TOPOGRAPHICAL

GEOLOGICAL REPORT

OF THE

PROGRESS OF THE SURVEY OF KENTUCKY,

FOR THE YEARS 1858 AND 1859.

BY

SIDNEY S. LYON, Topographical Assistant.

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INTRODUCTORY LETTER.

To Dr. D. D. OWEN, *Principal Geologist:*

SIR: I herewith transmit my Report of the progress of the work of the Geological Survey of Kentucky, made by Corps No. 2, during the year 1858, according to your instructions, a copy of which is hereto annexed.

All of which is respectfully submitted.

SIDNEY S. LYON.

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INSTRUCTIONS

FOR THE GUIDANCE OF S. S. LYON, TOPOGRAPHICAL ASSISTANT
TO THE GEOLOGICAL SURVEY OF KENTUCKY,
FOR THE YEAR 1858.

You will proceed, as soon as possible, to organize the base line party; and, as soon as the weather will permit, take up the line where it was left off last fall, and carry it through, in a due east course, to the Virginia line, with as much dispatch as is consistent with accuracy and permanency.

While on that line, wherever a favorable opportunity offers, you will make accurate and minute geological sections of the strata that present themselves on, or sufficiently adjacent to, the line—not to consume too much time in their construction, or interfere with the main object of the work. You will also make such collections, as opportunity may afford, of all remarkable or interesting soils—*i. e.*, such that can be either definitely referred to a particular geological formation for its derivation, or to individual members of any formation—or such as have interest from supporting any particular growth; or such as seem to be deficient in any particular ingredient, from failing to produce certain crops.

You will also make collection of such ores, minerals, rocks, or fossils, as may be of practical interest and importance.

So soon as the base line is completed, you will disband such members of the corps as may not be required in the prosecution of the topographical work, to be continued through the counties of the western coal field; and then, organize the western corps to proceed with the detailed Topographical Geological Survey of Hancock county, so as to enable you to construct a map of that county on the same scale and style as that of Hopkins county; and carry through said county of Hancock such a system of levels, as will enable you to lay down and report on the relative elevations of the various outcrops of coal, limestone, ore beds, or such beds of rocks as will enable you to identify the horizon of the leading and important members of the western coal measures.

When the Survey of Hancock county is completed, you will proceed with the detailed Topographical Geological Survey of Grayson county, on the same plan as that of Hancock.

During the month of October, you will take a few weeks to make some special collections, at localities of peculiar interest in the various departments and branches of the Survey.

In the latter part of the season, when the weather becomes unfavorable for field operations, you will, with the aid of your sub-assistant, plat up the work of the season, and construct the maps of the counties surveyed, to be ready as early as possible for the engraver.

D. D. OWEN, *State Geologist.*

CHAPTER I.

The necessary preparations having been made, the base line party arrived on the ground and began their labors on the 26th day of April.

The monuments set up at the terminus of the line at the close of the last season were found undisturbed. No difficulties were encountered not necessarily connected with a work of this character, other than those incident to the organization of a party composed of persons not previously engaged in such work. All parties engaging with a good will, the zeal of those employed soon enabled each to perform his duty, and the work made fair progress.

During the early part of the season the work was much retarded by frequent and continued rains.

In addition to the observations made on that part of the line previously run—reaching from Uniontown, eastwardly, 376,847 feet, or 71¼ miles—observations were frequently taken by the barometer to determine the elevations of important points along the base line.

The party were kept at work until the 18th day of September, when the field work on the base line was closed for the season, on the waters of Jenney's creek, near the Big Sandy river.

The total length of the line up to this point was 1,468,757 feet, or 278 miles 917 feet. The distance accomplished this season being 1,091,910 feet, or 206 miles 8 poles.

The season being far advanced, our outfit being insufficient for the residue of the line, the members of the corps being worn out by the length of the time employed, and the mountainous character of the country beyond rendering a different organization of the corps necessary, it was deemed advisable to disband the base line party for this season, especially as one of the wagons and team employed by the base line party was required for the use of corps No. 3 in the operations in the eastern coal field. As soon as the other team was recruited and preparation could be made, I proceeded to make a reconnoissance, preparatory to the work of next season, around the eastern margin of the coal field lying in Grayson, Edmonson, and Hart counties, which was farther extended

into Warren, Allen, Larue, Hardin, Nelson, and Bullitt counties, making at the same time the collections as specified in the instructions.

The topographical and geological details of the country crossed by the base line will be seen by the accompanying diagram and section. The length of the line run can only be conveniently exhibited on a very reduced scale, viz: of six miles to the inch.

It will be seen by the diagram referred to that the line begins at Uniontown—which is situated in a nearly level country, though, geologically, the rocks lie high in the coal measures of the west—and that it crosses successively the coal measures, the millstone grit, and the intercalated beds of limestone associated with it, the sub-carboniferous beds of limestone, and the sandy mudstones of the beds usually called the knobstone.

Descending the sub-carboniferous beds near the valley of Salt river, the line runs on the low valley of the Beech fork of Salt river, on the beds of black slate, the next rock in the descending series, occasionally crossing spurs of the knobstone.

The black slate in the vicinity of the line rests on beds of the Upper Silurian rocks of the age of the Niagara group of the New York State Survey. Hills of inconsiderable altitude frequently including the knobstone, black slate, and considerable masses of the Silurian rocks at the base. As the country becomes higher, toward the east, the black slate forms outliers, capping the hills in the eastern part of Nelson and the western part of Washington county. The shaly limestone beds are cut by the valleys in Nelson county, and form no inconsiderable portion of the surface rock of the western part of Washington county.

After leaving the valley of Cartright's creek, for a short distance the sandy mudstones of the Silurian period occupy the surface. These beds frequently alternate with a soft friable shell limestone.

All the beds are generally soft, and easily cut by running water, thus producing a rolling country—locally quite fertile. One mile west of the last crossing of Salt river, the base of the sandy or muddy silicious beds come to the surface. From Salt river to the valley of Dick's river the country is elevated, nearly level; and the general surface rock is the cavernous bed of the Lower Silurian period. This bed gradually changes by intercalation of the upper and thin plate-like layers of the bird's-eye limestone. This last rock forms the walls of the gorge in which Dick's river flows. Occasional patches of the sandy member are

seen on the west side of Garrard county. The base line crosses Kentucky river near the mouth of Big Hickman creek. The base of the sandy mud beds were not seen at the crossing into Jessamine county. A fault which is coincident with the valley of Hickman creek has carried this rock on the east side of the creek below the surface of the Kentucky river, where the line crosses it. The sandy mud beds are gradually ascended, and are found covered by the yellow magnesian beds of the Upper Silurian group at the crossing of the Lexington and Richmond turnpike, near Richmond. About four miles east of Richmond the black slate, which was last seen in Nelson county, is again the surface rock, rising even in elevated positions; the streams cutting into the yellow beds beneath. This alternation continues to the last crossing of the Kentucky river into Estill county. The last portion of the line cutting the Silurian rocks is at White Oak creek, on the east side of the Lone knob.

The land now suddenly assumes an elevation above the valleys of about 600 feet, and contains, in sections, sandstones of the millstone grit (?), or coal measures, on the top of which rest the whole body of sub-carboniferous limestone, the black slate, and a few feet of the Silurian rocks at the base, including the horizons of the beds of iron ore of Bullitt and Nelson, as well as the beds, probably, equivalent to those of Lyon and Marshall counties, on the western margin of the western coal fields.

Here, in a space of 600 feet, we have rock formations which, in the west, occupy probably 2,700 feet in thickness. The base line from the last crossing of the Kentucky river became very laborious, the country being traversed by deep rocky valleys, from 400 to 500 feet deep, the walls generally vertical, the width varying from 300 to 1,600 feet, while the country is generally heavily timbered and grown up with an undergrowth of hickory, oak, red bud, black locust, &c., depending upon the geological member forming the surface rock—the great feature of the country and of the geology being the great sandstone, so well seen at the old furnace, and known as the State House.

From the vicinity of the old furnace to the crossing of Swift's Camp creek, this notable sandstone is seen in every valley crossed by the line. After crossing Swift's Camp creek, softer beds of the coal measures form the surface rocks, and continue until the line reaches the ridge at the head of Red river, which divides the waters of the Burning fork of

Licking from the head waters of Jenney's creek. The heavy sandstone formation of these ridges is probably the geological equivalent of the sandstone at the top of the section, near Mount Savage furnace, and is considered to be the highest member observed in the coal measures of this region. Since the beds are frequently very much modified in a short distance, minute geological sections were incompatible with the objects of the base line survey; and, indeed, are only of local interest.

To the foregoing statement of the general features of the country traversed by the base line, I shall add a few details and local sections, taken at different points along the line, with some inferences, along with some other observations made in connection with my field work in other parts of the State during the last five years.

The value of the observations made by myself and other members of my corps, is much increased by their continuity, without breaks, over extended tracts of the country; and further, having no special theory to support, I have only followed, or endeavored to follow, the deductions necessarily flowing from the facts themselves.

SPECIAL GEOLOGY OF THE BASE LINE IN BRECKINRIDGE COUNTY.

The following section, taken near the base line, opposite 378,337 feet post, will serve to show the stratigraphical arrangement of the upper beds of the millstone grit, on the eastern edge of the western coal basin.

No. 1. *Section of King's hill, Breckinridge county, east side of Fur fork of Clover creek, the top of the hill being capped with loose blocks of sandstone, which was traced to the yellow sandstone under the "Breckinridge coal," Hancock county, one and a half miles distant:*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Blocks of coarse sandstone, marked by bands of ferruginous stains	21	8	344	8
Thin bedded sandstone	63	------	323	------
Earthy limestone, on surface	5	4	260	------
Steep, covered space, limestone, (?)	10	8	254	------
Slope, covered space, aluminous shales, (?)	84	------	244	------
Beds of limestone, containing Productus and Crinoidea	30	------	160	------
Limestone, containing great numbers of Belerophon	37	------	134	------
Covered space, showing occasionally beds of aluminous shale; base of the mass of black shale	53	4	97	------
Limestone in place, thick beds	13	8	44	8
Aluminous shale	11	------	31	------
Thin bedded sandstone	10	------	20	------
Ledge of sandstone, "Tar Rock"	10	------	10	------
Top of limestone.				

To this may be added the following section, taken immediately north of this locality, and at the Tar Spring. The sections united will form a continuous section. The lower sandstone in section No. 1 is the equivalent of the sandstone at the top of the following section, and is here the place of the tar deposit, which flows down through fissures in the inferior beds, and at the Tar Spring flows out at the base of the sandstone first below this bed:

No. 2. *Section at Tar Springs, Breckinridge county.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Tar sandstone, thin beds	16	------	190	2
Tar sandstone, thick beds	14	8	174	2
Yellowish gray thin bedded limestone, containing Retepora, Archemides, Pentremites, &c.	32	4	159	6
Whitish limestone, thick beds	5	------	127	2
Mass of coarse sandstone	20	------	122	2
Four masses of sandstone beds, well defined by the obliquity of the deposition of the different beds	62	2	102	2
Marly shale, containing lenticular masses of limestone	3	------	40	------
Limestone.	1	6	37	------
Blue gray marl	------	6	35	6
Covered space, probably limestone	35	------	35	------

The Tar Spring sandstone is cut by Clover creek, at the crossing of that creek by the line.

In the foregoing sections a thickness of 534 feet 10 inches of the sand and limestones of the millstone grit beds are given, which circumscribe the coal field of the west on this part of its margin.

Before proceeding eastward, a few remarks will be made in reference to the beds lying above the top of the masses in section No. 1.

The section given in Vol. 1, Kentucky Geological Reports, diagram No. 4, gives the equivalent of the rocks both above and below sections Nos. 1 and 2 united.

On pages 458 and 459, Vol. 3, Kentucky Geological Reports, a section of the masses near the margin of the coal field is given. On the line westward from the Tar fork of Clover creek to Knottsville, the measures are undulating, and frequently cut by the head branches of Blackford's creek.

It is probable that there are no coal beds of workable thickness on the line east of the Hawesville and Hartford road, in Hancock county.

The country between Knottsville and Yellow creek exposes only the beds of the Hawesville section, and those of the section given on pages 458, 459, and 461, Vol. 3, Kentucky Geological Reports.

The beds associated with the Estis or Lewisport coal, were not recognized on the line east of Yellow creek. The line running along the crest of an anticlinal wave, it is probable the beds last alluded to are wasted by denudation in the vicinity of the line, east of Yellow creek; and that they are carried down by rapid dip near the creek, and are lost under the soft beds west of it.

West of Yellow creek the country is covered by the silicious quarternary marls, and no section could be obtained between the creek and Green river.

West of Green river the upper part of the coal measures, associated with the coal beds worked at Newburg and Evansville, Indiana, come to the surface. The section of the Holloway borings, in Henderson county, given on pages 32 to 36, Vol. 1, Kentucky Geological Reports, will serve to illustrate the geology of the line from Green river to Uniontown—it need not be repeated here.

Returning toward the east we find the great sandstone of the Tar Spring forming the banks of Clover creek; the masses covering the sandstone having suffered considerable alteration. The limestone immediately above is semi-oolitic; the upper part of the mass being buff colored, and abounding in *Pentremites*, *Phyriformis*, and *Retepora Archemides*. At the crossing of the Beech fork of Clover creek the great sandstone is beneath the drainage, and is not cut by that creek where we crossed it. The section at Beech fork is identical with the following, taken at Clover creek, except the lime and sandstone masses at the base:

No. 3. *Section of the millstone grit bed at the crossing of Clover creek.*

	Feet.	Inches.	Total.
Covered space	41	.....	158
Buff Pentremital limestone	12	.....	117
Oolitic limestone, (fossils rare)	12	.....	105
Sandstone, single ledge	14	.....	93
Heavy bedded sandstones, oblique lines of deposition	45	.....	79
Talus	20	.....	34
Dark gray concretionary limestone	14	.....	14
Bottom not seen. Bed of creek.			

The creek, where the line crosses it, evidently lies in a synclinal fold, with a rapid dip toward the northwest.

Between Clover and Sugar Camp or Doverty's creek the line lies upon an elevated plateau, with no large streams crossing it. The upper part of section No. 3 is cut at Mr. Weatherford's, on the Hardinsburg and Hartford road, a short distance south of Hardinsburg.

At Sugar Camp creek the following section is visible:

No. 4. *Section at Sugar Camp creek.*

	Thickness.		Elevation.	
	Feet	Inches	Feet.	Inches.
Covered space over limestone—generally flat knolls	25	.....	150	5
Limestone, Pentremites, &c.	24	.....	125	5
Covered space, wasted sandy shales	32	.....	101	5
Buff limestone beds	5	4	69	5
Oolitic limestone, fossiliferous	5	4	64	1
Oolitic limestone, few broken fossils	5	6	58	9
Whitish beds, limestone Pentremites abundant	5	4	53	3
Hard bluish limestone	5	3	47	11
Six plates of limestone, the lower three full of segregations of chert	5	4	42	8
Limestone with regular beds of chert—fossils rare	6	.....	37	4
Covered space, waste of limestone	10	.....	31	4
Fine grained yellow sandstone	5	4	21	4
Bed of sandstone	16	.....	16	.....
Bed of creek, top of Tar Spring sandstone.				

After leaving Clover and Sugar Camp creeks the line lies on the south side of the dividing ridge, between the waters of the streams emptying into the Ohio river and those emptying into Rough creek. The head of some of the streams emptying into Rough creek are cut on the 85th and 86th miles. Near the 86th mile post the drainage cuts through the Tar Spring sandstone, the bed of limestone beneath it, and into the lowest and last sandstone of the millstone grit.

The following section, taken near the 86th mile post, corresponds very nearly with a section obtained one mile west and two miles south, at Mr. Compton's, on Lost run. Immediately west of the place of this section the sandstone of the Tar Spring rises in a bold precipice, where this rock is seen forming a bluff for the last time along the line:

No. 4. *Section on the farm of the Widow Whiteworth.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Rounded outlier of the Tar Spring sandstone, showing 35 to 40 feet sandstone at the base	50	----	151	4
Aluminous and micaceous sandy shale	10	8	101	4
Hard crystalline limestone, thin beds	5	------	90	8
Hard crystalline limestone, containing great numbers of Belerophon	2	6	85	8
Earthy limestone, dingy-buff color, containing few or no fossils	14	6	83	2
Lime-tone, abounding in Pentremites and Crinoidea, with a few Terebratulæ	4	------	68	8
Limestone, whitish colored, fossils rare	10	------	64	8
Covered space, showing occasionally beds of blue aluminous shales	12	8	54	8
Covered space	16	------	42	------
Thin bedded sandstone	26	------	26	------
Bed of branch, on sandstone.				

Eastwardly from the place of this section, the sandstone at the base of the millstone grit to the valley of Sinking are frequently cut through, and the upper beds of the great mass of the sub-carboniferous limestone exposed. The base of the foregoing section, (No. 4,) was obtained on the 87th mile, as follows:

No. 5. *Section near the farm of Mr. Perin's.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Sandstone, equivalent to sandstone at 26 feet of section 4	25	------	99	------
Sandy and aluminous shale	10	------	74	------
Limestone, descending into the cavernous member of the sub-carboniferous limestone	64	------	64	------

Half a mile east of Mr. Perin's, on the farm of Mr. Chandoin, the limestone at 68 feet, section 4, is the surface rock. Near the line, the sandstone at 99 feet, section 5, appears impregnated with desiccated coal tar, and persons have made an effort to trace the tar to the coal bed from which it is supposed it flowed. There is locally a thin bituminous shale at the base of the sandstone, from 4 to 6 inches thick. The section at Mr. Dent's, two miles east of Mr. Chandoin's, and one and a half miles north, is the counterpart of that at the latter locality.

It would be proper to state that, at the locality of section No. 5, part

of the wasted mass of the Tar Springs sandstone is in sight, forming an outlier of that mass, reduced to a few acres in extent.

No. 6. *Section at Mr. Dent's, west side of Sinking creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Tar Springs sandstone	14	6	97	2
Limestone	34	------	82	8
Shale and clay bed	8	------	48	8
Sandstone	3	------	43	------
Limestone	1	------	45	------
Sandstone	4	------	44	------
Sub-carboniferous limestone, (?)	41	------	40	------
Drainage, dry ravine.				

Sandstone No. 3, or the Tar sandstone of Breckinridge county, forms the surface rock at Mr. Chandoin's, on the 88th mile. On the 89th mile the drains emptying into sinkholes, and those emptying into Sinking creek, cut through the beds lying above the cavernous member of the sub-carboniferous limestone, and down to that member. The dividing ridge between the waters of Sinking and Rough creeks are capped by the lowest sandstone, limestone No. 1, and, on the higher parts of the ridge, by the waste of sandstone No. 2, or the sandstone forming the great bed at the Tar Springs.

The dip observed at various points in the vicinity of the head of Sinking creek indicates a dome-like upheaval, somewhat prolonged in the direction of Big Spring; the apparent longer axis of this upheaval from east to west being about eight miles—that from north to south about two miles. The territory included within this limit being entirely surrounded by a band of the sandstone beds Nos. 1 and 2, with the included bed of limestone No. 1. Toward the north, in the direction of the mouth of Sinking creek, the dip brings sandstone No. 1 down to the level of the drainage. Still further north the beds of sandstone Nos. 1 and 2 are raised again, and at the Ohio occupy a position from 100 to 150 feet above the river.

The sinks and basins at the head of Sinking creek exhibit, in a striking manner, the eroding effect of rains and frost — some of the sinks, which are from forty to one hundred and ninety feet deep, covering an area of from five acres to two thousand. The rim of sand-

stone surrounding these depressions is, generally, nearly level; the outcropping rocks within are also nearly horizontal. Near the center there is an opening of from three to fifteen feet in diameter; into this opening the water which has fallen within the margin of the basin has been drained since the day when the rocks exposed within were raised above the drainage of the country, and thus, by the slow process of washing and weathering, the rocks, which once filled these cavities, have been worn and carried down into the subterranean drainage of the country. All this has evidently come to pass in the most quiet and regular manner. The size of the central opening is too small to admit extraordinary floods; nor is it possible, with the level margin around, to suppose that these cavities were worn by eddies in a current that swept the whole cavernous member of the sub-carboniferous limestone of western Kentucky; but the opinion is probable that the upheaving force which raised these beds to their present level, at the same time ruptured and cracked the beds in certain lines; that afterwards the rains were swallowed into openings on these fractures, producing, by denudation, the basins of the sinkhole country, and further enlarging the original fractures by flowing through them, and thus forming a vast system of caverns, which surrounds the western coal field. The Mammoth Cave is, at present, the best known, and, therefore, the most remarkable.

The following section, taken three fourths of a mile north of Mr. Felix Styles', (94th mile,) will carry the sections into the sub-carboniferous limestone, and connect that member with the sandstone and limestone beds above it:

No. 7.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Covered space, wasted sandstone	15	6	214	4
Fine grained sandstone	5	6	198	8
Fine grained sandstone, containing round segregations of pyritiferous sandstone	5	------	193	2
Coarse sandstone, containing balls of sandstone	5	------	188	2
Heavy sandstone, ripple marked, with oblique marks of deposition	10	------	183	2
Thin bedded sandstone	26	------	173	2
Covered space, shales, (?)	5	4	147	2
Oolitic limestones	5	4	141	8
Bluish-earthy limestone, with silicious segregations	5	------	136	4
Earthy and oolitic limestone, with remains of Crinoidea near top	21	8	131	4
Ledge of compact limestone	10	8	119	6
Ledge of whitish limestone, earthy near the top	10	8	108	8
Chert bed	1	6	98	------
White limestone, containing Crinoidea, *Dichocrinus beds*	21	------	96	4
White limestone, with Crinoidea	10	8	75	4
White and blue beds limestone, alternating	16	------	64	6
Blue beds of limestone	21	6	48	6
Buff silicious limestone	5	4	------	------
Hard blue-gray limestone, with Productus	5	------	21	6
Hard gray limestone, with Crinoidea	5	8	16	6
Hard gray limestone, with Pentremites	10	8	10	8
Flat at Sinking fork of Sinking creek.				

About ten feet below the base of the sandstone, the bedding places of the limestone are completely covered with the remains of Pentremites floralis, P. pyriformis, and P. globosus.

The rocks are quite hard, and the fossils crystallized carbonate of lime; they are not disintegrated, but weather as fast as the rock in which they are imbedded. About fifty feet from the base of the sandstone the red earth first appears. This is the usual color of the subsoils of the sub-carboniferous rocks below the sandstone. The action of the rains on masses of this rock is remarkable. Rocks which are detached, and stand isolated and unprotected, are weathered into deep fluted furrows by the falling rains, while the extreme upper parts of the ridges between the furrows are kept quite sharp. The same beds have since been seen in the Mammoth Cave, which are readily recognized by the same flute-like grooves produced by water trickling over their exposed faces. This is the more remarkable when the texture of the rock is considered. It is quite fine grained, and compact.

The base line, after it crosses Sinking creek, soon ascends a platform of sandstone, lying quite level, and seldom penetrated by the water.

