GEOLOGY OF RUSH COUNTY.

BY MOSES N. ELROD, M. D.

GENERAL DESCRIPTION.

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

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

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

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

with beautiful maple shade trees. The water supply is drawn from inexhaustible wells. The city government is complete, with a uniformed police force, fire department, and everything to indicate a thriving, vigorous town.

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

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

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

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

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

TOPOGRAPHY.

TABLE OF ALTITUDES, RUSH COUNTY.

Cincinnati, Hamilton & Indianapolis Railroad.

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

TOPOGRAPHY—Continued.

Cambridge Branch of Jeffersonville, Madison & Indianapolis Railroad.

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

Vernon, Greensburg & Rushville Railroad.

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

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

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

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

DRAINAGE.

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

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

In all drift regions, especially where the drift is heavy, as is the case in the north half of Rush county, the rivers and creek channels seldom reach down to the country rock. Below Hungerford's dam, section 4, township 12, range 9, the bed of Big Flat Rock River is generally rocky, and the same is true of Little Flat Rock Creek, below Milroy. With these exceptions, and appearance of stone in the bed of the river, four miles below Rushville, and in Little Blue River, below Arlington, the bed and banks of the streams are clay, gravel, or sand. Flat Rock River, where its bed lies wholly in the drift, has well-marked, level terrace banks, or second bottoms, ranging in width from one-half to one mile, with an average width of three-fourths of a mile in the vicinity of Rushville. The average width of the river-bed, or first bottom, is about 300 feet; height of bank is 10 feet; and the difference between low and high water is 8 to 11 feet. The bluff banks of the second bottoms vary in height from 10 to 50 feet,

and, in a few places, may reach even 80 feet. The second bottoms of Big Blue River at Carthage, vary in width from one-half to one mile, with bluffs from 20 to 50 feet high. Here, the river banks average 10 feet in height, and the difference between low and high water is 10 to 12 feet. In the early history of the county, most of the streams, having their origin in the ponds and swamps of the flat lands, were everlasting brooks and branches, which wound their sluggish way beneath the protecting shadows of a dense forest, but, under the improving hand of man, many of them have been changed into artificial ditches that are dry one-half the year. In this fast age, even the creeks and rivers are required to do their work in a hurry; the barriers that once held back the waters have been removed, the very soil, by tilling, deprived of its superabundant moisture, and the floods sent rushing down to the ocean.

GENERAL GEOLOGY.

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

CONNECTED SECTION.

QUATERNARY AGE.

ALLUVIAL EPOCH.

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

DRIFT PERIOD.

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

PALÆOZOIC TIME.

DEVONIAN AGE.

CORNIFEROUS PERIOD.

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

UPPER SILURIAN AGE.

NIAGARA PERIOD.

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

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

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

PALÆOZOIC GEOLOGY.

UPPER SILURIAN TIME.

NIAGARA PERIOD.

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

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

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

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

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

Chemically, the Niagara limestone is a carbonate of lime and magnesia, in variable proportions, together with alumina, silica, and oxide of iron in much smaller quantities. The reddish color of weathered specimens of the stone is due to a change of the oxide of iron from a lower to a higher oxide, by exposure. The percentage of silica is greatly increased in the flinty or cherty portions of the top strata, and is aggregated into irregular masses, nodules, and rough tables, that cause the stone, on exposure, to break into fragments. The Rush county stone seen by me is comparatively free from cherty matter, as I have before mentioned; and, hence, the upper ledges are more valuable than the outcrops at some other places. Uniformity of structure is an important element in a durable limestone for building purposes—hard and soft places differ widely in the amount of water the stone will absorb, and so, by freezing, subject it to very unequal strains and cause it to shell and break. Mr. Geo. C. Clark called my attention to the gradual crumbling, to fine fragments, of the court house foundation in Rushville, where, frequently, as much as an inch has been worn away. Whether this erosion was due to atmospheric waste, acting on a stone deficient in the cement that holds the particles together, or irregularity in density, it was not possible to say with certainty, but probably the former; and it may be that the durability of a

limestone, aside from the homogeneity manifest to an ordinary quarryman, can be thoroughly tested only by time and exposure. And while but few ledges of this stone seen in Rush county will come up to the high standard required of a first-class building rock, for use in expensive structures, all of it will be found valuable for the thousand-and-one uses to which stone is now applied. It can be economically worked in road-making, to form a base on which to spread gravel. This experiment is being made on the Milroy and Andersonville pike with every prospect of it proving a success. In time, the south part of the county will be fenced with stone walls taken from the Niagara beds of Big and Little Flat Rock; and, but for its nearness to the quarries just south of the Decatur county line, it would now be in demand for fence posts and bases. At present what stone is taken out is mainly used for foundations and other purposes about light buildings.

