

GEOLOGY OF WASHINGTON COUNTY.

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GENERAL DESCRIPTION AND HISTORY.

Washington County, situated in the southern part of the State of Indiana, is separated from Lawrence and Jackson counties on the north by the east fork of White River and its large tributary, the Muscatatuck River; east it is bounded by Scott and Clark counties; south by Floyd, Harrison and Crawford counties, and west by Orange and Lawrence counties. The area included within its domain is about 510 square miles, or sections of land, equal to 326,400 acres. There are thirteen civil townships in the county. Beginning in the north-west corner of the county and going east there are Brown, Jefferson, Monroe and Gibson in the first tier of townships; Vernon, Washington and Franklin in the second tier; Madison, Howard, Pierce and Polk in the third tier, and Posey and Jackson in the fourth tier.

The first permanent settlements were made about the year 1800, and the county was organized by act of the Legislature in 1814.

Salem, the beautiful county seat, is situated nearly in the geographical center of the county. It is a town with an enterprising population of about 2,000, and contains many thriving industries. The population of the county is about 20,000. The following table shows the gradual increase of population in the county since 1810:

Population in 1810	250
" 1820	9,039
" 1830	13,064
" 1840	15,269
" 1850	17,040
" 1860	17,909
" 1870	18,495
" 1880	18,955

Salem was platted, and, by law, made the county seat the same year that the county was organized. While in no period of its history has the town ever made the phenomenal growth for which many American towns are noted, it has, nevertheless, kept steadily abreast of the business of the

county, and has never suffered a decline of growth nor business, nor retrograded in any particular. Its enterprising citizens have recently erected commodious water works, which are fully adequate to supply the necessities of the city for many decades to come. Commercial enterprises are the main industries of the place, and in the various lines of commerce the business men of Salem have an entire monopoly over a very large extent of territory.

There are, however, quite a number of manufactories vigorously at work, and the energy they display in the discharge of their various labors is ample evidence that the results are profitable. Flouring mills, saw mills, woolen mills, foundries, carriage and wagon works, cabinet shops, blacksmith shops, and the manufacture of boots, shoes and clothing are among the many industries represented at Salem, and to some extent in the other towns of the county.

The other towns and villages of the county are Campbellsburg, a station on the L., N. A. & C. R. R., in the north-west corner of the county, which had in 1880 a population of 386; Livonia, in the western part of the county, population in 1880, 211; Hardinsburg, in the south-west corner of the county, population in 1880, 126; Harristown, five miles, and Pekin, nine miles east of Salem; Canton, four miles north-east of Salem; Philadelphia, four miles east of Canton; South Boston, four miles south of Philadelphia; Chestnut Hill, in the extreme south-eastern part of the county; Little York and Gooseport, in the north-east corner of the county; Kossuth, Plattsburg and Millport, in the northern part of the county; Saltilloville, a station on the railroad, two miles west of Campbellsburg; Fredricksburg, in the southern part of the county; Martinsburg, six miles east of Fredericksburg, and Claysville, three miles north of Livonia.

The population of the county is mainly an agricultural one. The foreign and colored population is small. School facilities are excellent, and the citizens are quick to take advantage of them. The Salem Graded School, under the effective superintendence of Prof. Bridgman, and the Academy, under the management of Prof. May, are schools that compare favorably with similar institutions in many larger cities.

The various religious denominations are represented at Salem, and throughout the county, by energetic and conscientious pastors and intelligent memberships, who have comfortable houses of worship.

TOPOGRAPHY AND DRAINAGE.

From the vicinity of Salem westward to the county line, especially along the line of the Louisville, New Albany & Chicago Railroad, the surface of the county generally is level, or nearly so. The northern and eastern parts of the county are broken and rough. Frequent ravines have been cut deep into the soft shales of the Knobstone group of rocks,

and these have formed long ridges with abrupt sides and acute summits. These ridges terminate, in many instances, in steep, picturesque headlands, which have acquired the local name of "knobs." The creeks of the northern part of the county flow a northerly course, with a slight trend to the west, and empty their waters into the East Fork of White River or the Muscatatuck. Beginning on the west is Clifty Creek, four miles in length; Twin Creek, seven miles long; Rush Creek, four miles long; Buffalo Creek, six miles long; Delaney's Creek, ten miles long, and Elk Creek, in the north-east, eight miles long, all tributaries of the Muscatatuck or White River. These creeks all have more or less small branches for tributaries, and the bluffs of all are invariably high and steep, but with the exception of Clifty, Twin and Rush Creeks, the bluffs are not precipitous. The eroded beds of Rush, Twin and Clifty Creeks were cut down through the heavy limestones of the St. Louis group of rocks, and along these streams picturesque walls of perpendicular limestones may be seen the greater portion of the way along their courses. Along the other streams that have worn their way through the shaly sandstones of the Knobstone rocks, the sides of the bluffs have a steep incline, or a slightly rounded contour. The disintegrated and decomposed rocks have formed a light-gray soil, heavy and silicious, which supports a sparse vegetation of oak and chestnut saplings, with some other varieties of trees, and many wild vines and bushes. Huckleberry and blueberry bushes grow quite plentifully upon the "knobs," and the fruit they produce is gathered quite eagerly by the children of the vicinity. Felling the oak trees, and stripping them of their bark, during the spring of the year, for tanning purposes, has been quite an industry in the "knobs" for many years. The few walnuts and large poplars that grew in this region have all been cut and shipped to the lumber marts of the East. All of the eastern and southern parts of the county are drained by Blue River, or some of its many branches. Blue River rises in the eastern part of Washington County, flows a south-westerly course, and empties into the Ohio River near Leavenworth, in Crawford County. The entrance to the famous Wyandotte cave, of Crawford County, is near this stream, four miles from Leavenworth. The principal branches of Blue River, in Washington County, are the North Fork, which rises north-east of Salem, and flows south-westerly; Middle Fork, which rises north-east of Canton, and the South Fork, which rises north of Philadelphia. Bear Creek rises near Chestnut Hill, and flows north-west through Franklin Township, and empties into the South Fork. The junction of the two larger branches of Blue River is near the county line, in the vicinity of Fredricksburg.

The central and southern parts of the county are, in many localities, considerably broken, but the land is not so rough as much of the north and east.

The sources of the many branches of Blue River are near the line of the eastern limit of the Keokuk limestones. Following the streams down their courses they are observed to have cut their channels down through the limestones, and into the sandstones and shales of the Knobstone rocks. At one time the valleys were evidently very deep, and their sides steep or precipitous, but the deep gorges have gradually been filled with the *debris* and wash from the hillsides and uplands, until now these small streams all have broad and beautiful, and better still, most fertile strips of bottom land, that yield most abundantly in response to liberal cultivation.

West and south-west of Salem the St. Louis limestones are the surface and underlying rocks for a distance of ten to fifteen miles. These rocks are sometimes referred to as the Cavernous limestones. Water percolating through them for long periods of time, and carrying elements in solution that assisted in decomposing the rock, has finally cut out subterranean channels of immense extent. Washington County has quite a number of caverns, some of considerable extent and remarkable beauty, which will receive further notice in this report. In some instances the stone arch forming the ceiling of the cavern has given away and caused a "sink" in the superincumbent strata. The depression on the surface assumes a funnel shape, and the water that may run into it sinks into a subterranean channel and flows away through the tortuous windings of some cavern of greater or less extent. These "sinks" are quite numerous in the western and south-western part of the county. They vary in depth from eight or ten feet to fifty feet or more; and in diameter from eight or ten yards to seventy-five or more. In some instances the opening at the bottom becomes closed, so that the water can not get through, and a pond is formed. The ponds thus formed are sometimes ten or twenty feet in depth, and, when stocked with sunfish or common catfish, they furnish a lasting supply of a very choice article of food.

Along the western line of the county, beginning about four miles south of Campbellsburg, and extending to the southern limit of the county, is a range of high ridges. The summit of these ridges is about one hundred and fifty or two hundred feet above the level of the county, east. The eastern base of these ridges is from two to four miles east of the west line of the county. They consist of a great mass of limestone, capped with from fifty to one hundred feet of Chester Sandstone. The ridge, known locally as "Sandstone Ridge," is cut into by deep ravines, that usually have a south-easterly direction. The summit of this sand ridge is probably one hundred feet higher than any other point in the county. The railroad cut through Spurgeon Hill, at Harristown, five miles east of Salem, is the highest point along the Louisville, New Albany and Chicago Railroad, in Washington County. The summit of the "Knobs," in Gibson Township, is somewhat higher than the surface in the vicinity of Salem.

South of Campbellsburg, and just north of the northern end of Sandstone Ridge, are the headwaters of the north fork and south fork of Lost River. They rise in the level region, evidently an old lake bed, and flow west through Orange and Martin counties, and empty into White River, near the Dubois County line. The junction of the two forks is two or three miles west of the Washington County line. South of Orleans, about four miles, the stream sinks into the ground, and runs through a subterranean channel to Orangeville, a distance of seven or eight miles, when it again appears with a considerable accumulation of water, which is evidence that it has subterranean tributaries.

The summit of the "Knobs" is said to be over 900 feet above the ocean level. At Harristown the railroad track is 874 feet above the ocean; the altitude of Salem is 717 feet, and that of Smedley Station, five miles west of Salem, is 877 feet. At Salem the altitude given is that of Blue River. The court-house is located upon land twenty-five or thirty feet higher, and the top of the hill upon which the reservoir is located, is about 90 feet higher than the lower part of the town. The summit between Blue River and White River is 911 feet above the sea. The top of Spurgeon Hill, at Harristown, is probably 125 feet higher than the Railroad track in the cut, or 1,000 feet above the ocean. The surface of Blue River, near the Harrison County line, is 595 feet above the sea. This stream crosses the county line just east of the Sandstone Ridge, and its course was abruptly changed to the south from this point by the rocky barrier to the west.

The depression between the Sandstone ridge on the west, and the summit of the "Knobs" on the east, forms a valley from twelve to fifteen miles in width, with a general south-west direction across the county. This valley is the effect of vast erosions, in which the whole of the Chester group, and from one hundred to two hundred feet of the St. Louis limestones were decomposed, disintegrated, and broken down by various causes, and washed entirely away.

