GEOLOGICAL SURVEY OF KENTUCKY.

JOHN R. PROCTER, DIRECTOR.

REPORT

ON THE

GEOLOGY OF CLARK COUNTY.

BY W. M. LINNEY.

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INTRODUCTORY LETTER.

HARRODSBURG, KY., December, 1884.

Hon. Jno. R. Procter, Director of the Kentucky Geological Survey:

DEAR SIR: I herewith transmit to you for publication reports on the Geology and other natural features of Clark and Montgomery counties. The region is an interesting one, and I am largely indebted to the kindness of the citizens in making my work and intercourse with them very pleasant. Mr. J. B. Hoeing, of the Topographical Department, has prepared the map and section, as he has those before published, in the best of style. Owing to the presence of the same groups in the various counties, there is more or less repetition of description in my reports, but this can not be avoided, as the way they are distributed, generally to each county, makes this necessary and does not injure the matter really for the final reports. Yours very truly,

W. M. LINNEY.

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GEOLOGY OF CLARK COUNTY.

Clark was erected into a county in the year 1792. Its position is a little to the east of the center of the State, and has on the north Fayette and Bourbon, on the east Montgomery and Estill, on the south Estill and Madison, and on the west Madison. Originally it was much larger than now, its territory having been divided into other counties. Red river extends for some distance along its southern border, and the Kentucky river washes its western outline. While these streams do not now have much to do with the economy of the county they will add much to the convenience of the people when the improvements are completed which are being made in the channel of the Kentucky, and obstructions are removed from the bed of Red river. It is along these waterways that the county should receive the coal and lumber which is now imported into it.

The county is well drained by Stoner, Boone, Lower Howard, Two Mile, Upper Howard and Lulbegrud creeks and their tributaries. None of these creeks are large, but they afford water power for mills a part of the year, and are great conveniences in watering stock at all times.

The Chesapeake and Ohio Railroad extends through the county in rather an east and west direction, the Kentucky Central crosses the former at Winchester in rather a north and south line, while from Hedge's Station the Kentucky Union is being constructed southeastward toward North Carolina. With the latter completed, the county will have all the conveniences of transportation that would be needed, and a system of which few counties in the State could boast. Clark county has an area of 255½ square miles, and in 1880 had a population of 12,115.

Winchester, 7° 8′ west longitude from Washington, and 38° of north latitude, is the county town, and is situated where it has a fine natural drainage, is well laid off, and planted with shade trees to a larger extent than our towns usually are. Its population in 1880 was 2,277, and it has had a steady and healthy increase, since. This town is well supplied with schools, but many of the common-school houses over the county sadly need renewing with a better class of structures, and with riper, more experienced teachers.

The county is fairly well supplied with good roads, yet some of them need to be macadamized and others constructed. The improvements now being made and projected will give an excellent system. Good turnpikes over a county are one of the greatest boons which the citizens can have, and they rank high as showing the character of a people and their financial prosperity.

The drainage of the county all flows into the Kentucky river, with the exception of the waters of Stoner creek, which is a tributary of the Licking. The water-shed between these two lines is a ridge which runs northeastwardly through the county, and from this ridge the surface slopes more or less to the northwest and to the south and southwest. Generally the northern part of the county is gently rolling, with few places where steep hillsides come in, except immediately along the sides of streams. The rest of the county is more broken, and often the hillsides are very abrupt. On some of the streams, as Boone's and Lower Howard's creeks, and the Kentucky river, they are sometimes almost perpendicular. In the southern part of the county the surface rises into small "knobs." The slope from the center of the county toward the south from the dividing ridge spoken of, allows the eye to take in some magnificent scenes across the county and for many miles beyond. Portions of several counties can be seen from a single point. One may from here look over on one side and see some of the richest and most prized farming and grazing lands, and on the other side, while viewing in the foreground a good territory, see the rugged mountains and poorer soils, beyond,

which stretch on towards the Cumberland Mountains. Many panoramas of beauty could be photographed from the eminences along this comparatively elevated line. The extreme difference between the water level of the Kentucky river and the highest points in the county is only about five hundred and seventy-five feet, though the apparent difference is much more than this.

The following table shows the elevations at various points in the county, the first four correctly, the others approximately:

	Ft. ab'ye sea level.	Formation.
Kentucky River, low water	525	Chazy.
Pine Grove	960	Trenton.
Winchester Depot	961	Lower Hudson.
Hedges Station	976	Middle Hudson.
Stoner Creek Railroad Crossing	961	Trenton.
Thompson's Station	1,037	Upper Hudson.
Clark and Montgomery line	1,051	Upper Hudson.
Divide between Stoner Creek and Kiddville	1,100	Upper Hudson.
Divide on Red River Pike, Mr. Franklin's	1,091	Middle Hudson.
John Goff's	791	Black Slate.
Divide on Ruckerville road, over Upper Howard's Creek	1,086	Middle Hudson.
Lulbegrud Creek, at Eastin's Mill	700	Corniferous.

These figures show the relation of the surface features, and the right hand column the group of rocks which are at the surface, and both should be kept in mind for an intelligent understanding of the problems connected with the disturbances which have altered the natural arrangement of the rocks of the county.

GENERAL GEOLOGY.

The general geological section of Clark county extends from the Chazy Limestones to the summit of the Black Slate, giving a vertical section of about twelve hundred feet of rocks, whose edges can be seen as they overlap each other in going across the county from the mouth of Boone's creek to the waters of Lulbegrud. It is the variations in the composition of these rocks and the positions they occupy, that make such contrasts in the surface, such distinctions in the soils, and the variations in the distribution of the timbers. It is well if these

subjects be carefully studied, for a knowledge of them produces happiness, and the application of this knowledge leads to great results in many ways.

The following table shows the separate divisions into which geologists have apportioned them for convenience of study, and to follow a natural order or sequence which they hold toward each other:

Age.	Period.	Formation.	Feet.	Feet.
Devonian.	Hamilton.	Black Slate.	100	
	Corniferous.	Corniferous.	6	
	Oriskany.	Oriskany Sandstone.	1	107
Upper Silurian.	Niagara.	Blue Shales.	18	
	Clinton.	Clinton Shale and Limestone.	50	68
Lower Silurian or Cambrian.	Hudson River.	Upper Beds.	300	
		Middle Beds.	150	
		Lower Beds.	175	625
	Trenton.	Trenton Limestone.	200	
		Birdseye Limestone.	125	325
	Canadian.	Chazy Limestone.	. . . .	100
Total	. . . . .	. . . . .	. . . .	1,225

The colored map which accompanies this report shows the outlines of these divisions, while the profile section exhibits the relation they bear to each other, as well as how some of them are lost beneath others as they are extended across the county.

CANADIAN PERIOD.

Chazy Limestone.—The Chazy Limestone is the only portion of the Canadian Period exposed to view in the State, and is the lowest brought to view. On the Kentucky river, at Camp Nelson, they are seen three hundred and fifty feet thick, but in this county they are reduced to about one hundred. From the Boonesboro ferry down to the mouth of Boone's creek they have this height above the river. In going up the gorges of the creeks between the points mentioned they appear in the banks for some distance. Tough, massive layers, these rocks make a picturesque rampart, sometimes perpendicular, again receding into terraced shelves, they give but a narrow fringe open to inspection here, though they extend beneath all the rocky floor of the country and reappear south of the Cumberland Mountains.

These rocks are much fractured where seen, and are thus half quarried. As they are among the strongest, most durable stones we have, it would be an easy matter to raise them from their beds and ship them by the river if there should become a demand for them. The same may be said of the group above them. No soils having distinctive characters are here formed from the rocks, as the little which collects on the cliffs is mixed with that which comes down from above.

TRENTON PERIOD.

Birdseye Limestone.—This series of limestones which overlie the Chazy, in Kentucky, have the same extent on the Kentucky river and the branches and hollows which enter it along this line, but they lie higher up and are exposed farther back, though in many cases they help make the steep walls of the cliffs at their tops. There is, at the base, ten or twelve feet of a magnesian limestone which has received the name of the Kentucky Marble. It has been quarried some on Boone's creek, Lower Howard creek and near the Boonesboro ferry. It has been used about the court house in Winchester and at Lexington and Frankfort. This stone is in convenient layers,

quarries and works well, but it can not be said to rank high amongst the best building stones. It often breaks from old dry seams or other causes and on exposure it discolors to an ugly yellow, not uniform in color.

These layers contain on average thirty-five per cent. of carbonate of magnesia and are classed as dolomites. They are not uniform in color, being a light marbled blue in the interior, or on fresh fractures, and a tawny yellow when exposed for a year or two. An analysis from one of these layers by Dr. Peter shows,

Specific gravity	2.675
Lime carbonate	54.866
Magnesia carbonate	35.820
Alumina, iron and manganese oxides	1.750
Phosphoric acid (P2 O5)	.310
Sulphuric acid (SO3)	.230
Potash	1.140
Soda	.430
Silica and silicates	5.917
Total	102.638

There are other layers in the Birdseye which wear in all their natural exposures much better than does this rock, and retain their colors for an indefinite time. These are from light to dark dove colors and unlimited quantities of them could be easily quarried along their outcrops. The soils derived from the destruction of these series are of a very limited extent, yet there are, among the cliffs, many small places where these soils could be utilized in the growing of grapes and other plants. The character of these soils rank with the best, containing a large proportion of phosphoric acid and potash, two of the elements which are the most necessary in the formation of real productive soils. An average of six of the Birdseye soils of the State is given below.

Organic and volatile matters	4.453
Alumina, iron and manganese oxides	6.513
Lime carbonate	.453
Magnesia	.383
Phosphoric acid (P2O5)	.207
Potash extracted by acids	.178
Sand and insoluble silicates	84.632
	96.819

This series is uniform in thickness and lithological characters with the same rocks as seen in Garrard and Mercer counties. The same fossils are here found that are seen in the other situations, and the reader is referred to the reports on the above named counties for other information.

Trenton Limestone.—This series of rocks, which rest on the Birdseye below, are at the surface in the northern and northwestern part of the county, and makes the most beautiful and richest of the agricultural lands. These rocks are also exposed in part of the valleys of Two-mile and Four-mile creeks. They approximate two hundred feet in thickness and with only a few exceptions approach the same character in the various layers which go to make up the whole. At the base there is a layer of cherty matter which in its natural alteration resembles a sandstone. The fossils here are silicified and not in good condition for cabinet specimens. Several species of *Orthoceras*, *Orthis pectinella*, *Orthis tricenaria*, *Orthis testudinaria*, *Leptæna sericea*, with species of *Cyrtodonta* are the prevailing and characteristic forms. These beds give heavy clay soils apt to cut badly by washing, but they are of very limited extent.

Above the last are to be seen some thin layers of an earthy limestone which has some properties for making an hydraulic lime, and associated with them are thin beds of blue shale which give a gray clay in their destruction.

Near the top of the Trenton are some heavy bedded stones which have a granulated structure and, on exposed surfaces, have an appearance to the touch, and also to the eye, of being sandstone. These are the granular limestones of other reports and are seen in a few places below Wade's mill quite prominently. This stone here is not as good for building purposes as the same layers in Mercer county. It has been quarried and finished at or near Wade's mill, where it was thought it would make a fair article of marble, but it does not hold its colors and it is in places very unevenly bedded, and splits unevenly along its lines of lamination.

The rest of the series is made up of beds which wear into

thin blue or gray layers, rather easy of decomposition, and thus serve as the basis of the excellent soils which lie above them everywhere. The upper part of the Trenton, where these granular rocks are seen, has two well-marked peculiarities which seem to impress them everywhere. One is the dark color which they have after exposure in fences and other places. This feature makes them readily recognized by one used to them, without examination. The other is, that they will become covered with moss sooner and in greater quantities than any stones which I know of in the State. The last condition is due to the fact that here these rocks are in part phosphate of lime and the plant food is thus largely prepared in the rocks while its open granular and vesicular structure allows the penetration, easily, of the roots of the moss.

It seems to be certain that at least one half of these two-hundred feet of rocks, contain a large amount of phosphate of lime. Dr. Peter has analyzed quite a number of specimens containing from five to twenty-five per cent. of phosphoric acid and from this it is easy to see why the soils derived from them are the richest known in Kentucky.

I am satisfied that this great accumulation, of this essential element of fertility, has been derived from the destruction of a very small, almost microscopic shell, belonging to the univalves and described by palæontologists under the name of *microceras*. The shells have undergone a decomposition, usually in the rocks, but their forms in earthy looking casts can be seen by myriads whenever a fragment is examined. The richest rocks are those that contain the greatest number of these shells.

What a wonderful and almost inconceivable revelation comes to us when the history of these rocky layers and all their results is read aright?

Who can calculate the time that swept over the old ocean's floor, in the Trenton times, while tiny shells, just large enough for the naked eye to trace, came forth and grew and died in numbers sufficient that their frail shells would constitute a hundred feet of rocks. Since then these rocks have been covered with many hundreds of feet of other kinds, raised by

great earth movements from the sea, the upper ones being dissolved and carried away until the old beds have been reached again, and their decomposed elements now furnish alike the richest food which gives characters, of quality and size, not only to the blade of bluegrass, the grain of wheat and the husk of corn, but to the fleet racehorse, the flesh of cattle and the physical qualities of the men and women. These are facts which can not be controverted, and we have here stored up the matter which might enrich other soils of the State. These richest layers should be made to give up their fertilizers for transportation to those soils which have not enough phosphates in them to make them rich.

These Trenton soils are all good, and the differences which exist in them are largely due to the depth of soil, the nearness of the rocks to the surface, or to the want of care in retaining the soils as they should be, and sometimes to the excessive removal of crops from the farm. Where the soils are deep and well taken care of they are nearly practically inexhaustible. They are earlier in the season, because they are warmer and richer in young plant food, yet they do not stand long excessive hot weather so well as some poorer but moister soils.

