GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

REPORT ON THE

GEOLOGY OF THE REGION

ADJACENT TO THE

LOUISVILLE, PADUCAH & SOUTHWESTERN RAILROAD,

WITH A SECTION,

BY CHAS. J. NORWOOD.

PART VI. VOL. I. SECOND SERIES.

This page in the original text is blank.

INTRODUCTORY LETTER.

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

DEAR SIR: I present herewith a report on the region adjacent the line of the Louisville, Paducah and Southwestern Railroad, accompanied by a horizontal section, exhibiting the geological structure of the country examined, under instructions received from you.

Thanks are due to many for kind attention given and interest exhibited in promoting the work of the Survey.

Thanks are especially due to Mr. D. Brock, the former General Superintendent, and to Mr. D. F. Whitcomb, the present General Superintendent of the road, for favors received.

Respectfully,

CHAS. J. NORWOOD.

LEXINGTON, KENTUCKY, May 5th, 1875.

INTRODUCTORY.

The work of constructing a horizontal section of the rocks, in the region traversed by the line of the Louisville, Paducah, and Southwestern Railroad (the Elizabethtown and Paducah, as it was then called), was commenced in January, 1874, and continued till the first of April of the same year. At that time circumstances required that the work be suspended for a time. In September, 1874, the work was resumed and carried to completion.

Mr. Carl Schenk was detailed as Topographer, but circumstances were such that little could be done in that direction.

It has been the aim not only to obtain a section of the rocks along the road, but also to acquire an insight into the general mineral wealth of the region adjacent.

The very nature of the work in hand, however, precludes detailed discussion, to any large extent, of *particular* districts.

The distance to be traversed could not possibly have been gone over in the allotted time, had detailed examinations been extended any considerable distance on either side of the road. Every effort having been made to make the report so, it is hoped, that it may be found of present economic value, as well as an assistant in future investigations.

In regard to the horizontal section accompanying the report, it is proper to state that in a number of localities the hills are quite distant from the railroad, and frequently without exposures. In some instances, also, the rocks dip towards the road. In such cases, although the rocks were referred to the road, which was used as a datum, they are not represented exactly in their true position towards it The dip is always so irregular that no reliable calculation could be made to correct that evil. When it is known, however, that where no exposures

are to be found immediately on the road, the section refers to those on the nearest hills, the matter will be understood.

That everything might be as correct as possible, the hills on the north were used, whenever within convenient reach. Sometimes, however, when the hills on the north were not available, those on the south were used.

In some instances the road passes along the trough of a fault for a few miles. In such instances it is not unlikely for slight mistakes to be made, in *referring* the rocks to the road, for very evident reasons. It is believed, however, that, as a whole, the section is a fairly accurate representation of the geological structure of the region across which it is taken; and where a mistake may have been made it is easily rectified.

No pretense to accuracy is made in the delineation of the topographical features of the country traversed: the hills are merely sketched in; they may be too low in some instances, or too high, and again they may be too regular in outline.

Particular attention was given to the question regarding the number of coals in the region traversed by the road, and their persistency. It was desired that this report be a scaffolding upon which to build some general system, for the entire western coal field of Kentucky. Every effort was made to obtain the material for that purpose.

As large a number of coal analyses as might properly be expected are not presented, because of two reasons: the first is, that some of the samples were miscarried, and the other, that it is intended, at a future time, to give a general review of the Kentucky coal, in its character as a fuel for manufacturing and other purposes; when it is proposed to give a complete list of analyses of the coal at many points.

CHAPTER I.

GENERAL GEOLOGY.

The geological formations exposed along the road from Elizabethtown to Tennessee river, include the LOWER CARBONIFEROUS and COAL MEASURES.

The lower carboniferous rocks are exposed, both at the eastern and western extremities of the road, while the coal measures occupy a basin between.

At the eastern extension of the road there is a gradual descent of the rocks towards the west, with but few undulations. As the coal measures are approached, however, flexures are frequent and faults occasionally occur. In the coal measures the rocks are frequently faulted, but most of the irregularities in the strata may be referred to waves.

Dip and Strike.—The dip of the rocks is quite variable. With the few observations at hand it is a difficult matter to arrive at any correct estimate for the general dip, as there are so many local modifications.

Towards the east, from Green river to Elizabethtown, the dip may be considered as being *about* west, the strike being alternately east of north and west of north, occasionally due north.

Beyond Green river the dip is eastward, with a greater number of local changes than on the east. Towards the western limits of the coal field the rocks are frequently so faulted as to cause them to dip northwardly or southwardly, as the case may be, at various degrees.

This is illustrated between St. Charles and Tradewater river. Between those points the road runs along the trough of a fault. On the north side of the road, rocks occupying a high position in the series, are seen dipping rapidly in a southerly course, while on the opposite hills lower ones are exposed, dipping in a northerly direction, creating the false impression that the rocks on each side are equivalents.

The following is a tabulated list of the local dip and strike of the rocks at a number of points along the road:

Locality.*	Dip.	Course.	Strike.
2d cut west of East View	. . .	W.	N.
3d cut west of Stephensburgh	2°	S. 54° W.	N. 36° W.
3d cut west of Stephensburgh	2°	N. 40° E.	N. 50° W.
At East View	1°	N. 69° W.	N. 21° E.
Big Clifty bridge	2°	N. 87° W.	N. 3° E.
1st cut west of the 62d mile-post	2°	S. 20° W.	N. 70° W.
2d cut west of the 65th mile-post	3°	N. 55° E.	N. 35° W.
1st cut east of the 68th mile-post	. . .	N. 65° E.	N. 25° W.
1st cut west of Litchfield	2°	N. 42° E.	N. 48° W.
4th cut west of the 71st mile-post	. . .	E.	N.
1st cut east of the 72d mile-post	4°	W.	N.
At the 76th mile-post	5°	S. 80° W.	N. 10° E.
1st large cut west of Millwood	9°	E.	N.
At the 39th mile-post	20°	N. 50° W.	N. 40° E.
1st cut east of the 80th mile-post	15°	S. 75° E.	N. 15° E.
Ridge south of the 80th mile-post	2°	S. 23° E.	N. 67° E.
Renfrow's, at Spring Lick	8°	S. 30° E.	N. 60° E.
Wm. Miller's coal bank, Horse Branch	9°	S. 60° W.	N. 30° W.
Hill north of 1st bridge east of the 91st mile-post	. .	N. 70° E.	N. 20° W.
Hill north of the 92d mile-post	. . .	N. 48° E.	N. 42° W.
Near foregoing place	4°	N. 54° W.	N. 36° E.
Horse Branch tunnel	. . .	N. 25° E.	N. 65° W.
4th cut east of Horse Branch tunnel	. . .	N. 80° W.	N. 10° E.
3d cut east of the 97th mile-post	2°	E.	N.
South of the 1st large fill west of the 96th mile-post	4°	N. 75° E.	N. 15° W.
South of the 1st large fill west of the 96th mile-post	9°	S. 19° W.	N. 71° W.
1100 feet south of the 1st cut east of the 97th mile-post	. . .	S. 81° W.	N. 90° W.
Opposite the 2d cut east of the 97th mile-post	. . .	N. 75° W.	N. 15° E.
3d cut east of the 100th mile-post	2°	N. 82° E.	N. 8° W.
1st cut west of Elm Lick	. . .	S. 30° E.	N. 60° E.
1st cut east of the 104th mile-post	2°	S. 35° W.	N. 55° W.
North of Rockport	10°	S. 35° W.	N. 55° W.
North of Rockport	10°	N. 35° E.	N. 55° W.
Paine's coal mine, near Green River Station	. . .	N. 60° E.	N. 30° W.
Collier & Woodcock's mines, near Green River Station	. . .	N. 5° E.	N. 85° W.
Richmond coal mines	. . .	W.	N.
1st cut west of the 121st mile-post	3°	S. 45° W.	N. 45° W.
Mercer's mines	2°	S. 45° W.	N. 45° E.
Cut at the crossing of the Owensboro and Russellville Railroad, Owensboro Junction	. . .	N. 40° W.	N. 50° E.
Ross mine, Owensboro Junction	2°	N. 45° W.	N. 45° E.
1st cut west of the 135th mile-post	. . .	N. 75° E.	N. 15° W.
In the Russellville road, near Greenville	6°	N. 30° W.	N. 60° E.
½ mile southwest of the depot at Greenville	1°	N. 20° W.	N. 70° E.
Fübel & Krauth's coal, on Pond river	1°	N. 30° E.	N. 60° W.
Gibson's, at Woodruff	2°	N. 55° E.	N. 35° W.
Jos. Ray's, near Woodruff	2°	S. 55° W.	N. 35° E.
350 yards east of 152d mile-post, on a ridge south of the railroad	13°	N. 50° E.	N. 40° W.
Ashmore's land, 2½ miles south 60° west of Woodruff	3°	S. 34° E.	N. 56° E.
Coal Ford, on Tradewater	2°	N. 20° W.	N. 70° E.

* Where no angle of dip is given the angle is less than a degree and not calculated.

It should be noticed in the table that in twenty-five cases the strike is about north 42° west; in twenty instances, north 42° east, and in six due north.

I am inclined to believe that, when the subject is more fully studied, and some system arrived at, the strike will be found to be nearly north and south, perhaps bearing a little to the east.

It seems to be the fact that the coal measures, in their western extension, terminate in a heavy fault.

Before reaching Tradewater, which is near the western limit of the coal formation, faults are numerous, some of them quite perplexing and on a large scale for that region.

Indeed months of incessant labor might be devoted to the study of the disturbances in the region lying along the borders of Christian, Hopkins, and Union counties, to unravel them and reduce the whole to a system. There seem to be faults and cross-faults, as well as waves in the strata. Beyond the limits of the coal measures, however, the rocks are comparatively horizontal, and end at the Tennessee river in an abrupt vertical escarpment.

LOWER CARBONIFEROUS.

Two divisions of the lower carboniferous rocks may be distinguished in the series along the road; these are the Chester and St. Louis Groups. The base of the formation was seen at no point along the road,* so that its precise thickness cannot be given at present.

THE ST. LOUIS GROUP.

This group includes the lowest rocks seen at either end of the road. The beds vary in their description somewhat, but still have certain characteristic features which serve to identify them from the rocks of the overlying Chester Group.

The group may be divided into two divisions, according to the lithological characters of the strata.

Towards the top of the group beds of beautifully oölitic limestone occur, alternating with beds that are drab to cream-colored, fine-grained, and compact, resembling lithographic

* The line running from Elizabethtown to Paducah is the one under consideration. No examinations were made along the Louisville Extension.

limestone in texture. Unfortunately, however, they are usually marred for lithographic purposes by thin seams and small specks of calcite, quartz grains, or pyrites. In some instances beds are found which may answer for work not requiring great nicety.*

Below the "lithographic beds" (so-called for convenience), beds of coarse grey, often semi-oölitic limestone, occur. These are quite variable in texture and color, passing from a dirty grey, coarse-grained rock, frequently quite argillaceous, to a blue or white, close-textured and fine-grained limestone. This forms the base of the upper division. Chert beds are of frequent occurrence in this part of the upper division, frequently abounding in organic remains.

Below the above described division and extending to the base of the group, so far as known at present, are beds of dark-blue, frequently fetid limestone, with numerous small drusy cavities studded with quartz or calcite crystals.

Patches of calcite are also distributed through the mass, and fluor-spar is of no unfrequent occurrence.

Chert is also abundant in the lower part of the group, occurring either in irregular bands or concretions.

This division is so well marked by the deep blue color and its geodiferous character, that it is easily identified wherever seen. The St. Louis Group is mentioned in the former Geological Reports on Kentucky as the "barren" or the "cavernous limestone," no attempt being made to identify it with the grouped rocks of the other States.

It is possible that the name, "cavernous limestone," as applied by Dr. Owen, may also include a series of limestones below the ones in question. It is a fact to be remarked that in its entire extent in western Kentucky, this group retains its cavernous character, and may even be identified, in great measure, by the topography.† In a region underlaid by rocks of the St. Louis Group, "sink-holes" and semicircular valleys,

*The lithographical limestone quarries at Glasgow Junction, Barren county, are probably in the upper division of this group.

†This cavernous character is also one of the features of the group as represented in Missouri.

caused by the roofs of caverns giving way, are marked features in the topography.

At the eastern extension of the railroad in Hardin and Grayson counties, between Cecilia Junction and East View, inclusive, the group, so far as exposed, is made up of a mass of coarse-grey limestones, very fine-grained dove-colored limestones, oölitic and arenaceous limestones, and shales.

A blue limestone is exposed at Elizabethtown, which is probably a member of the group, occupying a place towards the lower part.

The following is a descriptive section of the rocks from Cecilia Junction to East View, and includes all of the rocks so far as exposed between those points:

No.		Thickness.
A.	"Big Clifty" sandstone, at the base of the Chester Group.	
1.	Limestone; heavy-bedded, lumpy, color dark-grey, coarse-grained. Abounds in *Productis mesialis* and *Athyris subquadrata*, with great numbers of *Spiriferæ* in the upper part	7 feet.
2.	Limestone, abounding in *Bellerophons*	1 "
3.	Fine-grained, dove-colored limestone, abounding in *Hemipronites Keokuk*	3 "
4.	Limestone; grey to dove in color	10 "
5.	Oölitic limestone, with great numbers of gasteropods	18 "
6.	Arenaceous and calcareous shale	10 "
7.	Thin-bedded sandstone	17 "
8.	Limestone; grey and drab, containing *Pentremites*	8 "
9.	Heavy-bedded, grey limestone	25 "
10.	Compact, dove-colored limestone	7 "
11.	Grey, compact limestone, containing *Productus elegans*	12 "
12.	Arenaceous cellular limestone	3 "
13.	Calcareous sandstone	6 "
14.	Arenaceous limestone	8 "
15.	Limestone, abounding in *Pentremites*	8 "
16.	Limestone, abounding in *Rhynconella*	2 "
17.	Oölitic limestone	3 "
18.	Silicious limestone; "Fire Rock"	6 "
19.	"Lithographic limestone"	4 "
20.	Oölitic limestone	5 "
21.	"Lithographic limestone"	4 "
22.	Oölitic limestone	5 "
23.	Fawn-colored, calcareous sandstone, or arenaceous oölitic limestone	7 "
24.	Compact, oölitic limestone	3 "
25.	Fawn-colored, calcareous sandstone, and oölitic limestones	16 "
26.	Blue, somewhat fetid, cherty, geodiferous limestone	20 "

No. 26 is the lowest rock at Long Grove, on the railroad, and at "White Mills," on Nolin river, south of East View.

It corresponds to the blue limestones in Caldwell and Lyon counties; it is at about the top of that division. On the Louisville extension of the road, the geodiferous limestone, containing *Lithostrotion proliferum* and *Syringopora ramulosa* (?) is

exposed. It occupies a position below No. 26; unfortunately no opportunity presented itself for connecting the beds.

The origin of the oölitic limestones is clearly demonstrated in the foregoing section. The passage from coarse sandstone, made up of rounded grains of sand cemented by a calcareous paste, into a coarse and then fine oölite, is beautifully exhibited.*

In the western extension of this group, beyond Tradewater, oölitic limestones are not so frequent, and the individual beds are not so easily identified by their organic remains. There seems to be a blending of forms in the various beds. The two grand divisions, previously mentioned, are easily distinguished, however.

The drab-colored limestones predominate towards the top, there, and beautiful oölitic limestone occupies the place of the poorer sandy beds of the eastern margin, as is to be seen at Princeton and vicinity. Chert beds are also more frequent.

Plate 2 represents a general section of the group.†

Paleontology.—As much information as is desirable, concerning the paleontology of the St. Louis Group as it exists in southwest Kentucky, cannot be given for want of the proper means and adequate time for studying the organic remains. It is hoped, however, that at some future time the matter will receive more extended attention, as there certainly are interesting questions to be decided, and a clear exposition of the subject to be given. Save in the upper members of the group, fossils are rather scarce, at the eastern margin of the formation. This, however, is not so remarkable, as there is such a preponderance of arenaceous beds in the lower part. In its western extension organic remains are more numerous.

The fossils identified so far are:

Productus cora, Prod. mesialis, Prod. Altonensis? Prod. muricatus, Prod. elegans, Hemipronites Keokuk, Athyris subquadrata, Athyris Royssii, Spirifer Forbesi, Spr. lineatus, Spr. tenuicosta-

*They do not seem to have been formed by infiltration of silica, causing a replacement, in the manner that some oölitic limestones are accounted for.

†The thickness of No. 26 is given as it is seen beyond Princeton. It does not represent the *total* thickness, however, as that was not determined.

tus, Spr. Keokuk, Terebratula trinuclea, Rhynconella subcuneata, Rhynconella mutata, Orthis dubia, Orthis Michellini? Pleurotomaria, Loxonema, Polyphemopsis, Nautilus —? Myalina —? Macrocheilus —? Pentremites Koninckiana, Pentremites pyriformis, Pentremites Godonii, Pentremites Norwoodii? Agassizocrinus —? Dichocrinus —? Lithostrotion proliferum, Lithostrotion canadense, Zaphrentis spinuliferum, Syringopora ramulosa? and Archimedes.

Cyathophylloid corals are quite abundant in some of the geodiferous beds.

THE CHESTER GROUP.

Above the St. Louis Group, and below the coal measures, a series of limestones, sandstones, and shales are included.

These constitute beds of passage, as it were, from the massive limestones of the lower carboniferous to the coal measures; marking an era of rapid deposition and changeful currents existing during the period preceding the epoch of the coal measures. As will be noticed hereafter, they mark the first appearance of the coal-making plants in this part of the western carboniferous area.

The organic remains and general features of the series at once identify the group with that collection of limestones, shales, and sandstones, constituting the upper division of the lower carboniferous rocks in Illinois, and denominated the "*Chester Group*" in the geological reports on that State.

It corresponds *in part* to the "millstone grit series" of Lyon, a group, however, which included members of the coal measures as well as the underlying rocks extending to the St. Louis Group.

The members of this group are met with at intervals from East View, Hardin county, to Litchfield, Grayson county, and beyond; and also at points between Scottsburg, Caldwell county, and Tradewater river.

The group is in the best condition for study on the eastern margin of the lower carboniferous area, as its divisions are

more distinctly defined. On the western margin it is not so well exposed.

The group is mostly made up of a suite of limestones and sandstones alternating with beds of marly shales. The limestones are usually thin-bedded, frequently mere plates of limestone in shale.

A general statement of the arrangement of the series, as they occur in Hardin and Grayson counties, is the following:*

No.		Thickness.
1.	Shale, with thin beds of limestone	15 feet.
2.	Heavy-bedded, cherty limestone	13 "
3.	Red and green shale	5 "
4.	Rhomboidally jointed sandstone	0 to 10 "
5.	Limestone	2 "
6.	Shale	10 "
7.	Limestone and shale; the upper ten feet usually heavy-bedded limestone, the lower ten feet thin-bedded limestone and shale; great numbers of organic remains	20 "
8.	Green, purple, red, and blue marly shales, "Litchfield marls"	25 to 60 "
9.	Shale and thin-bedded limestone	5 "
10.	Shaly sandstone	0 to 20 "
11.	Heavy-bedded, dark-grey, and blue limestone	15 to 45 "
12.	Heavy-bedded sandstone, the "Big Clifty sandstone"	60 to 130 "

The different strata making up the group are exceedingly variable in their lithological features and horizontal extent, and, consequently, furnish very unreliable data upon which to base observations. Indeed it is a question whether any one member of the entire series (unless it be the Big Clifty sandstone) can be traced continuously for a distance of five miles, unchanged in its thickness or its physical features.

At one locality a limestone may be compact, thick-bedded, possibly adapted for building purposes; at another it will be represented by a bed of marly shale with thin limestone layers. At other places the shales will attain great thickness, reaching as much as fifty feet or more, with but a few thin beds of limestone; these will be found at another locality greatly diminished in thickness; again they are entirely absent, limestone occupying their place. There is a continual wedging out and thickening of the strata throughout the entire series.

These local modifications, both in the thickness and lithological features of the rocks, are interesting as well as curious, affording a subject worthy of careful study.

* For reasons hereafter made evident, the section is not applicable to all localities, even in the counties named, and may be accepted merely as a *typical* one.

The limestone No. 2 varies in thickness from five to thirteen feet, and is the one usually found at from five to ten feet below coal K, in Grayson county. When in thin beds organic remains are rare, but when fully developed the upper part is charged with small *Bellerophons*. The sandstone No. 4 is very seldom present (it was found only in Grayson county), though fragments of it are frequently found strewn over the hills in the vicinity of Grayson Springs Station. It is peculiar in its character, being somewhat calcareous, thin-bedded, and breaking in rectangular blocks; it also contains *Brachiopoda*. It is easily recognized, as it always presents the appearance of a flag pavement, and, possessing the features above mentioned, differing essentially from the other sandstones.

Number 7 is remarkably variable in its lithological appearance, as well as thickness. At certain localities it is only three feet thick, and a good, compact limestone; at others, it is represented by ten feet of limestone, or by a mass of shale and thin limestone beds, twenty-five feet thick. It is in this number that the greatest quantity of organic remains are found.

Number 8 is also quite variable in its thickness. It alternately thins and thickens; it is entirely absent at some points, and at others is thirty feet thick. Some of the beds, especially the green, will answer admirably for fertilizing the worn out lands so common in the hilly regions.

It is exposed in the vicinity of Grayson Springs Station, at Litchfield, and at other points along the road in Grayson county. Analyses of it will be found in the Chemical Report.

Number 9 is also absent occasionally.

Number 10 is seldom present. It is a shaly sandstone, occasionally becoming compact, but usually merely a sandy shale. When continuous for any considerable distance its prevailing thickness is twelve feet; as a rare thing it is twenty feet thick.

Number 11 is as remarkable as any of the rocks in its lateral changes.

At "Grayson Springs," in Grayson county, near the Catholic Chapel, it is forty-five feet thick and a good compact rock.

From that point towards the railroad it seems to thin and change in character. It was quarried on the land of Mr. Patterson, near Grayson Springs Station, and used in the construction of the railroad bridge over Big Clifty Creek.

At Grayson Springs, and a few other localities, the rock contains beautiful crinoideæ.

Number 12, the Big Clifty sandstone, is at its best and fullest development at the Big Clifty bridge. It presents different features at either margin of the carboniferous area.

In its eastern extension the rock varies in thickness from sixty to one hundred and thirty feet, and from a soft, friable rock to a close-textured, heavy-bedded one. It is also of different colors, the prevailing ones being buff to cream, often ferruginous.

At East View, Hardin county, it is very soft and friable, color white or buff, beautifully mottled and banded with brilliant purple or dull brownish spots and stripes. The quartz grains are usually exceedingly small and loosely cemented. Cross lamination is a frequent feature in the mass.

At the western outcrop of the Chester Group, in Caldwell county, the sandstone is represented by a mass of sandstone and shales in an alternating series; the sandstone predominating in the upper part and at the bottom, with shales and thin sandstone beds at the middle.

This sandstone, forming the base of the Chester Group, is the equivalent of the "ferruginous sandstone" of Illinois. It is also equivalent to the "ferruginous sandstone" (*in part*) of Missouri.

In Swallow's Geological Report on Missouri, 1855, page 93, that sandstone is spoken of as "occupying the position of the *millstone grit* of the English geologists, the conglomerates of Ohio and Tennessee, and the 'conglomerates and ferruginous grits' of Iowa (Owen)."

There seems to have been some confusion existing in regard to the place of that sandstone, however. There is reason to believe that there are two distinct *ferruginous sandstones* in that State (Missouri); one resting on the St. Louis Group, the

equivalent of the ferruginous sandstone of Illinois, of Iowa,* and of the Big Clifty sandstone in this State; the other taking the place of the conglomerates, possibly (?) occupying a place similar to our *Bee Spring sandstone.* When comparing the Chester Group, as represented in Kentucky, with that of Illinois, the great similarity both in its lithological and paleontological features is at once apparent. In that State as in this one there are incessant lateral changes in the lithological aspects of the strata.

It is a marked fact that towards the southern and western borders of the coal measures, in the vicinity of the conglomerate, shales preponderate greatly, and that the Big Clifty sandstone in a great degree loses its character as a sandstone and passes into shales.

It seems that the conglomerate does thus gradually change, marking the ending of the turbulent waters, and ushers in the more quiet days of the coal measures.

Plate 1 is a general representation of the group.

Paleontology. — Great abundance of organic remains are found in this group; chiefly confined to the shaly beds, however.