From a point beginning in the vicinity of Beck's mill, six miles south of Salem, and extending on to the Harrison County line, is a region of country called "The Barrens." This area, about ten to fifteen miles in width, abounds in the "Sinks" peculiar to the "Cavernous limestones." The growth of timber in this region now consists mainly of various varieties of oak, black oak predominating, and none of the trees are more than about one foot in diameter. The growth is thick, however, but the point of main interest consists in the fact that within the memory of the oldest settlers of the region the whole area was entirely bare of timber, and where the young forests now are there were only a few straggling bushes of various species, the largest of them not more than three or four inches in diameter.

Springs are numerous in all parts of the county, but the whole of the

western half of the county is noted for underground currents, which emerge in many places as creeks of considerable size. Clifty Creek, three miles north of Campbellsburg, flows out of a large cave on the farm of Mr. Henry Robertson. The cavern has never been fully explored, but parties have been in it for a considerable distance, and it is said to be of considerable magnitude, and to possess many features of interest. Clifty Creek, as it emerges here, is a stream sufficient to furnish water power to run a large mill. Mr. Robertson uses the power to run a distillery and grist mill.

On the farm of Gen. James A. Cravens, one mile north of Hardinsburg, there is one of the most remarkable springs of this character in the county. The power is not utilized, but it is said there is sufficient power available to furnish a forty foot head of water, and enough to drive a one hundred horse power engine.

On the lands owned by the Salem Stone and Lime Company there is another spring of large size which emerges from a cave in the same manner. The power here is scarcely available, however. Many more springs occur in various parts of the county.

GENERAL GEOLOGY.

The rock formations of this county all belong to the great Sub-Carboniferous system. The Knobstone, the oldest rocks exposed, occur in the eastern and northern parts of the county. These rocks are exposed in the creek channels as far west as Harristown, and within three miles of Salem. The Knobstone exposures are followed by the Burlington limestones, Keokuk limestones, Warsaw limestones, St. Louis limestones, Chester limestones and Chester sandstone. There is no absolutely clear distinguishing feature between the rocks that I have referred to as Burlington and the Keokuk, inasmuch as many fossils largely found in the Keokuk group occur also in these beds. But many of the species characteristic of the Burlington rocks occur here, and, on the whole, I think in the strata immediately overlying the Knobstone, in the vicinity of Philadelphia and north-west of that point, the Burlington fossils largely predominate. Among the Crinoids found in that section may be enumerated *Agariocrinus nodosus*, *Batocrinus christyi*, *Dorycrinus roemeri*, *Eretmocrinus remibrachiatus*, *Platycrinus halli*, *Synbathocrinus wortheni*, and several others.

The Warsaw beds, which are referred to frequently as the Warsaw division of the St. Louis group, to my mind certainly possess as many distinctive features for classification as any other member of the Sub-Carboniferous system. There is a marked uniformity in the fossils wherever these rocks are exposed, and the stone varies as little, probably,

in its lithological characters, as the rocks of any other group in this formation. Besides, many of our most eminent paleontologists and geologists, in referring to these rocks, always speak of them as a group, and not as a division of a group.

When there is so little difference in the lithological characters of the rocks of the different groups as there exists in Washington County, and where there are so many fossils in every division common to all the groups, and where disintegration, decomposition and erosion has been so extensive as it has here, it is a task of the greatest difficulty to accurately determine the thickness of any stratum or group of rocks to anything like absolute correctness. A great portion of the overlying clays, with their attendant geodes and fragments of chert, are composed almost wholly of decomposed limestones and other rocks. The clays are almost wholly of a dark red color, containing a very large per cent. of *ferric oxide*. In many localities these clay are found to contain vast numbers of perfectly preserved fossils, sufficiently silicified to preserve them from decomposition by the elements that destroyed the limestones in which they were imbedded. These clays cover the hills, hill-sides and ridges throughout a large portion of the county, and it is no uncommon thing to find in one locality fossils that are characteristic of two or more groups of rocks, which shows that the disintegrated rocks, of which they are the remains, consisted of portions, at least, of two or more groups. Hence, it will be observed that where no rocks are exposed, and where one has no data to draw conclusions from, except the knowledge to be obtained from an examination of the fossils to be obtained from such localities, it is very difficult to find or fix the exact limits of a group or series of rocks.

The following connected section was made from examinations of isolated exposures in different parts of the county, and it is not assumed that it is more than approximately correct. Scarcely two points at which examinations were made were even contiguous to each other, and the difficulty of ascertaining the thickness of a group of rocks from partial exposures was such as to preclude the possibility of securing absolute correctness. Besides, the lithological character of the rocks, in some instances, changes so rapidly that in some cases it would be impossible to recognize two exposures in the same neighborhood as being portions of the same stratum, in the absence of characteristic fossils for a guide.

The following is the connected section :

CONNECTED SECTION.

QUATERNARY AGE.

Soil and alluvium	5 to 40 feet.
Lacustral	5 to 50 feet.

CARBONIFEROUS AGE.

SUB-CARBONIFEROUS PERIOD.

Chester Group:

Chester sandstone	10 to 100 ft.	
Coal, semi-cannel		6 in?
Thinly bedded gray limestone	5 to 20 ft.	
Heavy bedded lithographic limestone	10 to 40 ft.	

St. Louis Group—Upper Division:

Bryozoan bed, cherty limestone	3 to 6 ft.
Ferruginous crystalline limestone	0 to 12 ft.
Buff to gray argillaceous limestone	5 to 30 ft.
Blue magnesian limestone.	10 to 20 ft.
Ferruginous crystalline limestone	4 ft.
Dark blue bituminous limestone	6 ft.

Lower St. Louis or Warsaw Group:

Gray quarry stone, oölitic.	10 to 60 ft.
Blue crystalline limestone	6 to 12 ft.
Gray fossiliferous limestone	5 to 15 ft.
Blue argillaceous and magnesian limestone	6 to 15 ft.

Keokuk Group:

Buff cherty limestone	2 to 6 ft.
Gray limestone containing geodes	4 to 8 ft.
Gray to blue limestone with characteristic fossils	4 to 12 ft.
Gray shaly limestone	5 to 15 ft.

Burlington Group:

Buff to gray silicious limestone	4 to 8 ft.
Blue to gray shales.	2 to 4 ft.
Blue crystalline limestone.	4 to 6 ft.

Knobstone Group:

Yellow compact sandstone.	0 to 60 ft.
Buff, heavy bedded limestone	0 to 20 ft.
Yellow to gray sandstone	0 to 80 ft.
Ferruginous sandstone	10 to 20 ft.
Pyritous shales.	80 to 100 ft.
Dark blue shales containing ironstone nodules	150 to 200 ft.

THE KNOBSTONE GROUP.

The rocks of this group are exposed in the townships of Brown, Jefferson, Monroe, Gibson, Franklin and Polk. In Brown Township they are only seen at the bottom of the bluff of Clifty Creek, near its mouth, or in the bed of the creek itself, and they are exposed in the same manner near the mouth of Twin Creek. Where exposed here they are massive, light-buff in color, and somewhat coarse in texture. The stone may be quarried in blocks of any size, which are readily worked into any form the mason may wish. This rock withstands the influence of the weather well, and were it not that it is in a locality that furnishes an unlimited

quantity of limestone of a quality not excelled in the world, it would undoubtedly be much sought for for building purposes. There are from twenty to thirty feet of this stone exposed on Clifty Creek, and there is no marked variation in it either in color or quality. It is quarried to some extent for barn foundations. It is only exposed for two or three miles above the mouth of Clifty Creek. Near the mouth of Twin Creek the exposures are great, and the depth of exposure continues to increase as one goes east, owing to the westward dip of the strata. The general dip of the rocks in Washington County is from ten to twenty feet to the mile, with a west by south-west direction. Passing up Twin Creek to the mouth of Rush Creek, the sandstone exposures are much more prominent. The rock continues to be of the same uniform color and texture until the Rush Valley Postoffice is passed. But an exposure of the bluff on the road from Rush Valley to Mount Carmel reveals a stratum of twenty feet of buff to gray limestone, with sixty feet of sandstone overlying it. The following section shows the position of all the strata exposed at that point:

SECTION OF BLUFF ON RUSH VALLEY AND MOUNT CARMEL ROAD.

Soil and ferruginous clay	20 ft.
Oölitic gray limestone, St. Louis	20 ft.
Blue, bituminous limestone	4 ft.
Buff, cherty limestone	6 ft.
Gray to blue limestone and shales	10 ft.
Buff, argillaceous sandstone	20 ft.
Yellow, coarse, compact sandstone	40 ft.
Buff, argillaceous limestone	6 ft.
Buff to gray limestone	10 ft.
Buff limestone	4 ft.
Yellow sandstone	20 ft.
Gray, fine grained sandstone	30 ft.
Gray, shaly sandstone	30 ft.
Total	220 ft.

The limestone, as it occurs at the outcrop, is in thick ledges, and is variable in texture from soft and porous to very dense and hard, the grayer portions being hardest.

Passing up Rush Creek, the sandstone shales are found to take the place of the buff and yellow sandstone. At the farm of Mr. Williams, one mile above Rush Valley P. O., the shales are exposed to a height of forty or fifty feet above the bed of the creek. The Keokuk limestones here rest directly upon the shales. No limestone is exposed below the top of the Knobstone. The shales are blue, soft and pyritous, and quickly decompose when exposed to the air. *Streptorhynchus crenistriatus*, *Spirifera carteri*, and many other fossils having a wide vertical range, occur here, and at the bluff on the Rush Valley and Mount Carmel Road also. At the latter place they occur both above and below the ledge of Knob limestone.

Buffalo Creek runs north-westerly through Jefferson Township, cutting off about one-fourth of the north-east corner of the township. The Knobstone is exposed to a still greater extent along this creek. Near the junction of the stream with White River, the sandstones reach entirely to the top of the highest bluffs. Near the top the rocks consist of buff and yellow sandstones, changing into a gray, lower down, and passing, finally, into the blue, dirty shales. Toward the bottom of the bluffs here, iron-ore concretions begin to appear, and they may be seen, where they have washed out all along the bed of the stream, for a distance of two or three miles. These concretions vary in size from an inch in diameter to eight or ten inches. They are almost invariably hollow, and sometimes contain small acicular crystals. They usually contain an ochreous substance, stained sometimes to a beautiful dark pink, or other color, by *ferrie oxide*.

