of the base are not uncommon, and huge stems, some of them very singular in having pro-

longations, wings, growing from every fourth or fifth ossicle, are abundant and found only in the upper blue limestone. The fragments of crinoids are referred to the genera *Megistocrinus*, *Synbathocrinus* and *Rhodocrinus; Dalmanites ohionensis*, Meek, was found only in these beds. The various species of *Strophodonta* have a wider range through all the upper and middle strata. Probably the lower division is best characterized by the absence of all higher forms of life than the corals, except *Conocardium*, which is common in some places.

A general subsidence of the ocean level took place at the close of the Silurian age, and that the lower Coniferous was deposited from shallow water, more or less contaminated with impurities, seems evident from the per cent. of alumina contained in it; that it was a sea filled with coral reefs and islands is shown by the great beds of zoophites found in masses of so-called millstone grit; corals grow and form limestone only when they are in reach of the waves (Dana). The thin laminæ of stone seen on Haw creek and Duck creek near Hope are the result of gentle wave action. These conditions were somewhat changed near the close of the Corniferous epoch, there must have been a slight subsidence of the interior continent, an increase in depth and clearing of the water favorable to the growth of higher forms of life, and the formation of pure crystalline limestone.

Section at James Manley's Lime Kiln, Rock Creek Township.

Soil	00 ft. 00 in.
Black shale, equivalent of the Genessee shale, etc No. 6. C. S.	1 ft. 00 in.
Blue crystalline limestone, North Vernon stone, massive and even bedded, fossiliferous, upper division of the Corniferous group, No. 7. C. S.	2 ft. 6 in.
Light blue crystalline limestone middle division of the Corniferous group, massive, slightly irregular in bedding, with chert nodules, fossiliferous, No. 8, C. S.	9 ft. 2 in.
Light blue compact massive stone, fair quarry stone, No. 8, C. S.	2 ft. 00 in.
Gray heavy bedded stone, lower division of the Corniferous group, No. 9, C. S.	2 ft. 00 in.

Gray heavy bedded stone with geodes and *Favosites hemisphericus*, Y. & S., containing petroleum...	2 ft. 00 in.
To the bed of Little Sand creek.....	4 ft. 00 in.
Total.....	22 ft. 8 in.

The stone at this section is extensively quarried for making lime, and all the members are used except the top blue limestone ledge that might be made useful for heavy foundations, but will be found hard and rather refractory to work. The lime rock ledges occasionally contain nodules of chert that are rejected in breaking the stone for the kiln; where mixed with silex the stone runs and vitrifies when heated, coming out at the bottom in glass-like masses, frequently studded over with beautifully colored beads. But the most singular phenomenon is the occurrence of good shaped nodular coral masses of *Favosites hemisphericus*, Y. and S., imbeded in the stone just as they grew at the bottom of a shallow sea and holding in the cup-like cavity of the colony, sometimes as much as an ounce of petroleum, that many eminent authorities think has been the result of the decomposition of the animal matter with which the living coral was charged. Aside from this no other evidence of bituminous matter was seen. At the bluff, south of the so-called Indiana mound, the middle Corniferous limestone has a thickness of from ten to twelve feet, very shelly in bedding, with quite an accumulation of talus at the foot, showing that it is a rock that will not successfully resist the vicissitudes of climate. As the dip of the strata to the west is but little greater than the fall of the creek, its banks show the same outcrop from Burnsville to the Manley lime kiln, except that the Black shale and blue limestone are not seen east of the road crossing Little Sand creek, Sec. 5, T. 9 N., R. 6 E. The creek cuts through the light blue fossiliferous limestone, and reaches the lower division of Corniferous group, near the residence of Dr. McLeod. It has already been mentioned that only a few plates of the middle Corniferous are to be seen in Clifty and Haw Creek townships, but the lower division, as may be seen from some of the sections given under the local details of the Niagara group, is thick and massive, but not of sufficient variety in structure to demand further notice. We may, in passing, remark that by the weathering of the soft stone at many points

where exposed by the Drift, quantities of fossiliferous chert are found covering and imbedded in the soil.

Section at Mrs. R. Miller's Quarry, Haw Creek Township.

Soil mixed with gravel	3 ft. 0 in.
Gray massive limestone, lower division of the Corniferous group, in ledges from four to ten inches thick	8 ft. 0 in.
Soft gray stone in thicker ledges, No. 9, C. S.	2 ft. 9 in.
Gray stone in ledges from one to four inches thick, harder portions breaking into wedge-shaped pieces, No. 9, C. S.	4 ft. 0 in.
Gray limestone, weathering in places to a bluish color, No. 9, C. S.	4 ft. 0 in.
To bed of Duck creek	16 ft. 0 in.
Total	37 ft. 9 in.

Considerable quantities of stone have been quarried at this place, but it is not now worked. In bedding the stone is inclined to be irregular and does not break across the line of stratification with an even fracture, and aside from its not weathering well does not make a first class fencing stone, however, with some care in selecting and working, good stone may be had for light foundations and use where long durability is not a question.

Section on Duck Creek, John E. Robbin's Farm, Haw Creek Township.

Soil mixed with gravel	0 ft. 0 in.
Light blue fossiliferous limestone, middle division of the Corniferous group	0 ft. 11 in.
Gray limestone, lower division of the Corniferous group, even bedded	0 ft. 7 in.
Gray limestone, lower division of the Corniferous group, even bedded	0 ft. 3 in.
Gray limestone, lower division of the Corniferous group, even bedded	0 ft. 4 in.
Gray limestone, lower division of the Corniferous group, even bedded	0 ft. 3 in.

Gray limestone, lower division of the Corniferous group, irregular in bedding	0 ft. 10 in.
Gray limestone, lower division of the Corniferous group, irregular, in thin laminæ	3 ft. 4 in.
Gray limestone, lower division of the Corniferous group, massive, even bedded ledge	0 ft. 10 in.
Gray stone, thin ledges	1 ft. 6 in.
Soft gray stone in thin ledges not over one inch thick	2 ft. 8 in.
Gray massive stone, No. 9, C. S.	1 ft. 3 in.
To bed of Duck creek	10 ft. 0 in.
Total	21 ft. 11 in.