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

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

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

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

DEVONIAN AGE.

CORNIFEROUS PERIOD.

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

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

In the banks of Big Flat Rock, near Moscow, it has the same general character as the strata further south. It is a coarse, argillaceous stone, having much the physical appearance of a sand-rock, and is frequently so called by the quarrymen; but the ease with which it is burned to lime proves that it is not a sandstone. Near the bridge over Little Flat Rock Creek, just west of Milroy, the Corniferous is the only stone seen in the outcrop, and has the same earthy color and appearance, but is in thinner

strata that break into wedge-shaped pieces with feather edges. In general appearance it is identical with the outcrops of the same formation in the vicinity of Greensburg, and contains a higher per cent. of carbonate of lime than the equivalent beds on Big Flat Rock. In its western exposure, at Moscow, the bedding is from medium to heavy massive, breaking into angular blocks that are rounded at the corners by weathering, and under certain conditions of constant moisture, disintegrate to a fine powder. One mile below Milroy, on Little Flat Rock, the Corniferous outcrops above the Waldron shale and has local characteristics that distinguish it from either of the two varieties before described. Here it is a thin-bedded, shelly, blue or drab, crystalline limestone apparently free from admixture with earthy matter. In lithological appearance, it is the equivalent of the middle division of the Corniferous group that lies just under the North Vernon stone in many other parts of the State. Nowhere in the adjoining counties have I seen a stratum of so highly crystalline stone as this at the base of the group. These varieties, occurring within a radius of a few miles, indicate that they were formed under local conditions acting near the margin of a surf-beaten coast.

LIST OF FOSSILS FOUND IN RUSH COUNTY.

UPPER SILURIAN.

NIAGARA GROUP.

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

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

DEVONIAN AGE.

CORNIFEROUS GROUP.

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

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

LOCAL DETAILS.

Following the banks of Big Flat Rock, north from St. Paul, the height of the bluffs gradually grows less, until, at Moscow, they are less than twenty feet. Generally, after crossing the county line, but one side of the

stream shows a full bluff outcrop, the other side having been eroded away by the forces that, in ages gone by, excavated a valley many times greater than the rain storms of this day ever fill. Underlying some of these low bottoms, quarries can be opened and worked economically; the quarrymen will find but little stripping necessary, nature having done this part of the work for him.

SECTION AT MOSCOW, ORANGE TOWNSHIP.

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

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

pike; a continuation of the same spirit will macadamize a road west to Big Flat Rock. Let the proprietors of the quarries show what they have on hand, and those in need of stone will get it away.

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

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

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

QUATERNARY AGE.

DRIFT PERIOD.

In Rush county, covering alike the Upper Silurian on the east and the Devonian on the west, to a depth ranging from ten to one hundred feet, and thus largely concealing them from view, is found a mixture of clay, sand, gravel, pebbles, angular, subangular, and rounded stones, generally unassorted, unstratified and unfossiliferous. Out of this apparently

heterogeneous mixture, a careful study evolves a degree of order that, in its history, has been governed by the same invariable laws of antecedents and sequences as in the other domains of nature. The general arrangement of the drift materials is illustrated in the following sections:

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

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

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

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

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

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

AVERAGE OF ARTESIAN CHALYBEATE WELLS, WEST END OF RUSHVILLE.

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

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

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

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

AVERAGE OF WELLS IN CARTHAGE, RIPLEY TOWNSHIP.

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

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

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

AVERAGE OF WELLS IN ARLINGTON, POSEY TOWNSHIP.

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

SECTION IN WELL AT MANILLA, WALKER TOWNSHIP.

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

AVERAGE OF WELLS AT MOSCOW, ORANGE TOWNSHIP.

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

AVERAGE OF WELLS AT MILROY, ANDERSON TOWNSHIP.

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

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

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

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

In the southern townships, Orange, Anderson and Richland, the average thickness of the Drift will not vary much from thirty feet. On the east side of the county, in Richland, Noble, Union and Washington townships, near the water-shed, the deposit grows thinner, and will not generally exceed twenty feet. At Rushville, Henry Ormes & Co., who have made many borings and wells, give forty-eight to fifty feet as the average depth of stone. North, northwest and west of Rushville the general

depth will reach sixty feet and over. At Manilla, the well above reported passed through seventy-three feet of Drift; and another, bored on an adjoining farm, is said to have been put down one hundred and twenty-three feet before reaching the bottom of the blue clay.