Delany's Creek has its source two or three miles north of Salem, and it runs nearly due north through Monroe Township. It is marked by high, steep bluffs on each side, the same features possessed by all the other streams that flow toward White River or the Muscatatuck. Along this creek the sandstones are found extending to the tops of the ridges for a distance of five miles above the mouth. Near the Muscatatuck the dense buff and yellow sandstones are found capping the series, but in the neighborhood of Plattsburg they thin out to ten or fifteen feet in thickness. At Plattsburg they underlie the limestones. The blue, pyritous shales occur below the yellow sandstones, and here they are exposed to a thickness of one hundred and fifty to two hundred feet. The iron stone nodules are observed here also.

Elk Creek is from three to five miles east of Delany's Creek. It runs northward through Gibson Township, which is in the north-east corner of the county. Gibson Township exhibits nothing but Knobstone rocks, except in the south-west corner, where the ridges are capped with limestones. On High Gap Ridge, about two miles west of Gooseport, an ancient village on Elk Creek, the buff and yellow sandstones are again exposed. They are too soft, however, for any economic use, although, in the absence of any other ready material, they are sometimes used for the foundations of light buildings. Here they are very full of fossils, mainly brachiopods. Gibson Township is known as the "Knob" region of the county. The "knobs," or ridges, rise to the height of fully three hundred feet above the creek bottoms. The bluffs are all very steep, but not vertical. The pyritous shales crumble rapidly away, and soon decompose, leaving the steep hillside covered with a thin, cold soil that possesses but little fertility. In many places the slopes are so steep that one could not ascend them at all if it were not for the stunted bushes that grow upon them. Even with the bushes to cling to it is dangerous in many places to walk along the slopes. When one starts down one of the deep ravines, so numerous in this locality, he must follow it to the end,

or retrace his steps, for it is the next thing to impossible to ascend many of the bluffs. The following is about a correct section of the exposures along the west bluffs of Elk Creek:

SECTION.

Buff sandstone	10 ft
Yellow sandstone	20 ft.
Blue shales	270 ft.
Total	300 ft.

South and south-west of Little York the buff and yellow sandstones were not observed, though they may occur in some localities. Four or five miles above the mouth of Elk Creek the "knobs" rise to the height of more than 300 feet above the creek bottom. The exposures show blue shales all the way to the tops.

The terraces or bottoms of all the creeks that flow into the Muscatatuck and White River are built up of these disintegrated and decomposed shales. The soil, therefore, is hard, cold and of a dull ash color. Where they are subject to the periodical overflow of the White River, and receive the alluvium of that stream, they are, of course, fertile, and produce excellent crops, but above the points subject to overflow the lands do not respond generously to the hand of cultivation. The addition of bone phosphates and lime to these bottoms would make them produce corn and other cereals bountifully.

In the townships of Franklin and Polk the Knobstone is not exposed, except in the cuts made by the creeks and branches, but these are so numerous that it is not difficult to find the outcroppings of these rocks in any neighborhood. Along the South Fork of Blue River, from the vicinity of Philadelphia, almost to the point where the stream is crossed by the Louisville, New Albany and Chicago Railroad, the Knobstone shales may be seen at many points. They underlie the Burlington and Keokuk limestones, and are of the uniform dull, blue color, soft and pyritous, crumbling rapidly away on exposure. About a mile south of South Boston the yellow sandstones are again found, and there is a quarry opened at that point, from which good building stones are obtained. The rocks are dense and firm, and are very easily worked. Col. Jack Bowman, near Pekin, had a spring house constructed of these rocks several years ago, and they resist the action of the elements seemingly as well as any stone in use. They do not decompose, and the only way in which the elements can destroy them is by slow attrition. They do not crack, split nor break under the influence of frost.

The same rocks are exposed again on the road, about one mile east of Harristown, on what is known as the old Rodman farm.

The sandstone is yellow and somewhat coarse, but would evidently make fair foundation stone. The following section was obtained at this point:

SECTION ON PUBLIC ROAD AT THE RODMAN FARM.

Soil and red clay	20 feet.
Magnesian limestone	20 "
Shaly limestone.	10 "
Gray to blue limestone	20 "
Yellow sandstone	25 "
Blue shale	35 "
Total	130 feet.

About three miles east of Salem, on the Canton Road, at a cut in the side of the creek bluff, is an exposure of the blue shales, and they are so near the top of the bluff that one would expect to find them exposed on the creek in the vicinity of Salem; but it seems that the dip is somewhat greater here, being sufficient, at least, to carry them under the bed of the North Fork at Salem. There are eight or ten feet exposed at the point mentioned, and the superincumbent stratum is clay. A little farther up the creek, at what seems to be a lower altitude, the limestones occur in the bed of the stream, and several species of fossils characteristic of Burlington rocks have been found in them.

North-east of Canton, about one and one-half or two miles, the shales may be seen outcropping along the perpendicular banks of a small creek. In fact, along the course of any of the small creeks in the eastern or northern parts of the county, the shales may be seen, usually underlying blue crystalline limestone.

There is no difficulty in distinguishing the Knobstone rocks, wherever they are exposed in the county. Their lithological characters are so distinct that in the absence of characteristic fossils they may be readily recognized.

Among the fossils found in these rocks in Washington County are the following named species which are somewhat common: *Spirifera carteri*, *Streptorhynchus crenistriatus*, *Phurotomaria textiligera*, *Schizodus medinaensis*, *Palaeoneilo bedfordensis*, *Cardiamorphia subglobosa*, *Grammysia rhomboides*, *Grammysia ventricosa*, and a fucoid like *Spirophyton candi-galli*.

Dr. S. H. Harrod, at Canton, has collected vast numbers of fossils from different parts of the county, especially from the Knobstone, Burlington, Keokuk and Warsaw beds, and it was intended to procure a complete list, if possible, of the many species collected by him; but he has donated the most rare species to public collections, and no complete list of them has been preserved. No other collector has ever been able to secure so many fine specimens as he has, especially from the Knobstone, Burlington and Keokuk rocks.

At the close of the period in which the great mass of sand and other material now forming the Knobstone group of rocks was deposited, the surface of the deposit was evidently broken by slight but irregular wavy ridges, or gentle undulations, or else subsequent to the deposition of the sediment, and prior to the beginning of the limestone formation, certain modifications occurred which produced those conditions. In tracing the Knobstone across the northern part of the county, one will readily notice those slight undulations succeeding one another in regular order. Owing to them, a variable dip is seen in the strata at the point of contact between the sandstones and the limestones, which has led some observers to the erroneous conclusion that the irregularity was due to an upheaval. The variable dip is not observed in the overlying limestones, nor is it seen near the bottom of the Knobstone rocks, while evidence of an upheaval would show as distinctly in one stratum as another.

While engaged in the survey of the county, Mr. John Craycraft, an intelligent citizen of Florida, but formerly a resident of Washington County, in a letter published in the *Salem Democrat* called my attention to a supposed line of upheaval extending across the northern part of the county, through the townships of Gibson, Monroe, Jefferson and Brown, and extending on westward. I gave the suggestions in that letter my careful attention, but found no evidence to lead me to join Mr. Craycraft in his conclusion in regard to an upheaval. The great seams and fissures mentioned by him are but the effect of the vast erosive forces that were once in action here. The river valleys, the creek beds, the deep ravines, the sink holes and caves of Washington County are all the work of the same agent, water. The evidence indicates that vast torrents have poured over the county for long periods of time, undermining, disintegrating, decomposing and tearing down immense walls of rock, and hurling the fragments into the ravines and valleys where they were rolled together and ground into the finest particles. The great valley through which Blue River runs, and the deep ravines and creek valleys of the northern part of the county are palpable examples of the potency of this great agent.

The Knobstone group of Indiana has been supposed by many geologists to be equivalent to the Kinderhook group of Illinois, and the Waverly group of Ohio. In Illinois the Kinderhook group includes all the rocks from the top of the Devonian black shales to the base of the Burlington limestones. Ohio geologists divide the Sub-Carboniferous rocks into three divisions, the upper member of the system being Sub-Carboniferous limestone, followed by the Waverly group and Erie shales. The Waverly group they subdivide into Cuyahoga shale, Berea grit, Bedford shale and Cleveland shale. The upper portions of the Knobstone in Indiana appear to be more nearly identical with the Waverly rocks of Ohio, and the lower portions more closely allied to the Kinderhook of

Illinois. If the three groups are identical, the priority of names accrues to the Knobstone, as that application was given to these rocks in this State by Prof. David Dale Owen, in 1837. The Kinderhook group did not receive that appellation until 1861, while the term "Waverly" is not of much earlier origin. If the Knobstone rocks are not identical with the rocks of Ohio and Illinois, that occupy the same stratigraphical position, it is certainly clear that the name should be retained as a term properly distinctive of a series of rocks so well known and extensively developed as the Knobstone of Indiana.

ECONOMIC VALUE OF THE KNOBSTONE.

The argillaceous and pyritous shales of the Knobstone group are, of course, wholly worthless for any economic purpose. When exposed to the weather they soon disintegrate, and their component elements are mixed with the surrounding soil, or carried away by the streams and deposited as bars along their various courses. The more compact sandstones, however, found in the northern and south-eastern parts of the county, form an element of considerable utility in the erection of various buildings. The facility with which they may be quarried, and their general accessibility at many points of exposure, furnish advantages in their use which many of the farmers have availed themselves of in preference to transporting limestone for several miles over tortuous roads. But as to adding anything to the mineral wealth of the county, it is hardly probable that the sandstones of this region will ever be in such demand as to become an article of commercial importance.

BURLINGTON GROUP.

These rocks have a maximum thickness in this county probably not exceeding twenty-five feet. They are exposed along the bluffs of the South Fork of Blue River, in the neighborhood of Philadelphia. They are distinguished by three distinct layers of variable thickness. South of Philadelphia, on a bluff of the stream, is a fair exposure which gives the following section:

SECTION.

