

GEOLOGY
OF
LAWRENCE COUNTY,
INDIANA.

BY JOHN COLLETT.

Lawrence county is situated in the southwestern part of the State, 75 miles south, southwest from Indianapolis. It is bounded on the north by Monroe, east by Jackson and Washington, south by Orange, and west by Martin and Greene counties, and contains 438 square miles. These outlines describe nearly a perfect square. The surface is agreeably diversified. The eastern and northeastern parts are undulating or gently rolling plateaus drained by deep narrow valleys, the central region north of White river is hilly, and the western and southwestern is rough and broken. Each of these divisions is covered with a soil almost wholly formed from decomposition of underlying rocks; we consequently find the soil in the first tenaceous clay and sand; of the second a calcareous clay, and of the third principally siliceous material, with an intermixture from both of the others. In that part of the county

underlaid by St. Louis limestone comprising a broad belt about 12 miles wide, passing centrally from northwest to southeast, "sink holes" are so numerous as to form a striking feature in the configuration of the surface. These sink holes are funnel shaped depressions, hewn down into the solid rock by rain fall charged with gases from the atmosphere, leading to a cavern or outlet in the underlying limestone. Sometimes the small parting at the bottom is filled or puddled with clay washed from the sides, and pools of water are formed; into some of these fish have been introduced. Many others ought to be so utilized. The larger basins of this nature give origin to streams of water which others in turn hide away in their capacious caverns.

The principal streams are the east fork of White river, and Indian, Salt, Leatherwood, Guthries, Sugar and Beaver creeks.

White river crosses the eastern boundary of the county three miles north of the southeast corner, and passes out of the county at a point almost exactly to the west. It is a broad, clean river, as large as the Wabash at Lafayette, flowing with a rapid strong current. It is a grand mill stream offering many eligible sites for works of great extent, with a low water capacity far in excess of any probable demand. The purity and coldness of the water derived from inflowing cave springs offers special inducements to paper makers. The river is generally belted, except where the stream impinges against precipitous bluffs of limestone, with broad alluvial bottoms of remarkable richness. The fertility of this formation is proverbial throughout the State, "As rich as the White river bottom," is the highest standard of excellence and may not be surpassed. Indian creek flows into the county from Martin, seemingly with the purpose of finding an outlet by Fayetteville to Salt creek, and after describing an arc of an absurdly crooked description, often turning back into sharp bends upon itself, returns in apparent disgust to its native county and sand-rocks. The bottoms are narrow. The walls of its valley are generally precipitous or overhanging escarpments of

conglomerate sandstone. Salt creek enters near the centre of the northern boundary, and flows with sharp graceful curves in a southwesterly direction to White river. Near Guthrie this stream and its affluents have wide bottoms, entirely beyond the needs or erosive capacity of the present creek. Thence south narrow bottoms are found on either side of the creek, often of great fertility, but sometimes the soil, partaking largely of the aluminous nature of the bed shales, are cold and tenaceous. Several sites afford good mill power, which are profitably used. At spring floods the creek is a river; at low water a slow, lazy stream. Leatherwood has its source in the northeastern part of the county, and flows in a straight course southwest to White river. This creek is small, but somewhat reliable; it drives a woolen and other mills. Guthrie creek passes into the county near Leesville; although narrow, its valleys have a rich soil and are bounded by bold hills well timbered. Sugar and Beaver creeks are in the southern part of the county; from their course and peculiar connection with the ancient terraced flood plains which are seen near their sources, they were at some period a side or main channel of White river then flowing at a level 150 to 200 feet above the present channel. Many small brooks flow into these creeks; and fine springs, some of great volume, are common.

This county was originally heavily timbered, comprising, on the uplands, the usual varieties of oak, hickory, beach, maple and chestnut, with walnut, oak, elm, etc., in the bottoms, and valley lands. Bedford, the county seat, is pleasantly situated on the high divide between Salt creek and White river; and by Prof. Owen's determination is 680 feet above the level of the ocean.

GEOLOGICAL FORMATIONS.

The geological formations of this county comprise three divisions of the quaternary age, two of the coal measure group, and four of the sub-carboniferous groups.

These different formations are seen upon the surface or in

successive outcrops passing from the tops of the hills on the west to the bottom of the ravines on the east side of the county, all dipping at a variable rate towards west of south-west; consequently, in a few hours travel on the line of Ohio & Mississippi R. R., which runs directly across the dip of these strata, the geologist may see *in outcrop* a section measuring in vertical space about 700 feet. Sections taken at isolated points, present the following stratigraphic exhibit:

CONNECTED SECTION OF
LAWRENCE COUNTY, INDIANA.

QUATERNARY SYSTEM.

1.	Soil and clays.....	4 to	10.00
2.	Alluvium, recent.....	30 to	10.00
3.	Alluvium, ancient.....	450 to	40.00
4.	Loess.....	20 to	5.00
5.	Boulder drift.....	00 to	0.00

CARBONIFEROUS SYSTEM.

Carboniferous Group.

6.	Lower coal measures.....	20 to	0.00
7.	Conglomerate (mill stone grit)	50 to	120.00
8.	Pyritous shale and shaly S. S. with bands and nodules of iron ore.....	4 to	10.00

SUB-CARBONIFEROUS GROUP.

Chester Beds.

9.	Bituminous and argillaceous L. S. with coal measure and sub- carb. fossils mingled and alter- nately predominating.....	38 to	2.00
10.	Siliceous and bit. shale.....	0 to	9.00
11.	Place of a rash coal.....	8 in. to	0.04
12.	Thin bedded Sandstone, "Grind- stone" and "Whetstone" grits	20 to	65.00
13.	Coarse heavy bedded S. S. (local).....	6 to	0.00

14.	Blue argil. L. S. with black flints and chert.....	45 to	16.00
15.	Red and blue clay with plates of chert, passing into heavy argillaceous L. S. cement.....	12 to	5.00
16.	Coal bone, bit. slate.....	0 to	0.08

ST. LOUIS LIMESTONE.

17.	Gray argil. or bit. brecciated limestone, locally cement stone	20 to	4.00
18.	Vermicular limestone.....	10 to	4.00
19.	Blue and gray argil. and magnesian L. S.....	35 to	10.00
20.	Bands of chert and amorphous geodes in shales and argillaceous limestones, which weather to a reddish brown clay, (paint), Lithostrotion bed and other corals.....	5 to	40.00
21.	Blue quarry L. S. sometimes concretionary or breaking with conchoidal fracture.....	28 to	9.00
22.	White quarry limestone.....	4 to	12.00
23.	Oolitic limestone, fossil bed....	4 to	0.00
24.	Blue argillaceous limestone.....	5 to	30.00

KEOKUK BEDS.

25.	Blue and gray shales or limestone, with bands of chert.....	0 to	10.00
26.	Geodes in blue shaly clay.....	6 to	4.00
27.	Blue L. S. with Hemipronites etc.	3 to	6.00
28.	Geode bed with mammoth geodized fossils.....	2 to	3.6
29.	Shaly and "pink" limestone full of fossils, shells and crinoid stems.....	2 to	1.6

KNOBSTONE FORMATION.

30. Knobstone shales with thin beds of massive sandstone in its upper division.....	0 to 250.00
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	677.00

SURFACE GEOLOGY.

The *Recent alluvium* bordering the different streams has already been mentioned. Its origin is due to causes now in action. Formed by the generous commingling of material derived from all the rocks through which the streams have wrought their valleys, and containing a large amount of vegetable matter, a rich, warm, marly loam is the general result. The White river bottoms are unrivalled for fertility. Shrubs and bushes grow to a wonderful size. Trunks of Wahoo (*Euonymus*) and spice-wood (*Benzoin*) were noted from four to five inches in diameter, or twice as large as I have seen them elsewhere. Walnuts, oaks, and other giants of the forest are of large growth.

The *Ancient alluvium* offers some features worthy of note. This deposit begins at the first benches above the overflowed bottoms, and may be recognized by terraces or beds of gravel and sand, thence to a height in extreme cases of over 300 feet. These record the ages which have elapsed, and mark the different levels at which White river and its affluents have flowed, since the beginning of our present system of water courses; characteristic sand-bars, etc., of this kind are seen at Whittaker's section 28, T. 5, R. 2 W., at "old Palestine," and on the summit of the highest hills N. W. from Bryantsville.

Next in date succeeds the *Loess*. This consists of ash gray siliceous clays, containing minute shells of animals now inhabiting a sub-tropical climate. It is found as originally deposited on the summit of the highest hills near Huron, and generally along the West line of the county. When undisturbed, this deposit presents a yellow color; but it is more frequently seen in a modified form and then has the noted typical gray color and compact texture. This soil is well adapted to the growth of fruit, and the persim-

mon is almost invariably present. This deposit is better developed in counties to the West and South. It is equivalent to the *Loess* of European geologists, or to the "Bluff formation" of Iowa and Missouri, and is referred to a period when lakes and broad currentless rivers occupied the central valley of the continent.

The *Bouldern drift* is the next deposit in sequence of time. It is typically a heavy bed of tenaceous blue and gray clays, generally un laminated, containing a large amount of pebbles and boulders from the region of the great lakes, and deeply covers the northern half of the State. Great flows or bergs of ice are required to account for the transportation and pulverization of this mass.

In this county no *drift* deposits were seen, except pebbles and a few small boulders, found on the bars of creeks whose headwaters have their source to the north in the drift region; but as already mentioned, deep wide valleys, in size far beyond the present or possible usitude of the actual creeks flowing from north to south, are remarked: outliers of conglomerate and Chester sandstones are seen to east and west of Fayetteville, and near Springville, from two to four miles east of the present outcrop of the corresponding beds, which, by regularity of stratification, and susceptibility of identification, show that once continuous beds extended to or beyond these stations. The outliers are separated from the present beds by wide irregular valley plains which offer no evidence of fluviated erosion; the general topography shows that between these points, and in a broad belt extending from north to south, a little west of the center through the county, erosion on an extensive scale has taken place, sufficient to wear away and remove from 50 to 180 feet of solid rock; all these seem to point back to the period of the boulder drift, and indicate a time when the great iceflow, whether by glacier or berg, was obstructed by a barrier or ridge of rocks in the adjoining region to the north, where the great masses of ice melted and sent an avalanche of water down the steeply inclined surface of this county, producing the erosive phenomena here noted. Had

either solid ice or bergs been present, we would surely have found gravel and boulders. In Iowa and Illinois, a neighborhood about Dubuque and Galena, is noted as the "blue mound" region. Conical mounds, from 100 to 300 feet high, stand out on the prairie plains, their sides terraced by rocks of different geological formations, and their tops castellated by boldly escarped walls of Niagara limestone. Here the erosive action has been tremendous, and the phenomena can be explained only by calling into action the forces which seem to have exhibited such energy here.