An average of thirty-two of these Trenton soils taken from several of the counties of the State gives the following results:

Organic and volatile matters	6.211
Alumina and iron and manganese oxides	11.200
Lime carbonate	.749
Magnesia	.644
Phosphoric acid (P2 O5)	.328
Potash extracted by acids	.404
Sand and insoluble silicates	73.380
Water expelled at 205° F.	not est.
Potash in the insoluble silicates	not est.
Total	92.916

When it is considered that the average of phosphoric acid contained in soils is only 0.17 per cent. and of potash 0.14 per cent. it can easily be seen why these best soils of Central Kentucky take such rank among all others. And as the soil, subsoil and the underclay all are equally rich in these two

necessary elements of fertility, it is certain that as long as the rocks upon which they are based dissolve themselves into soil there can be no essential loss in the fertility of these lands. No application of bonedust will be needed, for the phosphate of lime is its equivalent. Yet organic matters in the form of stable manures, straw and green crops of clover, etc., turned under, are necessary to give the best results, as by their chemical action the food for growing crops is prepared for being taken up and assimilated by the plants.

The soils from near the upper part of these beds are often red from the presence of oxide of iron, a mineral which has a world-wide distribution, and is one of the great chemical agents which act upon other substances in the soils and prepare them for fertility. This red soil through this region is highly prized, for the people have by observation learned its intrinsic worth.

So close is the relation between the growth and quality of the bluegrass and the phosphatic limestones that one may be usually able to determine the presence of the limestone beneath by the growth of grass above.

There seems to be no way to solve the question as to whether the bluegrass was indigenous to the blue limestone soils of Kentucky at the first introduction of settlers. There is a legend which is often told that Grassy Lick creek, in Montgomery, was named from the presence of bluegrass growing around a sulphur spring, where it had been trampled by buffalo who came hither to drink the water.

Mr. Fielding Bush, one of the oldest men in the county, told me that he was the first to clean up the woods in the region of Lower Howard's creek and sow bluegrass seed. He obtained the seed from the farm of Robert Cunningham, on Stoner creek. Mr. Cunningham always claimed that he introduced it into Kentucky from the South Fork of the Potomac river, in Virginia. This locality in Virginia had soils very much like the ones of Central Kentucky, and it is known that bluegrass was a native there from the first history of the country. Had it been a native in Kentucky, it would certainly be

so widely distributed that no doubt would ever have arisen as to its having been indigenous to the State. This introduction in 1800, by Mr. Cunningham, seems to be the most reasonable solution to its earliest introduction with us.

Since writing the above I have seen the following published statement of Samuel McElwain, of Henry county, on the introtroduction of bluegrass in Kentucky:

"I was born in Clark county, Kentucky, upon an adjoining farm to the Thomas Goff farm. Mr. Goff was in the habit of driving cattle East, and having discovered this grass, near the Blue Ridge Mountains, cut the sod with a pocket-knife and brought it home with him in his saddle-pockets and cultivated it in his garden. This was about the time of my birth, in 1807. My father had a blacksmith shop in the neighborhood of the Cunninghams, Donaldsons, Beans, Patons and others. I heard them discuss the subject many times, and all told the same story just as I have told. After I was old enough to remember, the grass was sparsely scattered through the neighborhood, having followed the course of a creek running by the Goff farm, and as it took root and formed tufts of sod, the seed was gathered and sown each year, till when I left there, at the age of seventeen, the farms in the community were generally well set with it. Its first introduction into Henry county was in 1824, by Mr. Seth Duncan, who sowed some seed in a turnip patch on the farm now owned by Mr. J. T. Shaw, about four miles west of New Castle."

It is a noticeable fact that the road dust, blown into the margin of the fields and pastures, where the pikes have been made from the layers of phosphatic limestones, enriches the growth of grass and grains, and a close study of this will show the rows of corn which have received this fine matter. If this proposition is true, then it is evident that, if those layers of rock which contain the largest percentage of phosphate matter were ground into a fine flour, its application to soils would be easy and the benefits derived very great. Its application to wheat soils would probably be very beneficial, as the average amount of that grain grown is greater on these than on any soils

in the State. Inquiries made in several directions point to the conclusion that the weight of white burley tobacco is more to the acre than on either of the other soils of the State on which it is grown. And while these soils of the Trenton are of such limited distribution in the State, nearly all of the hemp growing is confined to their boundaries. These remarks will apply with equal force to the soils of a portion of the Upper Hudson beds.

The changes which are recorded in the Trenton group from Mercer county to Clark are not many nor great. Nearly every character which ones sees in the soils, the rocks, the slopes and the general appearances, are very much alike. There is the absence of the Upper Birdseye in Clark in its type character, yet, at the horizon to which it belongs there are partial structures in the rocks which show that at least part of the conditions were present. A greater number of layers is made up of the little *microceras;* consequently, there is a greater development of phosphate of lime in the latter county. Some of the Trenton layers are unevenly laminated and sometimes this amounts to cross-stratification, but, nowhere, have I seen in the Trenton beds a perfect representation of those great wave marks which are so typical of the Lower Hudson. But there is a point on Lower Howard's creek near the Calmese estate where this feature is as perfect as can be seen at any point in the Lower Hudson beds.

The change in the forest is more marked by the introduction of great numbers of burr oaks. In the region along the Bourbon line, and on, and near, Stoner, Strode's creek and other small streams this species is in greater number than any other and sometimes the forest seems to have been more than half of these oaks alone. The quality of the wood is good, and the trees are larger than I have met them in any other county. I measured two of these on the farm of Chas. Swift, Esq., and found them to be six feet two inches and five feet three inches in diameter, and there was said to have been one in the neighborhood which was over twenty-eight feet in circumference. In other situations the distribution of the trees

was about as usual, consisting of blue ash, white ash, wild cherry, hackberry, black walnut, white chestnut oak, here called white oak, red oak, mulberry, black locust, coffee bean, and shell-bark hickory. The forest has been largely destroyed and only a few aged trees are seen in little skirts of woods, and many of these are falling into decay.

One of the saddest sights, to one who has studied the economy of forests to only a limited extent, is, to pass year after year along some of the roads of Central Kentucky, and notice how each annual loss has altered the appearance of the familiar woods. A tree has fallen because the multiplication of worms has been so great that they have actually eaten it down, another one has been cut for fuel or to make sticks to hang tobacco on, while the sweeping winds have hurled others to the ground and broken branches, by storm or rot, have left others as unsightly objects. Few farmers are caring for their groves and fewer yet are making any effort to restore from the dismantled earth young trees to bless and preserve those who come after them.

Destructive changes have come to the best part of our State by the disrobing of the forests and, perhaps with much truth, it is claimed by all the intelligent old men, that in some counties, and on many farms, the season for plowing and planting is a month later than it was fifty years ago.

The Trenton in this county does not contain as many caves as in some of the other counties, yet there are a few known. These are not of any particular interest. One, on the farm of Mr. Joseph Jones, is the best known and the largest. This cave is often visited by the people of this section. It contains a spring of good, cool water and has room enough to make a storehouse for fruits, vegetables and meats, purposes to which many dry caves are very suitable.

There are not many large springs on the Trenton area, yet some good ones exist on and near some of the streams. Wells usually give plenty, and water of good potable character. Several wells have been bored near Pretty Run which have afforded full supplies of sulphur water. One at Mr.

Chas. Swift's is a very pleasant white sulphur which I had arranged to have analyzed, but for some cause the sample has not yet reached Dr. Peter for examination.

The fossils which mark the Trenton in Kentucky are to be seen in this county, but they are rarely, if ever, very well preserved. Among the characteristic types are *Stromatopora rugusa*, *Columnaria alveolata*, *Orthis testudinaria*, *Orthis borealis*, *Orthis clytie*, the small form of *Orthis lynx*, *Rhynconella increbescens*, *Streptorhyncus planumbonum*. At one point I found some specimens of *Orthis deflecta*, quite a rare shell, and of which I had only found, heretofore, such poor fragments in Boyle County that they could not be identified. *Leperditia capax* and *L. morgani*, Safford's species, were seen in the partial birdseye layers near the top of the series. Many other forms are included in the various layers.

At the top of the Trenton is to be seen, at several points, a bed which has not been seen elsewhere, and consists of a number of layers of blue limestone, separated by mud shales, all of which wear down into a stiff clay soil. These rocks contain *Orthis occidentalis*, small *Orthis lynx*, *Orthis linneyi*, *Cyclonema bilix*, *Constellaria antheoloidea*. The first and third of these I had never met with near this horizon before.

HUDSON RIVER GROUP.

This group makes about one half of the surface of the county, and, not being uniform in its character, has been divided into three series of beds in which natural distinctions are to some extent the dividing lines. The colors on the map allow the student and reader to note at once the extent and position which they occupy.

Lower Hudson Beds.—These beds, which furnish a very characteristic series of rocks, soils and slopes, are to be seen in their usual characters in going from Winchester five miles out on the Ruckerville road, or to Stoner creek, on the Clark and Montgomery pike. They are more or less modified by circumstances, over their other outcrops, but are essentially

the same series. These beds are one hundred and seventy-five feet in thickness in the county, whereas in Madison, and some other counties this is increased to two hundred. There is an absence here of some of the heavy clay shales which lie near the base.

The rocks are usually more compact and somewhat more crystalline than those of the Trenton below, and having usually more or less shale between them, there is more apt to be loose blocks lying on the surface from the destruction of the shale beneath them. There are fields, along the roads spoken of, where these blocks of stone nearly cover the surface, and at times an absence of care has allowed the soils to wash away, leaving barren and unsightly places in the fields and pastures. There is no excuse for this condition of things, for near them, and with the same natural conditions existing, are beautiful bluegrass swards and fine growing crops.

There is more of the phosphatic limestones in these beds than are usual in the counties to the northwest; consequently there is no doubt but that the soils are better than is usual on the same group.

It is evident, also, that more care has been given to the preservation of the larger part of the Lower Hudson in Clark than in Mercer and Washington. In these latter counties the soils have been in many cases ruined by a criminal carelessness in overcropping and leaving the fields in condition where the soils were torn away by heavy rains. The slopes in Clark are more gentle than the average of these rocks elsewhere, and the crops and grass are often as good as can be seen on the Trenton. Some of the most desirable farms in the county are thus situated on these soils, while elsewhere they do not rank nearly so high in value. The soils are heavier clays, of rather a light yellow color, and take good rank where carefully protected. In fact one of the three richest soils which have been examined from Kentucky was taken from the lower part of this series. Its composition is added for comparison:

Organic and volatile matters	10.865
Alumina and iron and manganese oxides	13.126
Lime carbonate	1.995
Magnesia	1.234
Phosphoric acid (P_2O_5)	.333
Potash extracted by acids	.762
Sand and insoluble silicates	72.035
Total	99.850
Water expelled at 212° F.	4.500

Some of the layers in the lower part have been quarried for stonework, and as usual they wear well. These hard layers from the Lower Hudson make an excellent material for turnpikes, for which purpose they are largely used. Along some of the roads they have been in almost sufficient quantities on and near the surface, so that they were merely gathered up without quarrying.

The great wave-marked layers, which are so conspicuous and characteristic of these beds wherever they have been seen, are in full force in this county, and can be seen in the beds of the branches at a great many places. They hold their character well wherever seen, and attract the eye wherever they may be exposed. There is a layer which comes rather in the upper part of these beds which is rather singular, and yet everywhere present with the same peculiarity. This is a very tough, hard, blue layer, about four inches thick, which has on top, as a part of it, about two inches of a more resisting rock. Where these have been broken up and worn under the soil they take on the shapes of so many anvils. The top and often the bottom are extended like these tools, and the sides hollowed as is the case with them.

This series of rocks, from Spencer County to Madison, along its whole outcrop, was originally covered with white oak as the characteristic tree. In crossing the Kentucky River into Clark there is a change in this distribution. Where its extension approaches Madison there were some localities where it grew in some abundance, but as a general rule there was very little of it on these soils, and over a large part of its surface there was none. This feature is evidently a result of the fault line which here separates the connection of the Lower Hudson beds

entirely. A glance at the map of the region near Boonesboro and east of that point shows how the separation occurs.

The usual fossils seem to be present as a general rule through these rocks, the characteristic ones being seen at a number of places.

Middle Hudson River Beds.—Overlying the Lower beds just noted is seen the next division, which, in the earlier reports by Dr. Owen, were termed the Silicious Mudstone. The rocks which compose them are unlike any other series in the State, being composed very largely of silicious matter in a very finely divided condition. They are all blue when quarried freshly, but soon part with their lime by leaching, and are seen on the surface resembling soft sandstones of a dark-yellow color. There are, however, some layers of hard blue limestone, which come in between them, but these do not often show on the surface. Between the various layers is more or less shale. Some of this is hard and sandy, and flakes of it are often left exposed, but more often it is a mere mud. From these characters the rocks decompose easily and rather rapidly, forming a deep soil, which imbibes a large amount of moisture, and in dry seasons stands drouths exceedingly well.

An average of eleven analyses of these soils by Dr. Peter gives the following results:

Organic and volatile matters	4.778
Alumina and iron and manganese oxides	7.064
Lime carbonate	.101
Magnesia	.605
Phosphoric acid (P_2O_5)	.165
Potash extracted by acids	.155
Sand and insoluble silicates	86.551
Total	100.00

The proportion of carbonate of lime in these soils is very low, not being one third of the average in the various soils of the State, and it is probable that applications of slacked lime, or dust from the phosphatic limestones, would largely benefit them, especially in the growing of wheat and other small grain. The proportions of phosphoric acid and potash are also somewhat

less than the general average of Kentucky. With these facts before us, it is certain that these soils produce fine crops of corn, and, where taken care of, do not seem to deteriorate by many years of incessant cropping of this grain. Some of them have been badly used, and in the horizons, where the hard sandy shales are found, worn places are apt to be made, but often, though, on steep slopes, the grass is good, and some farms on this series are very desirable, but, on the other hand, some few of them have been ill used almost to destruction.

The ease with which these series of rocks are acted on by erosive agencies often leaves them with characteristic steep slopes, and the drainage lines cut deep and close to each other. This fact gives to the country usually a very broken, hilly appearance. One of the peculiar characters of these rocks is the great concretionary-like structure of some of the heavy layers. These are often seen exposed in the beds of creeks, as is the case on the Four-mile pike, not far from Mr. C. Haggard's. This is the best representation of these layers which I have noticed. They show for nearly a mile in the creek bed and its branches, and very rough indeed are the roads over them. From all that can be seen of them here their origin must have been produced by very turbulent waves, and is not the result of shrinkage or concretionary action subsequent to their original deposition.