Buff, cherty limestone	5 ft.
Gray shales	3 ft.
Blue, semi-crystalline limestone.	3 ft.

Along this stream these rocks, where exposed, rest directly upon the argillaceous shales of the Knobstone group. Just west of Philadelphia, on the Canton road, they are again exposed, and the locality is one quite fruitful of fossils. Among the species found here are *Productus semi-reticulatus*, *Spirifera plenius*, *Batocrinus christyi*, *Batocrinus pyriformis* and *Granatocrinus norwoodi*.

The blue crystalline limestone is, in many places, full of fossils, the most common of which is *Streptorhynchus crenistriatus*. Crinoid stems are abundant. About a mile north of Philadelphia, and about one-fourth of a mile from the road leading to Little York, these rocks are again exposed in a deep ravine that cuts down through them, and into the shales. They lie upon the shales there, but present no marked difference from the exposures seen farther south. The following section is shown there:

SECTION.

Gray, arenacious limestone.	4 ft.	
Gray, arenacious shales	2 ft.	6 in.
Blue limestone	4 ft.	
Total.	10 ft.	6 in.

Fossils are found there in good state of preservation. *Spirifera plenius*, *S. Forbesi*, *Granatocrinus norwoodi*, *Batocrinus turbinatus*, *Actinocrinus lowii* and several other species of crinoids have been found there. Some of them are clearly characteristic of the Burlington group, and a few of them as clearly belong to the Keokuk. The Burlington fossils, however, predominate throughout these rocks wherever exposed, and as it is a recognized fact that the position of a stratum can be more accurately determined by the fossils found within it than from mere stratigraphical position, I am, on this account, inclined to view these rocks as being not only stratigraphically but paleontologically in the Burlington group.

Of similar rocks exposed in Harrison County, Prof. John Collett, in the Indiana Geological Report for 1878, page 310, says: "The lower member of this bed is a buff or greenish-gray argillite. Stratigraphically, it occupies the horizon of the Burlington group of Illinois and Iowa, and, although fossils of the Burlington group are quite numerous, yet Keokuk fossils are still more abundant; therefore, until more decisive evidence as to the existence of synchronous conditions corresponding with those so remarkable in the geology of the States just named, we may still retain those beds in the Keokuk group."

In the connected section of Harrison County, same Report, page 303, Prof. Collett gives the Keokuk group, as follows:

"KEOKUK GROUP.

Gray or brown limestone	8 to 22 ft.	
Buff argillite, with small geodes	16 to 14 ft.	
Encrinital limestone and geodes	4 to 12 ft.	6 in.
Blue and gray banded shales, somewhat calcareous	4 to 18 ft.	
Buff, argillaceous limestone with Burlington fossils	6 to 4 ft.	
Blue gray calcareous shales	20 to 5 ft.	6 in."

From the above section it will be seen that the stratum of limestone in Harrison County containing Burlington fossils, with the underlying bed

of calcareous shales, has a thickness of from ten to twenty-six feet, which corresponds with the thickness of the rocks in Washington County that contain the same fossils. There is quite a marked difference in their lithological character, however, though they occupy the same stratigraphical position.

In giving a list of fossils of Harrison County, Prof. Collett says: "In the lower Keokuk beds, although fossils of that age predominate, yet as all indications point to the synchronism of these strata with the Burlington group of Illinois and Iowa, the following list of fossils found in Harrison and Clark counties is parenthetically added. Many of them are exclusively Burlington:

<i>Platycrinus halli</i> (plates and stems).	Shumard.
<i>Platycrinus discoideus</i>	Owen & Shumard.
<i>Platycrinus planus</i>	Shumard.
<i>Dichocrinus striatus</i>	Owen & Shumard.
<i>Dichocrinus lineatus</i>	M. & W.
<i>Actinocrinus unicornis</i>	O. & S.
<i>Synbathocrinus wachsmuthi</i>	M. & W.
<i>Synbathocrinus dentatus</i>	O. & S.
<i>Zeacrinus ramosus</i>	Hall.
<i>Zeacrinus troostianus</i>	M. & W.
<i>Strotocrinus perumbrosus</i>	Hall.
<i>Pentremites burlingtonensis</i>	M. & W.
<i>Productus burlingtonensis</i>	
<i>Productus flemingi</i>	Sowerby.
<i>Spirifer grimesi</i>	Hall.
<i>Orthis michilini</i>	L'Eveille.
<i>Athyris incassata</i>	Hall."

It will be noticed that nearly the whole of the above list of fossils found in Harrison County are strictly characteristic of the Burlington rocks, and the tendency of the evidence leads strongly to the conclusion that thin beds of this group separate the Keokuk from the Knobstone throughout the greater portion of Washington and Harrison counties. Quite a large number of the species of Burlington fossils that occur in Harrison County are also found in Washington County, while quite a large number of species occur in the latter county not enumerated in the above list by Prof. Collett.

Another noticeable feature observed in Washington County is that in the beds where Burlington fossils are found they are in much greater proportion, compared with those characteristic of the Keokuk beds, than they are in Harrison County.

Burlington fossils have also been found along the creek in the vicinity of Canton. In that locality they occur in a thin stratum of grayish limestone that lies immediately in the bed of the creek. The limestone is argillaceous and arenaceous, and gives forth a peculiarly resonant sound

when struck with a hammer. Among the fossils that have been found there are *Productus semi-reticulatus*, *Spirifera plenus*, *Spirifera grimesi*, *Orthis michilini*, *Scaphiocrinus wachsmuthi*, *Platycrinus planus*, *Batocrinus pistillus*, *Dorycrinus unicornis*, *Agariocrinus nodosus*, *Agariocrinus pentagonus*, and probably several other crinoids that at various times have been found and contributed to public or private collections.

These rocks, wherever they are exposed, almost invariably contain crinoids, either perfect or in fragments, and vast quantities of crinoid stems are always to be seen in them. Were the Keokuk fossils wholly absent, scarcely any geologist would hesitate to refer them to the Burlington group.

ECONOMIC VALUE.

Owing to the immediate proximity of the oölitic beds of the St. Louis group of rocks, the facility with which those rocks are obtained, and their general adaptability for all the uses to which limestones are applied, no effort has ever been made to make the Burlington limestones available for any purpose except rough foundation work. The blue crystalline limestone that generally occurs at the base of the series may be quarried in blocks of any size, and is very well adapted to foundation work, but it is too hard to dress readily under the hammer and chisel.

KEOKUK GROUP.

The rocks of this group have a thickness in this county of from fifteen to forty-five feet. They vary greatly in color and lithological character. The greater mass of them is cherty or shaly. They are exposed pretty generally throughout the northern parts of the county along the creeks and ravines, and capping many of the ridges. Numerous outcroppings are seen east and north-east of Salem. The principal exposures run east of a line from the north-western to the south-eastern corners of the county. The presence of these rocks is at once announced by the vast number of geodes that are seen upon the surface where they are the surface or underlying rocks. The geodes vary in size from an inch or less in diameter to two feet or more. Many of them are hollow and filled with beautiful clear crystals of quartz. In many of them the crystals are colored to various shades of pink or blue. Others of them are filled with crystallized gypsum, zinc-blende or galena. In many localities dozens of wagon loads of these singular concretions might be picked up. Several of the layers of limestone are full of them. Other layers contain a larger proportion of chert and limestone. Many fossils are found throughout the county partially or wholly geodized. In many of them the expansion resulting from crystallization has not destroyed the form of the fossil. One obtained from Hon. Wm. R. England, at Little York, shows perfectly

the form and many of the surface markings of *Athyris lamellosa*. Another in the possession of Dr. Harrod, only partially geodized, may readily be identified as *Penremites woodmani*, while another, procured from Prof. Bridgeman, at Salem, is easily recognized as belonging to the same species. Both specimens are greatly expanded, being about two by three inches in transverse and longitudinal diameter, respectively.

Keokuk limestones are exposed on the farm of Mr. W. W. Stevens, about one mile north of Salem. They are seen in the bed of the creek underlying the St. Louis rocks. They occur there in buff, cherty ledges, and in shaly layers containing hundreds of geodes of all forms and sizes. A common form that occurs here is one with a flattened disc-like appearance. These disc-like geodes are found in many localities, and are sometimes seen eight or ten inches in diameter by one and one-half to two inches in thickness. Many of them seem to have been globular in form, and by sudden pressure instantly flattened. They are frequently seen with numerous cracks in them as though they had been changed from hollow spheres to their present shape by sudden pressure. Their most usual shape, however, is spherical.

Quite a number of fossils, generally but poorly preserved, occur in the rocks along the creek in the vicinity of Mr. Stevens's farm. *Spirifera striata*, *S. neglecta*, *S. keokuk*, *Streptorhynchus crenistriatus*, *Platyceras equilateralis*, *Productus semi-reticulatus*, *P. punctatus*, *Onychocrinus exculptus*, *Cyathocrinus decadactylus*, and a number of other species occur there. A fine specimen of *Onychocrinus exculptus*, obtained from Mr. John Clark, at Salem, was found in this locality. Plates and spines of an *Archaeocidaris* also occur here.

In a deep ravine north-east of Plattsburg there is a good exposure of Keokuk limestones near the top of the bluff. The following section is shown there:

SECTION OF KEOKUK LIMESTONE.

Buff to gray limestone and chert	7 ft.
Geodiferous shales	4 "
Heavy bedded gray limestone	11 "
Limestone chert and shales.	9 "
Total.	31 ft.

Spines of *Archaeocidaris* (sp. undt.), crinoid stems and fair specimens of *Spirifera grimesi*, *S. striata*, *S. keokuk*, *Athyris lamellosa*, *Myalina keokuk*, and *Platyceras equilateralis* were seen there. The fossils at this locality are uniformly imbedded in a flinty matrix in the crystalline limestone, and they are so firmly fixed that it is almost impossible to secure specimens in a perfect condition.

Keokuk limestones underlie the Warsaw beds just north of Plattsburg.