Where the limestones are thick-bedded and compact they are not so numerous, but where alternating with shales hundreds of fossils may be collected in a short time.

Sufficient study has not been given to the collections made to enumerate all of the species found; the following list, however, embraces the principal and typical fossils of the group, as exposed along the road:

OF THE BRACHIOPODA: *Productus cora, Prod. elegans, Spirifer Leidyi, Spr. spinosus, Spr. increbescens, Spr. setigerus, Athyris Royssii, Retzia vera.*

LAMELLIBRANCHIATA: *Allorisma Chesterensis* and *Aviculopecten —?*

CRINOIDEA: *Scaphiocrinus (Zeacrinus) manniformis, Agassizocrinus dactyliformis, Pentremites obesus, Pentremites cervinus,*

*See Hall's Report, volume 1, part 1, page 109.

Pentremites pyriformis, Pentremites Norwoodii? Pentremites Godonii, Pentremites Koninckiana, Pentremites globosus?

CORALS: *Zaphrentis Spinulifera, Chaetetes,* etc.

BRYOZOA: *Archimedes Oweni (?)* and *Retepora lyra.*

COAL MEASURES.

As intimated on a preceding page, the coal measures occupy a basin extending from a point three or four miles west of Litchfield to a point about four miles beyond Tradewater. the lower carboniferous rocks forming the rim.

The basin proper, however, as generally understood, extends from Green river to Tradewater river, with the centre (as regards the railroad) near Owensboro Junction; the strata rise in waves both to the east and west of that place.

It is premature to discuss the history of this basin at present, therefore the subject will be deferred for future consideration.

It is suggested, however, that the basin, as it is at present, is in great measure due to uplifts at either margin of the field, and subsequent fractures.

In consequence of the numerous faults and flexures in the strata the lower rocks are seldom seen along the road, and the continuity is frequently abruptly broken. An absolutely correct vertical section of the rocks in the western coal field cannot, therefore, be constructed, relying altogether on observations made exclusively along the line of the Louisville, Paducah, and Southwestern Railroad.

It is deemed advisable, therefore, to number the coals from the top down, giving to each one a letter.

In the geological report on the State of Indiana for 1869, by Mr. E. T. Cox, a statement is made calculated to produce the impression that we have but four coals in this field.

It is stated that "the *Ice-house* coal, No. 3, is the equivalent of No. 1 B, having been mistaken for a higher coal. And the *Curlew coal*, No. 4, is the equivalent of No. 11."

Therefore the sandstone above No. 4 is regarded as being nothing more than the "*Anvil Rock*" *sandstone.*

The conclusions of Mr. Cox, however, must certainly have been hasty; or, based only on observations made in Indiana. If the latter is the case, there is no cause to wonder at his mistake; for it is now known that all the coal beds in a coal field are not co-extensive with its entire area. Consequently, although certain of the Kentucky coal beds may, and probably do, extend into Indiana, there is no reason to believe that they all do. As will be shown hereafter, they are not all co-extensive even with the entire area of the Kentucky coal field.

Therefore, as Mr. Cox says, the attempt to apply a section made of the coal measures in the Western Kentucky coal field to that of Indiana, would certainly create confusion. The same may be said of Illinois.

It must be admitted that when the matter of determining the true number of coals in the western coal field of this State was taken in hand, it was with a mind favorable to the conclusions given by Mr. Cox.

After a careful study of the coals, however, over an area of considerable east and west extent, the error was apparent. It is possible, and even probable, that coals at certain places were referred to the wrong number; but the existence of twelve beds of coal below the "Anvil Rock" seems to be true, beyond doubt.

Everything tends to prove Dr. Owen's numbering of the coals *between* the *Anvil Rock* and *conglomerate* to be correct.

He gives the number as twelve, giving to each bed, whether thick or thin, with a few exceptions, a distinctive number.

This certainly was not the best policy to pursue, as a number are so thin and poor, and so limited in their lateral extent, as to be of no value. Working after him, however, it is but justice to accept his system of nomenclature in discussing the number of the coals; and according to that plan at least twelve distinct beds are known to exist along the road.*

However, although Dr. Owen's section may be accepted as embracing the coal field in general, it is not applicable in its

* Letters are adopted at present instead of Dr. Owen's numbers, as it may be decided not to number the thin beds. The advisability of this, however, can only be determined when the entire coal field is studied.

entirety to any *particular* district. No matter how carefully made, no single section will answer for the entire coal field. It is a question, indeed, whether a single section will answer for any coal field.

It is deemed best, therefore, to insert vertical sections, as complete as could be obtained, for certain districts only.

Coals are found in certain regions that do not exist in others; so that all the coals as numbered will not be found in any one boring. Coals are found at about the centre of the field (following the railroad), that wedge out both to the east and the west. In fact, of the twelve beds enumerated by Dr. Owen, and recognized by the present Survey, not more than four or five are even tolerably persistent, and only one is unbroken in its entire extent.

Consequently the propriety of giving sections for certain districts only, and of lettering the coals at present, is evident.

Were a section desired applicable to the entire field, only the thick coals should be numbered, as the thin ones are certainly in some instances local beds, probably not existing outside of an area of a few square miles. Were the numbering to be done over again, such would be the plan. There would then be about eight beds to which numbers could be applied.

Upper Coal Measures.—Except in one doubtful case, to be cleared up hereafter, no coals were found above the Anvil Rock, although Dr. Owen represents a series of sandstones, shales, coals, etc., above that sandstone (in all some 2,000 feet thick), which are denominated "upper coal measures." Eight distinct beds are mentioned as existing in that series, making in all twenty beds of coal in the western coal field of this State.

Though not prepared to discard the upper part of his section in toto, there is reason to doubt the accuracy of the observations upon which the section was established.

As far as my observations extend (excepting the doubtful case already referred to, and which involves about sixty feet of rocks, including a coal stain), the Anvil Rock is the highest in

the coal measures. It certainly is the fact that the coal beds were duplicated, and extremely doubtful whether there are really any upper coal measures in this coal field; it seems almost a certainty that what were considered as such was simply a repetition of the series included between the Anvil Rock and conglomerate. There even appears to have been a reduplication of the supposed upper series; coals being repeated.

Therefore, though accepting the section as given for the series from the Anvil Rock to the conglomerate, the existence of the upper part, denominated *upper coal measures*, is extremely doubtful, and in all probability must eventually be discarded; this is certainly true for the region adjacent the railroad. The entire thickness of the coal measures may be included within one thousand feet.*

For reasons heretofore made evident, the coal field along the railroad has been separated into three divisions; the *first* extending from Green river to Spring Lick, and towards Litchfield; the *second* embracing the major part of the field lying between Green river and Pond river, possibly even beyond; the *third* from Pond river to Tradewater.

As certain coals are to be found in each division that are absent in the others (so far as the observations along the road extend), distinctive sections will be given for each.†

The following is a condensed section of the coals included between the Anvil Rock and conglomerate, according to Dr. Owen, with the lettering adopted in this report:‡

1. Anvil Rock sandstone	20	feet.
2. Coal, No. 12 (Coal A)	3	"
3. Space	21	"
4. Coal, No. 11 (Coal B)	5	"
5. Space	46	"
6. Coal, No. 10 (Coal C)	3	"
7. Space	68	"
8. Coal, No. 9 (Coal D)	5	"
9. Space	50	"

* In some instances it is not more than eight hundred or even seven hundred feet.

† It must be noted that these divisions refer only to the line of country adjacent the railroad, say for three to five miles on either side. Little is known at present concerning the geology beyond those limits.

‡ The thickness of the beds and their distances apart are according as given in Owen's section, in every particular.

10. Coal, No. 8 (Coal E)	2½	feet.
11. Space	43	"
12. Coal, No. 7 (Coal F)	2	"
13. Space	84	"
14. Coal, No. 6 (Coal G?)	3	"
15. Space	65	"
16. Coal, No. 5 (Coal H?)	4	"
17. Space	95	"
18. Coal, No. 4 (Coal I)	4	"
19. Space	154	"
20. Coal, No. 3 (Coal J)	2½	"
21. Space	71	"
22. Coal, No. 2 (Coal K?) No thickness given.		
23. Space	82	"
24. Coal, No. 1, B (Coal L)	5	"

Although the coals correspond in number, it must not be understood that the vertical distances between them, as represented in the foregoing section, are the same in the one constructed by the present Survey; nor is the thickness given to each coal the same. On the contrary, in some instances the distances are increased, in others diminished, and several of the coals are not represented as being so thick as given in Owen's section. The following section embraces the rocks and coals in the first division, extending from Green river eastward:

1. Anvil Rock sandstone			35	feet.
2. Shale with iron ore (carbonate)	0	to	30	"
3. Bituminous shale (not always present)			1	"
4. Coal A			5	"
5. Fire-clay			3	"
6. Sandy shale (not always present)			7	"
7. Sandstone (seldom present)			12	"
8. Limestone, fossiliferous	1½	to	8	"
9. Clay shale			½	"
10. Bituminous slate (seldom present)			1	"
11. Coal B, with one or two clay partings	5	to	7	"
12. Fire-clay	5	to	7	"
13. Sandstone and shale	15	to	35	"
14. Coal C	0	to	2½	"
15. Sandy shale			15	"
16. Sandstone			30	"
17. Shale with indurated pyritous concretions and iron-stones			25	"
18. Clay, fossiliferous	0	to	½	"
19. Bituminous slate			5	"
20. Coal D			5	"
21. Fire-clay			3	"
22. Shale and sandstone			50	"
23. Bituminous slate			3	"
24. Coal E			1½	"
25. Sandstone and shale	80	to	100	"
26. Coal			2	"
27. Shale and fire-clay } Coal H			8	"
28. Coal			1⅛	"
29. Sandstone and sandy shale			165	"
30. Blue shale with iron-stones			18	"
31. Coal			7	inches

32.	"Bee Spring sandstone"			45	feet.
33.	Coal			⅓	"
34.	Sandy shale with occcasional iron-stones			16	"
35.	Coal K	1	to	2½	"
36.	Shale, locally containing iron-stones			15	"
37.	Sandstone	15	to	25	"
38.	Sandy shale, locally containing iron-stones			15	"
39.	Bituminous slate containing *Lingula*			⅓	"
40.	Coal L			2¼	"
41.	Shale	10	to	25	"
42.	Sandstone, base of the coal measures			10	"

It will be noticed in the foregoing section that although the rocks, from the base to the top of the coal measures, are represented (as they appear in the district under consideration), only eight of the twelve coal beds are present.

Coals F, G, I, and J are entirely absent, as are also their associate rocks.

In the vicinity of Greenville, however, the Coals F and G are present, as represented in the following section; the high coals indicated are found at Owensboro Junction and on the high hills near Greenville.

The section is intended to represent the arrangement of the rocks and coals in the second division, from Green river to Pond river.

1.	Anvil Rock sandstone	25	to	60	feet.
2.	Sandy shale with iron ore			25	"
3.	Bituminous slate			1	"
4.	Coal A			5	"
5.	Fire-clay			3	"
6.	Shale			7	"
7.	Sandstone	0	to	12	"
8.	Limestone	3	to	8	"
9.	Clay shale			½	"
10.	Bituminous slate			1	"
11.	Coal B	5	to	7	"
12.	Fire-clay			7	"
13.	Sandstone and shale			25	"
14.	Coal C	0	to	2½	"
15.	Sandy shale			15	"
16.	Sandstone			30	"
17.	Shale with pyritous concretions, sometimes ochreous, and occasionally with a thin ferruginous limestone bed			25	"
18.	Pyritous clay	0	to	½	"
19.	Bituminous slate			5	"
20.	Coal D			5	"
21.	Fire-clay			3	"
22.	Sandstone			25	"
23.	Covered; all sandstone?			15	"
24.	Limestone	½	to	2	"
25.	Sandstone			40	"
26.	Shale with ochreous concretions			20	"
27.	Bituminous slate	1½	to	3	"
28.	Clay	0	to	1	"

29. Coal E	0	to	1½	feet.
30. Shale with thin layers of sandstone, and impure, sandy iron-stone concretions	5	to	10	"
31. Pink and white disintegrating sandstone			20	"
32. Bituminous slate	0	to	3	"
33. Coal F	0	to	1½	"
34. Fire-clay			1	"
35. Sandstone and shale with concretions of ochre	0	to	5	"
36. Limestone; mottled; sometimes a breccia of limestone and sandstone, or even passing into clear gritty sandstone			3	"
37. Sandstone and shale	42	to	70	"
38. Bituminous slate			1	"
39. Coal G (said to attain a thickness of 14 inches)			½	"
40. Fire-clay			9	"
41. Sandstone			55	"
42. Bituminous slate			1	"
43. Coal			3½	"
44. Fire-clay } Coal H			(?) 4	"
45. Coal			5	inches
46. Fire-clay and argillaceous shale			20	feet.

It should be stated that in the foregoing section, from number 37 in part to number 46 inclusive, is the record of a shaft sunk at Greenville, the coal No. 43 and 45 being at the bottom.

In the third division, that district west of Nortonville, it is necessary to give a section only of the lower coals. The higher ones are exposed and worked, but it will simply be a repetition of what has gone before to include them.*

It is as follows:

1. Sandstone underlying Coal H	15	to	20	feet.
2. Shale			5	"
3. Coal I†			1	"
4. Drab and dark-grey sandy shale			5	"
5. Sandstone			5	"
6. Limestone, fossiliferous	2	to	8	"
7. Sandstone and sandy shale	20	to	40	"
8. Coal J (sometimes with a 12-inch clay parting)	4½	to	5	"
9. Covered			100	"
10. Sandstone, top of the conglomerate?				

The data for the foregoing section was obtained on the hill south of the St. Charles mines, on the hills south of Hamby's Station, and at the tank on the St. Louis and Southeastern Railway, three miles south of Nortonville, Hopkins county.

For a better comparison of the coals as exposed along the railroad with the coals as represented in Dr. Owen's section, and to illustrate the lateral changes undergone by the

* It is probable that the coals F and G are absent.

† At one locality this is reported to be three feet thick. It was partially covered; therefore, the thickness only as seen is given.

rocks, the several sections have been grouped and presented as plate 3.

DISTRIBUTION OF THE COAL.

The observations upon which the following deductions are based were necessarily restricted to a limited north and south area; therefore, what may be true for the region adjacent the railroad may not stand for the entire coal field.

There seem to have been disturbances in the coal region at the time of the formation of the coal, as well as at a later period.

The disturbances, however, were slight, and there is every reason to believe that in the early history of the coal measures the rocks were rather horizontal; otherwise the measures, instead of conforming with the dip of the sub-carboniferous rocks, as they do, would rest unconformably on them.

At the time of the deposition of the coal the region seems to have been subject to repeated floods. The evidences of these overflows, however, are visible only in certain parts, occurring irregularly along the road. This leads to the conclusion that they must have been local, produced, perhaps, by an irregularly changing level in the surface. With the exception of one bed, Coal D, there is a continual change in the thickness of the coal seams. Coals which at one place are represented by merely an inch or so of carbonaceous matter, will in a short distance thicken to as much as thirty inches, or a coal of three and a half feet, or even five feet, may thin materially or disappear entirely. The upper and lower coals afford ample illustrations of these changes. Coals A and C are so exceedingly variable in their thickness that not the least confidence may be placed on them. Other coals will wedge out, terminating in a sandstone bed, or a bed of shale at one locality, apparently disappearing forever; then in a few miles they will be found again, presenting their usual thickness. This wedging out of the coals was caused, no doubt, by a number of temporary currents cutting away the vegetable matter in certain places before the coal bed was completely formed, depositing

mud or sand, as the case may be, in its stead, followed by a more extended overflow continuing the work of deposition above the coal. The frequent passage of sandstone into shale in the localities of this so-called wedging out of the coals, certainly lends force to the supposition.

There also seem to have been a series of subsidences and elevations going on during the entire period of the deposition of the coal.

This has also caused the coal to be very irregularly distributed, as the flooding waters had frequent access to it in certain parts, while on the high points it was untouched.

The low coals appear to be thicker towards the southern and western margins of the field, while the high coals thicken towards the north.

It is possible, therefore, that such thin beds as Coals C, E, F, and G, may assume a workable thickness towards the north, or at least be thicker than they are in the region traversed by the railroad, if they extend so far.

DESCRIPTION OF THE COALS AND THEIR ASSOCIATE ROCKS.

In these descriptions it is the aim to afford the explorer some satisfactory means of identifying the distinctive beds in the region he contemplates examining, as well as to discuss the relative merits of the coals.

In some instances the information concerning certain beds is very meagre, which necessarily renders the description of them incomplete. It is believed, however, that all knowledge requisite for the identification of the most reliable beds is given.

It is hoped that those coals necessarily inadequately described at this time may yet receive such attention as to render the means of their identification more definite. It has been considered best to take the coals in the order as they are numbered; the descriptions begin, therefore, with the highest and descend to the lowest.

The Anvil Rock (*Mahoning Sandstone?*)—Occupying a position at the top of the coal measures, is a massive sandstone,

known in the former Geological Reports on this State as the "*Anvil Rock.*"

It is frequently compact and close-textured, with but few scales of mica.

Its character, however, is exceedingly variable. At Rockport, where it forms cliffs on the east bank of Green river, it presents its usual appearance.

When fully developed it is usually coarse-grained, micaceous, mediumly-soft, color light buff to cream, and buff speckled with white and black. Occasionally hollow concretions of limonite occur towards the top. Large fragments of fossil trees, viz: *Sigillaria* and *Calamites tuberculosus (?)* with *Stigmaria ficoides*, associated with the markings of other trees and plants, are abundant in some parts of the rock.

These are usually very much contorted and broken. Often the plants and bark of the trees are changed into fibrous coal.

At certain parts the rock is literally a mass of vegetable remains; the markings of which, however, are, in nearly all cases, quite obscure.

The rock disintegrates at about the middle. so that, when the upper part is absent, it is frequently a mere bed of sand.

One very marked feature of the rock, though not a characteristic one by any means, is its tendency to weather with a honey-combed appearance. This is considered by some to be a reliable means of identification; but nothing is more likely to lead to error.

In fact it is a difficult matter to distinguish one sandstone from another over large areas in this region merely by their physical characters. They so often resemble each other, and change so frequently in appearance, that to be able to identify them respectively requires close attention to the accompanying strata and topography on the part of the observer.

I am very much inclined to regard this sandstone as the equivalent of the "Mahoning sandstone." Sufficient data have not been collected to justify a decided opinion in the matter, but certain facts elicited during the explorations suggest that such is the case.

In the vicinity of the McHenry mines, large and small tumbled fragments of very ferruginous conglomerate sandstone were found strewn over the hillside, lying above Coal B. The pebbles are of quartz, varying in size from that of a pea to that of a chestnut, sparsely though widely distributed throughout the mass. The sandstone has nowhere been found *in situ* containing such pebbles, but these must certainly have come from it.

The Anvil Rock is known to cap the neighboring hills, and is exposed near the top of the hill in question. It is very evident that the fragments were broken off from this sandstone. As it is known to contain pebbles at this locality, it is possible that the sandstone may be found possessing a conglomerate character in other parts of the coal field not yet examined. According to the investigations of Mr. Crandall, in eastern Kentucky, the Mahoning sandstone is not always a conglomerate. He also places it at from four hundred to five hundred feet above the conglomerate (not very much lower than the position of the Anvil Rock), with eight coal seams between.

The similarity between the rocks is apparent.

The Anvil Rock must have been deposited in turbulent waters, judging from the many and varied changes found in it.

In some regions it rests directly on the limestone over Coal B, with what are probably the crushed fragments of Coal A, distributed in patches and pockets through the lower part.

At Owensboro Junction the lower two feet of the sandstone is a conglomerate of yellow earthy limestone fragments. Whether these are from the limestone overlying Coal B, is a matter for speculation only.

Coal A.—The Coal.—Coal A, the first coal below the Anvil Rock, is perhaps the best workable coal, as far as regards *quality*, to be found in the region traversed by the railroad.

It is undoubtedly the best in the upper series, counting from Coal H upwards.

Unfortunately it is seldom found in a suitable condition for working. Its unreliability is such that those engaged in mining in the western coal field place no confidence in it.

When present at all, it varies in thickness from three to six feet.

The deposition of the coal seems to have been frequently interrupted. It appears as if at certain points there had been an eddy in the water bearing the sand which went towards forming the Anvil Rock, tearing the soft coaly material from its bedding and depositing it again in the same place mingled with the mud and sand.

When found in a workable condition, however, it is comparatively free from all irregularities, and is easily mined.

In texture it is somewhat variable, occurring as a firm, glossy black, dense coal at one locality, while at another it may be rather soft and apt to slack considerably upon much handling.

Compared with others, there is little sulphur present in the coal, little more, in fact, than in the celebrated Block coal of Indiana, as the following general average analysis will show:*

Specific gravity	1.339		
Moisture		4.15	
Volatile combustible matter		33.14	
Fixed carbon		55.71	Coke 62.71.
Ash		7.00	
		100.00	
Sulphur	1.873		

In an analysis made by Dr. Peter, and published in the fourth volume Kentucky Geological Reports by Dr. D. D. Owen, the per centage of sulphur and ash is represented as being quite small. The analysis is numbered 1164, and is as follows:

Specific gravity	1.593		
Moisture		7.06	
Volatile combustible matter		30.84	
Fixed carbon		58.70	Coke 62.10.
Ash		3.40	
		100.00	
Sulphur	0.879		

By whom the sample analyzed was taken is not known to me, as no name accompanies the label attached to the analysis. There is every probability that it was not an *average* sample

*Single analyses will of course differ from this somewhat, being better in some instances and poorer in others.

but a picked specimen; in no other way can the great difference between the two analyses be explained.

As far as regards the amount of sulphur present, however, the coal could be successfully used in the raw state for the manufacture of iron; but the fact of its being too *fat*, producing too much bitumen when heated, thus caking and agglutinating, choking the furnace, and obstructing the blast, precludes the possibility of making good iron with it when used raw. It was thus used at Airdrie, but the quality of iron produced was poor.

Excellent coke may be made of it, however, and when thus used there is no reason why a fair quality of iron may not be obtained.

An analysis of samples of coke procured by P. N. Moore from a large heap of the material prepared for use at the Airdrie Furnace seventeen years ago, is as follows:

Moisture expelled at 212°	7.50
Moisture expelled at red heat	4.20
Fixed carbon	82.90
Ash	5.40
	100.00
Sulphur	0.64

As remarked by Mr. Moore,* the sample "does not fairly represent the coke that can be made from the coal;" the pile (containing several thousand bushels) has been exposed to the action of the weather for seventeen years, and a large amount of water was naturally absorbed. Besides, it was prepared in open heaps, which method does not produce as good quality of coke as when closed ovens are used for the purpose.

When these facts are taken into consideration, it will be conceded that an excellent coke may be made from the coal.

The quality of Coal A is as good at Airdrie as at any point near the line of the railroad; but there is a bare possibility that in some part of the coal field it may be found with quite as little sulphur, and approaching more nearly to a dry free-burning coal, capable of being used in the furnace without coking. It is a fine domestic fuel and an excellent steam coal.

*See his published report on the Airdrie Furnace, in the Louisville *Courier-Journal*, January 11th, 1875.

The Slate.—As a rare case only is bituminous slate found capping the coal. It seems to have been pretty generally removed over the entire region covered by this report.

The Shale.—The coal is frequently immediately overlaid by a bed of argillo-sandy shale carrying thin beds of carbonate of iron (usually altered to limonite near the surface).

The shale varies in thickness from twenty to thirty-five feet. Towards the bottom, near the coal, it is generally quite hard, and forms a good roof; sufficiently strong, with judicious propping, to support the overlying strata whilst the coal is being mined.

When once seen and sufficiently studied, the shale is easily identified at other localities. Ferns of the genera *Neuropteris, Sphenophyllum, Asterophyllites, and Sphenopteris* are found in it.

Without paying due attention to the peculiarities of each, there is a great possibility of confounding this shale with that overlying Coal D. A sufficient examination of each, however, will reveal to the explorer characteristic features by which he may be guided and make no mistake. The iron ore formerly used at the Airdrie Furnace was taken from a bed of this shale overlying Coal A at that place.

Coal B.—The Coal.—This is the coal numbered 11 in Dr. Owen's report. It is very unreliable in the region under consideration. At Paradise, and the surrounding region, it is at its best development, so far as regards uniformity in thickness and quality.

It is always found with at least one clay parting, sometimes two.