These facts grouped in connected view, indicate the following sequence of events in the quaternary or most recent Geological age; after the old Tertiary sea which is so well developed west of the Mississippi river with its rich tropic flora of palms, spices and fruits, its wondrous fauna of giant mammalia and saurians, (according to Newberry* extending as far up the Ohio as Louisville), had retired.

1. The northern part of the continent was elevated to a great height, the surface rapidly sloping to the south. A period of intense cold condensed and partly congealed vast amounts of water, which by gravitation was driven southward. From the southern line of the ice a sheet of fresh water flowed with great violence cutting channels to a depth of from 50 to 150 feet below the present beds of our rivers. No animals are known to have existed here at that time, no life among these naked rocks, except a few pines, birch and cedars.

2. The surface was depressed to or below its present level. The ice line and rigorous climate retired to the north. A fresh water sea occupied the basin of the northern lakes, the surface of which was sometimes partially frozen, for we find boulders and pebbles on its shore lines, and in the sedimentary deposits known as the Erie clays. Another similar sea, having a sub-tropical temperature, occupied southwestern Indiana and adjoining regions to south and west. Either a difference in level, or a barrier connecting the

* Second Report of Progress.

Ozark and Cumberland mountains, confined this water, and overflowed the deep channels hewn out by the melted ice of the glacial era, to a depth of 400 to 600 feet. It was a quiet, waveless sea, for wave washed sands are not found along its shores. The climate was warm, for the few animal remains found in the Loess sand are sub-tropical, and few or no pebbles or boulders are met in shafting down into the black, mucky deposit of clay and vegetable remains, recognized as the sedimentary clay of this epoch; consequently we infer there was no ice to seize upon the pebbles and stones and heap them up along the shore line or cast them down with deep water sediment. Sub-tropical plants as cypress, magnolia, white gum, persimmon, live oak, and monster vines were characteristic; and great sloths, beavers, saurians and marsupials of Australian or South American type, with the rhinoceros and elephant, were representative animals. It is probable that at this time, while the ice line still lingered and made obstruction at the mouth of the St. Lawrence, the great northern lake found discharge to the south by the valley of the Wabash at intervals, but finally secured an easy and uninterrupted outlet by its natural channel, the gulf of St. Lawrence. During this epoch, the chasms and thoroughfares previously hewn by the rapid torrents flowing from the melting glaciers, were partly filled up with sediment deposited by this great southern lake; hence in such old channels we find beds 50 to 200 feet in depth, of tenacious mucky clays and quicksands with much vegetable matter, the trunks of trees, etc., locally known as "Noah's cattle yard." Beach lines of this lake were marked with yellow sands and loams, while the shallows were covered with ash gray loess sands, becoming fine and impalpable as we descend to deep water.

3. An oscillation in the crust of the earth concluded the last epoch, elevating northern areas, and wasting away the barrier which obstructed this southern lake in its exit to the gulf of Mexico. The water level was gradually depressed, though stationary for long periods, and formed new shore lines of loess sand around the tops of high hills

and ridges. The rain fall gave current to arms and lagoons of the lake and formed sandy terraces. This process continued and repeated at intervals until the waters of the lake were entirely drained away, and the existing state of affairs was inaugurated. The creeks and rivers then commenced cutting their channels in the *more ancient valleys* now silted up. Terraces were formed on the hill sides of sand marking the high water line and flood plain of a stream, while lower are beds of gravel and coarse material marking low water riffles. White river, at an early period, evidently discharged through its valley a large volume of water with a powerful current; for in geology of Dubois county, ancient sand bars are noted 180 to 250 feet, and riffles bedded with geodes (evidently natives of the Keokuk rocks of Lawrence and Jackson counties) from 50 to 126 feet above the present channel of the river.

This erosive action has been continued during a long period, until the silted deposit has been almost wholly removed from the valleys, except so much as is found below the present channel of the streams. This undisturbed bed is found, where pierced, on lower White river in Knox county, to have a depth of at least 50 feet, and on the Wabash to extend down to from 60 to 90 feet below the present channel of the rivers.

Facts recently observed indicate that areas to the north are being depressed more rapidly than at the south; and if this is so, river channels in future will not be deepened. On the contrary streams flowing to south will become sluggish, and have their channels obstructed by bars and sands.

The foregoing surface deposits although theoretically above the underlying rocks and so described to properly fix the sequence of their occurrence in time, it is hardly necessary to say are actually found resting upon and against the sides of the hills and reaching down into the deepest valleys.

PALEOZOIC GEOLOGY.

The order of succession and average thickness of the rocky formations has already been given. In the following general description the Nos. referred to are those of the general section; see page 264.

COAL MEASURES.

Commencing with the highest or most recent rocky formation on the western side of the county, we find thin beds of shales and shaly sandstones at the top of some of the highest hills belonging to the lower coal measures (No. 6 of section.) These beds are of no great extent, mere outliers, and the probability of their affording *workable* seams of coal is very remote.

CONGLOMERATE SANDROCK.

Below these beds is found the conglomerate or mill stone grit, a massive gray or brown sandrock, (No. 7.) This rock forms bold precipitous hills, and is well developed north and south of Silversville and thence to the southwestern corner of the county. Although generally pebbles are rare, yet at B. Williams' Sec. 8., T. 4. R., 2. W., an outcrop was seen presenting a pudding stone mass of hard, brightly colored or white pebbles. A pyritous shale No. 9 underlies the conglomerate, and by reason of the decomposing and disintegrating nature of the pyrite, rapidly wears away on exposure to the elements; and affords the usual "rock house" feature so common at this horizon. An example occurs on J. E. Bryant's land Sec. 19., T. 4., R. 2. W.

CHESTER FORMATION.

The upper member of this formation is a limestone exceedingly variable in its character, equivalent to the Kas-

kaskia limestone of Hall. The upper surface consisted of elevated hummocks, and valleys filled with iron stones and coal measure shales; in thickness it ranges from about 40 to 2 feet; and in color from whiteish gray to a dark brown or black, and when of last color, highly bituminous. Generally the fossils are emphatically of sub-carboniferous type, as *Archimedes*, *Pentremites* and *Crinoidæ*. At a few points these are mostly absent, and common coal measure fossils are found to predominate, as *Lophophyllum*, *Athyris subtilita* and *Productus Cora*. At such stations a rash coal, No. 11, is found. This coal is seldom of workable thickness in the Indiana coal field, and while variations to that rule are found to exist, such occurrences are rare. Poor returns and much disappointment will be the result of time and money spent in search of coal at this horizon.

Nos. 12 and 13 comprising the "grit stones" of Owen, are equivalent to the "Ferruginous sandstone" of Missouri. They consist of thin bedded sandstones showing a thickness south of White river of 65 feet, but thinning irregularly to the north. Throughout much of the region bounded on the west by the conglomerate, on the east by the underlying limestones, and extending from the southern line nearly to the northwestern corner of the county, this formation offers fair building stones and good grits. The fossils are *Stigmaria*, *Sigillaria*, *Lepidodendra*, (3 sp.), with cones, fruits and leaves, *Diploptegium*, *Ulodendron* *Cordaites*, *Pecopteris*, *Alethopteris*, *Neuropetris*, *Hyemenophyllites*, etc. At the base is locally found a coarse sandstone, which I am informed becomes persistent in adjoining regions to the south. The blue or gray argillaceous limestone, No. 14, is often very homogeneous, and from appearances will afford lithographic stone; but this can only be known by practical test. Good samples were seen and obtained on Dr. Johnson's land Sec. 21, at Craig's mill, Sec. 17, both in T 5, R. 2 W., and on the bank of White river near Stump ford. In Beaver creek valley this stratum contains thick bands of dark hornstone which afforded the Indians a favorite article for the manufacture of flint weapons, and other fabrics of wrought stone.

No. 15 is pretty constant, a bed of red and blue clay with plates of chert passing into an argillaceous cement stone. It contains many silicified fossils, as *Orthocerata* a *Bellerophon*, *Nautili*, a *Zaphrentis* and *Syringopora*. No. 16—an attempt at a coal seam, is of no economical importance, except as an easily recognized stratum. It was found ranging from one to four inches thick at almost every outcrop in the county of the rocks of this horizon. Good examples are seen at Pace's hill, Bedford, Avoca, Goose creek and Hamer's mill.

ST. LOUIS LIMESTONE.

As before remarked, this limestone occupies the surface in the central area of the country, commencing with a belt about 12 miles wide in the southeastern part, and widening to over 14 miles at Bedford; it thence narrows to less than 5 miles at the northwest. Taken as a whole or in each of its different strata it is so variable in thickness and character that no two sections will exactly correspond. Fossils alone are relied on for its identification. "Without the aid of fossils, which everywhere characterize this formation," scientists remark* "it would be utterly impossible to identify it at the various localities in consequence of the decided changes in its lithological character." Among the fossils most generally distributed and easily recognized are two corals of the genus *Lithostrotion*; *L. Canadense* (or "petrified wasps' nest") is found in masses of considerable size, composed of calyces of many angles, giving it the appearance of a honey comb in which the cells are enlarged to from three to eight times their ordinary diameter, the central area raised and pointed: in *L. proliferum* the cells are circular, sometimes massive or in tufts, but generally the calyces are solitary or disconnected. Worn specimens of the latter are locally known as "petrified corn cobs." With these may be mentioned *Productus (tenui-costus)* *Cora*, *Athyris ambigua*, *Zaphrentis spinulosus*, *Archimides*

* First Volume Illinois Reports.

Wortheni, *Pentremites conoides* as common, together with many other fossils which will be found enumerated in local details at the place of their occurrence. When this limestone forms the surface rock, funnel shaped *sink holes* are numerous. Water collected and conducted by these give origin to caverns; for this reason the St. Louis has sometimes been called the Cavernous limestone.

The upper divisions and some of the lower strata are so highly argillaceous, that, on exposure to atmospheric influences, they break into angular fragments: re-cemented with lime dissolved and transported by water, it forms a brecciated mass. A good example of this is seen along the railroad about a mile south of Bedford. These beds from conchoidal fracture, and appearance of weathered fragments have hydraulic properties. Specimens were secured for chemical examination.