Good exposures are also seen along the bluffs of Rush and Twin creeks. On the farm of Mr. Harrison Williams, about a mile east of Rush Valley post office, they attain a thickness of nearly forty feet. The talus and slope covers a good portion of the bluff, so that a complete section could not be made, but the Keokuk rocks are near the top of the bluff and are pretty well exposed. A number of fossils were found there, among which were several weathered crinoids, exposed on the surface of the rocks, but they could not be preserved owing to the flinty character of the stone. The following is a section of the bluff of a ravine that enters Rush Creek from the south, almost opposite the residence of Mr. Williams:

SECTION.

Dark blue limestone, weathering gray with <i>Platycrinus hemisphericus</i> , <i>Onychocrinus exculptus</i> , <i>Spirifera striata</i> , <i>Spirifera lateralis</i> , etc.	6 ft.
Heavy bedded gray limestone	12 "
Gray to blue limestone.	10 "
Gray limestone and shales	10 "
Total	38 ft.

Throughout that section of the county where the Keokuk are largely the prevailing rocks, the lithological character changes so rapidly that in many places it would be altogether impossible to recognize them in the absence of characteristic fossils. The chert and geodes are not always present, and where isolated exposures occur the true stratigraphical position can not always be accurately determined. Where erosion and denudation occurred throughout the county, the denuded areas were subsequently covered with a local sediment of the disintegrated and decomposed rocks of the immediate vicinity. The different groups of rocks represented in Washington County, with the exception of the Knobstone, have a very limited vertical extent. Erosions, therefore, extending to two hundred or three hundred feet, cut down through three or four different groups of rocks in many places, and the clays and other residual matter forming the slopes of the ridges, hills and bluffs are composed of the *debris* from two or more groups of rocks. As already mentioned in this report, many of the fossils that weathered out of the slowly decomposing rocks were sufficiently silicified to withstand the destructive influences of the various elements that destroyed the rocks, and they are frequently found in the clay in an excellent state of preservation. But in most instances they do not assist materially in fixing the horizon of the underlying rocks, from the fact that fossils of the Keokuk, Warsaw and St. Louis beds are all likely to be found in the same bed of clay. They clearly indicate, however, that when the rocks were in place, the various groups to which the fossils belong were all represented in their true positions.

Many other exposures of the Keokuk rocks occur throughout the county, especially in the southern part, where the erosions were sufficient to cut down through the St. Louis and Warsaw beds, but in that section the exposures are limited and more isolated.

ECONOMIC VALUE OF THE KEOKUK LIMESTONE.

For economic purposes, the Keokuk rocks are too silicious, cherty and variable in character to be of especial value. The shales are to some extent pyritous, and therefore disintegrate rapidly, while the more compact forms of rock are too hard and flinty to work easily. They contain too much silica and magnesia, as a general thing, to make good lime. The blue limestones of this group, as a general thing, do not weather well. The gray limestones, wherever used, are well adapted to foundation work, as they resist the influences of the climate and are very easily worked. The unlimited supply of oölitic limestone throughout the county renders the use of inferior stone at any point wholly unnecessary; therefore, to the citizens of the county, the value of any other stone is scarcely a matter for a moment's consideration.

LOWER ST. LOUIS, OR WARSAW DIVISION.

This division or group of rocks has a maximum thickness in Washington County of over one hundred feet. They are variously spoken of as the "Warsaw division of the St. Louis group," "the Warsaw beds," "Warsaw limestones" and "the Warsaw group." Without attempting to give the fine distinctions between "beds" and "divisions" and "groups," it is thought just as well to refer to them in this connection as a distinct division or group, inasmuch as nearly all the scientific interest and commercial importance of the rocks of Washington County attaches to this division. It is merely intended, however, to give their general characters, extent and exposures, as seen in Washington County. Prof. Miller, the able paleontologist of Cincinnati, in his catalogue of American Paleozoic Fossils, refers to them as a group; while Prof. N. H. Worthen, the eminent State Geologist of Illinois, regards them as merely a division of the St. Louis group. In referring to the St. Louis group, pages 83-4, Vol. I, Geological Survey of Illinois, he says:

"Under this head we include the evenly-bedded limestones of Alton and St. Louis, the concretionary and brecciated limestones of the former locality and points further north. The oölitic limestone which outcrops at the river's edge three miles above Alton, and the equivalent beds at Bloomington and Spurgeon Hill, Ind., and the blue calcareo-argillaceous shales and magnesian and arenaceous limestones at Warsaw, in Hancock County. The last-named beds are characterized by a somewhat peculiar group of

fossils, and have usually been regarded as forming a distinct division of the mountain limestone series, but on careful examination of the beds we are satisfied that such a division is entirely arbitrary, and not justified by paleontological evidence. Many of the species of fossil shells that occur in the beds above named are also found in the *upper* division of the limestone at other localities, and the changes that occur in the fossil contents of the rock at the various localities named may be attributed to the local conditions under which the sediments were accumulated, rather than to any specific change in the character of the fauna of this period."

There is probably as little change in the general character of these rocks, as they are exposed throughout Washington County, as exists in any other class of limestones found in the county. At Spurgeon Hill, a locality well-known to paleontologists everywhere, the railroad cut gives an excellent exposure. Spurgeon Hill cut is five miles east of Salem and one-fourth of a mile east of Harristown, on the Louisville, New Albany & Chicago Railroad. The earthy layers, or ferruginous clays, composed largely of the residuum of decomposed limestones, which form the surface deposits of the locality, have been the source of the abundant supply of fossils found in those famous beds. At Paynter's Hill, four miles south of Salem, the same deposits of clay and other residual matter occur, equally productive of the same species of fossils found at Spurgeon Hill. On the top of the south bluffs of Rush Creek, eight miles north by northwest of Salem, on the farm of Mr. Harrison Williams, these beds occur again in the same condition. At that point the dark red clays contain vast numbers of *Pentremites* of various species, with numerous crinoids of the genera *Batocrinus*, *Alloprosallocrinus*, and several specimens of *Catillocrinus tennesseæ*, Troost, which are locally known as "quart cups." The same clays occur again about one-half mile north of Plattsburg, where they rest directly upon the Keokuk limestones. Among the fossils observed there were *Pentremites conoideus*, *P. grosvenori*, *P. koninckianus* and fragments of *Pentremites longicostalis*. South-west of Salem about one mile, the same clays are exposed in an old field where a large number of species are found. *Pentremites woodmani*, *P. longicostalis*, *P. conoideus*, *P. koninckianus*, *Batocrinus icosidactylus*, *B. plano-discus*, *B. irregularis*, all occur there; besides, *Athyris hirsuta*, *A. lammellosa*, *A. trinuclea*, *Conocardium cuneata*, *Eumetria verneuilliana*, *Rhynchonella grosvenori*, *R. ricinula*, *Paleacis cuneata*, *Syringopora ramulosus* and many other fossils also occur there.

With the exception of the blue magnesian limestone at the bottom of this series, that is sometimes seen overlying the Keokuk rocks, the limestones of this division consist of a nearly pure carbonate of lime. When burnt into lime they make an article of the very best quality. The gray fossiliferous limestones are composed wholly of the minute shells of foraminiferous animals. In many localities immense ledges of these rocks

may be seen that are made up altogether of foraminifera. The beautiful little fossils are seen to be closely cemented together, but their forms and surface markings are plainly visible, and from the softer rocks, with a proper instrument, many of them may be readily removed without injuring them in the least. Much of the oölitic limestone appears to be largely concretionary, the small egg-shaped nodules appearing under the glass like concretions of carbonate of lime, but where the very best specimens of the rock are obtained and a careful examination made by the aid of a good microscope it will doubtless be seen that the egg-shaped particles are not concretions, but the true shells of probably a single species of minute foraminifers. In much of the stone there are delicate concretions around the fossils, and a still larger portion of it is composed of merely masses of fragments of shells. Large masses of the stone, observed at Spurgeon Hill and on Mr. Press. Haynes' farm, four miles south of Salem, were found to be composed of fossils from the size of *Bellarophon sub-lævis* down to forms so small that they could scarcely be seen with the naked eye, and their general forms and surface markings could only be seen through a good glass. With the exception of the blue limestones that occur at the bottom of the series, the rocks of the Warsaw Beds which are exposed in the railroad cut at Spurgeon Hill are all soft; and the upper layers, those in which the minute fossils are so perfectly preserved, are very friable and rapidly disintegrate on exposure. They are probably closely allied in texture and composition to the disintegrated rocks of which the superincumbent clays are largely composed. The fossils, however, are not silicified as were those in the overlying strata.

The following is a partial list of the fossils found at the various exposures of the Warsaw Beds throughout the county. The list is as near complete as it could be made at this time:

FOSSILS OF THE WARSAW BEDS IN WASHINGTON COUNTY, IND

PROTISTA.

<i>Palæacis cuneata</i>	M. and W.
<i>Rotalia baileyi</i>	Hall.

RADIATA.

<i>Aulopora gigas</i>	Rominger.
<i>Syringopora multattenuata</i>	Goldfuss.
<i>Syringopora</i>	
<i>Zaphrentis casedayi</i>	Milne-Ed.
<i>Zaphrentis spinulifera</i>	Hall.

BRYOZOA.

<i>Archimedes reversa</i>	Hall.
<i>Archimedes wortheni</i>	Hall.
<i>Cosciniium asterium</i>	Prout.
<i>Cosciniium elegans</i>	Prout.
<i>Cosciniium escharoides</i>	Prout.
<i>Cosciniium keyserlingi</i>	Prout.
<i>Fenestella plumosa</i>	Prout.

ECHINODERMATA.

<i>Actinocrinus indianensis</i>	L. and C.
<i>Agariocrinus americanus</i>	Roemer.
<i>Agariocrinus calyculus</i>	Hall.
<i>Alloprosalocrinus conicus</i>	L. and C.
<i>Batocrinus calyculus</i>	Hall.
<i>Batocrinus icosidactylus</i>	Casseday.
<i>Batocrinus irregularis</i>	Casseday.
<i>Batocrinus lagunculus</i>	Hall.
<i>Batocrinus mundulus</i> (?)	Hall.
<i>Batocrinus planodiscus</i>	Hall.
<i>Calceocrinus nodosus</i>	Hall.
<i>Catillocrinus tennesseæ</i>	Troost.
<i>Cyathocrinus multitrachiatu</i> s	L. and C.
<i>Dichocrinus constrictus</i>	M. and W.
<i>Dichocrinus dichotomous</i>	Hall.
<i>Dichocrinus simplex</i>	Shumard.
<i>Granatocrinus curtus</i>	Shumard.
<i>Lepidesthes colletti</i>	White.
<i>Pentremites conoideus</i>	Hall.
<i>Pentremites grosvenori</i>	Shumard.
<i>Pentremites koninckianus</i>	Hall.
<i>Pentremites longicostalis</i>	Hall.
<i>Pentremites varsouviensis</i>	Worthen.
<i>Pentremites woodmani</i>	M. and W.
<i>Poteroocrinus divaricatus</i>	Hall.