Here we have surface drainage on the north into the sinks and Sinking fork of Sinking creek, and on the south side into the sinks and Rough creek.

This table land extends to the head of May's creek, a tributary of Rough creek. Further eastward, the sandstones between the conglomerate and the cavernous member of the sub-carboniferous limestone are only seen in isolated patches on the knobs, which stand here and there detached from the main mass of sandstone, which caps their summits, and, from its resisting character, maintains these knolls in their present form.

From May's creek to the head of Otter creek, the rocks are nearly level, with a slight dip to the west and southwest. From the one hundredth mile to the crossing of Otter creek, the sinks are less numerous, the valley of Otter cutting below the cavernous member, the hills on the east and west sides being capped with it. The drains usually lie on the surface, with occasional large springs breaking into the valleys. A short distance from the eastern edge of the sandstone the chert waste from the sub-carboniferous rocks covers the surface, and is more or less abundant from the 100th to the 115th mile; for this distance the chert is quite fossiliferous, and usually cellular.

No satisfactory section of the whole mass of the cavernous member could be obtained along the line; it is estimated at about four hundred feet. The rocks at the base of it are earthy, and frequently contain beds of marly clay. The upper part being generally hard and brittle, containing two distinct beds of oolitic limestone.

On the 115th mile the line enters the breaks of Muldrough's hill, passing over the crystalline limestone beneath the clay beds, and cuts the head of Otter creek.

The line crosses the Louisville and Nashville railroad on the 116th mile, and enters the valley of Clear creek, descending the beds of the knob member of the sub-carboniferous rocks, which are here represented by alternating beds of limestone, chert, and silicious mudstone. Toward the base of the mud beds are a few layers of fine grained sandstone. These last beds are the equivalent of the Waverly sandstone of Ohio, and correspond to the geological horizon of the section taken at the mouth of the Scioto river, and reported on page 371, Vol. 2, Kentucky Reports. Some of the beds of limestones at the top of the mudstones

and muddy shale, on Clear creek, abound in Crinoidea, usually silicified and distorted; some of these remains are probably new, both in genera and species.

The valley of Clear creek, but especially the cut made by the Louisville and Nashville railroad company, afford fine sections. The line of the road ascending the hill, the entire section of the hill may be obtained. Here, as has been frequently observed elsewhere, the rocks are interrupted by numerous waves, and the dip falls off with the line of the creek, which would reduce the thickness of the rocks to less than the height of the hill. No good section of the base of the knob member was obtained on the west side of Rolling fork of Salt river, which the line crosses near the mouth of Beech fork, on the 120th mile.

The black slate, usually considered of the Devonian period, is first seen on the base line at the crossing of Rolling fork.

The level land on Beech fork to the 126th mile lies on the black slate. At this point the drains and branches begin to cut through the slate, and expose, occasionally, the beds beneath it The shales and sandy mudstones at the base of the sub-carboniferous beds form the hills and ridges. Outliers of the black slate are seen occasionally up to the 134th mile, beyond which it is no longer seen.

The dip to the west, from the 134th mile westward to Rolling fork, is quite gentle and regular.

No. 8. *The following section, taken at Mr. Jonathan Newman's, on Long run, will serve as a key to the arrangement of the rocky masses of the hills:*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Top of remains of sandy mudstone.				
Waste of knobstone	47	.....	146	5
Aluminous shale	19	.....	98	5
Hard fine grained sandstone	.....	3	79	5
Waste of black slate	14	.....	79	2
Black slate, stained with oxide of iron	27	6	65	2
Black slate	22	.....	38	6
Yellowish and flesh colored limestone, upper surface water worn, containing remains of encrinites, corals, &c.*	.....	.....	.....	.....
Limestone, buff colored, containing *Cariocrinus ornatus*, *Pentamerus oblongus*, &c, equivalent of the Niagara group	11	.....	11	.....
Bed of Long run.				

* This bed of 5½ feet, under the black slate, and above the Silurian beds, containing imper-

The hills gradually increase in height as the line passes up the river.

The black slate has decreased in thickness from the Ohio river. On Long run it is found only 63 feet thick, while at the Ohio it is upwards of a hundred feet.

The limestone at 16 feet, 6, is frequently wanting on the line: the slate there resting on the Silurian beds.

The Devonian limestones, which are estimated at from 20 to 30 feet at the falls of the Ohio, have entirely disappeared, having thinned out toward the south, or been removed by denudation before the deposition of the black slate.

The beds being thus contracted, hills of inconsiderable height are found containing all the remains of the black slate, the Devonian limestone (?), and a part of the Silurian rocks; the whole capped by the mudstones of the lower part of the beds of the knobstone.

The general direction of Beech fork is from east to west from the 121st to the 141st mile, near Fredericksburg, when the direction is from north to south. The base line crosses this river twice on the 121st mile; the 131st mile post falls in it. It is crossed again at the 134th mile and the 136th mile; both posts falling in the river. It is again crossed twice on the 139th mile; and the last and eighth time at the mouth of Cartright creek. At this point the line enters Washington county. The shaly shell beds of the Silurian date are cut through, and the upper beds of the silicious mudstone are first seen on the slopes of the hill west of the last crossing.

The following sections, taken at different points from the crossing of Rolling fork of Salt river to the last crossing of Beech fork, will show the arrangement of some of the beds, and the modifications and changes exhibited in short distances:

No. 9. *Section on 126th mile.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Covered space, waste of knobstone	20	------	91	------
Knobstone in ledges	40	------	70	------
Knob shales, (silicious mudstone)	30	------	30	------
Top of black slate.				

fectly preserved Crinoidea, which appear to be allied to sub-carboniferous forms. Should future researches determine these fossils to be analogous to the sub-carboniferous, and not to the Devonian types, it would be necessary to separate the black slate from the Devonian, and place it at the base of the sub-carboniferous beds.

The 30 feet shale bed is much thicker farther west; and the ledges of knobstone are seen here for the first time on this line. These rocks appear to be solid, and of good quality; they may be wrought, and would, probably, produce a building material equal to the Waverly sandstone.

No. 10. *Section on* 127*th mile.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Base of black slate?				
Yellow Crinoidal limestone	3	------	80	------
Soft earthy limestone	5	------	77	------
Rough weathering buff limestone	15	------	72	------
Thin bedded limestone	14	------	57	------
Soft earthy limestone, whitish	10	------	43	------
Harder beds limestone	15	------	33	------
Marly (?) clay shale	10	------	18	------
Clay, white	8	------	8	------
Bed of branch.				

The soils produced by the disintegration of these beds is of excellent quality. From 20 to 40 feet of the upper part produces cedar, on southern aspects; below the cedar line, buckeye, beech, and hickory; on the lower part, about 40 feet, is mixed poplar, ash, sugar-tree, and beech, with occasionally walnut.

No. 10. *Section on* 131*st mile.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Top of hill	------	------	21	------
Covered space, black slate	54	------	------	------
Yellowish limestone	14	------	156	------
Thin beds limestone, alternating with thin beds of marlite, with plates of soft limestone	15	------	142	------
Limestone, solid bed	18	------	127	------
Marlite, with occasional plates of limestone	26	------	109	------
Limestone, solid bed	14	------	83	------
Marlite, with plates of limestone	20	------	69	------
Bench and covered space	15	------	49	------
Limestone, solid bed	10	------	34	------
Marlite, with beds of limestone 8 to 10 inches thick	24	------	24	------
Bed of Beech fork.				

The 131st mile post falls in Beech fork; also the 134th. Between the two crossings of the river the land is spread out into a table, with

occasional rocky drains. The land is of excellent quality, produced by the disintegration of the shale beds at the base of the knobs, the black slate with the beds near the upper part of the Silurian limestone. Its color is dark reddish brown.

No. 11. *Section at the crossing of Beech fork, east of St. Thomas' College, Nelson county.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Black slate, capping river hills on northeast side of river	18	------	21	8
Top of second cliff	49	------	21	8
Top of first cliff, composed of two members	32	6	141	8
Foot of cliff, covered space	75	10	119	2
Foot of steep bank, covered space	43	4	143	4
Water, Beech fork.				

Between the 134th and 135th mile posts beds of limestone are seen, equivalent to the Crinoidal beds of Guthrie's quarry on Beargrass creek, Jefferson county, Kentucky. In the wasted materials upon the surface the fossils of the sub-carboniferous beds—seen in Muldrough's hill, 300 feet above the black slate—were in great abundance. The fossils were cherty, and almost indestructible by the weather. Considerable beds of sub-carboniferous chert was also found. This place is notable as the most eastward limit of the remains of sub-carboniferous beds; and also for the appearance of the beds associated with the hydraulic limestone of the falls of the Ohio. The Catenipora and coral beds, equivalent to those at the falls of Ohio, are absent, and the Crinoidal beds rest on Silurian rocks, containing Pentamerus and Eucaliptocrinus.

The line on the 136th, 7th, 8th, and part of the 139th miles, lies on the north side of the river. On the 139th mile the river is crossed twice.

The rocks of section No. 10 are cut as they rise more rapidly than the river; the cuts are becoming gradually deeper into the beds.

No. 12. *The following section shows the modification of the beds eastwardly. The section does not reach to the horizon of the black slate. The distance from the top of section to the slate is only a few feet:*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Yellow limestone, 5 feet below slate, (?) and covered space	16	3	186	8
Red subsoil, lower part yellow marlite	32	6	170	5
Yellow marlite, a few beds of yellow rock on top	27	5	137	9
Covered space, covered with cedar	27	5	110	4
Yellow limestone, covered with cedar on all patches of soil	28	------	83	4
Yellow limestone	5	------	55	4
Thin bedded limestone, lower limit of cedar	10	8	50	4
Indurated blue silicious mud	5	4	39	6
Yellow drab marlite	16	2	34	2
Top of beds, containing spherical masses of Favosites.				
Fossil bed	10	------	18	------
Thin bedded gray limestone	8	------	8	------
Bed of Mill creek.				

Between the place of this section and Bardstown the decomposed layers of the argillaceous beds have been wrought into common earthenware, but the manufactory has been discontinued. The reason of its discontinuance I did not learn. The clay seems of good quality; though it may be wanting in silicious earth.

As before stated, the yellow limestone terminates on the line on the 140th mile, where the base of it caps the hills. The dip increases and brings up about 100 feet of the shell limestone; in the 139th and 140th miles are also a few feet of the silicious mudstone of the Silurian period, which is cut by the turnpike descending the hill from Bardstown, near Fredericksburg.

The belt of the soil which is characterized by the cliff beds of the Upper Silurian, extends along the line from the 124th to the middle of the 140th mile, 16½ miles. This belt is probably above the average width.

The belt of country particularly marked by the shell beds, silicious mudstones, and marl beds, extends from the middle of the 140th mile to the middle of the 166th mile, or 26 miles. As these beds are variously modified, being layers, alternately, of sandy mudstone, indurated aluminous shales, thin beds of shell limestone, or hard, resisting limestone. The outcropping edges of these beds produce, by disintegra-

tion, soils differing widely in chemical constitution, which consequently differ greatly in fertility: the character of the soil always corresponding in chemical elements to the beds from which it is derived.

On the silico-calcareous belt some of the beds coming to the surface are mostly composed of fine sand and silicious mud; when these cap a ridge, and no calcareous bed lies above them, the soil is quite poor, and the timber invariably oak. The same rock composing these oak ridges, when properly mixed with the waste of the calcareous or marl beds, produces a fertile soil easily cultivated.

The first characteristic bed of the silico-calcareous rocks of this part of the base line extends from the west side of Beech fork, from the 140th mile to Little Beech fork, on the 148th mile. This bed is composed of sandy mud shales and friable, irregularly thin bedded limestone, abounding in fossil shells. The most abundant of which are *Orthis*, and Spirifers, some of the beds being almost entirely made up of the latter genus. These beds are sometimes sufficiently solid to project in cliffs, but usually they are soft; and the country underlaid by these beds is in rounded hills and terraces; the soil almost invariably of a black or dark brown color. The last beds outcrop along the valley of Cartright's creek, and extend to the 147th mile. The beds coming to the surface here are more largely interstratified with beds of marlite. The hills are more rounded, and the soil is not so dark, partaking more of the yellow and whitish color.

The bold springs which mark the more open upper part of these beds in the valley of Cartright's creek, have no equivalent at the base of this sub-division of the Silurian rocks, where, the beds being quite close textured, the springs are generally feeble.

No good section was obtained of the beds coming to the surface, from Beech fork to Little Beech—no doubt on account of the softness and easily disintegrating character of the beds; there being in this region some 200 feet, beginning with the upper silicious mudstones at the top and ending with the lower sandy mudstones and sandstones, the edges of which are mostly concealed by debris.

The line of Doe creek shows a rapid dip from one to three degrees. From the 144th to the 146th mile the rocks dip nearly due west. This great dip brings up, on the east side of Little Beech fork, beds alternately sandy and calcareous, interstratified with marlite. These

beds are distinguished by a rolling country; the hills high; drainage cuts deep; and especially marked on the line by a growth of large poplar timber. These strata cover a belt of territory 10 miles wide, from Little Beech to the head of Glen's creek, from 148th to 158th mile. These beds are estimated at 250 feet of limestone and marl in the upper part, with 490 feet of sandy and muddy members at the base: making the whole mass 740 feet in thickness.

The western margin of this zone is somewhat modified by the waste of the beds spoken of as forming the west side of Little Beech fork.

The beds become more silicious on the east slopes.

At the head of Glen's creek is an oak ridge, covered in some parts by thin, fine-grained sandstones, which have resisted atmospheric action; while the softer, and more easily wasted beds, have crumbled and been carried away.

Eastward of the divide between Glen's creek and the waters of Chaplin fork 190 feet of beds are exposed, immediately under the sandstones of the divide before alluded to.

The zone covered by the outcropping edges of these and similar inferior beds crop out east of Chaplin, producing a country of similar soil and timber, extending from the first quarter of the 159th to the 164th mile, the surface gradually becoming more level toward the east. These last beds are composed of marlites, and soft shales, and fossiliferous limestone. The land is of superior quality; the hills rounded and short. This zone is particularly distinguished by the red oak timber, mixed with beech, poplar, sugar-tree, hackleberry, &c.—red oak being the most abundant. These beds extend from Chaplin to the dividing ridge west of Salt river, including the sandy beds at the base of this division; and are estimated to be 310 feet in thickness, from 10 to 15 feet at the base; being alternations of sandstone and marl in thin beds. The sandstone at the base is distinguished by producing, on ridges, *white oak* land. The white oak ridges of Mercer county are all derived from the wasted materials of this bed.

The limestone beds seen at the crossing of Salt river are cut in a few places by the branches west of the dividing ridge. The dip is so slight that it is only apparent by levels taken two or three miles apart. These comparatively horizontal rocks extend from 165th to 175th mile. The slight westward dip brings, however, west of Harrodsburg, about 240

feet of limestone to the surface, from beneath the sandstones of the oak ridges. It is the middle and lower part of this 240 feet of rock which produces the famous blue grass soils of central Kentucky. The masses of these beds are usually thin; the bedding surface generally uneven. The body of the beds being filled with the remains of fossil corals and shells. The action of the air, frost, and water upon these rocks is quite rapid, especially in immediate contact with the soil, and where it is not exposed to the direct rays of the sun. The rapid decomposition of these beds have supplied the waste occasioned by unscientific farming in the early settlement of the country. Some places have, however, been entirely denuded of soil, making unsightly spots in this truly beautiful district. The soil may be restored to such spots, if lying on a gentle slope, in a few years, by covering the bare rocks with waste straw, the halm of hemp, in fact, anything to prevent washing, and which will, at the same time, cover the rocks. A thin soil formed of the wasted mass of the rock, united with the covering material, will give sustenance to blue grass, which soon covers and accelerates the decomposition of the rock on which it grows and to which its roots cling.

Near the base of this mass of 240 feet are intercalated several beds of chert, seldom regular in thickness, and frequently interrupted. Immediately below the chert beds are to be found caverns and underground drains—the lines of those drains being marked upon the surface by sinks or depressions.

Whenever the drainage of this country cuts below this bed, and the dip is favorable, these underground drains pour forth the water which had entered at some higher point, in many cases several miles distant. The beds are frequently interrupted by cracks and water courses. I have proposed to distinguish them as the cavernous member of the Lower Silurian rocks of Kentucky. It is probable that these are the water-bearing beds reached by boring the Artesian well at Louisville—the waters of which are already so celebrated.

It had been predicted, before any considerable progress had been made, that the boring would reach upwards of two thousand feet before water would be obtained, the if beds outcropping to the east and south held the same thickness at Louisville which they had at these outcropping edges. This well of Messrs. DuPont is probably the deepest boring ever made in rocks of the Silurian period. It certainly is the

deepest in these beds made in the western States. The register of the materials was carefully kept, as also the coarser parts of the borings pumped up at different depths. The analogy between this record and that of the surface section kept on the base line, is sufficiently close, both as to thickness and the material brought up, to enable an expert to point out at the outcrop of the different beds as they came to surface between Louisville and Dick's river.

On Cane creek, one mile west of Dick's river, the rocks are much more disturbed than at any point observed on the base line since the margin of the coal measures was left in Hancock county.

The rocks near the top of the Bird's-eye limestone are ruptured and tilted toward the west and northwest—between Cane creek and Dick's river, the angle of dip rising frequently as high as 15° to 18°. The gorge in which Dick's river flows is apparently an open fracture, since the rocks generally dip away from this river when the bends in the stream are sudden, except at the points coming forward into the bends, which are long and narrow; in such cases the point frequently falls or dips toward the river; but, even then, rocks on the opposite side dip, as usual, away from the stream.

It is not probable that the gorges in which Dick's and the Kentucky rivers flow are due to denudation; but it is a legitimate inference, from the arrangement of the rocks forming their sides, that these rivers flow in the lines of original fractures produced by the upheaving forces elevating these rocks from the place in which they were deposited to that which they now occupy.

Mr. J. E. Thompson states that the 171st mile post of the base line is near the center of the belt of blue ash, walnut, and sugar-tree land, which extends towards the north and crosses Kentucky river in the neighborhood of Munday's Landing, having an average width of two and a half miles. On the south side of the line this belt extends toward Danville, gradually spreading or extending in width, at Danville it being from 6 to 8 miles wide. The whole length of this peculiar soil south of Kentucky river being about 20 miles. The same belt of land extends north of the Kentucky river into Nicholas, Woodford, Bourbon counties, &c., expanding in width north of the Kentucky river.

This peculiar soil being produced by the decomposition of the limestones immediately above the cavernous member of the Silurian rocks,

and the deepest seated rock of the upland country of middle Kentucky, its margin indicates precisely the form of the great anticlinal axis which divides the State. If this boundary was correctly defined, it would at once give the key to the dip over a vast extent of country, and determine nearly all questions in relation to Artesian wells. This is becoming a subject of considerable importance, in an economical point of view, in addition to its scientific interest.

The Bird's-eye limestone forming the walls of Dick's river is in compact thick ledges, from 2 to 6 feet thick, varying little in character for 175 to 200 feet.

The deepest cut rocks on the line are seen at the crossing of this river.

After crossing Dick's river the line lies for nearly six miles in Garrard county — the surface rock being composed of the beds near the top of the Bird's-eye limestone. On the 180th mile a considerable uplift is crossed. Where it was examined, the rocks on either side dip from a line to the east and west. Three fourths of a mile to the east a branch runs parallel to the Lexington and Danville turnpike. On this branch is seen a reversal of dip for a considerable distance on a west and northwest course. Approaching Kentucky river with the line of the branch the dip is seen gradually to change, and, finally, near the river, the dip is to the southwest and away from the line of the river. The greatest angle of dip observed being nearest to the river: the angle of the dip varying from 1° to 50°. The beds being, moreover, frequently fractured and slipped. The line of greatest fracture, or main axis of disturbance, lies on a course north 10° E, South 10° west. The mouth of the branch enters Kentucky river opposite Boon's knob, which is an isolated mass of the Bird's-eye limestone, 210 feet high, separated by the fault before alluded to, which crosses the Kentucky river near this point. The character of this disturbance is considerably changed on the other side of the river; the rocky masses on the west side appear lifted, while those on the east side are fallen forward and depressed. The axis of the fault on the north side of the river, so far as examined, coincides with the line of Big Hickman creek.

A remarkable disturbance in the rocks was observed on our return from the work of the base line, a few miles east of Winchester. It is not improbable that the fault at Kentucky river may be extended into

Clarke county, and this disturbance and that in Clarke may be cotemporaneous. The rocks disturbed in Clarke county are the yellow magnesian beds of the Upper Silurian date and the beds of black slate. These disturbances, if connected, would determine the geological period in which they occurred, and would doubless throw much light on the ancient coast lines of the different geological epochs ruptured by the fault or by a succession of disturbances. At all events, there is no doubt that the fault, and the lines of the Kentucky and Dick's rivers, which lie in the deep gorges of the Bird's-eye limestone, are cotemporaneous and produced by a common cause.

On the 181st mile, the line crosses the Kentucky river and enters Jessamine county. On the 182d mile, the line cuts a bend and crosses the river twice. The Bird's-eye limestone is no longer seen after entering Jessamine county, while the sandy and marly beds, equivalent to those on the west side of Salt river, prevail on the 165th mile, making a distance of 16 miles along the base line. The distance between these beds is probably greater both on the north and south side of the line. On the 185th mile, the Kentucky river is crossed the fourth time.

The land between the third and fourth crossing of the river is rolling, the hills rich and rounded, being composed of soft beds consisting of soft muddy sandstones, alternately with thin beds of marly clays and limestone. The mixture of the decomposed materials of these beds forms a soil very rich in all the elements required for farm crops, while it is friable and easily cultivated. The steepest hillsides are cultivated in corn and other plowed crops; yet such is the softness of the beds composing the hills, that the soil is kept up and restored by fresh disintegration for years on slopes from 30° to 45°.

From the fourth crossing of the Kentucky river to Richmond, (198th mile of base line,) we passed along a level country. Toward the west the lines of the creeks cut deeply into the soft measures lying between the magnesian limestone of Upper Silurian date, and the Bird's-eye limestone, and the equivalent of the beds spoken of as composing the surface rocks of Nelson, Washington, and Mercer counties. The lower beds of these measures, as seen in Jessamine, Garrard, and the western part of Madison counties, are softer than on the west side of the great anticlinal axis. No positive determination was made of the thickness of the soft measures alluded to, but they are believed to be thicker on

the west than on the east side of the axis. What part of the thickness is lost to view by the sinking of these beds on the east side of Big Hickman has not yet been determined. The rocks are more fossiliferous on the east than on the west side of the axis, and the fossils are less washed and broken.

Near the fourth crossing of the Kentucky river a thick bed of reddish limestone is seen in outcrop, about 70 feet above the river, filled with the remains of Isotelus platycephalus (gigas.) On the 195th mile considerable beds of sandstone are seen in ledges from 20 to 30 feet in thickness; the upper part of these beds having a number of thin beds of limestone intercalated. In some localities the beds are replaced by segregated masses of limestone which occupy their places.