At this section was seen the most northern outcrop of the light blue limestone anywhere observed in the county. Here the stone contains a greater per cent. of alumina, and presents more the character of an argillaceous stone than at other points further south, but is free from shaly or clay partings.

Section at Robert Spaugh's Quarry, Haw Creek Township.

Soil, clay and gravel mixed	4 ft. 0 in.
Black soil, calcareous, with gravel	1 ft. 3 in.
Gray flagging stone, lower division of the Corniferous group, ranging from one to six inches in thickness	2 ft. 10 in.
Gray stone, even bedded No. 9, C. S.	0 ft. 8 in.
Gray stone, even bedded No. 9, C. S.	0 ft. 5 in.
Gray stone, even bedded No. 9, C. S.	0 ft. 7 in.
Gray stone, irregularly bedded	0 ft. 7 in.
Covered space to bed of Haw Creek	0 ft. 0 in.
Total	10 ft. 4 in.

Section at C. Deitrick's Quarry, Haw Creek Township.

Soil with gravel, lower part black and marly	3 ft. 0 in.
Weathered rotten stone, lower division of the Corniferous group, thin bedded	2 ft. 0 in.
Weathered rotten stone, lower division of the Corniferous group, more compact	0 ft. 5 in.

Gray stone, bedding regular, No. 9, C. S.....	0 ft. 7 in.
Gray stone, bedding regular, No. 9, C. S.....	0 ft. 6 in.
Gray stone, bedding regular, No. 9, C. S.....	0 ft. 8 in.
Gray stone, bedding regular, No. 9, C. S.....	0 ft. 9 in.
Darker gray stone, slightly irregular in bedding, No. 9, C. S	0 ft. 8 in.
Darker gray stone, slightly irregular in bedding, No. 9, C. S.	1 ft. 0 in.
Darker gray stone, slightly irregular in bedding, No. 9, C. S.....	0 ft. 11 in.
Darker gray stone, slightly irregular in bedding, No. 9, C. S.....	0 ft. 9 in.
To bed of Haw Creek, covered.....	0 ft. 0 in.
Total	11 ft. 3 in.

The stone at these places quarries in even blocks and is much more regular in bedding than at other points where sections of the lower Corniferous group have been taken. In structure it is non-crystalline to the naked eye, and not very compact, but seems to weather well. As a flagging stone it is superior, quite durable and when put down has much the appearance of a sandstone. It has been largely used in the pavements of Hope, and if selected would make the very best stone for that purpose, especially desirable on account of its soft structure breaking the sound of footsteps, so marked where the harder limestones are used.

When broken across, the stratum shows fine lines of lamination, more or less irregularly parallel with the stratification; where eroded by exposure the top and under sides of the stratum show nodular elevations and shallow depressions, as the result of the irregularity of the laminæ. It is evident that this stone was formed beneath the waters of a shallow sea and the lamination the result of wavelets, acting upon a fine sediment more or less mixed with alumina.

No fossils or signs of organic remains were seen, nor were any indications of chert noticed in any of the beds of the lower Corniferous where the four last sections were taken, but fragments of *Conocardium trigonale*, H., were seen in stone from a well in Hope.

Section of Jacob Everroad's Quarry, Clay Township.

Soil	0 ft.	0 in.
Genesee shale, Hamilton period	3 ft.	0 in.
Blue crystalline limestone, upper division of the Corniferous group, the equivalent of the North Vernon stone, massive, even bedded, in ledges from six to fifteen inches thick, fossiliferous, good quarry stone	3 ft.	5 in.
Blue crystalline limestone, No. 7, C. S., varying slightly in color, good quarry stone, fossiliferous.	1 ft.	3 in.
Blue crystalline limestone, No. 7, C. S., hard and compact, good quarry stone, and covered space to chert bed	3 ft.	6 in.
Chert bed, middle division of the Corniferous, not measured	0 ft.	0 in.
Total	11 ft.	2 in.

Section at John Yealy's Quarry, Clay Township.

Soil	0 ft.	0 in.
Black shale, Genesee, much weathered and discolored when exposed	2 ft.	6 in.
Blue crystalline, massive, compact, quarry limestone, upper division of the Corniferous group, fossiliferous	1 ft.	0 in.
Blue crystalline limestone, good quarry stone, fossiliferous, No. 7, C. S.	1 ft.	3 in.
Blue quarry stone, No. 7, C. S., to the bottom of ravine on the east	4 ft.	0 in.
Total	8 ft.	9 in.

These quarries are near each other in the northeast corner of the township, and, as may be seen from the sections above, are much alike in the quality of the stone quarried. While considerable quantities of stone have been taken out, neither one has been worked to the bottom of the upper division of the Corniferous, and it is only an approximation made by estimate when we give the thickness of the whole at nine or ten feet, there is but little doubt, however, that this estimate, measuring from the chert bed to the black shale, is below rather than over

the average. The stone for the foundation of the old Columbus court house, and that used in building the piers of the Clifty bridge at Newbern, came from here. The stone quarries in thick smooth slabs that break with an even square fracture, but does not split so well, except where natural seams exist. As for durability and power to resist pressure, it can not be excelled by any limestone in the west.

Some of the ledges, especially on the top of the stratum, are covered with fossils, but on account of the compactness of the martrix are very hard to get out in anything like a good condition, and through the mass of the stone fragments are not infrequent. The most common fossils are *Spirifera acuminata*, Conrad, *S. mucronata*, Conrad, *Strophodonta hemispherica*, H., *S. demissa*, H., an undetermined species of *Murchisonia*, and the calyces of *Megistocrinus* and *Synbathocrinus*, together with the pygidium of *Proetus planimarginatus*, Meek, and of *Dalmanites ohioensis*, M. The abundance of large and peculiar crinoid stems show that that form of animal life was once common.

HAMILTON PERIOD.

Black Shale, Genesee Epoch.

The stone of this epoch is locally known as black slate, but as it is slate only in appearance, we use the better term *shale*. It is the equivalent of the New Albany and Louisville black slate; Delphi, Ind., black slate; Huron shale of Ohio; Devonian black shale of the west; Genesee shale of New York, and the authors generally.