BRACHIAPODA.

<i>Athyris hirsuta</i>	Hall.
<i>Athyris trinuclea</i>	Hall.
<i>Athyris lamellosa</i>	Leveille.
<i>Chonetes planumbona</i> (?)	M. and W.
<i>Orthis dubia</i>	Hall.

<i>Productus indianensis</i>	Hall.
<i>Productus semireticulatus</i>	Martin.
<i>Productus biseriatus</i>	Hall.
<i>Productus ovatus</i>	Hall.
<i>Productus tenuicostatus</i>	Hall.
<i>Rhynchonella grosvenori</i>	Hall.
<i>Rhynchonella mutata</i>	Hall.
<i>Rhynchonella subcuneata</i>	Hall.
<i>Rhynchonella macra</i>	Hall.
<i>Rhynchonella ricinula</i>	Hall.
<i>Rhynchonella wortheni</i>	Hall.
<i>Spirifera bifurcata</i>	Hall.
<i>Spirifera lateralis</i>	Hall.
<i>Spirifera propinqua</i>	Hall.
<i>Spirifera tenuicostata</i>	Hall.
<i>Spirifera glabra</i>	Martin.
<i>Spirifera norwoodiana</i> (?)	Hall.
<i>Spirifera subcardiformis</i>	Hall.
<i>Spiriferina spinosa</i>	Norwood and Patten.
<i>Streptorhynchus crenistriatus</i>	Phillips.
<i>Terebratula formosa</i>	Hall.
<i>Terebratula turgida</i>	Hall.
<i>Terebratula trinuclea</i>	Hall.

PTEROPODA.

<i>Conularia subcarbonaria</i>	M. and W.
<i>Conularia missouriensis</i>	Swallow.

GASTEROPODA.

<i>Bellerophon gibsoni</i>	White.
<i>Bellerophon sublaevis</i>	Hall.
<i>Bulimorphia bulimiformis</i>	Hall.
<i>Bulimorphia canaliculata</i>	Hall.
<i>Bulimorphia elongata</i>	Hall.
<i>Eotrochus concavus</i>	Hall.
<i>Cyclonema leavenworthianum</i>	Hall.
<i>Euomphalus planispira</i>	Hall.
<i>Euomphalus planorbiformis</i>	Hall.
<i>Euomphalus spergenensis</i>	Hall.
<i>Holopea proutana</i>	Hall.
<i>Loxonema vincta</i>	Hall.
<i>Loxonema yandellianum</i>	Hall.
<i>Murchisonia attenuata</i>	Hall.

<i>Murchisonia terebriformis</i>	Billings.
<i>Murchisonia turritella</i>	Hall.
<i>Murchisonia vermicula</i>	Hall.
<i>Murchisonia insculpta</i>	Hall.
<i>Platyceras infundibulum</i>	Hall.
<i>Platyceras acutirostris</i>	Hall.
<i>Pleurotomaria conula</i>	Hall.
<i>Pleurotomaria humilis</i>	Hall.
<i>Pleurotomaria meekana</i>	Hall.
<i>Pleurotomaria nodulostriata</i>	Hall.
<i>Pleurotomaria piacensis</i>	Hall.
<i>Pleurotomaria swallowana</i>	Hall.
<i>Pleurotomaria subangulata</i>	Hall.
<i>Pleurotomaria trilineata</i>	Hall.
<i>Pleurotomaria wortheni</i>	Hall.
<i>Straparollus quadrivolvus</i>	Hall.

CEPHALOPODA.

<i>Nautilus clarkanus</i>	Hall.
<i>Nautilus</i> (2 sp. undt'd.)	
<i>Orthoceras epigrus</i>	Hall.

LAMELLABRANCHIATA.

<i>Conocardium aequilaterale</i>	Hall.
<i>Conocardium carinatum</i>	Hall.
<i>Conocardium cuneatum</i>	Hall.
<i>Conocardium catastomum</i>	Hall.
<i>Conocardium meekianum</i>	Hall.
<i>Conocardium prattenanum</i>	Hall.
<i>Cypricardella nucleata</i>	Hall.
<i>Cypricardella oblonga</i>	Hall.
<i>Cypricardella subelliptica</i>	Hall.
<i>Cypricardia indianensis</i>	Hall.
<i>Cypricardia subplana</i>	Hall.
<i>Nucula shumardana</i>	Hall.
<i>Nuculana nasuta</i>	Hall.
<i>Pinna subspatulata</i>	Worthen.

ANNELIDA.

<i>Spirorbis annulatus</i>	Hall.
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CRUSTACEA.

<i>Leperditia carbonaria</i>	Hall.
<i>Phillipsia bufo</i>	M. & W.
<i>Phillipsia portlocki</i> (?)	M. & W.

It may be ascertained that several of the fossils enumerated in the above list do not occur in the rocks of the Warsaw beds, but all those mentioned have been found in the clay exposures, where, with an occasional exception, the fossils all belong to these rocks. *Lepidesthes colletti* and *Pentremites woodmani* both seem to have a vertical range in this county from the Keokuk to the Upper St. Louis rocks. Both species have been found in the Warsaw beds about a mile south-west of Salem.

About two miles south of Salem, on the farm of Mr. Colclazier, the massive gray limestones are highly fossiliferous. Nearly all the forms found in the clays at Spurgeon Hall and Paynter's Hill may be found there in the soft, gray calcareous rocks. A dozen or more specimens of *Pentremites conoideus* are often seen sticking out on a piece of rock less than six inches square. They may easily be obtained, with a little care, in perfect condition. On Mr. Williams's farm, on Rush Creek, the same fossiliferous rocks occur, and the specimens contained within them may be obtained with the same facility.

Throughout the northern, central and southern parts of the county the Warsaw limestones, owing to erosions, are the surface rocks in many places, but at no particular point do they differ materially from their general characteristics as given in the general section. In the north-western corner of the county, along the bluffs of Clifty Creek, the oölitic limestones are exposed for a distance of five miles, and in some places their thickness is fully sixty feet. They are exposed along the bluffs of Rush Creek, showing in many places a thickness of from thirty to forty feet. And along Delaney's Creek ten to fifteen feet of these rocks are often seen exposed along the western bluffs. Splendid exposures occur at Beck's Mill, at Foults's Mill, near Fredericksburg, and an unlimited quantity of the finest quality of this stone is seen on the farm of Gen. James A. Cravens, one mile north of Hardensburg.

The area embraced in the oölitic limestone region of Washington County is from one hundred and seventy-five to two hundred square miles, with an average thickness of thirty feet.

ECONOMIC GEOLOGY OF THE WARSAW BEDS.

The value of the Indiana oölitic limestones, for the various uses to which limestones are applied, is everywhere recognized and generously appreciated. It is generally admitted that they are very greatly superior to any other stone of this class known. The quarries at Salem, Bedford, Ellettsville, Stinesville, Putmanville and other points are well-known to contractors and builders throughout the United States; and their product is rapidly acquiring a reputation, even in Europe, on account of its beauty, durability, evenness of texture and color, the facility it possesses of being easily worked into any desired shape, and other excellent qualities.

The Salem Stone and Lime Company, of Louisville, Ky., has an extensive quarry about one and one-half miles west of Salem, on the Louisville, New Albany & Chicago Railroad. In connection with their quarries they have three large lime-kilns, which have a capacity of several cars per day. The oölitic limestone of Washington County contains over ninety-six per cent. of carbonate of lime, and the lime manufactured of it can not be excelled anywhere. The unlimited supply of the stone, and the ease with which it is obtained, enables the manufacturers to produce lime at a very small cost, and to convenient markets they can supply it at a price with which many others do not care to compete. Lime of the very best quality may be manufactured of the oölitic limestone wherever it occurs throughout the county.

The Salem Lime and Stone Company employ a force of nearly one hundred and fifty men, and when it is considered that nearly all the work in a stone quarry is now done by machinery, and that this company has all of the latest and very best machines in use, it will be recognized that the capacity of their works is very great. Steam channelers, steam drills, steam saws, steam planes and polishers, steam travelers, immense machines for transporting the huge blocks of stone from one point to another, and steam derricks or cranks, are all in use here, and the one hundred and fifty men employed are occupied nearly altogether in operating the machines.

A section at the quarry where the principal force of men is employed was taken, which is herewith given:

SECTION AT THE QUARRY OF THE SALEM STONE AND LIME COMPANY.

Soil and rubbish	3 ft.
Dark blue, bituminous limestone (bastard)	6 "
Gray oölitic quarry stone	30 "
Blue crystalline limestone	6 "
Total	45 ft.

The gray quarry stone mentioned in the above section is a solid stratum thirty feet in thickness, without seam or parting of any kind, and with only an occasional water-worn fissure. The color is uniformly a light gray, the only exception being an occasional slightly blueish tinge to a small portion of the stone, which was occasioned by the dissolving of some form of iron, and the subsequent coloring of the stone by the solution. The stone at this quarry is a fair sample of that embraced in an area of two hundred square miles, extending over nearly the whole of the western half of the county. It may be quarried in blocks of any dimensions, and the color and texture is the same all the way through. The Salem stone contains but few fossils, but in other localities the quarry stones sometimes contain fine specimens. A quarry is opened south of the railroad on Spurgeon Hill, and the stone, which is of excellent quality

for any purpose, contains many fine specimens, the most valuable being very fine specimens of *Conularia missouriensis*, some of them ten to twelve inches in length.