No. 18 of the section, a hard and compact limestone, is remarkably persistent whenever its horizon appears in the outcrop. It is named *vermicular limestone*, for the reason that it is traversed in all directions by cylindrical cavities from one-eighth to half an inch in diameter, as if worm eaten. These cavities are supposed to be casts of sea weeds which have long since decayed. A curious form of crystallization, known as *crystallites*, is seen in this and some of the adjoining strata, consisting of a parallel system of crenulated columns, the opposing surfaces fitted to each other in a zigzag line. From their resemblance to the sutures in the human skull, Prof. G. C. Swallow has suggested the name of "*Suture joints*." Their origin has been attributed to pressure of heavy overlying masses, applied to the stone material while yet in a plastic state. No. 20 consists of beds of clay and argillaceous limestone containing plates and massive bands of chert and irregularly formed geodes, the whole mass disintegrating and combined forms beds of red and brown ochre. Some of these "*psuedo*" geodes seemed to have commenced crystallization at the center of a cavity, and when half formed to have ceased their growth. The cherts are highly fossiliferous; sometimes a band is

principally composed of thin layers of lace-like Bryozoans; from the shales, the creeks wash out silicified specimens of *Lithostrotion*, *Syringopora*, *Zaphrentis*, *Productus*, *Athyris*, *Sponges*, *Pentremites*, *Trilobites*, etc. A variety of sponge is found as the nucleus of the globular cherty concretions locally called "marbles" and "petrified plums." One of these, examined by Dr. Gardner with his excellent microscope, showed distinctly the characteristic "*spun-glass*" spicules. These balls are so numerous at places as to cover the surface; good examples are seen at Bedford, Mitchell, and Mr. Cole's farm, Sec. 7, T. 5, R. 1, W.

Nos. 21 and 22 constitute the most important quarry beds, and furnish a large amount of superior stone. The upper bed is sometimes argillaceous, and concretionary—in such cases inviting tests for hydraulic purposes; but at a few points it offers a stone suitable for chisel dressing, of remarkable solidity and of a dark, blueish color, desirable for water tables and line work in large edifices.

The lower bed No. 22, is the quarry bed which furnishes in unlimited supply the famous "*Bedford stone*" so favorably known and so much used in first class structures at Indianapolis, Cincinnati, Louisville, Springfield, Illinois, and St. Louis. This stone is composed almost wholly of minute fossils cemented with shell and coal dust. It varies in color from gray to a creamy white, and may be quarried in blocks or columns the entire thickness (12 feet) of the stratum, and without limit as to length. Homogeneous in structure, it is readily sawed or moulded by the chisel, into such forms as the architect may require. These qualities constitute a stone rarely surpassed; and the proprietor's of the Bedford quarries claim that it is not equalled by any stone in the Western States. Further particulars will be given in local details in Bedford Section, and under the head of Economic Geology.

Connected with this quarry-stone and generally forming its lower member is No. 23, the famous fossil bed, so well studied by Prof. Hall at Spurgeon Hill and Bloomington. It is from a few inches to three or four feet in thickness,

and is made up almost wholly of the shells and other remains of marine animals; some of them are microscopic and all are very small, yet as perfectly formed and symmetrical as if designed by a master's hand. The bed affords about seventy species, of which the following genera are characteristic, viz.: *Rotalia*, *Phillipsia*, *Cythere*, *Chiton*, *Bellerophon* (2 sp.), *Pleurotomaria*, (3 sp.), *Murchisonia* (2 sp), *Natica*, *Loxonema*, *Bulimella* (2 sp.), *Euomphalus*, *Rhynchonella* (3 sp.), *Spirifera*, *Nucula*, *Chonetes*, *Athyris*, *Waltheimia*, *Terebratula*, *Retzia* (2 sp.), *Cono-cardium*, *Archeocidaris*, *Actinocrinus* (2 sp.), *Pentremites* (3 sp.), *Dentalium*, *Sphenopoterium*, *Aulopora*, *Coscinium*, *Archimides* and other *Fenestella*.

Good examples of this fossil bed may be seen on the Miller farm southeast qr. sec. 5, T. 5, R. 1 east, and in the valley of Spider creek west of Bedford: at the latter station this material has been subjected to chemical action while yet in a plastic state, probably to a long bath of thermal water saturated with silica, which after dissolving the shell lime, replaced the cavities thus made with siliceous material, and forms an imperfect Buhr-stone.

No. 21 succeeds, and is sometimes when dark colored charged with Petroleum, which flows out where the pores are ruptured or from crevices and cavities. At such localities it yields a compact bluish quarry stone, which properly seasoned, is of desirable quality, affording a stone that contrasts well with the light colored beds. Generally, however, it is argillaceous, and liable to break in splintery fragments; sometimes magnesian, with slight additions, a good cement may be manufactured from it. Its fossils are rare: a few *Pentremites* were found, with *Hemipronites crenistria*, *Productus cora* and *Spirifer striatus*. Throughout almost the whole area in which the St. Louis limestone forms the surface rock, the creeks and larger branches have cut their valleys down to the lower beds.

KEOKUK BEDS.

The upper member of this formation is of no economic

importance. In other regions it is rich in beautiful *Crinoidæ*; here but a few broken specimens of *Actinocrinus* were found. Near Heltonsville at the junction of this stratum with the geode bed, a curious crinoidal form was found apparently showing the internal structure or frame work of the animal. *Hemipronites crenistria*, *Productus punctatus*, *P. cora*, *P. semi-reticulatus*, *Spirifer striatus*, and *S. Keokuk* were the ordinary fossils.

No. 26 contains in a mass of shaly clay a wonderful collection of Geodes, locally known as "Nigger heads." Spherical in shape, rough and unattractive in outward appearance, these Geodes when broken open present a never ending variety of nature's most beautiful work. They vary in size from one inch to one foot or more in diameter. Generally hollow, the internal mass is composed of crystalized silica, with cavities lined with pure limpid, black or rose colored crystals, or chalcedony; and occasionally containing calc spar, or double-ended or twin crystals. Mingled with the last, zinc blende, galena, and pyrite is rarely found. The second geode bed No. 28 presents all the varieties above mentioned, but in addition affords quite a number of geodized fossils as *Spirifera*, *Bellerophon*, *Zaphrentis*, *Goniatites*, *Crinoid* heads and stems, *Palæchinus* and *Nautili*, all of giant size. These are so numerous and so unmistakably distinct, that we may infer that animal remains caused the cavities and gave initial direction to the form of many, if not all the geodes. Good beds are seen at Ft. Ritner, Leesville, Heltonsville, Bartlettsville and Guthrie.

The stratigraphic position of No. 28 of the general section would assign it to the formation known as the "Burlington limestone" by Iowa and Illinois geologists, but not having found distinctive fossils, for the present it is included with the Keokuk formation. It consists of shaly and hard pink limestones profusely filled with disjointed stems of *Crinoidæ* and *Pentremites*, and in addition contains *Hemipronites crenistria*, *Spirifer striatus*, *S. Keokuk*, *S. Kentuckensis*, *S. lineatus*, *Productus cora*, *P. semi-reticulatus*, *P. punctatus*, *Archimides Oweni*, *Aulopora*, *Chetetes*,

Zaphrentis, *Pentremites*, and a few specimens of *Actinocrinus*. In almost every locality where the "pink" or chocolate color prevails, shark's teeth of the genera *Helodus*, *Cladodus*, *Cochliodus* and *Deltodus* are found. Good outcrops of this bed may be seen near the water line along the lower half of Salt and Leatherwood creeks, at the top of the hill west of Guthrie, at Hamer's railroad cut near Rivervale, and generally on the high lands between Ft. Ritner and Heltonsville. As a quarry stone, this lime rock is very compact, and affords some good material for foundations and hammered masonry.

KNOBSTONE SHALES.

This formation is the lowest visible in the county. Its whole extent is nearly 500 feet thick, of which about 250 feet outcrops in the eastern and Southeastern parts of the county. The whole is principally composed of dark aluminous shales, compact and tenaceous, but decomposing on exposure to the air, and readily yielding to the action of running water, hence the creeks and brooks have cut deep valleys with precipitous sides, and ramifying in every direction have moulded the surface near the water courses into a continuous system of sharp, conical hills or "Knobs," which give appropriate name to this formation. The circumstances under which these shales were deposited was not favorable for the preservation of animal remains. Fossils are rare. The following only were found: *Spirifer capax*, *S. (sps ?)*, *Productus cora*, *P. semi-reticulatus*, *Pleurotomaria ?*, *Hemipronites crevistris*, and *Athyris lamellosa ?*, all in a poor state of preservation.

The upper member of the Knobstone contains locally bands and thin beds of homogeneous sand stone, which is enduring, and may be sawed or cut with facility. This rock is equivalent to the celebrated "Waverly sandstone" of Ohio, and invites the attention of manufacturers of wrought stone. Outcrops are seen at Ft. Ritner, Guthrie, and throughout the eastern side of the county.

To the foregoing general description will be added local observations and representative sections.

LOCAL DETAILS.

The court house at Bedford is a stone structure, commodious, neat and substantial. It is built of material obtained from quarries in that immediate vicinity, so well known as "*Bedford Stone*," and doubtless will prove a good investment to the tax payers of the county as a demonstrative advertisement of the vast quarry beds which surround the town. The high school, well situated upon a commanding elevation, is of brick ornamented with stone. It challenges comparison with similar structures in the cities. The chert bed of the St. Louis limestone, which on disintegration forms a reddish brown ochre, colored with hydrated oxide of iron, outcrops at all the hill tops around town, and may be considered the surface stone. It is from twelve to forty feet thick, and is composed of beds of gray, green or red shales, enclosing bands of chert and flint from two to twelve inches thick. No outcrops of this strata in place could be found, as on exposure to the air the clay crumbles away and the chert breaks into small angular fragments. A band of soft white chalky material, though not found in place, occurs frequently and appears to be persistent. It contains some fragmentary fossils, but is principally composed of well preserved whorls of *Archimides*.

The following sections taken at Borland's mill on Spider creek, and at Campbell's cave a mile south of town, show close parallelism :

SECTION ON SPIDER CREEK.

Clay and chert.....	30 ft. 00 in.
Argillaceous limestone and shale.....	8 ft. 4 in.
"Coal bone"—slate rich in petroleum..	3 in.
Hard, gray bituminous limestone.....	3 ft. 6 in.
Vermicular limestone.....	4 ft. 4 in.

Laminated bituminous limestone.....	5 ft. 00 in.
Blue argillaceous limestone, with <i>Pro-</i> <i>ductus semi-reticulatus</i> , <i>P. Cora</i> , <i>Atthyris lamellosa?</i> , <i>Terebratula</i> and <i>Fucoides</i> , breaking with con- choidal fracture, indicating hy- draulic qualities.....	8 ft. 00 in.
Indurated limestone, containing <i>Pen-</i> <i>tremites</i> and Spurgeon Hill fossils.....	12 ft. 00 in.
"White quarry" limestone.....	15 ft. 00 in.
Blue limestone in creek.....	8 ft. 00 in.
	— —
	94 ft. 05 in.

SECTION AT CAMPBELL'S CAVE.

Clay and chert.....	10 ft. 00 in.
Bituminous limestone.....	2 ft. 6 in.
"Coal bone"—slate.....	3 in.
Dark bituminous limestone, laminated	2 ft. 00 in.
Argillaceous limestone.....	2 ft. 00 in.
"Vermicular" limestone.....	4 ft. 00 in.
Hard gray limestone.....	4 ft. 00 in.
Compact argillaceous and magnesian limestone.....	6 ft. 00 in.
Blue hard limestone	10 ft. 00 in.
"White quarry" limestone, to water..	9 ft. 00 in.
	— —
	49 ft. 9 in.