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

The blue, plastic clay, bowlder clay, glacial clay, or hardpan, is a very generally diffused member of the Drift, occurring universally, except in the valleys south of Rushville, where the rivers and creeks reach down to, or near, the bed-rock. Wells and borings sunk in the first river terrace on Big Blue River, at Carthage, and on Big Flat Rock, at Rushville, pass through the blue clay, showing that the forces which have excavated the valleys ceased to act at these points before reaching the bottom of the blue hardpan. Taking the average depth to stone of the Rushville wells at forty-eight feet, and comparing it with twenty feet, the average height of the bluff part of the city above the bed of Flat Rock, it will be seen that many of the wells go twenty-eight feet below the river channel before reaching stone. The exposure of stone, before mentioned, on the west bank of the river, at the head of the millrace, on a level with the bottom of the stream, shows that Flat Rock does not reach down to the bed of the ancient valley. During the Drift period, the valley was filled with clay and gravel, and the channel of the present river subsequently formed near the close of the period. The well at the northeast corner of the court house yard (dug eighteen feet in the surface clay and gravel without striking the blue clay), indicates that the bed of the river may have shifted from the north to the south at a still later date in geological history, or the bed of the modern Flat Rock may formerly have been much wider and gradually contracted, by silting, to its present limits. In physical appearance it is a blue or lead colored clay, where protected from atmospheric change; where exposed, of a lighter shade. It usually occurs in compact beds, ranging from a soft, laminated, plastic, putty-like mass, to a dry, impervious hardpan, that can only be excavated with a pick. That these differences in consistency are largely due to moisture may be shown by subjecting different specimens to the same drying process. Chemically, it is an alumina silicate, mixed with fine, impalpable

sand and salts of iron; its color is due to the latter. At Rushville, Mr. Geo. C. Clark describes this stratum, by saying that "It is not properly blue clay, but a hardpan of dark bluish cast, very gritty, filled with coarse sand and pebbles or gravel, intermixed like grouting. It has a very disagreeable smell, and, when it forms the wall of a well or the well is walled inside of it, the water has an offensive smell and taste for some months, but, finally, becomes palatable. In some places this bluish hardpan is forty feet thick, but generally less." "Southwest of the city, four or five miles, a well, bored sixty feet deep, did not strike stone, but found real blue clay, tough and resisting the drill by elasticity." In some places, fair-sized bowlders of northern origin are found in this stratum, but, as a rule, they are small, worn, and occasionally striated. Not infrequently it contains intercalated beds of sand.

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

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

until it will measure thirty feet or more. Near the southeast corner of the county, the yellow clay is very thin; and over the line in Franklin county it fails as a factor of the Drift period, and leaves the blue clay exposed as the surface clay.

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

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

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

across the ancient flood plain. These terraces are supposed to be evidence of a greater flow of water, some time in the past, together with a gradual elevation of the land on the north, that gave greater velocity to its rivers and, hence, more power to scour deep channels.

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

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

RECENT PERIOD.

SOIL AND ALLUVIUM.

The soil of Rush county is almost wholly derived from the Drift deposits. Scarcely any of it is due to decomposition of the country stone found *in situ*; it is the combined result of the Quaternary Age acted on by the fertilizing agency of animal and vegetable life. In color, it ranges through various shades from black to pale yellow; the former is locally known as the black land, and the latter as the clay land. The black loamy soil covers the greater part of the surface of the county, and is general over the central and western parts. The great body of the black lands were formerly wet and swampy, and the dark color is due to the humus and carbonaceous matter derived from the decayed vegetation that grows luxuriantly over its surface. The yellow clay beds form the subsoil, except in the terrace bottoms, where the clay is sometimes replaced by gravel or sand. Outside the black lands, the distinction between the top and subsoil is not marked; the pale yellow surface clay grows brighter

as it gradually grows deeper, and has more the character of a true tenacious clay. The tenacity of the subsoil explains why all the lands of the county are improved by tiling. A happy blending of calcareous matter, sand and clay in the subsoil, renders it peculiarly susceptible to the aerating influences of under-drainage. Exposed to the fertilizing influences of air and rain, charged with carbonic acid, the calcareous matter locked up in the clay and fine limestone gravel is unloosed, the salts of potash and soda set free, organic matter taken up, and, directly, it supports a vigorous growth of vegetation. The yellow clay subsoils of Indiana universally contain all the inorganic and a large per cent. of the organic elements of fertility; those of Rush county, in consequence of their fine state of division, readily yield their elements in a bountiful harvest, the substantial foundation of all wealth. Practically, they are inexhaustible; they may deteriorate under continuous cultivation and non-rotation of crops, but rest soon restores them to pristine productiveness.