Most thorough chemical and mechanical tests of the Salem stone were made at the instance of the State House Commissioners of Georgia. The following extracts from their report to the Senate Committee on Public Property shows the estimate they placed upon the stone after the most careful tests had been made:

"Salem stone was selected by the Commissioners in the belief that when strength, beauty, durability and cost are considered, it was the best material offered to the Board, and we have been strengthened in that conviction in every way since the selection was made.

"It possesses the most remarkable uniformity of grain and texture, is exceedingly bright and handsome in color, can readily be worked into any shape, is peculiarly suited to the design we are carrying out, is less liable to discolor than almost any other stone of so light a color, and the evidence from witnesses qualified to testify is that its durability is equal to that of any stone in the world.

"For the purpose of becoming familiar with the constituency and physical properties of this stone, the Commissioners have had it subjected to chemical analysis and some mechanical tests, the results of which are herewith reported.

"The chemical analysis of Salem stone is:

Carbonate of lime	96.04 per cent.
Carbonate of magnesia	0.72 per cent.
Oxides of iron and alumina	1.06 per cent.
Insoluble silicates	1.13 per cent.
Chlorides of soda and potash.	0.15 per cent.
Water expelled at 212° F	0.10 per cent.
Combined water, etc.	0.80 per cent.

"This analysis was made in the office of the Georgia State Chemist, and agrees with all the published analyses within very close limits.

"As to its capacity to resist heat, we had a small block of this stone heated in the office of the State Chemist, in a cupel furnace, to a temperature of 1,200° F., without injury to the stone.

"Mr. Champayne, the superintendent of the capitol, and a bonded and sworn agent of the State, has made careful tests of its absorption of water on a random specimen, and finds it to absorb water at the rate of 1 to 42, or 2.38 per cent.

"Col. L. H. Charbonnier, Professor of Physics in the University of Georgia, certifies to the Board that he has tested the stone for strength, in a Richle testing machine, and finds a resistance of 8,975 pounds per square inch. This strength is less than that shown by Gen. Q. A. Gilmore, and by the Indiana geological reports, which state it at 11,750 and

10,000 to 12,000, respectively, and the difference is due to the fact that the sample tested for the Board was a freshly cut specimen, and had not become indurated by exposure, as was the case in the samples tested by the authorities noted."

It is worthy of remark that the chemical and mechanical tests made of the Salem oölitic stone were ample and exhaustive, and after careful examination of all other building material in use, they selected this as the *cheapest, most beautiful, strongest and best adapted in every particular* to the work on hand. The report of the Commisstoners, of whom Henry D. McDaniel, Governor, was, by virtue of his office, chairman, was approved by the Legislature, and the building is now in course of erection.

The tests of this stone, made by the State House Commissioners of Georgia, agree very closely in results with all other tests made, so it is unnecessary to furnish other examples. It has been used in Washington County for various purposes for more than fifty years, and in no instance has it ever been known to crack, split, disintegrate or break in any way. At the numerous exposures along the various water courses, where it has been subjected to the action of the elements for hundreds, and perhaps thousands of years, it does not display in a single instance a tendency to disintegrate or break down under prolonged exposure.

While it may not be superior to the oölitic stone of other counties, it is certainly a fact that the Washington County stone is not surpassed, in the many qualities that make stone valuable, by any other material of this character in the country.

Among the buildings that have been constructed of this stone, and where it has proven to be a superior material, are the following :

City Hall	Louisville, Ky.
Galt House	Louisville, Ky.
City Hospital	Louisville, Ky.
Broadway M. E. Church	Louisville, Ky.
First Christian Church	Louisville, Ky.
German Methodist Church	Louisville, Ky.
German Evangelical Church	Louisville, Ky.
Temple Adas Israel (Jewish)	Louisville, Ky.
Hamilton Block	Louisville, Ky.
J. T. Tompkins & Co., Block	Louisville, Ky.
Falls City Bank	Louisville, Ky.
Pendennis Club Building	Louisville, Ky.
Cincinnati Court-house	Cincinnati, O.
Cotton Exchange	New Orleans, La.
State Capitol Building	Trenton, N. J.

The County Commissioners of Washington County are erecting a commodious and elegant court-house, which will be built wholly of Salem stone, and when completed it will be a most convenient and imposing structure, of which the citizens of the county may well be proud.

A large number of other buildings in various parts of the country might be enumerated, but these are sufficient to show that it is generally used and is satisfactory.

Grand exposures of this stone occur at many points throughout the county where it might be quarried without stripping, and at a nominal cost. At Clifty Mill, on the farm of Mr. Henry Robertson, it is exposed in a solid stratum sixty feet thick, and is uniform in texture and color. A company with proper capital could open up a mine of wealth here. A switch could readily be built from Campbellsburg, on the Louisville, New Albany & Chicago Railroad, or from Fort Ritner, on the Ohio & Mississippi Railroad, and a quarry at this point, could compete in any market. Hydraulic limestones in unlimited quantities occur at the same point, and, upon actual test, it makes a most excellent slow-setting cement. Water-power is immediately at hand for grinding the cement, and the citizens of the county should avail themselves of the advantages offered at this point for opening up one of the best paying industries in the State. Stone, lime and cement works in operation here would certainly yield handsome profits.

At Beck's Mill almost the same advantages are offered, and at many other points throughout that portion of the county.

What is badly needed is a railroad running east and west through the center of the county. With proper shipping facilities, the mineral wealth of Washington County is not inferior to that of any other county in the State. The L., N. A. & C. R. R. Co. afford the best facilities in their power, and on accommodating terms, but transferring to other lines adds very materially to the freight expenses, which, in some instances, renders it very difficult for the people of Washington County to compete with inferior stone.

UPPER ST. LOUIS LIMESTONES.

These are the surface rocks, generally over that portion of the county known as the "Barrens," and throughout the western part of the county, where the sinks occur. The exposures are few, but the clays which occupy the horizon of these rocks are characterized by a peculiar reddish brown color, and great fragments of bryozoic chert or limestones scattered over the surface. The Upper St. Louis limestones are exposed along the eastern base of the Sandstone Ridge from the neighborhood of Livonia to the Harrison County line. They show in the bottoms of the deep ravines, cut down through the eastern side of the ridge. They occur in the tops of the bluffs along Blue River, above Fredericksburg and above Foults's Mill. *Lithostrotion* beds occur on the bluffs north of Foults's Mill, where fine specimens of *L. canadense* and an occasional specimen of *L. proliferum* may be obtained. *Syringopora ramulosa* also occurs in the same locality.

At the head of Clifty Creek, just above Clifty Mill, the whitish gray

argillaceous limestones occur, lying just under a stratum of hard, flinty and almost black ferruginous limestones. These gray limestones occur again at Beck's Mill, where they are known locally as "freestones." They will probably make a good article of cement, as they are free from chert and other impurities, and evidently have hydraulic properties. Underneath the gray limestones is a thick stratum of blue magnesian limestone. This stone is from ten to twenty feet thick. It is uniform in color, fine-grained and free from chert. It has been fully tested as a cement rock, and when properly burned and ground hardens under water or in the air to the density of hard limestone. In the neighborhood of Clifty Mill the black, ferruginous limestones referred to above are three or four feet thick, and they lie in strata from twelve inches to fifteen inches in thickness. They break out in rhomboidal blocks of various sizes, generally from two to three feet in length and from sixteen to twenty inches in breadth. Fossils are occasionally seen sticking on the surface of them, but they are generally so weathered as to destroy all their characteristic features.

Immediately underlying the blue magnesian limestone in the vicinity of Clifty Mill there is a stratum of very hard crystalline ferruginous limestone, about four feet in thickness. This stratum contains a very large per cent. of iron. The stone appears to be as hard as flint, and it will make the fire fly from the best steel hammer at every stroke. The only point where it is exposed is on a point or ridge just west of Clifty Mill.

ECONOMIC GEOLOGY OF THE UPPER ST. LOUIS ROCKS.

With the exception of the Argillaceous and Magnesian limestones of these rocks there are none calculated to be of much value for any domestic purposes. But if, on the most thorough tests, the hydraulic limestones at Clifty Mill and at Beck's Mill are found to sustain the tests already made at the instance of Mr. Henry Robertson, then at the two points above mentioned there are most excellent advantages offered for the manufacture of cement. The rock is practically inexhaustible, and the convenient water power at each point furnishes a ready and cheap force for grinding the rock. If shipping facilities were procured, the stone, lime and cement business might be made very profitable at either point, and especially at Clifty Mill, where there is the more available power, and where the oölitic limestone and hydraulic limestone are immediately at hand.

CHESTER GROUP.

The Chester group in this county consists of two distinct divisions. The upper division consists wholly of sandstone, and is from ten to one hundred feet in thickness. The lower division consists altogether of limestone, and is from fifteen to sixty feet thick. The calcareous rocks con-

sist of massive, gray, lithographic limestones of fine texture, breaking with the conchoidal fracture peculiar to these rocks, which gradually change to a thinly-bedded stone near the top that breaks into rough, angular fragments. On the road from Salem to Livonia they occur in great masses in ascending the Sandstone Ridge. About a mile south of the Salem road the lithographic limestones rest on the bryozoan bed of the Upper St. Louis rocks, and as no fossils occur in the lithographic rocks it is difficult to determine to which horizon they belong. However, as the lithographic limestones underlying the Chester sandstones in the adjoining counties have been identified by characteristic fossils and are included in the Chester group, it is thought from the stratigraphical position of these rocks, and their general resemblance in lithological characteristics to the lower Chester limestones in contiguous localities, that they may be properly included with the Chester rocks. Although no fossils were found in them during the progress of the survey, it is probable that they do occur in some localities, and they will yet be found and the rocks fully identified. The limestones of the upper portion of this series still preserve the color and general appearance of the lithographic stones below, but upon striking them with the hammer they break into angular fragments of various sizes.

The sandstones of this group are of uniform, fine texture, varying in color from yellow at the bottom of the series to brown or dark pink at the top. The upper portion is highly ferruginous, and frequently large portions of the rock contain concretions of iron ore. But few fossils have ever been found in these rocks. Young Mr. Beck, son of the proprietor of Beck's Mill, collected a few specimens, some of which are very good. Among them were *Calamites cannaeformis*, *Calamites sulcatus*, *Lepidodendron* (2 sp.), *Sigillaria*, *Stigmaria*, and several other specimens that were poorly preserved.