Campbell's cave is known to be half a mile in length, but was too muddy at the time of my visit for pleasant exploration. On the hill above were noticed "waxberry myrtle," "mouse-eared plantain" and *Gnathalium* or "Ditny."

Half a mile west of Campbell's, and a mile and a half southwest of town, is Dunnehew's, the most extensive cavern known in the county. It has been explored through a space of two miles, and is said to contain beautiful stalactites, stalagmites and chambers of considerable

size. At "Leatherwood cut," on the railroad south of Bedford, the rocks which constitute the base of the St. Louis, and top of the Keokuk beds are argillaceous, the quarry limestone evidently having thinned out. In "pockets" are found *Pentremites conoideus*, *P. Woodmani*, *Batocrinus*, *Cyathocrinus*, a *Phillipsia*, *Productus punctatus*, *Spirifer Keokuk*, *Aulopora*, and large whorls of *Archimides*. Half a mile north, the hill on the west side of the railroad is composed of angular fragments of limestone, re-cemented with tufa. Such fracture would naturally result if the bare hill was exposed to the air; and water leached through the overlying calcareous earth, would, in the course of time, fill up the interstices. This theory accounts for the phenomenon without calling to our help earthquake or other violent agencies. In the shaded or cavernous sides of this brecciated hill, a blue color was noticed tingeing the recesses of the rocks, which was thought might be the stain of copper, but on submitting a specimen to Dr. Gardner's microscope it was at once recognized as a fungous growth. A similar incrustation was noticed on the housed rocks at the old railroad quarry near Scottsville.

Proceeding north a stratum is seen at the next cut, from four to nine feet thick, which from its splintery fracture and weathered appearance invites experimental tests for hydraulic qualities. Specimens were secured for the State cabinet and analysis. Coats' and D. Johnson's quarries, one mile south of Bedford, near the Louisville and Chicago railway track, have been long in work. The "white stone" may be obtained in columns or blocks, ten feet square at base, and of any reasonable length. Columns twenty feet long were seen in the yard. It comes soft from the quarry, may be sawed by hand or power, is easily chiseled and is well suited for door and window caps and sills, columns and highly ornamented capitals and brackets. The lower bed, after seasoning, withstands the action of frost and weather well; gray or blue colored, it affords a striking contrast with the "white," and is used for water tables and string courses by architects.

The following section shows the extent of the quarry :

COATS-JOHNSON SECTION.

Hard laminated limestone.....	4 ft. 00 in.
White quarry stone.....	10 ft. 00 in.
Blue quarry stone.....	7 ft. 00 in.
	<hr/>
	21 ft. 00 in.

At Coats' quarry a few casts of a large *Bellerophon* were noticed, occasionally having their internal cavity filled with petroleum or asphalt. At N. L. Hall's quarry the following section is seen :

HALL'S QUARRY.

Soil and clay.....	4 ft. 00 in.
"White limestone".....	9 ft. 00 in.
Blue limestone to bottom of quarry...	4 ft. 00 in.
	<hr/>
	17 ft. 00 in.

Great energy and skill is shown by the proprietor of this quarry. Commencing without capital, he has by industry created a business and character worthy of emulation. His territory is ample, and a powerful engine drives three gangs of saws. The demand for his manufactures has exceeded the capacity of his mill, and it is intended to double the number of saws the coming year.

The white stone comes soft from this bed and is sawed with facility, but tough under the stroke of the chisel, is carved into handsome monuments, columns, capitals, brackets, mouldings, etc. Specimens of the product may be seen in the following structures, viz: The Bedford Court House; U. S. postoffice, Indianapolis; State University, Bloomington; the new State House, Springfield, Illinois; for coping and posts at Lincoln Park, and in the Custom House at Louisville, etc.

The "blue stone" is harder and finer in texture and furnishes a grateful contrast in colors. A large demand has

arisen for coping and posts to support iron fences about cemeteries, and for monumental purposes.

Stone from this quarry has been tested by competent engineers and architects, and it is found to have cohesion sufficient to resist the compression and cross-strain of large structures.

A wall of this material, it is estimated will prove three times as strong, and more than twice as enduring as a wall of well burned bricks. Columns of any size, within the limit of railway transportation, may be obtained, and blocks have frequently been shipped measuring one hundred cubic feet. Fragments from the quarry are burned and produce a good article of lime. Mr. Hall spread the refuse from his lime kilns on an old worn out field, which no longer paid for cultivation, applying less than twenty bushels per acre. The first year showed marvelous improvement and made the crop of 1873 equal to the average of virgin ground. Other experiments in liming for manure, I am informed, have proven equally profitable. Whitted's quarry, a mile west of Bedford, was formerly worked. The stone is easily quarried, works well, and is said to be of superior quality.

Near by, on the land of Jacob Viehl is a moderate flow of "*White Sulphur*" water, strongly charged with sulphuretted hydrogen. It deservedly has quite a local reputation for medicinal properties. Leaves covered with this water were noticed shining with tints of red and yellow. On examination the color was found to be due to the presence of myriads of animalcules of the lowest order of life, merely a sack or cell with an investing membrane, but all alive with motion. This animal closely resembles the "red snow fungus," and would be probably so classed did not celerity of action indicate animal life. These and many other microscopic studies found on the mosses offer an interesting field for the naturalist.

Passing to west, northwest, east and southeast from Bedford, as we descend into the valleys of Salt and Leatherwood creeks, full outcrops of the whole depth of the St. Louis

limestone may be seen amounting to about one hundred feet. Well preserved fossils are not common, but myriads in a fragmentary condition may be seen, comprising the following genera and species:

Batocrinus, *Actinocrinus*, *Dichocrinus*, *Pentremites conoid-eus*, *P. Woodmani*, *Archimides Wortheni*, *Coscinium asteria*, *Aulopora*, *Zaphrentis spinulosa*, *Bellerophon levis*, *Athyris ambigua*, *Terebratula*, *Platyceras*, *Pleurotomaria*, *Productus cora*, *Rhynchonella*, *Phillipsia*, etc: At the base of the hills near the water line in each of these valleys, occur the geode beds and laminated limestones of the Keokuk formation, having a thickness of twelve to twenty feet, and containing excellent specimens of *Hemipronites crenistria*, *Productus cora*, *P. semi reticulatus*, *Spirifer Keokuk* and *S. striatus*. At some of these localities the "white" quarry limestone, equivalent to Warsaw limestone of Iowa, is reduced to a thickness varying from a few inches to less than two feet, and is replaced with hard, gray argillaceous lime rock, showing that the Warsaw beds are not absolutely persistent.

Northeast from Bedford on the Heltonsville road, N. W. qr., Sec. 8, T. 5, R. 1 E., below the white quarry bed, is a fine outcrop of the "Spurgeon Hill" fossils. In a stratum less than two feet thick the following were found:

Phillipsia (*sp?*), *Rotalia Bayleyi*, *Cythere carbonaria*, *Chiton carbonarius*; joints, plates and spines of *Platycrinus*, *Batocrinus* and *Actinocrinus*; plates and spines of *Archeocidaris Wortheni*, *Pentremites conoideus*, *P. Woodmani*, *Coscinium asteria*, *C. (Sp?)*, *Aulopora*, *Zaphrentis spinulosa*, flanges of *Archimides Wortheni*, *Sphenopoterium cuneatum*, *Conocardium cuneatum*, *Spirifer*, (*sp?*), *Productus cora*, *P. muricatus?*, *Nucula*, *Myalina*, *Cypricardella?*, *Rhynchonella sub-cuneata* R. (*s?*), *Athyris ambigua*, *A. (?)*, *Retzia Verneuillanum*, *Waltheimia (Sp?)*, *Euomphalus planorbiformis*, *Pleurotomaria* 3 sp., *Murchisonia* 2 sp., *Bulimella* 2 sp., *Natica Littonana*, *Bellerophon laevis*, *Platyceras acutirostris*, *Terebratula hastata* and *Dentalium primum*, with some undescribed forms. A short distance

to the north of this station, a coarse blue limestone with characteristic Keokuk fossils is found near the bottom of the hill and accompanying geodes; with the latter the bottom of Leatherwood creek was found covered.

At the Miller farm N. E. qr., Sec. 4, T. 5, R. 1 E., the following outcrop showing junction of the Keokuk limestone with the knobstone shales was seen. Viz:

SECTION AT MILLER FARM.

Soil and clay.....	25 ft. 00 in.
Geode bed.....	5 ft. 00 in.
Blue Limestone with <i>Hemipronites</i> and <i>Productus cora</i>	4 ft. 00 in.
Geode bed.....	3 ft. 6 in.
Coarse limestone with joints and plates of <i>Crinoidæ</i>	1 ft. 2 in.
Shaly limestone.....	2 ft. 6 in.
Coarse limestone.....	1 ft. 0 in.
Knobstone-dark, gray, red and yellow shales.....	60 ft. 0 in.
	— —
	101 ft. 2 in.

At Rollins' mill the following outcrop was seen just below the dam, viz:

ROLLINS MILL SECTION.

Chert, fragmentary.....	20 ft. 00 in.
Argil. and vermicular limestone...	15 ft. 90 in.
Argil. limestone—Pentremital.....	8 ft. 00 in.
Gray limestone.....	30 ft. 00 in.
Keokuk limestone with Spirifers, Geodes, etc.....	12 ft. 00 in.
Keokuk reddish limestone with Crinoid joints <i>Productus</i> and <i>Hemipronites</i>	7 ft. 00 in.
Knobstone shales and siliceous limestone with large <i>Nautili</i>	16 ft. 00 in.
	— —
	108 ft. 00 in.

The tops of the hills around Springville are capped with outliers of the Chester formation. A mile east of the village near the summit of the hill is an outcrop of the upper Chester (Kaskaskia Limestone) crowded with crinoid joints and including *Pentremites obesus*, *P. pyriformis*, *Zaphrentis spinulosa*, and *Chonetes variolata*. The small band of coal usually underlying this limestone was not seen.