It thins and thickens in a remarkable manner; occasionally it is represented by only twelve inches of soft smutty coal, and again will attain a thickness of seven feet.

It ranks next to Coal D in persistency, however.

When workable the coal is of fair quality, but is so subject to clay slips, rolls and undulations, that the mining of it is attended with more expense than in the case of the other coals. It is not intended to convey the impression that the coal is never without these evils, for such is not the case.

At Paradise, for instance, the coal lies in very good condition for working.

The coal is glossy black and compact, frequently with fibrous coal between the laminæ. Immediately at the top a layer of from one eighth to two inches of the fibrous coal occasionally occurs. An interesting analysis, by Dr. Peter and Mr. Talbutt, of a piece obtained at the Muhlenburg mines (Muhlenburg county), is presented:

Specific gravity	1.503		
Moisture		1.20	
Volatile combustible matter		7.50	
Fixed carbon		86.48	Powdery residue 91.30.
Ash		4.82	
		100.00	
Sulphur	2.43		

This analysis is of much interest, as showing the per centage of sulphur, of fixed carbon, and volatile matters. It is shown to have great heating power; so that, though adding to the amount of sulphur in the coal, it augments its heating power greatly. It is in fact not much more than a *coke*, and the name *mineral charcoal*, usually given it, is peculiarly applicable. Its presence no doubt adds to the amount of ash as well as sulphur in the coal; and it is so poor in volatile matters that much of it detracts from the value of a coal for gas purposes. As a *heating* fuel, however, it is of peculiar worth.

The upper part of the coal is, on an average, the best, the quality deteriorating towards the bottom.

Wherever a clay slip occurs the quality of the coal is affected for yards. At such places the coal is usually slaty, with much iron pyrites mingled with it.

The clay cuts both the coal and the roof in many instances, and often there will be what may be termed a *main* slip extending entirely across the bed, so far as exposed to view, with several little leaders spreading out from it.

These "slips" may be accounted for in three ways, the explanation depending upon whether the clay simply cuts the coal or whether it cuts both the roof and the coal.

First, when the clay cuts only the coal. In this case the clay is to be considered as of later date than the coal bed.

As is apparent in the rolls and undulations of the under clay forming the floor for the coal, the vegetable matter was deposited on an uneven surface. There were, consequently, inequalities in the thickness of the vegetable matter. The coaly matter may also not have been of uniform hardness. As a consequence, the weight of the superincumbent strata pinched down the coal at certain points to a much less thickness than at others. A slight but uneven depression or elevation of the bed would cause a fracture or series of fractures in the stratum, and these fractures would naturally be at the weakest points. A subsequent flood removed the overlying strata, and when the work of redeposition began the muddy sediment held in the water found its way into the fractures of the coal, and there remained, being squeezed into compactness by the weight of the succeeding strata.

Second. In this instance the clay cuts the coal as before. Considering that the coal was deposited in the same manner as previously described, and that the bed was fractured in the same way, it is possible that when the succeeding strata were deposited the additional weight forced the plastic under-clay up in the fractures.

Third. When the clay cuts both the roof and coal it is accounted for in a somewhat different manner from the foregoing.

It would seem that the clay came from above the coal. Subsequent to the deposition of the roof shales a series of very slight disturbances produced small fractures in the strata, which were afterwards filled with clay. In some instances these cracks were widened by the erosive action of running water; in that case the width of the clay seam is greater. The evidences of fractures are presented in the smooth-worn sides of the coal, etc.

The explanation of the whole matter, however, resolves itself into that given in the first place. It is a noticeable fact, that where these clay slips are most frequent, part of the strata overlying the coal have been removed

The coal varies in its quality considerably, the greatest change being in the amount of sulphur present.

Unfortunately a sufficient number of samples could not be obtained to make it possible that a reliable average analysis might be given. The two following analyses are given, however, as being better than none.

The first is an *averaged* analysis of samples taken from the Muhlenburg mines; the second an average of the analyses made of samples, collected by P. N. Moore at Paradise:*

No. 1.

Specific gravity	1.304	
Moisture		2.25
Volatile combustible matter		41.54
Fixed carbon } Coke		50.62
Ash } 56.26		5.64
Sulphur	2.982	

No. 2.

Specific gravity	1.310	
Moisture		3.96
Volatile combustible matter		36.90
Fixed carbon } Coke		52.60
Ash } 59.13		6.53
Sulphur	4.41	

There is considerable difference between the two analyses in the per centage of sulphur indicated. Comparing analyses of the upper part of the bed at each locality, however, the difference is not so great.

No. 1.†

Specific gravity	1.332		
Moisture		1.52	
Volatile combustible matter		40.00	
Fixed carbon		50.92 }	Coke 58.48.
Ash		7.56 }	
		100.00	
Sulphur	2.840		

No. 2.

Specific gravity	1.274		
Moisture		3.60	
Volatile combustible matter		38.70	
Fixed carbon		53.70 }	Coke 57.70.
Ash		4.00 }	
		100.00	
Sulphur	3.158		

The Under-clay.—The clay below Coal B is, in some instances, suitable for the manufacture of fire-bricks. Its thickness is variable, ranging from two to seven feet.

* From his published report on the Airdrie Furnace.

† No 1 from Muhlenburg mines. No. 2 from Paradise.

The bricks made (so far as is yet known) are not of the best quality, but will answer the purpose when better ones may not be had.

An analysis, by Dr. Peter and Mr. Talbutt, of a fair sample obtained at the Ross mines, Owensboro Junction, exhibits an undue preponderance of silica and too little alumina. The presence of sulphur is also injurious.

The following is the analysis:

Silica	63.180
Alumina, &c.	26.281
Lime	.203
Magnesia	.255
Phosphoric acid	.179
Sulphur	1.312
Potash	2.000
Soda	.425
Water and loss	6.165
	100.000

The Slate.—The bituminous slate over Coal B was found in a few instances only; a bed of limestone or clay usually rests immediately above the coal. Where seen it is compact, brittle, close-textured, of rather a glossy black color, and jointed rhomboidally. Few fossils were found in it.

Cox gives a list, in volume three of Dr. Owen's reports, of shells found in the shale over Coal B. They, no doubt, came from the overlying limestone. With two or three exceptions the fossils enumerated by him were found in a much lower coal, *i. e.* Coal D.

The Limestone.—Occupying a true position above the slate, but usually resting immediately on the coal, or else separated from it by only a few inches of clay, a bed of limestone occurs.

This varies from a loose, friable or marly mass, to a hard, compact rock, and in thickness from six inches to eight feet; the usual thickness being eighteen inches.

It is easily identified by its organic remains; which are *Productus splendens, Athyris subtilita, Martinia perplexus, Martinia plano-convexus, Spirifer cumeratus, Spirifer Kentuckiensis, Retzia punctulifera, Rhynconella Osagensis, Chonetes Smithii*, a large *Chonetes, Macrocheilus inhabilis, Bellerophon percarinatus, Pleurotomaria Grayvillensis, Murchisonia? Lophophyllum proliferum.*

Archæocidaris megastylus, *Chaetetes milleporaceous*, etc. *Martinia plano-convexus* is the most abundant and characteristic fossil.

The rock varies in color greatly, changing from drab to blue, grey or buff, or buff mottled with ashy white. It is always quite impure, very earthy, and often pyritiferous.

The Sandstone.—At Airdrie, the only place, perhaps, near the railroad where coals A and B are in their true position towards each other, a sandstone twelve feet in thickness overlies the limestone, separating it from the fire-clay of Coal A.

Farther west the sandstone is entirely absent, the two coals approaching very near to each other; in some instances, as at the Muhlenburg mines, separated by two feet of clay only.

The absence of the sandstone may be easily accounted for, but it is not necessary to do so here.

Coal C.—This coal is very erratic and quite seldom present. It is usually no more than a two-inch smut. At first it was proposed not to number it, but subsequently, determining to follow Dr. Owen's system of numbering (for the present), it was thought best to do so, especially as it was found at a few places exhibiting a thickness of two and a half feet. It is remarkable in its lateral changes. At Paine's, on Green river, it is a thin streak in sandy shale, scarcely noticeable. Proceeding west to the Richmond mines, a distance of about one mile, it is found presenting a thickness of two and a half feet. It retains that thickness for barely half a mile, and is then lost sight of. It will be seen by this that it has no economic worth.

Coal D.— The Coal.—This coal varies in its quality and physical features wherever seen. There is not much change in short distances; only at points widely separated are the differences very marked.

It is not strictly true that the *quality* changes frequently, but rather that the texture is variable.

The coal is usually hard and compact, made up of alternating dull and shiny black layers, with layers of fibrous coal between, giving it an appearance remotely resembling *splint coal.*

It is an excellent heating coal, but is too fat and sulphurous for a furnace fuel. The upper two and a half feet is usually the best, in that it is freer from pyrites than the bottom, though such is not always the case. It is never free from *iron pyrites*. This unwelcome mineral is always found in it, either as thin bands, or plates introduced between the vertical joints, or occurring irregularly throughout. The position occupied by the pyrites in the coal cannot, therefore, be used as a means of identifying the bed; a fact contrary to the supposition of many. As a general thing, however, most of the pyrites is found below the middle, increasing in quantity towards the bottom.

Fortunately the greater portion of the pyrites occurs as bands concentrated at one point in the bed, and may be removed when the coal is mined.

The coal is remarkably persistent and uniform in quality and thickness, and from this circumstance may be considered the most valuable of any of the coal beds in the southwestern portion of the State. Its thickness ranges from four to six feet, averaging about four feet nine inches.

At one locality only was it found troubled with clay slips; it is indeed singularly free from the evils attending the other coals. It is somewhat inferior in quality to Coals A and B, but this is balanced by its great persistency.

The following is an average of seven analyses made of the coal, by Dr. Peter and Mr. J. H. Talbutt:*

Specific gravity	1.371	
Moisture	3.27	
Volatile combustible matter	35.31	
Fixed carbon	53.12	Coke 61.26.
Ash	8.14	
Sulphur	3.218	

The coal has been tried in a few instances for the manufacture of iron—once at least in the raw state. A glance at the analysis, however, shows that besides having an excess of sulphur, it is too apt to cake and choke up the furnace to be used raw.

*Single analyses will be found in a table given at the end of this chapter.

If well washed, however, so as to remove as much of the pyrites as possible, it will, no doubt, make a fair coke, and may thus be used.*

There is, no doubt, a certain amount of sulphur present in the coal in an uncombined state (as is probably the case with all bituminous coals); but it is likely that most of it is present as thin plates of pyrites introduced between the joints of the coal or in heavier masses, and may be partially removed.

It is always provided with a reliable roof, which renders the mining of it safe.

The Slate ranges in thickness from two to five feet. It is usually dense, smooth, and even-textured, cleaving readily in thin laminæ, varying in color from dark blue to bluish-black. Though usually dense its texture is variable. When the slate is more than ordinarily earthy, it is coarse-grained and inclined to soften under the influence of water.

In some localities many pyritous concretions of various fanciful shapes are found in it. Some are discoid or spherical, and others long and flattened.†

These concretions are occasionally entirely of yellow iron pyrites, but are often a dark blue, heavy, pyrito-bituminous limestone. In the latter case fossils are often found in them, including *Productus muricatus Solenomya*—? *Bellerophon carbonarius*—? a minute *Polyphemopsis?* etc. Vegetable remains are also occasionally found in the concretions.

What appear to be the remains of minute gasteropods are occasionally found in the slate.

Between the slate and the coal a mass of flattened remains of *Sigillaria* and *Cordaites*, with other plants, so interlaced as to form a matting, is nearly always present. The plants are always found converted into hard, brittle, brilliantly black coal.

The Clay over the Slate.—Immediately over the slate a bed

* It is believed that most of the sulphur is present in the plates of pyrites in the joints.

† Some of these concretions are of such curious shapes that they are frequently mistaken by miners and others for "petrified fish," "trees," "cabbages," etc. Such stories occasionally find their way to newspapers, and to one not conversant with the facts are subject to much interesting comment.

of dark or blue pyritous clay, varying from two to twelve inches in thickness, is usually found.

It is literally filled with fossils, including many species. The following are those identified at this time:

Productus muricatus, Prod. Nebrascensis, Hemipronites crassus, Meekella striato-costata, a Lingula (rare), *Rhynconella Algerii?* (it may be *Rh. Osagensis* of Sw.), *Astartella vera, Nucula ventricosa, Chonetes mesoloba, Nuculana bellistriata, Aviculopecten rectalaterarea, Aviculopecten —? a Prothyris, Macrodon tenuistriata, Pleurotomaria carbonaria, Pl. speciosa? Pl. sphærulata, Bellerophon carbonarius, B. percarinatus, B. Montfortianus, Macrocheilus inhabilis, Mac. fusiformis, Nautilus decoratus, Orthoceras cribosum*, and long slender univalves, probably belonging to the genus *Loxonema.*

Productus muricatus is about the most abundant fossil; next to that in abundance is *Pleurotomaria speciosa?* and then the slender univalves.

These fossils are seldom found grouped together; on the contrary, the clay may be charged with *Producti* at one point, while at another a *Pleurotomaria* may be the predominating fossil.

The clay is not always present, and may even be found in but a few places in a single mine. Wherever found, however, it absolutely identifies Coal D.

The Paleontology.—The fossil shells found connected with this coal, besides those already enumerated, are *Aviculopecten acosta, Pleurotomaria Grayvillensis, Productus Prattenianus, Athyris subtilita, Spirifer cameratus.* Plants: *Neuropteris hirsuta, Pecopteris Miltoni, Sigillaria—? Stigmaria ficoides, Calamites tuberculosus?* etc.

The Blue Shale.—From ten to thirty feet of blue argillo-sandy shale usually lies above the bituminous slate. In certain regions this is a very good index to the coal, but it is not always present; or rather it often passes into sandstone. The sandstone, however, is usually quite shaly and bluish-grey in color; so that, upon the whole, considerable confidence may be placed in the shale. Occasionally, though seldom, beds of

ochreous limonite (altered carbonate of iron) are found in the shale. In the western portion of the coal field this circumstance is apt to create confusion in identifying the coal bed.

The shales in certain localities in that region resemble those overlying Coal A, and, without exercising great care, there is danger of the explorer mistaking Coal D for Coal A. In the eastern portion of the coal field, however, the shales were nowhere found with any abundance of the ochre, and there is little danger of any mistake being made.

Occasionally a thin ferruginous limestone, almost an iron ore, containing very small univalves (Bellerophons?) is found in the shale, occupying a position about twenty-five feet above the coal. The limestone is very thin, scarcely ever greater than two and a half inches, more often one half an inch in thickness, and is not constant.

The Sandstone.—Overlying the blue shale is a mass of sandstone varying greatly in its thickness and physical characters. It is variably coarse and fine-grained, and passes from a hard, compact, heavy-bedded sandstone to a soft, loosely-cemented or shaly one, weathering into caverns or rock-houses. In some instances it is an excellent building stone; again it is a bed of sand.

A curious feature in the way this sandstone weathers is the honey-combed appearance of the cliffs formed by the massive variety.

This feature, however, is not peculiar to this rock alone, but is found in nearly all the sandstones from the Big Clifty to the Anvil Rock, inclusive. It varies in thickness from thirty-five to fifty feet.

Coal E.—This coal is regarded as the equivalent of No. 8, according as the coals were numbered by the old Survey. It is of fine quality, occurring as a glossy black, firm, even-textured coal. There are only two reasons why it is not the most valuable coal in the field, viz: its limited thickness (varying from one half an inch to thirty inches), and the manner of its distribution. It is sometimes entirely absent, represented only by a bed of bituminous slate underlaid by a thin bed of fire-clay,

with or without a coal streak. However, it is of such superior quality, that were a bed three or three and a half feet thick found, it would be considered as workable, even in the neighborhood of thicker coals.

Its associate rocks are not always the same. North of Greenville, Muhlenburg county, on the Madisonville road, it is represented by a mere streak of coal capped by bituminous slate and underlaid by shales holding thin beds of sandstone and nodules of sandy iron-stone.

Nearer the town, in a valley, about half a mile southwest of the Station, the coal is entirely absent; bituminous slate is present, however, resting immediately on sandstone, the shale with the iron-stones having disappeared. Near Gordon's Station, about three and a half miles west of Greenville, it is again found, presenting a thickness of eighteen inches, and capped by eighteen inches of dense slate.

Its unreliability is apparent

The Slate.—The slate is dense, glossy black, and even-textured, rhomboidally jointed, and cleaving readily in thin plates. At some localities it is literally filled with fish remains, generally the scales, with occasional spines. Teeth are rare; *Peripristis semi-circularis* is occasionally found.

The Shale.—Overlying the slate, ochreous shale, varying from ten to twenty feet in thickness, usually occurs. Occasionally it is absent, and the overlying sandstone rests immediately on the slate.

Coal F.—This seam is of no consequence either in an economic or commercial point of view. It was found at Greenville and vicinity, but only as an impure earthy coal, immediately underlying a disintegrating ferruginous sandstone, and resting on a brecciated limestone. Occasionally it is overlaid by bituminous slate.

The Limestone.—The limestone below the coal makes some curious changes in very short distances. It was seen only at Greenville, and is probably local.

At one locality near the town it is a rough blue limestone mottled with dove, drab, and buff, mediumly compact and hard.

At another place it is a breccia of limestone and sandstone, passing into a sandstone containing calcareous lumps, then suddenly shading into a micaceous sandstone, merely to resume its former character within a few yards. These peculiar changes take place without any break in the continuity of the bed. At other places it is a rough, nodular, calcareous mass, cemented by oxide of iron. A sandstone, accompanied by shale inclosing nodules of iron-stone, is occasionally interpolated between the limestone and coal.

Coal G.—This coal was not observed anywhere along the road, but is reported as occurring in the Greenville shaft. Every evidence tends to verify the report, although there are discrepancies in regard to its thickness.

It is a thin bed, of no economic value, so far as known to the Survey.

Coal H.—This coal was first noticed at Mr. Sandifur's, on the Hines Mill and Cromwell road, about one and a half miles south of Elm Lick, in Ohio county.

Only the outcrop was seen, and nothing very definite in regard to it could be obtained. It is divided by shale into two members. The shale varies from two to eight feet in thickness, which would lead to the supposition that there are really two distinct beds of coal, and that they may be more widely separated at other localities.

This coal is also reported as lying at the bottom of the Greenville shaft, where its upper member is said to be three feet two inches thick, and the lower one eighteen inches.*

Coal I.†—Little is known regarding this coal; an accurate description of it cannot, therefore, be given. It was observed on the hills south of the St. Charles mines, Hopkins county, measuring one foot in thickness.

It is immediately overlaid by argillaceous shale, which lies beneath a heavy-bedded, rather soft sandstone. The most

*One of the men who sunk the shaft places the thickness of the lower bed at five inches.

†On Col. Gano Henry's land, southwest of Hamby's Station, Hopkins county (on the old Breathitt place), there is a coal that may be referred to this; it is said to be three feet thick, and is of excellent quality.

accurate means of identifying it is the limestone lying at from ten to fifteen feet below it.

The limestone varies in thickness from two to eight feet. It is easily recognized by its fossil contents, which are, *Spirifer cameratus*, *Productus muricatus*, *Prod. Prattenianus*, *Prod. splendens*, *Martinia plano-covexus*, *Fenestella*, and *Crinoid* columns.

Productus splendens is especially abundant, and may be regarded as the typical fossil.

Coal J.—This coal occupies a position at from twenty to forty feet below the limestone. But little better opportunity was afforded to examine it than was the case with coal I. As seen in the bank, the coal is of admirable quality; glossy black and compact. It is occasionally separated into two members by a clay parting twelve inches thick. The most reliable and convenient means for its identification is presented by the limestone previously mentioned.

Coal K.—This was first observed in the first cut west of Millwood, Grayson county. It varies from nothing to two and a half feet, and is only of medium quality. It occupies a position about twenty feet below the Bee Spring sandstone.*

Coal L.— The Coal.— As demonstrated by investigations made in Livingston county, this is an inter-conglomerate coal.† In Grayson county it usually occupies a position at from five to ten feet above the Chester Group. Occasionally, however, a sandstone nearly ten feet thick is interpolated between the coal and limestone.

At the western border of the coal field the coal rests about fifteen feet above a heavy conglomerate, and is from three to four feet thick. In Grayson county, it occupies a position at from sixty-five to seventy-five feet below the Bee Spring sandstone, which corresponds to the "fifth sandstone" of Lyon.

At the Union coal mine in Livingston county it occurs at ten feet below a conglomerate twenty feet thick, with another con-

* This sandstone received its present name from a noted spring in Edmonson county. Further concerning it may be found in Mr. Moore's report on the iron ores of that county.

† This is true, provided the conclusions were correct in identifying the coal on the railroad with that in Livingston county, which is believed to be the case. The coal is undoubtedly that numbered No. 1 R by Dr. Owen, which number M. Lesquereux assigns to that at the Union coal mine, Livingston county. (*See "Report on the Lead Region of Livingston, etc."*)

glomerate, varying from forty to one hundred feet in thickness, below it.*

It is barely possible that the sandstone twenty feet thick which occupies a position twenty feet above the coal in Grayson county, and the one occasionally found below it in that county, correspond to the conglomerates found in Livingston county. Should this be true, the coal lying twenty feet below the Bee Spring sandstone is probably the one overlying the upper conglomerate in Livingston county.

This is regarded as the equivalent of Coal No. 1 B of the old Survey, and a hurried examination made in September, 1874, gave the impression that it is also the "*Knob Lick*" *coal* of Edmonson county. In the eastern part of the region embraced in this report the coal is seldom more than twenty-seven inches thick; but on Tradewater, in the conglomerate district, its thickness is from three to four feet.

The Slate.—Overlying the coal there is usually a bed of bituminous slate, from four inches to three feet thick. It is usually quite earthy, frequently almost imperceptibly shading above into dark drab, argillaceous shale. *Lingula mytiloides?* (*L. umbonata Cox*), associated with long slender leaflets of plants, *Pinnularia(?)*, often occurs in great profusion. When most abundant, however, the *Linguleæ* are not widely distributed through the slate, but seem to have been gregarious. In other instances, although present, many slabs may be examined before any of the fossils will be found.

The *Lingula* seems to belong almost exclusively to the shale overlying Coal L. At one locality the clay over Coal D was found to contain an occasional individual; but in all the examinations of that shale for fossils, no more than three or four specimens of *Lingula* were obtained. These were quite small, and may not belong to the same species as those in connection with Coal L.

The Shale.—On Tradewater, interposed between the conglomerate and Coal L, is a bed of dark blue, somewhat argillaceous shale, with concretions of carbonate of iron.

* See report on the Lead region of Livingston, Crittenden, and Caldwell counties.

No good exposures were observed; therefore no opinion can be given respecting the value of the shale as an iron ore repository.

The Conglomerate.—The conglomerate, so far as known, extends only around the southern and western margins of the coal field. It is not seen near the road in the east, but towards the western margin is exposed as a great pebbly mass from fifty to one hundred and twenty-five feet thick (probably more in places), and lying at about twenty feet below Coal L.

It is not always conglomeratic in its entire vertical extent. The pebbles are more abundant towards the middle and the bottom, though frequently distributed irregularly throughout the mass.

There seems to be a gradual change from a coarse, pebbly rock at the bottom, to a loosely cemented, often disintegrating, exceedingly fine-grained sandstone at the top, marking the advent of the more quiet time preceding the deposition of Coal L. It is also frequently devoid of pebbles, and may extend for miles simply as a ferruginous, dirty, moderately fine-grained sandstone. Towards the top the lines of deposition are very irregular, as would naturally be expected from the nature of the rock.

There are evidently two conglomerates in the western coal field; a fact first brought to light by the examinations in the lead region of Livingston county.

The conglomerate on Tradewater is regarded as the lower one, and which skirts the southern borders of the coal field, while the upper one (so far as known) is not present so far east; this is true at least for the region under consideration.

Sub-Conglomerate Coal.—Immediately below the conglomerate, on Tradewater, near the railroad bridge, a coal is exposed at low water. Its thickness is variously reported as being eighteen inches and two and one half feet thick. It has never been opened, being in the bed of Tradewater river, and its precise thickness is not known. The outcrop was seen at the time of low water in the autumn of 1874.

DISTANCES BETWEEN COALS.

The following table exhibits the average distances between the coals, from A to H, inclusive, as they occur along the line of the railroad:

1. Coal A	5	feet.
2. Space	5	"
3. Coal B	6	"
4. Space	15	"
5. Coal C		
6. Space	75	"
7. Coal D	5	"
8. Space	75	"
9. Coal E	1½	"
10. Space	20	"
11. Coal F	1½	"
12. Space	50	"
13. Coal G	½	"
14. Space	100	"
15. Coal H	4½	"

COAL IN THE CHESTER GROUP.