The upper part of this member forms the surface rock in the N. E. corner of Garrard county, on the tops of the hills, locally capped by from 10 to 15 feet of marly clay. When this last bed caps the hills, their sides are frequently covered with a fine growth of black locust timber.

Under the sandstone beds at the fourth crossing of Kentucky river are about 200 feet of beds of alternations of limestone and marlite. Although the valleys are deep, and the sides abrupt, still accurate minute sections are difficult to obtain on account of the loose debris disintegrated from the soft materials composing the hillsides concealing the outcropping edges of the strata.

East of Paint Lick creek the line crosses a series of hills capped by wasted fossiliferous sandstone. These beds contain comparatively little lime, hence the soil is inferior to that derived from the decomposition of the beds lying below and farther west. The timber on the sandy beds is principally oak and hickory.

On the bottoms and slopes of the low hills on the west side of Silver creek, great quantities of quartz pebbles and geodes were observed covering the land and mixed with the soil. The pebbles were, doubtless, derived from the conglomerate lying farther south. The geodes are from the sub-carboniferous limestone; many of them containing characteristic fossils of that formation.

The rocks seen on Silver creek dip in the direction of the stream to the northwest, at an angle varying from 4° to 6°. The dip with the line of the branches and creeks from the 187th to the 196th mile is the

usual arrangement of the rocks. To the north about 10 miles, on the Kentucky river, the dip is reversed, and would form a synclinal fold, between Richmond and the Kentucky river. On the head of Tate's creek, near the Richmond and Lexington turnpike, (197th mile,) the upper beds of the sandy mudstones dip under the base of the yellow magnesian limestones, equivalent of the beds of Nelson county. Near Owingsville, Bath county, is a point west of which the yellow limestone is not seen.

East of Richmond the surface of the country gradually falls off in altitude, from the 198th to the 209th mile, when the Kentucky river is crossed for the fifth time. The valleys of the branches and creeks which cross the line, are not cut so deeply into the rocks between Richmond and the Kentucky river on the east, as they are on the west. The lands east are generally level; the rocks on the line have little or no dip, except locally. On the 203d mile the yellow or buff beds are well marked on the plantation of Mr. Peter Todd, where they are capped by sandy shales.

On the 204th mile, on the farm of Solomon Turpin, the white earthy beds, recognized as the equivalent of the beds near the favosites beds of Nelson county, are cut by the drains. The land is level; the soil whitish and swampy.

On the 205th mile the wasted beds of black slate are seen, capping elevated situations. Slips of the beds again bring to view strata which had previously disappeared below the surface.

At the Flatwood's Meeting-house the beds lie level. Near the sawmill of Mr. Henry Moore, search has been made for coal in the black slate beds which have been confounded with the bituminous shale associated with coal beds. It is quite impossible to obtain coal in the black slates and its inferior beds. The rocks intervening between it and the coal beds observed farther east, are several hundred feet in thickness, burying the black slate under the lowest coal beds to that depth. On the 210th mile, on the north side of Kentucky river, the point in the bend falls forward towards the river, and is capped with the knobstone, equivalent to the Waverly sandstone of Ohio, and the beds of the knobby country of Nelson, Bullitt, and Jefferson counties.

The 212th mile is located on hills covered by the waste of slate beds, and the lower part of the knobstone based on the yellow mag-

nesian limestones, which have considerable quantities of chert intercalated in beds and segregated masses. Small pieces of crystalized copper pyrites have been found in several places near the line in those beds. Several of the most noted localities of "copper" were visited; nothing was seen which would, in our opinion, justify expensive workings in any of these localities. The 213th mile post would come in the Kentucky river, which was crossed here for the seventh and last time.

The bank of the river, on the west side, rises into a perpendicular cliff, of which the following is a section:

No. 12. *Section at 213th mile post base line.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Black slate, top beds earthy, probably possessing hydraulic properties	130	------	169	------
Earthy limestone and chert beds	14	------	39	------
Limestone, gray and yellow	25	------	25	------
Bed of Kentucky river.				

The timber has suddenly changed in character. The waste on the hill tops of the knobs is covered by black pine and whortleberry bushes, or chesnut oak and red oak; the sides with laurel and pine.

From the 213th mile the "Mountains" are in sight. The highest of these *mountains* are generally from 600 to 650 feet above the drainage at the base.

The characteristic features of this formetion are well marked here: the hills are steep and rounded; the outliers of the sub-carboniferous limestone and great sandstone at the base of the coal measures standing out in prominent, isolated hills beyond, and as high as the general mass from which they have been disjointed by the same force that elevated the rocks of the surrounding district; subsequently these outliers have been further severed from the parent rock by the action of running water seeking the deepest lines of fracture, and thus wearing away and undermining the softer layers upon which the more massive rocks repose, which, splitting at right angles to the bedding, finally are precipitated into the valley, leaving the remainder of the outlier standing with nearly vertical walls.

The pebbles of quartz of the conglomerate are strewed miles from the parent rock, having resisted the disintegrating agencies which have carried away the finer and more soluble earths.

The 213th mile lies on low hills of slate. The 214th mile crosses Calloway's creek. The 215th mile begins at the base of a pine-covered knob on the waste of the knobstone, crossing near the summit and ending on the benches at the base of the "Lone knob." The 216th mile rises the Lone knob at the north end, and cuts the summit at the edge of the precipice of sub-carboniferous limestone, which rises nearly to the extreme height at the north end. The summit, at the south, is capped by sub-carboniferous limestone; the north end by blocks of the great sandstone near the base of the coal measures. The sides of the knob are precipitous on the northeast and west sides. On the south it rises by a rapid slope. The height above the drainage at the base of it is, by barometer, 623 feet.

No. 14. *The following section is from the southwest side of the Lone knob, Estill county:*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Sandstone, in two benches, at north end of knob	12	.....	623	.....
Iron ore and earth, resting on limestone	10	.....	611	.....
Sub-carboniferous limestone, upper beds hard, and in ledges 8 to 10 feet thick	150	.....	601	.....
Knobstone and covered space, with a few ledges of hard sandstone cropping out	410	.....	451	.....
Shale beds, containing kidney-shaped masses of carbonate of iron	15	.....	41	.....
Black slate	26	.....	26	.....
Branch at foot of knob.				

The steepness of the hill being unfavorable to correct results by the Locke's level, the barometrical determination of the height is taken as being more reliable. Subsequently a carefully made detailed section of the sub-carboniferous limestone was obtained at Cottage furnace; by this section the limestones are found to be thicker than at the "Lone knob." I do not infer that the limestones at Cottage furnace were originally thicker than at the knob; but suppose that all the limestone at the knob may not have been included in the section above; the base of the mass was probably hidden from view at the knob.

The whole line from the 216th to the 235th mile crosses drains which cut into the limestone.

The following section obtained on the 218th mile will give the character of the beds cut by the branches of Cow creek, and especially the beds of sub-carboniferous limestone which are cut by all the drains on both sides of the ridge dividing the Kentucky and Red rivers from Cow to Lo Devil creeks, from the 218th to the 235th mile.

The character of some of these drains and gorges will be particularly described in a subsequent part of this chapter.

No. 12. *Section of the limestone of the sub-carboniferous beds, lying between the knobstone beds and the great sandstone at the base of the coal measures of Estill, Powell, Owsley, and Morgan counties:*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Thick, irregularly bedded sandstone; fine, sharp grit; remarkable for obliquity of lines of deposition, produced by currents from the N. E.	10	------	293	------
Thin bedded sandstone, sharp grit	11	------	283	------
Whitish silicious shales, when first opened gray-lead colored, especially near the base	22	------	272	------
Place of ore beds.				
Gray shales	2	------	250	------
Buff thin bedded earthy yellow limestone, containing a few fossils; character not preserved	8	------	248	------
Thin bedded earthy limestone, containing Retepora, Archemides, and Pentremites	2	6	240	------
Thick bedded gray-drab limestone	13	------	237	4
Covered space, with aluminous and calcareous shales?	10	------	224	4
Whitish oolitic limestone, in flags, containing *Pentremites pyriformis* of large size	10	------	214	4
Buff limestone; upper part earthy and soft, breaking into irregular angular fragments	11	------	204	4
Semi-oolitic crystalline limestone, producing red earth by disintegration	22	------	193	4
Rough concretionary bluish-gray limestone	10	------	171	4
Gray limestone, with buff colored segregations	2	6	161	4
Bright buff colored earthy limestone, non-fossiliferous	4	6	158	8
Irregular thin bedded greenish-gray limestone, non-fossiliferous—the top of the bed having a few beds of chert	24	------	154	2
Base of Cottage furnace stack.				
Section below Furnace.				
Thick bedded limestone, semi-oolitic, upper part non-fossiliferous, containing beds and segregations of green flint, the lower part of the bed containing Pentremites, Crinoidea, Bellerophon, and remains of fish	22	------	130	2
Blue earthy limestone and shales, containing corals, Spirifera, Penbratular, Retepora, and Crinoidea	38	6	108	2
Soft earthy yellow limestone	56	------	60	6
Base of sub-carboniferous limestone.				
Section of Knobstone above Cow creek.				
Soft greenish silicious shale, (knobstone)	32	------	64	------
Hard beds of greenish sandy shale	16	------	32	------
Hard beds of fine grained sandstone	16	------	16	------
Bed of Cow creek.				

The sub-carboniferous limestone, by this section, appears to be 186 feet thick. The knobstone is cut by the drainage 64 feet below the limestone, at the place where the section was taken. At the point where the base line crosses this branch the knobstone is cut much deeper—about 300 feet. This section, with slight modifications, would apply to the sides of the numerous deep drains which the line crosses to the 235th mile; the cutting into the knobstone becoming gradually less and less to the head of Miller's creek, when the knobstone disappears under the superior beds; the head of the section gradually increasing by the additional thickness of coarse sandstone and conglomerate, until the conglomerate and associated beds attain a thickness of 243 feet—the sectional cuts made by the branches being kept up to about 400 feet. All the streams on the line have precipitous banks, either on one or both sides, from the 218th to the 235th mile. The valleys from the summit of one ridge to that of another vary from 1,400 feet to 3,500 feet. Of these drains, no less than forty were crossed in seventeen miles between the points referred to.

Our work, in crossing these abrupt valleys, was very laborious. Owing to the precipitous character of the walls of these valleys, it was necessary, in crossing them, either to head the valley or to find a break in the wall, on one side, by which to descend; making egress from the valley by some similar drain on the other side; but, since these drains were neither on the line nor opposite to each other, it was frequently necessary to walk from one to three miles to cross ravines only 2,000 feet wide. In addition to these difficulties, the sides of the drains were frequently grown over with underbrush, matted into a dense mass by vines growing amongst it.

The ridge dividing the waters of Kentucky and Red rivers, (the summit of which is also the dividing line between Estill and Powell counties,) and the continuation of the same ridge dividing Morgan and Owsley counties, frequently crosses the base line in its tortuous course towards the heads of the water courses by which it is eroded.

At the head of Miller's creek the ridge is interrupted and is no longer continuous. Miller's creek rises north, and the South fork of Red river south of the summit, thus throwing the highest ridge in lines nearly at right angles with the axis of the main ridge, which again assumes a continuous line on the east side of Miller's creek. The

course of this ridge deviates sometimes several miles from a straight line, the irregularities being sometimes in curves and sometimes forming the sides of an acute angle.

The "*Old Furnace*" of Estill county lies north of the 223d mile. The highest land found in the county lies half a mile west of the furnace, where the sub-carboniferous limestone comes nearly to the top of the ridge. The ridge is capped by the ore bed under the great sandstone before alluded to. At this locality the ore is associated with a thin coal from 2 to 6 inches thick. East of the furnace, near the 224th mile post, the coal of this geological horizon has increased in thickness to nearly two feet. It has been opened and wrought; but the supports of the drift have fallen in so as to make it at present inaccessible.

North of the furnace lies a fine example of the sandstone at the base of the coal measures. On the north side it is 235 feet in height. The summit of this rock is less elevated than the sub-carboniferous limestone half a mile to the south of the furnace. Between the furnace and the "State House"—a conspicuous cliff of this sandstone—the rocks are seen dipping to the north from 5° to 20°, with evidence of much slipping towards the north. The ridge along its whole length shows a dip on either side away from the ridge both to the north and to the south. The high land west of the furnace is dome-like, and the dip is also from it in all directions.

The materials at the base of the State House sandstone are found to vary remarkably in short distances.

The sandstone is usually found resting on beds of silicious shale, with locally thin bedded sandstone, which, when present, are found to be well marked by impressions of fossil plants. Under the sandy shale and sandstone thick beds of clay are found in certain localities, which is used as a fire clay at the old Furnace, and is reported to be of excellent quality. It is usually under the horizon of the fire clay bed that the ore bed is found. In some localities the clay and sandy shales are absent, and the ore is found resting on the water-worn surface of the sub-carboniferous limestone. The base of the "State House" sandstone, in such cases, is separated from the ore bed by a thin bed of clay or silicious shale. The modifications of these beds are numerous; the above mentioned are the most common. The ores are raised both by stripping and by drifting; the bed varying in thickness from 3 to 24 inches. Not having the time

at command, while carrying the base line through the territory where these beds are most favorably cut, the associate beds have not yet received the examination that their importance demands.

The 224th mile post falls near the corner of Powell county, in the Estill county line; the base line crosses to the north side of the ridge, within a few yards of the corner; after crossing one stream the line recrosses the ridge to the south side.

The 226th mile post falls on the slope of the hill, on the east side of Miller's creek, having crossed the branch called Lowry's branch of Miller's creek.

The 227th mile crosses to the north side of the ridge, and again lies in Powell county. The dividing ridge lies south of the line from the 227th to near the end of the 233d mile, making a great bend to the south between the 231st and 233d mile. From the 233d to the middle of the 236th the line lies in Owsley county. On the 230th mile the conglomerate sandstone attains its maximum thickness, and the hills are capped with soft beds lying above it. The drains and creeks cut the knobstone for the last time on the line on the 229th mile.

Eastwardly from the 229th mile the bends of the streams are nearly all at right angles, sharp and abrupt—the valleys walled by the mass of coarse sandstone, which is so prominent a feature on Baker's branch of Little South fork of Red river, Graining Block creek, and numerous nameless branches on the north side of the ridge; and on Miller's creek, Low Devil, and smaller streams on the south side of the ridge. Some of the walled sides of the Little South fork are said to be impracticable for seven miles, where it is walled in, nearly perpendicularly, to the height of 200 to 300 feet without a break. The same remark will apply to the valleys of the numerous branches of Graining Block creek. The head of the Hotel branch terminates abruptly against a cliff 250 feet high, the chasm being about the same width.

The base of the sandstone is frequently exposed from the 227th to the 234th mile; it was examined carefully on the line for the ore and coal beds of this horizon. The coal was seen in several valleys. The ore bed was not observed east of the 227th mile. North of the line, on the main branch of Graining Block creek, the coal is said to be four feet thick, (on the 233d mile.) On a branch of Red river, north of the 254th mile, three fourths of a mile distant from the line, the coal was

seen well exposed; it was only eighteen inches thick. At this locality no traces of the ore were seen.

The rocks begin to dip more rapidly toward the east on the 236th mile; and at the crossing of Swift's Camp creek the top of the conglomerate sandstone is seen for the last time, the level being much lower than at the head of Low Devil creek, where it is the surface rock. About 80 feet above the conglomerate is a sandstone, into which is wedged a coal, varying from a line to several inches in thickness. This bed is frequently parted and insinuated between the cracks of the rocks above the place of the bed. The sandstone varies, in different localities, from 15 to 35 feet. It is usually well marked by impressions of plants. The space between the conglomerate and this bed is filled with soft material, mostly covering the outcrop of the strata.

The parts exposed were composed of sandy and aluminous shale. When decomposed, these beds form a soil which produces well for a short time, especially in places where the surface is reasonably level. Near the top of the conglomerate, and at the base of the soft beds, is generally a belt of hemlock, and white and yellow pine timber; while the upper part of the soft bed supports a heavy growth of poplar, white oak, black oak, and black gum.

At the Spruce gap, at the head of Low Devil creek, the dividing ridge is very much depressed. It was through this "gap" that the original inhabitants passed on their journeys between Red and Kentucky rivers. The *old Indian trace* through Spruce gap is even now considered the best route between the two streams.

The soft beds referred to above, as lying above the conglomerate, are probably the equivalent of the shales of Little Sandy river, (see Vol. 2, page 351, Kentucky Reports,) given in the upper part of the section as being 100 feet thick. A more detailed section is now given on page 352. No coal beds were seen in this mass. The cuts on this part of the line are unfavorable for special sections. The hills of soft measures rise as high as three hundred (300) feet above the drainage, marked by two to four benches of harder materials. No beds of coal or iron ore are seen from the 237th to the 243d mile, which reaches and crosses Stillwater, a branch of Red river.

Considerable disturbance is again seen in the rocks on the east side of Stillwater creek. On the west side, on the farm of Mr. David Rose, the

first coal above the conglomerate is again seen—it is only 6 inches; five feet below the coal is a bed of compact silicious rock, containing from 4 to 6 per cent. of iron (?). Lithologically it is the exact counterpart of the silicious bed near the road at Star furnace, Carter county. This bed would fall into the section at Star furnace, given on page 353, Vol. 2, Kentucky Geological Reports, immediately above the Star furnace sandstone. South of 243d mile post the coal bed above referred to lies in the bed of the creek, at the old mill. The sandstone at the first locality which overlies the coal bed thins out in the distance of half a mile, and the coal at the second locality is covered by silicious shale.

On the farm of Mr. Abraham Swango, eastwardly of the second locality half a mile, the coal and sandstone are brought above the drainage, to be again carried down by a dip of from 5° to 15°. This rapid dip continues a very short distance, and at Mr. Adam Harmon's we have the coal, seen at Stillwater, again brought down to the level of the drainage. The hills from Stillwater to Lacey's creek, 243d to 246th mile, rise above the drainage from 180 feet to 250 feet.

The section of the base of these hills, so far as obtained, shows the same measures on both creeks.

Ascending the road branch of Stillwater creek one and a half miles, the dividing ridge between Stillwater and Lacey's creek is reached. The elevation above the three vein coal, in section No. 13, is 190 feet, divided into four benches or terraces. The road passing through a gap, the extreme height of the hill is not given.

The last section of these beds was obtained near Mr. Harmon's, as follows:

No. 13. *Section of coal measures on Stillwater, near the farm of Mr. Adam Harmon.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Sandstone bench	25	------	88	10½
Sandstone	1	6	63	10½
Sandy shale	3	------	62	4½
Coal	------	6	59	4½
Sandy shale	------	2½	58	10½
Coal	------	8½	58	8
Shale	------	6	57	11½
Coal	------	1½	57	5½
Bluish aluminous clay	4	------	57	4
Bluish aluminous clay, with fossils	2	------	53	4
Sandy shale	13	------	51	4
Thin bedded sandstone	20	------	4[illegible]	4
Blue and black shale	18	------	28	4
Sandstone, thick bed	4	------	10	4
Coal, 4 to 15 inches	------	4	6	4
Shale, 4 to 6 feet	6	------	6	------
Sandstone, thin bedded; branch; equivalent of Star furnace stack sandstone.				

On the road line from camp on Stillwater, to Lacey's creek, two exposures of the section at Stillwater was seen on the waters of Lacey's creek.

The materials composing the hills between Stillwater and Gilmore creeks are soft; the hills rounded, and very steep.

Immediately south of the line, 247th mile, on Lacey's creek, on the farm of Mr. Jos. Rose, the following section was obtained; it appears to be the equivalent of section 13 at Mr. Harmon's, with the addition of the masses below, seen at Mr. David Rose's, on Stillwater, (243d mile.)

No. 14. *Section of coal measures on Gilmore's creek, on 248th mile, base line.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Covered space, occasionally showing beds of sandy shale	60		104	
Coarse loose textured sandstone	8		58	
Sandy micaceous shale, dark-gray and yellow	6		50	
Bluish shale	1		44	
Coal. Bituminous		6	43	
Shale, (silicious mud)	8		42	6
Coal. Bituminous		7	34	6
Aluminous parting, clay	1	8	33	9
Coal. Shaly cannel or splint?		8	32	1
Ash colored shale	15		31	5
Gray sandy shale	1	4	16	5
Pyritiferous sandstone	2	10	15	1
Sandstone, thick masses	8		12	3
Shaly sandstone	1	8	4	3
Sandstone	1		2	7
Shale, lead-gray		2	1	7
Sandstone	1	5	1	5
Branch.				

The beds cut by the valley of Gilmore's creek are the same as those of Lacey's creek, Section 14. The section is not exposed quite so low on the latter as the former. The sandy shale and sandstone are near the foot of the hills, which receive an additional thickness of shale and sandstone upon the top. All the beds appear to be composed of coarser materials than further west. The hill land is becoming poorer as the materials become coarser.

On the 250th mile the hills, in a few places, on the highest points, are capped by a bed of sandstone about 20 feet thick; the ridge north of the 251st mile, the divide between the head of Johnson fork of Licking and Red river, is capped by this last rock. Immediately beneath the sandstone capping the ridge is a bed of iron ore; judging from surface indications, the bed is from 18 to 20 inches thick; the ore appears to be of good quality. The extent of this ore bed was not ascertained; it appears on most of the ridges between the Road fork and main Red river, above Widow's creek; extending east and northeast, disappearing to the south and southwest; the hills in the latter direction being capped by measures lying beneath the ore bed.

Between the first and second branches of Johnson fork of Licking the sandstone caps the top of the hill; the measures beneath it being

quite soft, while the sandstone is quite hard, it has been undermined, and immense blocks of it are broken and tilted toward the valley. Some of the blocks are from 30 to 40 feet in length, 25 to 30 feet wide, and 20 feet thick—being remarkable objects; capping, as they do, high very steep hills, composed of softer materials, which in many places are not sufficiently wide to receive one of them on the top without part of the block projecting over the sloping sides.

The valley of Wheelrim fork of Johnson cuts below the tops of the hills from three hundred and forty (340) to three hundred and seventy-five (375) feet. At the crossing of this branch, near Mr. Elam's, the following section is seen:

No. 15. *Section at the crossing of Wheelrim creek, (255th mile.)*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Steep hill, in three terraces, capped by waste of "top hill rock"	312	------	347	------
Coal. Bituminous	------	6	35	------
Gray sandy shale	4	------	34	6
Coal	------	7	30	6
Sandy and aluminous shale	1	3	29	11
Coal	------	8	28	8
Sandy shale	7	------	28	------
Sandstone	2	------	21	------
Shale, sandy	14	------	19	------
Micaceous sandstone and shale	5	------	5	------
Bed of Wheelrim branch.				

There can be no doubt as to the equivalency of these with the beds at Lacey's creek. The same beds as those of this section are seen on Johnson's fork for several miles, variously modified in a few feet as to the thickness of the coal and the separating masses. On the face of the same cliff the changes are sufficient to alter every figure in the section.