In this neighborhood unusual attention has been given by farmers to "shrubbing" and preparing their land for the culture of grass, for which the soil is naturally well adapted. In the bed of Goose creek, on the farm of Ed. Turney southeast quarter Section 30, T. 6, R. 1, W., was seen the parting of coal bone, having a strong odor of petroleum, which so persistently appears in the upper division of the St. Louis limestone. At Avoca on the farm of Owen W. Owens, is a *White Sulphur Spring*, which deservedly has a good local reputation. It acts as a laxative, tonic, anti-dyspeptic, and febrifuge. For bathing it is found highly efficacious in diseases of the eye and the skin. The water is strongly charged with sulphureted hydrogen gas, whose antiseptic qualities are well known. Close by is a salt well, bored to a depth of 160 feet about the year 1814. Salt was made here for sometime, but the manufacture has been abandoned for more than 50 years; another thin outcrop of black bituminous slate was seen in the brook adjoining. Lower down Salt creek on the land of Abram Reynolds northeast quarter Section 8, T. 5 R. 1, W, an additional salt well was bored many years ago; at a depth of 90 feet the workmen found a bed of black material and reported a seam of coal six feet thick. The well was commenced below the St. Louis limestone, continued into the Knobstone formation, and at about the horizon where the coal was reported there is a bed of black, tenaceous bituminous clay (as may be seen in Leatherwood below Heltonsville); this was mistaken for coal, which is never found at or below the St. Louis limestone.

Continuing south one mile, an outcrop is seen on the land of Alfred Pace northwest quarter Section 17, T. 5, R. 1, W, comprising the lower part of the Chester and upper member of the St. Louis limestone.

SECTION AT PACE'S HILL.

Red drift, with fragments of coal.....	20 ft. 00 in.
Dark sandstone.....	3 ft. 00 in.
Shaly sandstone.....	10 ft. 00 in.
Gray chert.....	1 ft. 6 in.
Shaly sandstone.....	4 ft. 6 in.
Dark laminated limestone.....	5 ft. 00 in.
Blue St. Louis limestone.....	6 ft. 00 in.
Vermicular limestone.....	10 ft. 00 in.
Place of "coal bone".....	3 in.
Blue and white argillaceous limestone... 15 ft. 00 in.	
Yellow magnesian limestone.....	6 ft. 00 in.
Shaly argillaceous limestone—geodes... 8 ft. 00 in.	
Blue Pentremital limestone.....	22 ft. 00 in.
	— —
	110 ft. 9 in.

Mr. William Boyd reports that at an early day he assisted in digging a well near his residence, S. E. qr. Sec. 7, T. 5, R. 1 W. At a depth of eight feet he found a bed of soft yellow substance from which silver was said to have been obtained. He proposes to open this well and make a complete examination. The well was commenced in a "sink" below the "chert bed." This horizon outcrops at several points in the neighborhood, and at those places, no evidence was observed indicating the existence of silver ore. In the "Silver Sink" some choice specimens of silicified *Fenestella* were obtained.

At Shiloh mill, S. E. qr. Sec. 19, T. 5, R. 1 W., the following section was taken, the cut for the mill race affording unusual facilities for observation:

SECTION AT CAVE MILL.

Chert and covered.....	50 ft. 00 in.
Banded blue limestone.....	12 ft. 00 in.
Chalky white clay.....	4 ft. 00 in.
Siliceous and calcareous shale.	3 ft. 6 in.
Black bituminous shale, "coal bone,"	3 in.
Shaly limestone, St. Louis.....	1 ft. 00 in.
Hard blue limestone.....	3 ft. 4 in.
Laminated blue limestone.....	2 ft. 00 in.
Brecciated soft limestone.....	3 ft. 2 in.
Vermicular limestone.....	4 ft. 6 in.
Massive limestone.....	28 ft. 00 in.
Covered	20 ft. 00 in.
Oolitic quarry limestone.....	40 ft. 00 in.
	— —
	171 ft. 9 in.

The mill was formerly driven by water brought through a tunnel from the cave.

SHILOH CAVE.

The entrance to this cavern is on the side of a sink whose funnel once collected the water which tunnelled a pass way thence to Salt creek, three-fourths of a mile distant. Descending a short rugged slope, a wide room, thirty feet in hight, is found. The moist air and the brook babbling over the floor justify the name by which it is sometimes known: "Wet Cave." Bewildered by darkness and the novelty of the situation, an oppressive awe startles the mind and ear as strange mocking voices are cast up from the black depths. A lofty hall leads off in a southeasterly direction, the precipitous sides of which show stratified beds of limestone; and fragments of chert from the roof prove the horizon to be the cherty or upper member of the St. Louis. The echoing noises increase as we proceed, and soon a natural fountain is perceived, which pours three jets of pure silvery water from an orifice near the roof down upon the floor, from which a cloud of spray arises.

The cold water is grateful and refreshing. Proceeding across the small brook the lofty sides are draped and festooned with stalactites, sometimes hanging in graceful folds, or ribbed with giant corrugations. Above, the roof and overhanging sides bristle with clear, quill-like tubes, fragile as glass, each tipped with a drop of water which sparkles in the lamplight like a crystal jewel. Passing on for half a mile the beauty and purity of ornamentation does not flag, although frequent crossing of the brook, now of considerable size, becomes tedious. Here it leaps from a small precipice with much report of "falling water." The pond below blocks the way, but with waterproof boots, the southern outlet may be found a fourth of a mile beyond, near Salt creek. Several side passages have not been explored, and will reward some future Columbus. Near the middle of the cave was a stalagmite as large as a man's body, five feet high, named the "Image of the Manitou." Some ruthless iconoclast has broken the statue, and scattered the fragments on the floor. This cavern far exceeds Mammoth cave in beauty, and rivals any that I have ever seen, though only one mile has as yet been explored. The temperature of external air, Nov. 15, was 55°, of the cave, 69° Fah. Inhabitants, as noted by tracks, etc., were coons, rats and ant-lions.

DRY CAVE.

This cave has its doorway on the side of a hill in the N. E. part of Sec. 12, T. 5, R. 2, thence in a southeasterly direction it underruns part of Sec. 7, T. 5, R. 1 W., and in connection with the intervening valleys on the land of Mr. T. C. Cole and others, once probably formed a junction with Shiloh cave. The horizon is partly in or just below the heavy chert band of the St. Louis. The top of the hill holds an outlier of Chester sandstone, containing coal plants fossilized. A narrow doorway opens into a lofty vestibule, whose arched dome is twenty-five feet above the floor, with a few stalactites upon the walls; soon the cave is apparently ended; a monumental altar rises in the center of the

passage, guarded around with pendant stalactites which almost hide the tablet with their snow-white shield. From these a curtain, scarce half an inch thick, draped in graceful folds, and caught in stone, is thrown across the passway. The curtain is rent, broken by some sacrilegious hand. Immediately beyond, from a projecting cornice, ten feet above the floor, thousands of stalactites fringe either wall of the passage with a profusion of ornament. Behind the altar a mighty stalagmite has grown up to support, like a pillar, the roof above. Beyond, we ascend by a ladder to an upper floor, and thence in large roomy halls, showing many interesting forms of stalactites and stalagmites which relieve the otherwise gray or yellow walls, we find the termination of the cave. It is inhabited by rats, mice, ant-lions and crickets—all observed, were seeing animals. The deepest point below the floor of the vestibule was twenty feet; temperature 68° Fah. The chemical processes resulting from decomposition, etc., of the different salts of magnesia and lime, produce in the cave an atmosphere remarkably free from moisture, highly antiseptic, and consequently equal to a first-class "fruit house" for the preservation of animal or vegetable food. Advantage has been taken of this fact by farmers, who sometime deposit for preservation in this and other dry caves, the carcasses of their slaughtered animals, and their winter supplies of apples, sweet potatoes, etc. The floor of the cavern contains much loose clay which is highly charged with nitre.

GRINSTAFF'S CAVE.

This cavern has its entrance in south half of Sec. 10, T. 5, R. 2 W. It was not entered, but information obtained from visitors, gives the following description:

It consists of two stories or floors, the upper one dry, the lower one washed by a small stream of water. As yet it is only partially explored; many passages have not been entered at all, but the fact that the parts already visited have a length of more than two miles, shows that it is extensive. The sides are ornamented with a variety of stalactites,

some of translucent spar, and there are quite a number of columnar or spheroidal stalagmites.

Fayetteville is surrounded by a thrifty agricultural community. The soil, generally of a reddish brown color, is derived from the upper member of the St. Louis limestone, and produces fair crops of corn, wheat and clover. Several good fields of blue grass were noticed. Sink holes are very common, and the rocks beneath are tunneled with caverns. At every outcrop of the cherty surface rock, fine massive specimens of *Lithostrotion Canadense*, *L. proliferum*, a *Syringopora* (*inds.*), and shaggy lumps of crystals are found. These are used by some of the citizens to form ornamental rock work mounds in their door yards. Many localities are rich with single calyces of *Lithostrotion* ("petrified corn cobs"), *Zaphrentis spinulosa*, *Bryozoans*, *Productus cora*, *Athyris ambigua*, *Bellerophon levis*, *Orthoceras* (*s?*), and plates and spines of *Archeocidaris Wortheni*.

The following section commences at the valley about one mile west of Fayetteville, and is continued along the hill for a space of half a mile:

FAYETTEVILLE SECTION.

Coarse sandrock.....	30 ft. 00 in.
Bituminous limestone, with fossils...	6 ft. 00 in.
Shaley coal.....	00 ft: 6 in.
Laminated fire clay.....	2 ft. 6 in.
Blue and gray shale (pyritous).....	25 ft. 00 in.
Covered (Chester sandstone?).....	40 ft. 00 in.
Blue and gray limestone with a large <i>Bellerophon</i> , <i>Orthocerata</i> , <i>Euompha-</i> <i>lus</i> , etc.....	35 ft. 00 in.
Chert bed containing St. Louis fossils in abundance.....	40 ft. 00 in.
	— —
	179 ft. 00 in.

The coal here worked by James Tannehill will burn, although slaty. The outcrops do not indicate the proba-

bility of a workable bed. On the adjoining farm of Dr. W. R. Johnson is a stratum of compact siliceous limestone, very homogeneous, in laminae of from two to four inches, which closely resembles lithographic stone, and invites a careful test. The stratum is fully four feet thick.

At Robert Gray's mill on Indian creek, S. E. qr. Sec. 17, T. 5, R. 2, W., the limestones are rich in characteristic fossils. In the bed of the creek quite a number of springs burst up through crevices in the bed-rock, discharging "white sulphur water" accompanied with sulphureted hydrogen. They will be found to possess the medicinal properties appertaining to similar springs. They are valuable.

At Michael Wagner's, Sec. 19, T. 5, R. 2 W., a thin seam of slaty coal has been opened. The following section was observed:

SECTION AT M. WAGNERS.

Conglomerate sandrock in hillside, and covered.....	90 ft. 00 in.
Bituminous or gray limestone.....	12 ft. 00 in.
Black slate and Coal.....	00 ft. 10 in.
Pyritous shale.....	10 ft. 00 in.
Blue limestone to branch.....	8 ft. 00 in.
	— —
	120 ft. 10 in.

From the bluffs near Silverville across the valley of Indian creek, outliers of sandstone are seen on sections 16 and 21, T. 5, R. 2 W. Some are sharp conical mounds, symmetrical as if shaped by hand for monumental purposes, and show that erosive currents of water have acted upon the summit of these hills. They are known as the "Hay stacks."