In Grayson county, in the Chester Group, a thin coal seam occurs immediately below a thick limestone. It occupies a position at from seventy-five to one hundred and twenty feet below the top of the group, according as the strata are thick or thin.

The only personal knowledge I have of it is of its occurrence on Mr. Horn's place on Rock Creek. Mr. Moore, however, cites several localities where it is known to exist.

Its thickness is only about two inches, but it is remarkably persistent. The same coal seen on Rock Creek is reported to occur about three miles east of Mammoth Cave.

The limestone overlying the coal is regarded as being the lowest in the Chester Group, though this cannot be said with certainty, as there was little opportunity to study it. Mr. Moore's section at Manyan's, on Nolin river, near Wheeler's mill, which he has kindly placed at my disposal, shows the position of the coal very nicely. It is as follows:

1. Sandstone	10	feet.
2. Covered (all sandstone?)	15	"
3. Limestone	38	"
4. Shale	2	"
5. Coal	1½	inch
6. Shale	5	feet
7. Shaly sandstone	15	"

The coal has a dull, dry, somewhat slaty appearance, and a foliated structure, susceptible of being divided in very thin leaves; approaching very much in appearance to bituminous slate. It breaks with ragged edges, the faces of the fracture having a banded, brilliant black appearance. Like bituminous slate ordinarily is, it is crossed by vertical joints, the bed separating into rhomboidal blocks quite easily.

The coal seems to be formed entirely of *Cordaites*, the markings of which are distinctly visible on each sheet, no matter how often the coal be split.

Notwithstanding the poor appearance of the coal, an analysis of it shows it to compare very favorably with most of the coals in the coal measures.

The analysis, by Dr. Peter and Mr. Talbutt, is as follows:

Specific gravity	1.338		
Moisture		4.24	
Volatile combustible matter		30.82	
Fixed carbon		55.52	Coke 64.94.
Ash		9.42	
		100.00	
Sulphur	2.892		

The only plants found, besides the *Cordaites* mentioned, belong to the genera *Sphenophyllum* and *Hymenophyllites;* others may occur. Ordinarily a thin bed of calcareous shale overlies the coal, intervening between it and the limestone, but no bituminous slate has been found connected with it, so far as I know. Coal occupying a similar position to the one under consideration is reported to occur in Livingston county.

The presence of this coal in the Chester Group indicates a growth of coal-making plants, notably *Cordaites*, and a feeble attempt at the formation of a coal bed at a period long anterior to the epoch of the coal measures, making the Chester Group a link between the massive limestones of the lower carboniferous and the coal measures.

Though of no economic value, and not militating in the least against the generally accepted opinion that no coal of importance will be found below the coal measures in this country, it antedates the time usually given for the first appearance of coal.

SAMPLING COALS FOR ANALYSIS.

It seems expedient in discussing the coals that a few notes on sampling them for analysis be given.

It is an impossibility to fairly sample coals without the adoption of some methodical plan. No one, be he ever so honest in his endeavors to obtain specimens showing a fair *average* quality of the bed, can do so trusting to his own power of discrimination, or relying on his impartiality. Take him to the stock pile and his collection will invariably represent the quality of the coal to be better than it really is, or, trying to avoid that evil, he will go to the other extreme, selecting samples with two much sulphur or other bad qualities.

The plan adopted in sampling the coals in the district embraced in this report was purely mechanical, otherwise the analyses appended to this chapter would have shown the coals either in a better or poorer light, and been of little value. The plan was as follows: Entering the mine, chips were taken from the bed, beginning at the top and descending to the bottom, at intervals along the main entries, selecting freshly fractured surfaces when available; then entering the rooms, chips were taken from them, sampling the entire bed, from the top to the bottom, in every case.

Everything was included, except in the case of clay partings or where a *thick* band of pyrites occurred, which it was *evident* could be and would be separated from the coal when mined.

These chips, usually a large collecting satchel full, were then taken out and so mingled together as not to have the chippings from one part of the mine distinct from those of another.

The pile was then halved, one half being thrown away, and the other undergoing another course of mixing. This pile was then halved, and the process continued as before till the desired bulk was obtained necessary for analysis.

In this way it is believed that a fair average was obtained of the quality of the coal *as it lies in the bank.*

Though the foregoing plan may be considered a good one for special applications, it is open to objections when the quality of the coal, as it is sent to the market, is to be obtained.

In passing over the screens, it is of course separated from some of the impurities found in the mine.

The analysis is sufficiently accurate, however, to approximately determine whether the coal is suitable for gas or an iron furnace fuel. A general plan for the sampling of the coals in a large mining district, the object being to obtain an accurate analysis of the coal in the entire region, is suggested as follows.

First, chippings from the mine should be taken in the manner previously described. Then samples, to the quantity of several shovel-fulls, should be taken from the stock pile of lump and nut, and averaged by *quartering*.*

Third, samples to be taken from the *lump* and *nut* coal piles separately and averaged as before; this represents the coal as it is sent to the market. And lastly, samples should be taken from the slack pile.

This would give a series of five analyses for each mine, showing the quality of the coal (as near as could be obtained) in the bank, its quality after exposure in the stock pile, the quality of the lump and nut separately as sent to market, and lastly, the amount of impurities removed as slack.

An average of the sum of the analyses made for a number of such collections would then be a fair one for the entire district. The only apparent hindrance to the successful operation of the plan in a general survey is the length of time required for its accomplishment.

On the following page a table of analyses of certain coals, by Dr. Peter and Mr. Talbutt, sampled according to the plan heretofore mentioned, is given.

* This is by dividing the pile into quarters; then taking the opposite quarters they are mixed together and that heap quartered, proceeding in this manner till the amount required for analysis is obtained.

ANALYSES OF COALS FROM CERTAIN COAL MINES IN THE WESTERN COAL FIELD OF KENTUCKY.

	Taylor coal mine, (Beaver Dam)	Stevens' mine, (Beaver Dam)	Rockport mine.	Rockport mine.	Rockport mine.	Mercer's mine.	St. Charles mine.	Ross mine, (Owensboro Junction).	Muhlenburg mines.	Muhlenburg mines.	Muhlenburg mines.
Specific gravity	1.315	1.316	1.421	1.332	1.534	1.358	1.322	1.470	1.297	1.332	1.280
Moisture	3.34	3.30	3.50	3.00	3.00	3.60	3.20	4.16	3.10	1.52	2.98
Volatile comb. matter	35.84	36.76	35.00	36.20	33.50	34.00	35.90	37.44	40.68	40.00	43.08
Fixed carbon	54.36	52.60	52.50	53.70	55.10	50.60	54.00	49.80	50.66	50.92	50.22
Coke	60.86	59.94	61.50	60.80	63.50	62.40	60.90	58.40	56.22	58.48	53.94
Ash	6.50	7.34	9.00	7.10	8.40	11.80	6.90	8.60	5.56	7.56	3.72
Sulphur	3.826	2.604	3.390	2.837	3.332	4.032	2.759	2.727	2.779	2.840	3.125
Number of coal	D*	D*	D	D	D	D	D	A	A	B†	B‡

* Somewhat better than an *average* sample. † Upper part of bed. ‡ Lower part of bed.

CHAPTER II.

DESCRIPTIVE GEOLOGY.

It is the purpose in this chapter to give an outline of the geological structure of the country in reference to the railroad, believing that it may be of assistance to the explorer, and considering it necessary as explaining the horizontal section accompanying the report. The endeavor has also been made to give it a present economic value by treating of the mineral resources of the district traversed by the road in as much detail as possible. Work was practically commenced at a point between Cecilia Junction and Long Grove. From Elizabethtown to Cecilia the country is quite flat for a considerable distance on each side of the railroad. From Cecilia to Long Grove occasional outcrops of the St. Louis Group are seen; but it is not till the latter place is reached that any important exposure of rock is found.

At that point the hills approach the road and lower carboniferous rocks come to view. The first place at which there is any considerable exposure is on Shiny Mountain, about two miles in a southerly course from Long Grove. A good section of the St. Louis beds was obtained there, beginning at the top of the hill and descending on the south side to the valley of Valley Creek. The rocks are included between numbers 12 and 24 of the general section of the St. Louis Group. The upper part of the lower division of the St. Louis Group is exposed in the field of Mr. Eskridge, about half a mile south of the road.

Legends are current in this region, as indeed they are in nearly every locality in southwest Kentucky, that lead or silver has been found in the hills, either by Indians or old settlers, and worked. These old-time stories are not to be believed, however; the relaters were too indiscriminate in the selection of their places. It is as frequent that the lead is said to have been found in sandstones belonging to the coal formation as that it was obtained in rocks where there is even a remote probability for it to occur.

The cause of the mistake is to be referred to the quantity of calcite (pure carbonate of lime) contained in the rocks, which is frequently thought to be silver or lead by those unfamiliar with either metal in its crude state.

From Long Grove to Stephensburg there is a gradual fall in the rocks, with occasional slight flexures in the series, as higher rocks come to view.

Around Stephensburg the rocks included between numbers 6 and 19, of the general section of the St. Louis Group, are exposed, with the sandstone No. 7 (?) capping the hills. In the vicinity of Stephensburg a limestone excellent as a "fire-rock" is exposed. It is grey, hard, and quite silicious and faintly oölitic. It is exposed in the old town and at the east end of the second cut west of the station, and is easily recognized in that vicinity by its peculiar banded appearance. It is universally used at Sephensburg in the construction of backs and jambs of fire-places, and is much esteemed.

At the first large cut west of the fifty-second mile-post the sandstone and shale, numbered 6 and 7 in the section previously referred to, are seen. At the base of the shale the limestone containing *Pentremites Godonii*, *Pent. pyrformis*, *Pent. Koninckiana* and *Pent. Norwoodii?* is exposed. The sandstone and shale are exposed at intervals from this point on to within a short distance of Nebo Tunnel, at which place the Big Clifty sandstone comes to view.

The Big Clifty sandstone is then the most prominent rock exposure on to Big Clifty Creek. At some points in the vicinity of East View it exhibits a thickness of sixty feet, thickening towards the west.

A short distance beyond Big Clifty Creek the sandstone disappears, and the first of the series of limestones and shales overlying it come to view.

At the first cut west of Big Clifty Creek the following section of the Chester beds was obtained:

1. Coarse, dark and bluish-grey, impure limestone, in several thick beds, with shale partings. The beds vary from two to five feet in thickness. The fossils are, *Agassizocrinus dactyliformis, Archimedes Oweni* (?), and *Zaphrentis spinulifera* . . . . . 10 feet.
2. Mottled, dark and olive colored calcareo-argillaceous shale, with thin beds or layers of limestone at the top abounding in fossils . . . . . 5 "
3. Hard, bluish-grey, sub-crystalline limestone, in several layers, with partings of calcareous shale. Organic remains are abundant, the list including *Spirifer Leidyi, Zaphrentis spinulifera, Retepora lyra, Archimedes, Dichocrinus, Agassizocrinus dactyliformis, Athyris Royssii, Straparollus, Spirifer increbescens*, etc. . . . . 3 "
4. Dark blue shale, with thin layers and plates of limestone, abounding in fossils, 8 "

The foregoing rocks are near the base of the series, lying a few feet above the Big Clifty sandstone. Towards Grayson Springs Station higher rocks come to view, the series having a general dip towards the west. At Mr. Patterson's, near the station, a quarry has been opened in the limestone at the base of the group. It is blue, hard, and compact. Large blocks thirty inches thick and six feet long are quarried from it. It is suitable for building abutments, foundations, &c., and can be used for such rough masonry as jails, etc. From Grayson Springs Station to the Springs the rocks descend by what may be termed a series of step-like faults, the Chapel limestone there being the one at Patterson's quarry near the station.

From Grayson Springs Station to Leitchfield the Chester rocks are exposed in an alternating series of limestones, shales, and sandstones; the higher rocks coming to view at the latter place.

A short distance beyond Leitchfield the rocks at the base of the coal measures make their appearance, the sandstone overlying Coal L coming to view.

At Keyser's Tunnel (at the seventy-fifth mile-post) the Bee Spring sandstone is exposed, displaying a thickness of forty feet. At the bottom a thin local bed of coal is seen.

The sandstone is exposed in the railroad cuts between the tunnel and Millwood. At the latter place Coal K (?) is reported at a few feet below the surface; it was not seen.

Beyond Millwood, at the seventy-ninth mile-post, Coals K and L are exposed in the sides of the cuts. The Bee Spring sandstone caps the hills, exhibiting a thickness of from fifteen to twenty-five feet.

The following section was made at the cut on which mile-post No. 79 stands:

1. Covered space from hill-top; probably sandstone		40	feet.
2. Sandstone		15	"
3. Drab argillaceous shale		5	"
4. Concretionary bed of impure sandy iron-stone; too sandy to be of value as an iron ore		½	"
5. Drab argillaceous shale, with small iron-stone concretions		4½	"
6. Coal K. Not of very good quality	0 to	2½	"
7. Fire-clay		½	"
8. Bluish colored shale, with iron-stone concretions. (To railroad track).		10	"
9. Compact grey and buff sandstone		7	"

In the next cut west Coal L is exposed, but its precise thickness could not be determined. The bituminous slate overlying it, containing *Lingula mytiloides*, is only four inches thick.

In the second cut west, however, the coal was well exposed, displaying a thickness of twenty-one inches. The coal is about level with the railroad track, which descends rapidly towards the west. At seventeen feet below the coal a bed of limestone, one of the superior members of the Chester Group, is exposed. The Bee Spring sandstone caps the hill, occupying a position about fifty-five feet above the coal.

It also caps the hills from the seventy-ninth mile-post to Caneyville. About one quarter of a mile east of the latter place the rocks are faulted twice. At the first fault, opposite the bridge over Bennett's Fork, the Chester limestone is brought up to a level nearly with the sandstone capping the hill on the west side of Caneyville.

The limestone coming below Coal L is forty-four feet above the road, with a thin sandstone interposed between it and the coal. The section is as follows:

1. Twenty feet slope strewn with sandstone fragments.
2. Five feet soft buff sandstone.
3. Ten feet covered space; all sandstone?
4. Fifteen feet irregularly-bedded limestone, abounding in fossils pertaining to the Chester Group.
5. Forty-four feet covered space to the railroad.

Just before reaching Caneyville, and at the town, there is another fault, a down-throw. All the faults hade westward.

Caneyville lies in a valley coursing about north and south, the valley being apparently the sequence of a fault. Sand-

stone is exposed on the ridges both on the east and the west. The sandstone on the west seems to lie in its true position, but that on the east seems to be thrown down. On the hill at Mr. Stephen Bond's, at the north end of Caneyville, the sandstone has been quarried. It makes a handsome and endurable building stone.

From Caneyville to Spring Lick the rocks lie horizontally, the Bee Spring sandstone still acting as the capping of the hills. On Jas. S. Carroll's land, three eighths of a mile north of the "Wolf-pen Tank" on the railroad, Coal K has been opened. The coal is about twenty-six inches thick, covered by six inches of soft blue clay filled with plants, among which *Cordaites*, *Lepidodendron*, and *Sigillaria* were recognized. At sixteen feet above the coal the Bee Spring sandstone is exposed.

At Spring Lick, on Mr. Russell Renfrow's land, Coal L is seen, exhibiting a thickness of eleven inches or more.

The following section was made near Spring Lick, commencing on the hills about one mile and a quarter west of north of Mr. Renfrow's house, and proceeding south to the railroad:

1. Eleven feet sandstone weathering with a honey-combed appearance.
2. Twenty-five feet covered space, probably shale.
3. Fifteen feet soft sandstone.
4. Seventy-five feet covered space.
5. Five feet sandstone.
6. Twenty-two feet covered space.
7. Three feet ochreous clay.
8. Seven inches hard, brittle coal.
9. One foot fire-clay.
10. Twenty-six feet covered space.
11. Seven feet very thinly laminated, hard, sandy shale.
12. Twenty feet sandstone.
13. Twenty feet shale.
14. Four inches bituminous slate.
15. Eleven inches coal.
16. One foot fire-clay.
17. Five feet covered space.
18. Limestone of the Chester Group.

It is probable that the Coal No. 8 is Coal K. The rocks dip west from Mr. Renfrow's, the coal seen at his dwelling passing below the railroad. It was reached in a well dug at Spring Lick Station, which showed it to be ten feet below the railroad at that point.

On Mr. Evan Rodgers' land, one quarter of a mile north 35° east from the bridge over Spring Lick Run, two thin beds of coal are found, occupying a position above that at Spring Lick. The upper coal is regarded as a local bed, at least not having any very extended area; the lower one is probably Coal K.

The following section shows the position the two beds hold towards each other:

1. Three feet buff, brown, and drab sandstone.
2. Two feet ochreous and blue clay.
3. Four inches brashy coal.
4. One foot plastic fire-clay.
5. Fifteen feet ochreous and blue shale, with sandy concretions.
6. Four inches hard, sandy shale.
7. Fourteen inches coal.
8. Ten feet sandy and argillaceous shale.
9. Sandstone; the first above Coal L.

From Spring Lick to Ferguson's Station, which is at the ninety-third mile-post, the rocks are nearly horizontal, but undergo several local modifications.

The Bee Spring sandstone is pretty persistent; but the first sandstone above Coal L passes into shale, and Coal K thins to an inch or so, and finally disappears at some point between mile-posts ninety and ninety-one. On the hill opposite the ninety-first mile-post about forty-five feet of bluish-grey sandy shale is exposed, the bottom level with the railroad track, with about seventy-five feet of sandstone still above.

It does appear here as if the Bee Spring sandstone had disappeared or passed into shale, with the sandstone, which occupies a position above it, come to view.

At Ferguson's Station the shale is exposed in the railroad cut. On the hill back of the store a thin coal, about twelve inches thick, occurs at the top of a sandstone some ten or twelve feet thick.

I am rather doubtful respecting the place of the coal, being inclined to regard it as equivalent either to Coal K or to a thin seam only two inches thick seen running through the shales over the Bee Spring sandstone about half way between Spring Lick and Ferguson's. The top of the sandstone, immediately below the coal, is a mass of *Stigmaria ficoides* with

the rootlets attached. On Mr. Jas. Ferguson's land, about one mile and three quarters northeast from the station, several openings in the coal have been made. Two horizons of coal are found as indicated in the following section:

1. Ten feet or more of blue, blue and chocolate colored argillaceous shale.
2. Three feet of coal. The upper three inches of the bed is dull black, with a fracture resembling that of cannel coal. The bottom four inches rash coal made up of the flattened bark of *Sigillaria* and *Stigmaria ficoides*. The remainder of the coal is glossy black, close-textured, firm, and of excellent quality.
3. Twenty feet shale.
4. One foot coal.

This coal has been regarded as Coal H, though it is a question whether the conclusion is correct. For the present, however, it will be so considered; at least till more light may be thrown on the subject by future investigations in this region.

There is some confusion existing in regard to the rocks in the locality in question, the information concerning them not being as complete as desirable. This is, in great measure, due to the fact that the sandstones have a great tendency to pass into sandy shale, the change frequently being so abrupt that, without the aid of numerous exposures, the observer is apt to be led astray; also to the fact that at Ferguson's the rocks are dipping south, while towards the east they are horizontal.

Between Ferguson's and Horse Branch, a distance of two miles and a half, rock exposures are rare. The hills on the north recede from the railroad, while the rocks on the southern ridges are so disturbed that, with the limited outcrops, it is a quite difficult matter to connect them.

At the first cut west of the 49th mile-post, seventeen feet of blue sandy shale is exposed, which probably is a continuation of that seen at Ferguson's Station. It appears to be dipping east. There is reason to believe that the rocks on the southern hills make a wave between Ferguson's and Horse Branch, the crest of the wave occurring somewhere between mile-posts 94 and 95, the rocks falling off towards both Ferguson's and Horse Branch.

On Mr. Wm. M. Miller's land, about south of mile-post 95, a coal bank has been opened. The coal ranges from twenty-

seven inches to two and one half feet in thickness, and is of fair quality. Its bedding, however, is very irregular; slickensides and rolls being predominant features in it. The coal has much the appearance of the three feet bed north of Ferguson's, but there is reason to believe that it occupies a lower horizon. The coal, so far as opened, has a general dip of 9°, course south 60° west. This is a very strong dip, and, if constant, represents a fall of sixteen feet in every hundred, or, approximately, eight hundred and thirty-two feet in a mile. Of course, however, the angle is not constant; but it is undoubtedly persistent for a sufficient distance to bring the coal below the sandstones and shales at Horse Branch.

In the cuts just west of Horse Branch the thick series of sandstones and shales underlying Coal H come to view. The total thickness has been estimated as being from eighty to one hundred feet. The sandstones are very micaceous, loose-textured, quite friable, and curiously cross-laminated. They frequently and abruptly pass into shale, the transition often being so sudden as to escape notice. The series are exposed in the cuts from Horse Branch to Rosine and beyond, exhibiting an alternating system of shale beds and sandstones. The tunnel just east of Rosine is driven through the upper part of the series. From Rosine to mile-post one hundred and four, a distance of five miles, this sandstone is exposed at intervals in the hills and in the railroad cuts. It has a gradual dip to the west, allowing Coal H to come to view at Mr. J. M. Sandifur's house, about one mile and a half a little west of south of Elm Lick.

The coal is exposed in two places there, on the creek; at an old mill site, as a smutty coal of fourteen inches, and in the bank of the creek, about fifteen feet below that, as a good bed two feet thick. A better view of the coal was obtained there than was offered at any other point along the railroad.

A section made in the vicinity exhibits the following arrangement of the strata:

1.	Brown and ferruginous shaly sandstone	10 feet.	
2.	Earthy coal	1 "	2 inches.
3.	Sandy shale	4 "	
4.	Ferruginous shaly sandstone	7 "	
5.	Covered space, about	3 "	
6.	Brown disintegrating sandstone	2 "	
7.	Firm, glossy black, good coal	2 "	
8.	Blue sandy shale. This is very changeable; it is sometimes grey, soft sandstone, and again passes below into brown sandstone, containing markings resembling *Caulerpites*	5 "	

In digging his well on a point higher than the mill-site, Mr. Sandifur pierced one coal bed of two feet thickness, at eight feet below the surface, and penetrated another, supposed to be the upper bed at the mill-site, at eight feet below that. These are included under the letter H, according to the numbering of the coals adopted in this report.

In the Hines' Mill and Cromwell road, just west of Sandifur's house, the coals found in his well are exposed, as exhibited in the following section:

1.	Soft brown disintegrating sandstone	58 feet.	
2.	Buff and drab clay	1 foot.	
3.	Coal stain		9 inches.
4.	White and ochreous fire-clay	5 feet.	
5.	Buff to brown micaceous sandy shale, in hard, thin laminæ	5 "	
6.	Ochreous argillaceous shale	3	
7.	Coal stain		4 "
8.	Clay and shale	7 "	
9.	Covered to level of valley. Level of railroad nearly	10 "	

About one quarter of a mile west of Mr. Sandifur's the sandstone No. 1 of the foregoing section is exposed, exhibiting a thickness of forty feet.

Ascending the hill, following the road towards Beaver Dam, additional sandstone is exposed, making the entire thickness in that locality to be about eighty feet. There is great similarity in the physical features of this sandstone and that seen on the railroad between Elm Lick and Rosine, but I scarcely think they are equivalent. It is more probable that the one in question overlies the Rosine sandstone, with Coal H between. Such was the conclusion when the vertical section for this district was constructed.

The sandstone caps the ridge on to Richard Stewart's house, which is about one mile or a little more west of Sandifur's, on the Beaver Dam road.

About one quarter of a mile east of Stewart's a thin coal stain of about two inches, sixty feet below the hill top and thirty feet above the level of the valley, is exposed. The valley at this place is about seven feet lower than the railroad track is at a point near the bridge over the South Fork of Big Muddy Creek. This coal is probably equivalent to the upper bed at Sandifur's. In Stewart's well, on the top of the ridge, eighteen feet below the surface, a thin coal is reported to have been found. Possibly it is an outlier of Coal E.

Sandstone equivalent to that at Sandifur's was found underlying the coal, and penetrated to the depth of twenty feet.

From Stewart's to Beaver Dam the sandstone crops out at intervals; occasionally seen in thin layers and again in massive beds; always soft and with a tendency to disintegrate.