On Johnson's fork, at the "Rock House," the following section is cut:

No. 16. *Section at "Rock House," on Johnson creek, north of 254th mile, base line.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Sandy shale, lead-gray	25	------	25	8
Bituminous shale	------	4	6	4
Gray sandy shale	1	8	6	------
Coal. Bituminous	------	8	4	4
Bituminous shale	------	5	3	8
Coal	------	8	3	3
Under clay	1	7	2	7
Gray sandy shale	1	------	1	------
Bed of creek.				

The hills south of the place of this section, as determined by barometer, are 350 feet in height above the drainage. The tops of some of the ridges receive the ore bed and the sandstone above it.

The measures on the east side of Wheelrim creek are divided into three benches, above the top of the shale beds at the top of section 16.

The upper of these benches, or terraces, is capped by a slope lying under the top hill sandstone and ore bed. The hill may be divided as follows:

No. 17. *Section east side of Wheelrim creek,* (255*th mile.*)

	Thickness.		Elevation.	
	Feet	Inches.	Feet.	Inches.
Covered space, principally shales, with capping of sandstone	88	7	254	10
Covered space, to top of terrace, (2d)	18	------	166	3
Covered space, sandy shale, with a few plates of sandstone	122	7	148	3
Top of shale in *section* 16.				
Section 16	25	8	25	8
Bed of branch.				

The dip to the northwest with the valley in one mile is equal to 95 feet, as the rocks are slipped toward the line of the great streams and from the dividing ridge. No fault was observed after a careful examination; the dip being apparent on Johnson's creek, east of this place, carrying the section at the head of the valley to nearly the same height above the branch for four miles down the stream, which has a rapid fall.

The line from the 255th to the 258th mile post lies along the spurs and breaks, into the valley of the Long branch of Johnson fork, lying on the same measures.

The 259th mile enters the breaks and crosses the valley of Cow creek. On the 259th and 260th miles the hardening of the measures of section 17 is quite manifest; the slopes beneath the terraces frequently present benches of compact, coarse sandstone, from 5 to 10 feet thick.

Near the line on the Middle fork of Licking river the beds rise above the creek, and a section was obtained from Middle fork to the top of the ridge east of Cow creek.

By barometer the height of the ridge is 314 feet. The thickness of the different members composing it are as follows:

No. 18. *Section of hill between Middle fork of Licking river and Cow creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Heavy sandstone, 15 to 25 feet	15	------	280	------
Shales and ore bed	5	------	265	------
Sandstone and hard sandy shale, from 80 to 100 feet thick	90	------	260	------
Whitish silicious clay	8	------	170	------
Loose coarse sandy shale	75	------	162	------
Black bituminous shale	2	6	87	------
Bituminous coal, 26 to 28 inches	2	2	84	6
Compact sandy shale	10	------	82	4
Sandstone	30	------	72	4
Sandy shale	9	------	42	4
Coal, 4 to 6 inches thick	4	------	33	4
Sandy shale, 7 to 9 feet	8	------	29	4
Sandstone, marked by fossil plants, thin sheets of coal injected	6	------	21	4
Coal	------	4	15	4
Sandy shale in slope, partly covered	15	------	15	------
Middle fork.				

The masses of rock by their united thickness make only 280 feet; while the height of the hill is three hundred and fourteen (314)—a difference of 34 feet—there being that amount of dip in the length of the section. The direction of the dip is east. The west side of the ridge gives nearly the same result; the measures are not quite so well exposed, and the dip, being more rapid, the measures at the base of the section on Middle fork are carried below the drainage on Cow creek.

The line between Middle fork and Licking rivers lies over hills which

are not sufficiently high to receive the ore bed and the sandstone over it. At one point on the divide the wasted blocks of the top hill sandstone was seen. East of Gardiner's branch the hill has lost in altitude and materials.

The following section exhibits the characters of the mass of the hill at 263d mile post:

No. 19.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Top of hill.				
Sandstone, separated into 3 masses by shale beds, 4 to 6 feet each	88	------	145	8
Dark lead-gray and dove colored shale	57	8	57	8
Bed of Gardiner's branch on shale bed.				

To this section, on the 264th mile, near Licking river, the same beds are cut about 30 feet deeper than at Gardiner's branch. In the mass of shales near the top of 57 feet, section 19, a coal is seen on Licking river. Near the water, 71 feet below, a thin coal is seen. The shales below the sandstone, section 19, have increased in thickness regularly, from the west toward the east. On the waters of Licking and Burning fork, they are modified by the intercalation of limestone, either in interrupted beds or segregated masses.

Occasionally the shale beds are less earthy, and run into sandstone beds of greater or less thickness. The intercalated beds of limestone in the shales at Licking river, and in the valley of Burning fork, produce a corresponding change in the character of the soil and timber—the forest on the wasted shale in limestone beds being beech, sugar-tree, ash, buckeye, linn, &c.

The following section is from the north side of the valley of Burning fork, near the house of Mr. John Prather, (267th mile):

No. 20.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Coarse sandstone, usually covered by pine forests	30	------	159	9
Sandy shale, gray and yellow	38	------	129	9
Black shales, with thin *coal*, (sugar-tree horizon, limestone?)	17	------	91	9
Sandy shales	40	------	84	9
Heavy masses micaceous sandstone	16	------	44	9
Bituminous shale	1	2	28	9
Bituminous coal	11	------	27	7
Silicious under clay	1	8	26	8
Sandy shale, with a few beds of thin fleecy stones	16	------	26	------
Dark-gray shale, (micaceous)	10	------	10	------
Bed of branch, near Camp.				

The hill is distinctly divided into three terraces, with steep slopes between them.

The coal at 27 feet 7 inches is pyritiferous, and entirely useless. The shales at the base of section are doubtless the equivalent of the upper part of the 57 feet 8 inches of the shale bed at the base of section 19. The shale beds at Licking are remarkable for their softness, great thickness, and dark color. They are recognized in all the deep valleys from Licking river to the 278th mile, (13 miles.)

One and a half miles west of the place of section 20 a coal is in sight, near Adamsville. It is probably the 11 inch coal, at the base of section 20, which is thicker locally than at the place of the section.

The dip from the head to the mouth of Burning fork is to the west, and with the line of the stream. The distance is six miles; the same beds being cut the whole length of the valley.

The beds of iron ore do not appear in the valley of Licking and Burning fork; occasionally nodules of carbonate of iron are found in the drains, derived, apparently, from the shale beds beneath the coal, at 27 feet 7 inches, section 20.

On the 267th mile the line crosses the road from the lower counties to Prestonsburg, and continues north of it to Big Sandy river. The road rises the ridge at the head of Burning fork by a gentle slope, crossing through a low gap; the separation between the waters flowing into Licking and Big Sandy is hardly apparent. The line lying farther north passes the ridge at a rounded pinnacle in the ridge, at the head of the Rock Lick branch, a tributary of Burning fork. At the head of

Rock Lick the drainage is on the coal, at 91 feet 9 inches, section 20, rising, by a steep grade, a hill 254 feet high, capped by the 20 feet of heavy sandstone seen at the head of Johnson fork of Licking. The ore bed under this rock was not seen at this point. Along the line of Rock Lick the lower coal (at section 20) has a thickness of 20 inches; the coal above, in same section, being represented by from 5 to 6 inches of bituminous shale. On the 247th mile these beds are separated by only a few feet of sandstone. The rock separating these beds here has the same general character of the rock supposed to occupy this horizon, seen on Lacey's creek, Johnson and Wheelrim creeks. If this deduction be the true one, the Licking shale beds are the equivalent of the soft measures seen at Swift's Camp, immediately above the great sandstone.

The hill dividing the waters of Licking and Big Sandy becomes much raised, not by the addition of other rocks, but by the local elevation of the whole country. The beds of coal appear gradually to increase in thickness, subject, however, to many local changes.

The sandstones are better defined, and it is probable that the shale bed immediately above the great sandstone is thicker than when it is first seen on Trace fork of Stillwater creek. The hill top sandstone, as found at the head of Red river, is a most unmistakable horizon. The rocks lying below it differ widely, both in composition and division, even in quite short distances, rendering sections taken of the same bed in different outcrops, in the same hill, dissimilar in thickness and material.

The head branches of Middle creek, Green Rock fork, and South fork of Jenny's creek, falling into Big Sandy, head within a few yards of each other. Rock House fork heads east of the ridge, at the head of Rock Lick creek, and runs toward the north for a mile, when it turns abruptly to the west and passes through a gap in the ridge. On the south of the line the valley of Middle creek, within two miles, is 445 feet below the top of the capping rock, at the head of Rock Lick.

Eastwardly, on the 276th mile, the valley of Jenney's creek is 611 feet below the same point; a very considerable amount of this sum is due to dip.

The 30 inch coal seen at A. J. Rice's dips with the line of Jenney's creek, in half a mile, between Mr. Rice's and Mr. Payne Patrick's, 37 feet, about equal to the fall in the creek between the two points.

At the 272d mile post the top of the ridge is covered with the iron ores of the bed under the sandstone, equivalent to the sandstone seen at the Red river, Johnson's fork, Middle fork, and the head of Rock Lick creek.

This sandstone is, doubtless, the equivalent to the sandstone lying immediately above the Baker bank, Laurel furnace, the coarse sandstones capping the bead of Cole and Alcorn creeks, the conglomerate lying over the Carrington and Highton banks, near Steam furnace, Greenup county, and the sandstone at the top of section at Clinton furnace, (page 362, Vol. 2, Kentucky Geological Reports.)

On the 273d mile, near Jenney's creek, we have the follo wing section:

No. 21. *Section on farm of Mr. A. J. Rice,* (273*d mile.*)

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Top of low hill.				
Wasted shale bed	20	------	125	6
Sandstone	35	------	105	6
Bituminous shale	------	8	70	6
Coal	3	------	69	10
Silicious under clay	------	10	66	10
Sandy shale	18	------	66	------
Sandstone	8	------	48	------
Sandy shale	6	------	40	------
Sandstone	8	------	34	------
Gray sandy shale	18	------	26	------
Sandstone	3	------	8	------
Bituminous shale	------	8	5	6
Coal	------	10	4	10
Sandy gray shales	4	------	4	------
Bed of Jenney's creek.				

The shales at the base of the above section and upward, to 69 feet, are doubtless the equivalent of the beds on the east side of the river, at the crossing near Licking Station.

The dip at the place of section is eastwardly. There are many changes in the direction of dip, running for short distances. The rocks are laid in waves; the apparent dip is, therefore, in various directions, the general direction being to the east or southeast.

The shales are probably increased in thickness at the base of the coal measures. The sandstone beds are becoming much better defined, and the coal beds have increased in thickness. The three feet coal (section 21) has a good roof; the face of the coal presented to the eye appears to be free of pyrites, and of excellent quality.

The line on the 273d, 274th, and 275th miles lays in the valley or on the spurs of main Jenney's creek—the 276th mile ending on the ridge dividing Middle creek from the main creek. The 277th mile crosses a high ridge between Middle creek and the East branch.

The ridge embraces no new measures. The hills are remarkable only for steepness, and the increased thickness of the shale beds, and for the better definition and less thickness of the beds of sandstone.

Half a mile south of the 278th mile, the following section lies near the bed of the creek:

No. 22. *Section on the east branch of Jenney's creek, south of the line half a mile.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Sandy shales	45	------	111	1
Sandstone	30	------	66	1
Sandy shale, 1 to 2 feet	2	------	36	1
Pyritiferous sandstone	------	8	34	1
Black bituminous shale	------	10	33	5
Iron ore, 2 to 4 inches	1	4	32	7
Coal	2	6	32	3
Under clay	1	------	29	9
Sandy shale	15	------	28	9
Clay and bituminous shale	8	------	13	9
Coal	------	6	3	6
Shale	1	------	4	6
Coal	------	6	3	6
Sandy shale	3	------	3	------
Bed of branch.				

The dip is very rapid toward the northeast; rapidly running under the beds at the base of section; the line crossing the branch on the bed near the coal at 32 feet.

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INSTRUCTIONS

FOR SIDNEY S. LYON FOR THE PROSECUTION OF THE TOPOGRAPHICAL SURVEY OF KENTUCKY, IN THE YEAR

1859.

You will complete the base line; running it, as heretofore, from your last station near the mouth of Little Paint creek, near the corner of Johnson and Floyd counties, due east to the Virginia line.

You will select for this work the part of the season most favorable for your operations on the line—taking advantage of the high water of Big Sandy for the transportation of your supplies and camp equipage up to Prestonsburg, or other point on that river, most convenient to your starting station.

You will also connect the base line in Hardin county with the surveys in Hopkins county, along the eastern margin of the western coal field, through the counties of Breckinridge, Edmonson, Hart, Butler, Muhlenburg, Christian, and, probably, Warren, so as to define that boundary line.

You will also make such surveys as may be necessary to connect said base line in Hardin county with the surveys in Hancock county, and thence to the Ohio river, so as to complete the eastern outline of the western coal field, from the point of intersection near the confluence of the Ohio river and Tradewater, to near Hawesville, on the Ohio river, in Hancock county, around the circumference of the entire western coal field.

If time and means permit, you will also complete the Topographical Geological Survey of Hancock county—so as to construct the map of that county on the same scale and the same plan as that already executed of Hopkins county.

You will bring your field work to a close in time to complete your

plotting of the Topographical work, and write up your Report by November, 1859, as well as to finish any other office work connected with your department of the Survey.

You will also furnish me, in October, 1859, with a synoptical report of your entire surveys, made during the years 1858 and 1859.

D. D. OWEN.

CHAPTER II.

REPORT OF THE OPERATIONS OF 1859, ON AND NEAR THE MARGIN OF THE WESTERN COAL FIELD OF KENTUCKY.

The work of the season began on the Ohio river, at Stephensport, Breckinridge county, extending into Breckinridge, Grayson, Edmonson, Hart, Warren, Butler, Logan, Todd, Christian, Muhlenburg, Hopkins, Ohio, and Hancock counties.

By my instructions, I was required to extend the work of this season so as to enable me to lay down the margin of the western coal field of Kentucky.

The lines have been extended into the counties above enumerated, and a skeleton map is constructed on which is laid down the geological measures, forming the surface rock, when intersected by the line of survey.

The party under my direction began its field operations on the 21st of April, and closed on the 12th day of July. During the early part of the season the work was somewhat retarded by continued and heavy rains; notwithstanding which, the party has been able to accomplish during the time they remained in the field, 482 miles of line.

A greater part of the region in which this work had to be done is the roughest country in western Kentucky. The margin of the coal field in western Kentucky is, as you are well aware, surrounded by the millstone grit sandstones and the intercalated beds of limestone and aluminous shales; usually dipping at a considerable angle. These formations worn into deep ravines, by most of the water courses, produce a broken country, while the interval between the streams is usually filled with steep, rocky hills. Within this margin of millstone grit the surface is generally more level, since the beds of the coal measures are spread out with a dip, becoming gradually more gentle from the margin toward the centre of the basin, with which the surface of the country generally conforms.

To define the margin of the coal measures, which was the principal object of the work of this season, the surveys were mostly located in or near the belt of the millstone grit, and associated limestones.

A familiar acquaintance with the several beds of the millstone grit, became of the first consequence to enable me to direct the work in such a manner as to accomplish the immediate object of the work of this

season as rapidly as possible, and confine it to as narrow a belt of country as practicable. In consequence, however, of the impracticable character of the country, and the want of roads along my line of observation, many considerable divergences became necessary on either side of the exact boundary line to be defined; rendering it frequently necessary to run around a country instead of passing through it; which, if practicable, would more effectually have accomplished the purpose intended, *i. e.*, to define the margin of the western coal field.

The surveys previously begun in Union county had been extended into Crittenden, Caldwell, and Christian counties; now it was necessary to extend them through the northern part of Todd, Logan, Butler, Warren, Edmonson, the western part of Hart, the southern and western part of Grayson and Breckinridge, to the Ohio river.

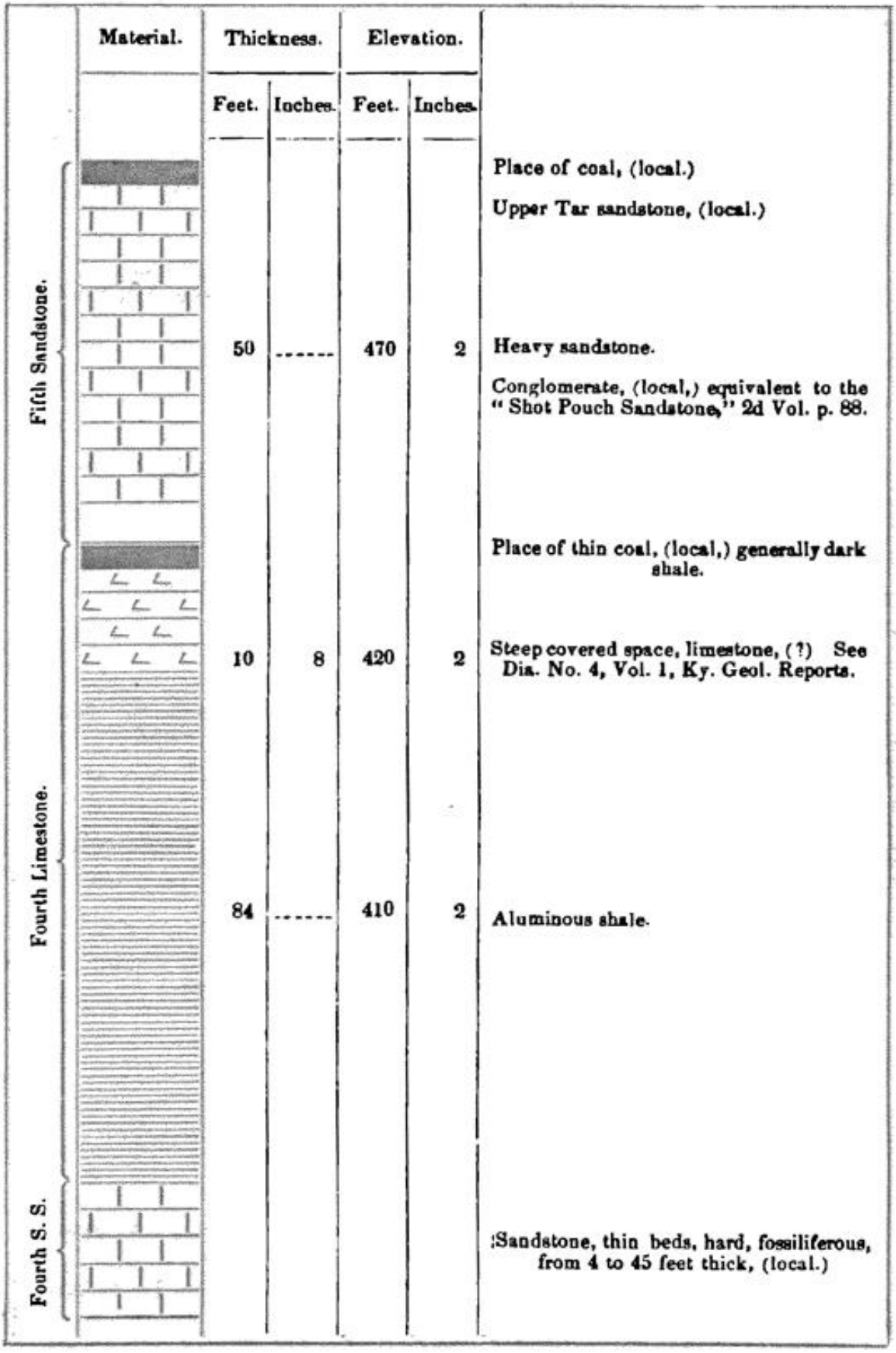
The coal measures on the north and east side of Green river were found lying on the tops of the ridges and table-land. The branches and creeks cutting through them have carried portions of them away, leaving occasional patches and outliers on the ridges between the streams.

Before entering upon the details of this survey, the following section of the millstone grit, and the limestone intercalated with it, will be given. The beds of this section will be designated in this chapter by the numbers here severally atttached to them. No cut was found on the margin of the basin which gave the whole section; it has, therefore, been constructed of two or more sections joined together—reference of locality being made to the place of each part of the section:

No. 22. *Section of the Millstone grit beds, at the margin of the Western coal field of Kentucky, in Hancock and Breckinridge counties.*

Material.	Thickness.		Elevation.		
	Feet.	Inches.	Feet.	Inches.	
	1	6	511	8	Place of Breckinridge coal, Hancock co., under clay and sandy shale.
	40	------	510	2	Soft yellow sandstone.

Section No. 22—Continued.



Section No. 22—Continued.

	Material.	Thickness. Feet.	Thickness. Inches.	Elevation. Feet.	Elevation. Inches.	
Third Limestone.		30	------	326	2	Limestone, containing Productus and Crinoidea. (Locality, King's Hill.
		37	------	296	2	Limestone, containing Belerophon.
		53	4	259	2	Covered space, occasionally showing aluminous shales.
						The base of the mass aluminous shale.
		13	8	205	10	Limestone in thick beds.
		11	-----	191	2	Aluminous shales.
Third Sandstone.		16	------	180	2	Thin bedded sandstone, Tar Sandstone.
		14	8	164	2	Thick bedded sandstone, Tar Sandstone.

Section No. 22—Continued.

	Material.	Thickness. Feet.	Thickness. Inches	Elevation. Feet.	Elevation. Inches	
Second Limestone.						Yellowish gray limestone; thin beds.
						Buff limestone, (local.)
						Chert beds, (local.)
		37	4	149	6	Oolitic, (local.)
						White limestone.
Second Sandstone.		20	------	112	2	Coarse sandstone.
		62	2	92	2	Coarse sandstone; oblique beds of deposition; 4 beds.
						Lower Tar Spring Sandstone, of Breckinridge county.
First Limestone.		3	------	30	------	Marly shale containing lenticular masses of limestone.
		1	6	27	------	Limestone.
			6	25	------	Blue gray marl.
		15	------	25	------	
First S. S.		10	------	10	------	Fine grained sandstone, 10 to 35 feet thick.
						Cavernous member of sub-carboniferous limestone.

The Topographical Geological Survey begins at Stephensport, Breckinridge county, on the Ohio river, on the cavernous member of the sub-carboniferous limestone, (section 22.) The hills near the Ohio river rise rapidly, and include sandstones and limestones Nos. 1 and 2, the hill being capped by sandstone No. 3 in a few places; the various changes in these beds may be seen by the several sections on the lines traversing Breckinridge, Grayson, and Edmonson counties.

On the east side of the mouth of Sinking creek the cavernous member of the sub-carboniferous limestone is in sight, while the beds on the west side are covered by the wasted materials of the same beds at their outcrop, and those lying above in the hill, concealing the lower part of the section. Half a mile south of Stephensport, the lower part of the hill, on the west side of Sinking creek, is made up of hard and soft material, producing two distinct terraces. From the top of the terraces to the top of the hill, we have the following section:

No. 23. *Section south of Stephensport, Breckinridge county, half a mile from the Ohio river.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Top of hill.				
Covered space	30	------	291	2
Yellow sandstone, with yellow aluminous spots, (in cavities?)	22	------	261	2
Covered space	54	------	239	2
Limestone, upper part earthy	15	------	185	2
Earthy ash-colored shale	16	------	170	2
Sandstone	20	------	154	2
Pentremital limestone	8	------	134	2
Thin bed of limestone	1	3	126	2
Gray limestone	3	------	125	11
Sandy mud bed	2	11	122	11
Limestone.	10	------	120	------
Covered space to bed of Sinking creek	112	------	112	------
Bed of Sinking creek.				