The eastern boundary of the outcrop is defined by the exposures in the banks of Little Sand creek, one mile east of James Manley's lime kiln, at the Yealy and Everroad quarries in Clay township, at the Manley lime kiln, and at the old saw mill near the residence of Martha Russell, in Rock Creek township. At the latter place the dip has gained on the base of the creek, so that the shale forms the bed of the stream. It is reported to have been struck in digging a saw mill well south of Elizabethtown, and in a well at Petersville. West of these points no outcrop is seen till it is exposed by the bed of White river at the Valley mills west of Taylorsville, and down the river to the Catfish falls below Lowell mills. The black shale

was found and penetrated to a depth of thirty-one feet in digging a well at Krusee's garden in West Columbus.

The shale, where protected or unaltered by contact with the underlying rock, is a jet black stone, where exposed and weathered changing to lighter shades and splitting into thin foliaceous scales and plates. Imbedded in it, at the outcrop on White river are frequent nodules and masses of iron pyrites, ferrum sulphide, that rust and combine with the oxygen of the atmosphere. When quarried in large blocks they soon break and slack, the line of fracture being as often across the lamination as with it. It is said to contain ten or more per cent. of bituminous matter and by distillation to yield from ten to twenty gallons of oil to the ton. Taking the per cent. of organic matter at ten, the beds of this county contain enough bitumen to form a coal seam seven feet thick. Thrown on a fire it burns for a few minutes like stone coal, but the bulk of stone never grows less, the oily matters is burned out, leaving the earthy residue undiminished and not a true ash. From this many persons are led to think that deeper in the hill or by boring, coal might be found, aside from geological evidence; frequent borings show that this is not the case; it is not even a sign of coal. Attempts have been made to utilize it, and at one time great hopes were had of its being useful as a roofing material, spread on felt, but expensive trials made by grinding it at Lowell mills, in this county, and at New Albany, proved financially disastrous to the experimenters. It has been recommended as a road material, but its tendency to slack will preclude its use for this purpose. If of any practical value, other than as a part of the great mass of rocks necessary to the formation of the crust of the earth, we have not heard of it. In this age of cheap petroleum its distillation can not be made profitable.

The black shale at points south of this county, and especially in Ohio has been found to be fossiliferous. Nothing of the kind has been found by us, but may be, as large masses of hard rock, probably limestone, are reported, that frequently contain remains of fish.

While the crystalline limestone strata of the latter part of the Corniferous epoch teach us that they were formed under deeper and purer waters than had prevailed earlier, the great thickness of the black shale, stratification and homogeneity of structure,

all point to its formation under shallow seas of impure water, conditions favorable to the deposition of sediment mixed with mud, and that these conditions were unchanged for a long period.

The question as to the origin of the bituminous matter can not be satisfactorily answered, but the paucity of the lower forms of vegetable life that had as yet come into existence and limited extent of dry land, would seem to show that it was derived from the organic remains so common in the preceding epoch, and not wholly wanting in this.

During the oil excitement, some years ago, Mr. C. C. Anderson sunk a well at the Valley mills on White river, and Mr. I. N. Smock, Trustee of German township, who lives in the immediate vicinity of the bore, has kindly furnished a record of the strata passed through. The section is given in Mr. Smock's own language, our comments in parentheses.

C. C. Anderson Bore, Valley Mills, German Township.

Earth (first river bottom)	10 ft.	0 in.
Slate (black shale, Genesee epoch)	40 ft.	0 in.
Appearance of coal (soot bed)	2 ft.	0 in.
Soft stone of same kind (black shale) of lighter color	18 ft.	0 in.
Stone resembling soapstone (black shale)	10 ft.	0 in.
Hard rock, upper division of Corniferous group	2 ft.	0 in.
Total	82 ft.	0 in

Deducting ten feet of earth and two feet of hard rock, we have seventy feet as the thickness of the black shale, which, compared with the estimated thickness from dip and bores made by Dr. Arwine and others, in Brown county, we think the measurement rather below than above the maximum. The presence of the base of the Knobstone series resting directly on the shale below Catharine's creek show that the deposit in this vicinity has not been much reduced by erosion. If borings are ever made in the southwest part of the county it will doubtless be found to increase in thickness, as most of our formations outcrop in greater force on the south.

We decide that "the stone resembling soapstone," is black shale mainly from stratigraphical position. No other than the

black shale has been reported as occurring anywhere in the State, between the Corniferous limestone and Knobstone group.

The persistence of the "appearance of coal," at this bore, and at both bores in Brown county, the "soot" of the latter, and the occurrence of a soft black stone that could not be "picked" at the bottom of Krusees' well in West Columbus, at a depth of thirty-one feet, point to the conclusion that the black shale may be divided into two divisions, and that each of these may be of a different epoch, having fossils peculiar to each.

CARBONIFEROUS AGE.

SUB-CARBONIFEROUS PERIOD.

Knobstone Group or Epoch.

Many obstacles are met in trying to get a connected view of the sandstones and shales of this group, as the great mass of the rocks are covered by detritus and soil on the hillsides, and the clay banks of the creeks and tributary branches never expose the stone so far as we saw, but by repeated measurements where an opportunity offered and the lithological characters of the strata, enough is known to determine the general averages with a good degree of accuracy.

At Catfish falls, between Columbus and Lowell Mills on White river, the blueish gray calcareous shale, the equivalent of the Rockford Goniatite bed, has a vertical exposure of a few inches. The outcrop is fossiliferous and shows in thin even bedded, smooth homogeneous stones with a fracture at right angles to the bedding.

The blue aluminous shale, the equivalent of the New Providence shale of Prof. Borden, the next member of the Knobstone group in ascending order, has a thickness ranging from twenty-five to eighty-five feet. It is locally known as a soapstone, and is the underlying stone of the whole of Jackson township and the low hills of Wayne, Ohio, Harrison, Union and Nineveh, between the Wall ridge and the White river bottoms.

In structure, the blue shale is tolerable uniform, with a tendency to become ferruginous, near the base. In places it resists the action of the atmosphere and water better than the higher drab colored shales. Where weathered it forms a blue plastic clay, and cold subsoil.

Section at Noble Hill, Jackson Township.