Valleys, which are usually wider towards the railroad than towards the south, frequently cut the ridges, which in many instances recede far from the railroad. Rock exposures are few. In the Hartford and Morgantown road, opposite J. M. Peak's house, and a short distance from the railroad bridge over the South Fork of Big Muddy, the sandstone overlying Coal H is exposed for twenty-five feet, the base being about twenty feet above the bottoms. It seems that the rocks are dipping towards the road.

At the side of the road leading south from Beaver Dam, near Mr. Thomas Stevens' coal bank, Coal E is exposed. It is eighteen inches thick, covered with hard, polished, slabby, bituminous slate, and is of excellent quality. It is about fifty feet below the coal at Stevens' bank, and twenty-five feet above the railroad at Beaver Dam Station. The coal is also found on Mr. J. M. Peak's and on Mr. J. B. Poyner's land. At Mr. Poyner's, which is about one mile and a quarter south 25° east from Beaver Dam, the coal ranges from fourteen to twenty inches in thickness, and is of excellent quality. It is covered by three feet of hard, polished, bituminous slate, abounding in fish scales and spines.

At Mr. Peak's, three quarters of a mile north 25° east of Beaver Dam, the coal is thirteen inches thick, covered by one

foot or more of bituminous slate, with *Cordaites* and fish remains. The coal is only fifteen feet above the bottoms at this place; a consequence of the northward dip of the rocks.

The coal is also exposed in the east banks of Rough Creek, at Hartford. The coal there is rotten, varying from four to fourteen inches in thickness, and covered by two feet of smooth, slabby, bituminous slate, containing numerous fish scales of the same species as found at Poyner's and Peak's.

In the Hartford and Beaver Dam road, about one mile and a half from the latter place, a coal stain of fourteen inches is seen, occupying a position below Coal E. It is doubtfully referred to the highest coal at Sandifur's. It is overlaid by twenty-five feet of shale and sandstone, and underlaid by olive and drab sandy shale.

At Mr. Thomas Stevens' coal bank, about three quarters of a mile south of Beaver Dam, Coal D is worked. The coal averages four feet eight inches in thickness, and is of very fair quality. The thin pyritous shale usually accompanying the coal is found in the bank, filled with the typical fossils.

From Stevens' bank to the Taylor coal mine* there is a rapid fall in the rocks, the coal at that place occupying a lower level than the railroad track.

The distance is about one mile, the rocks making a descent of about seventy-five feet in that distance. On the hills back of the Taylor mine the limestone over Coal B makes its appearance, the coal being represented by a mere stain. The "Anvil Rock" sandstone caps the hill.

From the Taylor mine to the McHenry mine, a distance of about two miles and a half, the rocks lie tolerably horizontally, Coal D retaining its position towards the railroad. At McHenry Coals A and B are both found on the hills; neither is fully developed, however. From McHenry to the Lewis Creek tunnel the sandstone overlying Coal D thickens. At the cut immediately west of the Lewis Creek bridge, about half a mile west of the 113th mile-post, it is exposed, displaying a thickness of fifty-five feet.

*This coal mine, with others along the road, is noticed in another chapter.

At the Lewis Creek tunnel, which is but a short distance east of mile-post 115, two thin coals are seen, which are referable to Coal A.

The following section displays the arrangement of the strata:

1.	Shale with thin beds of carbonate of iron	24	feet.
2.	Bituminous slate	3	"
3.	Coal	1	"
4.	Shale; black and bituminous, shading into slate	9	"
5.	Coal	2	"
6.	Clay with pyritous concretions	1½	"
7.	Clay and coal	½	"
8.	Hard clayey shale with large pyritous concretions	4½	"
9.	Limestone; impure, ashy-blue mottled with white. Local?	2	"
10.	Drab shale with nodules of sandy iron-stone	3	"
11.	Limestone; very nodular. To railroad	5	"

Between Lewis Creek tunnel and Rockport the rocks extend in a series of undulations, and are faulted several times, ending with a down-throw at Green river.

The first fault occurs a short distance east of mile-post 116, the Anvil Rock falling to a level with the railroad.

At the first cut east of Rockport the rocks are much disturbed, the strata being contorted and crushed in a singular manner. At the extreme eastern end of the cut, a six-inch coal smut, underlaid by fire-clay, is exposed level with the railroad track. Taking a wave-like dip to the west, it is lost to sight for a short distance, but makes its appearance once more at the west end of the cut. A slight fault, or rather fracture, occurs there, and the coal takes a sudden dip to the west, disappearing below the railroad.

Between the above mentioned cut and the one near the depot building at Rockport there is sufficient rise in the rocks to bring up Coal B, which is exposed as a thin bed at that place.

The following section exhibits the structure of the eastern end of the cut:

1.	"Anvil Rock" sandstone	10	feet.
2.	Sandy shale	1	foot.
3.	Clay and coal		6 inches.
4.	Blue clay	2	feet.
5.	Limestone, containing *Prod. Prattenianus*	1	foot.
6.	Shale and marlite	2	feet.

7.	Limestone; rough, irregularly-bedded, abounding in fossils, viz: *Spirifer cameratus, Spr. plano-convexus, Chonetes Smithii, Archaeocidaris megastylus*, etc.	6 inches to 3 feet.
8.	Dark argillaceous shale	1 foot.
9.	Coal	7 inches.
10.	Blue and yellowish argillaceous shale, with ochreous concretions about the middle. Calcareous nodules are distributed through the lower part	8 feet.
11.	Earthy limestone	1 foot 6 inches.
12.	Sandstone and shale to the railroad.	

This section is of interest as showing the presenee of limestone below coal B, which is represented by the thin coal No. 9.

Excepting No. 1, all the strata on the south side of the cut, down to No. 12, lie horizontally till they near the west end. On the north they dip slightly to the west. At the west end the sandstone is brought down by a fault, crushing down the underlying rocks. and resembling a wedge. At the river, a short distance beyond the cut, it is horizontal, standing out in a vertical escarpment, the mass presenting a thickness of forty feet.

Beyond Green river, in Muhlenburg county, the Anvil Rock and associate coals still continue to furnish exposures, extending in a series of waves to within a mile or two of Greenville.

At Paine's mines, about one quarter of a mile north of Green River Station, Coal A has been worked at a thickness of six feet, the coal being reached by drifting. The thickness is said, however, to be very variable, ranging from one to six feet. The drift having been deserted, was in such a bad condition that it could not be entered.

In the first cut west of Green River Station the sandstone underlying Coal B is exposed.

Coal C makes its appearance as a streak of three inches, included between the upper beds of the sandstone.

From Green river to within a short distance of the Richmond mines, a distance of nearly two miles, the rocks are regular and retain their horizontality.

Between the two points, at the old mines of Collier and Woodcox, opposite the 118th mile-post, Coals A and B have each been worked. Coal A is five feet thick, immediately overlaid by the Anvil Rock.

Coal B is also five feet thick, and occupies a position five feet below Coal A.

From these mines to the Richmond mines, a distance of not quite half a mile, gentle hills are seen on either side of the road, with occasional intervening valleys.

Near the Richmond mines the strata are found to have experienced peculiar changes. Coal A has dwindled to a few inches, Coal B has also thinned materially, while Coal C has thickened remarkably, displaying a thickness of two and a half feet at the mines; farther west, however, it commences to thin, and in a short distance finally disappears.

Coal D, the working coal at the mines, is reached at ninety-five feet below the bed of the railroad. In the three miles included between mile-posts 119 and 122, the rocks, though apparently horizontal, make a slight undulation, dipping first to the west and then rising, thus bringing the Anvil Rock sandstone on a level with the railroad between the points, but allowing the first underlying coals to come to view at either end.

At the first large cut west of the 119th mile-post the sandstone displays a thickness of from forty-five to fifty-five feet.

At Nelson Creek Station Coal A has been estimated to lie at from eighteen to thirty-five feet below the surface, depending altogether on the nature of the ground.

At the cut on which mile-post 122 stands the rocks rise, allowing the shale under the Anvil Rock to come to view.

The rocks here present some remarkable changes, both physically and in position. The major part of the cut is through sandstone. Towards the west end, however, this rises, or more truly seems to thin from below, and a medley of clay and shales comes to view.

Coal A is represented by a few patches and thin streaks of coal in the base of the sandstone. Towards the west these eventually split off from the sandstone, and traverse the shale for a short distance, gradually disappearing as mere threads. Then a sandy limestone makes its appearance, varying from twelve to eighteen inches in thickness, which, after a series

of irregular undulations, also disappears towards the west. Figure 1, plate 4, represents a hasty sketch of the cut.

The limestone is argillaceous, quite ferruginous, and somewhat sandy. It resembles the limestones at Lewis Creek tunnel, and is probably of local origin.

It is probable that the irregularities in the bedding of the strata at the cut are caused by a slight fault; the rocks beyond the cut west seem to make a drop of a few feet, and then fall gently to the west.

At Owensboro Junction the centre of the coal basin, as it is noted along the line of the railroad, is reached. Coals A and B occur about on a level with the railroad. A number of mines have been opened in either the one or the other bed at the town. These are mentioned in a succeeding chapter.

From Owensboro Junction the rocks and coals rise rapidly to the west, Coal B, which is level with the road at the Junction, being about thirty-five feet above the railroad at Mercer's mines, a distance of three miles. This is not all of the rise, however; the railroad ascends eight feet, making the total rise to be forty-three feet. From Mercer's to the Muhlenburg mines the rise is still more rapid. The distance is not quite a mile, the rocks taking a rise of fifty-four feet, still ascending towards the west till they disappear. The effect of this rapid ascent of the strata is seen at Greenville and vicinity, where the lower series, from Coal D to Coal F, come to view. It seems, in fact, that the explanation is to be found in a faulting of the rocks just east of Greenville.

In the town of Greenville Coal F is exposed in a ravine back of the "Reno House."

A section made to include the rocks in the immediate vicinity of the town is as follows:

1. Ten feet or more of soft, ferruginous, disintegrating sandstone capping the high points in the immediate vicinity of the town.
2. Fourteen inches of coal dirt. Coal F.
3. One foot of fire-clay.
4. Five feet of sandstone and shale, with ochreous concretions.
5. Three feet of mottled blue, dove and drab, somewhat nodular limestone.
6. Twenty-five feet or more of soft sandstone.

The limestone number 5 undergoes some remarkable and sudden changes. Where first seen, in the ravine back of the "Reno House," it was noted as a heavy-bedded, somewhat nodular limestone, coming immediately under the coal. On the road towards the depot, it is a breccia of sandstone and limestone, gradually shading into sandstone. Then on the Russellville road, at the south part of the town, it presents the appearance of a good, compact limestone. It is very probable that the rock is peculiar to the district around Greenville; certainly having a limited area as far as regards the region adjacent the railroad.

About half a mile southwest of the station, up a little ravine, the place for Coal E is found. It is only represented by the overlying bituminous slate.

On the Madisonville road, about one mile in an easterly course from "Rickett's Orchard," the same slate is exposed. The coal is represented by a mere stain.

The following section includes the rocks immediately associated with the slate at that place:

1. Three feet bituminous slate.
2. Eighteen inches clay, with a thin coal stain.
3. Three feet white sandstone, resulting from fire-clay.
4. Ten feet or more of shale, with occasional thin layers of sandstone, and large, heavy, dark blue ferruginous sandstone concretions.

In the cut just east of Greenville, a curious instance of cross-bedding in sandstone is to be seen. Figure 2, plate 4, represents a rough sketch of the sandstone. Besides the remarkable cross-lamination and bedding, there appears to be a fault there, the sandstone at the east end belonging above that at the west.

Beyond Greenville the rocks are horizontal, but with a higher series come to view. Coals D and E are both found in the hills.

At Gordon's Station Coal D is worked at the several mines located there. It is in the hills high above the railroad. On the old "Lucket farm," below the railroad, Coal E is exposed.

The following section exhibits the order in the strata at Gordon's Station and vicinity, commencing at Estill's coal

bank, and descending to the level of the valley south of the road:

1. Sandstone, about	25	feet.		
2. Sandy shale	25	"		
3. Heavy ferruginous limestone, containing small *gasteropods*			2	inches.
4. Sandy shale	20	"		
5. Black bituminous slate	1½	"		
6. Coal D	4	"	10	"
7. Mostly covered space; notably sandstone	40	"		
8. Hard, blue, pyritiferous limestone			6	"
9. Mostly covered space; sandstone outcroppings	25	"		
10. Sandstone	15	"		
11. Sandy shale	15	"		
12. Bituminous slate			10	"
13. Coal E	1½	"		

Beyond Gordon's Station, at a point between mile-posts 137 and 138, there is apparently a fracture in the rocks, the coals dipping rapidly to the west so as to pass below Coal B at Pond river, where it is thirteen feet above the bed of the railroad at the bridge.

The distance is six miles, and the fall is one hundred and forty-five feet, a little more than twenty-four feet to the mile.

Down the river from Bakersport, about half a mile below the railroad bridge, Coals A and B are exposed on land belonging to Föbel and Krauth. Coal B has been worked to a limited extent, the mine being entered by a drift. Coal A displays a thickness of five feet, and Coal B a thickness of four feet ten inches.

The two beds are separated by sixteen inches of limestone. At Bakersport, on the west bank of Pond river, the limestone displays a thickness of six feet, showing a remarkable thickening (for that especial rock) in the short distance separating the two points.

From Bakersport to Nortonville the rocks are nearly horizontal, Coals A and B occasionally outcropping on the southern hills.

At Nortonville a heavy fault is met with. In fact, the town seems to stand on the eastern limits of a series of faults, some of them coursing in a northerly direction, and others coursing about south 55° west.

These latter faults, however, are not immediately in the vicinity of the road at Nortonville, but are some distance to the north and south of it.

The main fault, which seems to be a down-throw, crosses the road a short distance west of the town.

At Mr. Wm. Mills' coal bank, about one quarter of a mile north of Nortonville, on the east side of the St. Louis and Southeastern Railway, Coal B has been worked, and has been estimated as being about level with the Louisville, Paducah, and Southwestern track at the town.

West of the town, on the west side of the St. Louis and Southeastern Railway, the sandstone overlying Coal D is exposed.

The coal does not crop out, however, so far as known, at any place in the vicinity of the town.

The amount of down-throw is from sixty to eighty-five feet. From this main fault the rocks and coals seem to rise in a series of curious step like faults.

In representing these faults in the horizontal section there is a degree of uncertainty as to the exact location of the line of the fractures. The exposures are not continuous in the hills, and small valleys are frequent; consequently, the whereabouts of the fractures had to be estimated. As the horizontal section is not represented as being an *absolutely* correct one, however, but is to be subject to future corrections, acting as a preliminary basis for studying the geological structure of the region across which it is taken, any mistakes, if there be any, will be easily remedied.

The faults in question extend from a short distance beyond mile-post 152 to Rocky Gap. Beyond the Gap the rocks make a drop of about twenty-five feet, Coal D lying at about ten feet above the bed of the road. It then rises towards Underwood, lying about level with the road there, and then makes a slight bend to the west to Caney Fork of Tradewater.

Near Thos. G. Davis's house the sandstone overlying the coal is exposed on each side of the valley of Caney Fork, standing out in heavy cliffs.

At the centre of the valley it is brought down by a fault, crushing the coal up at that point.

The rocks rise from the middle of the valley, both to the east and west, assuming a comparatively horizontal position within a short distance of either side of it.

This fracture in the rocks at Davis's is no doubt an associate of the faults at the Caney Creek mines, discussed in a succeeding chapter.*

As intimated, the strata in the vicinity of the Caney Creek mines exhibit a series of disturbances; but in general the rocks from those mines to Woodruff lie horizontally east and west, *rising* towards the *north*, however. The rocks on the southern hills, however, *dip* towards the north, a lower series coming to view than is to be found in the northern hills. In fact, it appears that the railroad from Caney Creek to within three or four miles of Tradewater passes along the trough of a fault, the course of which is about north 55° east.

On the north side of the road, to within two miles (perhaps a little more) of Tradewater Station, the high coals cap the hills, dipping towards the road, while on the south coals as low as Coal J are exposed.

The hills on either side of the railroad are in many instances quite distant from each other, so that the coals on the south are apparently, so far as their topographical position would imply, identical with those on the north, while in reality they belong below. The coals on either side, as previously intimated, dip towards the road, those on the north having the greatest fall. The existence of the fault in question does not seem to have been noticed by the majority of those making investigations in the region, and, as a consequence, much confusion and perplexity has ensued. The attempt has been made to connect the beds as exposed on the north and south with each other; of course resulting in failure. An illustration of the topographical relation the coals in question bear to each other is to be found in the vicinity of the St. Charles

* The singular position of the rocks at Davis's suggests that they may have been faulted by the undermining by water of the lower strata.

mines. The coal worked at the mines is Coal D, occupying a position (as measured from the mines) about thirty-two feet above the railroad. On the hills south of the road, on Mr. Childer's land, opposite the mines, Coal I crops out with the limestone lying forty feet above Coal J, also exposed, both dipping northwardly

These occupy a position about sixty feet above the road, measuring the distance from their place of outcropping to the railroad. Were they extended to the road, however, the distance would be diminished considerably.

The coal at the St. Charles mines dips south 30° east, at the rate of three feet in the hundred; this is sufficient to bring it about level with the road, did it extend so far.

Not perceiving the fault, these coals have been regarded by some as identical, who thus commit a serious mistake.

The coal on the south having been recognized as No. 4 of Dr. Owen, by those acquainted with the coals in Union county, they have considered that at the Caney Creek and St. Charles mines to be No. 4 also, when, in fact, it is his No. 9, or Coal D, according to the nomenclature adopted in this report.

In studying this district the two regions lying to the north and south of the road should be kept distinct.

Taking the limestone previously mentioned, which is probably equivalent to the "Curlew limestone" of Dr. Owen, as the starting point on the south, and allowing for the dip, there will be no difficulty in locating the different coal beds towards the south; but when the attempt is made to build conclusions for the country north of the road, based on what may be seen on the south, it will inevitably lead to error.

It has been previously stated that the railroad followed the trough of the fault. The statement was intended to be general in its character: the fault has a general course south 55° to 80° west, while the road runs nearly west; following the valley, however, which is probably a sequence of the fault.

Beyond the St. Charles mines the hills are, in the greatest number of instances, quite distant from each other, with the rocks still retaining their synclinal dip.

Consequent on the curves in the course of the road the rocks are sometimes level with, and again above it.

The rocks associated with Coal D extend a considerable distance beyond St. Charles, but finally disappear from view beyond Hamby's Station, and the connection between them and the lower ones is lost.

On the south side of the road, however, Coals I and J may be followed until the connection with Coal L is made. On the horizontal section, therefore, a gap of about three quarters of a mile was left to avoid producing confusion, and the geology then drawn in as it is presented on the southern hills.

In Dr. Woodruff's lane, about half a mile in a northwesterly direction from Woodruff, Coals A and B crop out, with two feet of limestone between them.

The coals are about three hundred yards north of the railroad, and ten feet above the track, brought down by the rapid dip mentioned heretofore.

The sandstone overlying Coal D is seen on Cane Run, a short distance away from Coals A and B. Starting at these Coals (A and B), and following up Cane Run to the old Pritchett farm, the sandstone is in view all the way, rising rapidly to the north.

At the Pritchett farm it constitutes the backbone of the ridge (one of the spurs of Wright's Mountain?) Pursuing an irregular westerly course from there, following the ridge, the sandstone is traced to Hamby's Station.

On Sandstone Branch (between Cane Run and Rocky Mt. Branch), half a mile east of Hamby's Station, it is exposed in heavy beds, some thirty feet thick.

On Rocky Mt. Branch, at the crossing of the Princeton and Greenville road, about half a mile north of Hamby's Station, it is seen presenting a thickness of from thirty to forty feet.

At Mr. John Day's, a short distance up the branch from the Greenville road, the same rock is seen with a coal bed about ten feet above it. The thickness of the coal was not known.

On Mr. Dixon Wright's land, about one mile and a half north 24° west of Hamby's Station, coal also occupying a

position above the sandstone (probably equivalent to that at Day's) is found. It is of excellent quality, so much as could be seen, which was only two feet, the base not being exposed.

Coal is exposed in a number of places on Mr. Wright's property. At one place, where measured, it was found to be five feet thick. It is reported to be seven feet thick near Mr. Wright's house. This coal and that on Mr. Thomas Crabtree's place, about two and a half miles north of the railroad bridge over Sugar Creek, is in all probability Coal A. It is of good quality, and underlies a large area of the country.

At Capt. John Hamby's house, which is about half a mile in a northeasterly direction from mile-post 160, sandstone is exposed, which is probably equivalent to that overlying Coal D. A bed of coal is reported to occur above the sandstone. It was penetrated two feet, but not passed through.

On Captain Hamby's land, about two hundred yards west of the 160th mile-post, north of the railroad, a well dug to the depth of twenty-two feet exposes sandy shale very like that overlying Coal D. It is quite probable that coal is to be found within a short depth. Beyond Captain Hamby's house, the sandstone traced from St. Charles mines is lost to view, the country merging into flat land.

Farther north, however, at Mr. Dutch Woodruff's coal bank, Coal D is exposed and has been worked.

Consequent on its rise to the north the coal is high in the hill, with another bed two feet thick and most excellent in quality at from fifty to sixty feet below it.

On the old Breathitt farm* on the south side of the road, about two hundred yards west of mile-post 160, the limestone above Coal J crops out. It is about fifteen feet above the level of the valley, indicating that the coal should be found at about twenty feet below the surface.

Half a mile south of the mile-post, also on the Breathitt place (south of the house), Coal I has been partially opened. Its entire thickness could not be seen; it is reported to be

* Now owned by Col. Gano Henry.

three feet. The coal is hard, glossy black, and at its exposure appeared to be most admirable in quality.

In a hill about four hundred yards south of the railroad, about three quarters of a mile east of Murray's switch, Coal J is found. Only the upper part was exposed, so that its precise thickness could not be ascertained by actual measurement. It is reported to be four and a half feet thick, which measurement agrees very well with other reports.

The limestone is seen on the hill at forty feet above the coal, the intervening space being taken up by sandstone and shale. The coal is one hundred feet above the valley of Caney Creek, on which stream an outcrop of sandstone is seen, which is probably the top of the conglomerate, or the first sandstone above it.

At Tradewater Station the conglomerate and associate coals make their appearance. The conglomerate is about eighty-five feet thick, and is exposed in the cuts at the station and in the hills. At Mr. Alexander's, about half a mile south 50° east from the station, Coal L has been worked, and is reported to be two and a half feet thick.

According to barometrical measurements, the coal should be found at from ten to twenty feet above the level of the railroad at the station.

At "Coal Ford," on Tradewater, the coal crops out in the west bank of the stream, showing a thickness of four feet (scant). The coal dips north 20° west, at an angle of about 2°; the situation of the bed is such that the angle of dip could not be accurately determined with the means at hand.

During time of low water in the river a coal lying below the conglomerate may be seen in the bed of the stream. Its thickness has never been ascertained.

Beyond Tradewater, the conglomerate forms the geological features along the road for several miles, disappearing at some point near the 171st mile-post. The exact limit of its western extension was not definitely ascertained, however, the time necessary for so doing not being convenient; nor was it considered necessary for the usefulness of the work in hand that it should be done at this time. When the question of the

mineral wealth of Caldwell and adjoining counties comes to be considered, it certainly will be very important that its exact limits should be defined, on account of the coals, and possibly iron ores, associated with it.

The first exposure of the rocks underlying the conglomerate, the Chester Group, is seen a short distance east of the 171st mile-post.

The limestones, alternating with shales, are exposed at intervals on to the first cut west of mile-post 172.

At that cut sandstones and shales occupying the position of the Big Clifty sandstone,* lying at the base of the Chester Group, come to view.†

They are exposed in the two succeeding cuts, dipping at a high angle, nearly 45°, north 60° east. The total thickness is about two hundred feet.

The upper members of the St. Louis Group appear at the cut where mile-post 173 stands. Here the rocks dip south 60° west, at an angle of 2°. It will be noticed that this is the reverse of the dip at the cut where the Big Clifty sandstone is exposed. The axis of the anticlinal is about six hundred feet east of the 173d mile-post.

From this point to Princeton the members of the upper division of the St. Louis Group are exposed, assuming comparative horizontality near Scottsburg, and retaining it, with slight variation, on to Princeton and beyond.

At Princeton and vicinity fine exposures of the group are obtained, nearly all the beds, from the top of the series to the blue limestone of the second division, appearing in the hills back of the town and in the railroad cuts.