The hill is farther increased by the addition of superior beds; and at Mr. Thompson Greene's the hills are, by barometer, 413 feet high, or 122 feet higher than top of section, rising into the shales and limestones of No. 3, equivalent to the beds of Grayson Springs, Falls of Rough creek, and the beds above and at the base of the Nolin furnace. The triangular Bryazoa found in such abundance and perfection at the falls of Rough creek, was recognized here. It has a short, vertical range, and

has been found only in the upper part of the beds of the 3d limestone.

The same beds are seen on the road between Lewisport and Harrodsburg; the dip is quite irregular. Though the same beds are seen between these two localities, there are certain modifications of the materials worthy of note. The bed of limestone No. 2, at Mr. John Elder's, receives upon it a thick bed of aluminous shale and marlite. A well having been sunk in these shales at Mr. Elder's, the water was found to be so much impregnated with alumina and sulphate of iron (copperas) as to be unfit for use; even the cattle refuse to drink it. In the waste of the materials dug from this well are to be found crystals of sulphate of lime.

The land upon these beds is rolling; generally heavy timbered with white oak, poplar, sugar-tree, gum, &c.

The line crosses a ravine at 40,940 feet from Stephensport, in which is exposed a thin plate of Productus limestone, a part of limestone No. 2. This bed is seen at the crossing of Clover creek, and again in Hardin's creek valley. It has been seen in no other part of the millstone grit beds, and is probably quite local.

About five miles south of Stephensport the road crosses a deep synclinal fold in the rocks, the deep valley cutting only to the top of the 2d limestone.

The following section shows the change in the beds of the 2d limestone, as seen in the cut immediately north of Hardinsburg:

No. 24.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Heavy sandstone, (sandstone No. 3)	22	------	106	3
Aluminous shale	6	------	94	3
Semi-oolitic limestone	10	4	84	3
Yellow earthy limestone	15	8	77	11
Crystallized limestone	10	------	62	3
Covered space, soft sandstone, top of sandstone No. 2	48	3	52	3
Sandstone	4	------	4	------
Hardin's creek.				

From Hardinsburg southward, toward Winchell's mill, the rocks are quite horizontal; the surface rock generally being beds of sandstone No. 3, with occasional patches of limestone No. 3. These patches of

limestone No. 3 occupy usually only a few acres in extent, presenting the appearance of a flat knoll.

The soils surrounding these knolls of limestone are modified by the addition of lime, derived from the beds in the knolls; a change of timber invariably marks the margin of the influence of the lime beds.

The upper part of sandstone No. 3, on the line before alluded to, is in thin beds, fine grained, decomposing rapidly. The lower part of the mass being a thick bedded, hard sandstone, resisting atmospheric influence well; it stands out when cut in a bold escarpment.

The chemical character of the whole mass is not such as to produce fertile soils by decomposition. The lack of phosphate of lime may be supplied by the fossiliferous limestones lying both above and below it; the lower bed being cut into by nearly all the drains crossing the road.

Tewell's branch cuts through limestone No. 2 at the road, and runs on the top bed of sandstone No. 2. On the south side of the branch the dip is strongly marked 3° to 4° to the north.

The bed of the North fork of Rough creek, east of the road, presents considerable disturbance.

No. 25. *Section on north side of North fork of Rough creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Coarse sandstone, conglomerate, (5th sandstone)	30	------	274	8
Sandy shale, with thin coal markings	2	------	244	8
Sandy shale	14	------	242	8
Earthy yellow limestone	1	6	228	8
Crystalized limestone, *Pentremites*, &c	2	------	227	2
Limestone, partly covered	38	------	225	2
Covered space	74	------	187	2
Sandstone	21	6	113	2
Pentremital limestone	22	------	91	8
Limestone talus	2[illegible]	8	69	8
Thin bedded sandstone	16	------	43	------
Heavy sandstone	16	2	27	------
Covered space	10	8	10	8
Bed of North fork of Rough creek.				

A trough occurs between Tewell and North fork of Rough creek; the hills and table lands are about the same in altitude as the table north of Tewell's creek.

The base of the 5th sandstone is first seen at one and a half miles

of North fork. The second sandstone lies near the drainage on the south side of North fork, dipping rapidly toward the creek. On the north side of the creek, at the place of Section 25, the rocks dip to the north as far as they are exposed. The beds of the branches flowing into the North fork show frequent waves and interruptions of dip.

The hill on the south side of North fork is ascended on the sloping mass of sandstone No. 2, which becomes the surface rock for some distance.

At the farm of Mr. Spencer the road ascends the 2d limestone and the 3d sandstone, capped by an outlier, or isolated patch, of the 3d limestone. The 3d sandstone then becomes the surface rock to McDanielsburg; from which point to Rough creek, at Winchell's mill, the drains and branches lie in beds mostly on limestone No. 2 and the upper beds of sandstone No. 2. Near Rough creek a small patch of limestone No. 3 caps the tops of the ridge, on which the road lies. In no part of the route on the south side of the North fork of Rough creek has the waste of the 5th sandstone, or any bed of it, been seen.

The beds of limestone Nos. 2 and 3, which are cut by drainage and denudation, near Rough creek, show the action of rapid currents during their deposition; the fossils are generally washed and broken. The triangular Bryazoa of the falls of Rough was seen in limestone No. 3, three quarters of a mile from the mill.

The rocks are much disturbed and fractured near the mill. Immediately above the road crossing the rocks are the cavernous beds of the sub-carboniferous limestone. On the north side of the creek they are tilted at an angle of from 8° to 20° toward the northwest. This dip continues for some distance up the creek, rapidly bringing to the light the sub-carboniferous beds.

On the south side of the creek the beds, from the sub-carboniferous limestone upward, are well exposed; they exhibit the unmistakable evidence of disturbances in the cavernous member of the sub-carboniferous limestone previous to the deposition of sandstone No. 1. The limestones of the former bed are cracked and slipped, forming deep notches between the standing and the slipped parts of the bed; the surface of the beds is water-worn, and the upper angular corners are rounded. Upon this worn surface, and into the notches, the thin, flag-like beds of sandstone No. 1 are deposited; several of the first beds

being required to fill the vacancies occasioned by the sunken part of the limestone. The ends of the first beds abut against a perpendicular wall of it; after the cavities are filled, the beds are continuous over the bed previously deposited and the higher parts of the limestone beneath it.

No. 26. *Section of sub-carboniferous limestone and millstone grit beds, north side of Rough creek, at Winchell's mill.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Covered space, dark clay shale	21	8	245	8
Limestone	18	------	214	------
Thin bedded sandstone, (probably slipped)	5	------	196	------
Limestone	25	------	191	------
White clay	14	------	166	------
Sandstone, in heavy beds	60	------	152	------
Thick bedded limestone, very few fossils	20	------	92	------
Silicious clay	12	------	72	------
Fine grained sandstone	10	------	60	------
Three ledges of limestone, (sub-carb.)	50	------	50	------
Rough creek.				

From 50 feet to bed of creek, belongs to the cavernous member of the sub-carboniferous limestone; 50 to 72, 1st sandstone; 72 to 92, to 1st limestone; 92 to 166, 2d sandstone, equivalent to the lower Tar Spring sandstone of Breckinridge county; 166 to 214, 2d limestone, increased in thickness. The hills near by contain superior beds to those at the top of section; they are not added because they are so much slipped and disturbed that they cannot be satisfactorily measured.

The waters of the creek being so much swollen that crossing was not possible, the line was retraced to McDanielsburg, and taken up at the forks of the road leading toward the Sulphur Springs, on the North fork of Rough creek. From the forks of the road to the Sulphur Springs the land lies level for two miles, when it rapidly falls off toward the creek, carrying down all the measures, in half a mile, about 100 feet. At the foot of this slope, limestone No. 2 is the surface rock. The rocks between this point and the Springs are broken into faults and waves. Near the Spring one of these waves is cut in section by the creek valley. A small branch flows into the North fork in the trough. The dip is from the main creek up the valley of the branch, which flows on the upturned edges of the rocks, which dip rapidly under its

bed. Sandstone No. 1 caps the mouth of the branch valley; the limestones beneath are of the cavernous member of the sub-carboniferous. The Sulphur Spring rises in the bed of the main creek.

The strong dip here is nearly south; the direction of the dip at Winchell's mill is northwest; in both instances dipping away from the line of the creeks. The dip at North fork varies from 15° to 35°. On the north side of the creek, near the Sulphur Spring, the dip is less rapid; 5° to 15° toward the southeast; and away from the bend below the Spring, and toward the bend above it.

The rocks between Rough creek and Eskridge's ferry are all the beds of the millstone grit; the 5th sandstone capping the "Sand knob" near the farm of Mr. Owens.

From Eskridge's ferry we have the following section—the thickness of the beds determined by barometer:

No. 27. *Section from Eskridge's ferry to top of "Sandstone knob." Horizontal distance, one and a half miles.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Heavy sandstone, conglomerate in lower beds	145	------	427	7
Covered space, showing shales, limestone, and sandstone at the base	134	7	282	7
Sandy shale and limestone	94	------	148	------
Covered space, heavy bed of limestone on top; part of sandstone showing near middle	54	------	54	------
Bed of Rough creek.				

Crossing at Eskridge's ferry, the work enters Grayson county.

The first elevation after crossing Rough creek is a steep rocky bluff of 45 to 50 feet; the base and middle of the mass consisting of the beds of limestone No. 2; the upper part being the lower beds of sandstone No. 3.

Notwithstanding the many reversals of dip the beds are falling toward the southwest; the 3d sandstone being at least 200 feet lower than the equivalent bed at Winchell's mill and McDanielsburg.

The shale beds associated with limestone No. 3 have been found to diminish in thickness from Clover creek eastwardly; they are found to be thickening to the southwest.

From the ferry to the falls of Rough and the Litchfield road the land is

nearly level; one outline of the shale and the limestone beds of No. 3 being encountered near the forks of the road to McGee's ferry. From this point the dip is south; the surface falling with the dip to the Litchfield road, which is entered at the junction of the beds of limestone No. 2 with sandstone No. 3.

Towards Litchfield the road lies in the valley, and frequently in the bed of Pleasant run, a creek with a rapid fall. The valley of the branch, for a considerable distance, lies on the top part of limestone No. 2. Near the farm of Mr. Jas. R. W. Eskridge the rocks dip rapidly to the southwest; the hill tops on the south being capped by a bed of coal; the hill rising above the branch 217 feet.

No. 28. *Section from Pleasant run to Smith's bank; coal on hill, south of run.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Covered space, sandy shale, (?)	30	------	217	10
Iron ore bed, 15 to 25 inches	1	6	187	10
Sandy shale	15	------	186	4
Black bituminous shale	4	------	171	4
Bituminous *coal*	2	------	167	4
Black rash, sometimes bituminous shale	1	4	165	4
Under clay and shale	15	------	165	------
Sandstone, thin beds, (5th sandstone)	20	------	150	------
Steep covered space, top showing coarse sandstone	65	------	137	------
Covered space, limestone and shale (?) beds	72	------	72	------
Pleasant run.				

The coal of this section is the lowest coal seen on the margin of the basin south of Rough creek and north of Green river. It probably lies above all the heavy beds upon the 5th sandstone.

From Pleasant run eastwardly towards Litchfield the road line does not rise above the 4th sandstone.

The aluminous shale associated with limestone No. 3 increases rapidly toward the east, especially the beds forming the upper part of this division. In some localities, the middle part of limestone No. 3 contains Pentremites sulcatus, (?) Rom. This fossil has a short vertical range, and has not been found in any other bed; it is probably a distinguishing and characteristic fossil form of limestone No. 3. It is a rare form, and is found only in certain localities in this bed.

By the line from the Litchfield road to Winchell's mill, Little Clifty is crossed near the Sulphur Springs. The line of Little Clifty presents considerable disturbance, the bed of the creek being on the cavernous member of the sub-carboniferous rocks.

Sandstone No. 1 is quite thin. Immediately below the Spring, an enormous mass of sandstone No. 2 has fallen toward the creek, and forms the bank on the west side of it. The exact arrangement of the rocks was not investigated. On Little Clifty, west of the Spring, the superior rocks are much broken, and in many places are cavernous. Between Little Clifty and Alum Cave fork the beds of sandstone No. 2 and limestone No. 2 are the only beds above the drainage. At the crossing of Cave fork, the upper part of limestone No. 1 is nearly even with the water of the creek; the beds exposed are soft and shaly, and contain great numbers of Productus, Terebratula, and comminuted remains of Crinoidea. The rocks dip to the west and south, frequently interrupted by small faults, by which the rocks are again raised.

The point of intersection with the Winchell's mill and Litchfield road (line D) is on sandstone No. 3. The rocks dip towards the north and northwest from this point nearly to the mill, with occasional waves reversing the dip. The waves are generally small; the effect is quite inconsiderable.

The following section, taken three miles south of Rough creek, at Winchell's mill, will show some of the changes which are presented in the millstone grit beds, and towards the south and southeast:

No. 29.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Bluish-buff sandstone, in thin plates; breaking into rectangular and parallelogramic blocks, (4th sandstone,) fossiliferous; the plates separated by aluminous shale	20	------	243	------
Limestone, buff colored beds	18	------	223	------
Shale bed, seen as red aluminous clay	12	------	205	------
Gray limestone, thin plates	12	------	193	------
Shale, seen as yellowish clay	10	------	181	------
Limestone	18	------	171	------
Shale bed, seen as black clay	8	------	153	------
Thin bedded sandstone, impregnated by coal tar, (3d sandstone)	25	------	145	------
Limestone, oolitic, 38 to 40	40	------	120	------
Sandstone, heavy beds, (2d sandstone)	75	------	75	------
Limestone, thin beds	10	------	------	------
Bed of branch.				

One mile south of the place of section, sandstone No. 3 is well marked with fossil tar, and measures 30 feet thick. The base of the 2d limestone is well seen; the beds are thicker than at any heretofore observed locality.

The summit of the ridge dividing Rough creek and Nolin river, two miles north of Litchfield, has a capping of the wasted beds of the 5th sandstone; some of the localities still preserves the ores equivalent to the bed at the top of Section 28.

South of Litchfield, on the Grayson Springs road, the shale beds associated with limestone No. 3 have increased in thickness. In the following section, one mile northwest of the Springs, the character of this change is set forth:

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Top of wasted materials of sandstone No. 5	8	------	123	3
Ferruginous sandy shale	20	------	112	3
Yellow aluminous shale, containing iron ore	2	------	92	3
Gray aluminous shale	4	------	90	3
Yellow aluminous shale	5	------	86	3
Blue aluminous shale	3	------	81	3
Yellow aluminous shale	2	------	78	3
Yellow aluminous shale, hard	5	------	76	3
Reddish aluminous shale	5	4	71	3
Covered space, aluminous shale, with fragments of sandstone No. 4	30	4	65	11
Earthy ferruginous limestone	1	5	35	6
Earthy ferruginous limestone, shell bed	1	5	34	1
Yellow aluminous limestone, 4 to 6 inches	6	------	32	8
Red aluminous clay, (Indian red), breaking into angular blocks	10	8	32	2
Yellow clay shales, in place	5	4	21	6
Yellow and blue shale	16	2	16	2
Branch, head of Bear creek.				

The changes in color between the beds of shale are sharply defined; the colors are very bright. The 4th sandstone is represented by a few segregated blocks. Limestone No. 4, if represented at all, is represented by clay shale. On Bear creek, below Grayson Springs, the lower part of limestone No. 3 is seen, represented by 28 feet of limestone, 10 feet of blackish gray shales, above which lies the fossiliferous bed of this locality.

I am not able to fill the hiatus at the base of the above section; the yellow and red shales at the base of the section are not seen at the Grayson Springs.

The section continued downward, by adding the members outcropping at the Springs, will be as follows:

No. 29.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Break at base of section.				
Top of point below Grayson Springs.				
Covered space, aluminous shales	18	------	63	2
Crystalline limestone, remains of Crinoidea	3	6	45	2
Thin bedded limestone, Crinoid beds	1	8	41	8
Aluminous shale, black and gray earth	10	------	40	------
Limestone, in solid masses	30	------	30	------
Top of 3d sandstone.				

Remarkable changes of dip are observed south of Litchfield. The rocks are sometimes disposed in waves which conform to the hills. Descending towards the head of Bear creek the dip is rapid and singular. Near the Springs it is frequently as high as 25°.

From the Springs, eastwardly, to the Millerstown road, the body of sandstone No. 2 is seen on the north side of the creek, rising in bold cliffs. The surface rocks on the south side, near the stream, being the aluminous shale beds of the top of section 29, brought down, probably, by a fault. The top of the ridge, between Bear and Rock creeks, is capped by shale beds or the waste of the 5th sandstone. The hills along the road affords no well exposed section.

The valley of Rock creek is bounded by the 2d sandstone—on the south side of the creek standing in wall-like masses—is here covered with hemlock and laurel.

On the east side of the creek the road ascends the masses of sandstone No. 2, limestone No. 2, sandstone No. 3, and one bed of limestone No. 3, with about 65 feet of clay and marly shales, to the base of the 5th sandstone, when it ascends the divide between the Hunting branch and Rock creek. This ridge is capped for about a mile with a few feet of the base of the 5th sandstone, from 10 to 50 yards wide, resting on the beds equivalent to the shales at top of Section 28. The sandstone here is a coarse conglomerate, containing few impressions of fossil plants.

At the east end of the ridge the rocks have become thinner.

The rocks of section 22 are passed over in descending toward

Millerstown, from sandstone No. 5 to the cavernous member of the sub-carboniferous limestone.

No exposures are seen upon the road, except at the base of limestone No. 3 and the beds of the cavernous member. The top of these beds is buff; having much the character of the buff beds of limestone No. 3. Sandstone and limestone No. 1 are neither of them seen; they are probably absent. The great faults and disturbances beginning at the end of the depositions of the cavernous member, which were so well exposed at Winchell's mill, directed attention particularly to the lower beds of the millstone grit.

To the southwest, down the valley of Nolin river, and along the Hunting branch of Rock creek, we have, on ascending from the river, the following section:

No. 30. *Section at Nolin river, at Millerstown, to the N. W.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Conglomerate sandstone, (5th sandstone.)				
Top of ridge, head of Hunting branch	20	------	300	------
Clay shales—thick near the head of branch, becoming thinner to the west	70	------	280	------
Sandstone No. 3	20	------	210	------
Limestone seen at Hodger's tan-yard	30	------	190	------
Sandstone at top of hill at Millerstown; sandstone No. 1, or Nos. 1 and 2 together, (?)	60	------	160	------
Gray clay shale	7	------	100	------
Limestone, containing Productus	8	------	93	------
Clay shale, soft bed	15	------	85	------
White and gray limestone, sub-carboniferous	70	------	100	------
Nolin river.				

On the head of Hunting branch sandstone No. 4 appears in considerable force, and the shale beds above it are diminished.

The dip lies in the direction of the line of Hunting branch, and the 5th sandstone is brought down to the drainage near "Sugar Camp," below which, for a short distance, the dip is interrupted; finally, at the mouth of Hunting branch, the line of the branch becomes a regular fault; on the south side sandstone No. 4 is the surface rock; on the north, the base of limestone No. 3 forms the line of the creek, standing in its bed at angles, ranging from 20°, 40°, or even as high as 70°; the hill on the north rising a considerable distance by dip alone; and

finally receiving several beds of limestone No. 3, shales, sandstone No. 4, thin shale beds, and sandstone No. 5.

On the south side of the creek the rocks are much broken and bent, presenting the faces of the rocks, which dip south and bring the 5th sandstone nearly to the top of the ridge, half a mile distant. One and a half miles south of the mouth of Hunting branch coal has been opened; it lies in the first valley south of the Hunting branch, having been brought down to the drainage. The rocks with which it is associated are much bent and disturbed, lying in irregular and broken troughs, nearly parallel to the Hunting branch and Nolin river.

The top of the ridge between Rock creek and Nolin river is capped by the 5th sandstone, which dips to the south, bringing the coal bed down to the drainage of the branch, on the south side of the ridge. South of the branch the coal and beds beneath are raised about 50 feet, when the dip is again south for 400 yards; the dip is now changed and rises at the rate of from 5° to 10°, which, in a short distance, brings the inferior beds—*i. e.*, limestone Nos. 3 and 2, with the associated sandstones—into view, high in the hill, half a mile south of the coal opening. The width of the coal bed, as exposed here, is about half a mile, interrupted by one fault near the middle. This locality is in the west end of an outlier, lying between Nolin river and Hunting branch, severed from the coal field, which lies west of it, by Rock creek.

On the north side of Hunting branch of Rock creek, one mile above its mouth, we have the following section:

No. 31. *Section on Hunting branch of Rock creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet	Inches.
Sandy shale, 40 to 60 feet	40	------	209	8
Shale, with thin plates of sandstone	8	------	169	8
Place of Gheslin coal, 2 feet 6 inches.				
Coal rash, 8 inches.				
Irregular bedded sandstone, charged with tar, (conglomerate)	15	------	161	8
Soft sandstone	21	------	146	8
Thick bedded hard sandstone, (at Sand knob, 144 feet)	10	------	125	8
Indurated clay, (slate,) 10 to 12 feet	12	------	115	8
Aluminous shale, generally seen as yellow clay	40	------	103	8
Soft muddy sandstone, (4th sandstone?)	3	------	63	8
Dark lamellar shale, place of coal, (at Horn's old place?)	10	------	60	8
Thin limestone and marlite	2	------	50	8
Aluminous shale	5	4	48	8
Marlite	8	------	43	4
Earthy limestone	2	6	42	8
Aluminous shale	1	8	40	2
Thin bedded limestone	2	6	38	6
Marly shale, broken shells, and Crinoidea	5	------	36	------
Pleurotocrinus remains, bed 1 foot	1	------	31	------
Limestone, large Pentremites sulcatus	3	------	30	------
Limestone, thick bedded	27	------	27	------
Sandstone, bed of Hunting branch, top of 3d sandstone.				

The coal (?) at 60 feet 8 inches has been seen at two localities. The first, at the Horn old farm, 5 miles east of Grayson Springs; the other, in a ravine, three miles N. W. of Millerstown. At both localities, the coal is found under limestone; first, a thin bed of shale, over this about four feet of limestone, upon which rests a sandstone, from 5 to 10 feet thick. The coal at Horn's is 8 inches thick, Pentremites and Retepora Archemides were sought for in the limestone above the coal at both localities, but none were found.

This horizon is probably the equivalent of that of the 10 inch coal reported in diagram No. 4, Vol. 1, Kentucky Reports, as being found on Shot Pouch creek, under Pentremital limestone.