FAYETTEVILLE HEMATITE BEDS.

Four miles southeast from Fayetteville, in beds of sand deposited on the top of hills, several hundred feet above the present level of the water courses, beds of rich iron ore are

found. The principal developements have been made by the "Southern Indiana Iron Company" on the land of Geo. W. Whittaker Section 28, T. 5, R. 2, W. Ore is also found at different levels on the adjoining farms. Test shafts put down to a depth not exceeding nine feet, at fourteen different stations in Section 28, discovered the ore in each, varying in thickness from two feet four inches to four feet (on the Fordyce tract), and averaging, according to measurements reported, not less than three feet. But one pit was free from water, etc., at the time of my visit: in this the ore was fully three feet thick, with a four inch parting of clay near the centre. One sample of Whittaker's ore analyzed by Prof. Cox gave the following results:

WHITTAKER'S HYDRATED BROWN HEMATITE.

Moisture and combined water.....	13.000
Silicic acid.....	0.900
Ferric oxide	84.890
Alumina.....	trace
Phosphoric acid.....	0.145
Carbonate of Lime.....	1.000
	99.35

The *ferric oxide* reduced gives 59.426 per cent. of metallic iron. Booth's Encyclopedia of Chemistry gives a table of iron ores in per centages which is quoted for comparison:

Magnetic ore—metallic iron.....	70.5 to 50. 9
Specular ore—metallic iron.....	45.8 to 51.17
<i>Hydrated</i> ore—metallic iron.....	35.5 to 49. 9
Whittaker's ore—metallic iron.....	59.42

From this it appears that the Lawrence county Hematite is unrivalled. Excluding the water, it is freer from deleterious ingredients than ordinary cast iron, and will be of great value for the manufacture of Bessemer steel. Other beds

mentioned by Mr. Whittaker as occurring at lower levels, were covered at the time of my visit and not seen. The "Shoals Iron Company" intend building a tram way from the mine to White river, distant two miles, thence making use of water transportation to their furnace at Shoals.

A high range of hills on the north of White river, extends from the west side of the county nearly to Salt creek. They are generally capped with different members of the Chester formation, and in extreme cases attain a height of 595 feet above the river. Near the palatial residence of Barton Williams in the southwest corner of Indian creek township, occurs a typical bed of "pebbly conglomerate," and a stratum of fibrous spar having a faint tinge of blue color: the latter has apparently the specific gravity of "heavy spar" (Barytes), but the structure, color, etc., is that of Celestine (sulphate of Strontia). For determination I refer to the Chemist's report.

Good examples of the overhanging, or "rock house" character of the conglomerate or mill stone grit, are seen on the land of Col. J. E. Bryant, Sec. 19, T. 4, R. 2, W., on the opposite side of the river. Here the Chester beds are changed to siliceous shales. Fragments of coal, from a small, covered seam, were found in the talus of the hill, near the water level.

SECTION ON COL. BRYANT'S FARM.

Massive conglomerate.....	125 ft. to 70 ft. 00 in.
Laminated sandstone	15 ft. 00 in.
Bituminous limestone.....	10 ft. 00 in.
Silicious shale—place of coal.....	20 ft. 00 in.
Shale and limestone to White river.....	50 ft. 00 in.
	— —
	165 00

Crossing a high range of hills to the south, capped with *Loess* and containing much sandstone with frequent outcrops of iron ore, we descend to the valley of Beaver creek.

The region about Huron is eminently a timber country. A large amount of cooper stuff, poplar and other lumber, is prepared and shipped from this station. Advantage is taken by the enterprising citizens of the *equalization of temperature* found to exist on the summit of the surrounding sharp hills, which are two hundred to two hundred and fifty feet high, to plant extensive orchards, which produce highly remunerative crops of excellent fruit. It has been frequently observed here that in cold weather ice of considerable thickness forms in the valley, when no frost has fallen upon the hills just above. This arises from the fact that cold air is heavier than warm air, and in obedience to gravitation descends, and may fill the valley, leaving the peaks above bathed in warmth. Mr. Late. Prosser has an orchard of eighteen hundred peach trees, seventy-five pear trees and nine hundred apple trees, of improved budded or grafted varieties. Mr. John Terrell's orchard includes two thousand fruit trees of choice selection. These, notwithstanding the extreme rigor of the winter* of 1872-3, which caused such destruction of the orchards of Central Indiana, remain prolific and uninjured. Such facts invite the attention of fruit growers.

Undeveloped outcrops of silicious iron ore were seen on the lands of T. Snow, L. Prosser and J. Connelly. Workable beds are possible, but not probable. The "iron mountain," on the Marley farm, west of town, exhibits a wonderful amount of silicious ore, which although not pure enough to work alone, it is believed will prove valuable for fluxing specular ores.

The following shows the succession of rock on the surface; and in a well put down at the steam mill, viz :

*Mr. Prosser informs me that during that severe winter the thermometer indicated—22° in the valley, and the peach trees in the valley perished; at a height of one hundred and fifty feet the trees survived, and two hundred feet above the valley, the trees not only lived, but bore a full crop of fruit the next summer (1873).

SECTION AT HURON.

Conglomerate sandrock, with wedges and pockets of white sand.....	40 ft. 00 in.
Bituminous limestone with <i>Spirifer</i> <i>incrassatus</i> , <i>S. lineatus</i> , <i>Produc-</i> <i>tus cora</i> , <i>P. Semi-reticulatus</i> , and <i>Athyris subtilita</i> ..0.....	18 ft. 00 in.
Place of rash coal.....	4 in.
Thin bedded Chester grit stones.....	65 ft. 00 in.
Heavy bedded Chester grit stones.....	6 ft. 00 in.
Blue limestone.....	16 ft. 00 in.
Red and blue clay.....	2 ft. 00 in.
Soapstone and pyrite.....	4 ft. 00 in.
Black slaty coal.....	0 ft. 8 in.
Soapstone	1 ft. 8 in.
Gray limestone with flints.....	16 ft. 00 in.
	— —
	129 ft. 8 in.

Half a mile west of the village the Chester beds were once extensively worked. The product was known to the trade as the "Huron stone," and a considerable quantity of grind and currier stone grits was quarried and prepared for market. The quality of the product was satisfactory, but the enterprise perished for want of capital. The supply is inexhaustible, as the bed is 25 feet thick.

Going east from Huron the strata rise against the dip at the rate of about eighty feet to the mile, and the bituminous limestone at or below the surface near town, is found at Connelly's hill, two miles east, to have mounted to the summit. Thin outcrops of slaty coal were noted on the sides of the hill; but as these strata are below the proper horizon, the existence of a workable seam is exceedingly improbable if not impossible.

The following section taken on the S. E. qr. Sec. 4, T. 3, R. 2, W., ranges down through the conglomerate and the Chester beds to the upper part of the St. Louis formation.

SECTION ON CONNELLY'S HILL.

Sandy soil with Hematite.....	10 ft. 00 in.
Conglomerate, with stems of fossil plants.....	45 ft. 00 in.
Bituminous limestone— <i>Producta</i> , <i>Spirifera</i> , etc.....	14 ft. 00 in.
Place of rash Coal.....	8 in.
Laminated and shaly sandstone with partings of chert.....	55 ft. 00 in.
Argillaceous limestone containing chert and partings of sandstone..	30 ft. 00 in.
Cherty limestone in cave.....	8 ft. 00 in.
Argillaceous limestone with black flints.....	6 ft. 00 in.
	168 ft. 8 in.

The flint bed noted, was a favorite resort for the Indians. Here they quarried the material and extensively manufactured arrow and spear points, and other implements. Many ancient fire hearths are seen in the valley adjoining, surrounded with heaps of "flint chips." Mounds on the top and eastern face of the hill indicate the presence of an earlier race.

CONNELLY'S CAVE

Has its door at the foot of the hill, Section 4, Township 3, Range 2, West. Its general course is from northwest to southeast. The roof is usually from 12 to 20 feet above the brook which runs over the floor; the width is about the same but many wide chambers were found, some of which were adorned with snowy curtains of stone supported by robust stalactites and spherical stalagmites. It has an explored length of two miles. Much nitrous earth, spangled with shining crystals, is found in the upper part. A bed of pure yellow clay, ready washed, invites experiments by potters. The cave was formerly frequented by the black bear whose wallows and winter beds may be seen. For a list of the actual fauna, I am indebted to Dr. Elrod, of

Orleans, viz: A Fly, Beetles, Crickets, Centipedes, Crawfish, Blind-fish, etc. including several new species. The blind animals are permanent residents of the cave. A large-headed "seeing fish," *Potamocottus?* winters in the cave, but goes out at the breeding season to the light and sunshine of summer.

"Spice Valley" in which Bryantsville is situated, gives name to the civil township. It was originally a dark gloomy forest. Giant walnut and poplar trees towered above, while a tangled mass of tree-like shrubs as Wahoo, Spicewood, etc., crowded the surface. Now cultivated, good crops of corn and wheat are raised. The "Old Kentucky" settlers have given much attention to the cultivation of the grasses, and several good *bluegrass* pastures are the result. This valley once had an outlet to White river, but the mouth is now silted up by a sand and gravel bank of great height. Beds of sand are noted on the old Bryant farm 225 feet above the present river. Near the residence of Wm. Bryant, southwest quarter Section 13, T. 4, R. 2, W, a small crevice pierces the roof of an unexplored cave; rocks thrown in may be heard for several seconds leaping and crashing down the black abyss. A stone attached to a string wandered 125 feet toward the bottom of the cave. Just below stump-hole-ford the "Buzzard" or "Saltpeter cave" is known to contain apartments on two floors. On Isaac Kerns' land, northwest quarter Section 12, T. 4, R. 2, W., a steep bluff exposing nearly the whole depth of the St. Louis beds occurs: along the crest of the bluff may be seen numerous specimens of *Lithostrotion proliferum*, sometimes in tufts, but generally the calyces are solitary.

Blue Spring cave on the south side of White river, and two miles below Wood's ferry, has been explored three miles. A large stream of water runs out, which is said to have cut basins within the cavern to a depth of more than 100 measured feet; the volume is greatly increased by rains, or at time of high water, and then its current may be seen sweeping across the river into which it is discharged. It would be interesting to discover the source of this greatly

increased amount of water, whether from "sinks" and branches, or from the river itself at a higher level.