The original timber over these soils in Kentucky was more largely beech than of all the other species. In Clark this was to a small extent the case, but along its northern outcrop to the Montgomery line there was often an absence of this tree. In some spots, where the destruction has not been so general, there are small woodlands where the beech trees stand thick to-day. In some localities the sugar maple was the prevalent growth; at others the white oak grew largely. Linn, buckeye, walnut, chinquepin oak, wild cherry, sometimes blue ash and large yellow poplars, made up the old forests.

In this formation, and along some of the small branches which find their way into Stoner Creek, I several times met with a layer of rock, four to six inches thick, which held small quantities of petroleum in its cavities, When these layers were broken

they seemed almost as if they were saturated with it. This is the horizon in which the oil is seen on Plum Lick branch, on the line of Bourbon and Montgomery counties. This layer was a fossiliferous one, and the fossils have been destroyed, leaving the cavities open. It is very doubtful that this oil could have had its origin in the rock where found. The quantity is too small ever to have any value, and is mentioned to show how little value there is to the occurrence of petroleum in some of the rocks of Kentucky.

This series contains quite a number of fossils, but always in very poor condition. Plant impressions are quite common on some of the flag-like layers of silicious rocks. *Chætetes* corals are often in the shale and the limestones. *Streptorhyncus plano convexus* is always present in large numbers at one horizon near the top. This is the most characteristic fossil in the group, and its presence marks a well known layer through all the counties. It ever seems the same, and confined to the same association and condition.

Upper Hudson River Beds.—The upper beds of the Hudson are some three hundred feet thick, but are not homogeneous in character, the lower and upper parts being very much unlike in their constituents. The lower seventy-five feet are thin bedded, blue limestones, not very even in their deposition, and about twelve feet of them were very roughly laid down. This unevenness of structure almost amounts to cross stratification, and sometimes resembles large wave marks. These rocks are best seen along the Montgomery line, from Mr. Chorn's, by Thompson Station, to Mrs. Cunningham's, on the Kiddville road. They make an excellent class of soils, having nearly the character of the best Trenton lands, and can only be distinguished from them by an examination of the rocks beneath. The timbers in their distribution, and the slopes, are very much alike. These rocks show a little along a line northwest of Allensville, but here the dip is so great that they are carried below others in such a short distance that their true characteristics are not to be seen. These beds are marked by a series

of fossils which are characteristic. *Orthis linneyi*, *Ptilodictya hilli*, *Cyrtoceras vallandighami*, with various forms of branching corals.

Above the last mentioned there are one hundred feet of rocks which have been appropriately called the Lynx Bed, from the prevalence of a well known fossil shell of wide distribution. This has received in its description the name of *Orthis lynx*. These are usually shelly layers, which break up into small fragments in their natural exposures, and often make bare places by the number of them, which cover the slopes. There is more or less earthy matter in them, which assists in their destruction. The soils are very good, when rightly used, usually producing bluegrass, but not so well, generally, as the Trenton and the division just below. These beds can be seen in a great number of places in the county, and a large number of fossils gathered from them. These layers are sometimes quarried for rock fences and other purposes, but soon break down and become worthless. There is an occasional layer which is better, and two or three which make a very good lasting stone, but the usual amount of stripping required does not pay to remove them. Some of the layers make a very good article of lime, and this might be advantageously used on other contiguous soils which need its application.

Above the Lynx beds lie some one hundred and twenty-five feet of sandstones and sandy shales, with some beds of thin limestones, which have been included under the name of the Cumberland Sandstone. These all contain more or less lime, though some of them are to a large extent composed of silica. They show along part of Lulbegrud creek, the line of Red river, a short distance along the Kentucky, and along part of the valley and hills of Upper Howard's creek. A good type of them is seen going down the hill at Vienna, as is another in the neighborhood of J. Harry Boone, Esq., to the right of the Red river pike, nine or ten miles from Winchester. At these points the rocks are on the surface in places, and they are so sandy and crumble so fast that they leave places bare of vegetation and which are very hard to renew with any plant covering.

There is about twenty-five feet of this kind of rock, in one bed, which is worthless for building or anything else. Some of the rest of the beds are much better, and one, at least, good layer of limestone is contained in them. Grass does not hold well on these soils. This is partly due to the slopes, which are nearly always here quite steep, and the soil breaks down by wetting and drying, and often from the treading of stock. The surface of Clark made by this rock is quite small, being seen only in a narrow line around the outcrop of the next division, that of the Upper Silurian, and is soon concealed by the overlapping of those rocks. This closes the description of the Lower Silurian in Clark county.

UPPER SILURIAN.

This great division of ancient rocks, having at some places in the United States an aggregate thickness of many thousand feet, with a great variety of strata, has as its representatives here less than seventy feet of rocks and shales. It is more of a northern and eastern formation, and its thinning to the west and southwest is a well-established fact. As shown by the map, it is only to be seen in narrow lines and patches in the southern part of the county, often then hid by the falling of the material from above. Where it is thickly exposed, it has the following divisions:

Lower Helderburg Period	
Salina Period	
Niagara Period	Niagara Epoch.
	Clinton Epoch.
	Medina Epoch.

The first two periods have no representative here, but the presence of part of the Niagara is very well shown.

Clinton Group.—The rocks of the Clinton are for the most part magnesian limestones and shales. At the base are some heavy sandy layers which may represent the Medina sandstone. These are more or less earthy and friable, crumbling into small pieces from the exposed layers, and when thoroughly reduced and washed of the clay there is left often, in places, only pure sand. These rocks contain some casts of shells in very poor condition, though the *Orthis lynx* is often one of them. Perhaps a small form of *Atrypa reticularis* is among them. These are succeeded by thinner layers of coarse-grained limestones and shales, then several layers of heavy, rough-bedded blue limestones, after which there are shales and thin limestones overlaid with heavy strata of limestones.

These present about the following section, though they are not by any means uniform in every place:

	Feet.
Heavy limestones	8
Shales	7
Thin limestones	9
Heavy limestones	6
Limestones and shales	11
Sandstones and shales	9
Total	50

The larger part of the limestones are rough and unevenly bedded, breaking unevenly, and contain some silica and clay. These make a tough material for pikes and have been used for that purpose. While they are a dirty blue, when fresh broken, they all become, on exposure, a dirty yellow, which is so peculiar to magnesian limestones. There is rather more than twenty per cent. of magnesia in all these limestones. The thin layers are more even in their character, and some of them would make flag-stones.

The seven feet of shales seem to be the equivalent of the Crab Orchard Shale of Lincoln and Garrard counties. They contain the association of thin lime plates, balls of iron pyrite

and crystals of sulphate of lime. At Kiddville, at the residence of Mr. Groves, a well dug into these layers gave a strong epsom water similar to the Crab Orchard variety. The following is the analysis and the remarks by Dr. Peter:

"No. 2,471. Magnesian mineral water at Kiddville, Clark County. Property of J. E. Groves. Sample collected by W. M. Linney, July, 1884. Tastes strongly of epsom salt. Reaction mutual.

Iron Carbonate, with some little Magnesian Carbonate	0.0024
Lime Carbonate	.3740
Magnesia Carbonate	.0191
Lime Sulphate	3.2610
Magnesia Sulphate	4.7776
Potash Sulphate	.0490
Soda Sulphate	.7118
Sodium Chloride	.2120
Lithium Chloride	.0130
Total saline matters in 1,000 parts	9.4199

"This is an epsom water resembling the Crab Orchard waters of Lincoln County."

It is probable that here a number of wells or pits could be made where the Crab Orchard variety of epsom salts could be manufactured.

These shales are blue and red, but on exposure they become ash-colored or white.

At Kiddville and several other places one of the layers of limestone was red in color, due to the infiltration of iron. On further examination it was seen that there are two layers, which must be the representatives of the beds of hematite ore in the Clinton Group in East Tennessee. The same lenticular structure is prevalent. Sometimes this is a true ore, with all the characters of the Clinton. There is some little strontian contained in these rocks, a very usual thing in Kentucky. *Pentamarus ovalis* and *Zaphrentis bilateralis* are very common fossils. Small forms of *Atrypa reticularis* and other fossils are found, but they are not good specimens.

Niagara Group.—Over the Clinton is spread sixteen to twenty feet of blue and red shales, which have intercalated

about three inches of thin limestone plates. These make four layers and are filled with small fossils, usually round-stemmed corals. They also contain sometimes *Strombodes pentagonus* and *Favosites niagarensis*. These seem to determine the position of this shale, which is the only representative of the group. This shale, when on the surface, gives a very stiff, tenacious clay, and when roads run over it and are not macadamized they become almost impassable. This clay could be used for making a common article of stoneware, though it is not a very profitable business. It can best be seen at Eastin's mill, where there is a perpendicular section entirely through it.

These clays of the Upper Silurian promise to be very valuable in the future. They really come under the class of marls or marly clays, containing in some places valuable percentages of sulphate of lime, potash and phosphoric acid. The analyses of two of them are given from the reports of Madison county.

COMPOSITION OF TWO MARLY SHALES, DRIED AT 212° F.

	No. 2186	No. 2187
Silica	42.300	48.780
Alumina, etc	20.840	17.320
Iron peroxide	4.120	3.240
Lime sulphate (gypsum)	. . .	19.285
Lime	13.320	. . .
Magnesia	.461	.496
Potash	2.387	4.768
Soda	.351	.240
Combined water, carbonic acid and loss	16.221	5.871
Total	100.000	100.000

The two beds in Clark county are the continuations of those in Madison, and most probably have about the same composition. The examination of the water at the well of Mr. Groves shows a large percentage of gypsum. These marly shales need no burning, but if they were mixed with quick-lime in a compost heap before spreading, their advantageous effects would be sooner seen.

There is little doubt but if they were hauled out and put on

the tired lands of the Black Slate, and other classes of soils, which are contiguous to their outcrops, they would exhibit fine results within two or three seasons.

The marl beds of New Jersey have been of inestimable value to that State; lands that were of no value have been made very rich by the application alone of marls as dressings for the soil.

The chemical composition of the New Jersey marl is shown by the following table, which is taken from the "Geology of New Jersey, 1868:"

Silica	51.16
Alumina	6.10
Oxide of iron	17.68
Lime	8.48
Magnesia	2.04
Potash	4.27
Phosphoric acid	4.54
Sulphuric acid	0.48
Water	9.18

DEVONIAN.

This, another of the great geological divisions, though of immense thickness in places, is here represented only by about one hundred and eight feet of strata, one hundred of this being the black slate and the remainder being divided between two other divisions, the Oriskany sandstone and Corniferous limestone.

Oriskany Sandstone.—This is represented by a single layer of stone, about one foot thick, but which is present at all the places where I have examined for it in its proper horizon. It is rather a dull, dirty blue when broken, but exposed it is nearly white, especially in the beds of creeks where it has been smoothed by the scouring of sand and water. It is quite tough, though the edges are sometimes brittle. The great peculiarity of this stone is that several inches of its base is literally made up of the bones, spines, plates and teeth of fishes. The larger part of these had been ground into pebbles before they were left to be consolidated into rock, but many of the small teeth

are whole and the tubercles on the plates are well preserved. Some of these fish must have been very large and must have required an immense number of individuals to have covered many square miles of the bottom of the Devonian sea with their fragments of bone and teeth. As unimportant as this single layer of rock may seem at a moment's thought, yet it has greater importance here than many feet of other layers might have. Though it is never quarried for any purpose, yet in its decomposition it has given a wonderful effect to some of the soils by the amount of fertilizing elements which it yields in its destruction. This fact will be referred to further on.

A sample of the lower part of this layer was submitted to Dr. Peter for analysis. The specimen was taken from near Stuart's old mill, and is, perhaps, an average of this rock as seen in its outcrops for at least twenty miles in this end of Clark county. In its chemical character it is here rather more of a limestone than a sandstone, though at other places it contains enough silicious matter to rank with sandstones.

"No. 2469. Phosphatic limestone; Stuart's mill, Lulbegrud creek, Clark county. Oriskany formation.

"A dark brown-grey, conglomerate rock, containing many dark-colored fragments of fossil organic remains."

COMPOSITION.

(*Air-dried.*)

Lime carbonate	21.380
Magnesia carbonate	3.055
Alumina and iron oxide	not est
Phosphoric acid (P2 O5)	9.710
Potash	.830
Soda	.228
Silicious residue insoluble in acids	25.580

In the valuation of marls one per cent. of phosphoric acid is worth $1.80 to the ton, while thirty per cent. of lime gives a value of $1 per ton. This stone then, if in the form of a marl, would have on the farms of Clark county a value of about $18 per ton. If it was prepared as a commercial fertilizer, such as are sold so largely over the country, its value per ton would be more than doubled.

With the wealth of ingredients contained in this rock, the shale below it as a potters' clay and marl, the cement qualities of an upper layer and the good building qualities of one or two layers of the Corniferous limestone, a section here, near to the line of the Kentucky Union railroad, promises very much for the future.

Corniferous Limestone.—The seven feet of rocks lying between the Oriskany sandstone and the Black Slate belong to the Corniferous group, and are here in several layers, as follows:

	Ft.	In.
Brecciated layer	1 to 2	0
Cement layer	1 to 2	0
Earthy sandstone	0	10
Blue limestone	1	8
Buff limestone	1	0
Total	7	1

All of these layers are not present everywhere, as the upper ones sometimes thin out, and at other places are entirely absent. Sometimes, altogether they are not more than three feet thick. Two of these layers would make good building stones, and several of them would make a very fair lime. The one next to the top appears to be an extension of the cement rock used, from the falls of the Ohio, at Louisville, and would perhaps do for that purpose here. A number of representative fossils of the Corniferous group are found in this region. *Zaphrentis corniculum*, *Heliophyllum halli*, *Phillipsastrea gigas* are among the most conspicuous. The hornstone (flint), which so often marks the Corniferous, is quite common in places, but is often entirely absent.