The dividing ridge between Rock creek and the head of Conoloway creek receives the coal above the conglomerate. (See map for northern limit.)

The 36 feet of sandstone beneath the coal bed on Section 31, was not recognized on Conoloway and Rock creeks. The 4th sandstone has increased in thickness, and the coal appears to rest on the shale bed at the top of the 4th limestone, which is represented here by a few thin plates, and 6 to 8 feet of marlite. The drains east and north of the

bank cut into the bed beneath the coal, and show a remarkable change to have taken place in these beds. Between the bed here and those seen on Hunting branch, the 4th sandstone has increased in thickness to 10 feet of hard quartzite sandstone. All the beds dip toward Rock creek. On the slope of the hill the measures on top of the ridge are nearly level, or dip very little toward the south.

Crossing the ridge toward Bear creek, several drains are crossed, lying high on the ridge. These drains all cut into the clay shales under the coal bed. The capping of coal measures is from 10 to 50 feet thick.

In the valley of Bear creek, 3 miles south of Grayson Springs, the base of the banded clays of Section 28 is seen at the glade on the road, the lower part exposed:

No. 32. *Section on Brownsville road, three miles south of Grayson Springs.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Surface soil	4	------	39	8
Yellow gray shale, aluminous	2	------	35	8
Dove colored shale, aluminous	2	------	31	8
Purple-red shale, aluminous	3	------	29	8
Blue-red shale, aluminous	1	9	26	8
Yellow gray shale, aluminous	4	------	24	11
Yellow, deeper colored, aluminous	1	8	20	11
Gray shale	2	------	19	3
Yellow shale	1	3	17	3
Gray shaly sandstone	2	------	16	------
Gray shaly sandstone	8	------	14	------
Hard fossiliferous sandstone, (4th sandstone) Branch.	6	------	6	------

These banded clays are equivalent to the beds of Section 28; the shades of color distinctly separate the beds by a sharp line; the red band of Section 32 is on the geological horizon of the red band Section 28, at 32 feet 2 inches.

Section 32 is 134 feet below Section 28; difference of level deduced by barometer.

The dividing ridge between Bear and Conoloway creeks, on the line of the Grayson Springs and Brownsville road, is ascended about 4 miles south of the Spring. Where the ridge is ascended by the road, the base

of the 5th sandstone caps the hill. No outcrop of the coal bed was seen on the line north of the head of Saltsman's branch, about 4 miles from Nolin river. The ridge has the measures containing the place of the coal from the forks of the Mammoth Cave and Brownsville road.

The ore beds above the 5th sandstone, which had been opened by the managers of Nolin furnace, are first seen about two miles north of the head of Saltsman's branch. Occasional patches of the measures containing the ores cap the hills nearly to Nolin river. The knolls containing the ores lie on the 5th sandstone, about 50 feet above it, and contain an area from a few rods square to 50 acres and upwards; the beds are easily entered in outcrop. The deepest stripping would probably be 25 feet; the average thickness of the whole ore territory, between Davis' branch and Nolin, would be about 5 feet.

The ore beds are seen frequently north of the head of Dismal creek, and on the high ridges 3 miles north of Green river, on the Brownsville and Litchfield road; surface ores were frequently seen in the road cuts from 40 to 50 feet above the 5th sandstone.

While in the neighborhood of Davis' branch and the furnace, several sections were made of the best outcrops; but it will require very minute surveys satisfactorily to connect the different sections in such a manner as to form an unbroken geological column. The weight of evidence would direct certain connections; but with the facts in my possession, there is so much doubt that I refrain from making any. I will, however, express the opinion I have derived from the facts now in possession.

No. 33. *Section on head of North fork of Dismal creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Top of hill, covered space	26	------	146	4
Sandstone, hard firm blocks	5	4	120	4
Covered space, *laurel horizon*	34	------	115	------
Heavy sandstone	10	------	81	------
Soft shales	2	------	71	------
Ledge of sandstone, partly covered	11	------	69	------
Covered space*	54	------	58	------
Coal in bed of branch, containing several thin beds of black shales and clay	4	------	4	------

* The lower part of this space is black bituminous shale.

Under the coal are coal rash and black earthy shales, from three to six feet thick.

This coal is about thirty-five feet above the limestone first seen beneath it.

The following section is at the coal opened on the east side of Davis' branch, half a mile northeast of the furnace:

No. 34.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Yellow thick bedded sandstone, (5th sandstone)	55	------	168	6
Covered space, terrace	15	------	113	6
Steep covered space, sandstone, (*laurel horizon*)	45	------	98	6
Thin bedded sandy shale, irregular	10	------	53	6
Thin bedded sandy shale, regular	3	------	43	6
Pyritiferous shale	2	------	39	8
Coal. Bituminous	4	------	40	------
Pyritiferous band	2	------	39	8
Coal and shale	6	------	39	6
Coal and clay shale, the latter predominating	2	------	39	1
Pyritiferous *coal*	1	------	37	------
Silicious under clay	3	------	36	------
Sandy shale, 7 to 10 feet	10	------	33	------
Shale and sandstone	21	------	23	------
Limestone	2	------	2	------
Bed of branch.				

One fourth of a mile to the northeast a bed of iron ore has been opened, locally containing great numbers of fossils, principally chambered shells, the forms perfectly preserved as iron ore.

The top covering of the bed, where best seen, for 5 feet was of thin beds, alternately of sandy and aluminous shale; the sandy shale is very soft, composed of coarse sand, charged with fragments of plants. The upper part of the ore bed consists of thin ocherous layers, separated by shale similar to the covering; this bed is very irregular, in thickness from one to three feet. In the lower part of this last bed are deposited, in masses from 10 to 100 pounds, a shelly ore, almost entirely composed of Goniatites Nolinenses, Nautilus ferratus, N. canaliculatus, Orthoceratiti, several species of univalve and bivalve shells, filled and surrounded by ferruginous sand, small fragments of reedy coal, nearly all squarely broken across the length of the plants. Beneath this bed is about ten inches of blocks and irregular formed masses of ore, the whole resting on a thin bedded, coarse sand shales.

The beauty and abundance of fossils, especially the association of shells and plants, render this locality one of no ordinary interest, aside from the value of the ore beds. This bed was not traced to its position in the geological column. It has been located 29 feet above the coal bed of Section 34, (see section page 164, Vol. 1, Kentucky Geological Reports.)

At the head of Saltsman's branch the coal was opened immediately under the 5th sandstone, probably the exact equivalent of the bed at 40 feet at section 34; the sandstone is better exposed here than at any locality visited in this section of the country. It is about 100 feet thick, formed of coarse sand, with some small pebbles on the bedding faces of the rocks. The base of the sandstone is separated from the coal by from five to ten feet of soft materials, principally black bituminous shale. Where opened the coal appears to be of excellent quality, 2 feet 9 inches thick, with 3 to 4 inches of coal rash at the base, on white under clay. The materials associated with the coal at this locality are apparently very different from those in section 34. There can be no doubt, however, that they are part of the same bed.

Beneath the sandstone (5th) which caps the hill near the furnace, we have the following arrangement of the beds:

No. 35.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Covered space, sandy shale and sandstone	25		258	6
Sandy shale, or decomposing sandstone	43	2	233	6
Yellow sandstone, soft	21	6	190	4
Carbonaceous band, place of coal	5	4	168	10
Limestone	10	8	163	6
Ore bed?				
Buff limestone, used as flux at furnace	5	4	152	10
Covered space, yellow and reddish clay	37	8	146	6
Shaly limestone, Cellular chert	2	8	108	10
Gray limestone, in thick beds, used in construction of stack	16	8	106	2
Blue aluminous shale, place of Crinoidea beds	5		89	6
Buff limestone, with sandy shale	5	4	84	6
Covered space, aluminous shale	16		72	9
Limestone, No. 3	43	2	63	2
Sandstone, No. 3	21		21	
Dave's branch.				

South of Nolin river the 5th sandstone increases rapidly in thickness to Balen creek. On the north side of the river there is also a great

increase of this bed toward Dismal creek; near the mouth of the creek it appears to attain its maximum thickness, becoming much thinner toward Brownsville, where the rocks are represented in the following section:

No. 36. *Section of 5th sandstone and some of the inferior beds, from Green river toward the top of the hills to northwest.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Coarse white and brown sandstone	35	------	272	8
Sandstone, large pebbles	5	------	237	8
Sandstone, small pebbles	5	------	232	8
Coarse yellow sandstone, no pebbles	15	------	227	8
Covered space, gray and black shales, aluminous	20	------	222	8
Covered space, blue shale in cuts	15	------	202	8
Black and dove colored shale	5	------	187	8
Blue muddy shale	12	------	182	8
Aluminous shale, with 14 inches plate of limestone at top.				
Aluminous shale	10	------	165	8
Limestone, 3d limestone	38	------	155	8
Sandstone, (3d limestone,) bed thin on top, thin below	37	8	117	8
Limestone, upper part oolitic	32	4	80	------
Waste of sandstone, 2d limestone	10	8	47	8
Covered space	37	10	37	------
Water, Green river, at ferry.				

One mile north of this section 85 feet of this bed of sandstone is seen in a perpendicular cut, where it has no division.

At no locality south and west of the mouth of Dismal creek has the coal at the base of the 5th sandstone been opened. Several good exposures were seen at the base of the sandstone which exhibited no coal. The place of coal at 168 feet 10 inches (Section 35) was seen as dark, earthy, aluminous shale. Toward the north and west, on the heads of the streams emptying into Bear creek, a bed of coal has been opened, which appears to be the exact equivalent of the Davis' branch coal, Section 34. It is about 28 inches thick, and has been used for smith's work, and is generally approved. The only mining has been performed by stripping the outcrop.

South of the head of Dismal creek, and between Bear creek and Green river, the hills are again capped by the equivalent of the measures containing the ore beds, between Conoloway creek and Davis' branch.

Should the ore beds here prove to be equal in thickness to those on Davis' branch, and north of it, there is ore territory sufficient for sev-

eral furnaces south of Dismal creek, all of which could be sufficiently near Green river to reach navigation at a small expense.

On the road from Brownsville to Cloverport the line of Bear creek is crossed at a fault or slip in the rocks, from the west and northwest side, dipping to the southeast by a constant but wavy dip, for over a mile, bringing the 5th sandstone (?) down to the bed of the creek. On the southeast side of the creek the rocks are apparently raised about 90 feet. In the neighborhood of Little mountain the ore measures again cap the hills.

Satisfactory sections cannot be obtained in the neighborhood of Little mountain; but sufficient may be learned from natural outcrop to show that valuable iron ores may be obtained in vast abundance, over a large district lying between Bear creek and along the dividing ridge between Green river and the waters of Rough creek.

The following section from Little mountain, near the farm of Mr. Robinson, appears to contain beds not found further west; they probably thin out to the west and southwest:

No. 37. *Section at Little mountain.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Coarse sandstone, no pebbles	8	------	192	------
Fine grained sandstone	7	------	184	------
Iron ore (?) bed	7	(?)	177	------
Shales, mostly covered	36	------	170	------
Block ore, 2 to 4 feet	4	------	134	------
Shales, mostly covered	55	------	130	------
Shale, bottom carbonaceous	21	------	75	------
Segregations of carbonate of iron	4	------	54	------
Black bituminous shale, 6 to 11 feet	8	------	50	------
Coal, 12 to 30 inches, equivalent to Nelson and Smith banks	2	------	42	------
Under clay and coal rash	40	------	40	------
Sandy shale, yellow in exposed situations	28	------	36	------
Gray mud shale	4	------	8	------
Dark gray shale, 2 to 6 feet	4	------	4	------
The fifth sandstone.				

The top of the 5th sandstone is frequently exposed in the deep drains.

In several localities the shale at 75 feet in the above section, lying immediately above the ore bed, is marked by fossil plants and small fragments of reedy coal.

For several miles toward the northwest the line of the road has cut into this sandstone, which, if followed, will soon lead to a cut exposing the ore bed beneath it.

At the intersection of the Litchfield and Morgantown with the Brownsville and Cloverport road Mr. William Nelson has opened and worked a coal bed at 42 feet, in Section 37.

The following is the arrangement of the materials of the measures at Mr. Nelson's coal bank:

No. 38.

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Surface soil, broken sandy shale, with a few loose blocks of quartzose sandstone	5	------	11	9
Black earthy shale	4	------		9
Black bituminous shale	2	------		9
Coal	1	6	3	9
Earthy band	------	3	2	3
Coal	2	------	2	------
Under clay, thickness not seen.				

No remains of the ore bed were seen near the Nelson "bank;" it is probable that the ore is separated by a greater interval than that given in Section 37.

Between the road above referred to and the crossing of Short creek the coal measures cap the hills in diminished quantities. The ridge south of the crossing of Caney creek has, probably, the greatest thickness.

Near Camp No. 17 the shales and Nelson coal (?) are seen in a deep valley, the hill to the east and west is capped by a sandstone, the equivalent of the Little mountain sandstone.

At the crossing of Caney creek, near the farm of Mr. George House, the rocks dip to the south and southwest at an angle of 5° or 6°. The bed of the creek at the crossing is the upper part of the limestone of No. 3, above which we have the following section:

No. 39. *Section at the crossing of Caney creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Coarse sandstone, top of hill, (5th sandstone)	15	------	140	10
Yellow or buff limestone and shale	33	------	125	10
Yellow silicious mudstone, (4th sandstone)	16	4	92	10
Drab-gray aluminous shale	26	------	75	2
Buff limestone	------	4	49	2
Blue-gray shale	16	6	48	10
Blue-gray shale	26	------	32	4
Chert beds	5	4	6	4
Dark shale	1	------	1	------
Limestone, bed of Caney creek.				

On Bennet's creek, 2 miles north, the 4th sandstone is seen in great perfection; it lies in blocks from 1 to 8 inches thick, breaking at right angles and perpendicularly to the bed faces of the rocks; many of the different layers are fossiliferous. It is a drab gray quartzose sandstone; maintaining its peculiar lithological character over a large district of country; the bed is, however, frequently interrupted and wanting. It is occasionally seen in every part of the country, on the margin of the coal measures, from Grayson to Christian counties.

The dividing ridge between Bennet's creek and Short creek has been denuded of all, or nearly all, of the coal measures. The road lies in many places on limestone, at Section 39.

On the north side of the valley of Lost creek the sub-carboniferous rocks are brought above the drainage; the dip from this axis of disturbance is toward the north and northwest from 25° to 30°, diminishing the angle of the dip toward the north. The upturned edges of sandstone No. 2 and limestone No. 2 form the first hill, which, on its western slope, is capped by sandstone No. 3, which underruns limestone No. 3, at Mr. Tilford's—the hill north of his house being composed of the limestone and shales of No. 3, capped by the waste of sandy shales at the base of the 5th sandstone. The dip has changed at Mr. Tilford's, and lies toward the southwest.

From the hill near Tilford's to the falls of Rough creek the surface falls about 310 feet. The base of the 5th sandstone is reached on only one hill between the two points. Great masses are seen on the ridge south of the road; probably 65 feet of it caps the hills. At the falls

of Rough creek, the measures seen at Mr. Tilford's, and frequently between the two points high on the hills, form the surface rocks in the bed of the creek; much changed, however, in lithological character. The exact counterpart of limestone No. 3 is seen below the dam at the mill. It has not been met in any part of the margin of the coal field.

No. 40. *Section at the Falls of Rough creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Surface soil	3	------	22	8
Aluminous shale	2	------	19	8
Black aluminous shale, 8 to 14 inches, non-fossiliferous	------	8	17	8
Thin flags, limestone	6	3	17	------
Marly shale, Spirifer and Productus	1	8	16	8
Hard sandy porous bed, containing Agassizocrinus; no other fossils observed	1	------	14	10
Carbonaceous aluminous shale, non-fossiliferous	3	------	13	10
Hard limestone, containing Crinoidea	1	------	10	10
Calcareous shaly bed, containing Bryazoa and Crinoidea; Pentremites rare	3	------	9	10
Calcareous shale, Bryazoa bed	2	------	6	10
Silicious calcareous bed, yellow Crinoidea and Pentremites	1	6	4	10
Limestone, gray, Crinoidea and Pentremites	1	6	3	4
Yellow silicious bed, segregated chert, containing Pentremites	1	10	1	10
Thick bedded limestone, bed of creek.				

The water of the creek has washed the soft shaly beds, undermining the hard bed from 6 to 8 feet, thus giving a perfect exposure of the character of the several beds.

Above the bed of above section the hill on the north side of the creek rises from 200 to 275 feet, formed of the shales and limestone (No. 3), of sandstone No. 4, and limestone No. 4, all capped near the creek by the base of the 5th sandstone. The road from the falls of Rough creek to Cloverport lies nearly with the line of strike, the branches and creeks indenting the margin of the coal field, leaving narrow bands of the coal measures upon the ridges between them. The ore beds near the top of the 5th sandstone are seen occasionally on this line.

At Mr. Wm. H. Howard's the ore beds are cut by the wear of the road. The ore is about 2 feet 6 inches thick, apparently of good quality. It lies in blocks, in a regular bed.

The shales of the 2d limestone are thicker here than farther east; the beds of limestone are also more compact and in thicker ledges, while the whole mass of the bed is less thick.

The Belerophon bed at 296 feet 2 inches (section 22) is recognizable in all the valleys between the falls of Rough and the Owensboro road, 5 miles south of Cloverport. The measures on the line of the road to Cloverport are all beneath the sandstone at 420 feet 2 inches, Section 22.

The following line crosses part of Breckinridge, the corner of Hancock, into Ohio, and closes on the last line on Bennet's creek. (See map.)

The river hills to the southwest of Cloverport are capped by the base of 5th sandstone. Below the sandstone the 4th limestone is a thin bed, 6 to 8 feet thick, containing Bryazoa. The shales of the 3d limestone are marked by three yellow or buff beds, separated by from 8 to 10 feet of gray or dove colored shale. The Owensboro road was crossed near Mr. Newton's farm. The ridge dividing Clover creek and the head waters of Panther creek receives a few feet of the shales under the "Breckinridge coal."

The ore bed was seen in a few places on the line; it is sandy, and thinner than farther to the south, east, and southeast and south.

On reaching the head of Panther creek the rocks are seen dipping to the south and southwest, the 4th limestone being the surface rock in the bed of the branches. The hills rise from 80 to 150 feet high above the drainage, and are made up of the bed of the 4th sandstone, shales, 5th sandstone, and a thin capping of coal measures above it. These patches are outliers of small area, and are not known to contain a workable coal.

On the Sugar Camp branch of Panther, about 2½ miles south of the dividing ridge, the coal measures are brought to the drainage.

Between Sugar Camp creek and Rough creek, at Hine's mill, the hills contain the measures of the Hawesville section up to the Lewisport coal. The limestone of the coal measures beneath the Lewisport coal bed forms the bed of Adam's fork of Rough creek for a considerable distance, the rocks dipping at the same rate as the fall of the creek.

Near Fordsville iron ore beds are exposed in natural outcrop in the road; the ore is sandy; it lies in sandy shale, 25 feet above limestone, which is probably the equivalent of the limestone under the Lewisport coal of Hancock county.

Between Fordsville and Hines' mill the hills are low; occasionally

fragments of coal may be found in the branches; none of the coal beds of this part of the county have been opened. On the north side of Rough creek the country, for a considerable distance, is flat, and overflowed by the creek during its floods. On the south side of the creek the lands are rather higher, but quite flat; the low ridge on the northeast side of the road being soft, sandy shales. About a mile south of Hines' mill a bold sulphur spring rises in the flat. One quarter of a mile south of the spring the rocks are found disturbed, and dipping to the northwest; the fault or disturbance having brought up the limestones of the millstone grit. High hills of soft measures lie toward the east and southeast, containing thin coal beds. The 5th sandstone has become soft, and much thinner than it is eastwardly; no pebbles were seen in any part of this bed between Caney creek and Green river. The lower part of the bed is represented by thin, ash-colored, sandy shales; the 4th limestone has an earthy fracture, and may, possibly, possess hydraulic cement properties. The drains and creeks frequently cut through the coal measures between Hines' mill and Caneyville. On the Caneyville road toward Litchfield the hills are capped by about 80 feet of coal measures, containing the coal measures and ore bed in Section 28 at 187 feet.

The ore bed is seen denuded near Caneyville, on the property of S. W. Bond. An opening has recently been made in the bed, which is five feet thick, consisting of blocks of ore and ocherous earth.

The cuts made by the branches and creeks are quite favorable for sections east and north of Caneyville as far as Bennet's creek. The ore bed exposed is not so thick as the equivalent bed seen west of Caneyville. It is, probably, not so thick as it is to the south and east.

The 5th sandstone between Caneyville and Bennet's creek is quite thin. It is represented by about 25 feet of soft sandstone, in thick beds, and about 55 feet of sandy shale, beneath which the 4th limestone has a thickness of about 25 feet—the thickest mass of this bed seen. Two miles to the north, at Mr. Howe's, (see Section No. 39,) it is entirely absent, its place being occupied by aluminous shale.

The only coal opened near the line of our work was that opened by Mr. Wm. Miller, southeast of the road, 1½ miles from Caneyville. The opening is made on the south side of a ravine. The coal is covered by 18 feet of sandstone and 5 feet of black bituminous shale, which is

sometimes changed to gray sandy shale. The coal, where seen, measures 20 to 22 inches; it lies on 3 to 4 inches of coal rash, under clay, and sandy shale; 18 feet to limestone in bed of drain. On the north side of the drain the limestone in the bed of the creek on the south side is lifted about 22 feet above the coal, the slip being 30 feet. The covering above the coal is about 45 feet thick.

From Caneyville to Morgantown the hills rise higher above the drainage, and are composed of vast beds of sandy and aluminous shale. At Dog creek the cuts reach the base of the 5th sandstone. South of the creek the land becomes level, with occasional knolls of the softer shale beds above the 5th sandstone, which sometimes rise from 80 to 100 feet above the general level of the country.

The head of Welch's creek cuts through the shale bed and into the 5th sandstone. From Welch's creek to Green river the road rises to the soft beds above the sandstone. One mile north of Green river the Yellow rock over the Roberts coal (Muddy river) is first recognized.

At Green river the 5th sandstone lies even with the pool. On the south side of the river the rocks rise in the direction of Morgantown, and again dip rapidly toward the valley of Renfro's creek and Woodberry. At the top of the ridge, east of the mouth of Big Barren river, the pebbles and small patches of the 5th sandstone are occasionally seen.

Returning to Morgantown and taking the line of the road to Russellville, the land soon becomes level or gently undulating; the valley of Renfro's creek is wide and flat; evidently underlaid, for a great part, by the rocks of the section taken at the coal bank opened by Mr. Moses Shearer, one and a half mile to the southwest of Morgantown.