Mitchell, a thriving railroad town, is situated at the crossing of the O. and M. with the L. and C. railway. The purposed road hence to the Ohio river at Rockport, fairly promises completion at an early day, and traversing, as it does, the coal fields of Dubois and Spencer counties, will give incentive to manufactures by furnishing cheap fuel. The town is surrounded by a wide area of level or gently undulating land which, judging from the surrounding hills, was originally a valley of erosion, and afterwards the flood plain of White river. The surface rock is the upper cherty member of the St. Louis beds. At every wash, around town, massive specimens of silicified corals as *Lithostrotion Canadense*, *L. proliferum*, and *Syringopora* are found with quantities of *Productus cora*, *Bellerophon levis*, *Dentalium primevum*, *Athyris ambigua*, etc. Sink holes are a constant feature, some forming pools of water—ready-made fish ponds—while others are dry, and some of which, shaded by surrounding trees, might be utilized as amphitheaters for lecture or festive meetings. Many wells in this region are fed by the underground brooks, and from these it is not unusual to draw up eyeless fishes and crustaceans, inhabitants of the adjoining caves. The "valley level" is bounded on the west by a range of hills composed of the Chester formation, running from northwest to southeast nearly parallel with, and about three miles west of the L. and C. R. R. From the top of one of these hills, on the Rariden farm, Sec. 26, T. 4, R. 1, W., one hundred and seventy-five feet above the plain, is obtained a good view of the surrounding country, including the conglomerate hills, six miles to the northwest; Bedford, eight miles to the northeast; the knobs of Washington and Jackson counties ten or fifteen miles away in the eastern horizon, with glimpses of White river and its valley. The broad alluvial plain within this area of more than one hundred and fifty square miles, is a measure of the duration and extent of past erosive forces.

The following section, taken at Peach Orchard Hill, Sec. 26, T. 4, R. 1, W., shows the extent of the Chester rocks at this point. Many interesting fossils, including perfect specimens of *Lepidodendra*, *Stigmaria* and *Sigillaria* were collected here by Miss Lottie Rariden :

SECTION AT RARIDEN'S HILL.

Slope, sand and clay.....	40 ft. 00 in.
Sandstone, ferruginous, laminated, with trunks and bark of carboniferous plants and thin partings of coal.....	60 ft. 00 in.
Argillaceous limestone with Chester fossils, the upper bands lithographic	35 ft. 00 in.
Chert beds with siliceous corals.....	40 ft. 00 in.
	— —
	175 ft. 00 in.

The proprietors of these elevated tables have taken advantage of the immunity from frost, afforded by sharp knolls, and devoted a large area to the cultivation of fruit with profit. In fact, persons who plant a few acres of such land, are at once placed in easy circumstances, with a source of income more reliable than mines of gold or coal.

Dr. Rariden, W. Dodson, John Edwards and others, have given the culture of fruit much attention. The area planted to peaches amounts to over one hundred acres, of which fifty acres are in full bearing. The average crop of peaches nets \$100 per acre. Mr. Dodson sold his crop of 1871 in the orchard for \$200 per acre. Vineyards of small extent are planted, with cheering prospects. The Ives seedling and Concord vines are thrifty, sure and prolific bearers; they are said to have never been affected by the "blight" in this vicinity.

In the road, near the residence of J. L. Dodson, S. W. qr. Sec. 26, T. 4, R. 1 W., is a coral reef—silicified *Syringopora*, in a matrix of chert. Blocks of this were quarried and used by the prehistoric races to make the reddish

colored wrought stone weapons, so often found in this vicinity. A weathered specimen of this coral was presented to the State Cabinet by Capt. R. P. Dodson, of exceeding beauty. Another, and masses of *Lithostrotion* were donated by Dr. J. W. Harbin. On the Dodson farm was found a sumach (*Rhus Glabra*) of prodigious size, the trunk measuring eighteen inches in circumference.

"Mitchell lime" is favorably known to the trade. Asa Erwin, on Rock Lick creek, N. E. qr. Sec. 24, T. 4, R. 1 W., uses a common kiln, capable of burning one thousand bushels at a time. His annual product is seventeen thousand and five hundred bushels, which sells at twenty cents per bushel delivered on the cars. The product is a white lime, which works "hot," and is found to be nearly equal to cement for foundations. He makes use of the *Vermicular stratum*, a bluish gray limestone, massive, but traversed in every direction irregularly by tubular canals, from one-eighth to one-half inch in diameter. The stone, on account of its porous nature, is found to burn and slake with great certainty. The waste lime from this kiln has been used with remarkable profit as a manure, and the result invites further experiment.

SECTION AT ERWIN'S KILN.

Soil and slope, broken chert.....	3 ft. 00 in.
Slaty coal.....	4 in.
Argil. limestone.....	2 ft. 6 in.
Argil. limestone, lithographic.....	1 ft. 2 in.
White or gray limestone.....	3 ft. 6 in.
Vermicular limestone.....	4 ft. 6 in.
Heavy bedded limestone.....	6 ft. 00 in.
Flaggy limestone.....	8 ft. 00 in.
	— —
	29 ft. 00 in.

The adjoining cave was formerly resorted to by black bears for hibernation. Bones and teeth of these animals are often found in the cave, and occasionally flint spear and arrow points, showing that our predecessors fought this

animal in his den. Rock Lick creek flows from the cave, crosses the circular "sink valley," and passes away under the hill on which the lime kiln is situated, to emerge in another valley beyond, playing "hide and seek" amongst the rocks.

In the neighborhood, Maj. D. Kelly and Jno. Tomlinson burn stone from the same geological horizon. Their annual product is about 10,000 bushels. The lime is popular and in demand for shipment to the lower Wabash and southern Illinois.

Near the residence of J. H. Crawford, S. W. qr., Sec. 18, T. 4, R. 1 E., is a good exposure of the upper St. Louis beds, rich in fossils—*Pentremites conoideus* and *P. Woodmani* were especially abundant. Going east from Mitchell, outcrops of the chert bed are seen along the hillsides and railroad cuts. Fossils are abundant, consisting of forms characteristic of the St. Louis limestone. At the top of the hill near Hamer's mill, the only *perfect* specimen of *Zaphrentis spinulosa* found in the county was picked up and presented by Dr. McIntyre.

HAMER'S CAVE

Is entered on the side of a hill, southeast quarter Sec. 32, T. 4, R. 1 E., 45 feet above the valley. A main and narrow side entrance, both handsomely arched, give admittance. The floor is level, six feet wide and covered with a swift stream of water eight inches deep, although at places the depth is increased to twenty feet. A boat of course is needed for exploration. Three quarters of a mile from the door is the first fall. The whole stream rushes down an incline only three feet wide, with great violence and a noise that fills the cave. The boat must be carried above this obstacle, when another voyage is taken along a space of 300 feet to the second falls, or "grand cascade." Beyond, the cave is low, wet, and full of rushing water, which flows out of a crevice in the rock. Eyeless fish, crawfish and other crustaceans are caught in this and the two adjoining caves, which have outlets in the grand amphitheater in which the mill is situated. The cave creek,

applied to a wheel 22 feet in diameter, affords a power equal to nine horses. By using unemployed facilities this power may be quadrupled.

DONNELSON'S CAVE.

Donnelson's cave has its entrance on S. W. qr. Sec. 33, T. 4, R. 1 E, near "Shawnee Cottage," the winter residence of Mr. George Donnelson. A large stream of water is discharged which was used by the former proprietor to drive a woolen, grist and saw mill. About the year 1800 gunpowder was here made from the great supply of nitrous earth found in the upper chambers. Remains of the powder mill may still be seen. The entrance to the cave is wide and lofty, but following the central passway it is soon reduced to a narrow passage, covered with a shallow stream of water. Explorations may be made by wading or in a light canoe. Within is a magnificent cascade, where the stream rushes and leaps down a narrow passage with such violence that the rumbling noise is heard at the entrance. This passway is known to extend through to Dalton's spring, three-fourths of a mile to E. S. E. Near the entrance a dry cave is seen opening to the east; directly opposite a lofty corridor leads to the west, and in less than one hundred feet enters a grand hall twelve feet high, three hundred feet long and forty feet wide. If lighted this would make a novel and interesting lecture or assembly room. In the winter thousands of bats gather here to hibernate, hanging in clusters, like a swarm of bees, from the ceiling or sides. The clusters of bats vary in numbers from twenty to several hundred, or in measure "from a quart to a bushel."

Eyeless fishes, crustaceans and crickets have been caught here. The cave shows signs of pre-historic inhabitants, as flints, stone axes and bones have been found in and around the door of the cave in numbers. I append a list of animals found in Connelley's, Hamer's and Donnelson's caves, by Drs. Elrod and Sloan; insects and fishes as determined by A. S. Packard and Prof. Cope. (See Geol. Ind. 1872, and report of trustees of Peabody Academy, 1872.)

CAVE FISHES.

Amblyopsis speleus.....Blind.

CAVE CRUSTACEANS.

(*Crawfishes, etc.*)

Cambarus pellucidus.....Blind.

Cæcidotea stygia.....Blind.

Crangonyx vitreus.....Blind.

Euphilosia Elrodii.....Blind.

Cauloxenus stygeus.....Blind.

CAVE INSECTS.

Anthomyia (?).....Blind.

Anopthalmus tenuis.....Blind.

Platynus marginatus.....Seeing.

Ceuthophilus Sloanii.....Seeing.

At the Mill creek quarry cut, of the O. & M. R. R., five miles east of Mitchell, is an interesting outcrop, showing the junction of the St. Louis with the Keokuk. The first is rich in characteristic fossils, including many *Pentremites*; in the latter was found a tooth of a shark, *Cladodus spinosus*. A bed of ochreous clay, of a rich brown color, in sufficient quantity to paint all the railway cars and agricultural implements in the world, covers the rocks, and ought to be utilized. Ochre is common and in unlimited quantities all over the county.

From this point eastwardly the Keokuk beds generally constitute the surface rock along the railroad. They are seen rapidly mounting the sides of the hills, and near Tunnelton form the cap rock, one hundred and fifty feet above the river.

SECTION NEAR TUNNELTON.

Slope.....
 White limestone..... 2 ft. 00 in.
 Blue limestone..... 6 ft. 00 in.

Argillite with geodes	5 ft. 00 in.
Magnesian limestone with <i>Hemipro-</i> <i>nites crenistria</i> etc.....	6 ft. 00 in.
Argillite with geodes.....	12 ft. 00 in.
Green and blue shales.....	20 ft. 00 in.
Silicious shales with bands of Waverly sandstone.....	30 ft. 00 in.
Knobstone shales, containing <i>Producta</i> and <i>Spinifer capax</i>	60 ft. 00 in.
	— —
	141 ft. 00 in.

Outliers of the Keokuk beds* are seen on the hill tops about Ft. Ritner. In the bed of the creek north of the village, an immense number of geodes, some of great size were seen. The Knobstone forms the sides of the valley; but very few imperfect fossils were found. The sandstone in this vicinity and at Tunnelton, although not extensive, is of excellent quality, and may be sawed or split. Well cut samples were seen at the residence of the "Section master" near the lower tunnel. The greatest exposure of the Knobstone shales in this vicinity measures 250 feet above White river.

