GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

A GENERAL ACCOUNT

OF THE

GEOLOGY OF A PART OF OHIO COUNTY,

BY CHARLES J. NORWOOD.

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PRELIMINARY LETTER.

Professor N. S. SHALER, *Director Kentucky Geological Survey:*

DEAR SIR: I herewith present the results (that are ready for publication) of my work in Ohio county. It is proper to state, that a number of matters have been left undiscussed, although notes were taken concerning them, as it seemed best that they should be considered in a report dealing with the county considered as a county alone. In this report the county is especially considered with respect to its value in aiding to make clear the history of the western coal field.

The acknowledgments of the Survey are due the citizens of the county generally for their coöperation in furthering the work in their respective regions, but especially are they due Mr. Harrison D. Taylor, Judge Baird, Dr. J. E. Pendleton, Hon. E. Dudley Walker, Mr. J. P. Barrett, and Mr. Carson, of Hartford; Mr. R. B. Thomson, of Elm Lick, and Mr. S. Woodward. Dr. Pendleton, Mr. Carson, and Mr. Woodward presented specimens of archæological value to the Survey; Mr. Taylor and Judge Baird furnished maps, and Mr. Thomson rendered very material assistance to me in a number of ways.

Respectfully,

C. J. NORWOOD.

A GENERAL ACCOUNT OF THE GEOLOGY OF A PART OF OHIO COUNTY.

PREFACE.

The conditions of the beds in Ohio county depend essentially on two nearly parallel disturbances, one of which is an upliſt, apparently a synclinal, and traverses the county in an irregular eastwardly and westwardly direction; the other, a disturbance lying within the counties to the south of the Ohio line, near the southern border of the coal field, and which seems to have been, in a large degree, instrumental in shaping the form of the southern limit of the field.

The counties nearest to Ohio county, within which this southwardly disturbance lies, are Butler and Muhlenburg. Accordingly, the southern part of Ohio county, and the northern parts of Butler and Muhlenburg counties, are found to lie within a common geological basin, which is a synclinal one.

North of the Ohio county disturbance the beds seem to have one general sweep — a downward one — towards the north, nearly, if not quite, to the Ohio river. The amount of the depression of the beds, however, varies in that direction; apparently being inconsiderable in the direction of Hawesville, Hancock county, but sufficient in the direction of Owensboro', Daviess county, to bring the upper coals within the hills facing the river, near that city.*

We find, therefore, in Ohio county two distinct geological areas: one occupying the southern half of the county, and forming, with parts of Butler and Muhlenburg counties, a

* It is possible that the very low rocks seen at Hawesville (beds at the base of the coal measures are visible there) may have been brought to light by another disturbance—causing a northwardly rise of the beds. Of this, however, I have no accurate knowledge, and refer to the forthcoming report of Mr. P. N. Moore, on the geology of that region, for the solution of this question.

synclinal basin, which reaches from Rough creek to the southern margin of the coal field; the other, an area with a single slope, and that towards the north. There certainly are local modifications of these conditions; but such seems to be a correct view of the *general* arrangement of the geological features of the regions.

The two regions seem to differ in some special particulars besides the relative positions, towards the surface, of the beds beneath it.

There seem to be indications of a wedging out (so to call it) of some of the beds towards the north, and a lessening in the thickness of some of the coal seams; hence it is not improbable that a larger number of coals are to be found south of the Ohio county disturbance than north of it. This is conjectural, however; and even should it prove true, it does not seem to have been effected by the disturbance—so far as the early history of the coal beds is concerned. This will become apparent further on.

It will be seen that each area has a certain individuality, which serves as a distinguishing feature, and that it is of sufficient importance to render the study of each section, by itself, desirable. Accordingly, the plan has been to limit the study of the geology of these districts less by the geographical than by the geological lines; so that the study of either section should not be confined to a single county, but would include such parts of the other counties as came within the geological bounds. With this in view, and in order that the report may be used in connection with, and properly form a part of, the record of the general results obtained in the study of the synclinal basin, only the southern part of Ohio county —somewhat more than half of the county—is now described.

I.

TOPOGRAPHY.

The topographical features of the district differ little from the general type presented in the interior portions of the western coal field. Soft sandstones and beds of shale of vari-

ous sorts (usually sandy shale) are the elements from which have resulted a region of much flat land, a few prominent ridges, and occasional conical or flat-topped hills.

The accidents to which the crust has been subjected, viz: the disturbance along Rough creek, with its attendant twisting of the beds, and the uplift at the southern margin of the field, have impressed themselves on the geography of the region in a general way; but the chief features of the topography, so far as relates to details, have been determined by the simple erosion or wearing down of sandstones (usually incoherent) and sandy or clay shales, according to localities. The valley of Muddy creek, of Lewis creek in part, and probably of Rough creek, have been largely determined by dynamical agencies; but the character, both as to course and size, of the larger number of the drainage channels, has depended entirely on the character of the underlying beds and the various degrees of resistance with which they have withstood atmospheric effects. It is not uncommon to find instances where the course of a valley has been altered by the lateral passage of shale into sandstone, or *vice versa*. The effect, on the topography, of the few limestones which occur in the section, seems to have been very limited. In the region about Sulphur Springs, and eastwardly and westwardly from there, along Rough creek, the Sub-carboniferous limestones have given an area of occasional underground drainage, and produced somewhat of the peculiar topography we find when it is based on such beds; but the limestones are so intimately associated with sandstone and sandy shale, that the general features are still very largely those of what may be termed "sandstone topography." The area of the Sub-carboniferous limestones is also quite limited, being confined to a comparatively narrow strip along Rough creek.

The principal streams of the district, besides Rough creek, are Caney creek, Hall's creek, Mill run, Muddy creek, and Walton's creek—all of which are tributaries of Rough creek—Lewis creek, Bull's run, Slate creek, and Indian Camp creek (the head waters)—all of which flow into the Green river.

Chief among these streams are, (1) Caney creek, which flows into the county from Grayson county, and then flows northwardly, approximately parallel with the eastern boundary of the county; (2) Muddy creek, which flows in an irregular westwardly course, and empties into Rough creek about one mile and a half below Hartford, draining the region principally about Elm Lick and Rosine; (3) Lewis creek, which flows westwardly into the Green river, and drains the larger part of the southern portion of the district; and (4) Walton's creek, which drains the larger part of the region about Centretown, and flows northwardly into Rough creek.

The principal ridges of the district are three in number, and are, (*a*) one bordering on Muddy creek, south of the stream, (*b*) one lying farther to the south, whose southern slope is drained by Lewis creek, and (*c*) the "Jerusalem" ridge in the region of Rosine and Elm Lick, which is drained in part by Muddy creek. The general course of these ridges is north of westwardly. There are other ridges, especially north and northeastwardly from Elm Lick and Rosine, which are prominent features in the topography of the region, but their extent is usually short, and their courses quite irregular. The first ridge (*a*), which may be termed the "Muddy Creek ridge," is a low one, for the larger part of its course, and is comparatively short; it seems to coincide with the second ridge (*b*) towards the west, or to fall away and disappear in that direction; it has not been determined which condition occurs. Towards the east it breaks up in a series of rounded hills, which are washed by the numerous small tributaries of Muddy creek.

The second ridge (*b*) may be termed the "Coal ridge," as within it are contained the largest number of important coal beds to be found in any one ridge in the district. This ridge is apparently a part of the main ridge of the coal field, which has been mentioned in a preceding report,* and will be more fully discussed hereafter.

The Jerusalem ridge (*c*) is also an important ridge; but, although it contains a thick and important coal bed, does not

*See part VII, volume IV, Kentucky Geological Reports, N. S. Shaler, Director.

have equal value, so far as concerns coal, with the "Coal ridge."

II.

THE GENERAL STRUCTURE AND COURSE OF THE UPLIFT.

Naturally, one of the most interesting features in the structure of the district is the disturbance which forms its northward limit; hence the discussion of it will serve as a fitting introduction to the general account of the other features of the region. It is a line of uplift which stretches across the county in a somewhat irregular eastwardly and westwardly direction, extending to the Falls of Rough, and perhaps beyond, on the east; and through McLean county as far west as Sebree, in Webster county, and probably beyond.

The existence of the disturbance was discovered by Dr. D. D. Owen; but he does not seem to have recognized its full importance, or to have traced it for any distance, nor to have determined its nature.* He mentions it as the "Barnett's creek disturbance," probably referring to the region about the old salt wells, on Barnett's creek, and does not seem to have traced it any farther towards the east.

The disturbance was for the first time suspected by myself in March, 1874, upon a visit to a point on Rough creek, above Hartford, known as the "Iron Mountain." The discovery of Sub-carboniferous beds there, and the inclination of the strata, proved the existence of some sort of disturbance, but of what kind was not known. Another visit made to the locality in 1875, and the examinations, undertaken along the north and south running railways in the same year, proved the disturbance to have a considerable extent; but it was not until May, 1876, that its true significance and general character became apparent, and it was determined to be a line of uplift. The uplift is probably connected with the disturbance in Union county, described by Dr. Owen, and designated as the "Bald Hill disturbance."† This, however, is entirely conjectural, as

*See page 147, volume I, Kentucky Geological Reports, old series, D. D. Owen, Director.

†See page 112, volume I, Kentucky Geological Reports, old series, D. D. Owen, Director.

that disturbance has not been studied as yet by any officer of the present Survey, nor the westward extension of this one fully determined.