No. 47. *Section of coal opened by Mr. Moses Shearer, near Morgantown.*

	Thickness.		Elevation.	
	Feet	Inches.	Feet.	Inches.
Top of hill sandstone	10	------	86	9
Covered space, aluminous shale	10	------	76	9
Limestone and aluminous shale	4	------	66	9
Aluminous clay and shale	18	------	62	9
Aluminous shale, segregations of limestone and marly shale, fossiliferous	10	------	44	9
Carbonaceous clay, pieces of coal in some localities	1	6	34	9
Drab aluminous shale	10	------	33	3
Black bituminous slate	------	8	23	3
Coal	3	7	22	7
Under clay, dark micaceous	5	------	19	------
Covered space	14	------	14	------
Bottom of drain.				

To the southwest from the Shearer coal locality, better known as the "Limestone hills," two and a half miles, the margin of the coal measures are reached, on the dividing ridge between Renfro's and Sandy creeks.

The valleys of Sandy, Big Muddy creek, and Muddy river cut into the millstone grit beds nearly to the mouth of all these water courses.

The coal measures are again seen on the dividing ridge between Big Muddy and Muddy river, north of McCoy's mill.

The Shearer coal has been opened and worked at several localities on this ridge. It is very unequal in thickness, varying from eighteen inches to three and a half feet. The termination of the coal to the southwest, between Muddy river and Big Muddy creek, is near the forks of the Elkton and Russellville road.

The work was extended toward Elkton, in the expectation of finding outliers of coal measures, to Haroldsville. At Rock Spring meeting-house, 45 feet of the 5th sandstone is found. It is here a coarse conglomerate, resting on the 4th limestone, which has the appearance of being water-worn previous to the deposition of the 5th sandstone.

The line was continued to within 8 miles of Russellville, when the 2d limestone was reached. It is oolitic, and greatly increased in volume, about 60 feet being in sight, and the bottom concealed below the drainage.

From the last point toward Greenville, by the Russellville and Green-

ville road, the rocks are found nearly level, or dipping slightly to the northeast. The country is level and rich; the soil being mostly composed of the waste of the 4th limestone, and the shades of the 3d limestone; the 4th sandstone is absent on the line of this road, or it is not recognizable.

The 5th sandstone is reached at the head of the Little Rawhide creek, a branch of Wolf Lick creek. It is a coarse conglomerate, 40 to 55 feet thick; the upper part of the mass is coarse, hard sandstone.

The dip of the rocks is to the southeast on the Wolf Lick side of the ridge and to the northwest, and occasionally the dip is seen lying toward the southwest.

Several patches or outliers of coal measures are seen on the hills between the northern branches of Muddy river and Clifty creek, rarely over sixty or seventy feet thick, above the 5th sandstone. One outcrop of ore was observed between the points above alluded to.

Near the crossing of Clifty creek the 5th sandstone is seen in heavy masses, 25 to 30 feet thick. North of Clifty the coal measures are reached at the Dug hill, half a mile southeast of the Rochester and Elkton road, where the following section is seen in the road:

No. 42. *Section at Dug hill, Muhlenburg county.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Sandy shale, 90 to 110 feet	90	------	169	6
Sandstone	11	------	79	6
Aluminous shale	38	------	68	6
Iron ore	------	6	30	6
Sandy shale	30	------	30	------
Top of 5th sandstone.				

The whole mass of sandstone at the base of the above section is about 80 feet.

From the intersection of the Russellville and Greenville with the Elkton and Rochester roads, to the narrows, the road lies on the upper part of the section above; near the narrows the road suddenly descends to the 5th sandstone—*i. e.*, the margin of the coal measures.

The 5th sandstone dips to both sides of the road from the ridge, (narrows,) which is probably an anticlinal wave; the synclinals on either

side being in the beds of Clifty creek, on the east and eastern branches of Pond river, on the west side of the ridge.

South of the narrows the 4th limestone and the 4th sandstone are dipping rapidly toward the northeast, and are raised a considerable distance above the horizontal position of the 5th sandstone at the narrows.

The narrow part of the ridge is about 60 yards wide, being, in fact, only a huge mass of the 5th sandstone, 80 feet thick, which is little else than a loose mass of quartz pebbles about the size of marbles, through which the water percolates. Being arrested by the clay shales at the base of the sandstone, it breaks out in bold springs on the east side of the ridge, which is doubtless the direction of the greatest dip of this locality.

About one mile south of the narrows the road has descended to the 3d sandstone, and the rocks are quite level, or are dipping gently to the southwest with the line of the branches to Pond river. The coal measures lying between the head of Pond river and Clifty are only a few feet thick, (80 to 110 feet,) from one to two miles wide, deeply indented by the streams, especially on the west or Pond river side of the ridge. The work having been extended from the narrows to the intersection of the "Old Highland lick" and Elkton road—sandstone No. 3 forming the surface rock—the Lick road was taken, and the line run to Bennet's mill, on Pond river.

On descending the first hill limestone No. 2 is reached, which continues to be the surface rock for about three miles; the direction of the road being to the northwest. Near the East fork of Pond river the dip becomes quite rapid, and brings down the mass of limestone No. 3, with its associated shale beds, to the East fork, in a few places covered by fallen masses of the pebbly part of the 5th sandstone. West of the East fork the dip is to the northeast, meeting the dip from the opposite direction near or at the line of the river.

The 3d sandstone has become quite yellow, and in the valley of the East fork forms the surface rock on the west side of the stream. The north side of the road is skirted by a low range of hills, composed of the 3d and 4th limestones, with a thin bed of the 4th sandstone; the whole mass 94 to 110 feet thick. Between the East fork and Bennet's mill, on West fork of Pond river, the ridge is composed of the millstone grit bed, from the 3d sandstone to the coal measures, including, on the

top of the most elevated points, from 15 to 30 feet of the soft bed above the 5th sandstone; the members, from base to top of the hill, being probably less than 200 feet thick.

The hills are broken; the dip irregular and wavy, falling from the summit of the hills to the streams on the east and west side; the height of the divide by barometer being 426 feet; 226 feet being due to the dip. The 3d sandstone is the surface rock in the valley of both the East and West forks when intersected by this line.

Line A extends from Bennet's mill to Petersburg, by the way of White Plains. On this line, which lies outside of the coal measures nearly its whole length, it was observed that the clay shales, associated with limestone beds Nos. 2, 3, and 4, are replaced, either in part or altogether, by sandy or micaceous shale. The mass of the 3d sandstone is also much expanded near Front Hill post-office; being there about 65 feet thick.

Plates and segregated masses of chert are associated with the 3d and 4th limestones. The higher beds are strewed with blocks of sandstone No. 4, and pebbles derived from sandstone No. 5.

The ridge dividing the valley of McFarland's creek and West fork of Pond river is capped by heavy masses of the 5th sandstone, (coarse conglomerate.) From the top of this ridge toward the northwest the dip is rapid, bringing the 5th sandstone to the valley. In about one and a half miles the dip is then interrupted and increased from 15° to 20°. This rate of the dip soon brings the 5th sandstone under the drainage, when it is brought up again by a slip of from 75 to 80 feet, and again dips below the drainage, to be again brought up by a similar fault—this arrangement being repeated four several times, gradually diminishing, and finally, the sandstone disappears under the soft shale bed of coal measures, to be again brought up two and a half miles distant, on the Madisonville and Hopkinsville road, at Mr. Brazier's, when the dip is from 8° to 15° to the northeast, marking the western margin of the synclinal fold.

At 254 north a bed of coal, one foot thick, is seen in outcrop, with under clay 6 inches beneath the coal; there is probably 65 to 80 feet of sandy shale, with one or two interrupted beds of sandstone. The measures from the conglomerate (5th S. S.) to the coal were not satisfactorily made out; the bed being so frequently slipped in this locality; it is not

improbable that some of them have been duplicated in the measurement between the 5th sandstone and coal.

Southwardly from Mr. Brazier's, at the margin of the coal field, toward Hopkinsville, the conglomerate beds are about 80 feet thick, resting on sandy shale. The measures lie in waves from three to four miles wide, with a gentle dip from ½° to 2½°. The synclinal fold is here first encountered. Its apparent depth is somewhat increased by denudation, which reaches the top of the 2d limestone. The western margin of the first anticlinal shows sandstone No. 3 near its base, dipping westwardly at 3½° to 4°. The banded shale beds and 4th sandstone are occasionally seen nearly to the sub-carboniferous limestone, which appears to abut abruptly against the shales above the 4th sandstone. The 1st and 2d sandstones are not seen east of the margin of the coal measures, in the edge of Christian county; nor is the 3d sandstone seen east of the 2d synclinal fold. The 4th sandstone and the banded shales are recognizable nearly to the margin of the sub-carboniferous limestone, 4 miles west of Hopkinsville. The indications are that the beds of millstone grit below the 3d sandstone have thinned out toward the east; or else, that they have been carried away before the deposition of the 2d limestone. The 4th sandstone, although very small, is so strongly marked by its distinguishing characteristics, that it is a reliable horizon whenever it is present. It is the only sandstone bed of the millstone grit beds now known containing fossil shells. It may be known by its lithological character alone.

The lines in Hopkins county were taken up at Clark's mill on Pond river, and carried to Greenville, connecting the work previously done in Hopkins and Muhlenburg counties with the survey of the margin of the coal field made this summer.

The work taken up on Pond river begins at a point high in the coal measures. The clear coal of the Hunting branch of Clark's creek is seen in outcrop near the mill, on the northeast side of the river, (see section, page 136, Vol. 1, Kentucky Geological Reports.) The coal dips rapidly about 4½° to northeast, away from the river. The beds forming the hill above the coal consist of from 50 to 60 feet of sandy and aluminous shale, 30 to 35, space covered, the whole capped by a very coarse-grained loose-textured sandstone. The waste of the beds forming the covering of the coal beds forms a warm productive soil,

and distinguishes the country between Pond river. At Mr. John Oats', six miles southwest of Greenville, two wells have been dug by Mr. Oats, both of which reach a bed of coal said to be five feet thick. This is probably the equivalent of the upper bed at Clark's mill. The measures change between Mr. Oats' and Greenville. The reason of the change is not apparent on the line. The shales are evidently thicker; the coarse sandstone has disappeared; the soil and timber are changed. The measures between Pond river and Mr. Oats' are again recognized near Pond creek, five miles south of Greenville. It is highly probable that the measures lying north of a line from Mr. John Oats' to Pond creek are higher than in the hills above the coal near Pond river; and that they correspond to the shales above the equivalent of the Anvil Rock at Providence.

At Mr. G. Leigh's, on the southeast side of Pond creek, a fault was encountered on the road. The rocks on the line dip to the northeast, at an angle from 45 to 50°.

The millstone grit beds are raised high in the hills, and extend to Clark's mill, on Clifty creek, as surface rocks. The dip is quite inconstant, varying both in quantity and direction.

The line between Clifty creek and Muddy river lies almost directly on the margin of the most southwardly outcrop of the 5th sandstone, and about two and one half miles south of the Roberts coal banks, on Muddy river.

On the northwest side of Muddy river the 5th sandstone is a coarse conglomerate. The masses of this rock lying near the river occupy a lower level than the equivalent bed toward the divide between the two streams. The bed is well exposed near the center of the divide, where it is a coarse sandstone without pebbles. On Clifty, 2½ miles to the northwest, it is strangely marked by pebbles, some of which are of large size, from 1½ to 2 inches in diameter.

To the southeast of Muddy river, the line was connected with the Rochester and Russellville road, and carried toward Rochester, (see map.) The hills toward Rochester are millstone grit. Deer Lick cuts into the 3d limestone. The 4th limestone and the 4th sandstone are both seen on the south side of Deer Lick. On the northeast side of Deer Lick creek the line rises a hill, the whole mass of which, from top to bottom, is composed of coarse sandstone (5th S. S.) without pebbles.

The country above this sandstone is nearly a plain, on which rounded knolls of coal measures are seen from 80 to 150 feet high; these measures continue to the Russellville and Morgantown road with the road to Rochester. From this point to Morgantown the line crosses a synclinal, the coal measures extending nearly to Morgantown.

Southwest of Morgantown the coal measures of Renfro's creek are no doubt connected with the equivalent beds lying in the valley of Big Muddy and Hickory Camp creeks.

The dividing ridge between Big Muddy and Renfro's creek, at the "Sand Hill," receives the coal measures as high as the equivalent of the sandstone at the top of the Little Mountain section of Edmonson county, (Sec. No. 37.) The difference of level from Big Muddy to top of the "Sand Hill" being 163 feet.

Between Morgantown and Woodbury the country is level and gently rolling; the creek valleys wide. At Morgantown the rocks dip to the southeast, bringing the measures of the hill below the valley of Renfro's creek in a short distance. The shale beds above the Morgantown sandstone being the surface material nearly to the mouth of Big Barren river. Sandstone 37 feet thick, in section, page 161, Vol. 1, Kentucky Geological Reports, is no doubt the equivalent of the sandstone at the top of the hill at Morgantown.

On the east side of Big Barren, as before stated, the conglomerate caps the hill-tops 175 feet above the river; the direction of dip was not satisfactorily observed. Toward the east, on the Glasgow road to Mr. J. M. Young's farm, 3 miles from the mouth of Big Barren, the hills do not contain coal measures. The well at Mr. Young's being sunk into the sandy micaceous shales at the base of the 5th sandstone. Southeastwardly from Mr. Young's, the country rises by a gentle slope about 100 feet in two miles; the measures rise with the hill, and only a few feet of the masses of the 5th sandstone, 30 feet above the horizon at Mr. Young's, cap the highest point of the ridge.

Descending the ridge toward the south appeared considerable masses of brecciated limestone, composed of limestone No. 4 (?), cemented by a silicious paste, containing small fragments of chert. The breccia occupies the horizon of the 4th limestone in a bed of aluminous shale. At the base of the shale the rocks are nearly level. The valleys are expanded, and, for several miles, the road lies either on the 3d lime-

stone or the 3d sandstone. Five miles to the northwest of Bowling-Green the road descends to the cavernous limestone. The hill bounding the valley on the north is capped by sandstone No. 2. The south side of the valley is partially bounded by isolated hills, which are capped by the 2d sandstone. The first sandstone was not recognized in Warren county. The base of the sandstone rests on Dichocrinus beds, doubtless the equivalent of the beds of Grayson county, 60 feet below the base of the 1st sandstone.

The general trend of the southern margin of the 2d sandstone is nearly east and west; no roads are made parallel to and south of Green river, north of the sub-carboniferous limestone. Between the lines of the Bowling-Green and the Woodbury, and the Bowling-Green and Brownstown roads, Line R was carried up the valley above referred to, to the Bowling-Green and Brownsville road, and by the last road to Brownsville.

After taking the road toward Brownsville, in two miles we reached the base of sandstone No. 2. The top of the ridge or table land is capped by about 65 feet of sandstone. On ascending the hill it turns toward the coast, and for two miles lies nearly on the strike. At 304, Line R, the road reaches a disturbed territory; the rocks dip to the northeast, at from 5° to 35°. Here the road makes a sudden bend toward the north, and runs over the upturned edges of the 3d sandstone for half a mile, to the hill on the south side of Alexander creek; here the 3d limestone is first seen on this road, unless the limestone seen at the last bend of the road be this bed. From Alexander creek to Chameleon Springs the rocks are disturbed. The greatest disturbance appears to be east of the road.

From the Springs to Brownsville the road lies on the beds below the 5th sandstone; rarely cutting below the 3d, even in the deepest valleys; reaching the 5th sandstone only once or twice. On this line, from the mouth of Barren river to Brownsville, there are only one or two small patches of coal measures above the 5th sandstone. No indications of workable beds were seen or heard of near the line. Between the line and Green river a coal is said to exist in good workable beds, probably the coal equivalent to that at Nolin furnace, Edmonson county. It was desirable that the territory near Green river should have been examined for the iron ore equivalent to the Nolin beds, but the

difficulties of the country were such that with one camp arrangement we were not able to travel it. It is known that outliers of the coal measures exist on the south side of Green river, east of the mouth of Big Barren. Of their value and extent nothing is certainly known. The ore bed found on the Rudy's and Sunfish creeks may possibly extend with the measures across the river; should they do so, and have the thickness and quality of the beds north of the river, their vicinity to navigation would render these ores of great value, especially as furnace rock, limestone, and wood are here in the immediate vicinity of the ores.

Having closed the line from Morgantown, on the lines formerly carried to Brownsville, the work was carried from the latter place to the Mammoth Cave; when Green river was crossed, and the line carried to Millerstown, through Edmonson and Hart counties.

From the forks of the Brownsville road to Bowling-Green and Munfordsville, by the road to the latter place to the Mammoth Cave, the 4th limestone and the 4th sandstone are absent; the shale beds of the third limestones are very thick, and form with the 3d limestone the surface rock for several miles.

Near the "Turn-hole," the 2d limestone and 2d sandstone are surface rocks. Between the "Turn-hole" and the cave the 2d sandstone is the surface rock for two and a half miles, when the surface becomes broken by deep sink holes for three quarters of a mile.

The flat table land near the cave lies on a mass of the 2d sandstone, which has a slight dip to the southeast. The Cave House is situated about 285 feet above Green river. The cavernous limestone is cut by the valley of Green river 213 feet.

The hills on the north side of the river are capped by the 2d sandstone which lies lower than the same bed on the south side of the river. About four miles north of the river, at Mr. P. P. Pace's farm, the road ascends the bed of the 5th sandstone, which is a coarse conglomerate, lying, by barometer, 329 feet above Green river.

For several miles to the northeast, the 5th sandstone is capped by occasional knolls of coal measures from 50 to 75 feet higher.

At the head of Belew's creek and Dog creek, the coal measures rise sufficiently high to receive the ore beds. It is not known that they exist here, nor can the question be answered except by digging.

After crossing Dog creek, the measures do not rise high enough

above the 5th sandstone to receive the ore beds. At the crossing of the Bacon creek the cavernous beds of the sub-carboniferous limestone are reached; these beds extend to Wheeler's mill, on Nolin river. As soon as the river is crossed the beds of the millstone grit are reached, which are the surface rocks nearly to Millerstown.

Crossing the river at Millerstown, the cavernous member of the sub-carboniferous beds form the surface rocks, with occasional patches of sandstone on the highest knolls, probably the waste of the 2d sandstone, which is seen in bold outliers toward the west. It forms the first sandstone hill west of Stephensburg. These patches of sandstone occupy quite a limited territory, the last seen are about six miles northeast of Millerstown.

The accompanying map is constructed from the lines actually run, from which it will be seen that a large portion of the margin of the coal measures are only approximately determined, as only that part absolutely determined is marked by solid lines, and all parts not so determined indicated by dotted lines.

The interior of polygons made, in which ore beds are known to exist, must be surveyed in detail to give an approximate determination of the extent and value.

The margin of the coal field extending from Clover creek, through Grayson, Edmonson, Butler, and part of Warren, will no doubt afford a territory rich in iron beds. The marginal coal beds are generally too thin to be of great value. In many localities they are found in sufficient thickness to be profitably wrought. The broad territory on the eastern margin of the coal field, which is thinly overlaid with the lowest coal measures, will give greater facility in reaching the iron ores, which have been sufficiently stripped by denudation to render them accessible at a moderate cost.

The ores, coal, rocks, soils, &c., collected during the surveys of this season, have been forwarded to the Geological Laboratory. Many of them probably cannot be reached by the chemist in time for analysis during the present season.

During the last two years, our parties have been treated with great kindness, and have received every facility required in the prosecution of the survey. To all those to whom I have been indebted, I take this public method of acknowledging my obligations. They have my thanks.

SIDNEY S. LYON, *Assistant Geologist.*

Since the foregoing part of this chapter was written, the work of the base line has been carried forward, and the work terminated on Tug river, which forms the eastern boundary of the State.

It will be necessary to add a brief description of that part lying between the termination of the work of last year and the end of the line.

The total length of the base line is three hundred and six miles, eighteen hundred and thirty-two feet. It lies in the following counties: Union, Henderson, McLean, Daviess, Hancock, Breckinridge, Hardin, Nelson, Washington, Mercer, Garrard, Jessamine, Madison, Estill, Powell, Owsley, Morgan, Breathitt, Floyd, Johnson, Lawrence, and Pike. Twenty-two counties are intersected by it. Nine of the counties enumerated are in the eastern coal field, either wholly or in part; the first five being in the western coal field.

The work on the line this year has been in the counties of Johnson, Floyd, Lawrence, and Pike. The country traversed in these counties is rough, rising into narrow, steep ridges, which ascend above the drainage of the country from two to six hundred and sixty-one feet, and is usually divided into terraces, or benches, caused by the unequal decay of the hard and soft beds composing the coal measures.

The soil in the valleys is generally sandy. The sides of the hills are covered by small pieces of shale or blocks of coarse sandstone.

The farms are generally quite small, lying in the narrow valleys extending along the streams; sometimes embracing the sloping land at the foot of the hills.

The valley land is estimated at about ten dollars per acre, that of the hills at from fifty cents to one dollar.

Procuring and rafting saw logs is extensively carried on in many places. Wagon roads are almost unknown, yet the country could be traversed in many directions by roads which could be made at a small cost.

Salt making has been carried on for a short time at Warfield, on Tug river, from which point the salt is distributed either by pack horses through the country, or in canoes on the river.

The rocky masses lying above the drainage, from Jenney's creek eastwardly, consist of the beds lying above the Licking shales. Some few cuts are made by the streams, from thirty to fifty feet below the

coal, which has been variously designated as the Adamsville coal, Jackson Rice coal, &c.

At the last crossing of Jenney's creek, on the 279th mile, the coal bed above referred to lies a few feet below the bed of the creek. It has been traced up the creek about two miles. Sometimes it is above the creek bed, and sometimes below it. This bed here dips with the line of the stream, but it is irregular and full of waves. The bed of coal is also quite irregular. It is sometimes seen as one bed; at other places near by it is divided into two beds, the separation being from half an inch to four feet thick. The upper part of the bed affords as much as two feet thick of workable coal; the lower division being from one foot to two and a half feet thick.

On the east side of Jenney's creek, the hill rises above the creek 661 feet, (barometer,) and is divided by the hard and soft measures into six terraces, or benches, composed alternately of sandstone and shale beds, the capping mass of the hill being a heavy sandstone, the lower part of which is locally a conglomerate, thickly charged with water-worn white quartz pebbles.

The measures above enumerated are found in part in every hill between Jenney's creek and Tug river—no hill ever rising geologically higher than the great sandstone which caps the hill at Jenney's creek.

The coal beds which are found high in these measures (to be hereafter noted) do not extend to the west of Big Sandy river on this line as good workable beds. The place of the beds found in some localities west of Big Sandy river is indicated by a streak of carbonaceous clay, above a bed of white silicious or aluminous clay; or by a bed of carbonaceous shale, with thin seams of coal interstratified.