ECONOMIC GEOLOGY.

AGRICULTURE.

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

In 1882, the assessors of Rush county reported 446,000 rods of tiling against 442,000 rods in Shelby, 477,000 rods in Marion, and 693,000 rods in Decatur; giving to Rush the third place in the State in the number of rods of tile put down. Before a people can expend money in improvements they must first produce a surplus. That surplus is easily accounted for. In the number of bushels of corn produced per acre, Rush outranked any other county in the State, and was third in aggregate yield, with 2,223,414 bushels grown on 57,669 acres. The two leading corn counties were Tippecanoe and Benton, both including extensive tracts of Wabash bottoms within their limits. With 55,070 acres sown in wheat, producing 997,772 bushels, it ranks fifth in the State, and is led by Gibson, Daviess, Posey and Shelby counties. In clover lands, it had 20,369

acres against 21,310 acres in Wabash county. No more direct proof could be adduced than the last item, of the attention paid to the rotation of crops and keeping the land up to its high state of fertility. In 1881, 59,891 hogs were fatted for market, which is nearly thirty per cent. more than was produced in any other county in Indiana. The number of horses, mules and cattle owned in the county is well up with the best. In the leading farm products and stock raising, Rush is found at the head of the list. A very few counties may exceed it in a single farm product; but, when the whole list is taken into consideration, it stands without a rival. The mines of California may be exhausted, manufacturing may be overdone, banks may break and securities decline in value, but, with proper care, the Rush county farmer need not have any fears for the future. The peculiar adaptability of its soil to the growth of any of the cereals or to stock raising gives a variety of resources, that, in all human probability, render a total failure an impossibility.

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

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

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

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

to his proud movements, while he is protected from the blazing sun in "pastures green" that are charmingly undulating and invite trials of speed. Everything in nature and the loving care of man conspire to give life and strength to the noble animal. The Blue Bull and Jim Monroe farms of the late James Wilson, of Noble township, attest what can be done. These farms have turned out trotters and pacers that take rank with the best in America. The Blue Bull strain has second place in the trotting list for horses that have made better than 2:30; and Monroe Chief, from the Monroe farm, has a trotting record of 2:16¾.

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

FRUIT.

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

LIME AND SAND.

The soft magnesian stone found at the base of the Corniferous group, at Moscow and Milroy, makes a lime that is highly prized by masons and plasterers, and especially by the latter, on account of its working easily

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

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

BRICK AND TILE CLAY.

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

GRAVEL.

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

BOG IRON ORE.

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

VEGETATION.

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

MINERAL SPRINGS.

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

WATER SUPPLY.

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

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

The Rivers' Pollution Commissioners of England, in their sixth report, make the following classification of water in respect of wholesomeness and general fitness for drinking and cooking: *Wholesome*—(1) Spring water; (2) deep well water; (3) upland surface water. *Suspicious*—(1) Stored rainwater; (2) surface water from cultivated land. *Dangerous*—(1) River water to which sewage gains access; (2) shallow wells. In this county

wholesomeness and safety lie in the use of water from deep wells that reach the glacial sand or gravel or a vein deep in the stone. Some facts have come to my attention indicating that the well water may be unwholesome that has percolated through the ancient forest bed or buried muck and carbonaceous soil. Especially does this seem to be true where the stratum rests on the native stone, and the water supply comes from it or from the stone just beneath. Organic matter in water, no difference what the source may be, supplies the conditions necessary for the development of microzymes. Every source of organic contamination should be rigidly excluded by digging deep, and protecting the mouth of the well from surface wash or soakage. A supply of soft water is had by storing rain and snow water in cisterns that are easily made in the clay.

ARCHÆOLOGY.

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

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

of South Carolina have been found in the mounds along the banks of Little Flat Rock Creek, it is presumed that the commercial relations of their builders were much more extensive than their limited means of travel would seem to indicate.

THANKS.

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