The cement layer in the section above has the following composition (air-dried):

Lime carbonate	33.980
Magnesia carbonate	11.185
Alumina and iron oxide	not est
Phosphoric acid (P2 O5)	1.842
Potash	not est
Soda	not est
Silicious residue insoluble in acids	31.720

Skillful, practical trials would soon determine the worth of

this rock as a material to manufacture hydraulic cement from. The quantity is not large, but if it was removed in order to uncover other layers, it would perhaps then be worth looking after by the cement-maker.

These rocks, from the undermining of the Niagara Shale, are often broken down. This condition is a rapid cause of cutting back the beds of creeks and the sides of hills. At Stuart's old mill, as also at Eastin's mill, this is well illustrated, for the heavy blocks fill the creek bed, where they have fallen from only a few feet above. This break has receded from this cause, on one side of the creek, fifty feet in forty years. These falls in Lulbegrud creek are quite interesting as a study of the destruction due to the undermining of underlying shales.

It is due to the foregoing facts that the soils of the Upper Silurian are mixed largely with the waste of the Corniferous layers. So in this county, like in many others, there are no distinctive Corniferous soils, and those of this group and the Upper Silurian have to be described as one. The soils of the Upper Silurian in the State are about of an average character, sixteen soils giving the following result:

Organic and volatile matters	6.234
Alumina and iron and manganese oxides	10.493
Lime carbonate	.322
Magnesia	.422
Phosphoric acid (P2 O5)	.190
Potash extracted with acids	.242
Sand and insoluble silicates	82.395
Total	100.300

Many of these soils are prone to wash very badly, and need much care to keep the drains from cutting deep. There is quite a large tract of land lying south of Upper Howard's creek, near the Red river pike, which is equal in fertility and beauty to any of the soils of the State. They lie on a very gentle slope toward the south, and were originally level enough to be swampy when thickly covered with timber. The drainage was so slight that the elements derived from leaf-mold, etc., did not waste away, and to these conditions were added the rich elements of lime, phosphoric acid, and potash, derived from the destruction of the

bone-bed of the Oriskany sandstone layer. It is to the latter, perhaps, in the largest measure is due the wonderful richness of the Indian Old Fields. The character of these lands is well illustrated by the farm of Mr. John Goff, which lies on each side of the Red river pike. To this principle must be due the richness of the "red-bud" soil of Madison county, which analysis shows to be one of the richest soils of the State.

On this soil, along part of Lulbegrud creek and Red river, especially about Vienna, there are many cedar and red-bud trees, though oaks are a prominent species.

Black Slate.—This group of well-known rocks is seen in Clark county, south of Upper Howard's creek only, and has a total thickness of a little more than one hundred feet. It has a general structure of thin black slaty layers, which, when exposed to the action of the atmosphere, become ashen gray. When quarried freshly, it appears sometimes as quite thick layers, but these generally soon exfoliate and split into thin plates. On the surface of a spring, flowing from it, drops of oil are sometimes seen, and where it wears into steep bluffs, or is undermined in its banks, a white and often a yellow efflorescence may be seen. The oil is the result of the decomposition of the black matter, while the efflorescence is a natural copperas, which is produced by the exposure and destruction of the iron sulphide (iron pyrite), which is nearly always present in the layers.

The conditions and circumstances under which this vast amount of material of this slate was deposited has been a subject of much investigation, but so far nothing more satisfactory than conjectures has been the result. It has been supposed to have been entirely deposited in deep waters, but this may be well doubted from some facts established by an investigation recently made by myself in this region.

In the bed of, and along the line of Copperas creek, near the junction of Clark and Powell counties, I found some conditions which I had not heretofore seen, though in hundreds of localities every layer of the black slate had been exposed to my inspection.

Only a few feet above the base, but in the true slate, I found

a layer of stone, which was local to several points, which clearly showed that its material had been arranged by strong wave action. Above this, some five feet, was locally a stratum of phosphatic sandstone two inches thick. The latter was composed of small rounded grains of hyaline quartz, and fragments of spines, bones, and teeth of small fishes. This quartz must have been brought by currents hundreds of miles before it could have reached this point, there being no nearer source for it.

A few feet above were ten or twelve inches of fire-clay, and on this the layers of slate for several inches were covered with the impressions of several species of plants. Some of these were land plants of the genus *Lepidodendra*, and another had leaves resembling our common flags, eight or ten inches long. These stems of trees and other plants were in immense numbers. Over the layers above, and, in one instance, below, these evidences of forest growth, were nodules scattered in a very promiscuous manner. In looking at them it was seen that these lumps were accretions of fossils replaced by iron pyrite, in which there was a species of *bellerophon*, and one of *orthoceratite*. The character of these nodules, their sizes, and their distribution, struck me that they were the droppings from fish, and this idea was strengthened by the finding in the shale, two feet above, of part of the remains of two individuals of a very large fossil fish, which had been found in the Black Slate in Ohio, and described by Dr. J. S. Newberry under the name of *Diniehthys herzeri* (Herzer's Terrible Fish). This determination is made through two dorso-median plates, nearly two feet each in diameter, but one of them is much more perfect than the ones figured in the Ohio Report. There is one bone much more massive than this, but to where it belongs is as yet unknown. These bones are simply imbedded in the slate, and are not contained in concretions of limestone, as were the remains of the same species in Ohio.

Still above the fish beds was seen at several places a layer, two inches thick, of a crystallized dolomite; at another, concretions over a foot thick of sandstone, and at one place was seen a thin layer of the asphaltum coal which is sometimes seen in

these beds Some of these features are inconsistent with the idea of a deep sea origin, but point to shallow waters, and a land surface at times.

The remains of great and small fishes, mollusks and plants, point to the sources from which were derived the petroleum which is always present, in some form, in these rocks, but never here, perhaps, in such conditions or quantities which will make it profitable. There is an outcrop on Copperas creek only a few hundred yards from Eastin's mill which shows, at once, an exposure of nearly eighty feet. The bank is very steep and covered with the thin, crumbling shale. In the niches and under the projecting ledges at the sides are exposed a native copperas. There is a larger amount of iron pyrite here than at any other place I know of in this formation. Such is its quantity, that it imparts its character to the water in the creek so that I was not able to find a single fish, cray-fish, worm or bug in its waters. This slate has been used some in road-making, and is a very desirable material. It is usually convenient of access, easily quarried and broken, and makes a good roadbed. It is used locally, sometimes, in making the back and sides to fireplaces. Blocks of petrified wood, of large size, are sometimes seen. These have come from the slate; they are the common form of *Dadoxylou newberryi*, which has been seen in all the counties where the series has been examined.

The slopes on the black slate are often steep, and should never be cleared of their timbers; but other portions are quite level, or very gently undulating, and the soils from them are sometimes passably good, though little care is taken of them, and rarely any effort made to improve them. An average of nine of the black slate soils of the State gives the following as their composition:

Organic and volatile matters	5.929
Alumina and iron and manganese oxides	10.587
Lime carbonate	.475
Magnesia	.524
Phosphoric acid (P2 O5)	.234
Potash, extracted by acid	.178
Sand and insoluble silicates	80.130
Total	98.057

It is certain that the application of certain substances to these soils would help them very much. The analyses show them to be of that character which can be improved. Application of lime, ashes, and organic manures, would be advantageous to them. Limestones outcrop all around the exposures, and wood is not so scarce but what lime could be burnt to supply all the needs of these soils. In the outcrop of the Upper Silurian and Devonian rocks, the layer of fish remains might be obtained and ground cheaply on some of the mills, on Lulbegrud creek or Red river, and applications of that made. These soils in other places are made to yield large returns, by the manner of treatment, and for grass-lands are sometimes not excelled by any. It would be of great value to the State if these slate soils were better managed.

The timbers on the Black Slate are largely beech and white oak, the latter of very good quality. Red oak, black oak, sassafras, poplar, dogwood and black hickory, with chestnut in places, are the more common kind. The trees have been largely cut from them, yet in places there is some good timber left, and what is of great value is the fact that over much of this land young timber is coming on and promises something for the future. If the present owners will take care of it and protect the valuable species, in time it will be a veritable heritage of wealth.

There are some places in the black slate where it has all the appearance of having been on fire. The layers are turned to terra cotta, as if they had been baked in an oven. I have been told that in the early settlement of the county spontaneous combustion sometimes took place and the shales would burn for a long time. As these points were near some of the lines of disturbance which pass through the county, it is possible that the gases which are being continuously evolved from the decomposition of the hydro-carbons in the slate, may have been ignited in clearing up and burning timbers, and have burned until these results were produced. These places are looked upon by the silver-hunters as the remains of old furnaces where parties long ago smelted precious metals. Sometimes small

quantities of ochre, of good quality, have been produced in this burning. There are a number of springs of mineral waters which issue from these shales, and some of them will be noticed under the head of springs. This formation closes the system of bedded rocks of the county. In a few miles south from the county line all of them disappear beneath higher and newer ones and are seen no more, towards the south, until they are brought up at the foot of the Cumberland Mountains, in Tennessee, in the same relation they have here.

WASTE BEDS.

All over the State, above the present rocks and soils, there have, in time, been others. These have dissolved or crumbled down and been removed by leaching through the soils, or been carried off by the running of water. In some places this has amounted to more than a thousand feet. In this destruction there are some forms of hard rocks which outlive all others, and in many cases these are retained in the soil, and, under favorable conditions, for an indefinite length of time. Pebbles, sand, and fossils, which have been replaced by some forms of silica, are the most common of these.

In the bed of Upper Howard's creek, largely, and in the valleys of other creeks, I found many masses of a large coral, *Lithostrotion canadensis*, which belonged to rocks four hundred feet higher than any now remaining in Clark. Geodes from near the same horizon, as well as pebbles from the conglomerate, are often seen in the northern extreme of the county. Sometimes the silicified corals from the Corniferous are found on the Trenton and over all the other formations.

In the analyses of the various rocks of the State, it is found that the general average (other than sandstones) of sand and silicates is about as twelve parts to a hundred. While in the same process of examination the proportion of the same substances found in our soils is, on an average, eighty parts in a hundred. This excess has remained from the destruction of higher rocks. We may have, therefore, in a quantity of soil taken from the low beds of the Trenton a portion of the remains

of all the groups up to and including the highest coal strata in the State. This sand adds a little to the growth of plants, for part of the hard parts of our cereals, like the outside of the stalks of corn, the stem of wheat, etc., are composed partly of silica, but they serve a useful purpose in making the soils loose and porous, allowing the penetration of roots and water, thus draining and warming them. The addition of sand to clay soils is often very beneficial. In this connection it may be stated that in Powell and Montgomery counties there rests on the top of the black slate a sandstone several feet in thickness, and while it does not exist in Clark as a regular bedded stone, it had its place here in time, as some of the black slate hills are covered with its disintegrated sand. This is especially the case on a hill owned by Mr. H. N. Froman, near Right Angle post-office. From this hill, for many years, this sand has been hauled for many miles and used for building purposes.

DISTURBANCES.

These will be described in the report on Montgomery county as *Disturbances in Clark and Montgomery counties.*

MINERAL SPRINGS.

Besides the springs which have been noticed in the foregoing pages, there are quite a number which issue from the black slate and near its junction with the underlying rocks. A black sulphur flows from the base of the slate at Mr. L. D. Stone's, on the road from Kiddville, to the mouth of Red river. Near Stuart's old mill (marked Clayville on the map), two springs come out from the base of the slate. On Mr. C. C. Eastin's farm there is a sulphur spring in the black slate, and a half a mile above, at the Oil Springs, there are six or seven springs which have been opened in this same rock or immediately below it. The analyses of several of these are given with the remarks of Dr. Peter on their character.

It may be remarked here that the Oil Springs have been known a long period, having been kept for a long time, years ago, by the father of the present owner. At that time this was

a fashionable summer resort, and many visitors still drive in the season to these waters.

No. 2472. Mineral water from "Oil Spring." Property of A. M. Eastin. Reaction alkaline. Junction of black slate and Corniferous.

No. 2473. Mineral water from "Chalybeate Spring" at Stuart's mill. Owned by Stuart and Harmer. Flows from the Oriskany sandstone. Reaction acid.

No. 2474. Mineral water, from the "Soda Spring" near Lulbegrud creek. Reaction alkaline.

No. 2474 (*bis.*). "Red Sulphur water," from the farm of C. C. Eastin. Black slate formation.

There were waters collected from several other springs, but the accidental breaking of the jugs prevented them from being examined. There are many other springs in this section, but many of them are beyond Lulbegrud, in Powell county.

COMPOSITION IN 1000 PARTS OF WATER.

	No. 2472.	No. 2473.	No. 2474.	No. 2474. (bis.)
Iron carbonate	0.0041	0.0192	. . . . .	0.006
Lime carbonate	.1198	.0004	. . . . .	.156
Magnesia carbonate	.0185	.0002	. . . . .	.051
Potash carbonate	. . . . .	. . . . .	0.0099	.022
Soda carbonate	. . . . .	. . . . .	.5266	.033
Lime sulphate	.0583	.0432	.0265	.038
Potash sulphate	. . . . .	.0119	. . . . .	. . . . .
Alumina sulphate	. . . . .	.0586	. . . . .	. . . . .
Calcium chloride	.0096	. . . .	.0035	. . . . .
Magnesian chloride	.0845	.0024	.0159	.067
Potassium chloride	.0196	.0055	. . . . .	. . . . .
Sodium chloride	.0973	.0162	.0371	. . . . .
Lithium chloride	. . . . .	Trace.	. . . . .	. . . . .
Sodium sulphide	. . . . .	. . . . .	. . . . .	.012
Silica	.0158	.0055	.0168	.067
Total saline matters in 1000 parts	0.4275	0.2131	0.6363	0.1452
	Oil Spring.	Chalybeate Spring.	Soda Spring.	Red Sulphur Spri'g

"No. 2472 is a weak saline water, slightly chalybeate.

"No. 2473 is a mild chalybeate, but sufficiently strong alum water; acid and astringent.