The location of the uplift is distinctly marked in the geography of the region by Rough creek, which, for the larger part of its course, closely follows the line of the disturbance, never permanently leaving it until within a few miles of the mouth of the stream; it does not, in fact, pass entirely beyond the limits of the uplift there. The detailed relations that exist between Rough creek and the disturbance cannot well be determined before the line of the uplift is accurately mapped; but all the evidence collected, so far, seems to indicate the date of the creek valley to be more recent than the disturbance, and that the course of the creek has been considerably influenced by the uplift. Although the disturbance is plainly an uplifting of the beds, and along some parts of its course is plainly an anticlinal fold, its general character, that which is most common throughout its length, is yet somewhat conjectural.

I am inclined to regard the uplift as an anticlinal fold, modified in its general character along some parts of its course. The balance of evidence favors such a classification; but as yet it must necessarily be a provisional one, as at some points the disturbance exists as a *fault*, while at some others the evidence seems to point to a *monoclinal fold*. So far as Ohio county alone is concerned, the disturbance may safely be regarded as (most commonly) an anticlinal fold; but as it extends far beyond the limits of this county, and must hereafter be considered in the relation it bears towards other parts of the coal field, it is desirable to avoid any name that may be too local in its application. Accordingly, from the relations existing between the disturbance and Rough creek, it is designated as the "Rough Creek uplift" in this and a preceding report.*

The course of the uplift varies considerably. The strike of

*See *Report on the Geology of the Regions Adjacent to the North and South Running Railways*, part VII, volume IV, new series, Kentucky Geological Reports, N. S. Shaler, Director.

the beds ranges from north 40° east, in the vicinity of Hartford, to north 85° east (though more commonly north 70° east), in the region about Sulphur Springs and Barrett's Ferry, while west of Hartford the variation is from north 30° west to north 85° west—the strike of the beds at the old salt wells, on Barnett's creek, however, being north 55° west to north 65° west. We thus find an almost complete swinging around of the line of the uplift westwardly from Hartford.

There seems to be little room to doubt, that when the line of the uplift is accurately mapped, it will be found to be marked very faithfully by the course of Rough creek; for that stream seems to depend very largely on the turns of the line of the uplift for its more important changes of direction. The value that the uplift has in directing the course of the stream is curiously illustrated by the decided curve to the south made by the stream when north of Hartford, and the turn then made towards the north just after Hartford is passed. That this is very largely due to the changes in the course of the uplift becomes plain when a map (even a poor one) of the line of uplift is compared with a good map of the stream—which we fortunately have.

From "Clifty Hill," above Barrett's Ferry, to the Sulphur Springs, and a short distance beyond, the general direction of the uplift is about north 70° east; it then changes, and at half a mile south of west of the Sulphur Springs bears north 65° east, and keeps this general course for several miles towards the west. The course is then altered again, and bears north 40° east, at a point northwardly from Hartford.

On the lower Hawesville road, northwestwardly from Hartford, a good view of the tilted beds near the axis of the uplift is obtained; their strike bears about north 85° west. This is modified to north 30° west, still farther west, and is again changed in the vicinity of the old salt wells on Barnett's creek, the strike of the beds there being north 55° west to north 65° west.

It will be seen that the course of the line of the uplift forms somewhat of an open loop near Hartford—the open part of

the loop being towards the north. The map of Rough creek shows the same feature in the course of the stream. This loop really represents a shallow synclinal in the vicinity of Hartford, as will be seen from the following: In the immediate vicinity of Hartford, and for some distance north of the town, the beds are found dipping nearly due west, the bearing being a little north of a due west course; but west of the town, on the west side of Rough creek, the dip is reversed, and bears south of east—in some places nearly due southeast—gradually, however, swinging around to the southwest towards Barnett's creek.

The existence of this synclinal may serve to explain the southwardly course of the stream from the mouth of Flat Lick to the mouth of Muddy creek, and its subsequent departure from such close connection with the uplift as exists eastwardly from Hartford. It cannot be said to ever pass entirely beyond the influence of the uplift, for there is a marked relation between the strike of the uplifted beds and the course of the creek, so far as it flows; but its channel is within a different set of beds from those on its upper course (which are the older), and the distance between the stream and the central line of uplift is increased. This seems to be due to the southwardly impetus gained by the stream when turned through the synclinal valley.

Northeastwardly from Hartford the beds, near the central line of uplift, are frequently exposed within short distances of Rough creek. On the Hartford and Sulphur Springs road, Chester limestone, overlaid by about forty feet of shaly sandstone, is exposed in the divide between Hall's creek and Sullenger's branch, about one mile from Hall's creek. Limestone of the same age is exposed in the region about the Sulphur Springs and Hines' Mill. In the vicinity of Sulphur Springs the limestone is frequently found toward the base of the hills, with massive sandstone above it.*

* For the details of the structure of this region, and of all that eastwardly to the Grayson county line, the reader is referred to the forthcoming report of Mr. P. N. Moore on the Eastern Margin of the Coal Field.

Northeastwardly from Sulphur Springs a thin coal bed occurs, in close connection with what seems to be Sub-carboniferous limestone. The coal is about nine inches thick, and is probably at the base of the coal measures. The precise age of the limestone underlying the coal could not well be determined, but it seemed to belong to the Chester Group. The coal is covered by four feet or more of drab sandy shale, and is firm and glossy black. The beds seemed to be dipping at an angle of about 6° course south 25° east. This is on Mr. N. P. Boswell's land.

At Mr. T. J. Barrett's "Sulphur Lick," about two and a half miles north of east from the Sulphur Springs, a sandstone is exposed which is tilted apparently at an angle of nearly 45°. Very little of the bed could be seen, so that the angle of the dip may really not be so steep. Limestone is reported to have been found below the sandstone.

In the Hartford and Hardinsburg road (the old "Louisville and Hopkinsville" road), about half a mile a little south of east from the Sulphur Lick, sandstone, probably equivalent to that seen at the lick, is exposed. The bed is dipping about south 20° east, the strike being north 70° east. Chester limestone is exposed in the road about seventy-five yards northwardly from the sandstone outcrop, but is apparently nearly horizontal. Its place seems to be below the sandstone. *Spirifer increbescens* is very abundant in the rock.

About twenty yards beyond the limestone a thin seam of coal, six to seven inches thick, is exposed, with a dip reversed to that of the sandstone. There seems to be the axis of an anticlinal here. This place is near Barrett's Ferry.

At "Clifty Hill," on the north bank of Rough creek, about half a mile north 65° east above Barrett's Ferry, a fine view of the central structure of the uplift is obtained. Tilted beds of sandstone, shale, and Sub-carboniferous limestone are seen in the following order:

1. Massive limestone.

2. Space; notably sandstone and shale, which are probably crushed.

3. Massive compact sandstone.

The beds are tilted at an angle of 60°, so nearly as could be determined; course about south 20° east. The arrangement of the beds is shown in figure 1, plate I.

Chester limestone, overlaid by sandstone, is also seen in the Hartford and Hardinsburg road, about one mile and three quarters south of west from Barrett's Ferry. The beds at this place seem to be nearly horizontal. Farther to the west, at the crossing of Sulphur run, about one mile and three quarters south 50° east from Sulphur Springs, the Chester beds are again exposed—at the foot of the dividing ridge between Sulphur run and Hall's creek. As the road mounts the ridge rhomboidal blocks of sandstone are exposed, whose place is above the limestone. The beds are nearly horizontal. The lessening in the degree of the dip of the beds is plainly seen as we recede from Rough creek.

In the vicinity of Hartford lower members of the coal measures are exposed, which are affected by the dip of the Subcarboniferous beds to the north, but show a change in the direction of dip, as compared with that seen towards Sulphur Springs. At the "Foreman Riffle," on Rough creek, about half a mile above Hartford, shaly sandstone is exposed—the beds dipping apparently south 45° west. The precise direction is obscure, as the outcrop is limited.

At the "water" mill, at Hartford, higher beds are seen, consisting of sandstone, limestone, and coal, which have a considerable dip nearly due west. At the mill the inclination of the beds amounts to eight feet in one hundred and eighty feet. On the Hartford and Hawesville road, about five miles west of north from Hartford, Chester beds, consisting of sandstone, limestone, and shale, are exposed, inclined at a steep angle. At one place the sandstone shows a dip of 28°, course south 60° west; this, however, seems to be a local exaggeration, as the more trustworthy beds of limestone show a dip of only 15°, course south 25° west, which is probably the general inclination of the beds in the locality.

On Barnett's creek, on Mr. Lewis Turner's land, and in Mr. Stephen Woodward's field, near the "old salt wells," Sub-carboniferous limestones are exposed tilted at high angles.* On Mr. Turner's land the limestone, thirty feet of which is exposed, is inclined at an angle of 40°, course south 35° west. This place is about three and a half miles, by map measurement, above the mouth of Barnett's creek.

Such are the features to be observed in a general survey of the Rough creek uplift. The disturbance is certainly one of the most interesting problems to be found in the western coal field, not only in its scientific but economic bearings, and merits a more extended study than it has yet received.

III.

THE GENERAL STRUCTURE OF THE DISTRICT.

As intimated on a preceding page, the principal topographical features of the district south of the Rough creek uplift are a principal ridge, having a northwestwardly trend, which forms the water-shed for the waters of Lewis creek on the south, and the waters of Muddy creek in part, and of Rough creek in part, on the north, and a subordinate ridge to the north and south of the principal one; this is the "Coal" ridge. These, with the "Jerusalem" ridge, are the principal features; but they are not the only prominent ones. The "Ben's Lick hills," between Brush creek and Ben's Lick creek (both of which streams flow into Rough creek); a few conical hills on the borders of Muddy creek; the ridge down which flow the streams of Flat Lick, Mill Run, etc. (but which is very much broken, and is really connected with the ridge northwardly from Rosine), and the ridge at Point Pleasant and near Centretown, are also prominent, especially in their geological value.