A thin seam of coal occurs near the base of the sandstone, and the prevailing opinion has been that coal in paying quantities might be found in the ridge. Two localities were visited where coal had formerly been found and mined to some extent for blacksmiths' use, but not a particle could be seen at the time of the visits. However, the coal is there in a seam from three to six inches in thickness, but it is evidently not persistent, for search has frequently been made for it in other localities at the same horizon, but it could not be found. It occurs about a mile north of Hardinsburg, but the opening was long ago covered by the wash from the hillsides, and no vestige of coal could be seen. The same conditions prevail at a place about a mile or two south of Livonia, which was also visited. The seam had evidently been worked on a very small scale, but the accumulation of several years' wash from the hillsides had obliterated all evidence of coal.

Dr. Schoonover, of Hardinsburg, once visited the opening near that

place and collected several good specimens of the coal, and he stated that a blacksmith of that place, years ago, obtained his supply of fuel there for smithing purposes.

So far as known, there is no point where the coal is actually exposed now. In the general section the horizon of the coal-seam is placed at the junction of the Chester sand and limestones. It is evidently, from the best information obtained, near that horizon, but the exact position is not known.

The Chester sandstones originally extended eastward to the vicinity of Salem, but the ancient erosions that created the great valley in the central part of the county carried away the great mass of them, together with the underlying rocks, and the high sand ridge on the west remains as a monument to show the wonderful destructiveness of the forces that once were in existence.

ECONOMIC GEOLOGY OF THE CHESTER ROCKS.

The great value and unlimited quantity of the Warsaw limestones, their ready accessibility and universal popularity, have a tendency to deteriorate the value of the other rocks of the county. In the absence of the oölitic limestones, the various limestones and sandstones would still be of great value to the citizens, for many of them are undoubtedly valuable for a great many purposes. The lithographic stones of the Chester group, while hard to quarry and difficult to work into handsome shapes, possess all the enduring qualities that make stone valuable. Besides, they may be obtained in blocks of any dimension, and in many localities they could be procured without any stripping whatever, as they are the surface rocks over a large extent of territory.

The sandstones are very fine and even in texture. Where they are free from iron they might be useful for grindstones, if they are hard enough, but their general appearance indicates that they are too soft and friable for that purpose. When first quarried they are, also, too soft for general building purposes, and they do not seem to harden sufficiently in "seasoning" to make them useful for anything but light foundation work.

When they are pounded or ground into sand, which is easily accomplished, they make a beautiful, even sand, too fine, though, as a general thing, for plasterers' use, though for some purposes this sand is valuable.

LACUSTRAL.

The lacustral area extends from the vicinity of Salem to the west line of the county, and on into Orange County. It also extends from Claysville and the northern end of Sand Ridge north of Livonia two or three miles, to the breaks of Sugar Creek, Clifty Creek and Rush or Twin Creek on the north. Probably a hundred square miles are embraced in

this area. The deposit is characterized by the generally level appearance of the country, the compact and uniformly gray appearance of the soil, and the occasional beds of fine sand that are found within it. On the farm of Col. Colclazier, two miles north-west of Salem, there is an extensive deposit of this sand containing a sufficient proportion of alumina to form a most excellent sand for moulders' use. Mr. Colclazier ships large quantities of this sand to various foundries in the West, and it is said to be one of the best articles in use.

This sand was evidently derived from the disintegrated Chester sandstones that once extended probably as far east as his farm. A careful examination of this sand shows that it is identical with the sand washed down from the Chester sandstones in Sand Ridge.

The clays of the Lacustral are uniformly gray, and the thickness of the deposit varies from ten feet to fifty feet or more. In the neighborhood of Campbellsburg the thickness is about fifty feet, and at Saltilloville it is about the same.

SOIL AND ALLUVIUM.

The soils of the county vary in color from the gray of the Lacustral region to the dark red soils of the Upper St. Louis, and the black soils of the alluvial deposits seen along many of the creeks and rivers. The Knobstone region also has a prevailing gray soil. Many of the red soils are very productive, containing a fair proportion of lime and phosphates. Their fertility may be preserved and enhanced by the generous use of barnyard manure. The gray soils need, in addition to the barnyard manures, the application of from 150 to 200 pounds of phosphate of lime per acre, applied about once in two years. The application of these fertilizers on the properly drained lands will increase the yield of cereals from 50 to 100 per cent.

COAL AND IRON.

Of course no coal exists in Washington County in paying quantities. The same may also be said with regard to the iron. Prospecting, digging and boring for coal was actually going on during the progress of the survey, but time, labor and money expended in that pursuit will certainly never yield any satisfactory returns. No coal deposits will ever be found in the county, and all efforts made with a view of developing coal mines anywhere in the county will be futile and unsatisfactory.

Iron may be found in small quantities in almost any part of the county, but probably a large portion of the iron that actually occurs in the county may be seen upon or near the surface, forming a part of the residuum resulting from the disintegration of superior strata.

The quality of the iron ore occurring here is not such as to make it a matter of importance or consideration to iron workers, and the quantity is so limited that it will never pay to collect it for any purpose.

DRIFT.

Boulders found occasionally in the north-east corner of Gibson Township are the only evidences of Drift seen in the county. The great high and compact structure of the Knobstone formed a barrier sufficient to permanently check the advance of northern glaciers. The southern limit of the Drift deposits is just north of the northern boundary of the county.

ARCHÆOLOGY.

While this does not seem to have been a locality that the aborigines chose for permanent homes, there is abundant evidence that it was one of their favorite hunting grounds. Mounds and other earthworks are few, but implements of stone and flint are found in abundance. In the neighborhood of Hardinsburg and Fredericksburg arrow and spear heads of the largest size and most perfect workmanship are very numerous. It is no uncommon thing to find such implements five, six, eight and even ten inches in length, and perfect in form and workmanship. Stone axes, hammers, pestles, mauls and polished implements of various kinds are very common throughout the county. Pipes are rare, and it is an unusual thing to find a piece of pottery. A few mounds occur, and some of them have been opened, disclosing ashes, charcoal, burned earth, and, in one or two instances, bones and implements.

There is an interesting ditch and wall on the farm of Mr. Pro, about three miles north-east of Campbellsburg that is evidently the work of the aborigines. They are about one-fourth of a mile in length, and when first observed, thirty or forty years ago, the ditch varied in depth from three feet to six feet, and the wall was of corresponding height. But the ditch has gradually filled up since that time until it does not, at the present time, average more than three feet in depth. Large trees grow upon the wall, indicating that it is very ancient. No mounds occur in the neighborhood, and no other works are connected with this wall. It runs along the slope of a gentle declivity, and is nearly straight. It seems evident that the Indians, who were evidently the Mound Builders, commenced to build here a walled inclosure and for some reason abandoned it.

CAVES.

There is an interesting cavern, of considerable extent, on the farm of Mr. Asbury Cravens, three miles north of Hardinsburg. The entrance to it is situated upon the side of a gentle slope, and is very convenient of access. On this account, and the varied and interesting character of the scenery within the cave, it has become quite a fashionable resort for pleasure seekers.

In company with Gen. James A. Cravens, a well-preserved hero of the Mexican war, and ex-member of Congress, to whom I am deeply indebted for extended hospitalities, I visited this cave, which is perfectly dry and easily explored. Although there is no running water in the cavern there is abundant evidence everywhere at hand that water was the agent that carved out this wonderful underground furrow, and wore it into curious and wonderful forms. There are a number of different branches to the cavern, but it does not extend in any direction much more than 200 yards from the entrance. The walls of the cave, from the floor to the ceiling, are covered with beautiful concretions of carbonate of lime, which, in many instances, are stained to a beautiful pink color by oxide of iron. Pendant from the ceiling hang hundreds of stalactites, many of them reaching the floor, or connecting with stalagmites, and forming columns of various beautiful shapes. Many explorers have visited this cave, and many of its most interesting features have been carelessly or ruthlessly destroyed. Ages are required for nature to build those beautiful forms of concretion and stalactite, and no one should be vandal enough to wantonly destroy them. However, there are enough of its beauties left to make the cavern well worthy of a visit.

The ceiling varies in height from eight to twenty feet, and the width of the cavern ranges from ten to sixty feet.

The caves at Clifty Mill may, it is said, be explored for miles, and one, known as the "Dry Cave," is remarkable for the beauty and varied character of the scenery.

The caves in the vicinity of Beck's Mill are quite extensive, and are said to possess many features of interest.

COLLECTIONS.

There are several interesting collections of geological and archæological specimens in the county. Among them are the collections of Dr. S. H. Harrod, at Canton; Hon. Wm. R. England and Mrs. Clark, at Little York; Dr. Hon. Dr. Barnett and Dr. Schoonover, at Hardinsburg; W. W. Stevens, Prof. Bridgeman, Mr. Samuel Clark, Mr. John Clark and Hon. Virgil Hobbs, at Salem. These cabinets, taken collectively, represent pretty well the paleontology and archæology of Washington County.

TIMBER.

Washington County was originally one of the heavily wooded districts of the State, but the high prices of walnut and poplar lumber that prevailed for a few years after the war resulted in the almost complete denudation of all the valuable timber lands of the county. The various kinds of white oak were cut and worked up into staves, spokes and headings, and now it is only occasionally that a really valuable piece of timber may be seen.

THANKS.

I am under especial obligations to the following named persons for courtesies and valuable assistance rendered to me during the progress of the survey, and to the citizens of the county in general for their uniform kindness: Prof. Bridgeman, Hon. Virgil Hobbs, Hon. Sam Voyles, Rev. Mr. Giles, Mr. Samuel Clark, Mr. John Clark, Dr. Hobbs, Mr. Thomas Williams, proprietor Hungate House, and Dr. Wilson, editor of the *Democrat*, at Salem; Dr. S. H. Harrod, at Canton; Gen. James A. Cravens, at Hardinsburg; Mr. Henry Robertson, at Campbellsburg, and Hon. Wm. R. England, at Little York. Also, to the Salem Stone and Lime Company, and the Louisville, New Albany & Chicago Railway Company.