Soil and covered space	40 ft.	0 in.
Blue shale, Knobstone group No. 5, C. S.	5 ft.	0 in.
Blue shale and iron ore nodules	5 ft.	0 in.
Blue shale to foot of the hill No. 5, C. S.	10 ft.	0 in.
Total	60 ft.	0 in.

This hill is said to be highest above the average level of any in the township. The iron ore nodules of this section were in good shaped masses that readily shelled and broke under the hammer, but in amount were insufficient to be of any practical value.

The other shales and the sandstones of Knobstone group are very variable in both vertical and transverse section, ranging from a blue to a drab, from argillaceous to silicious, from friable, coarse sandstone banded with iron ore to smooth homogeneous even bedded quarry stone. It is evident they were formed on the eastern shore and bed of an ocean generally quiet, whose currents came from the north or northeast burdened with sand and muddy sediment, derived from the wasting disintegration of some other land than the non-silicious limestones of the Devonian and Silurian ages of Indiana. The changing, fitful currents of this epoch that left sand at one time, and mud at another, and, again, both mixed together, were not favorable to the preservation of fossil remains, even if marine life existed to any extent under such conditions.

Section at Taylor Hill, Harrison Township.

Soil	0 ft.
Sandstone, coarse textured, with shaley partings and covered spaces, No. 1, C. S.	75 ft.
Sandstone, light colored, even bedded quarry stone, No. 2, C. S.	40 ft.
Shale, in thin beds and covered space, No. 3, C. S.	50 ft.
Iron ore, shale and sandstone, No. 4, C. S.	90 ft.
Blue shale, No. 5, C. S.	85 ft.
To level of Columbus court house	20 ft.
Total	360 ft.

The outcrop of the quarry stone at Taylor Hill has not been worked sufficiently to develop the true character of the rock, but enough has been taken out to show that it is a beautiful

even freestone, with a square sharp angled fracture, and will split well. Whether this range of stone is the exact geological equivalent of the celebrated Berea grit and flagging of Ohio or not, it is found in the same geological group, and both were formed under similar if not identical conditions, and it should be fully developed. If once put on sale in quantities the demand for it would soon grow; it is a superior stone for many architectural purposes. Unlike many sandstones it does not retain dampness and become moss-grown. The exact equivalent of this bed has been extensively used in Brown county, and has been found a durable stone that withstands heat and cold. Monuments and tombstones cut from it forty years ago show sharp corners and chisel marks untarnished by the ravages of time. It is not the province of a geological survey to open coal mines or develop stone quarries, but to point out where capital may be invested with the prospect of a fair return for time and money expended; a reasonable experiment in opening the quarry sandstone of the Wall ridge, and putting the stone in shape for use would certainly prove a financial success. For water tables, window sill and caps, the rapid growth of Columbus and demands of the surrounding country would furnish a good local market. It is a persistent bed, outcropping on all sides of the Wall ridge. Great blocks were seen on the south and north in crossing the ridge from John Ault's place to Bethany. The Dowell hill quarries are in the same range and show the same stone. Mr. M. Powell, near the Brown county line, has eighty acres of quarry that can be worked at almost any point. To multiply outcrops would be to give a list of the land owners of nearly the whole west half of Harrison township.

Section at Henry Grass' Quarry, Harrison Township.

Soil free from gravel.....	1 ft.	0 in.
Shale and sandstone in thin beds and wedge-shaped masses, Knobstone group, No. 1, C. S.	7 ft.	0 in.
Sandstone banded with iron ore, No. 1, C. S., irregularly bedded.....	1 ft.	1 in.
Sandstone, even bedded, No. 2, C. S.....	1 ft.	7 in.
Massive sandstone in an even, continuous bed, without any indication of horizontal seams or partings, No. 2, C. S.....	2 ft.	9 in.

Thin drab shales, No. 3, C. S.....	50 ft. 00 in.
Shale and iron ore No. 4, C. S.....	87 ft. 00 in.
Blue aluminous shale No. 5, C. S	47 ft. 00 in.
Total	185 ft. 5 in.

This section embraces 42 feet of blue shale and reaches to a level with Mr. Grass' residence; to the bed of Wolf creek would add 35 feet more. The two feet nine inches stratum is a rather coarse grained dark sodden looking stone that is worked mainly for foundations, and is remarkable for uniformity of structure and evenness of bedding for the whole length of the quarry.

HARTSVILLE FOSSILS.

As no attempt was made in the body of this report to give a list, even of the more common fossils of the calcareous shale, the following is here inserted and embraces all the species, except Bryozoa, that have been identified. An examination will show that it compares very favorably with the celebrated and well known Waldron locality.

List of Calcareous Shale Fossils.

(Found near Hartsville, Ind.)

PROTOZOA.

Receptaculites subturbinatus, H., rare.
Astylospongia præmorsa, Goldf., not rare.

CORALS AND BRYOZOA.

Streptelasma radicans, H., rare.
borealis, H., not rare.
Favosites spinigerus, H., not rare.
forbesi var. *occidentalis*, H., common.
Lichenalia concentrica, H., common.

CRINOIDEA.

Saccocrinus christyi, H., not rare.
Macrostylocrinus striatus, H., rare.
fasciatus, H., rare.
Glyptocrinus carleyi, H., rare.

Glyptaster occidentalis, H., rare.
inornatus, H., not rare.
Codaster pulchellus, M. and D., rare.
Cyathocrinus polyxo, H., rare.
nucleus, H., rare.
Lecanocrinus pusillus, H., rare.
Melocrinus (ined), not rare.
Rhodocrinus melissa, H., common.
Eucalyptocrinus crassus, H., common.
cælatus H., common.
ovatus, Troost, rare.
Stephanocrinus gemmiformis, H., very rare.

BRACHIOPODA.