The coal ridge, which, for the larger part of its course, lies south of the railroad, and extends in an irregular line from the head waters of Indian Camp creek to the Green river,

*This is probably the locality visited by Dr Owen; see page 147, volume I, old series, Kentucky Geological Reports, D. D. Owen, Director.

with its various spurs, seems to contain not only a larger number of coals, but a larger area of thick beds than any of the other ridges.

The Ben's Lick hills contain some of the thick beds; the Jerusalem ridge contains a bed from three feet ten inches to six feet six inches thick (including a clay parting), and within the ridge near Centretown, and at Point Pleasant, the thickest bed of coal in the district is found; but compared with that of the beds in the coal ridge, the area of the coals is small. The precise value, in beds of coal, of the coal ridge, cannot be determined until its form is accurately mapped.

The general slope of the beds from the Rough creek uplift is, east of Hartford, between 20° and 35° east of south; west of Hartford the direction, as indicated on a preceding page, is very variable, the general course, however, being southwestwardly. East of Hartford, the southwardly slope of the beds seems to terminate at the valley of Muddy creek, giving place thereat to a southwardly rise.

The region west of Hartford has not been studied sufficiently in detail for the precise limits of the various dips of the beds to be determined. The dip is not only very variable, but complicated by a small fault, which extends northwardly from Rockport, on the Green river. It may be said, however, that, in that region, there is a general retreat, to the northward, of the limit of the southward slope of the beds as the Green river is approached; that is, the line limiting the southward slope swings round west of Hartford and points towards the northwest, in the direction of the Green river.

It seems that, were these lines projected on a map, they would be found to represent an imperfectly formed letter V —one stem reaching out past Beaver Dam, Elm Lick, and Rosine, and the other one extending towards Point Pleasant, on the Green river—the angle being somewhere between McHenry and the Lewis creek tunnel.

South of these lines the strata rise towards the south. It will therefore be seen, that the larger part of the valley of Muddy creek is within a synclinal depression, the direction of

which is northeastwardly. It seems, indeed, that the "Muddy Creek" ridge, at the base of which Beaver Dam stands, may be regarded as a synclinal one. It seems to be near the central axis of the great synclinal (so to call it) extending from the Rough Creek uplift to the southern border of the coal field.

NUMBER OF COAL BEDS AND THE GENERAL SECTION.

There seem to be at least eleven distinct coals within the district; but only ten have been fully identified. This does not take into account the coals towards the extreme eastern margin of the county, in which direction there is at least one bed lower than the ones enumerated in the following section, nor yet those lying closely along the uplift. So far, I have been unable to satisfactorily obtain the direct connection between these lowest coals and the ones lying above them, on account of the limited character of their outcrops, and the difficulty of tracing the strata—a difficulty which will be recognized by one who has worked in this coal field, where the beds are seldom horizontal for any considerable number of miles, and the structure is so frequently masked by disintegration of the rocks. I have accordingly preferred to limit the section more particularly to those localities where the element of dip would have the least bearing in the computation of the distances between the beds; where, indeed, the direct connection of one bed with another one could frequently be obtained, by simply descending from the one bed to the other, without passing over any considerable horizontal distance. In the region bordering immediately on the lower uplifted rocks, the dip, as mentioned on a preceding page, is quite variable, both in amount and direction. Farther to the south, however, where the slope of the beds is towards the north, the dip is more regular in amount, and more constant in direction; consequently, the relations between the beds are generally quite plain. In several instances, vertical sections of the ridges have shown as many as four coals in orderly succession, while many of the sections show from two to three coals fol-

lowing one another within short horizontal distances. The grouping of these sections, by the identification of some of the members of one section with corresponding ones of another, has resulted in establishing a general section showing a thickness between five hundred and six hundred feet of beds —including at least ten comparatively constant coals and one whose character is yet conjectural.

Even those coals that may be regarded as comparatively constant are not, however, presumed to be present everywhere that their horizons are reached. There seem to be at least two whose places are sometimes filled with sandstone or beds of shale; and the indications seem to be, that in the vicinity of Fordsville (which, however, is north of the northern limit of the synclinal basin) there is a shortening from the base upwards of the section, and an absence of some of the coal beds. Whether this is actually the case, however, is as yet problematical; and should it prove to be the case, the cause is as yet imperfectly understood. There is this to be said, however, in such a connection: at Fordsville, and on the extreme eastern margin of the district, the coal-bearing series rest immediately on the Chester Sub-carboniferous) beds. At Fordsville, and near the Sulphur Springs, a thin seam of coal, which may possibly be Coal L, rests within a few feet (sometimes within a few inches) of the Sub-carboniferous limestone.* This is to be observed at Spring Lick, in Grayson county, and further east. At Spring Lick, Coal L occurs at five feet above the Chester limestone.†

Towards the southern border of the field, in Butler and Muhlenburg counties, a conglomerated sandstone, known simply as the "Conglomerate," lies at the base of the coal measures, and is interposed between the lowest coal and the Sub-carboniferous beds. The same conditions as those to which the Conglomerate owes its presence on the south, while it is absent towards the east and on the northern limits of the

* For a full discussion of the section at Fordsville and surrounding region, see the forthcoming report of Mr. P. N. Moore, hitherto mentioned.

† See page 54, part VI, volume I, Kentucky Geological Reports, new series, N. S. Shaler, Director.

synclinal basin, may have been of value in determining the distribution of the coal beds.* This is to be regarded merely as a suggestion.†

All things being considered, the evidence as to the apparent shortening up of the section, and the decrease in the number of coal beds in the direction of Fordsville, is of a nature too imperfect for the basing of any conclusion upon it. Any absence of beds that should be proved to occur in that direction might be due to such local accidents, comparatively limited in their operations, as are known to have occurred in connection with some of the beds in the more central part of the coal field.

Such suggestions as have been made in regard to the shortening up of the section, or diminution in the number of coal beds, are not, therefore, to be regarded as conclusions based on well-worked out facts, but as suggestions of the conditions possibly existing. It is only when the region is worked out carefully in detail that the problem will find its solution.

The following is a general statement of the beds in the synclinal basin;‡ it is a generalization of about forty local sections, besides the more general observations:

GENERAL SECTION.

No.	Description of Strata.	Feet.	Inches.
1	Sandstone, the "Anvil Rock."		
2	Shale.		
3	*Coal A*	5	
4	Shale		6
5	Limestone	1	6
6	Shale	0 to 2	
7	*Coal B*	6	
8	Under clay	2	
9	Sandstone [This space is sometimes filled with a single massive sandstone.]	25	
10	*Coal;* not always present (C?)		3
11	Sandy Shale and Sandstone	30	
12	Bluish Shale, with ochre concretions	25	
	Carried forward	97	3

*This question is probably discussed in the Biennial Report of the Director of the Survey.

†Some fragments of Conglomerate have been found near the line of the Rough Creek uplift, but have not yet been traced to a bed *in situ*.

‡The regions about Centretown and to the west, and that about Point Pleasant, are excepted, for reasons which are given on another page.

GENERAL SECTION—Continued.

No.	Description of Strata.	Feet.	Inches.
	Brought forward	97	3
13	Bituminous Slate . . . 2 feet to	4	
14	Pyritous band filled with fossils; not always, though usually, present		2
15	*Coal D* . . . 5 feet 7 inches to	4	8
16	Under clay; frequently contains an irregular bed of concretionary masses of light blue, smooth-grained limestone	3	
17	Sandstone and shale . . . 45 feet to	50	
18	Bituminous Slate containing fish scales . . . 3 feet to	5	
19	*Coal E;* sometimes divided into several members . . . 16 inches to	1	6
20	Space; notably shale	17	
21	Grey Limestone; may not be precisely in place	2	
22	Space; notably sandstone and shale	10	
23	Black Slate, filled with fish remains . . . 18 inches to	3	
24	*Coal E*[a] . . . 14 inches to	1	8
25	Under clay	3	
26	Soft disintegrating Sandstone. This is frequently a mixture of shaly disintegrating sandstone and sandy shales . . . (This space is sometimes increased to 40 feet, and filled with soft sandst'e.)	27	
27	Space; sometimes filled with reddish clay	5	
28	Bituminous Slate . . . 0 to	1	6
29	*Coal F* . . . 9 inches to	1	6
30	Under clay . . . 0 to	3	
31	Mottled dark drab and ashy-grey or white, impure Limestone. Has frequently a brecciated appearance on the surface, and is sometimes somewhat nodular on top. Weathers a brown or ferruginous tinge. Contains *Spirifer (Martinia?) lineatus, Martinia planoconvexus,* and *Rhombopora lepidodendroides* . . . 1 foot to	2	2
32	Shale	20	
33	Sandstone and shale . . . (This space is sometimes filled with a massive sandstone 65 feet thick.) 20 feet to	35	
34	*Coal G* . . .	1	2
35	Sandstone and shale . . .	30	
36	Blue, shelly earthy Limestone. In places has somewhat of a concretionary structure near the middle of the bed Breaks with an irregular fracture. Organic remains are abundant, including *Productus muricatus, Prod. Prattenianus, Prod. Nebrascensis? Spirifer cameratus, Athyris Subtilita, Aviculopecten ——? Chonetes mesoloba,* etc.	6	
37	Dark calcareous Shale, containing numerous small calcareous concretions; merges above into No. 36, and below into No. 38. Contains *Productus muricatus* and *Chonetes mesoloba* in the lower part	7	6
38	Impure, coarse-grained, dark grey crinoidal Limestone		
39	Argillo-calcareous material. Somewhat of a shale. Is filled with *Productus muricatus,* especially at the bottom	1	
40	Black Shale interlaminated with thin streaks of coal		1½
41	*Coal* . . . 11 inches to	1	6
42	Under clay. This is dark grey and very impure, specks of charcoal and small concretions of pyrites being abundant in it. Base not seen	1	
43	Space, mostly filled with argillo-sandy shale	7	
44	Hard Chert, usually in rhomboidal blocks Color, yellow and dark. Usually abounds in *Fusulina cylindrica,* and may be identified as the "*Fusulina Chert*"		6
49	Shaly Sandstone, or argillo-sandy shale . . . 10 feet to	20	
46	*Coal* . . . 16 inches to	2	7½
	Carried forward	376	8

GENERAL SECTION—Continued.