The crests of the Knobs have been devoted to fruit culture. Extensive orchards and vineyards have been planted with good results. The crop is sure, of good quality, and commands a ready market. Nature declares that for long periods in the past, these knobs have been protected by their peculiar structure from the effects of sudden "cold snaps," for on such high knolls, chestnut trees three to four feet in diameter are growing, vigorous and fruitful. These trees cannot bear fruit, can hardly live in the cold temperature of the valleys. The same fact was noted as to the high hills near Port Williams in the west side of the county.

At Leesville the soil is of rich, reddish brown, fading to a "mulatto loam," and would doubtless produce good tobacco as well as corn, grass and wheat. The surface rock is the Keokuk with outliers of St. Louis Limestone. The

creek valleys are cut down some depth into the Knobstone shales.

At Heltonsville is a good illustration of the uneven surface of the Knobstone, on which the more recent limestones were deposited. In the south part of the village the Knobstone exposes a thickness of over 90 feet, but dipping rapidly to the north and west passes below the water of Leatherwood in that part of the town. Heltonsville is famous on account of the number, variety and beauty of the geodes here found. Many of them are geodized *Crinoidae*, *Spirifera*, *Zaphrentes*, *Lithostrotion*, *Goniatites*, *Bellerophon*, etc.

SECTION SOUTH OF HELTONSVILLE.

Clay and geodes on slope.....	
Soft Knobstone.....	50 ft. 00 in.
Green and blue pyritous shale.....	40 ft. 00 in.
	— —
	90 ft 00 in.

SECTION NORTH OF HELTONSVILLE.

(West side of Leatherwood Creek.)

Slope.....	
Geode bed.....	4 ft. 00 in.
Crinoidal limestone crowded with joints, plates and crushed heads of <i>Encrinites</i>	8 ft. 00 in.
Knobstone shale and sandstone to creek.....	15 ft. 00 in.
	— —
	27 ft. 00 in.

A syclinal axis a mile north of town depresses the strata sufficient to allow outliers of St. Louis limestone, which are quarried for masonry and burning.

Guthrie is surrounded by high Knobstone hills capped with Keokuk limestone. Immense numbers of geodes varying from one to fourteen inches in diameter, are found

along the creeks and hill sides. Quarries of Waverly sandstone (Upper Knobstone), are of common occurrence; used for foundation and chimneys this stone presents a good appearance, weathers well, and invites exploration by parties desiring a sandstone which may be cut by sawing. The only Knob-fossil seen was a *Spirifer capax*, found on the roadside a mile east of town. The bottoms of Salt creek in this vicinity are of great width—entirely out of proportion to the necessities of the actual stream, and evidently owe their existence to causes anterior to the present state of affairs and not now in action. Large amounts of oak and poplar lumber, staves etc., are manufactured and shipped from this and neighboring stations. The knobstone soil is well suited to the growth of the fine grasses. Fair crops of corn and oats are produced, and plants that require a large amount potash as potatoes, turnips, etc., are of unrivalled quality. The knob shales contain much pyrite (Sulphuret of Iron) which decomposes on exposure. The sulphurous exhalations from this source are supposed to prevent blight and the growth of fungi on fruit trees and vines.

SECTION NEAR GUTHRIE.

	(west of town.)	(east of town.)
St. Louis limestone..	40 ft. 00 in. to	00 ft. 00 in.
Keokuk limestone...	25 ft. 00 in. to	3 ft. 00 in.
Knobstone.....	50 ft. 00 in. to	140 ft. 00 in.

145 ft. 00 in.

From a well dug by O. P. Anderson S. W. $\frac{1}{4}$ Sec. 15, T. 6, R. 1 W., the following St. Louis fossils were identified, viz: *Rotalia*, *Cypris*, *Euomphalus*, *Bellerophon*, *Fenestella*, *Zaphrentis*, *Terebratula*, *Rhynchonella*, *Spirifera*, *Murchisonia*, *Pentremites*, and *Batocrinus*.

West of Guthrie the soil indicates a natural adaptation for the growth of grasses. This indication may be followed with profit. Some good fields of blue grass were noted.

ECONOMIC GEOLOGY.

Agriculture is the chief source of a people's wealth. The quality of the different soils has been mentioned in the foregoing notes. About one-half of the land in Lawrence county has been reduced to cultivation; the other half is unimproved, and devoted chiefly to the production of brush, weeds and briers. I cannot too earnestly recommend that such lands ought to be improved by destroying the useless growth, and seeding to grass. Experience demonstrates that grazing is one of the most profitable branches of agriculture. Limestone is abundant, and may be burned by farmers at a low cost per bushel. The tests made by Messrs. Hall and Irwin show that worn fields may have their fertility restored and cheaply maintained by the use of lime.

WATER POWER.

This power is the cheapest known. The expense of a dam rarely exceeds the cost of engines and fixtures. The motive power of such a stream as White river, if utilized, is of great value. It is now allowed to flow away without let or hindrance. In New England such advantages would call into existence large manufacturing cities; and we may expect the same results here. A large amount of this power may be profitably applied to the preparation of stone for architectural purposes, or for metalling turnpikes.

STONE.

This county is well supplied with building material. The "Bedford stone" is so well known, that its excellence is proverbial. Similar beds exist in different parts of the county. We may surely look to these as a great source of wealth. With capital, energy, and the use of water power,

the market demand of several States could be easily supplied. The sandstones in the eastern and western parts are of fair to good quality. The fire and weather proof conglomerates are superior for foundations and heavy masonry. Sand, lime and clay, for bricks, are abundant.

The limestones throughout the county, broken in fragments, are well suited for metalling turnpikes; and enough to supply the county and adjacent regions could be cheaply prepared by machinery, recently invented for that purpose.

IRON ORE.

The Fayetteville ore is of unrivaled quality, and from tests made at Whittaker's farm is well developed. Careful examinations will discover similar deposits in neighboring localities. Small specimens of excellent ore were found near Bartlettsville, the amount of which has not been tested.

SILVER.

Indian tradition has located one or more mines of silver or lead in every township between the Alleghany and Rocky mountains. In this county they were more liberal, and in fancy gave beds of silver to almost every farm. No evidence to support such ideas was found, and the existence of workable quantities of silver or lead is highly improbable if not impossible.

MINERAL SPRINGS.

The White Sulphur springs noticed at Avoca, Bedford and Indian creek, have a well ascertained value for medical purposes, and may be relied on to cure or relieve our "national disease," dyspepsia.

CAVERNS.

The caves of this county are extensive, generally unutilated and full of interesting forms and life. They will command the attention of tourists and naturalists.

ANTIQUITIES.

On the southeastern slope of the hill over Connelley's cave, two miles east of Huron, is a group of seven mounds,

from two to four feet high, and an obscure winding way may be traced leading from the cave spring to the top of the hill. On the summit fragments of sandstone reddened by burning, and small shell heaps are seen. The mounds were probably habitations. From protruding pieces of stone seen on the sides, the internal construction was of that material instead of timber, as was usual in similar structures on the Wabash and Mississippi. A central tumulus having a double circular wall was probably for sepulchral purposes.

A mound similar to the last at the site of the former county seat, Palestine, or "Old Palestine" as it is called, was explored in 1870 by Messrs. Newland, Dodd and Houston. On the surface of the hill a confused mass of stones, such as a man could conveniently carry, were noticed, indicating a circular wall twenty feet in diameter. It was found to be a vaulted tomb. The first or upper vault, contained the bones of many women and children, a layer of flat stones divided this from the second, which contained the bones of men; another layer of flags, and at the bottom, six feet below the surface, two skeletons were found, with their heads placed to the east and faces to the north. The last were persons of great size, being not less than six and a half feet high. With the skeletons were found a quantity of flints, arrow points, etc.; near the head of the largest individual a pair of hammered copper ear rings and a globular "war whistle." The keen noise of the latter may be compared to the sound of a policeman's whistle, and can be heard nearly a mile. Stone axes and pieces of pottery are found on the surface near this tomb. Mr. Bart. Williams has a collection of stone relics, consisting of axes, flints, pestles and two carved pipes, one modeled after the head of an Indian, with strongly characteristic features, the other of a deer, both well executed.

Acknowledgements are due to the citizens of Lawrence county for courtesy and polite aid. Thanks are returned to the following persons for special favors and specimens presented to the cabinet:

Charles T. Woolfolk, I. W. Thomas, Theo. Aley, Eddie

Culbertson, Drs. Newland, Gardner and Stilson, Hon. G. W. Friedly, Thos. Dodd and H. and G. Houston at Bedford; to Col. J. E. Bryant, Dr. Johnson and J. and B. Williams, at Fayetteville; to Lafe. Prosser and J. Marley at Huron; to Dr. McIntire, Capt. Dodson, Hon. Wm. H. Edwards and Messrs. Hamer, at Mitchell; T. J. Reed, at Fort Ritner; Mr. Starr, Heltonsville; and Capt. W. and O. P. Anderson, at Guthrie.

NOTE.—Since the following pages were written I have learned that the BEDFORD STONE, of Lawrence county, Indiana, is exclusively used in constructing the exposed surfaces, pilasters and capitals in the new State House at Springfield, Illinois.

After a carefully conducted series of competitive tests, by experts, this stone was deemed superior to any other in the Western States for permanent, heavy structures where ornamentation is desired. Some of the capitals have been elaborately wrought at a cost, for labor, of eight hundred dollars each, and attest the superiority of this stone for carved work.

ANALYSES OF IRON ORES.

BY E. T. COX.

Hydrated brown oxide of iron from George Whitaker's land, Sec. 28, T. 5, R. 2, leased by the Shoals Iron Company, brownish red color, fine grained and free from chert.

No. 1 was sent from the Shoals blast furnace, Martin county Indiana.

No. 2, direct from George Whitaker.

Analysis of No. 1 :

Loss by ignition, water.....	13.000
Insoluble silicates.....	.900
Ferric oxide.....	84.890
Alumina.....	trace
Phosphoric acid.....	.145
Manganese.....	none
Magnesia	none
Carbonate of lime.....	1.000
Loss.....	.065
	100.000

Metallic iron, 59.423.

Analysis of No. 2 :

Loss by ignition, water.....	13.000
Ferric oxide.....	83.200
Alumina.....	trace
Insoluble silicates.....	1.200
Phosphoric acid.....	.150
Sulphur.....	trace
Carbonate of lime.....	2.000
Manganese.....	none
Loss.....	.450
	100.000

Metallic iron, 58.24.

This ore is rich in iron, containing from 58.24 to 59.423 per cent., and remarkably free from earth and deleterious impurities. It will, with proper treatment, make a very fine quality of metal, suitable for Bessemer and other uses. The Shoals Furnace Company have commenced to use it and expect to obtain their entire supply of ore from this county.