Crania siluriana, H., rare.
setifera, H., rare.
Orthis hybrida, Sowerby, not rare.
elegantula, Dalman, not rare.
Streptorhynchus subplana, Conrad, not rare.
Strophomena rhomboidalis, Wahlenberg, not rare.
Strophonella semifasciata, H., very rare.
Spirifera eudora, H., rare.
crispa, Hisinger, common.
crispa var. *simplex*, H., rare.
radiata, Sowerby, common.
waldronensis, M. and D., rare.
Meristina maria, H., common.
nitida, H., very common.
Nucleospira pisiformis, H., rare.
Retzia evax, H., very common.
Atrypa reticularis, Linn, very common.
Rhynchonella neglecta, H., not rare.
acinus, H., not rare.
Rhynchonella indianensis, H., common.
whitii, H., very common.
stricklandi, Sowerby, not rare.
cuneata, H., common.
Anastrophia internascens, H., common.
Eichwaldia reticulata, H., not rare.

LAMELLIBRANCHIATA.

Pterinea brisa, H., very rare.
Modiolopsis subalata, H.

GASTEROPODA.

Platyostoma niagarense, H., common.
plebium, H., not common.
Strophostylus cyclostomus, H., common.
var. *disjunctus*, H., not common.

CEPHALOPODA.

Orthoceras simulator, H., very rare.
Trochoceras waldronense, H., very rare.

ANNELIDA.

Cornulites proprius, H., not rare.

CRUSTACEA.

Calymene niagarensis, H., not rare.
Homalonotus delphinocephalus, Green., rare.
Cyphaspis christyi, H., rare.
Illænus armatus, H., rare.
Dalmanites vigilans, H., not rare.
verrucosus, H., not rare.
Lichas boltoni, var. *occidentalis*, H., rare.

All the above species were found on Clifty creek and tributaries, near Hartsville. Probably the best places for collecting are the Tarr Hole and Anderson's Falls. The north bank and bluffs of Little Sand creek, above Manly's limekiln, is the best place for getting corniferous group fossils; the corals are frequently very fine. The corals from the lower beds are found scattered over the fields and woods, mixed with the surface soil.

Among the corals found may be mentioned *Favosites favosus*, Gold., *F. hemisphericus*, Y. & S. *F. emmonsi*, Rom., *F. niagarensis*, H., *Michelinia trochiscus*, Rom., *Pleurodictyum problematicum*, *Cyathophyllum cornicula*, Rom., *C., geniculatum*, Rom., *C. rugosum*, E. H., *C. davidsoni*, M. E., *C. radicula*, Rom., *Blothrophyllum decorticatum*, Billings, *Phillipsastrea verneuili*, M. E., *Zaphrentis gigantea*, Raff. *Z. compressa*, Rom., *Amplexus yandelli*, M. E., *Cysti-*

phyllum americanum, M. E. One single specimen of *Nucleocrinus angularis*, Lyon, was found at the same locality, and a few species of brachiopods.

ANTIQUITIES.

That the East White river valley was once inhabited by a race of people superior to the Delaware Indians, the last tribe to disappear before the "star of empire," is shown by the number of stone implements, axes, hatchets and fragments of pottery, found scattered over the soil. Some of these relics are very fine, especially a highly finished dark stone pipe in the shape of a bird's head and bill, owned by Mrs. Dr. George Remy, found near Newbern, and an oblong double, greenstone hatchet and flesher, found and owned by Mr. VanBlaricum, near Burnsville. A number of elevations are pointed out as the work of the mound-builders, but we failed, wherever they were examined, to find any of the so-called Indian mounds of any other than natural origin. The mound on the Hacker farm, just above the Manley limekiln, is clearly proven to be a part of the high bank north of Little Sand creek, by an excavation made in the side, that exposes the rock of the mound and shows it to be continuous with the strata of the adjoining bluff. The Indians' burial place on the farm of Mr. James C. Remy, near Burnsville, is a natural ridge of upland gravel. That the Judge Tunis Quick Mound, in Flat Rock township, is not artificial, has been indicated in the discussion of the Drift period. In structure it is identical with the Hawpatch gravel, and shows no evidence whatever of being the work of man. It is not a mound, but an irregular hill that slopes to the south. We did not have an opportunity to examine the Tipton hill in Columbus, but from what we could learn the same is true of it. Artificial mounds ought to show peculiarities in stratification different from that of the surrounding plain. The finding of bones only proves that advantage was taken of the higher points to locate a cemetery. Bones have been taken from the bluff between the junction of Clifty and Fall Fork creeks, from the Remy gravel bed, and the so-called Hacker mound, but nothing else, so far as we could ascertain. If, in opening these mounds, beds of ashes, buried soil, broken bones of animals, water jugs, pottery, pipes, beads or ornaments

were found, the proof would be conclusive that they were the work of the extinct race of mound builders, but as only bones have been found, they are probably the "last resting places" of the modern Red man. In expressing the above opinion, we know we run counter to the traditions of the mass of the people, and if our adverse opinion shall be the means of inducing some one to hunt up the proof that our so-called mounds are artificial or the burial place of the mound builders, we shall be pleased and have done a good work.

ECONOMIC GEOLOGY.

AGRICULTURE AND SOIL.

Water, the great chemical solvent in its various forms of rain, dew, snow and ice, has been the principal agent in the formation of soil, together with the co-operation of heat, cold and other atmospheric influences. Besides being the principal force involved in the primary formation of soils, water has been the grand agent engaged in their comminution, mixing and distributing over the face of the barren rocks. But water and atmospheric influences alone, notwithstanding their chemical and mechanical power to change and build up the inorganic elements, could never make a productive soil. To secure fertility and give the potentialities of life to an otherwise inert mass of clay, sand and gravel, the organic must be added to the inorganic, the living must be added to the non-living. The early history of a productive soil begins with the earliest forms of life, those forms that mark the border line that distinguishes the animal from the plant. It matters not whether animal or plant, from the gray lichen to the monarch of the forest, from the tiny zoophyte to the leviathan, all furnish necessary and essential elements that cause the barren places to literally bloom as the rose. The product of these influences acting through countless ages, has given to Bartholomew county some of the most fertile lands in the great Interior Basin; will the farmer husband this heritage, or dissipate it by slovenly methods of working his land and non-rotation of crops. While the county can boast of some of the best, and most careful, scientific farming, much of the land is being rapidly exhausted. A soil once exhausted, can only be brought back to fertility at great cost,

and at the expense of some other locality that must furnish the necessary organic matter, or else wait years for it to be renewed by the slow processes of nature.