No.	Description of Strata.	Feet.	Inches.
	Brought forward	376	8
47	Space; mostly Sandstone. This space varies from 40 to 70? feet, and is sometimes nearly all sandstone.	30	
48	Argillaceous Shale	10	
49	The "*Elm Lick Coal*" divided by a clay parting thus:		
	a. Coal 18 inches.		
	b. Clay 4 to 18 "	6	
	c. Coal 36 "		
50	Space	5	
51	Massive Sandstone	35	
52	Shale	5	
53	*Coal* 22 inches to	2?	
54	Space	46	
55	Sandstone and shale	7	
56	Sandstone, soft and disintegrating	12	
	Total	534	8

It will be seen in the above statement, that the distances are sometimes considerably modified. The observations have not been sufficient to determine the most common distances between such beds, nor the character of the materials most generally filling the spaces. This is especially true of the spaces between the limestones No. 31 and No. 36, and between the Fusulina chert and the coal No. 49.

In the vicinity of Cromwell (as at Greenville, in Muhlenburg county), a coal bed of fourteen inches in thickness (No. 34 of the section) occurs at fifty-five feet below the "mottled limestone," No. 31—the space between being filled with shaly sandstone and shale. In the neighborhood of Mr. L. D. Taylor's, however, the section is shortened, the coal No. 45 being only one hundred feet below the mottled limestone, the probabilities being that coal No. 34 is not present. Near Mr. James Raley's the coal No. 34 is evidently not present, as a massive sandstone sixty-five feet thick occurs at twenty feet below the limestone; the sandstone also appears either to cut out the beds from No. 35 to No. 44, or to considerably lengthen the section. This is shown on plate 2.

The space between the Fusulina chert (No. 44) and the Elm Lick coal is also variable, and the standard distance has

not been fully determined. Barometrical measurements* have been made, which seem to show a variation in the distance from about fifty to seventy feet. The amount of variation seems to depend on the thickening or thinning of a soft massive sandstone, which underlies the first coal below the chert. The sandstone seems to vary in thickness from thirty to fifty feet, and thus causes the distance between the two coals to range from about thirty-five to fifty feet. It is not improbable that this sandstone cuts out the coal occasionally; of this, however, the evidence is not satisfactory.

The space between the Fusulina chert and the first coal below it (No. 46) varies comparatively little. It is probable that the coal will very generally be found at about twenty feet below the chert.

It will be seen that the lower part of the section undergoes considerable changes in the several parts of the district; accordingly, the record from bed No. 34 to bed No. 53 must be regarded as somewhat preliminary in character, until sufficient data have been obtained to warrant a final revision of the statement, and a determination thereby of the standard distances between the coal beds.† The expediency of this will become apparent hereafter.

From coal A (No. 3) downwards to coal F, however, the distances given in the general section seem to be comparatively constant; accordingly, that part of the section may be considered as generally applicable over the district.

It may also be well to state, that Coal G is, so far as at present known, more frequently found than not, at about forty feet below Coal F.

DESCRIPTION OF THE BEDS.

The larger number of the prominent beds of the section are so fully marked by their individual characters, that their identification is easy; some of them, however, are to be identified only by the beds found associated with them.

*These are without correction, as I was without facilities for checking them.

†This work is now in hand.

The "Anvil Rock" Sandstone.—As is mentioned in a former report* (in which it is fully described), this sandstone received its name from Dr. D. D. Owen. It is to be identified only by its relative position towards other beds. So far as relates to this county alone, there is little to be added to the descriptions of the rock which have already been published. Observations which have been made in Muhlenburg county, however, tend to prove the accuracy of the suggestions formerly made as to the probability of the sandstone being conglomerated in some localities.†

Coal A.—This bed is very seldom wrought in the county, as its extent, as a workable bed, is limited to small areas. Unless it is in the region about Point Pleasant and Centretown, the deposit seldom reaches any considerable thickness. This, in a large measure, is due to the high position it occupies in the section, which usually brings it so near the tops of the hills that the coal wastes away under the action of the weather. The place of the bed is frequently only indicated by a dark earth or by its stained "under clay."

The inconstancy of Coal A has been pointed out in a former report,‡ and was referred, in part, to the varying conditions which no doubt existed during the deposition of the Anvil Rock sandstone; but the examinations in this district have seemed to show, at some points, the absence of Coal B when Coal A was present. This, however, is not fully proven, as in every case where such conditions seemed to exist the section was not fairly exposed.

Coal B.—This bed has been fully described in a preceding report.

It is probable that in the region about Hamilton, McHenry, and Rockport, the coal may be found in a workable condition. It is worked at Paine's mines, on the river, opposite Rockport, and at Airdrie, farther up the river. The bed is not found east of Beaver Dam, and its place in the ridge south of that

*See part VI, volume I, new series, Kentucky Geological Reports, N. S. Shaler, Director.

†See part VII, volume IV, new series, Kentucky Geological Reports, N. S. Shaler, Director.

‡Part VI, volume I, new series, Kentucky Geological Reports, N. S. Shaler, Director.

place is only indicated by a black "dirt." Much that has been said concerning Coal A may be applied to Coal B in this district.

Coal D.—This bed has also been described sufficiently well in a former report. Since the publication of that report, however, the coal has been found showing a larger thickness than was reported therein.

On Mr. Alfred Brown's land, one mile and a quarter about south 10° east from Beaver Dam, the coal has been opened, showing a thickness of five feet seven and three fourths inches. The usual thickness of the bed is four feet eight inches. The coal is covered by a slabby bituminous slate, which frequently contains large pyritiferous concretions, and this is usually overlaid by bluish argillo-sandy shale, containing ochreous concretions. In some places, however, the slate is immediately overlaid by a massive sandstone, fifty to seventy feet thick, as at the old Taylor mine on the Green river, below Cromwell.

Coal D seems to be the most trustworthy coal in the district, but its area is irregular in form. So far, the observations seem to prove the bed to be confined to the region south of Rough creek. Its eastern limit would be marked by an irregular line drawn from near the mouth of Ben's Lick run, on Rough creek, in a southeastwardly course to Kate's Hill, on the Hartford and Morgantown road, southeastwardly from Beaver Dam; thence it extends, with a westwardly curve, to the old Taylor mines, on the Green river, passing west of Cromwell and Pinchico. There are probably some exposures of the coal east of this line in the southern part of the county, but they are quite detached, and occupy comparatively small areas, although some of them may doubtlessly be extensive enough to supply a mining company for years with coal. The line indicated undoubtedly marks the eastern limit of the coal as a solid sheet.

South of Lewis creek, the beds sink towards the west, so that Coal D may be regarded as underlying the larger part of the region included between the Green river and the imagin-

ary line to the east, except that part towards Rochester. In the vicinity of Rochester lower coals are the first ones beneath the surface.

North of Lewis creek Coal D does not seem to have so wide an area, at least not as a continuous sheet. It seems to underlie only a somewhat triangular area in the region between Clear run and Ben's Lick run, known as the "Ben's Lick Hills," reaching not quite to Clear run; and then to be absent for a considerable distance to the west, on account of both the geological and topographical conditions.*

In the region to the west the position of the coal is affected by the small fault which courses northwardly from Rockport. The coal, under other conditions, has a northwestwardly rise from Miller's bank (in the Ben's Lick Hills); but the Rockport fracture† having occurred since(?) the beds were raised in that direction, the coal has been let down about fifty or sixty feet towards the west along that line of fracture, and towards the Green river the direction of the rise of the beds is changed to about north 40° east. In consequence of these conditions, Coal D seems to be deep-seated in the region between Rockport and Point Pleasant.

Coal E.—This coal has been the source of some confusion, not only to myself, but to the officers of the first Survey. There is no doubt that this bed, and the one lying immediately below it, were confounded with each other—their slates being so nearly alike, and the distances between them so short—and the two referred to a single bed. The investigations of the past season prove the existence, beyond a doubt, of two beds instead of one, one of which, without doubt, corresponds to Coal E of the nomenclature adopted in the preliminary work of the present Survey, or No. 8, according to the numbering used by Dr. Owen. The other bed may, for the present, be designated as Coal E^a.

*In volume III, page 543, of the first series of Kentucky Geological Reports, a coal, which is exposed in the left bank of Rough creek, at Hartford, was identified as Coal D ("No. 9"). But, as shown in a former report, that coal is a lower bed. Coal D, as shown on a succeeding page, is worked in the Ben's Lick Hills, and is plainly above the bed seen at Hartford, even measuring the height by its topographical position alone.

†Described on a succeeding page.

In the report on the geology of the region adjacent to the Louisville, Paducah and Southwestern Railroad, the conclusion is given that Coal E is very untrustworthy. This statement was, of course, based on the impression that only one bed occurs in the space in which two are now known to lie, and which were confounded with each other. The more recent observations have shown the possible necessity of modifying the statement as to the constancy of the bed; but there is no reason to question the accuracy of the conclusions as to the general thickness, and the value of the coal for industrial purposes. It has nowhere been found sufficiently thick to be mined with profit.