The following section was constructed to include the rocks in the vicinity of the town: ‡

1. Drab limestone in heavy beds; the upper members rather coarse-grained, bluish-drab in color, with shale partings; the lower members fine-grained, even-textured, and compact . . . . . 35 feet

*See general section of the Chester Group.

†To avoid a redundancy of names, the name "Big Clifty sandstone" will be retained for this series of sandstones, &c., though differing physically from the sandstone seen in Grayson county, where it received its name.

‡The "Big Clifty sandstone" is exposed in the hills north of Princeton, but was not included in the section.

2.	Somewhat argillaceous, bluish-colored limestone, containing *Orthis dubia?* . .	5 feet.
3.	Moderately fine-grained, bluish-drab limestone, abounding in small *Bellerophons* and small *Pentremites*	5 "
4.	Coarse-grained blue limestone; abounds in *Productus elegans, Prod. cora, Retzia vera*, etc.	15 "
5.	Dark blue, fetid, impure limestone	2 "
6.	Blue, coarse limestone.	15 "
7.	Greenish calcareous shale	3 "
8.	Thin-bedded argillaceous limestone	2 "
9.	Grey and oölitic limestone, with chert	20 "
10.	Oölitic limestone	10 "

No. 10 is quarried by the Messrs. McElfatrick at Princeton. The stone is a most admirable material for fine structures, being both beautiful in appearance and durable in quality.

In fact, for all structural purposes this oölite (not particularly at this quarry, but in the entire region) can scarcely be surpassed by any of the lower carboniferous limestones. Beyond Princeton the rocks are comparatively horizontal, extending to the Tennessee river.

The Geodiferous limestone is exposed in the first cut east of the 182d mile-post, and forms the surface structure of the country on to the western limit of the carboniferous formation. Beyond Eddyville it has been eroded in places, and the channels thus made filled by drift deposits.

These places are indicated in the horizontal section accompanying the report, and do not need special description here.

The cut at mile-post 196 is of peculiar interest, the drift deposits, through which it is made, bearing large masses of fine limonite.

This is on the land of Governor Charles Anderson, who has quarried considerable ore from the cut. There is, indeed, a belt of country between the Cumberland and Tennessee rivers, and also somewhat to the east of them, which affords an abundance of very fine limonite.*

From the 196th mile-post to the Tennessee river the limestone is exposed at intervals. At the cut at the eastern end of the Tennessee river trestle it exhibits a thickness of fifty feet, lying horizontally, suddenly terminating at the river.

Beyond Tennessee river, extending to Paducah, the country is flat and covered with post-tertiary deposits.

*As the study of the iron interests of the State is in charge of Mr. Moore, the subject will not be commented on here, more than to state that there appear to be a large area in this region, accessible to the railroad or rivers, productive of the ore.

CHAPTER III.

MINES AND MINING.

The present mode of mining in our western coal field is, in many instances, defective; or it would, perhaps, be nearer the mark to say that the application of the system adopted is not so uniform or thorough as it should be.

It is true the mines are yet comparatively new, and many improvements may yet be introduced; indeed they must necessarily be adopted, that Kentucky may assume the position among the coal-producing States that she deserves. For, with capital to develop it, there is no question that in her wealth of coal she ranks among the first.

Too little care has been had for the future prosperity of the mines. Had they been opened with skill, and properly equipped with machinery at the very start, much money would have been saved that otherwise has been expended in the way of repairs, etc.

Now that these facts are becoming evident to the operators, and skilled men are given charge of the mines, the importance of improvements is acknowledged, and efforts are made to remedy the evils perpetrated by former managers.

It must not be understood that *all* the mines are here referred to; on the contrary, some of them were opened with care, and one or two are handsomely equipped.

There are in all some fifteen or twenty mines in operation along the line of the railroad, in immediate connection with the track, from all of which coal is shipped. There are, besides, a number of mines worked on a modest scale, and outcroppings of coal in the region adjacent the road, which may be connected with it by tramways, or else by side-tracks.

Though considered of but little importance at present, no doubt they will increase in value, and the coal be mined for exportation, when the Kentucky coal has taken its proper place in the different markets.

The following list embraces the important mines along the route, with the distance between each:*

Name of mine.	Distance in miles and tenths.
Taylor Mine*	
Render	1.7
McHenry	.8
Rockport	4.5
Richmond	2.9
Louisville and Stroud City	7.5
Ross	
St. Louis Coal Company's	.5
Cypress	1.4
Coppage	1.1
Mercer's	.1
Muhlenburg	1.0
Gordon Coal and Mining Company	6.2
Quinn's	
Arbuckle's	
Caney Creek	18.4
St. Charles	1.8

* This mine is 108½ miles from Louisville.

Out of this number certain ones may be selected as being worked on a more extensive scale than the others. These are the Taylor, Render, McHenry, Richmond, Louisville and Stroud City, Coppage, Mercer's, Muhlenburg, Caney Creek, and St. Charles.†

System of Mining.—The mines are all operated on the same general plan, that known as the *pillar-and-chamber* or *post-and-stall* system, as it is variously termed.

The rooms are turned at every thirty feet along the entry, and are eighteen feet wide, leaving a *pillar* of twelve feet and a *stump* of twenty-two feet. They are usually driven through from entry to entry, cross-cuts being made at intervals to facilitate the passage of air and expedite the removal of the coal as it is mined. The *main entries* are usually eight feet wide, and the side-entries (cross-entries) six feet in width.

In turning the rooms the entry is kept at a uniform width, usually six to eight feet, for twelve feet in; the rooms are then

* The distances are taken from a list of stations kindly furnished by the engineer's office of the Louisville, Paducah and Southwestern Railroad.

† The "St. Louis Company" were sinking a shaft when their locality was examined, and so were not fairly under way. See notice in another chapter.

widened out, either on both sides or altogether on one side, to the full proportions intended. There are modifications to the dimensions as given, but these hold true in a general application.

Plate 5 is a fair representation of the plan as it is operated in this coal field.

There are, of course, changes made in the direction of the drifts, etc., to suit local requirements, depending on the drainage, means of ventilation, depth from surface, etc., at the various mines.

It has been the custom to *pull* the pillars at an early stage of the workings at some mines, while at others they are left standing a considerable time before being removed; the whole matter, so far as I am aware, depending on the fancy of the inside manager.

This leads to the question, why cannot the *long-wall* system be introduced with success? There certainly are localities where it may be adopted.

The great advantage to be derived from it is the simplicity of plan, ease of ventilation, and increased proportion of *lump* coal to *nut* and *slack*, an item of great importance in mining our soft coal.

Mr. Warington W. Smyth,* in his excellent work on "Coal and Coal Mining," speaks in commendatory terms of the application of the long-wall system to coals of six to nine feet thick; not considering it indispensable, however, that they should be of that thickness only.

In suggesting this plan heretofore to some of the superintendents of our mines, objections were raised in instances where the roof was not good.

Mr. Smyth, whose position and range of observation has enabled him to speak authoritatively on the subject, says: "Nor is it necessary that the roof be good, although the expense will be very different according to its general fragility; but if operations be carried with sufficient smartness to push the working-place daily under a fresh or 'green' roof, it may

*Chief Inspector of the Mines of the Crown (England) and of the Duchy of Cornwall.

be managed on this system, even when composed of *mere fire-clay with slippery joints.*"

This is a strong recommendation, and as the roof is very seldom bad in any of our mines (excepting a few instances where Coal B is worked), there should be no objection on that score.

The economy of the system is manifest, both in the diminished cost of driving entries, in the increased yield of good coal, and in the additional safety to the miners.

It is a well known fact that when the pillars are *pulled*, after standing for any time, it is always accompanied with danger.

The long-wall system has, according to Mr. Smyth, been successfully applied even in the deepest Durham collieries.

It is hoped that the superintendents of our mines will yet give the matter their serious attention; they can yet change their present system into the *long workings*, and as a matter of economy it certainly seems advisable.

The majority of the mines are opened by drifting, the drift entering the hill either as a *slope* or a *level*. In some instances two good and distinct coals may be mined in a single locality; one by drifting and the other by shallow shafting.

In the majority of cases, where the coal is mined by drifting, the bed is sufficiently high in the hill for the coal to be drawn immediately from the mine to the tipple by the bank mules.

In a few instances, however, the bed and railroad are nearly on the same level, necessitating the use of steam power to elevate the coal to the tipple.

The tipple or *tip*, as it is usually termed, is built sufficiently high, about thirty-two feet, to allow a car to be run under the lump screen, and thus facilitate loading.

At the drifts where steam power is used in raising the coal to the tipple it is brought only to the mouth of the mine by mules. There the bank cars are attached to wire ropes passing around a *drum* operated by the engine in the tip-house, and over a series of rollers placed on an inclined plane, and are thus elevated to the tip; there they are taken charge of, and the coal dumped from the car down an inclined plane

through a chute, which carries it to the *coal flat* standing on the track below.

Where the mouth of the drift is level with the tip, or nearly so, the bank cars are carried directly to the tip by the mules.

Screens.—It is an undeniable fact that the coal from the mines in general in this coal field is not cleaned as thoroughly as it should be. The distance between the bars in the screens is not sufficient at many of the mines. In the large screen it should be at least one and three fourths inches, the maximum two inches, and in the smaller one, one half inch. The usual distances in the large screens, as now constructed, are one and one fourth and one and one half inches.

It is a mistake that the spaces between the bars are not enlarged; the increased sales of the coal consequent on its being cleaner would amply repay any additional expense attending the alteration.

The Kentucky coal is a soft coal, and under much handling makes considerable slack. We have a good coal to compete with in our home markets, and should, therefore, be especially careful to send ours away from the mines in as good condition as possible. This can be accomplished only by thorough screening.

The screens, inclined at an angle of from thirty-five to forty-five degrees, are placed in the tipple, thus loading and screening the coal at one and the same time. As the tips are constructed at present, two screens are used.

The first one (termed the *lump screen*) separates the *lump* from the *nut coal*, which, falling between the bars, drops on a second screen (the *nut screen*), and passing over it, is separated from the slack.

After passing over the lump screen the coal enters a *hopper* (in which the coal is weighed) provided with a gate raising vertically and an *apron* at the end. The apron, which is simply a gate swung horizontally, is for the purpose of running the coal over into the flat. When used, one end is fastened by means of clasps to the sides of the car; the other end being permanently attached to the hopper, it forms a gangway for

the coal to pass over. The hopper of course swings free, and is sustained by iron rods passing up into the weighing-house, and fastened to beams attached to the scales.

When the coal is to be weighed the gate is lowered into the hopper and the apron detached from the car. The coal is then dumped from above, and, after passing over the two screens, the lump enters the hopper, is weighed, and then passed over the apron into the car. The nut enters another car without being weighed.

Where the greatest care is taken to obtain clean coal a screen is placed in the apron, thus getting rid of much of the slack resulting from the bruising of the coal in its passage to the hopper. The plan of having a *third* screen is a good one, and should be adopted at all the mines.

The plan of weighing the coal in a hopper is not the best. An improvement is to have *track* scales, on the platform of which the flat to be loaded is placed.

The hopper is then stationary, or rather done away with, and the coal passes directly into the flat, to be weighed there.

When the coal strikes the gate in the hopper it is naturally broken into smaller lumps, and additional slack made; in its passage to the car it is again bruised, making still more slack; by being allowed to pass without obstruction into the car it suffers but one bruising, and is, therefore, comparatively free from fine coal, etc.

At some mines using track scales the gate is retained, but there is no need for it. Arrangements for keeping each miner's coal distinct could be made in other ways.

Shafts.—When the coal is procured by shafting, steam power is used in all cases.

The pits are usually fourteen and a half feet by six and a half feet in diameter, divided at about the middle by heavy planking into two apartments. Then by a simple arrangement of a revolving drum carrying a wire rope, and operated by the engine, a basket is raised and one lowered at the same time, with the same revolutions of the drum; the loaded bas-

ket passes up on one side while on the other the empty one descends.

The *bank cars* used at the mines are of various capacities. The large size hold thirty bushels; the small size about fourteen bushels.

SOME NOTES ON THE COAL TRADE.

The season of 1874 has been a very dull one in the coal trade of southwest Kentucky.

This was due to a variety of circumstances, the most prominent being the great scarcity of money, which brought down the price of coal everywhere, and also the depressed condition of the principal markets, in consequence of their being overstocked. Another cause acting greatly against the operators was the difficulty experienced in procuring a sufficient number of cars to transport the coal.

When certain mines were supplied with transportation, others were compelled to do without, and thus all the orders received could not be filled. This injured the trade materially, as orders which would have come to the Kentucky miners were of necessity filled by dealers in foreign coal.

It was not because of any partiality entertained by the officers of the Louisville, Paducah and Southwestern Railroad toward any particular mine, nor was it because they were regardless of the coal interests along their road, that affairs were thus. It was because the road was not sufficiently equipped with rolling stock to supply all the mines at one time.

The road was in pecuniary difficulty, and, applying to Louisville in vain for help, nothing could be done for the mines. There is no doubt that had Louisville helped the road when asked, thousands of dollars would have been saved to the State, or have been brought into it, that otherwise went to other coal markets.

The Louisville and Paducah Railroad is eminently a coal-road, running for nearly a hundred miles through a continuous coal field, with mines at intervals along its route for nearly that entire distance. It is the outlet for the Kentucky coal

field to the north and south, east and west, and as such should be sustained.

Connecting as it does with the St. Louis and Southeastern Railway at Nortonville, and the Memphis and Paducah road at Paducah, the greater portion of the South is within reach of our mines. A very fair southern trade was gradually coming within the control of our mines, but it unfortunately received a great check by the delayed action of Louisville in respect to the Louisville, Paducah and Southwestern Railroad. Besides the railroads as means of transportation, we have the Green, Cumberland, and Tennessee rivers.

The Tennessee river is already used as a means of transportation by the St. Bernard Coal Company. A fine tipple has been erected on the river, near the railroad bridge, by that company; from March, 1873, to October, 1874, that company had shipped about three hundred and fifty thousand bushels of coal South.

The principal points in the South to which the coal from the various mines is shipped are Jackson, Tennessee, Jackson, Mississippi, Holly Springs, Oxford, Canton, Water Valley, Mississippi, and Bolivar, Tennessee.

Much effort was made to obtain correct statistics of the amount of coal shipped from the mines, but the returns are quite imperfect. The operators of some of the mines failed to give even imperfect returns.

The following table shows only *approximately* the amount of coal shipped from the mines, dating from October, 1872, to October, 1874:*

COAL EXPORTED.

From the principal mines.		From other mines.		Total.		Value at 12 cents.	Cost at 5 cents.	Balance.
Tons.	Bushels.	Tons.	Bushels.	Tons.	Bushels.			
216,000	5,400,000	54,000	1,350,000	270,000	6,750,000	$810,000	$337,500	$472,500

*A number of the largest mines were not opened until 1873, so that for some of them the table does not represent a two years' business.

Points to which coal was shipped.	Tons.	Bushels.	Value. †	Cost. ‡	Balance.
Louisville*	171,000	4,275,000	$513,000	$256,000	$256,000
South and West	4,000	1,000,000	120,000	60,000	60,000

* This table is also a rough estimate. It is likely that much more coal went to Louisville than is estimated.
† Valued at 12 cents per bushel. The coal sells at from 10 to 14 cents per bushel, however.
‡ The cost is placed at 6 cents per bushel; this for mining, transporting, &c

It must be remembered that scarcely any of the mines had been opened longer than two years when the statistics were obtained, and a few were not more than a year old. The St. Charles mine, the largest one on the road, had been shipping coal for only nineteen months.

The coal interest is an immense one, representing far more capital than many have Estimated. A single mine working thirty miners will pay out about one hundred and twenty-five dollars daily, with a total for one year of about thirty-nine thousand dollars. Multiplying that by ten, which will include all mines working so many as thirty miners, and the total is three hundred and ninety thousand dollars. This, however, is scarcely even an approximately correct estimate, for some of the mines employ as many as one hundred miners, and nearly all are prepared to work sixty.

In fact, it would not be far from the truth to state that the coal mines of southwest Kentucky put as much as five hundred thousand dollars in actual circulation within the State yearly. This amount will, of course, increase as the mines assume more importance and increase in number.

The mines, as stated heretofore, are comparatively young, but it may be seen at a glance that they are a source of great wealth to all western Kentucky, and consequently to the entire State.

CHAPTER IV.

NOTES ON THE MINES.

In the description of coal mines, there is necessarily, where the system is alike in all, much repetition.

There is also a continual advance and change in the extent of the workings, so that a description given now of a mine examined several months ago will not represent its present condition.

It is determined, therefore, to avoid much detail in every case, except when a mine presents some peculiar or interesting feature not existing in others.

The Taylor Mine.—This is the first mine of importance west of Louisville. It is situated about two miles southwest of Beaver Dam, Ohio county, and is connected with the main stem of the railroad by a side-track. The mine is opened in Coal D, which averages five feet in thickness, and is worked by drifting, the drift entering a high hill capped by the Anvil Rock sandstone.

The coal is provided with an excellent roof of dense bituminous slate.

The coal is raised to the tipple by steam power in a manner heretofore described.

No returns were received from this mine for the amount of coal shipped up to October 1st, 1874. Mr. D. L. Sublett, the Superintendent, estimates the amount shipped up to January 1st, 1874, as being 15,832 tons (395,812 bushels). Since then, however, there has been considerable increase in the sales.

An analysis of the coal, made by Dr. Peter and Mr. Talbutt, is as follows:*

Specific gravity	1.315	
Moisture	3.34	
Volatile combustible matter	35.84	
Fixed carbon	54.36	Coke 60.86.
Ash	6.50	
Sulphur	3.826	

The Render Mine.—This mine is opened at Hamilton Station, a few yards south of the railroad.

* This analysis is not of a fairly-averaged specimen.

The number of the coal is the same as that worked at the Taylor mine. The mine is opened by a drift, and the coal raised to the tipple by steam power.

The coal is firm, made up of alternating dull and glossy black layers, with a little fibrous coal between the laminæ. It is an excellent heating coal.*

No returns were received from this mine exhibiting the amount of coal shipped up to October, 1874. From January 1st, 1873, to December 1st, 1873, seven hundred and twelve thousand six hundred and seventy bushels were shipped.

The following section, taken in the mine, exhibits the order in the strata:

1. Hard, blue, pyritous, somewhat sandy shale, with small pyritous nodules . . .	10	feet.
2. Blue, argillo-slaty shale; fossiliferous	¼	"
3. Bituminous slate	2	"
4. Coal D	4¾	"

Mr. Wm. Hamilton, sr., has charge of the mine, with Mr. Briggs as General Superintendent.

The mine is well ventilated, and kept in good order.

The McHenry Mine.—This mine is entered by a slope. The coal, as at the foregoing mines, is raised to the tip by an engine stationed in the tip-house.

The coal has a good reputation, and is gotten out in good order. It is, perhaps, in itself no better than that at the neighboring mines, the cause of its being so valued as a fuel depending on the care taken to get it out in good condition. Samples for analysis were taken from this mine, but were miscarried. Mr. Duncan is the Superintendent.

The Rockport Mine.—This is in the same coal (Coal D) as that worked at the McHenry mine. The bed is reached by a shaft sunk to the depth of eighty feet.

Coal B crops out at ten feet above the top of the shaft, and is said to be four feet thick.†

Above that Coal A is also exposed, said to be two feet in thickness.

At thirty-six feet below the top of the shaft Coal C was passed through—present as a mere streak, however. The

* Samples were collected for analysis, but were miscarried.

† It was not opened at the time the mine was examined.

company have three hundred acres, which, not taking into consideration the two upper beds, will produce one million five hundred and sixty-two thousand five hundred tons of marketable coal—estimating the waste in mining at one third. The three following analyses were made of the coal by Dr. Peter and Mr. Talbutt:

	No. 1.	No. 2.	No. 3.
Specific gravity	1.421	1.332	1.534
Moisture	3.50	3.00	3.00
Volatile combustible matter	35.00	36.20	33.50
Coke	61.50	60.80	63.50
Ash	9.00	7.10	8.40
Fixed carbon	52.50	53.70	55.10
Sulphur	3.39	2.837	3.332

The coal is raised by means of a twenty-five horse power engine, made by Shultz & Thurman, Evansville, Indiana.

The Richmond Mine.—This mine had been opened but a short time when visited, and comparatively little shipping had been done.

I am informed, however, that the managers have completed arrangements to work on a large scale, and will bring their mine up to assume an important position among others. Coal D is the one worked, and is reached by a shaft one hundred and ten feet deep.

The mine is provided with many of the modern appliances used in the West, including a fine engine, operating a drum seven feet in diameter, and every thing is kept in excellent order.

Mr. Aaron Evans is the Superintendent.

Louisville and Stroud City Mine.—This mine was opened December, 1872. Coal B is the bed worked at present, reached by shallow shafting. The company propose, however, to sink a shaft to Coal D.

A coal is reported in a boring at one hundred and sixty feet from the surface, below Coal D, said to be seven feet thick. There must be some mistake in this, however. It is probable that there was either an error in estimating the thickness of

the coal or that a bed of bituminous slate, with perhaps a bed of coal, was penetrated and supposed to be all coal. Coal E is very probably the one penetrated.

Mr. Maddox is the Superintendent.

The Ross Mines.—These are opposite the foregoing. Both Coal A and Coal B are worked by drifting. Coal A is of good quality, and in a good condition for working. Its thickness averages five feet. The following analysis of it was made by Dr. Peter and Mr. Talbutt:

Specific gravity	1.407		
Moisture		4.16	
Volatile combustible matter		37.44	
Fixed carbon		49.80	Coke 58.40.
Ash		8.60	
		100.00	
Sulphur	2.727		

Coal B is said not to be as badly cut by clay slips, etc., as is usual with that bed. The slips and rolls course north 50° west.

The St. Louis Coal Company's Mines.—This company owns the old "Finch Shafts" (working Coal B), just west of Owensboro Junction. No shipping was going on when the mines were visited. The work of sinking for Coal D was under way, and, according to information given by those at the mine, the old shafts were abandoned.

The Cypress Mine.—No mining was in operation when this mine was visited.

The Coppage Mine.—This mine is opened by a drift. Coal B is the one worked. No report as to the amount of coal shipped could be obtained.

Mercer's Mine.—This mine is worked by a shaft about sixty feet in depth. Coal D is the one mined.

The mine is fairly well ventilated, and much care taken for the health and safety of the miner. The coal is raised by one of John B. Davis's (Cincinnati, O.) forty horse-power engines, operating a drum five feet in diameter.

The arrangements for draining the mine are complete. The water is collected in a sump, six feet in depth, at one part of the mine, as represented in the diagram opposite page 77.

Then by means of a "Knowles A No. 1" steam pump, with a suction pipe three hundred and fifty feet long, in connection with the engine, and an "A No. 1" bucket-and-plunge pump, the mine is kept clear of water.

Attached to the steam pump is a column pipe seventy-five feet high, through which the water is discharged.

The bucket-and-plunge pump forces water upward seventy-five feet into a cistern in the engine-house, for boiler use.

The tip is placed at about thirty-five feet from the shaft. Three screens are attached to it, one for lump, one for nut, and one placed in the apron.

The lump coal consequently passes over three screens, and is as well cleaned as at any mine on the road.

The following is an analysis of the coal, made by Dr. Peter and Mr. Talbutt:

Specific gravity	1.358	
Moisture	3.60	
Volatile combustible matter	34.00	
Fixed carbon	50.60	Coke 62.40.
Ash	11.80	
Sulphur	4.032	

An interesting feature in this mine is observable in the eastern part. There the bed of a former stream, which had cut a channel through the coal, is found, clay now filling up the gap

Fragments of trees were found in the clay, when an entry was driven through it. No indication of this old water-course is to be seen on the surface.

Mr. Wm. Mercer is the Superintendent.

The Muhlenburg Mine.—Coal B is the bed worked at this mine, which is entered by a drift.

In some parts of the mine the coal is covered by five and a half feet of bituminous slate. Above that Coal A is found.

The limestone usually present over Coal B is wanting throughout the mine.

The coal is badly cut by clay slips, all having about the same general course, which is north 20° west.

From the condition of Coal B, it seems advisable that it be abandoned for the present, and Coal A be worked. The latter is a better coal, and more uniform in its bedding.

Coal B, however, is of good quality, as the following analyses, by the gentlemen above named, show:

No. 1.

Specific gravity	1.332		
Moisture		1.52	
Volatile combustible matter		40.00	
Fixed carbon		50.92	Coke 58.48.
Ash		7.56	
Sulphur	2.840	100.00	

No. 2.