For descriptive purposes the soils of the county may be divided with reference to their geological origin, into, (1) *Native*, those derived from decomposition of rocks found in place in parts of Ohio, Harrison and Union townships. (2) Terrace clay soil, derived in part from the knobstone shale, and in part from material deposited by water of the Terrace epoch, of Jackson township, and parts of Wayne, Ohio, Harison and Union. (3) *Terrace Sand* soil of Sand Creek and Wayne townships. (4) *Drift Gravel* soil, mainly of alluvial origin, of Flat Rock and Columbus townships. (5) *Alluvial* soil of the White river bottoms. (6) *Glacial* clay soil of Nineveh, German, Haw Creek, Clay, Clifty and Rock Creek townships.

The native soil of the Wall ridge is light and sandy, of a warm nature, supporting a splendid growth of timber; is not adapted to general agriculture, but is most excellent fruit land. The terrace clays are cold and sticky, but in favorable seasons excellent corn land. The terrace sand with its liberal admixture of calcareous matter is one of the best soils in the county, especially where mixed annually with organic matter of alluvial origin. The Haw-patch gravel soil, as mentioned above, is of alluvial origin, and the fact of its being of such origin should impress itself on every farmer living in that region, for once exhausted, nature will do but little to restore it, and artificial means be used with less benefit than on clay soils. The overflows and marshes that made the alluvial deposit ceased long ago, and will probably never recur again. The Haw-patch farmer has a bonanza, but like many other good things it may be wasted, and once wasted never regained.

The glacial clay soils, much the most general of any in the county, are in many parts or rather most places sticky and tenacious, retaining water and requiring under drainage. The importance of thorough drainage has been sufficiently demonstrated by what has been done, and in a few years will be made complete. This soil will last well and with average good care improve from year to year. Artificial means of improving and renewing can be applied with profit, as the top soil has a most excellent sub-soil that will return dollars for dimes invested.

TIMBER.

The primeval forest of the county was dense, much of it a magnificent growth that has fallen before the axe of civilization, so that a grand old poplar is now the exception. The timber of the Wall ridge is mainly the various species of oak, hickory and walnut with a dense undergrowth. The chestnut oak, *Quercus castanea*, is peculiar to the rich sandy soil of this region, and is in great demand for its valuable bark. By the present wasteful method of peeling the small trees and saplings the supply will soon be exhausted. The white oaks and yellow poplars *Liriodendron tulipifera*, are very fine. The timber of the White river bottoms is largely yellow poplar, white oak, black walnut, hickory, beech and splendid speciments of *Ulmus americana*, American elm, and sycamore, *Platanus occidentalis*. In the Hawpatch is found most of the trees peculiar to this latitude, and they are remarkable for their uniform size and height before putting out branches, giving to the forest the appearance of an improved woodland. The only form of undergrowth noticed was a species of hawthorn, *Cratægus coccinea*, and it is from the presence of this thorn that the name, Haw-patch, is said to be derived. The vast majority of the timber of the glacial clay is beech, *Fagus feruginea*, interspersed with white oak, red oak, ash, walnut, poplar and patches of sugar maple and hickory. Dogwood, red bud and many other species of small trees, common further south, are rather rare. Sweet gum, *Liquidambar styraciflua*, occurs on the wet lands; paw-paw, *Asimina triloba*, in profusion in rich open woods; coffee nut, *Gymnocladus canadensis*, and *Tilia americana*, bass wood, along the streams; *Fraxinus viridis*, green ash; *Populus monilifera*, cottonwood, and several species of willow are not infrequently found.

Notwithstanding the immense amount of timber that has been destroyed and worked into lumber, saw mills are more common than at any previous time in the history of the county, and while many of the logs they cut are of hard wood, fine poplars, from the land of some careful farmer, are not infrequent. The finest lot of poplar was seen at the Waymansville mill.

MINERAL SPRINGS.

There are three noted chalybeate springs in the county, and many more of minor renown. The Azalia spring two miles north of town on Little Sand creek has the widest reputation, and might be made a very successful resort for invalids and pleasure seekers. It is surrounded by a magnificent growth of American elms and other forest trees that furnish a peculiarly delightful shade in the hot summer afternoons. The Hartsville spring, in the south part of the College campus, has acquired considerable repute in the last few years. The Anderson spring, just below the Anderson falls on Fall Fork creek in volume of water is vastly the superior of the others. All these springs are in a sense artesian, they all boil up from the depths below; that at Little Sand creek, through the sand, that at Anderson's through a fissure in the underlying limestone. The temperature of each is about 53° Fahr. They are nearly if not identical in composition and in no way sulphur springs and should not be called such. Roughly tested they were found to contain iron, magnesia and lime; the iron probably exists in combination as carbonate of the protoxide, and the lime and magnesia as bi-carbonates, the latter salts occuring in no greater quantity than is usually found in potable well and spring waters. They are in local repute as remedial in a number of diseases, and as they are pure chalybeate waters may be safely used with advantage where a mild preparation of iron is indicated.

BUILDING STONE.

Nothing is left to say under this head as to the quality of the stone found in the county. But few counties in the State are so favorably situated as this for getting a home supply of good stone. On the east along Clifty creek we have the Niagara group magnesian limestone of the same geological age and structure as the Greensburgh and St. Paul stone, in Clay township the equivalent of the North Vernon blue stone, and in the Wall ridge of the Knobstone a splendid freestone. Along Clifty creek quarries may be opened in numbers that will require very little stripping, and especially are the Everroad and Yealy quarries favorably located for working with ease.

FRUIT.

Apples, pears, cherries and other small fruits do well in all parts of the county. The extreme cold of last winter, 1880, '81, and drouth of the succeeding summer, was very hard on many orchards, but may be turned to advantage in determining what varieties will stand the climate best. Under drainage is needed in many orchards. The Knobstone hills are specially adapted to the growth of peaches and grapes. The warm, sandy hill soil showed its influence on the orchards last spring, in bringing the apple and peach trees out in full bright green leaf, while the trees on the lowlands were shriveled and many dying. Much might be done to improve the peach orchards by planting better varieties.

LIME AND SAND.