The coal is usually overlaid by a thick deposit of dense, black bituminous slate, which breaks into slabs, and in which a few fish scales and spines(?) are found. The fish scales are peculiar in form, but alone do not serve to identify the slate, as the slate covering the lower coal is much more abundantly filled with them. For a perfect identification of the bed, in a case where one is unacquainted with those peculiar characters that may be observed in a certain coal, but not described, and are to be known only through practical experience with the bed, it is necessary either for the whole or a large part of the coal and its roof of slate to be exposed, or for some one of the coals associated with it to be exposed in the vicinity. The distance from the base of Coal D to the top of Coal E is from forty-five to fifty feet.

The following is a section of the bed as exposed on Mr. Poyner's land, southeastwardly from Beaver Dam; it may serve as an example of the conditions usually presented by the coal in this district:

No.	Description of Strata.	Feet.	Inches.
1	Black, hard, slabby bituminous slate	3	
2	Drab clay, rather hard		5½
3	Coal and clay	1 inch to	1½
4	Clay (14 inches)	½ inch to	1
5	Coal, base not seen.	said to be 1 foot to	2
		100	

The most trustworthy features to be observed in connection with this coal, and to be used as means for its identification, seem to be the extraordinary thickness of the black slate overlying it, the thickness of which sometimes measures five feet, the occurrence of the peculiar fish scales and spines(?) in the slate, and the clay divisions in the coal. The fish remains seem to be peculiar to the slates over Coals E and E^a, being, however, more numerous in the slate over the lower coal, which slate is also to be distinguished from the one overlying Coal E by its being less dense, and usually not more than half so thick.

Coal E extends over a wide territory. It lies near the surface east of Beaver Dam, in the region about Liberty Church, near Hartford, Cromwell, and Pinchico, and may safely be presumed to underlie all that area in which Coal D is present.

Coal E^a.—This bed normally occurs at twenty-five to thirty feet below Coal E. It is probably the one most often mentioned as Coal 8 in the reports of the first Geological Survey (although there is no doubt that the upper bed was also identified with that number), and is the one generally regarded as Coal E in the report on the coals along the line of the Louisville, Paducah and Southwestern Railroad.*

On account of reasons which it is now unnecessary to enumerate, the identity of this coal, as distinguished from the one now designated as Coal E, was not discovered when the region was examined for the first time.

The coal varies from fourteen inches to twenty inches in thickness, and is covered by two feet of usually hard, frequently polished, bituminous slate, abundantly filled with fish scales and spines(?). An occasional fish tooth, *Peripristis semi-circularis*, is also found in the slate; but teeth are rare. The slate is not always hard nor polished, but is sometimes dull black and quite fragile. The character and fossil contents of the slate serve as very fair means for identifying the coal.

* This bed was also identified as No. 7 at some places by officers of the former Geological Survey.

Coal E[a] probably has an area equal to that of Coal E, if not a larger one. It should be stated, however, that neither bed is frequently exposed in the county; other beds concealing them, or the topographical conditions being unfavorable.

Coal F.—When this district was first traversed this bed was not observed, the space seeming to be completely filled with sandstones and shales. The more general examinations made during the past season have proved the presence of the coal over a large part of the district.

The thickness of the coal varies considerably, ranging from nine inches to eighteen inches; but its horizon is well marked, and it may be identified wherever the topographical conditions and the positions of the beds are favorable.

As a surface bed, it is most frequently exposed in the region near Cromwell and about Liberty Church, its outcrops seeming to be chiefly limited to the ridge forming the water-shed for the waters of Lewis creek, Indian Camp creek, Slaty creek, and Muddy creek.

The place of the coal is marked by a peculiarly mottled drab-colored and ashy-white limestone, varying in thickness from twelve inches to twenty-six inches, which is described as No. 31 in the general section. This bed is the equivalent of the mottled limestone seen at Greenville, and probably of the upper "impure limestone" indicated in the Airdrie section, as given by Dr. Owen.* Its identification in this district proves the extent of the bed to be greater than was suggested in my former report.

Coal G?—This bed was also observed for the first time, in this district, during the last summer (1876). It was formerly presumed not to be present far beyond the Green river, in an easterly direction. Its precise character is still conjectural, as the bed was observed at only one place in the county, near Cromwell, and was then seen only as a coal "dirt." The general extent of the coal is accordingly unknown, but the bed

*See page 25, volume III, Kentucky Geological Reports, old series, D. D. Owen, Director.

seems to be irregular in extent, or, at least, to be interrupted by sandstone at some places.

Number 36—*Limestone.*—The principal outcrops of this limestone are in the region bordering Rough creek. As stated on a preceding page, it seems to be cut out, and its place filled with sandstones and shales, in some parts of the district; it is so earthy in composition, however, and disintegrates so readily upon exposure, that, in some cases, the limestone is probably merely concealed by débris, chiefly the result of its own disintegration, instead of being absent. In some places it seems to be represented only by a cellular, apparently somewhat silicious, yellow limestone, or calcareous mass, abundantly filled with *Productus muricatus*, which is immediately underlaid by the coal No. 41 of the section.*

Number 41—*Coal.*—This bed has been observed at but few places, its horizon usually being covered. It is exposed at the water's edge at the water-mill at Hartford (where its thickness is eleven inches); on the Hartford and Morgantown road, by the former residence of Col. O. P. Johnston (now owned by Mr. Williams), and on the land of Mr. J. B. Bennett, on the Hartford and Livermore road. Little more is known concerning the coal. It is possible that it may prove to be a bed of some value when more fully studied.

Number 44—*The "Fusulina Chert."*—This bed, or rather the débris of it, is more frequently found than the blue shelly limestone, which occurs above it. It seems probable that, in some places, it is present and the limestone not; but this has not been proved.

The chert is easily recognized by the large number of *Fusulinæ* contained in it. The chert was seldom found in a compact bed, hence its general thickness was not determined; in a few places it measures six inches. Few fossils, other than the *Fusulinæ*, were found in it.

Number 46—*Coal.*—This coal seems to be fully as persistent as any of the beds below Coal D. It has never been

* A fuller account of this limestone, and its general relations, which are important, will be given in another report.

found fairly exposed, its place usually being indicated by a stain or a "dirt." At one place, however (at Mr. L. D. Taylor's), the bed has been opened sufficiently to expose a hard, good-looking coal thirty-one and a half inches thick. In some localities the bed seems to have a clay parting.

It has been found on the Hartford and Morgantown road, near Col. O. P. Johnston's former residence, where its outcrop measured eighteen inches; at Mr. L. D. Taylor's, as mentioned above; on Dr. Berry's land, on the Morgantown road, about three miles and a half from Hartford, and on the William Hines tract of land, now owned by Messrs. Walker and Berry, about four miles and a half or five miles about south 80° east from Hartford. The place of the coal is indicated by the presence of the Fusulina chert at a number of other points in the district, viz: on the old Nall tract of land, now owned by Hon. E. D. Walker, two and three quarters miles about north 70° east from Hartford, by the spring near the house; on land belonging to the heirs of Mr. Richard Stephens (deceased), on the Morgantown road, three miles from Hartford; on Mr. Spangler's old place, near Beaver Dam, towards Elm Lick; in Mrs. Barnett's lane, about one mile westwardly from Hartford, etc.

Number 49—*The Elm Lick Coal.*—This coal is one of the most important beds in the district. It is the one which has been wrought at the Martin bank, about one mile westwardly from Elm Lick; at Mr. Otto's and Mr. Chiles' banks, near Rosine; the one which is now wrought occasionally at the bank on Hon. E. D. Walker's land, known as the "Hines bank," and at banks belonging to Mr. Henry Thomson and Mr. George Neighbors, in the region south of Elm Lick. It may be the coal opened on Mrs. Charlotte Barnett's land, near the Hartford and Owensboro' road, about three miles from Hartford; this, however, is conjectural, as the bed wrought there was not exposed at any time when the place was visited, and the descriptions given concerning it vary.

The coal seems to be, very generally, what is known among miners as a "split vein." It is parted into two members by

a clay seam, varying in thickness from three inches to eighteen inches. It may not be the rule, but, so far as observed, the thickness of the clay parting increases from the north towards the south. At the "Hines bank" it measures four inches, at the Martin bank six to nine inches, at the Chiles bank seventeen and one fourth inches, and at the opening on Mr. Henry Thomson's land the clay is from twelve to eighteen inches thick.

Following are sections of the bed which illustrate its general features in regard to thickness:

Name of bank.	Hines bank.		Martin bank.		Chiles' bank.		Thomson's bank.	
Thickness.	Feet.	Inches	Feet.	Inches	Feet.	Inches	Feet.	Inches
Upper member	1	. . .	1	6	1	9	1	5
Clay	. . .	4	. . .	6	1	5¼	1	6
Lower member	2	6	3	2	?	. . .	3	5
Total thickness	3	10	5	2	?	. . .	6	4

The upper member is usually poor, frequently being quite pyritiferous. As an average, it contains about 2 per cent. of sulphur. The lower member is very fair coal, though rather soft, and contains, as an average, about 1.8 per cent. of sulphur.

This bed will probably prove to be one of the most profitable coal deposits in the district.

Number 53—*Coal.*—Very little is known concerning the character and general extent of this bed. It was identified only at Mr. Jesse B. Mosely's, two miles and three quarters southwardly from Elm Lick; at Mr. L. L. Taylor's(?), half a mile eastwardly from Mr. Mosely's, and at Mr. Black's spring(?), about one mile and a half about northwest from Elm Lick.