Specific gravity	1.280		
Moisture		2.98	
Volatile combustible matter		43.08	
Fixed carbon		50.22	Coke 53.94.
Ash		3.72	
Sulphur	3.125	100.00	

No. 1 is the upper part of the bed; No. 2 the lower part. Up to October 1st, 1874, about 6,200 tons of coal had been shipped from the mine.

Mr. John Pollock is the Superintendent.

The Gordon Coal Mining Company's Mine.—Coal D is the one worked here. It is mined by drifting in a hill at a point about seventy-five feet above the railroad at Gordon's Station. The coal averages four feet ten inches in thickness. The mine is connected with the railroad, where the tipple is stationed, by a wooden tramway about five hundred feet long.

No returns for the amount of coal shipped were received.

Quinn's Mine.—This mine is near the former. The same coal is worked, and mined in the same manner as at that one.

Arbuckle's Mine.—This is also in Coal D, and is near Gordon's Station. The coal is reached by drifting.

In the vicinity of the above mentioned mines, on the old Lucket farm, now owned by the Louisville, Paducah and Southwestern Railroad, Coal E crops out in the bed of a branch. It is worked by stripping, by those living in the neighborhood.

The coal appears to be excellent in quality, but is only eighteen inches thick.

The Caney Creek Mine.—This mine is located on the line of the railroad about five miles west of Nortonville, in Hopkins county.

It was opened, ready for shipping, May, 1873. The coal worked is Coal D, which, contrary to its character at all other points, is cut by clay seams in a remarkable manner. These seams, however, differ in their character from those attending Coal B. They are evidently results of fractures in the coal, caused by the faulting of it and its associate rocks, and are, therefore, really faults and not clay slips in the ordinary sense of that term.

The course of the faults is north 80° east.

The region abounds in faults, and these at the mine seem to be related to them.

The mine is worked by drifting, the course of the main entry bearing about north.

A section of the strata in the immediate vicinity of the mine is as follows:

1.	Sandstone	50 feet.
2.	Blue and ochreous shale	10 "
3.	Bituminous slate	5 "
4.	Coal	5 "
5.	Fire-clay	5 "
6.	Clay, with masses of limestone	5 "

To facilitate the description of the mine plate 6 is inserted.

The drift is started in a little valley, about fifty feet wide, which seems to have originated in a fault. The shale No. 2 is brought down to the level of the bottom of the coal as now seen (the coal itself having been cut away, or else depressed), with the sandstone No. 1 resting above.

To reach the coal the entry was driven through the shale, as indicated in the figure.

Reaching the coal it was found to lie horizontally, and so it continued for a distance of seventy-five feet. At the end of that distance a second fault was met (fault No. 2), the coal suddenly assuming a position nine feet above the level of the tramway.

It continues in this position for thirty-nine feet; then it drops at an angle of about 45°, the coal being wedge-shaped, with the point of the wedge above. A shaly sandstone, about ten feet thick, accompanies the coal in its fall, lying immediately above it, as if there was an end of the bed (see faults 3

and 4). Driving through this sandstone wedge (so to call it), however, the coal was caught on the other side, *lying in a horizontal position*, and followed for one hundred and twenty-five yards. At the end of that distance another fault was met with, the coal dropping ten feet, and continuing in that position for sixteen yards.

It then rises and assumes its proper position once more. This is the last fault seen in the bank; but there seem to be indications of the existence of others still beyond. It will be noticed that the coal does not make these changes in position by rolls or undulations, but by sudden slips, the body of the coal dropping or rising for a certain distance, and then lying horizontally.

The ends of the broken parts are always connected by a thin streak of coal. The presence of the sandstone between faults three and four is, at first view, a problem difficult to solve. The solution, however, is presented by the coal itself outside of the mine.

At an old drift, north from the mouth of the mine, the coal is found to have overlapped itself, presenting a seeming thickness of eleven feet.

The bed having been fractured, was depressed or elevated; and the strata being subsequently moved by what was possibly a lateral motion of the earth, the two parts were, by the combined movements (the forward and backward), brought into the position they now occupy.

This explanation is applicable to the case of the sandstone. It is an overlap also, differing from the former, however, in that one of the parts is inclined at an angle of forty-five degrees, while the other retained its horizontality. The sandstone wedge is very probably a part of No. 1. It seems that the fracture of the coal bed was a clean, wide one, and that the sandstone was thrown down into the gap, either at a time preceding the action of the force which drew the sundered parts together, or during the operation of that action.

The absence of the shales over the coal at certain parts of the mine (near the fractures) may be accounted for by suppos-

ing the gaps to have endured some time before the sides were brought together.

The circumstance of the ends of the fractured coal being connected by thin streaks of the material tend to show, however, that the fractures were never very long exposed to outward agencies. It is more probable that the shales were partially removed before the faulting took place.

The connection of the broken parts in the manner referred to is of much interest, and suggests to the mind that the coal may have been partially dislocated when in a soft state. It is merely a suggestion, however, and does not bear with it conviction.

Mr. Wilverth, the Superintendent of the mine, deserves much credit for his energy and ability exhibited in driving the entry. When the sandstone wedge was reached it was calculated to discourage any one; but by wisely sinking a test shaft beyond, the coal was found and reached by driving the entry through.

As would be supposed, the number of these extraordinary "slips" retarded the work greatly, and, as a consequence, comparatively little coal has been exported. Up to October 1st, 1874, the shipments amounted to two hundred and seventy thousand bushels.

The St. Charles Mine.—This is the last mine on the road, going west. Coal D is the working vein. The coal is removed from the hill by drifting.

This is the largest mine on the road. Though only opened in March, 1873, 1,061,093 bushels of coal had been shipped up to October 1st, 1874. Quite a flourishing little village has sprung up around the works.

The greater portion of coal exported goes south by way of the Tennessee river.

There are a few unimportant slips in the coal; but though barely two miles west of the Caney Creek mine, this one is singularly free from them.

It is very possible that the slips encountered there extend as far as the St. Charles mine; but from the position the two

mines have in regard to each other, it is probable they pass to the southward of this one.

In the Dozier entry there is a slight slip, coursing northeast, which crushes the coal down to three feet. Large sandy, pyritous concretions frequently occur in the overlying slate in the Dozier entry. Some are of extraordinary size. They are apt to break down the slate when the coal is removed; otherwise the roof is excellent.

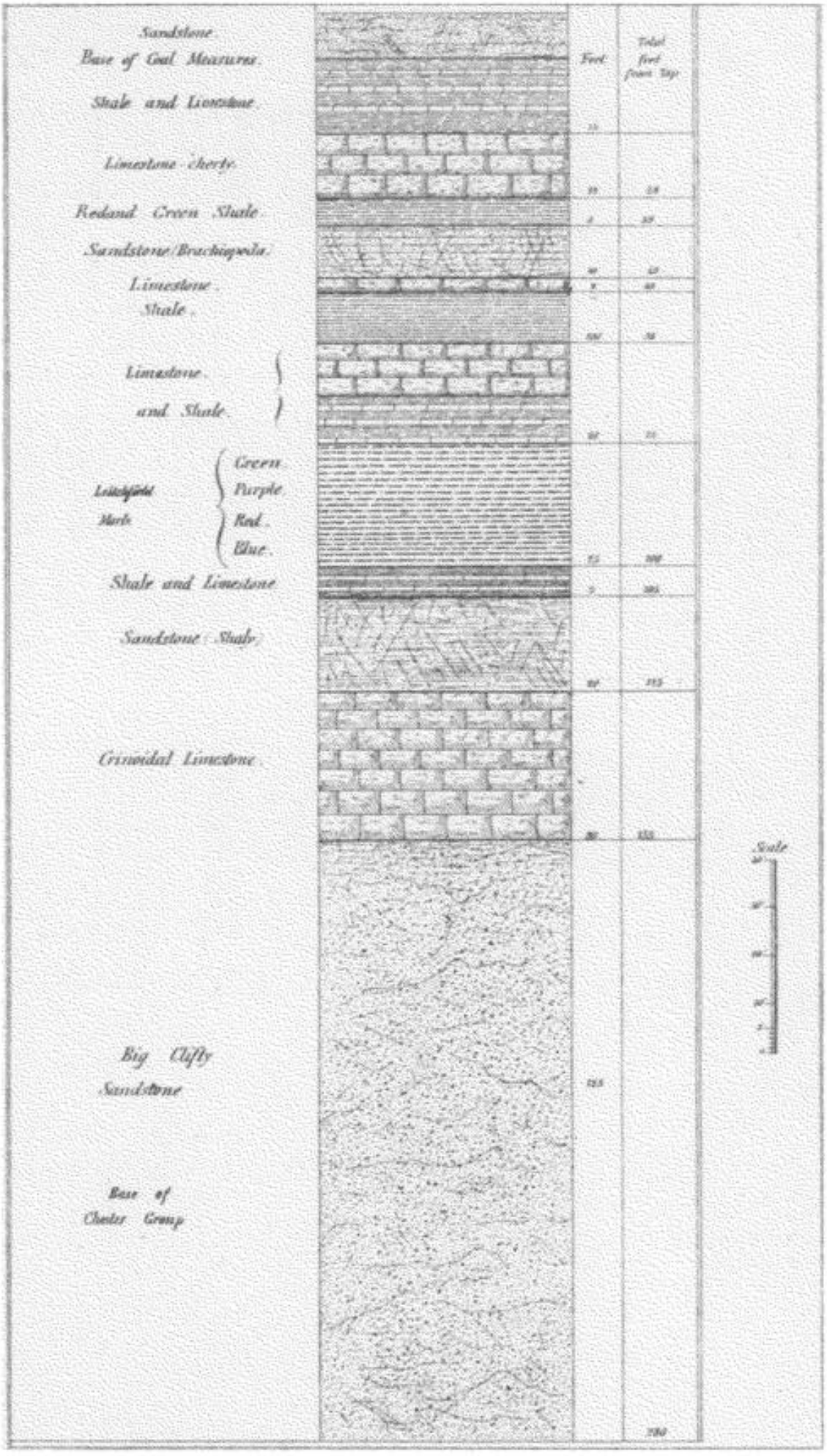
A section made at one of the air shafts of the Dozier entry is as follows:

1.	Earth, etc.	3 feet.
2.	Buff sandstone	10 "
3.	Dark blue shale, with pyritous concretions	14 "
4.	Black slate	4 "
5.	Coal D.	

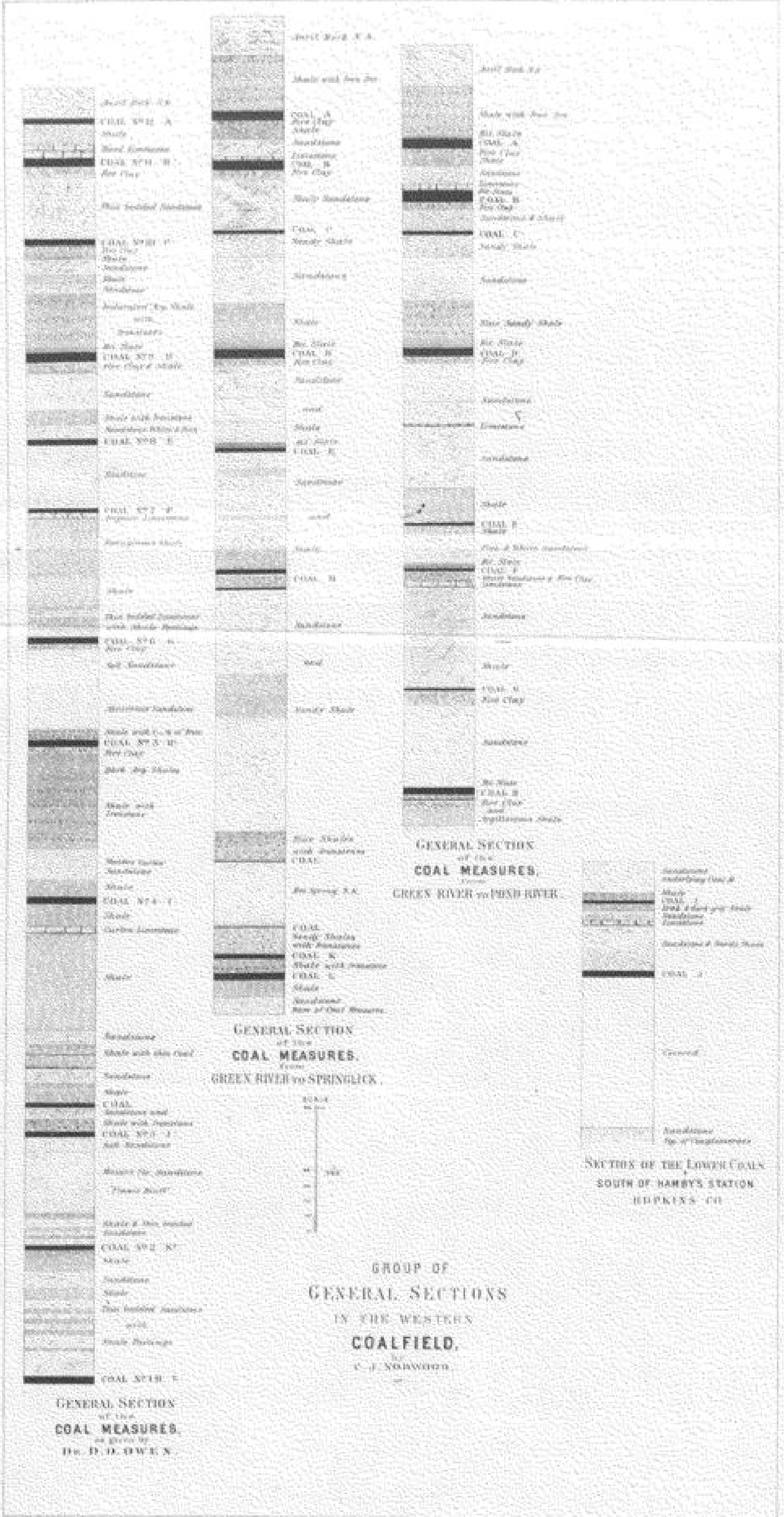
The coal rises rapidly north 30° east, the rise being about three feet in one hundred. Major M. M. Kimmel is the superintendent.

An analysis of the coal will be found on page 49.

This page in the original text is blank.



GENERAL SECTION OF THE CHESTER GROUP


GENERAL SECTION
of the
COAL MEASURES,
as given by
Dr. D. D. OWEN.
GENERAL SECTION
of the
COAL MEASURES,
from
GREEN RIVER to SPRINGLICK.
GENERAL SECTION
of the
COAL MEASURES,
from
GREEN RIVER to POND RIVER.
SECTION OF THE LOWER COALS
SOUTH OF HAMBY'S STATION
HOPKINS CO.
GROUP OF
GENERAL SECTIONS
IN THE WESTERN
COALFIELD,
by
C. J. NORWOOD.

This page in the original text is blank.

Horizontal Scale

Vertical Scale

Sec. 133
At first Cut West of Perrysburg Junct.

Sec. 131
First Cut East of Milepost 131

Sec. 130
First Cut East of Greenville Sta.

Sec. 129
First full cut East of Milligans Sta.

This page in the original text is blank.

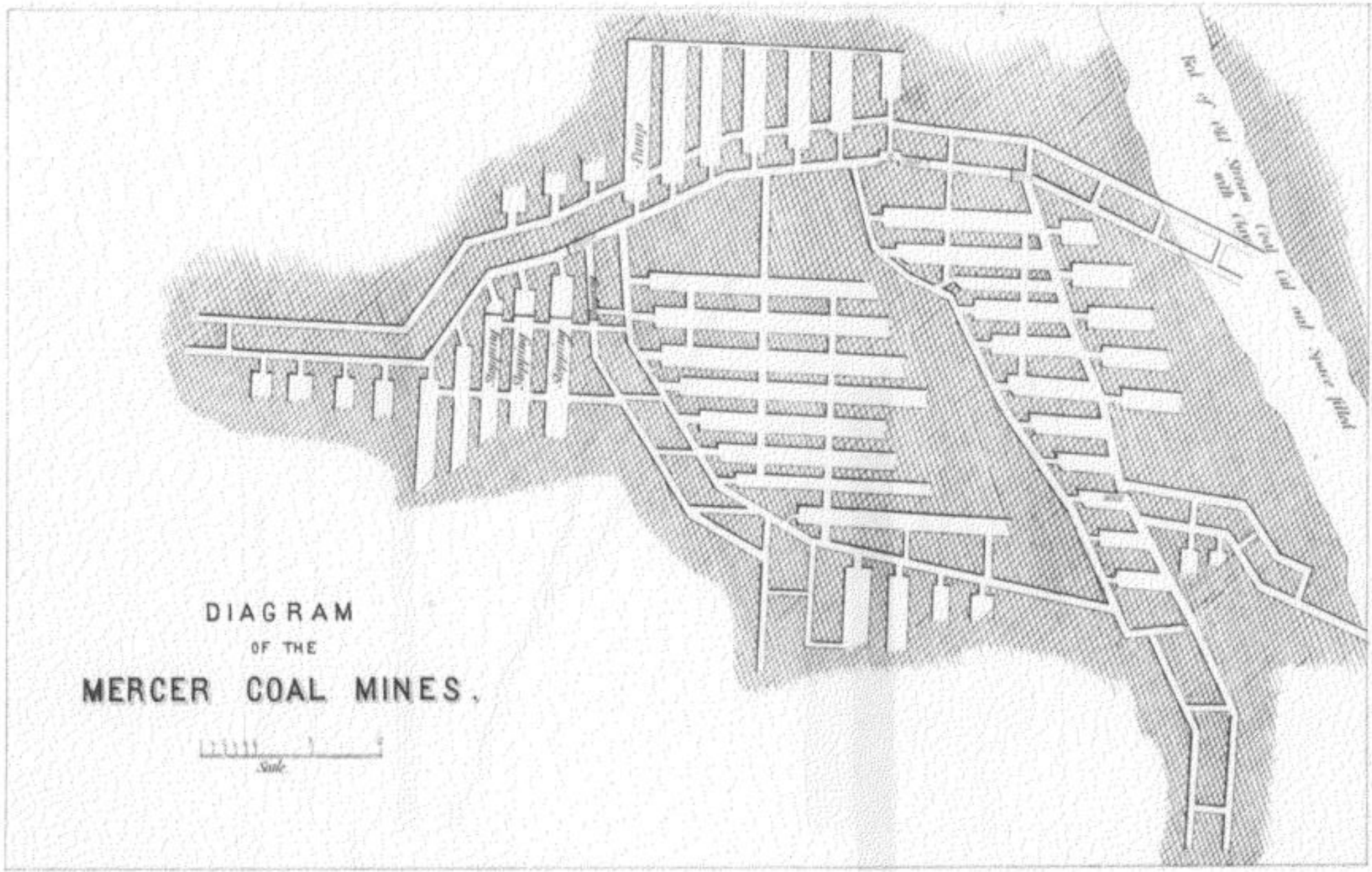
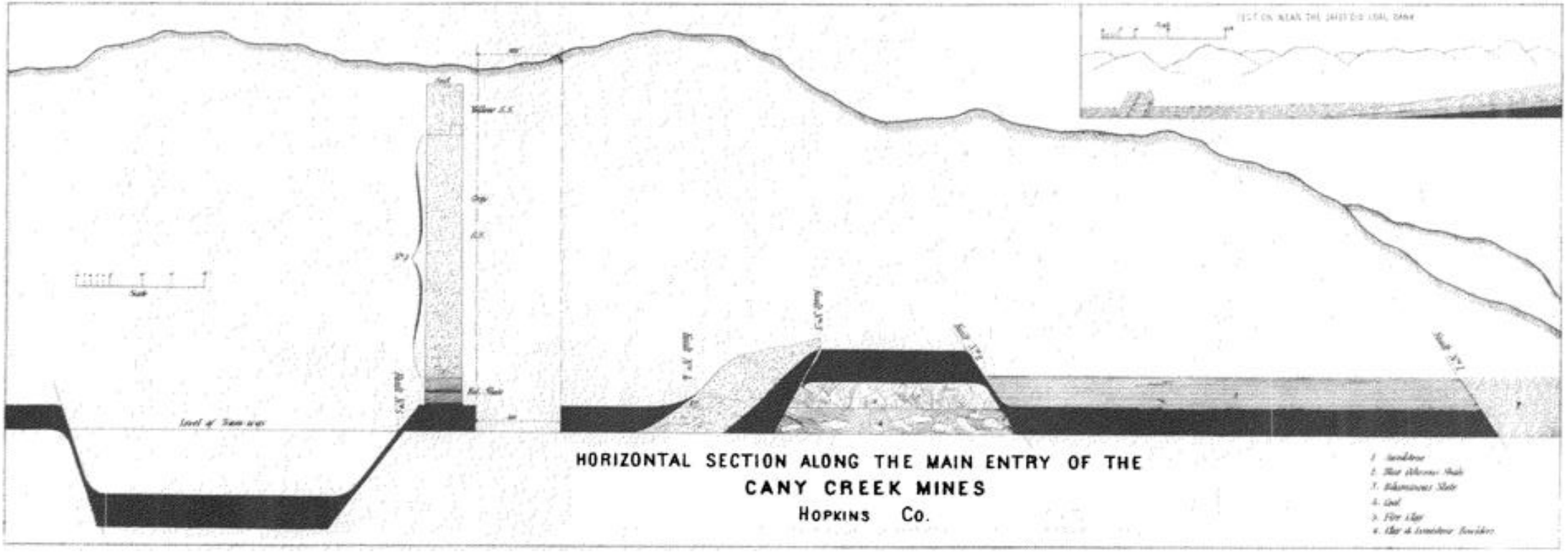
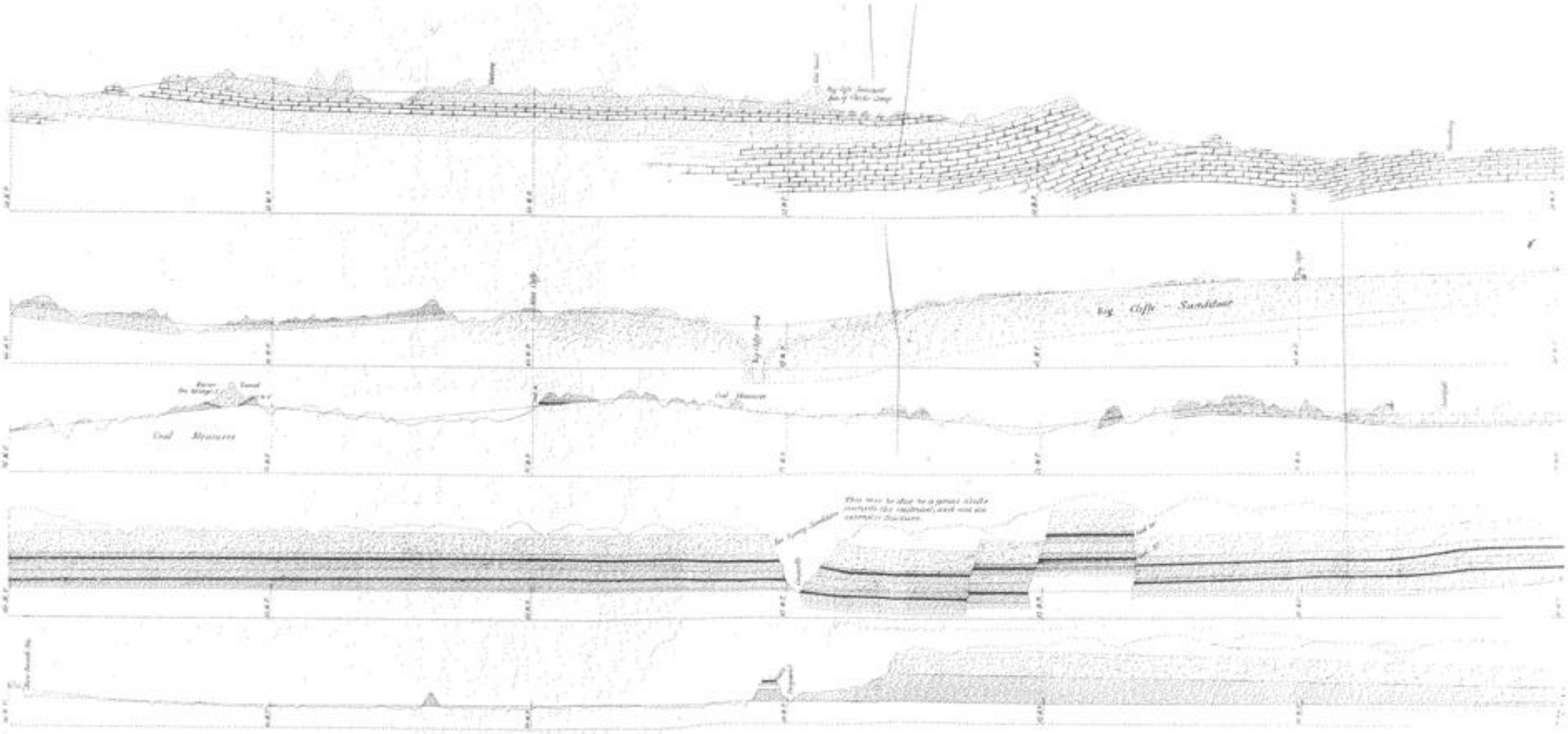