Mr. James Manley at his kiln on Little Sand creek, as has already been mentioned, uses the middle, light blue crystalline stone of the Corniferous group, and one or two ledges of the lower division for burning to lime. It makes a most excellent white lime, the small per cent. of alumina found in the stone adds to plastering qualities and gives it repute with the workmen for running on easily and smoothly. His kiln is a Page's patent, and has a capacity to turn out seventy-five barrels per day. Mr. Sam. Arbuckle runs two kilns near Hartsville, using the lower Corniferous stone, and making a good lime, for which he has a very ready sale at the kiln. In fact, all the Corniferous rocks are good stone for making the very best of lime.

The yellow bluff sand and washed creek sand stands at the top of the list for plasterers' and masons' use, and is found in abundance throughout the central and eastern parts of the county. The yellow bluff sand found near the Burnsville pike bridge is used for making moulds by the Messrs. Busch, founders, in the city of Columbus, and is found to fill the bill as a moulder's sand. Doubtless if brought to the attention of foundrymen at other points, a foreign demand would soon grow up.

BRICK CLAYS.

Brick clay may be found at almost any point where needed. In the county are five tile factories, a part of them using all the modern improvements in machinery and producing most excel-

lent tile, for which there is a good local demand. Some years ago earthen ware was made at Hartsville, from clay found in the vicinity.

MANUFACTORIES.

The flouring and hominy mills of Gaff, Gent & Thomas, located at Columbus and Lowell, may be said to have a continental reputation; their productions have found a market in Europe. The Drybread Brothers, proprietors of the Valley Mills, west of Taylorsville, do a very large custom and merchant flouring business; the Lowell and Valley Mills are run by water power, the cheapest of all power. The American Starch works at Columbus, are among the most extensive in the country. To further enumerate would be to attempt a business list of Columbus. Those mentioned above are only the most extensive.

ROAD MATERIAL.

Gravel for Macadamizing can readily be had in German, Flat Rock, Haw Creek, Clay, Clifty, and some parts of Rock Creek township, and from the bars in White river. It has been proven by testing in actual use that it is not every bed of gravel that will wear well, even some of the rounded metamorphic stone gravel seems to be rotten and soon breaks down into dust. The clean, dry gravel of Flat Rock is typical of the best. Where the per cent. of limestone pebbles is large, especially if derived from the soft Corniferous rocks, besides rendering the mass uneven in size, it will not wear well.

WATER SUPPLY.

Modern sanitary science has demonstrated that many of our most dangerous diseases are spread and the poison that produces them are frequently introduced into the system by impure drinking water, and as the water supply of a country is largely dependent on its geological structure, a word on the subject may not be out of place. All over the county are many fine springs of most excellent water, but not in numbers to supply the general demand, hence wells are the main dependence. Of the advantages of using only a pure soft water,

such as may be secured in large cisterns, nothing need be said only that their use should be made more general, and large enough to hold a summer supply. The wells dug in the glacial clay range from twenty to thirty feet in average depth and the water found most frequently in the underlying limestone, and afford a good hard water that may be considered free from dangerous contamination from surface drainage, where not sunk in low places as is frequently the case. Wells sunk in the gravel and sand are peculiarly liable from the very nature of the porous subsoil to become polluted, and should be so located as to avoid all danger of soakage from the kitchen, outbuildings or barn. The ease with which they may be poisoned will be apparent when we consider that the average depth of wells in the Hawpatch is about twenty feet, and in Sand Creek township from eighteen to twenty-two feet. Over a large part of the county, even in many places under and in the glacial clay, the water vein is found in the gravel. Such is the case in Sand Creek and Wayne townships, where the overlying soil is sand, and in German and Nineveh townships where the subsoil is clay. When inquiry was made as to the depth of wells, the answer almost invariably was, "We get water in the sand or gravel on a level with the river," and the general impression is that the supply comes from the river. That such is not the case above Columbus is apparent from the nature of the river bottom and banks, black shale and tenaceous clay, nor is it probable below the city. From railroad elevations we find that the bed of White river is thirty-four feet below the bridge at Columbus, and that the average depth of wells in the city fails to reach so low a level by twelve feet, and that wells have been sunk twenty-six feet below the river level before water was found, as at the McEwen well. Wells going below the river twenty feet are not uncommon. The explanation for the wide spread belief that the river level has to do with finding water, is found in the well-known fact that any bed of sand or gravel covered with clay is a water bearing stratum. Any experienced well or cistern digger will tell you that every little bed of sand passed seeps water.

EDUCATION.

Hartsville University, under the denominational control of the United Brethren in Christ (not Moravians), is located at Hartsville, and has a charter granting full University privileges and powers. Both sexes are admitted and are equally entitled to degrees on completion of the prescribed *curriculum*. "The course of study embraces the branches usually taught in such an institution East and West, and numbers among its graduates many worthy and prominent citizens of this and other counties and States." Parents and guardians who wish to place their children and wards at a good school, healthfully located in a town free from the vices and temptations of most larger places, can not do better than to consider the claims of this institution.

Moravian Seminary for Young Ladies, at Hope, "is a boarding school for young ladies, and is designed to afford, in the wholesome retirement of a rural neighborhood, and at a moderate cost the best opportunities for acquiring a thorough education. The institution has not been established for private advantage, but for public good. It is the property of the Synod of the Moravian Church in the Northern District of the United States, and is conducted on the plan and principles of the older and well known Moravian boarding schools in this country and Europe."