"No. 2474 is a mild alkaline saline water.

"No. 2474 (*bis.*) is a mild sulphur water, slightly chalybeate and alkaline."

PETROLEUM.

At Stuart's old mill, on the property of Stuart & Harmer, there has been boring in search of oil. There is some oil here, but in what quantity I do not know. There have been a few barrels pumped out, but the well was not in order when I visited it. Some distance below, on Lulbegrud creek, another well was driven, but not with favorable results. The one at Stuart's mill was begun at the base of the black slate, but at what depth it was concluded I am not advised. The oil here is subject, as far as can be seen, to the same condition as the well on Spencer creek, in Montgomery county, the notes on which are in this volume. (See notes on petroleum under Montgomery county.)

ARCHÆOLOGY.

Clark county has not been without its prehistoric inhabitants, who here made their homes and erected enduring monuments of their work in mounds and graves and the tools and implements used in their social life, their chase for game, and, perhaps, their battles. Over nearly every field are found some evidences of their former presence, for the arrow-head, the stone ax, or the flint chip equally bear evidence that human hands had fashioned them and left them where they lie.

The most remarkable of their works, here, is a large truncated mound on the farm of Mr. Jas. D. Gay, situated between Stoner creek and Pretty Run. This artificial elevation is a romantic sight as viewed from the residence or from the surrounding eminences, and has been carefully guarded from the destruction which has overtaken the most of the mounds of the county. It has a circumference of about two hundred and forty feet and an altitude of twenty feet. In looking at it from a distance it looks like a long mound with a depression in the center, but, upon a closer inspection, it appears as if there had been three mounds made into one, though this impression may have

been produced by the subsequent erosion to which it has naturally been subjected since it was first erected.

The material of which it is composed was taken from around its base, as can be now seen in the depressions which surround it. It was, when first known in the settlement of the county, covered with large trees, several of which now stand on and near its base. The stumps of others were removed some years since by Mr. Gay. Hardly a half mile to the east of this mound is a narrow ridge between a small hollow and Stoner creek, which is called the Devil's Backbone. On this ridge were some thirty or forty graves covered with rocks taken from the cliff below. These graves have been about all destroyed, yet from the description of those who took some part in opening them, there must have been something like two hundred bodies which were buried in them. Bones, flints, pipes, and other objects were taken from these graves.

If the division of the mounds in the Ohio valley into burial, religious, and lookout erections is to stand, then this would be apt to come under that of a temple mound, for the following reasons: In the wear and tear of felling trees and digging of stumps over it there has been no indication of any graves or tools on or in it; besides, the near proximity of the number of graves on the Devil's Backbone would show that these people preferred interring their dead in cairns rather than in mounds. The objection as to its having been a mound of observation is based upon its position in reference to other high points. From its top one may see down the valley of Stoner for several miles, but in no other direction can any points be seen more than a mile away. It is thus pretty evident that the people who erected this elevation must have done so for some social or religious purpose.

On Mr. John Goff's farm, and on a rise which overlooks the valley of Upper Howard's creek, is one of these old prehistoric circles one hundred and eighty feet in diameter, and thirty feet to the north-west is a single oval mound sixty-five feet in length and fifty-five in width. This elevation is now about six feet above the general surface, and being on one of the highest

points for a long distance around, it may well have been located here as a beacon for distances far away. From this mound is one of the finest views in all this section of the State. Towards the north one may look over the valley of Howard's Creek for a long ways to the hills, which make the divide to the waters flowing north in the county, while in the other directions the hills which make up the southern part of Clark, with the mountains which stretch from Madison through Estill, Owsley, Powell, and Montgomery counties are brought into view. There are no known graves near this mound, and for whatever purpose it was built, it was certainly well adapted for a point of observation. This mound and circle is on part of what is called the Indian Old Fields. This takes its name from the fact that when the county was first settled there were a few Indians living here with small cleared fields, in which they grew corn and beans. This point was well selected for cultivation. It is on one of the richest bodies of land in the State. One of the strongest reasons for believing the mound-builders to have been, in part, at least, an agricultural people is the fact that in nearly every case their mounds are situated on, or contiguous to, rich bodies of land and this holds good whether they be highlands, plains, or bottoms. This region was particularly full of game when Kentucky was first settled, buffaloes, deer, bears, and wild turkeys being plentiful.

On the farm of F. Piersall, south-west of Winchester, there was formerly a mound and also evidences that a village or encampment was near, from the number of bones and relics which have been found around it.

On the old Stuart farm, now owned by Chas. A. Stuart, there once existed a mound or fortification of some kind, where have been found large quantities of ashes, shells, beads, and many other things, remnants from the presence of a prehistoric people. In the Kentucky river bottom, on the place of A. Thompson, there have been plowed up quantities of pottery ware in fragments, and many flints.

On the hill south of Allensville were several graves and on a ridge farther to the south were several others.

Close to the Winchester and Mt. Sterling pike and near the county line is a pretty, small mound. In the region of Lower Howard's creek are several known graves which have been destroyed, while over nearly every field have been seen some mementoes of extinct races.

APPENDIX A.

STATISTICS OF CLARK COUNTY, COLLECTED FROM THE TENTH REPORT OF THE CENSUS OF THE UNITED STATES, 1880.

1880. Total population	12,115	Total cost of turnpikes	$325,000
1870. Total population	10,882	Av. cost of turnpikes per mile	2,500
1860. Total population	11,484	Number of horses	3,851
1880. White population	7,929	Number of mules and asses	1,133
1870. White population	7,167	Number of working oxen	774
1860. White population	6,598	Number of milch cows	3,311
1880. Colored population	4,186	Number of other cattle	14,020
1870. Colored population	3,715	Number of sheep	25,931
1860. Colored population	4,886	Number of swine	20,824
1880. Native population	12,029	Pounds of wool	152,896
1870. Native population	10,745	Pounds of butter	141,423
1860. Native population	11,369	Pounds of cheese	535
1880. Foreign population	86	Gallons of milk	8,865
1870. Foreign population	137	Bushels of Indian corn	791,292
1860. Foreign population	115	Bushels of wheat	129,943
1880. Winchester population	2,277	Bushels of rye	15,475
Number of farms	1,214	Bushels of oats	14,836
Acres of improved land	174,907	Bushels of Irish potatoes	13,702
Value of farms, including buildings and fences	$6,592,033	Bushels of sweet potatoes	5,944
		Bushels of barley	9,559
Value of farmi'g implements and machinery	104,398	Bushels of buckwheat	. .
		Tons of hay	2,638
Value of live stock	1,107,745	Value of orchard products	$23,882
Cost of building and repairing fences, 1879	39,127	Pounds of tobacco	17,187
		Manufacturing establishments	60
Cost of fertilizers purchased, 1879	2,686	Capital invested in	$93,280
Estimated value of all farm products, 1879	575,318	Hands employed in	99
		Amount paid in wages	$13,543
Assessed valuation, real estate	3,830,729	Cost of material	78,232
Assessed val'n, personal propt'y	1,140,347	Value of productions	131,700
Assessed valuation, total	4,971,076	Bonded debt	108,600
Taxation, State	22,618	Floating debt	. .
Taxation, county	21,048	Gross debt	108,600
Taxation, city, town, village and school district	2,039	Sinking fund	6,591
		Net debt	102,009
Taxation, total	45,705	*Total acres of land (1883)	153,056
Miles of railroad	41	*Average value per acre (1883)	$23.05
Valuation of railroads in county	$800,000	*Number of town lots (1883)	480
Miles of turnpikes	130½	†Value of town lots	$334,725

*From the Auditor's Report. †From other sources.

GEOLOGICAL SURVEY OF KENTUCKY.

JOHN R. PROCTER, DIRECTOR.

REPORT

ON THE

GEOLOGY OF MONTGOMERY COUNTY.

BY W. M. LINNEY.

JOHN D. WOODS, PUBLIC PRINTER AND BINDER.

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GEOLOGY OF MONTGOMERY COUNTY.

TOPOGRAPHY, ETC.

Montgomery county dates back its formation to 1795, when it was created from a part of Clark, and named after General Richard Montgomery, who was killed in the attack on Quebec in 1775. Originally it extended to the eastern limits of the State and comprised what are now twenty counties. It lies in the eastern part of the center of the State, and is bounded by Bourbon and Bath on the north, by Bath and Menifee on the east, by Powell on the south, and by Powell, Clark and Bourbon on the west.

As this county is one which lies partly within and partly without the bluegrass region, its topography is somewhat varied. Over the northern and central portions the lands are highly rolling, being cut into by drainage lines that are from one to two hundred feet in depth. There are exceptions to these along the central divide of the county, where there are places which are nearly level. Along Slate creek there are some level spots, but these give out over some rounded knobs which extend back to the foot of Morris Mountain and other elevated points. Very few of these lands are, however, too steep for cultivation, while they make the drainage almost perfect, giving a very healthy, desirable country.

There are no large streams here, and, like in Clark county, the drainage is separated to the north and the south by a continuation of the same ridge, which extends in a north-easterly direction into Bath county. Towards the north nearly all the drainage falls into Hinkston's creek, a tributary of the Licking river. The exceptions are some few little drains which reach

Stoner through Donaldson's creek. To the southward, and partly from the south, the larger part is received into Slate creek, which then runs eastward into Bath county till it reaches the Licking. Near the southern portion, along the Clark line, are various branches, forming the head of Lulbegrud creek, which finds its way into the Red, and thence into the Kentucky river. It is thus seen that the waters of this county run in every direction in seeking their outlets. Slate creek and Hinkston afford enough water-power for mills, through more than one-half of the year, but inquiry reveals the fact that the normal flow is not as continuous as it was at an earlier date in the history of the county.

The Chesapeake and Ohio railroad extends entirely through the county and does a large amount of business. South-east from Mt. Sterling is the Coal Road, which is continued into Menifee county. If the latter road was built some miles farther, it would reach a fine coal and lumber region, and could thus do a very large business.

A number of turnpikes are constructed in Montgomery, which are of great importance to the traveling classes, yet a number of others are very much needed to give all the citizens good roads through all seasons of the year.

The public schools outside of Mt. Sterling are, like in almost all the counties of the Commonwealth, far behind what should be the facilities for the proper education of the children. Few manufactories are in operation, farming and grazing being foremost among all classes outside of the town. The area of Montgomery is 205 square miles, or 131.200 acres, and its population in 1880 was 10,566.

Mt. Sterling is the county seat and the only town. It is a thriving business point and has good schools. In 1880 it had a population of 2,087, but has, since, more than doubled the number. Two or three little villages are sites for post-offices and stores, and several railroad stations are great conveniences.

As is common in all the counties which surround the Blue Limestone region of the State, there are some magnificent landscapes, which can be seen from many of the eminences

which overlook the valley of Slate and Lulbegrud creeks. Miles added to miles, till distance shuts off the view, are exposed to the eye. Over valley and hill, over cleared fields and green, waving woods, the sight can trace, through five or six counties, the high hills, which, in the far distance, take on all the appearance of a grand mountain chain. Perhaps no more beautiful view can be seen in the State than that revealed from the hill at Mr. Anderson's, above Hainline's store. This is one which should be seen by every lover of nature who visits this part of the country. The following are some of the elevations in the county, the first five correct, the others approximate.

	F't ab'ye sea level.	Formation.
Railroad, level Clark line	1,050	Upper Hudson.
Railroad, Maysville street, Mt. Sterling	945	Upper Hudson.
First crossing, Owen and Mt. Sterling pike	929	Upper Hudson.
Second crossing, Owen and Mt. Sterling pike	985	Upper Hudson.
Ewington	992	Upper Hudson.
Stepstone creek	731	Upper Hudson.
Stepstone Station	777	Upper Hudson.
Slate creek, county line	753	Upper Hudson.
Slate creek, above mouth of Spencer	774	Upper Silurian.
Slate creek, above mouth of Sycamore	783	Black Slate.
Jeffersonville	856	Black Slate.

GENERAL GEOLOGY.

When we come to examine the various layers of rocks which are exhibited in Montgomery county, we find them composed of very diverse kinds, but distributed in such an arrangement that, by traveling across the county in a line from the north-west corner to the south-east boundary, all of them are brought to view, the lowest in order being seen in the former and the highest in the latter locality. When they are all added together as one mass, they present, approximately, the following section. If a boring was made in the top of Morris Mountain all of these layers would be passed through, and the thickness to the bottom found nearly as in this:

Age.	Period.	Formation.	Feet.	Feet.
Coal Measures . . .	. . . . .	Conglomerate and Shale		15
Subcarboniferous . .	. . . . .	Upper Subcarboniferous	100	500
		Lower Subcarboniferous	400	
Devonian	. . . . .	Black Slate	110	119
		Corniferous and Oriskany	9	
Upper Silurian . . .	. . . . .	Niagara	18	78
		Clinton	60	
Lower Silurian . . .	. . . . .	. . . . .	. . . .	. . . .
	Hudson	Upper Beds	300	625
		Middle Beds	150	
		Lower Beds	175	
	Trenton	Trenton Group . .	. . . .	10
Total thickness . .	. . . . .	. . . . .	. . . .	134

Every intelligent man who has any interest in this county should have some knowledge of the series of rocks therein. These not only serve as a structural basis upon which the sur-

face rests, and enter into those structures which are necessary to his protection and comfort, but, in their soil-making characters, are the very bases of life and wealth. Too little attention is given to those things which are so necessary to our lives and happiness. Sufficient is written in this report and that of Clark, which accompanies it, to give a fair general idea of the surface arrangement of this region.

LOWER SILURIAN.

Trenton Group.—The rocks of the Trenton group, which make up so large a part of the fine lands of Clark, Fayette, Bourbon, and other counties, are hardly known in Montgomery. They are, however, cut into by Donaldson creek in the northwest corner, and, at the county line, are not more than ten feet above the bottom of the creek. No quarrying has been done in them, and no soils sufficient to be noticed have been derived from them, so the reader is referred to the Clark and other reports for their description, extension and other features.

HUDSON PERIOD.