A coal was seen at Mr. James Stewart's spring, about one mile nearly due south from Thomson's bank, which may prove to be the equivalent of this bed. It has a clay parting, and measures as follows:

a. Coal	12	inches.
b. Clay	2½	"
c. Coal	6	"
Total thickness	20½	"

At the time the locality was examined, it was thought that this bed (at Stewart's) was probably the southern extension of the one seen at Mr. Thomson's. But for this to be true, there must be either a local dip of the bed to the south in that region, amounting to thirty feet in the mile (provided the measurements for vertical distance are correct*), or a fracture, extending eastwardly and westwardly, south of the Thomson bank—allowing the beds to drop a distance of thirty feet south of that line; neither of which conditions is clearly indicated.

As stated on a preceding page, that part of the general section included between No. 34 and No. 53 is to be considered as, in a certain degree, preliminary to the general summing up of the facts concerning the whole basin, and, for the present, it serves rather as a basis to work from than as a fully determined conclusion. Accordingly, the relations existing between certain of the beds are given as they are now understood, but with the provision that it may become necessary to revise some of the present conclusions.†

There are some beds of coal which may not be represented in the section, as the conditions surrounding them were such that, although, as at Mr. C. W. Stephens', one of the coals was easily identified with another well-known bed, the general relations of the ones associated with it were not sufficiently clear for an attempt to be made to identify them. A comparison of the section at Mr. Stephens' (see plate VII) with sections at other places, containing some equivalent beds (see plates VI and VII), will make the reason of this apparent.

* Which were made with an uncorrected aneroid barometer, and, in consequence, are not entirely free from possible error.

† It must be understood, however, that any revisions that may become necessary will relate more particularly to the vertical distances between some of the beds than to the identification of them. It is also to be borne in mind, that the total number of beds of coal will not be affected thereby.

Plates II to VII, inclusive, present the local sections upon which the general section was founded, and of which descriptions will be found in the special account of localities.

The following is a table of analyses, made by the chemists of the Survey, of the samples collected from several of the coal beds of the county:

	1	2	3	4	5	6	7	8	9	10
Moisture	5.54	3.94	4.80	4.80	3.50	3.34	3.50	3.30	4.80	5.10
Vol. combustible matters	35.66	37.86	33.70	35.60	36.30	35.84	35.00	36.76	35.80	30.70
Fixed carbon	48.88	50.48	68.76	49.66	50.92	54.36	52.50	52.60	45.20	54.24
Ash	9.92	7.72	9.24	9.94	9.28	6.50	9.00	7.34	14.20	9.96
Sulphur	4.199	3.128	3.364	3.180	3.524	3.826	3.390	2.604	3.015	2.164
Specific gravity	.....	.....	1.386	1.356	1.345	1.315	1.421	1.316	1.384	1.382

	11	12	13	14	15	16	17	18	19
Moisture	6.66	3.96	4.80	6.54	3.70	6.00	5.30	6.80	2.70
Volatile combustible matters	33.64	40.50	41.00	37.92	36.64	34.30	45.70	32.40	39.30
Fixed carbon	51.56	52.38	49.14	51.54	55.30	50.36	45.00	52.50	45.90
Ash	8.14	3.16	5.06	4.00	4.36	9.34	4.00	8.30	12.10
Sulphur	2.768	3.128	2.356	1.917	1.241	4.357	2.150	2.109	7.959
Specific gravity	1.357	1.282	1.295	1.305	1.321	1.387	1.273	1.340	1.413

Analysis No. 1 is of samples taken from Doering's mine, near Centretown; 2, from Morton's mine, in the same locality; 3, from L. M. Patterson's mine, at Mt. Pleasant; 4 (Coal D), from Brown's bank, in the Ben's Lick Hills, near Hartford; 5 (Coal D), from Williams' bank, near Hartford; 6, the Taylor mine; 7, the Rockport mine; 8, Stephens' mine, near Beaver Dam; 9 (Coal E), from the bank of Rough creek, at the mouth of Brush creek; 10, from M. Sandifur's bank; 11, from Wm. Warden's, half a mile northwest from Centretown; 12, Henry Thomson's bank (the Elm Lick coal); 13, Wm. Hines' bank, sample taken from below the parting in the coal (the Elm Lick coal); 14, same locality, from above the parting; 15, Martin's bank, from the lower member (the Elm Lick coal); 16, Berry and Walker's land, in ravine draining into the North Fork of Muddy creek, near the Hines bank; 17, "old opening" on Berry and Walker's place, near the Hines

bank; 18, from L. D. Taylor's bank; 19, from A. Woodward's coal.

IV.

LOCAL OBSERVATIONS.

In order to avoid repetition in the "County Report," which is to follow hereafter, it is deemed inexpedient to give, at present, more than an outline of the local examinations made in the county.

As stated on a preceding page, the beds are so disposed, by disturbances in the county, that there is a descent in the order of the series, from Beaver Dam towards Cromwell on the south, and towards Hartford on the north.

In the region about Hartford the beds have been moved by local disturbances (as mentioned on page —); but, as compared with the series in the more southerly part of the county, they have, nevertheless, a northwardly rise.

This arrangement of the beds naturally tends to throw the higher coals along the central part of the district, as is shown to be the case in the "Coal Ridge" and the hills in its vicinity. The higher coals are not, however, confined to such a position, but, where the topographical conditions are favorable, they are found (frequently as isolated masses) both to the north and to the south.

At the old Taylor mine, on the Green river, about one mile below Cromwell, and at Cromwell and in its vicinity, there are, collectively, six coals; the uppermost coal that is distinctly exposed being Coal D, which is the bed formerly worked at the old Taylor mine.* On the hill above the drift, at the Taylor mine, fragments of the limestone which occurs between Coals A and B are found, but no traces of the coal beds have yet been discovered.

The following is the general section of the beds at the mines, and at Cromwell and vicinity:

*This place is mentioned on page 158, volume I, first series Kentucky Geological Reports, D. D. Owen, Director.

No.	Description of Strata.	Feet.	Inches.
1	Massive Sandstone	65	
2	*Coal D* (varies in thickness)	4	
3	Space	10	
4	Thin-bedded Sandstone	10	
5	Space	32	
6	Black Bituminous Slate	5	
7	*Coal E*	out crop.	
8	Space	25	
9	Black Slate, exposed for	2	
10	*Coal E*[a]	out crop.	
11	Space	10	
12	Shale, containing iron-stone concretions	25	
13	Space, about	5	
14	*Coal F*	. . .	6
15	Space	2	
16	Mottled Limestone	1	
17	Space; notably shale, sandstone and shale	55	
18	*Coal G* . . . . . 1 foot to	. . .	9
19	Shale	35	
20	Black(?) Slate?	4	
21	*Coal;* below the level of the river	1	6
22	Under clay	4	
23	Shale	16	

The mottled limestone and associated beds are exposed frequently between Cromwell and Kate's Hill, on the Morgantown road, towards the railroad. They are also exposed in the region about the Bald Knob Church, on the Pinchico and Caney precinct road.

Near Bald Knob Church, in the road, by the dwelling of Mr. Robinson (on the farm of Rev. B. F. Jenkins), the following section is exposed:

No.	Description of Strata.	Feet.	Inches.
1	Covered space, red clay on the surface	5	
2	*Coal F*	. . .	9
3	Under clay	3	
4	Mottled Limestone; has a brecciated appearance on the surface	1	
5	Sandy Shale and Shaly Sandstone	28	
6	Mostly covered; notably Sandy Shale	8	
7	Soft disintegrating Sandstone	35	

By the Bald Knob Church the coal is again exposed, with an admirable fire-clay below it. The following is the analysis of the clay:

Silica	62.760
Alumina	26.420
Oxides of iron and manganese, and phosphoric acid	1.580
Lime	.325
Magnesia	trace.
Potash	.916
Soda	.268
Water expelled at red heat and loss	7.731
Total	100.000

On A. H. Davis' land, half a mile about south 70° east from the Bald Knob Church, a limestone higher than the mottled limestone occurs. It is probably a comparatively local bed. It is coarse, granulated in texture, and grey in color. A number of fossils were found in it, among which the following species were identified: *Productus muricatus*, *Athyris subtilita*, *Spirifer cameratus*, and *Crinoid* columns. A poor, argillaceous iron ore was seen resting, in places, above the limestone. It also is fossiliferous, and may accordingly be presumed to be nearly, if not quite, as extensive in area as the limestone. The ore, in fact, seems to be derived from the limestone. The mottled limestone is exposed below in the hill-side, about two hundred and fifty yards away from the upper bed. We accordingly have a very good level (in these two beds) from which to work when examining the structure of the contiguous region. The upper limestone does not, however, appear to be constant. It is, perhaps, probable that it is developed most fully in the region just now under consideration, and is not to be found, as a rule, outside of a restricted area. Of this, however, the evidence is limited.

On lands belonging to Mr. L. D. Taylor and Mr. F. M. Gillstrap, about one mile north 85° east from Bald Knob Church, a coal is found at a level below the mottled limestone; the cherty limestone containing *Prod. muricatus* is also exposed. The connection between the upper and lower part of the section is probably to be obtained more easily in this vicinity than elsewhere in the county.

The following is the section of the beds exposed here:

No.	Description of Strata.	Feet.	Inches.
1	Granular Grey Limestone, about.	2	
2	Space	35	
3	Mottled Limestone	2	
4	Space . . . . . 70 to	80	
5	Fossiliferous Limestone and Chert	1	
6	Argillaceous Shale	20	
7	*Coal*	2	7½

By correlating this section with the ones obtained at Kate's Hill and in the vicinity (near Beaver Dam), we obtain a very fair knowledge of the arrangement and number of the beds from the summit downwards, for about three hundred and twenty-five feet.

The coal, No. 7 of the section, seems to be the equivalent of one to be seen, when the water is low, in the bank of Rough creek, at the Hartford water-mill. Between the lower cherty limestone and the mottled limestone a massive, incoherent sandstone occurs, filling up the larger part of the space.