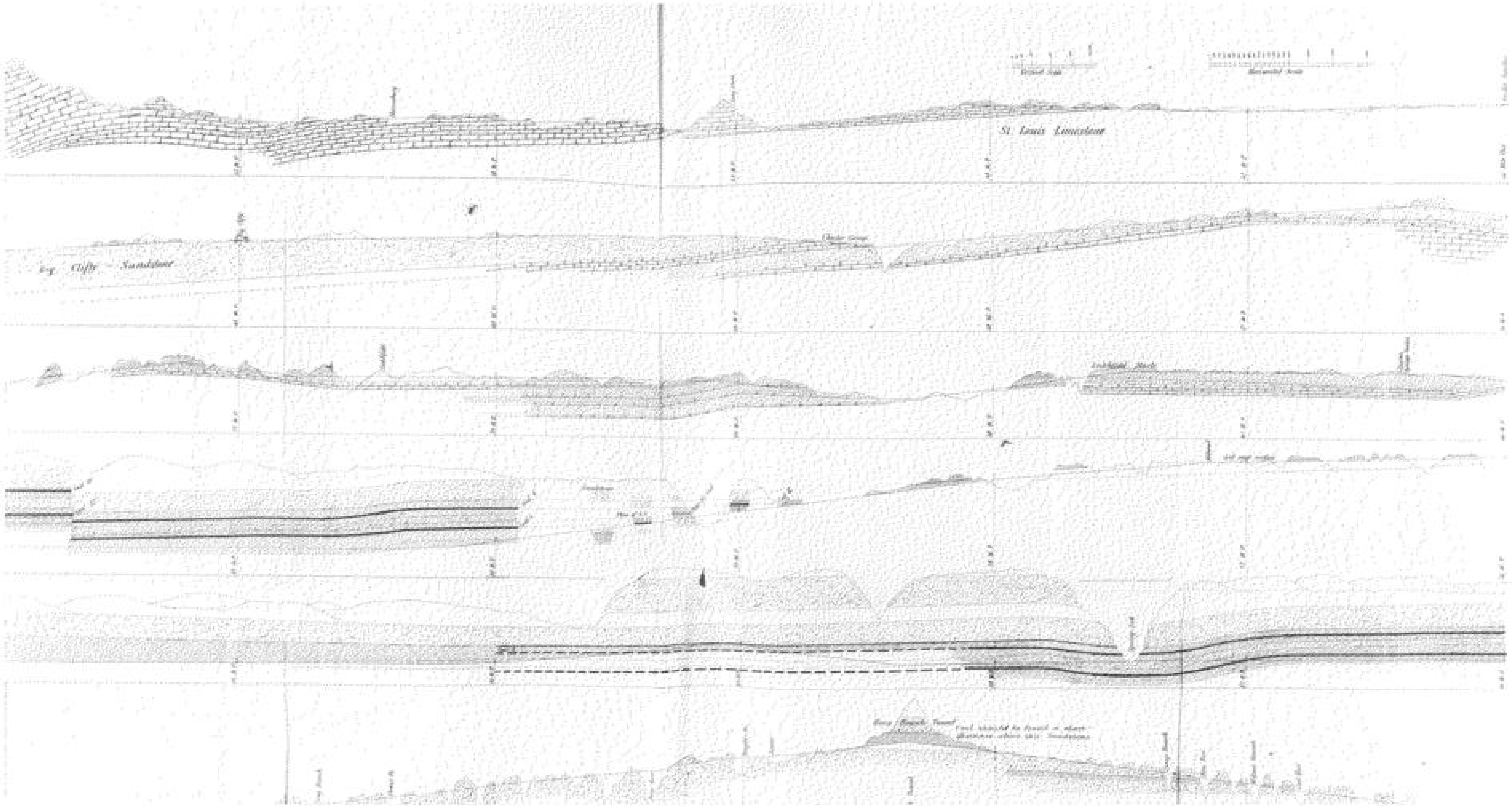
DIAGRAM
OF THE
MERCER COAL MINES.

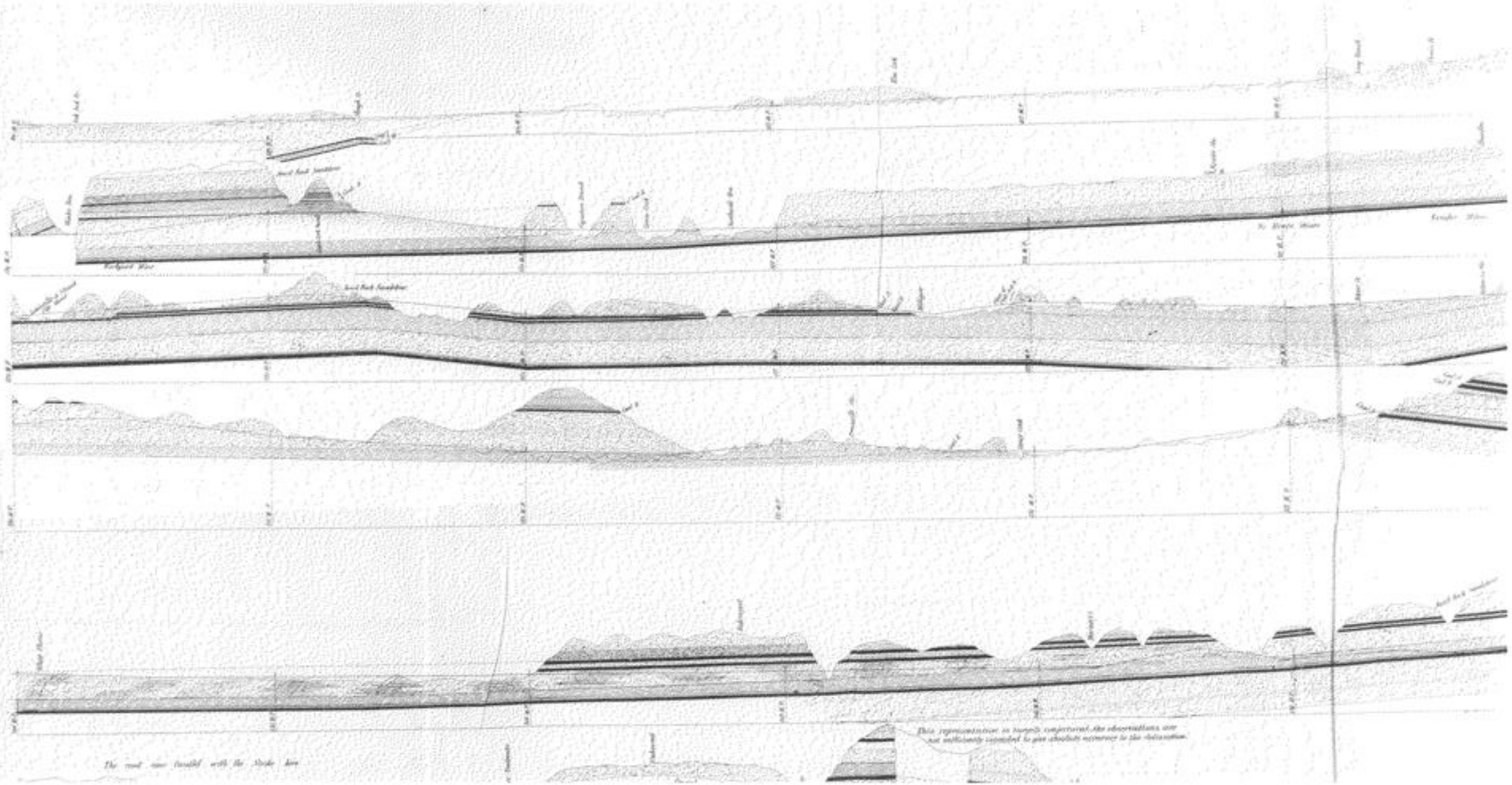
Scale

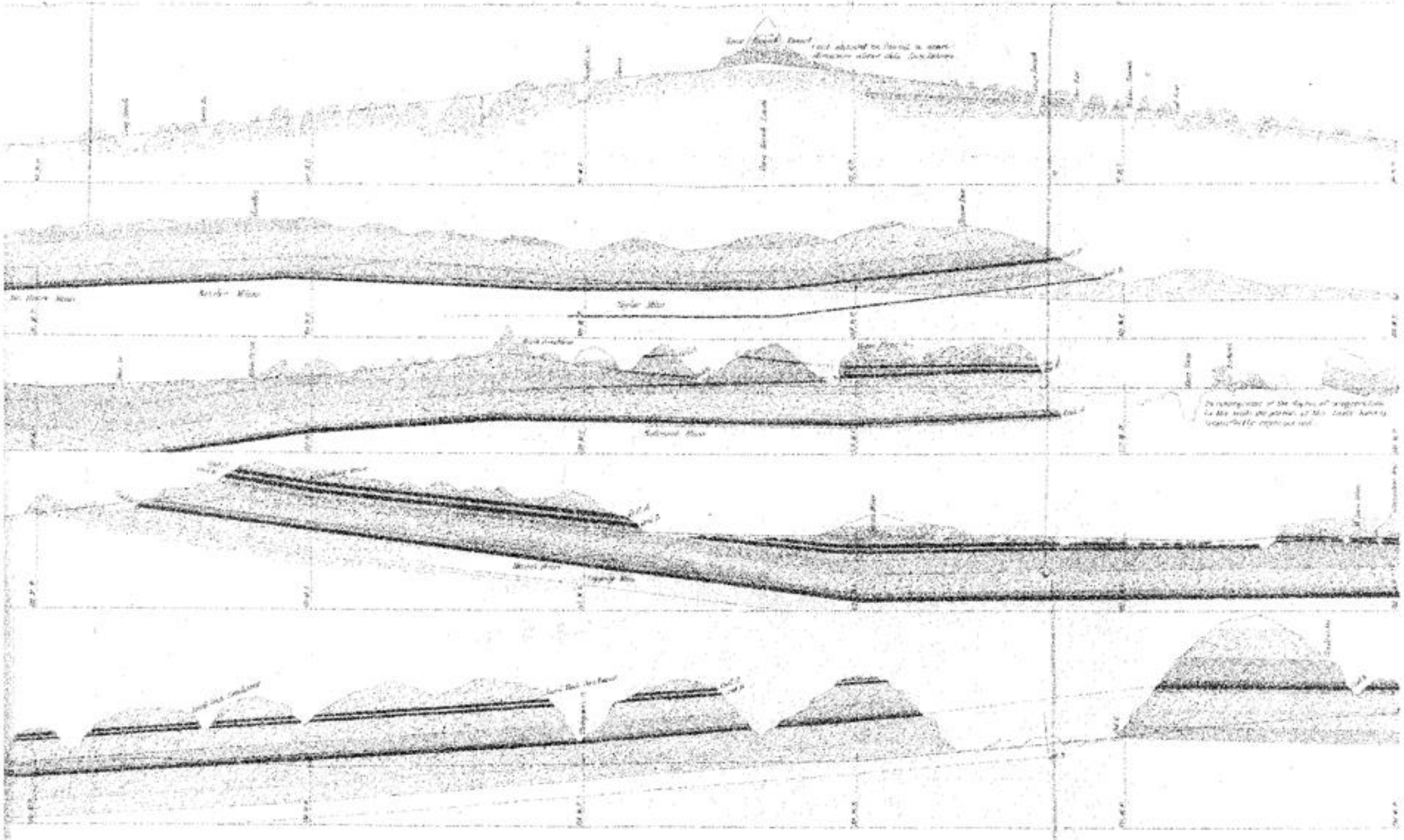


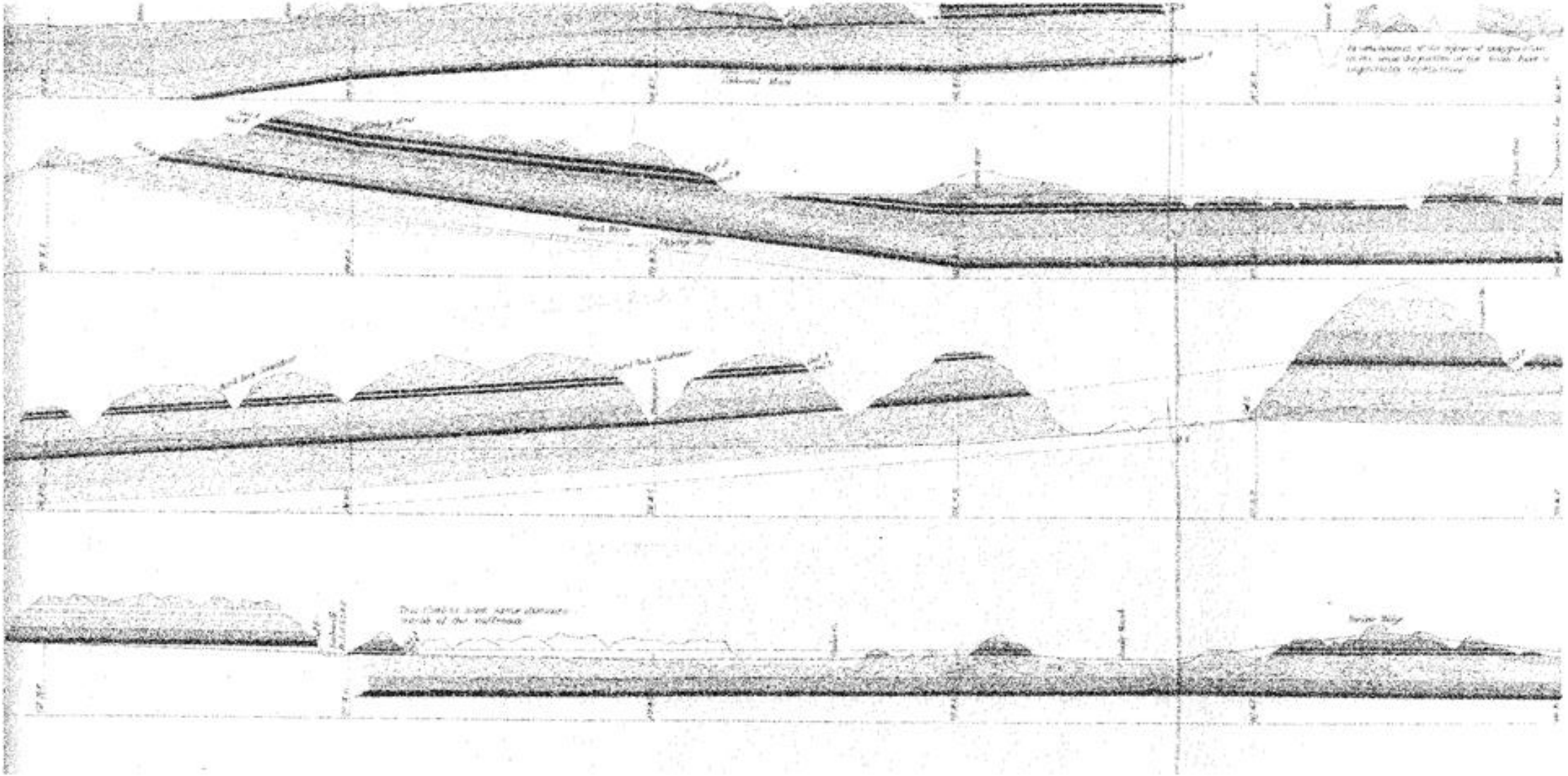
HORIZONTAL SECTION ALONG THE MAIN ENTRY OF THE
CANY CREEK MINES
HOPKINS CO.

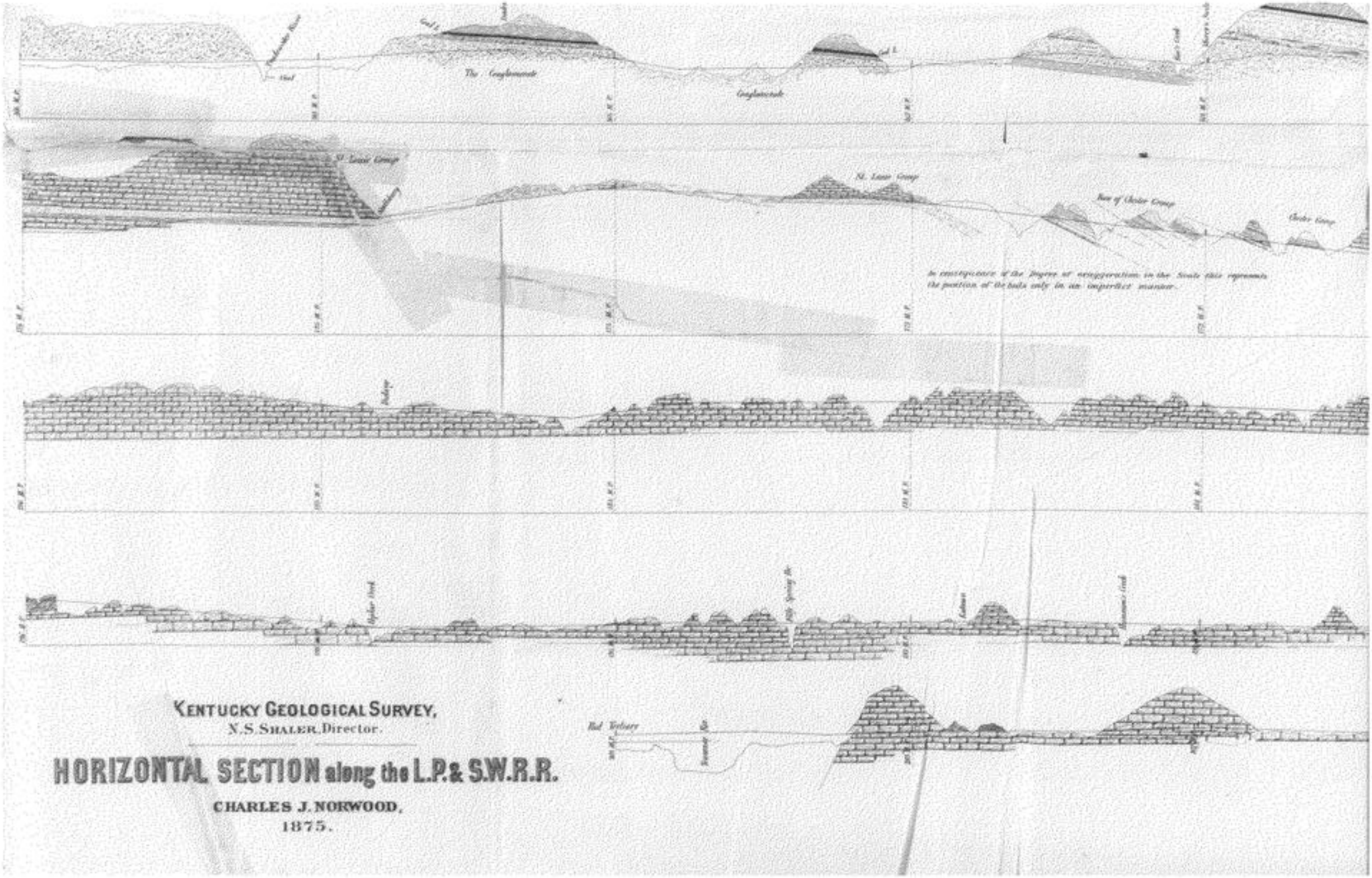

Coal Measures
Coal Measures


St. Louis Limestone
Big Clifty Sandstone
Vertical Scale
Horizontal Scale


Sand Rock Sandstone
Sand Rock Sandstone
This representation as regards comparative the observations are not sufficiently extended to give absolute accuracy to the delineation.
The road runs parallel with the Strike here



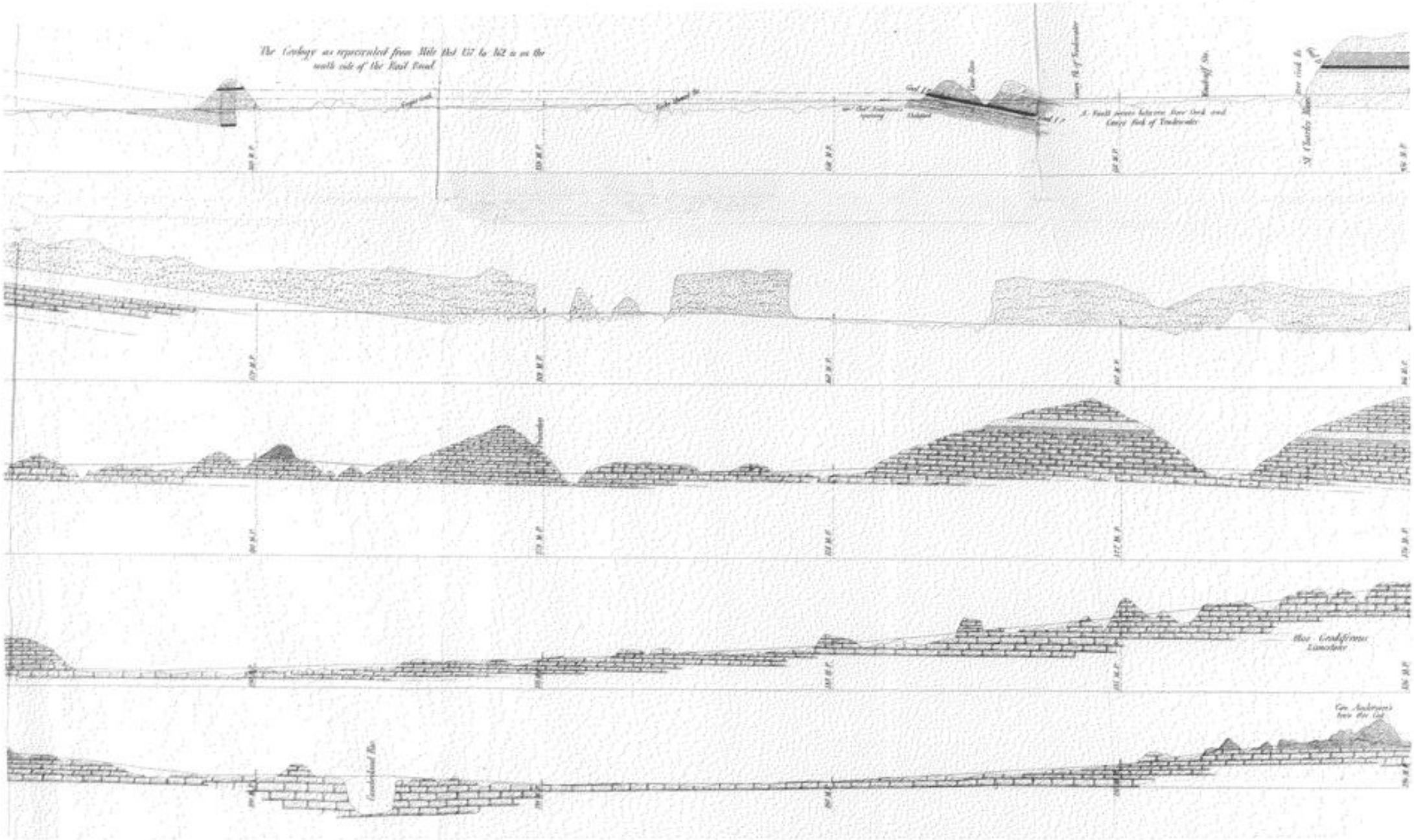




KENTUCKY GEOLOGICAL SURVEY,
N.S. SHALER, Director.

HORIZONTAL SECTION along the L.P.& S.W.R.R.

CHARLES J. NORWOOD,
1875.


The Geology as represented from Mile Post 157 to 162 is on the south side of the East Road
Blue Conglomerate Limestone