Lower Hudson River Beds.—Like the last, these beds are of quite a limited distribution in the county, being seen in their full thickness only on the hills which rise above Donaldson creek, here not reaching to the top of the county; and where they are cut down into, by Grassy Lick and its tributaries, Hinkston, and a few feet on Plum Run branch. In these places their usual characters can be seen and studied by those who desire it. On Donaldson can be seen the heavy clay beds which result from the destruction of the clay shales in the lower part, and over many other hillsides can be seen the loose blocks of hard limestone. This is a distinguishing feature of these soils, wherever they are not well looked after and protected. A few farms on the lower part of Grassy Lick also show this feature. The hard layers, and especially the heavily-bedded ones, may be seen at several places on the latter creek,

in benches twelve or fifteen feet high. Sometimes there is some sulphide of iron in some of the layers. These show quite often in rusty spots on the stones in fences. There is a sulphur spring near Aaron's Run Post-office which boils up in the creek. It must obtain its character from this iron source.

The great wave marks can be seen at a number of places, notably in the bed of the creek near Dr. L. C. Jeffries' gate, also near Mr. Highland's, on Somerset creek. A common feature to be seen are the blocks which wear into anvil shapes. The soils from these layers are of such small extent that it is not necessary here to note them; besides, they are usually, or always, mixed with that from the slopes above. Some white oak trees grew on the south-west slopes of the hills along Grassy Lick, but their number through here was small. The creek bottoms are quite rough in many places where the rocks of this series are washed into them. Fossils are common, especially the round, branching coral stems, which so largely make up the greater part of these beds.

Middle Hudson River Beds.—About one-fifth of the surface of the county is based on this division of the Hudson. They are confined to the north-western corner, except where they are exposed over a small area near the north fork of Lulbegrud creek. These are distinctive rocks when exposed, but fortunately this is not a common occurrence, their easy destruction causing them to be usually covered with soil.

As has been stated in other reports, the larger part of these rocks are fine particles of silica, rarely in the form of sand. There is usually a proportion of lime, but this does not make them a durable stone, for there are few layers that answer reasonbly well for building purposes or lime-making. There is one heavy layer which looks well when quarried. Its lamination is striped with blue and brown, and, if very durable, it would be very desirable. It is apt to split into shaly-like plates. Another layer, which looks like it would be durable, was quarried at Dr. L. C. Jeffries', and while it may wear a long time, yet from

its easy destruction beneath the soil it does not promise to be very lasting in this climate. Samples were collected of this last, and submitted to Dr. Peter for examination for phosphoric acid, but only 0.473 per cent. of P_2O_5 was found in it.

On Hinkston and branches, as well as below Mr. W. H. Prewitt's, can be seen the heavy layers of concretionary-like structure, and these are as rough as have been seen in any of the counties from Spencer to Montgomery holding these layers. The thin, sandy shales are sometimes seen on the hillsides and on the tops of the hills, where more than usually injured in the soils. A section of about one hundred feet of these beds can be seen in the neighborhood of the bridge over Hinkston, on the Maysville pike. While these rocks have nearly the same characters here which they have in Madison and Garrard, it is evident that here the soils are better and the farms more desirable. In the former counties the hillsides are much steeper and the consequent washing of the surface is greater. There the drainage lines are not so deep, the slopes more gentle, and the exposure of the rocks less common. These are important factors in the making of a good country, and have had much to do with the characters of the soils here, but it appears to me that these beds, like the Trenton and Lower Hudson, contain a greater amount of the matter which gives phosphoric acid and potash to them, than the same beds to the north and west. By some of the farmers who cultivate them, they are here considered as the best soils of which they know, preferable to the best Trenton soils of Bourbon county. Their porosity and depth which make them hold a great amount of moisture, deep in the ground, have, in a number of seasons, given them good crops of grass and grain, when the others have yielded very small returns. This quality is remarkable through the extension of these beds.

Bluegrass is better on this soil in Montgomery than I have seen it elsewhere, and the only drawback to this is the disposition of the sod to break down in narrow, terrace-like lines, though sometimes these approach small slides. The water which works down through the soils and porous layers often comes out all

along from the surface of one layer. This softens and loosens the sod and soil and produces the slips; in other cases the lightly coherent soil breaks beneath the foot. These features are not so objectionable as they might seem from the description, but are noted as being more usual on these soils than others.

Observations over this class of soils in ten different counties of the State have caused me to believe that they are less liable to injury in excessive cropping than any of the other soils of the State. Cultivation in corn, yearly, for fifty years or more, seems to give no diminution in the returns, and observant farmers who have lived on them all their lives claim that there is no deterioration in their crops. Of course these remarks apply to cases where the lands have received some care. There are cases, and many of them, where these soils have been allowed to wash until they are almost destroyed, and, in addition, there is one part of them, the hard, sandy plates, which, being at or near the surface, is liable to become poor. Usually, therefore, they seem to hold nearly throughout their whole depth all the essential elements which are required by good soils, and are always ready to give them up to the work of the careful husbandman.

I collected, as of typical character, from the farm of Dr. Jeffries, four samples for examination by our State Chemist. They were taken from the top of a ridge, where they could not be influenced by admixture from other soils above them, and where it was level enough not to be washed or leached more than ordinarily. The first was taken from the surface (after removing the grass, twigs, etc.), to the depth of eleven inches, thoroughly mixed from top to bottom. The timber was largely sugar-tree. It had never been cleared or cultivated, but had been grazed for many years.

The second was taken from the space nine inches below the first,

The third was from a field adjoining, which had been in cultivation for seventy-five years or more. Sample to the depth of eleven inches.

The fourth was the subsoil, taken from the same as the third, only it was nine inches below.

COMPOSITION OF THESE MIDDLE HUDSON SOILS.

(*Dried at 212° F.*)

	No. 1.	No. 2.	No. 3.	No. 4.
Number for Geological Report	2501	2502	2503	2504
Organic and volatile matters	3.955	3.387	3.908	3.208
Alumina and manganese oxide	5.088	6.120	4.441	7.037
Iron peroxide	4.210	4.370	6.220	4.870
Lime carbonate	.482	.407	.365	.305
Magnesia	.349	.410	.351	.393
Phosphoric acid (P2 O5)	.193	.184	.309	.238
Potash extracted by acids	.437	.405	.399	.432
Soda extracted by acids	. . . .	.077	.124	. . . .
Water expelled at 360° F.	.677	.658	.632	.688
Sand and insoluble silicates	84.901	84.209	83.212	82.733
Total	100.292	100.227	99.961	99.904
Hygroscopic moisture	2.540	2.760	2.785	3.370
Potash in the insoluble silicates	1.803	1.925	1.853	1.837
Soda in the insoluble silicates	.372	.421	.489	.414
Iron, gravel, etc.	4.600	5.000	1.900	6.300
Character of soil	Virgin soil.	Subsoil.	Old field soil.	Old field subsoil.

Dr. Peter remarks in reference to these: "They are all very good, fertile soils, containing more than the average proportions of phosphoric acid, potash, lime, etc. The difference between the surface soils and the subsoils is not very great, and cultivation does not appear to have greatly changed the composition."

The timbers generally over the Middle Hudson were sugar tree, chinquapin oak, blue ash, white ash, white walnut, black walnut, and, in places, large mulberry, yellow poplar, white elm, and black locusts. It was largely covered with cane, remains of which can still be seen. Beech, which, over these soils in many counties, was the great prevailing growth, was hardly known over them in this county. It would be very interesting to know to what its absence here was due. I did not see a

single tree on these soils in Montgomery, and could only hear of one.

Upper Hudson River Beds.—A glance at the map will show that these beds have the largest distribution over the surface of the county of all others. They make a wide belt through the center of the county from south-west to north-east, and comprise the water-shed which drains the surface towards the north and the south. These rocks are about three hundred feet in thickness; the lower portion seen on the north and the highest on the south of their surface extension. Those which show on top of and near the divide are thin-bedded, where naturally exposed, but looking often massive in the quarry. The upper portion has between the layers more clay shales, and near the top some sandy layers, called the Cumberland Sandstone. These are all passed over in going from the top of the hills at Mt. Sterling to Comargo. The soils derived from these rocks are all good, but in different degrees. Those from the lowest layers produce the best, and are unexcelled when at their highest degree. Samples of these were collected and forwarded to the State Chemist at Lexington for examination. The following results were obtained:

No. 1—Virgin soil, to the depth of eleven inches, taken from the farm of Joshua Owens, near the Mt. Sterling and Owensville pike; woods pasture; never cultivated, but grazed for many years.

No. 2—Subsoil of No. 1, taken from eleven to twenty inches below.

No. 3—Surface soil from a field cultivated for at least seventy-five years, on the opposite of the pike from the other. Farm of General Dick Williams. Sample of upper eleven inches.

No. 4—Subsoil of No. 3, taken from eleven to twenty inches beneath the surface.

The same care was taken in the collection of these samples, and, as near as possible, under the same conditions as those made at Dr. Jeffries'. The analyses show them to be very good soils, and there is hardly any perceptible impairment in the soil

from the old field. They are certainly, to all appearance, as fine soils as are to be seen in the State.

COMPOSITION OF THESE UPPER HUDSON SOILS.

(*Dried at 212° F.*)

	No. 1.	No. 2.	No. 3.	No. 4.
Number in Geological Report	2505	2506	2507	2508
Organic and volatile matters	5.495	4.092	5.160	3.816
Alumina and manganese oxide	4.885	7.992	5.597	5.473
Iron peroxide	4.365	5.566	4.540	5.360
Lime carbonate	.622	.718	.400	.319
Magnesia	.332	.538	.229	.178
Phosphoric acid (P2 O5)	.315	.261	.260	.157
Potash extracted by acids	.256	.610	.335	.526
Soda extracted by acids	.265	. . . .	.276	.279
Water expelled at 360° F.	1.425	1.176	1.382	1.246
Sand and insoluble silica	82.284	78.883	82.121	83.169
Totals	100.244	99.836	100.300	100.523
Hygroscopic moisture	2.825	3.250	2.425	2.915
Potash in the insoluble silicates	1.629	1.444	1.189	1.105
Soda in the insoluble silicates	.323	.277	.239	.206
Iron, gravel, etc.	1.170	.380	2.010	1.710
Character of the soil	Virgin soil.	Subsoil.	Old field soil.	Subsoil.

Towards the top of these rocks the soils become more heavy with clay, and do not rank so high, or have so good an appearance. Near the top they are more sandy and much more liable to wash into deep gullies and expose the rocks beneath. These are quite fertile when not worn.

There are not many good building stones in this series. There is one layer about one foot thick, which is seen about one hundred feet from the top, which is a very fair stone, but it is seldom exposed, being covered, usually, with soil. This layer is a very persistent one, being seen with the same thickness and character in Spencer, Nelson, Marion, Boyle, Lincoln, Garrard, Madison, Clark, and Montgomery counties.

Lime has been burned from rocks of this series at Mt. Sterling and on the pike near Levee. They make a good article of quicklime, but are not the whitest.

The timbers on the divide are blue ash, hackberry, wild cherry, coffee bean, shell-bark hickory, linn, white elm, black walnut, red oak, sugar maple, laurel oak, etc. On the southern part there is a large mixture of white oak and beech.

The fossils are very plentiful and are the types which are usual at the different elevations in these beds.

On the farm of W. H. Prewitt there is about thirty acres of very level land which has been, evidently for a long time, of swampy character. The decomposition of the upper rocks has left, just beneath the surface, a layer of bog-iron ore, cemented into a nearly impervious hard pan. The soil is nearly white, from the action, probably, of crayfish. It is plowed at first with difficulty, but improves by cultivation; yet, it is considered a poor soil. As it becomes cleared and cultivated, and the hard pan broken up to admit ready drainage, it will be improved. Trenching will certainly improve the drainage, and Dr. Peter suggests that, "as there is an absence of the usual proportion of phosphoric acid, the application of top dressings of bone-dust, superphosphates, and guanos would, undoubtedly, benefit it." These tracts are very rare in Central Kentucky, and of small extent. The following is an analysis of the top soil, with the note made by Dr. Peter:

"The dried soil is of a light grey-buff color; is in friable clods. The coarse sieve removed from it 10.3 per cent. of ferruginous concretions, etc. Its silicious residue, from digestion in acids, all passed through the fine sieve except a small quantity of fine hyaline quartz grains."

COMPOSITION. (*Dried at 212 F°.*)

Organic and volatile matters	3.102
Alumina and manganese, oxide	4.067
Iron, oxide	2.140
Lime, carbonate	.250
Magnesia	.169
Phosphoric acid (P2 O5)	.080
Potash extracted by acids	.127
Soda extracted by acids	trace.
Water expelled at 360° F.	.598
Sand and insoluble silicates	88.946
Total	99.479

Hygroscopic moisture	2.025
Potash in the insoluble silicates	.807
Soda in the insoluble silicates	.437

UPPER SILURIAN.

The rocks of this formation outcrop in narrow lines along the creeks, and in small areas overlying the top of the Hudson beds. Like the outcrops of the other series, they have a general south-west and north-east line. This series thickens some to the east, and is consequently a little thicker in Montgomery than it is in Clark. This was produced, more by the deposition of matter in each layer, than by the interpolation of other beds. The Niagara shale has about the same thickness, eighteen feet, but the Clinton has increased from fifty feet to sixty. The characters of the beds are given in the Clark County Report, so it would be superfluous to rehearse them here.

The greater increase in these layers is by a thickening of the sandy layers at the base, and they have all the characteristics which are seen in the western part of Marion and in Nelson county, and described there as Medina sandstone.

The Clinton division has the Crab Orchard shales and the rough-bedded, heavy limestones. The massive layers overlying the shale are some heavier, and in one or two places one of them shows well a wave-like structure with large ridges. Rarely there is a layer of even-bedded stone which would be desirable in building, but some of the thin layers are smooth and would quarry into good sized plates. Those tough layers of the Clinton are admirable for the construction of the surface of turnpikes, and are transported to Mt. Sterling for macadamizing the streets, the lynx beds around the town being a poor material for this purpose. These rocks break down from the removal of the shales, so it is not unusual to see them in blocks over the surface of hillsides.