From the region about Bald Knob Church, towards Beaver Dam, the beds sink towards the northwest.

The mottled limestone is seen occasionally along the Hartford and Morgantown road, south of the railroad, plainly showing this feature. Beyond the railroad the beds soon begin to rise.

On Kate's Hill the mottled limestone makes its last appearance south of the railroad. The general section of the strata forming Kate's Hill, and the ridge in which the coal banks of Mr. Albert Brown, Mr. Poyner, Mr. Stephens, Mrs. Austin, and the Taylor coal mines are opened, shows the beds from Coal A downwards to the sandstone below Coal F. The connection between the beds is very plain.

On Mr. Brown's place Coal D is especially well developed, being five feet seven and three fourths inches thick. Its usual thickness is four feet eight inches. Coal E is found at forty-five feet below Coal D, and is to be traced on to Mr. Poyner's land, where a still lower coal is to be found, which has been mentioned hitherto.

Towards Elm Lick and Rosine, from Beaver Dam, the beds

ascend. The Elm Lick coal is brought to view, by the upward rise, at several places a short distance southwardly from Elm Lick, and also at Mr. Martin's coal bank, about one mile, or a little more, westwardly from the station, north of the railroad.

At Mr. Henry Thomson's coal opening, two miles south from Elm Lick, the coal is more than ordinarily thick. The following is a description of the bed at this place:

a. Bluish drab argillaceous Shale			4½ feet.
b. Coal, divided thus:			
b'. Coal	17 inches.		
b''. Clay, containing stigmaria rootlets	18 "		6⅓ "
b'''. Coal	41 "		

The coal dips north 20° west, but at what rate could not be determined.

The bed is also exposed on land belonging to Mr. Julius Edward Otto, about one mile and a half southwest from Rosine. The upper member here measures twenty-one inches in thickness. Mr. Otto has drifted into the coal on his place, and it has been wrought in a limited way.

A short distance from Mr. Otto's drift, passing towards Rosine, but on the opposite side of the ridge, Mr. Robert E. Chiles has made entries in the coal at two places. Both entries were nearly filled with débris at the time these examinations were made. The thickness of the lower member of the coal could not be determined. The upper member measures twenty to twenty-one inches, and the clay parting seventeen and one fourth inches in thickness. Before reaching Rosine the coal seems to overshoot most, if not all, of the hill-tops. It is possible that it may be found in the knob just northeast of Rosine, the top of which is one hundred and thirty feet above the railroad at the station; but this is entirely conjectural.

Descending from Rosine towards Elm Lick, the beds dip rapidly in that direction, and the coal, which is wrought at Martin's bank, about half a mile northwardly from the Elm Lick water-tank, is brought down to a level, comparatively, forty or sixty feet above the railroad at the water tank.*

*Of course this is not the height at which the coal would lie, were it present in the hill at the tank—the element of dip being yet to consider in the calculation.

At Martin's coal bank the bed measures as follows:

a'.	Coal	1 foot	6	inches.
a''.	Clay parting		6	"
a'''.	Coal	3 "	2	"
		5 "	2	"

The coal was measured where it had been freshly exposed, and may increase somewhat in thickness when followed under a better roof.

Journeying, in a somewhat northwestwardly direction, from Martin's bank towards Hartford, higher beds come to view. The fall of the beds is still rapidly towards the northwest. The Fusulina chert appears near the Morgantown road, about half a mile a little northeast of Dr. Berry's place, on the Morgantown road, and there it and the beds associated with it form the structure of the region on towards Hartford.

On Dr. W. J. Berry's land, about four miles from Hartford, the coal underlying the Fusulina chert crops out in a ravine draining towards the Morgantown road. The coal measures thus:

a'.	Coal dirt	7 inches.	19 inches.
a''.	Clay	6 "	
a'''.	Coal dirt	6 "	

The coal is underlaid by argillaceous shale, the upper part merging into an inferior sort of fire-clay immediately beneath the coal. Scattered fragments of the Fusulina chert are found on the hill-side above the coal.

The same coal is exposed in the road by Mr. Wm. Taylor's house, about two and a half miles from Hartford. But between Taylor's and Berry's there seems to be a considerable swell in the beds underlying the coal—a massive sandstone seeming to thicken, midway between the two places, at least twenty feet. This would be best explained by a cross-section from Dr. Berry's to Mr. Taylor's. Just beyond Mr. Taylor's a higher coal crops out, near the forks of the road, which is equivalent to the one opened on Mr. L. D. Taylor's land, and also exposed on Rough creek, at the Hartford water-mill.

The following is the section from the forks of the road to Mr. Taylor's:

No.	Description of Strata.	Feet.	Inches.
1	Earthy, porous, yellowish Limestone, abounding in *Productus muricatus*	1	
2	*Coal* (No. 41 of general section)	1	
3	Space, about	8	
4	Fusulina chert, about		6
5	Space	10 to 15	
6	*Coal*		18

Proceeding northeastwardly from this place towards the Hines coal bank, the beds are seen to rise in that direction, as they mount the southwardly slope caused by the Rough creek uplift.

From Taylor's to the outcrop of Fusulina chert, on land belonging to the heirs of Richard Stephens, near the Morgantown road, about three miles from Hartford, the rise amounts to fifty feet; thence to the large spring on Hon. E. D. Walker's land (known as the "Nall's tract"), about two miles and three quarters north 70° east from Hartford, where the Fusulina chert is again exposed, the rise amounts to forty feet; and thence, to Hines' coal bank, the rise is fifty feet. Proceeding northwardly from Hines' bank, the coal wrought there, which is the equivalent of the Elm Lick bed, soon overshoots the tops of the lower hills.

At the Hines bank, which is about four miles south 80° east from Hartford, the Elm Lick coal has been wrought considerably. Two other openings in coal have also been made in the vicinity, but no mining done.

The following is the section of the beds in this vicinity:

No.	Description of Strata.	Feet.	Inches.
1	Fusulina chert	outcrop.	
2	Space, not fully determined on account of dip in the beds. May be from 20 to	40	
3	*Coal*		26
4	Space, about	45	
5	*Coal*—the "working" bed—divided thus:		
	a. Coal 1 foot.		
	b. Clay 4 to 5 inches.	3	11
	c. Coal 2 feet 6 "		
6	Sandstone, base not seen.		

This place is about two miles and three quarters, in a northwestwardly course, from the Martin coal bank, near Elm Lick.

Towards Hartford the beds sink and the Elm Lick coal disappears beneath the surface.

Two distinct coals make their appearance at Hartford, one at the water-mill and one in the left bank of Rough creek, just below the bridge over the stream, on the Owensboro' road. Apparently the coals lie near to each other in the series, but a computation of the dip shows the contrary to be true. From the Foreman grave-yard, where the limestone which overlies the lower coal is exposed, to the coal at the bridge, the dip is rapid. The condition of the beds can be well shown only by a cross-section, which may be given hereafter.

The following section exhibits the order of the beds about Hartford:

No.	Description of Strata.	Feet.	Inches.
1	Soft disintegrating Sandstone, top not seen	5	
2	Ochreous drab Shale	15	
3	Dark blue Shale	2	
4	Black bituminous Slate, containing fish scales	1	6
5	Coal	1	2
6	Under clay merging into shale below	6	
7	Grey shaly Sandstone and Shale	21	
8	Space, about	57	
9	Limestone (seen at the water-mill and at the Foreman grave-yard)*	6	
10	Shale, &c.	10	
11	Coal	...	11
12	Under clay; very impure, base not seen	1	
13	Space†	8	
14	Fusulina chert	...	6
15	Space	10 to 15	
16	Coal	1	6

* Described in a following section.

† From No. 13 to No. 16 relates to the section by the Johnston house, at the forks of the Hartford and Beaver Dam and Morgantown road.

The limestone, No. 9 of the section, is well seen at the Foreman grave-yard, but the best exposure of it is in the bank of Rough creek, by the water-mill, just above Hartford. The following are the details of the section there:

No.	Description of Strata.	Feet.	Inches.
1	Drab argillo-arenaceous Shale; underlies a disintegrating Sandstone (top not seen)	5	
2	Bluish, earthy, shelly Limestone. In places somewhat concretionary in structure. Has an irregular fracture, and may be split into thin plates. Abounds in fossils, viz: *Spirifer cameratus*, *Chonetes mesoloba*, *Productus muricatus*, *Athyris (subtilita?)*, *Productus Prattenianus*, *Prod. Nebrascensis?* an *Aviculopecten*, etc.	6	
3	Dark calcareous Shale; becomes quite calcareous at the base, and there merges into a coarse earthy lime rock. Contains fossils	8	
4	Tough, coarse-grained, dark lime rock	. . .	4
5	Very dark argillo-calcareous material, closely filled with *Productus muricatus*, and containing numbers of *Chonetes*	2	
6	Black carbonaceous Shale, with "streaks" of coal traversing it	. . .	1½
7	Coal	. . .	11

At the Foreman grave-yard the limestone, No. 2 of the foregoing section, is seen, exhibiting its usual appearance in this district when removed from such constant action of moisture as that operating on it at the water-mill. It seems to be somewhat pyritiferous, and, in some places, is dark blue and hard, frequently with a soft crust. Usually, however, there seem to be two beds—the upper one being a bluish, earthy, shaly limestone, with occasional hard and more compact parts; the lower bed being a pyritiferous blue limestone in the interior, but with a very thick, soft, greenish and yellowish crust—the crust being filled with fossils. The two beds seem to merge into each other. The principal fossils of the shelly bed are, *Spirifer cameratus* (which are usually large) and *Productus Prattenianus*. The lower bed is filled with *Productus muricatus*. On the slope above the limestone ochreous concretions, containing unusually large specimens of *Productus muricatus*, were found.