The highest hills west of Big Sandy (near the base line) exhibit the following section:

No. 23. *Section between Jenney's creek and Big Sandy.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Heavy sandstone, coarse grained near the base.				
Conglomerate, filled with white quartz pebbles	626	------	100	------
Covered space above sandstone	526	------	15	------
Coarse sandstone	511	------	64	------
Aluminous shale, place of ore bed at the head of Red river, on "State road," (no ore seen east of Jenney's creek)	447	------	15	------
Coarse sandstone	432	------	32	------
Covered space	400	------	10	------
Fine grained sandstone, in thick beds	389	------	37	------
Covered space, with sandstone at the bottom	352	------	49	------
Sandstone and sandy shale	303	------	94	------
Alternate beds of sandstone and dark sandy shale	209	------	209	------
Bed of Jenney's creek.				
Shales and sandstone	15	------	15	------
Coal, equivalent of the Adamsville and Jackson Rice coal bed	18	------	3	------

On Little Paint creek, two miles further east, an opportunity was offered to fill a portion of the space near the base of Section 23 with a more detailed statement of the materials of that portion of the section, a mass of rock having fallen, leaving a clean cut, of which the following is a section:

No. 24. *Section near Big Sandy, on the east side of Little Paint creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Covered space divided into terraces, the top of the hill being covered by the lower part of the sandstone at 511 feet, Section 23.				
Thin bedded sandstone	4	-----	90	2
Sandy shale	8	------	86	2
Sandstone	6	3	78	2
Sandy shale	4	6	71	15
Sandstone	2	1	67	5
Sandy shale	3	2	65	4
Lumpy sandstone	2	6	62	2
Bituminous *coal*	2	------	59	8
Under clay	2	4	57	8
Sandy shale	5	------	55	4
Sandy shale and lumpy sandstone	22	------	50	4
Sandy shale running into sandstone	5	------	28	4
Bituminous shale	2	------	23	4
Bituminous *coal*	2	6	21	4
Under clay	2	------	18	10
Dark gray sandy shale	16	10	16	10
Bed of Little Paint creek.				

The coal at 21 feet 4 inches above, is the equivalent of the coal at the base of Section No. 23.

On Big Sandy river, half a mile above the mouth of Little Paint creek, a bed of bituminous shale is seen, interstratified in the sandy shale, ten feet below the coal. At this point shales, similar in character to those at the base of the section above, extend downward to the bed of the river, 28 feet below the coal.

In the shales, beneath the coal above alluded to, are remarkable sandy segregations, which are generally symmetrical, and circular. One of the largest observed measured 6 feet in its greatest diameter, and four feet thick. The mass was separated into several beds by lines of stratification; at which lines the masses separate, forming circular blocks about six inches thick, the upper and lower portions forming sections of an ellipse. The blocks from the middle of the mass resemble huge unfinished grindstones.

These segregations are valuable as a mark indicating the geological horizon of the Jackson Rice, Adamsville, and Warfield bed of coal; especially as no similar masses have been found in any other horizon than that immediately below this coal bed.

The first of these segregations on our line are found on Stillwater creek, but they are seen on the line in all the valleys which are sufficiently deep, from that point to Tug river. Great numbers of these masses are seen wasted from the shales under the coal at Warfield, lying along the margin of the river, and many partially exposed in the shale beds forming the river bank immediately under the coal bed.

At the mouth of John's creek, on the east side of Big Sandy river, the coal bed at the base of section 24, lies a few feet above the bed of Sandy river.

From this point toward the north we have the following section:

No. 25. *Section from the mouth of John's creek to the coal opened by Mr. Samuel Auxier.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Covered space, sandstone (?)	50	------	285	2
Sandy shale, 10 to 14	10	------	235	2
Sandstone	14	------	225	2
Bituminous *coal*, (Auxier coal)	2	4	211	2
Parting clay	------	4	208	10
Bituminous shale	1	4	208	6
Bituminous shale, earthy	------	6	207	2
Bituminous *coal*, (Auxier coal)	2	------	206	8
Shale and under clay	1	------	204	8
Sandy shale	18	------	203	8
Bituminous coal	------	8	185	8
Under clay (?)				
Sandstone	80	------	185	------
Place of coal on Daniel's creek.				
Sandstone and sandy shale	36	------	105	------
Place of coal on Long branch.				
Sandstone and covered space	69	------	69	------
Top of coal on John's creek.				

It is not improbable that the true thickness of the measures, between the Sam'l Auxier coal and the coal at the mouth of John's creek, is not given in the above section. At the opening made by Mr. Auxier, the dip is found to be towards the northwest, the direction in which the section was measured. If the dip lies regularly in that direction, between the two points measured, the thickness of the measures will be too small in the above section by a quantity equal to the amount of the dip between the two points.

The remarkable bends of John's creek from its mouth to where the line crosses it, about four miles from Sandy river, would indicate considerable disturbance in the measures, even if no rocks were visible. The outcrop in a few places exposes the rocks, which exhibit considerable disturbance and wrinkling; probably the effect of thrust.

Two miles above the mouth of the creek a bed of coal has been opened, in a point of a ridge projecting into one of the bends of the creek. Where opened the bed in four feet thick; which is probably above its average thickness, as the opening is immediately at the axis of a synclinal fold. A short distance down the creek from the opening the unwrought outcrop is seen on anticlinal fold, where the coal is not

more than two feet thick. This bed is probably the equivalent of the upper bed exposed at Little Paint creek, given in Section 24.

A careful examination of the country in the vicinity of the line on John's creek and Daniel's creek, did not result in the discovery of any workable beds of coal between the horizon of the Auxier coal and that opened on John's creek by Mr. Delong, (equivalent to the upper bed at Little Paint.) Two or three thin beds of coal were found in the space between these beds, but none of them attained a greater thickness than from fifteen to thirty inches, if, indeed, the latter figures are not too high.

The coal beds opened by Mr. Delong, at the base of the section, as well as the equivalent of that opened by Mr. Auxier, are accessible the entire distance between Big Sandy and Tug river, in the immediate vicinity of the line.

On Tug river, at Warfield, the lowest bed in Section 24 is opened about forty feet above the bed of the river. It is about four feet thick, where it was seen near the town, on the southwest side of Warfield, where it occupies a position a little lower than at the works on the river. This indicates a slight dip to the northwest, and with the line of the river at this place.

The base line from the valley of John's creek crosses obliquely the ridges dividing the streams flowing into Tug river, and those flowing into John's creek and Big Sandy. The line crosses this ridge on the 288th mile, six miles east of the mouth of John's creek.

The line from the 288th to the 292d mile lies across the head branches of Rockcastle creek. The Beech fork is the first branch crossed; then Stonecoal fork, Scaffold fork, main Rockcastle, Lick fork, Laurel fork, and many small nameless branches. On the 292d mile, the line enters the "*breaks*," and crosses the ridge dividing Rockcastle and the Panther fork of Wolf creek. The 295th mile enters the White Cabin fork of Wolf creek. The 297th mile crosses main Wolf creek. On the 298th mile, Peter Cave creek, a large branch of Wolf, is crossed. Pigeon Roost fork is crossed on the 299th mile, the mile post falling on the summit of the ridge, on the east side of it, and the dividing ridge between White Oak fork of Emily's creek and Pigeon Roost. The 301st mile crosses White Oak. The 303d mile post is erected on the terraces on the east side of Emily's creek. The 305th mile reaches and crosses the head of several small branches of Big

creek. These branches run south from the line, which now enters the breaks of Tug river, at the head of Mt. Sterling branch.

It will be seen, by the foregoing summary, that the creeks crossed by the line are very numerous. The small nameless drains are nearly as deep as the valleys of the main creeks.

The spurs from the main ridges between the drains are generally as high as the dividing ridges themselves. In almost every instance the hills between the creeks, branches, and drains are capped by the heavy sandstone associated with the upper conglomerate bed, the valleys being from 300 to 500 feet deep, the drainage cutting into the measures nearly down to the Jackson Rice, Little Paint creek coal, frequently below it.

Practically the line lies on the strike line of the measures, which is modified locally by waves, wrinkles, and a few inconsiderable faults or breaks, the latter being readily recognized by the low gaps breaking the main ridges.

On the Stonecoal fork of Rockcastle creek, a bed of coal is exposed in outcrop, 244 feet below the "Bear Wallow Gap." On the ridge southeast of the gap, the great sandstone, which caps the hills, rises about 100 feet above the gap.

This coal is probably the equivalent of the Samuel Auxier bed of coal heretofore alluded to, and has been so considered.

The following section begins at the top of the ridge, and extends down Stonecoal fork about a mile, crossing to the north side of the base line, nearly at the middle of the distance.

No. 26. *Section on Stonecoal fork of Rockcastle creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Heavy masses of sandstone	100	------	431	1
Covered space, shale, sandstone, &c.	244	------	331	1
Bituminous *coal*	7	------	87	1
Parting, clay	------	5	80	1
Bright, hard bony *coal*	3	------	79	8
Dark silicious shale	10	------	76	8
Coarse sandstone	35	------	66	8
Dark sandy shale 15 to 20 feet	15	------	31	8
Bituminous *coal*	1	3	16	8
Under clay	2	------	15	5
Bituminous fossilliferous limestone	1	5	13	5
Sandy shale	12	------	12	------
Rockcastle creek, (sandstone.)				

The bituminous limestone is a most remarkable bed; it lies in blocks nearly square, from 15 to 18 inches thick.

The dividing ridge between main Rockcastle creek, and the head of Lick fork, is capped by a portion of the sandstone associated with the conglomerate beds which are seen in considerable force at the "Piney Gap." All the drains and branches are strewn with white quartz pebbles wasted from this top hill sandstone.

The following section, obtained at the divide separating Laurel fork of Rockcastle creek from the Panther fork of Wolf creek, will serve to give more in detail the measures in the covered space of 244 feet in Section 26 :

No. 27. *Section of the ridge between Laurel fork of Rockcastle and Panther fork of Wolf creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches.
Sandstone, with large blocks of conglomerate near the base of the mass	50	------	297	8
Sandy slope, (sandstone?)	30	------	247	8
Sandstone, bed soft at top	38	------	217	8
Covered space, sloping, (shales?)	25	------	179	8
Sandstone	35	------	154	8
Covered space, showing shales, (coal at top?)	25	------	119	8
Hard sandstone (*Rock houses*)	18	------	94	8
Sandy shale	20	------	76	8
Bituminous coal, 18 to 20 inches	1	88	56	8
Dark sandy shale	25	------	55	------
Bituminous coal, size not seen; dark sandy shales	15	------	30	------
Hard sandstone	15	------	15	------
Coal in bed of Laurel fork.				

Descending the valley of Panther fork of Wolf creek, the only line of travel practicable was in the bed of the branch. The rocks dip with the line of the stream nearly as rapidly as the fall of the branch itself. Two thin beds of coal were cut and brought to light by the branch; these should be placed in the upper part of the section. One bed is about 15 inches thick, and probably occupies a place in the section above at 179 feet 8 inches; the other, about 2 feet thick, at 119.8.

From Rockcastle creek eastwardly to Tug river the upper sandstone, which caps the hills so frequently referred to, caps the points and ridges as naked masses, which, seen from a distance, might readily be taken for castles or artificial structures.

The valley of Wolf creek, which is quite a large stream, is generally only a few feet wide. In many places the abrupt ascent of the hills begins at the water's edge on both sides of the stream; at all such places the only road lies in the bed of the creek.

The lower part of the hills are wooded with beech, poplar, ash, sugar-tree, gum, sour wood, and oak; the sides higher up with different species of oak; the *gaps*, *caves*, and top of the ridges are clothed with chestnut-oak, and pine.

A bed of coal, 7 feet thick, has been seen one mile south of the line, at the head of White Cabin branch of Wolf creek. I was not able to visit the locality of this coal. It is probably the upper part of the great bed seen on Stonecoal fork of Rockcastle, four miles further to the west.

At Mr. Samuel Moore's mill, three quarters of a mile south of the line, a bed of coal outcrops in the bed of the creek; it is about 20 inches thick. This bed must lie below the 7 feet coal above referred to. These beds are referred to as being equivalent to the upper part of the great coal of Rockcastle creek, and the first coal below it given in Section 26. If this reference be correct, then there are four horizons of coal in the first 350 feet below the conglomerate, which here caps the hills.

On our return from Tug river, a thin cannel coal was observed in several hills; it is the first coal under the conglomerate.

No satisfactory exhibition of the cannel coal bed was obtained. It is probably not over 18 inches thick, where it was crossed by the road from Warfield to the mouth of John's creek.

The base line crossed the Pigeon Roost fork of Wolf creek, half a mile north of James Howard's mill; near the mill there is a perfect exhibition of the following section:

No 28. *Section of coal, &c., at Howard's mill, Pigeon Roost fork of Wolf creek.*

	Thickness.		Elevation.	
	Feet.	Inches.	Feet.	Inches
Heavy sandstone, south of gap	80	-----	429	6
Covered space	45	-----	349	6
Covered space, divided into three terraces	241	-----	304	6
Sandstone, thick beds	25	-----	63	6
Sandy shale	15	-----	38	6
Bituminous *coal*	2	-----	23	6
Sandy shale	15	-----	21	6
Bony bituminous *coal*	4	-----	6	6
Under clay	2	6	2	6
Dark sandy shale, bed of Pigeon Roost fork of Wolf creek.				

White Oak fork of Emily's creek exhibits the upper part of section imperfectly. Although White Oak creek was traced to its junction with Emily's fork, and the latter stream carefully examined for four miles above the mouth of White Oak, no section could be obtained which would add any information to that already given.

The shale beds have probably increased in thickness east of Rockcastle creek. The rocky masses are softer east of Wolf creek than the equivalent beds are at the west. The hills are covered by the debris of rocks and shales, notwithstanding their sides form angles with the horizon ranging from 25° to 60°.

No further sections of the measures outcropping on the line were obtained. The tops of the hills are always capped by the heavy sandstone and its associated conglomerate beds, giving assurance that no new measures were to be examined, and that additional sections would be the equivalent of those already given, variously modified.

The unsettled and variable state of the weather since the passage of Jenney's creek has rendered the barometrical observations quite unreliable. No confidence has been given to observations taken at intervals longer than from fifteen to twenty minutes apart.

The observations by barometer between Jenney's creek and Tug river consist of a series of one hundred and seventy-six observations, besides twenty-four observations between Tug river and John's creek, on our return.

By the observations made on the road between Warfield and John's creek, the place of the cannel coal is set down at 97 feet below the gap at the head of Buck creek, or about 120 feet below the conglomerate, on the hill tops, and 94 feet below the ridge east of Mr. Cassiday's, on Rockcastle creek.

From John's creek, our route, returning, was down Big Sandy to the mouth of Big Paint creek, up this to the divide separating Little Paint fork of Big Paint from the latter; across this ridge to Little Paint fork, which was traced to its head, crossing the ridge, and descending the Road fork of the Burning fork of Licking river to Adamsville.

The road lies near the top of the Licking shales, sometimes sinking a little below the Adamsville coal, sometimes rising 75 to 80 feet above it.

To the northwest of Paintville, considerable disturbance was observed in the rocks under the Adamsville coal. The measures being thrown into waves, the axis of which is northeast and southwest, subsequently these troughs have been filled by deposits lying non-conformable.

It will be seen by what has been stated in this chapter that the coal beds increase in thickness and number east of Big Sandy; and, as far as can be seen in unwrought outcrop, the coal appears to be of excellent quality. On the west side of Big Sandy near our line, the coal beds are thinner and frequently separated by clay partings. The beds of iron ore cease and are not seen east of the head of the Green Rock fork of Jenney's creek. The horizon of the ore beds was frequently exposed eastwardly of this point, but no ore beds were seen.

By reference to Vol. 3, Kentucky Geological Reports, sec. 3, pages 330, 331, it will be seen that a ferruginous conglomerate occurs at 311 feet. The same geological horizon is in the succeeding sections, viz: Section 4, at 220 feet; section 5, at 396 feet; section 8, at 256 feet; section 9, at 360 feet; and in section 10, at 244 feet 10 inches. These sections are all taken near the margin of the coal field in Greenup and Carter counties; in all the conglomerate is found. In the last section the whole thickness of the coal measures lying between this remarkable bed of conglomerate and the sandy beds beneath the sub-carboniferous limestone, and including what remains of that division, is only 244 feet 10 inches.

The dividing ridge between Little Sandy and Tygert's creek carries the conglomerate bed to the vicinity of Laurel furnace. It is seen

again on the east side of Little Sandy, at Steam furnace, above the Carrington and Heighton ore banks. It occurs at the head of Indian creek, and follows the line of the ridge to the ore diggings of Caroline furnace, further to the southeast. It is seen again at Clinton furnace; the same bed at Mt. Savage furnace, (sec. 9,) twenty miles to the south, persistently capping the highest hills in the coal measures in Greenup and Carter counties. The column of the coal measures steadily increasing in height to the southeast, is always capped with this pebbly bed, except in the neighborhood of Amanda furnace, where a thin patch of the coal measures rise above it. (See page 453, vol. 3, Ky. Reports.)

To the horizon of the conglomerate bed mentioned above is referred the great sandstone mass, which so persistently occupies the head of the section on the base line east of the head of Red river. A line of sections across the country from Mt. Savage furnace to the head of Jenney's creek would place this question at rest, and, at the same time, determine the margin of the iron ores toward the southeast from Mt. Savage furnace, thus connecting the observations of the base line with the work of Greenup, Carter, &c., on the north.

The thickening of the coal measures toward the south and southeast has been satisfactorily established. At Jenney's creek we have above the Adamsville coal over 600 feet of shale, sandstone, and coal; below the Adamsville coal the Licking shales are from 150 to 200 feet thick, to which should be added the great sandstone at the base of the coal measures lying above the coal and iron ore beds of Estill county; this latter mass is about 240 feet, making together over 1,000 feet of measures on Sandy river, (supposing the lower measures, which are concealed, retain the thickness they have at the west,) against 244 feet 10 inches, as per sections on Smith's and Coal creeks, near the margin of the coal measures west of Little Sandy river in Greenup county.

After entering the coal measures, the general dip is to the south, frequently reversed by waves and a few minor faults. The small streams are generally in the line of the synclinal and the ridges the anticlinal waves.

The main anticlinals are remarkably serpentine, and throw off secondary anticlinals, into spurs to the right and left, direct and obliquely toward the east and west.

The hills rise toward the head of the streams or main dividing ridges,

as much, frequently more, by the dip lying with the downward course of the streams, than by the addition of measures toward the great dividing ridges; both causes are generally combined; especially when the remains of the great upper conglomerate sandstone are still in place.

The hills at the head of Red river, Burning fork of Licking, Rockcastle, and Wolf creek, are nearly on the same horizon.

The accompanying diagram of the base line will probably explain the character and elevation of the measures and the country better than anything I could add to what has already been said.

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INDEX.

ERRATA, &c.

Page 241, 6th line from top, "NELSON COUNTY" should be NICHOLAS COUNTY.

Page 248, under 2d line, add *Composition of the Ash.*

Page 324, for "*Catherine* Neef" read *Caroline* Neef.

Page 338, (foot note,) for *my* Report read *First* Report.

Page 355, line 19, for *carifolius* read *canifolius.*

Page 357, line 17, for *Fine* clay read *Fire* clay.

Page 370, line 5, for *oreopteridius* read *oreopteridius.*

Page 374, line 12, for Schizopteris read Schizopteris.

N. B. In the section on page 387, as well as in the others in M Lesquereux's Report, the distance between the strata is not printed exactly according to the scale laid down, viz: 1 inch to 200 feet, although the numerals are accurately printed.

Page 399, in the Section, 3d coal right hand, the place of Coal A 8th should be 20 feet below that of C. 9th.

Page 414, line 2, for page 40 read 357.

Page 428. These printed tables of comparative sections are not accurate according to the scale laid down, although the numerals are correct; they have, consequently, been accurately repeated in the lithographic plate inserted here.

Page 431, at the base of the Warfield section, read, at 125 feet, *first brine*, and at 525 feet, *strong brine.*

Page 433, line 3d, for Alethropteris read Alethopteris. At the bottom of the page, add: *Is very abundant with coal No. 4th.*

Page 448, 9th line from the bottom, for *t*own branch read *T*own branch.

Page 448, 13th line from the bottom, for Mince's read Miner's.

NOTE.

The Geological Survey of Kentucky—which sustained such a heavy loss, in November last, in the death of our distinguished Chief Geologist, David Dale Owen, M. D.—was brought to a pause by the failure of the Legislature, at its next following session, to make the necessary appropriation for its continuance. This, with the present distracted state of the country, may postpone its completion for an indefinite period.

The present volume embodies most of the materials, ready for publication, which had been reported to Dr. Owen before his death—and its general arrangement for the press was made by him; but it is proper to state that a large and valuable mass of matter still remains, in field notes and in other forms, in the hands of the various members of the late Geological Corps, which, should the Survey not be resumed at some not distant day, may be lost to the State and to Geological Science.

ERRATA TO S. S. LYON'S REPORT.

Page 503, line 18 from top, read "on the top of the whole body," &c., for "on the top of which rests the whole body."

Page 504, line 22 from top, for *Fur* fork read *Tar* fork.

Page 506, line 23 from top, for Phyriformis read pyriformis.

Page 507, line 3 from top, for *Doverty's* creek read *Dorerty's* creek.

Page 508, 3d and 9th lines from bottom of page, for *Chandoin* read *Chaudoin*.

Page 509, 23d line from bottom, for *Chandoin* read *Chaudoin*.

Page 511, 17th line from bottom, for *places* read *faces*.

Page 515, 15th line from bottom, for 21 read 210.

Page 516, 23d line from bottom, for 21 read 218.

Page 516, 22d line from bottom, for 20 read 200.

Page 516, 21st line from bottom, for 141 read 151.

Page 519, 13th line from bottom, for *hackleberry* read *hackberry*.

Page 528, 8th line from bottom, for Penbratulæ read Terebratula.

Page 558, 3d line from top, for Lichfield read Litchfield.

Page 558, add 7 feet to each sum above 3d line from base of Section No. 28.

Page 562, 8th line from base of Section 30, for Hodger's read Hodge's.

Page 564, 4th line from base of Section 31, for Plerotocrinus read Pterotocrinus.

Page 567, 8th line from base of Section 34, for 6 feet read 6 inches.

Page 567, 9th line from base of Section 34, for 2 feet read 2 inches.

Page 567, 10th line from base of Section 34, for 4 feet read 4 inches.

Page 567, 11th line from base of Section 34, for 2 feet read 6 inches.

And extend the sum 40 feet 6 inches, instead of 39 feet 8 inches.

Page 567, 6th line from bottom, for Orthoceratiti read Orthoceratite.

Page 567, bottom line, for Balen read Baleu.

Page 572, 8th line from bottom of Section 39, for 92 feet read 91 feet.

Page 572, 9th line from bottom of Section 39, for 125 feet read 124 feet.

Page 572, 10th line from bottom of Section 39, for 140 feet read 139 feet.

Page 573, 4th line from top, for "is seen" read "as seen."

Page 580, 8th line from top, for "when intersected" read "where intersected."

Page 580, 9th line, for line A read line N.

Page 581, 8th line from bottom, for "the clear coal of the Hunting branch of Clear creek" read "the twin coal," &c.

Page 585, 5th line from top, for *Rudy's* read *Reedy's*.

Page 589, 1st line top of Section 23*, for "Thickness" read "Elevation," and for "Elevation" read "Thickness."

* This should be 43.