They are, when thus seen, from the oxidizing of the iron they contain, of a dirty brown color, and are usually called the "yellow rock" by the people. A few places show slight indications of the red hematite iron ore which was seen in Clark. There

is also sometimes, in connection with it, some limonite iron ore, but this is small, and seldom to be seen. The soils are not of the best character, yet, except immediately on the shales, rank very well when kindly used, but often their texture is friable, and they are marked by gullies, which cut into them very fast.

The timbers over these soils have been nearly all removed, but seem to have been the usual species common to them. On some of the steeper slopes it would have been better if they had never been fully cleared. The large amount of magnesia which these rocks contain does not seem, from a practical view, to have interfered with the productive capacity of the soils originating from them.

DEVONIAN.

Corniferous.—The single layer of the Oriskany sandstone, with its fish remains and impressions of the cock-tailed fucoid, *Spirophyton canda-galli*, is generally to be seen in its place, and, overlying it, several layers of the Corniferous limestone.

The Corniferous has here the same character which it exhibits in Lincoln and Boyle counties, being disposed to thin out its beds in short distances. The layer resembling a breccia is rarely seen; the cement layer is not continuous, while the heavy layers are usually, but not always, marked with hornstone. Yet, in places, this flinty-like material is very common, filling the layer, or covering the ground, in large beds. This is especially noticeable near Little Slate creek, close to its mouth. Quite a number of characteristic fossils were seen here and at other points, amongst them the following: *Phillipsastrea gigas*, *Cyathophyllum halli*, *Amplexus yandelli*, *Cystiphyllum americanum*, *Zaphrentis gigas*, *Zaphrentis proliferum*, *Favosites epidermatus*, *Favosites limitaris*, *and Strombodes knotti*, the latter a new species, not heretofore found, except in Marion county. The outcrop of the Corniferous is such a narrow line that it gives, in this county, no characteristic soils. The usual soils on this series are very fair.

In a line from Levee to Howard's mills a number of the hill-tops are covered with iron ore. This ore seems to be identical with the limonite ore of Bath, and has, in a few instances, been gathered up and hauled to a furnace in that county. The quantity is not large enough at any point to be profitable, but its presence here is interesting. It lies on the rocks of the Clinton group, imbedded in the soil and covering the surface, yet it does not seem to have been imbedded with them, and left after their decomposition. Its presence here is connected with the disturbances which pass through the county, and its immediate connection seems to have been with the Corniferous limestones, as along the present outcrops of the latter there is sometimes seen, between the layers, a small quantity of iron ore resembling this.

The phosphate bed as described in the report of Clark county has some extension into Montgomery, and, at some points, may be of equal value.

Black Slate.—The Black Slate, like the beds of the Clinton, have thickened some towards the east, and are, in Montgomery, at their maximum one hundred and ten feet in thickness, but there is no noticeable change in their constituents.

In the valley of Slate and Lulbegrud creeks this formation is largely exposed, rising sometimes in hills from fifty to one hundred feet in height, but more commonly lying level, or comparatively so. Many farms are based on it, and over it there is still a large proportion of uncleared forest, though in the latter case the best timber trees have been culled out.

There are some localities on these lands that would make very desirable homes if the owners had a proper knowledge of these soils, and how to treat them for grass and fruit growing, and grazing. By an examination of the average analyses of a number of soils taken from them, and to be seen in the Clark report, it can be understood that these soils are really better than the reputation they bear. Experience has farther shown this in a number of instances.

They are not the best of soils. but are susceptible of great

improvement. Where they are desirable for cultivation, they are often quite level and need to be drained. They are usually stiff clays, which need to be treated with lime or sand to make them more porous. Throwing them into narrow lands, with permanent trenches between, is a common way to drain them, and the addition of lime has given desirable results.

Timothy grows well on the slate soils, and fine crops of hay are produced. Under favorable conditions good crops of corn are raised. Peaches often do well, as they bloom later than on other soils, and their flavor is very fine. These soils are not often deep, and apples do not do so well, as the trees often blow up by the roots. Small fruits all grow and bear well, with really superior qualities. Colonists wanting cheap homes could do well on some of these lands and those extending back to the Conglomerate uplands.

Among the other timbers usual on these slates there are, through here, great numbers of pine trees, of all ages, and the turned-out fields soon come up thick with them. The water birch is quite common near the creeks.

SUBCARBONIFEROUS.

This great group of rocks is very extensive in their geographical distribution, as well as in their thickness. Here they are somewhere near five hundred feet, separable, as is usual, into an upper and a lower division. Towards the west the upper one thickens and the lower thins out, while to the east these changes are reversed.

LOWER SUBCARBONIFEROUS.

The lower part of this series of rocks rests on the Black Slate, and is marked at its base by a sandstone which ranges from one to several layers, and in thickness from two to twelve feet. It is gray in color when broken, but in the natural exposures has a dark brown exterior. Here it is not evenly bedded, and splits into uneven blocks, some layers more so than others;

has been used very little in the county, but has a greater development, and is better in going towards Rowan county, where it has been raised for the construction of the Lexington courthouse. It is well marked in places with the *Canda-galli* fossil plant.

On top of this sandstone rests something like one hundred feet of clay shale, blue in color, and so easy of destruction that it is not often seen, except where some of the creeks have cut an escarpment into them. Towards the head of Sycamore creek they can be seen as blue banks, with rounded masses of iron ore protruding from them. There seem to be seven or eight layers of these iron kidneys in this shale, and these, in being washed from their beds, are left in the creeks, often a number of wagon-loads in a place. This ore is a carbonate of iron, heavy, blue inside, but rapidly turns red when exposed. There is not enough here for the iron master; the amount and difficulty of stripping would never be profitable. This ore has been used some in Bath and Estill, but combined with other ores. It is also the same ore which was used in Bullitt and Nelson counties many years ago.

These shales produce heavy clay soils, disposed to be wet, with cray-fish in the bottoms. With these drawbacks these soils, in the hands of the best farmers, produce ten barrels of corn, and twenty bushels of wheat to the acre. The cray-fish are destroyed or driven away by tramping and the application of lime, while the latter improves the soils. Clover benefits them very much, and large and small fruits are apt to succeed well.

Above these shales are three hundred feet of thin and heavy-bedded sandstones, with a few intercallated beds of thin limestones. These are to be seen in steep hillsides at Kash, Grape, and Pilot knobs. These sandstones were quarried on Grape knob, but an examination of those taken from the beds, and left, show them to be quite a poor building stone. Geodes are rare in them, and no fossils were seen but the impression left by plants.

These lower subcarboniferous beds are sometimes benefitted

from the waste of the limestones which are above them, and these could easily be made available for the improvement of many of the poorer tracts of land.

The much larger part of these soils is covered with the original timber, and, where not cleared for agricultural purposes, this should receive every care and protection, its proximity to the bluegrass region making the timber very valuable for the future.

Upper Subcarboniferous.—The rocks of this division, so well known for their mountain-making character, and the large caves which very often mark their presence, are only seen here in the face of Morris mountain. Here it is not open to good inspection, and it is impossible to know all of its characters or its real thickness, but I estimated the latter at about one hundred feet, not more than half as thick as in Rockcastle county, near the head of Roundstone creek. From fragments found in the road it seems to have here all the usual qualities; the *lithostrotion* layer, the layer of lithographic stone, the oolitic member, the earthy yellow layer, and the fine and the coarse-grained beds. Some of these make valuable building stones, and others good lime, but they are out of the way of transit for the former purpose, but should be largely used for the latter, on the more unproductive soils below.

These rocks wear down into good soils, and there are, on top of this and adjoining ridges, level tracts where good small farms could be made. The soil is deep and loose, and all the growth over them is thrifty. Springs break out from between the limestones on the sides, and ponds and wells could be made with little trouble. The timbers on these ridges are better than on the beds below, and are, as yet, almost untouched by the ax.

The greater part of these rocks belong to the St. Louis subdivision, but there is some evidence that the upper part, for a few feet, is Chester. There is said to be two feet of coal somewhere on the mountain. I could not see it, but the subconglomerate has its place at or near the crest. This is the position of the lowest coal in the State. Its quality is usually good.

While this thickness of limestones is well marked on Morris mountain, only a few miles away, I was unable to find it in

either Kash or Pilot knob, though both of these have conglomerate on them. If the St. Louis limestone is absent, then the conglomerate sandstone rests directly on the Waverly sandstone of the lower subcarboniferous. It is known that these limestones give out in going to the east, but the loss of one hundred feet in seven or eight miles is very unusual.

CONGLOMERATE.

This great sandstone, often called the millstone grit, is the top rock on the highest part of Morris mountain, Pilot, and Kash's knobs. On the Clark Pilot, which is in Powell county, but near the Montgomery county line, it is one hundred and thirty-five feet thick, marked in nearly all its parts with rounded pebbles of white quartz. On Morris mountain it is, perhaps, not more than ten or fifteen feet thick, and, where seen, is marked with large pebbles and sometimes with the cast of a branch of an old tree, *lepidodendron*, of the coal period. This rock has been quarried on Pilot knob and made into millstones, and they are highly prized under the name of hailstone grit. This completes the geological section of the county, but some other notes are added which are a part of the interesting history of this region.

WASTE BEDS.

Some of the hard rocks which have been left from the destruction of several of the groups above, are seen on the soil in a number of places far removed from where they are now in place. Thus the flint fragments and the silicified corals from the Corniferous are found over the Hudson beds; the large silicified coral of the upper subcarboniferous has the same distribution, while the "jack rocks" pebbles from the conglomerate, are sometimes seen to the farther boundary of the county. On the farm of Mr. Jamison, between Hinkston and Somerset creeks, are large quantities of sand and pebbles from the conglomerate, and among them the fossils before mentioned. In places these are several feet deep and are ten or twelve miles from their nearest outcrop. They have evidently been left from the de-

struction of the higher rocks, which at one time extended over the whole county, as well as over the whole blue limestone area of the State. These seen here are only occasional remains, while the greater mass has been ground into powder, and swept down the Ohio and Mississippi rivers into the gulf. Part of the remainder, the larger fragments and heavier clays, to a vast amount, fills the valleys of these rivers from Central Kentucky to the sea. It is also probable that a large portion of the drift, which covers parts of Ohio and Indiana, has at one time been the consolidated rocks and shales which time has removed from the center of our State.

DISTURBANCES IN CLARK AND MONTGOMERY.

During the deposition of the materials which form the rocks of this section of the State, numerous changes took place in the level of the bed of the oceans. Alternations in the depth of water are very evident, for, while parts of the rocks were laid down in calm, deep water, others had their materials distributed by waves of different intensity. Some layers of fine homogeneous particles, and regular thickness for many miles, must have required the former conditions, while others, with their particles arranged in curved laminæ, and great wave-like folds thickening or thinning here and there, must have required strong currents to have fashioned them as they are now found.

Disturbances which broke up the hardened rocks must have sometimes occurred. About the top of the Trenton are often seen rolled pebbles of limestone; these mark a period of change, when evidently some of the Trenton rocks were broken, rounded by shallow waves, and then distributed in thin beds for a number of miles, and afterwards consolidated in a layer with other matter.

In the Lower Hudson beds, where the alternations of hard limestones and shales are so constant, the intervals were produced by corresponding changes of condition, and in these hard layers are sometimes seen large pebbles of limestone, which have been worn until half round and then consolidated with

finer material. In the years in which I have followed the outcropping of the Middle Hudson beds, and studied the materials in their decomposition, the conviction has grown upon me that a large part of its material must have been deposited in a lake, or at least by fresh water, as the loess of our western rivers. No particular reasons can be given for this, only the silt-like character of the material when converted into soil, and the large preponderance of silica in such fine subdivision.

There are rounded pebbles of limestone in some of the strata of the Upper Hudson, and in the sand of the upper portion are recorded changes of more than ordinary character, while, all through the Upper Silurian and Devonian, great changes took place at wide, or at sometimes short intervals of time. The great number of fish remains and the rounded character of the bone fragments, as seen for many miles at the close of the Upper Silurian, exhibit, in unmistakable evidence, that along this line a disturbance occurred which destroyed the great fishes of the period, while their bones were ground and rounded by the action of waves.

The upper layer of the Corniferous was left uneven in its bedding, or worn into pot-like holes, to be filled evenly with the layer of cement rock which comes above it. All through the other groups are to be seen evidences of occasional changes under which the rocks were formed. The distribution of the fossils, and other evidences, point strongly to these changes as having been confined to a line running north-east and south-west through this region, a line which, weakened by fractures through it, at last gave way after the elevation at the close of the Coal Period, and became the most important elevation, in its effects, to this State. In several reports, as those on GARRARD, MERCER, and NOTES ON THE ROCKS OF CENTRAL KENTUCKY, I have mentioned a disturbance which crosses the center of the State in a north-east and south-west direction. It passes near Lebanon, Danville, Camp Nelson, and through Clark and Montgomery counties. Along this line the rocks have been thrown up into a ridge, which opened on top and caused the surface to slant away, both to the north-west and to

the south-east. Along the crest of this divide the lowest rocks of the State are exposed, and down its north-west slope the greater part of the blue limestone, or Lower Silurian region has been brought to the surface by the removal of the strata from above. On the other side the rocky series was brought down much more rapidly, and the upturned edges of the layers have protected them from such rapid destruction. This down-throw of the strata amounts to nearly six hundred feet along the Red river pike, from Winchester to Upper Howard's creek, but it is really included in one-half the distance.

One-half of this dip, in some places, is due to a regular fault, which has been traced from near the ferry at Boonesboro to near Kiddville. This fault nearly touches the county at the mouth of Boone's creek, passing just within the limits of Madison county, and crosses the river near Boonesboro. Here rocks of the upper part of the Trenton are brought down by the break to the level of the Chazy, the latter with all the Birdseye, and the greater part of the Trenton dropping down. On the river, not a mile above, the Lower Hudson is the lowest group to be seen. On the ridge above, the Trenton and Middle Hudson are together. This fault crosses Two-mile creek at E. A. Elkins', where the Trenton and Lower Hudson are on a level, but with some layers of the Birdseye thrust up in the break. At Mr. J. Bybee's the Trenton is on the north and the Middle Hudson on the south. This line crosses Four-mile creek near Owen's Chapel, a little north of Ruckerville, crossing the Red river pike near Mr. Stanhope's, and loses itself in a number of radiated fractures, which produced the right-angled drainages of the two forks of Lulbagrud creek. This splitting up of this fault into several lines of small anticlinals has left in Montgomery one line of small fault, which extends south-east from Levee, and has brought the Black Slate below the level of the Corniferous. The ending of this line of fault here was the origin of the water-shed which separates the drainage into Slate creek and Lulbagrud.