The following is the section here:

No.	Description of Strata.	Feet.	Inches.
1	Covered space from hill-top	28	
2	Sandstone	3	
3	Covered space	7	
4	Sandstone	2	
5	Covered space	30	
6	Coarse bluish Limestone, breaking with a hackly fracture	1	
7	Covered space	1	
8	Coarse, earthy, greenish Limestone, containing many fragments of fossils, many of which seem to be remains of Crinoids; many fragments of *Spirifer cameratus* were also seen	1	6
9	Shelly blue Limestone, containing *Spirifer cameratus* and *Producti*.	8	

The coal at the Hartford bridge has, by others, been referred to Coal D (No. 9 according to Dr. Owen's nomenclature); the sections that have been given are sufficient to show the error of this without going further into detail. It may be remarked, however, that Coal D is found in the Ben's Lick Hills, about two and a half miles below Hartford. and is shown by its topographical relations alone to be much higher than the Hartford coal; besides this, the Hartford coal sinks at a considerable rate in that direction.

It is possible, however, indeed it is probable, that one or more of the beds which are known to occur below Coal D, in the more southwardly part of the county, are absent in the region nearer Hartford, and towards the northwest. But it is also possible, that at least one bed which occurs in this region is not to be found far towards the south.

In the "Sugar Loaf" Hill, near Barrett's Ford across Muddy creek, about one mile southwardly from Hartford, two coals are exposed, the upper one being Coal E. A coal has also been opened in the bed of the creek at the ford. It is reported to be nearly three feet thick; but I was unable to verify this by personal observation.

The following is the section at the Sugar Loaf Hill:

No.	Description of Strata.	Feet.	Inches.
1	Slope	38	
2	Drab argillaceous Shale	5	
3	Black Slate	2	
4	Bluish-drab Clay		1
5	Coal E	1	5
6	Fire-clay (mostly)	5	
7	Greenish-drab argillaceous Shale	10	
8	Covered space	10	
9	Coal smut		10
10	Fire?-clay		6
11	Covered	45	
12	Sandy and argillaceous Shale	10	
13	Coal, reported. Is said to be covered with black slate. Thickness stated at	2	8

Westwardly from the conical hill Coal D is worked, at several places, in the Ben's Lick Hills. Coals E and E[a] are also found there, the beds showing a sinking towards the northwest.

The following is the section at Brown's coal bank, where Coal D is worked:

No.	Description of Strata.	Feet.	Inches.
1	Slope from hill-top	10	
2	Sandstone	10	
3	Coal dirt.		
4	Limestone	3	
5	Covered space	51	
6	Argillaceous Shale	5	
7	Bituminous Slate	1	3
8	Coal D	4	
9	Covered space	89	
10	Coal covered by bituminous Slate. Coal measures	1	3
11	Covered space to Rough creek	4	

Down the creek, near the mouth of Brush creek, Coal E is exposed, nearly level with the bed of the creek, and higher up Coal D crops out, with the limestone (No. 4 of the foregoing section) exposed high up in the hill. The following is the section obtained in the locality:

No.	Description of Strata.	Feet.	Inches.
1	Covered slope from hill-top	40	
2	Limestone outcrop	1	
3	Covered space	49	
4	Sandy Shale in thick laminæ	2	
5	Blue argillaceous Shale	5	
6	Black Slate	1	
7	Coal D, partially concealed, probably	4	
8	Under clay, with limestone masses, sometimes as a bed, through it. About	5	
9	Thin-bedded shaly Sandstone, or Sandstone in thin laminæ	10	
10	Thinly-bedded sandy Shale	38	
11	Black, slabby, bituminous Slate	7	6
12	Bluish Clay Shale, with one half an inch of coal just above the bottom	...	7½
13	Coal, divided thus:		
	a. Coal . . . 7 inches.		
	b. Clay . . . 1 "	...	9¼
	c. Coal . . . 1¼ "		
14	Fire-clay, containing stigmaria rootlets	1	
15	Slope to Rough creek	4	

It must be said of this section, that it was measured, except where a foot rule could be applied, entirely with an aneroid barometer; accordingly, some of the distances between beds may not be given with absolute accuracy.

Coal D is also worked at Mr. Elijah Miller's coal bank, and is known to occur at other places in the locality.

On the northwardly side of Rough creek, at Mr. J. B. Bennett's place, on the Hartford and Livermore road, about three miles from Hartford, the coal bed, which underlies the Hartford limestone (seen at the water-mill there), crops out. The coal is thin; it is said to measure, when under a good roof, eighteen inches in thickness. A limestone, under which a coal dirt occurs, is found above the Hartford limestone at this place. It seems probable that it is local in its development. The following is the section here:

No.	Description of Strata.	Feet.	Inches.
1	Dark bluish-grey to dove-colored, rather compact Limestone; contains *Spirifer cameratus*, *Chonetes*, and small fragments of Crinoid columns . . . . . 1 foot to	1	3
2	Space . . . . . 0 to	. . .	6
3	Coal dirt . . . . . 2 to	. . .	6
4	Chiefly argillaceous and sandy Shale	12	
5	Sandstone	5	
6	Space	3	
7	Blue shelly Limestone—the Hartford Limestone.	6	
8	Space	15	
9	Coal, reported to measure	. . .	15

Proceeding in a northeastwardly direction from Mr. Bennett's, the Hartford limestone is found at several localities towards Mr. Charles D. Stephens', on Rough creek, above Hartford. Several coals are found in the bluff facing the creek, at Mr. Stephens', and from their arrangement there seems to be here a distinct change in the character of the section from its appearance farther towards the south.

The following section exhibits the order of the beds here:

No.	Description of Strata.	Feet.	Inches.
1	Sandstone—massive	25	
2	Coal.	1	10
3	Massive Sandstone	40	
4	Space	5	
5	Coal.	2	2
6	Chiefly shaly Sandstone.	35	
7	Limestone; is probably not precisely in place, partially concealed.	2	
8	Coal, reported to be	2	
9	Space	5	
10	Chiefly Shale.	42	
11	Sandstone outcrop	3	
12	Covered space to the creek.	45	

Unusually thick coal is found in the region about Centertown and at Point Pleasant. So far, however, the identity of the bed has not been determined with certainty. It is believed best, therefore, to leave that question open for future solution.

At L. C. Morton's coal bank, about seven miles nearly due west from Hartford, the coal is reported to vary from eight to nine feet in thickness. It is divided by a clay seam varying

from one half inch to one inch in thickness. The lower member varies in thickness from four feet four inches to four feet seven inches. The coal is of very good quality, as shown by the analysis given on a preceding page.

The same bed has been opened on land adjoining the Morton tract to the west, at Dooring's mine. Here the coal is more than eight feet thick, as shown by the following measurements made inside the bank:

a. Coal.	3	feet	9	inches.	}	8 feet 4½ inches.
b. Clay.	½ inch to		2	"		
c. Coal.	4	"	5½	"		

Samples were also collected from this bank. At the time when these places were examined, the conditions were very unfavorable for obtaining accurate data upon which to base conclusions, and on this account it is deemed best to await further developments before endeavoring to identify the coal here with other known beds.

Below the coal there is a bed of iron ore of variable richness. It seems to underlie the coal on the Dooring tract and on the Morton tract, but its character is indefinite. At the Dooring mine eight feet of the ore was exposed, from which chippings for analysis were taken. According to Mr. W. C. Morton, the base of the bed was four feet lower than the bottom of the exposed portion. The analysis of the ore is given beyond.

What *seems* to be the westward extension of the Morton coal is wrought at Point Pleasant. The bed could not be well examined at the time the region was visited, as the bank was not in operation. But, from examinations made at the mouth of Mr. Patterson's drift, the bed seems to be eight and a half feet thick in places, taking into account two feet of poor coal towards the middle. The following section exhibits the arrangement of the beds at Point Pleasant:

No.	Description of Strata.	Feet.	Inches.
1	Sandstone	15	
2	Clay . . . 2 to		4
3	Coal divided thus:		
	a. 4 feet good Coal	8	6
	b. 2 " poor "		
	c. 2½ " good "		
4	Covered space, chiefly Clay?	6	
5	Limestone; mottled drab and ash, and drab and ferruginous-red. In some parts contains *Martinia plano convexus* . . . 18 inches to	2	
6	Clay Shale	5	
7	Massive Sandstone extending to the Green river	50	

The coal at Point Pleasant rises apparently between 5° and 10° north 40° east. The samples collected here for analysis were taken from the bed twenty yards in from the mouth of the entry, at Patterson's drift.

A number of coal openings, which were visited in the county, have not been described, as a discussion of them belongs properly in a detailed "County Report," which it is the intention to prepare hereafter.

Following are analyses of the most promising ores of iron found in the district covered by this report:

SAMPLES FROM DOORING'S ORE BANK.

	No. 1.	No. 2.
Iron peroxide	44.594	44.916
Alumina	20.419	13.204
Lime carbonate	trace.	trace.
Magnesia	.248	.176
Phosphoric acid	.287	.280
Silicious residue	26.550	32.504
Water	8.860	8.920
Total	100.958	100.000
Metallic iron	31.216	31.241
Silica	23.420	24.46
Phosphorus	.125	.177

ASHBY'S ORE.

Iron peroxide	61.179	Metallic iron	42.825
Alumina	15.503		
Lime carbonate	trace.		
Magnesia	.176		
Phosphoric acid	.648	Phosphorus	.283
Silicious residue	13.830	Silica	9.96
Water	9.273		
Total	100.609		

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