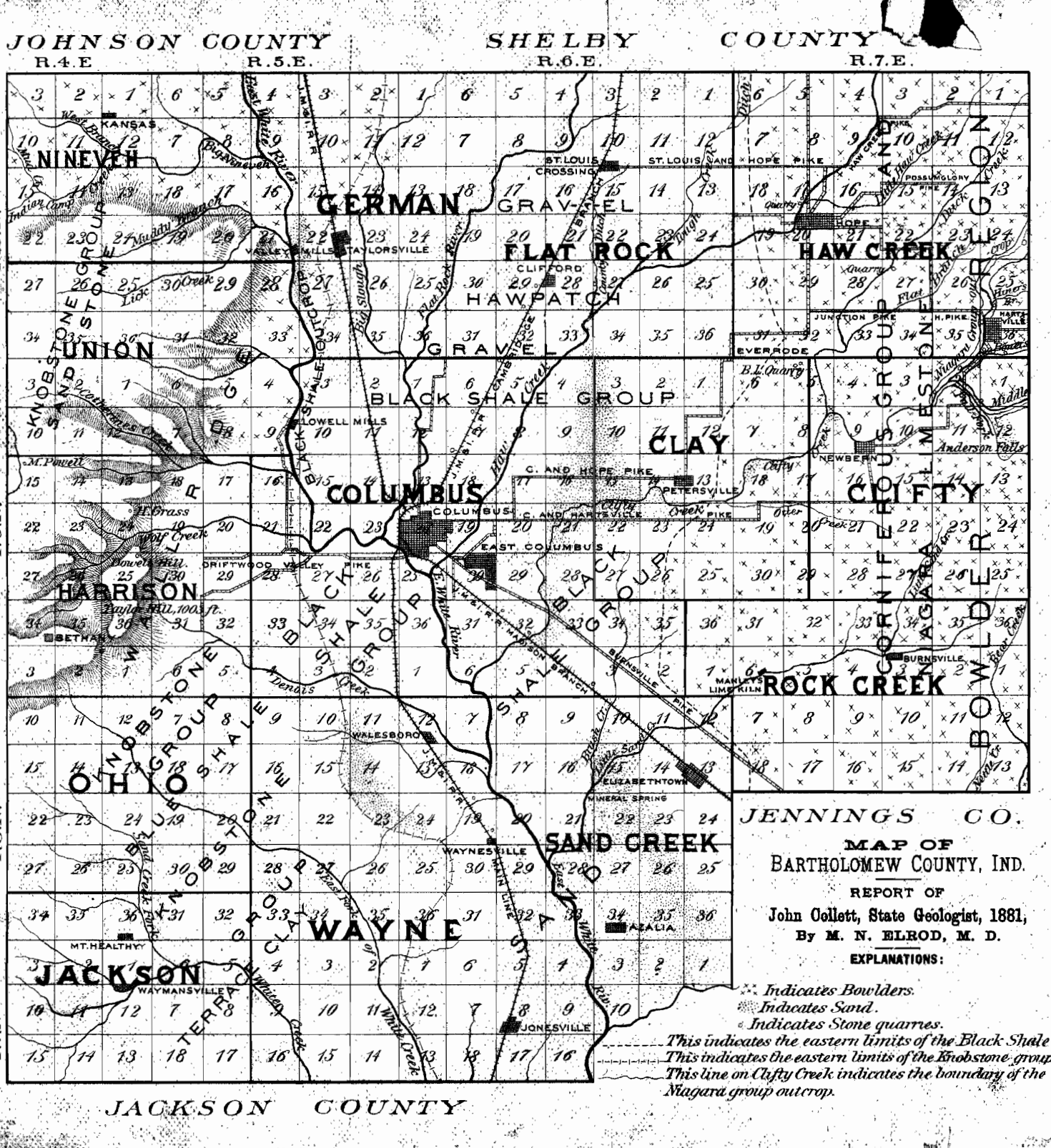
Central Conservatory of Music—This institution is located in the city of Columbus, in a building erected expressly for a musical academy, and is one of the most attractive buildings in the city. The class system of the conservatories of Europe is used. "The regular course of study is especially adapted to those desiring a complete and thorough education in music at the least expense and in the shortest possible time."

Columbus City Schools—Have, under the efficient management of Prof. Andrew Graham, assisted by an able board of trustees, taken rank with the best schools of the State. Graduates of the Columbus High School may well be proud of their *alma mater*.

THANKS.

In general we return thanks to all the citizens of the county whom we have met during the survey. For favors and information we are indebted to Lewis Donhost, county auditor, and James Wells, deputy; Messrs. Geo. Pence and Geo. W. Forester,

of Columbus; Mr. James Manley, of Rock Creek township; Dr. Henry Connelly, of Elizabethtown; Messrs. John Myer and Frank Miller, of Waymansville; Dr. Smith, of Bethany; the Drybread Brothers, of the Valley Mills; Mr. I. N. Smock, of German township; Messrs. S. S. Ryker, M. F. Dawson, H. G. Chamberlain, Dr. Geo. Remy and G. Will. Brown, of Hartsville; Mr. Nathan Newsom, of Sand Creek township, and Miss Julia Miller, of Hope.


JOHNSON COUNTY
SHELBY COUNTY
DECATUR COUNTY
R.4.E
R.5.E.
R.6.E.
R.7.E.
T.10.N.
T.9.N.
T.8.N.
T.7.N
NINEVEH
GERMAN
FLAT ROCK
HAW CREEK
UNION
CLAY
COLUMBUS
CLIFTY
HARRISON
ROCK CREEK
OHIO
SAND CREEK
WAYNE
JACKSON
BOULDER
KNOBSTONE GROUP
BLACK SHALE GROUP
CORNIFEROUS GROUP
NIAGARA LIMESTONE
GRAVEL
HAWPATCH
CLIFFORD
KANSAS
ST. LOUIS CROSSING
HOPE
EVERROAD
LOWELL MILLS
TAYLORSVILLE
VALLEY MILLS
NEWBERN
PETERSVILLE
EAST COLUMBUS
BURNSVILLE
WALESBORO
ELIZABETHTOWN
MINERAL SPRING
WAYNESVILLE
AZALIA
MT. HEALTHY
WAYMANSVILLE
JONESVILLE
BETHANY
DRIFTWOOD VALLEY PIKE
C. AND HOPE PIKE
C. AND HARTSVILLE PIKE
JUNCTION PIKE
H. PIKE
POSSUM GLORY PIKE
HOPE PIKE
BURNSVILLE PIKE
JENNINGS CO.
JACKSON COUNTY
MAP OF
BARTHOLOMEW COUNTY, IND.
REPORT OF
John Collett, State Geologist, 1881,
By M. N. ELROD, M. D.
EXPLANATIONS:
Indicates Bowlders.
Indicates Sand.
Indicates Stone quarries.
This indicates the eastern limits of the Black Shale
This indicates the eastern limits of the Knobstone group.
This line on Clifty Creek indicates the boundary of the Niagara group outcrop.