While the displacement in this break ends near the Clark line, yet the dip from the Kentucky Anticlinal passes entirely

through Montgomery county. This dip from Mt. Sterling to the mouth of Sycamore creek amounts to about four hundred and fifty feet. In looking over the map the north-east trend of the outcrops of all the formations can be seen at a glance. These are modified in Clark by the fault line. The Kentucky Anticlinal is a broad, flat ridge, whose crest is a little north of the drainage shed of the two counties. This axis of disturbance has produced all the surface features of these two counties, regulated the drainage, located the springs, distilled the petroleum, and silicified the fossils in some of the series of rocks. These are great results, but the records are here, indelibly written in the earth's lines. There are many small lines of fracture, taking the character of anticlinals and synclinals, which are all connected with this greater one.

PETROLEUM.

There are a number of places in Montgomery county, where small quantities of petroleum may be seen in, or coming from the rocks. These are in several geological horizons.

Near the Bourbon county line, on Plum Run Branch, are one or more layers of rocks belonging to the Middle Hudson in which oil can be seen. The quantity seems to be small, and it is impossible to see how any great quantities can exist here. It fills small cavities in the rocks, from which fossils have been leached. A boring has been made across the county line to a depth of over five hundred feet, penetrating into the Chazy Limestone, the rock material brought up showing the same succession as that seen on the Kentucky river. This well has determined nothing favorable, and the indications are that no good results could be obtained near here. About a mile from this point another well was bored, a number of years ago, from which a few gallons of oil were obtained, and this at only a few feet below the surface. My own impressions are, that all the oil in this horizon has come from the small quantity distributed through the cavities through not more than three feet of rocks, and being heavy, it may, from shatterings and expansions

of the layers, sometimes find its way into crevices, where a few gallons may accumulate, but never to any considerable depth. These layers were seen also in Clark county. At this well, on Plum Run, gas was struck at three hundred and fifteen feet, but not in great quantity.

In 1846, a boring was made for salt water on the farm of S. A. Duff, on Spencer creek, some five miles from Mt. Sterling. This well began about thirty-five feet below the base of the Clinton rocks, and at near three hundred feet gas was struck in such quantities that the drill was thrown out, and it is estimated by parties living near, that a thousand barrels of oil flowed from it and ran down the creek, the oil taking fire and destroying all the trees on the banks of the creek for several miles. This well was closed up, but reopened during the oil fever of 1866, and about fifteen barrels of petroleum obtained. On continuing the bore, salt water was met and no farther indications of oil obtained. The depth at which this oil was said to have been reached is about the horizon for the oil on Plum Run. It has not since been reopened, and no other borings have been made since that time. There is an old salt well down the creek which always contains a little oil on the surface of the water.

At about the horizon of the rocks where this well was begun on the surface, there are to be seen in many places, where the rocks are fresh broken, little cavities in them, filled with petroleum. These are often seen in the beds of the creeks and near them, where the layers are subjected to the heat of the sun. Under these circumstances the rocks are sufficiently expanded, so that the oil finds its way through them to the surface. As the oil scatters over the rocks, there appears to be much more than there really is. These cavities have had, at some time, fossils included in them, but it is impossible that there could be produced from one shell or one coral enough oil to have filled entirely the mold, which was left when it was destroyed. Along these places, which are in the Cumberland sandstone, it is nothing unusual to see bubbles of gas escaping up through water.

In the Clinton limestones there are several layers, which, when broken in the quarry and on the roads, show the same kind of oil; this is often in quantity sufficient to stain the whole surface of small pieces. The cavities are larger in this rock, and were probably left by some of the favosite corals. The same condition, but more sparingly, exists in a layer of the Corniferous limestone.

The Black Slate often exhibits thin films of oil on the water which escapes from it, but this is always in minute quantities; and yet it seems the most probable theory that all the oil seen in the various rocks of the county must have come from this formation. It has been estimated from repeated analyses that the Black Slate contains on an average not less than fifteen per cent. of bituminous matter, and, as not less than one hundred feet of these beds have at some time been continuous over the county, it is easy to estimate that countless millions of gallons of oil have been given up in the destruction of so much material. It is highly probable that the whole amount did not escape on the surface, but on the other hand some of it, especially the heavier products, would sometimes find their way below, and be preserved under favoring conditions.

In the elevation of the Kentucky Anticlinal, more or less of heat must have been involved, and especially where the greater faults and fractures were produced. This heat must have been of sufficient temperature to have distilled from these beds their oily products; at the same time it would have expanded the rocks so that the liquid could have entered their cavities and even filled long lines of fractures. The burning of gases like those mentioned in the Report on Clark county would, in a slight degree, produce the same results.

There may then exist, through the region drained by Slate and Lulbegrud creeks, some fractured lines in which there are stored considerable quantities of oil, but it could only be in crevices, for the rocks beneath are not of that open, porous character that could ever have made them reservoirs for the storage of immense quantities. Under the most favorable conditions the policy of boring would only be speculative.

SPRINGS.

There are no large, important springs in the county, the conditions not being very favorable for their formation. The best are those which flow from beneath the open, heavy beds of the Clinton limestone, though there are but few of these. A number of sulphur springs flow from the Black Slate, or usually from the heavy rocks just beneath its base, but none of them rank high, or receive many visitors.

At Daniel Orear's, on Spencer creek, is an old salt well, from which, many years ago, salt was manufactured, for some years. It was a weak, saline water, and did not yield much return in salt. This well was filled up, but the salt water rises and flows from another well, some hundred yards below. Small quantities of gas and some little oil escape with it.

ARCHÆOLOGY.

A great deal of investigation has been given to the distribution of the former inhabitants of the United States. Many localities have been critically examined and copious notes written on them. Every day material is being gathered which throws more or less light upon some portions of their history. In time, when all these facts are brought together, we will have a very interesting record of our prehistoric man. There are abundant evidences to show that in the present territory of Montgomery county there formerly lived, for lengths of time, a people whose impress is left after hundreds of years.

On the farm of Mr. G. B. Cockrell, there is a mound two hundred feet in circumference and fourteen feet high. This mound was overgrown with large trees of the same species which surrounded it. An excavation was made in it some years ago, on the south side, and the bones of a human being, presumably that of a woman, were discovered. This body had been buried with the head to the east and feet to the west, and had, apparently, a string of copper beads around each arm above the elbow, and a string of shell beads around each leg above the knee. Hempen fiber was still in the holes in the beads, and,

though the bones were nearly all decayed, the teeth were good. During the last summer, another opening was made in it, and the remains of a body found, but no relics of any kind with it. This body had been interred in the same position as the other. Each one of them seemed to have had large rocks placed around them. There are probably other remains still in this tumulus. A few hundred yards from this, on the farm of Dr. Spratt, is a small, artificial elevation which has never been disturbed.

One-half mile to the south-east of C. C. Haggard's were some graves situated on a small Black Slate knob, one hundred feet high, and these were covered with rocks, taken from the Clinton beds below. This removal of stones for some distance, to cover graves with, was a very usual thing with the people who buried the dead, in prehistoric times, in this state.

About one mile east of Camargo, on Amos Turner's place, there is an old circle, here called a fort ring, one hundred and fifty feet in diameter. This circle has nearly the same appearance as an old ring, used by our modern circuses, with usually an opening on one side. A few hundred yards away is another one of about the same size, only it seemed to have been laid off as a square, and then the corners rounded without making it a perfect circle, as is the usual shape. In the neighborhood there is a report that, when first known, there were the remains of a wooden post in the center of one of them, and this has been said of the ring at Mr. Goff's, in Clark county. A short distance from these old circles, and making a triangle with them, is a mound eight feet high and fifty feet in diameter. Two of the sides are higher now than the center, giving it the appearance of being a double mound, but it is probable that this has been produced by either an excavation or by the blowing down of a tree from its center. I could not hear of any relics as having been found either about the mound or the circles, though they have been found over the surrounding country. It seems the most probable to me that these old rings were the foundation for houses of the communial order like those used by the Iroquois Indians in the East, for some time after the settlement

of the United States, and, at a much later date, by the Mandans of the North. All of these places had large trees growing over them, some of which still remain.

Near Morgan's old station, and on the hill above Slate creek, on the property of Mr. Gilmore, there is another of these circles of a uniform size and character with the first one mentioned. Not far away is still another ring, while on the hill is a small mound, and in the bottom another.

Mt. Sterling received part of its name from a very large mound which formerly stood in the town limits. This was called, in the early days of the county, Little Mountain, and many surveys were made from it as a starting point. This elevation was destroyed many years ago, when it is said to have yielded many skeletons of human beings and a large number of interesting specimens of tools, ornaments, etc. There is a small mound remaining in the town near the beginning of the Owingsville pike.

One of the largest and most beautiful erections of this character is on the Ragan place, now owned by Col. Thomas Johnson. This is over sixteen feet high and is a regular cone, which is barely truncated. Not far away is another but much smaller one.

On the farm of John T. McGowan, Esq., is an enclosure nearly oval in form, containing nearly two acres of ground, and having three small mounds in the space. It is possible that this oval-shaped ring was left when the material was taken to erect the mounds.

On another Johnson farm, above Somerset creek, is another large mound which has not been excavated, and around this mound, and in the adjoining fields, there have been found a considerable number of implements left by these long-gone people.

Not far from Grassy Lick, on the farm of Mrs. Mitchell, there is a very pretty mound, some sixty feet in diameter and twelve feet high. On the farm of Joel Tresler, Esq., is a locality where there are fifteen or twenty graves.

Near Harry Hurt's, on Grassy Lick, there is another one of those circles, and close by is a small mound five or six feet high.

Mr. J. McDonald has plowed up several interesting specimens on his farm. From Mr. Nick. Haddon, on the Levee pike, I obtained a large sandstone ax which had a coating of iron, a sixteenth of an inch thick, all over it. There are, perhaps, many more remains of mounds and graves in the county, and hundreds of fields where the plow turns up some records of man.

APPENDIX A.

STATISTICS OF MONTGOMERY COUNTY, COMPILED FROM THE REPORT OF THE TENTH CENSUS OF THE UNITED STATES, 1880.

1880. Total population	10,566
1870. Total population	7,557
1860. Total population	7,859
1880. White population	7,000
1870. White population	4,858
1860. White population	4,967
1880. Colored population	3,566
1870. Colored population	2,699
1860. Colored population	2,892
1880. Native born	10,394
1870. Native born	7,402
1860. Native born	7,733
1880. Foreign born	172
1870. Foreign born	155
1860. Foreign born	126
1880. Mt. Sterling population	2,087
Number of farms	1,013
Acres of improved land	108,801
Acres of unimproved land	33,892
Value of farms, including buildings and fences	$4,215,058
Value of farmi'g implements and machinery	63,906
Value of live stock	740,280
Cost of building and repairing fences, 1879	34,911
Cost of fertilizers purchased, 1879	780
Assessed valuation, real estate	2,381,656
Assessed val'n, personal propt'y	492,492
Assessed valuation, total	2,874,148
Taxation, State	13,078
Taxation, county	30,000
Taxation, city, town, village and school district	4,779
Taxation, total	47,857
†Miles of railroad	. .
†Valuation of railroads in county	. .
†Miles of turnpikes	60
†Av. cost of turnpikes per mile	$2,500
†Total cost of turnpikes	150,000
Number of horses	2,991
Number of mules and asses	923
Number of working oxen	476
Number of milch cows	2,501
Number of other cattle	9,962
Number of sheep	13,914
Number of swine	13,226
Pounds of wool	8,708
Pounds of butter	136,073
Pounds of cheese	396
Bushels of Indian corn	4,241,288
Bushels of oats	595,083
Bushels of wheat	1,858,343
Bushels of rye	16,598
Bushels of Irish potatoes	45,855
Bushels of sweet potatoes	2,166
Bushels of buckwheat	643
Pounds of tobacco	8,624
Tons of hay	18,332
Value of orchard products	$63,744
Manufacturing establishments	56
Capital invested in	$80,145
Hands employed in	110
Total wages paid in year	$30,354
Cost of materials	64,207
Value of products	132,956
Bonded debt	150,867
Floating debt	3,800
Gross debt	154,667
*Total acres of land 1883	115,286
*Average value per acre 1883	$19.37
Number of town lots 1883	603
*Value of town lots	$495,275

*Auditor's report. †Other sources.

NOTE.—The 108,801 acres of improved land is divided into 53,284 acres in cultivation, and 55,517 in pasture and permanent meadow.

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GEOLOGICAL SURVEY OF KENTUCKY
John R. Procter Director.

MAP OF

MONTGOMERY AND CLARK COUNTIES

BY

J. B. HOEING Topographer

Scale 2 Miles 1 Inch

Geology by W. M. LINNEY.

SCHEME OF COLORS.

Carboniferous — Lower Coal Measures; Upper; Sub Carboniferous — Lower; Devonian — Black Slate; Conderous and Upper Silurian — Upper; Middle & Hudson River; Lower Silurian or Cambrian — Lower; Trenton; Birdseye; Chazy

BOURBON CO.

HARRISON CO.

MONTGOMERY CO.

MT. STERLING

WINCHESTER

CLARK CO.

FAYETTE CO.

MENIFEE CO.

POWELL CO.

MADISON CO.

ESTILL CO.

AREAS.

Clark	255½ Sq Miles
Montgomery	205 "

CONVENTION OF SIGNS.

Alignment; Roads; Rail Roads; Indian Mounds; Rivers; County Lines; Rail Roads in construction

SECTION ON LINE A-B.

Vertical Scale 2 Miles 1 Inch.