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REPORT ON THE GEOLOGY

OF THE PROPOSED LINE OF THE

ELIZABETHTOWN, LEXINGTON AND BIG  
SANDY RAILROAD,

FROM

MT. STERLING TO THE BIG SANDY RIVER,

BY A. R. CRANDALL.

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The geological periods represented by the rocks exposed along the line of the proposed extension of the Elizabethtown, Lexington and Big Sandy Railroad are the Cincinnati or Hudson period of the Lower Silurian; the Niagara period of the Upper Silurian, represented by the rocks of the Clinton epoch, and perhaps by some of the rocks of the Niagara; the Hamilton period of the Devonian age; the Lower Carboniferous, made up of two members, the Waverly sandstone and shales, and the Sub-carboniferous limestone; and the Carboniferous period. The aggregate thickness of these rocks is about 1,900 feet. Of this thickness, the Carboniferous rocks comprise about one half. The Sub-carboniferous limestone reaches, at one point, a thickness of nearly 100 feet. The Waverly rocks reach about 500 feet. The Devonian Black shales, and the Upper Silurian Magnesian limestone and shale, show each about 120 feet. Of the Blue limestone of the Lower Silurian, about 150 feet is exposed.

The accompanying profile section is designed to give a general view of the whole line, showing the succession of the rocks of the different periods, and also the occurrence

and distribution of valuable mineral deposits. The section is necessarily drawn on such a scale as to make the accurate representation of topographical features impossible; and the want of information in detail, at many points along the line, makes the section, like all profile sections, more or less diagrammatic in the representation of the special geological features. It is hoped, however, that, in connection with the text, it will give to the general reader an intelligent view of the country traversed by this line.

The rock formations enumerated above are shown in an ascending order eastward from Mt. Sterling, presenting successive belts of country that display more or less fully the features which are characteristic of the different formations, and which give to them their relative economic values. Only three of them have a thickness equal to the height of the hills where exposed, namely: the Cincinnati beds, the Waverly sandstone and shales, and the Carboniferous rocks or the coal measures. The overlapping of beds reduces the breadth of the belts which are wholly characteristic of these formations, and tends, superficially, to shade the successive formations into each other; yet the rocks of each period have given rise to a topography sufficiently characteristic to make it an index of the general geology. The value of the land for agricultural purposes is also closely related to the geology; more so, perhaps, from the character of the soil for fertility, than from the resulting topography.

The region of the Lower Silurian, as crossed by this line near Mt. Sterling, is almost exclusively agricultural. The beds of the Cincinnati Group are generally too thin for building purposes, and no minerals of commercial value are known to occur in them. The richness of the soil, however, more than compensates for the absence of mineral resources. It is the soil of a large part of the Blue Grass region, which is too well known to need special description.

The belt of the Upper Silurian forms the outer extent of the Blue Grass region. With a soil scarcely as rich as that of

the beds below,\* and with a more broken surface, it yet presents an area of rich farming land.

That part of the section which takes its character chiefly from the Upper Silurian rocks, extends from near the head of Stepstone Creek to the hills east of Mill Creek. But this belt is not exclusively agricultural. The occurrence of the Clinton iron ore bed adds the possibility of a large and profitable iron-making industry.† The thickness of this bed is twelve feet, as opened near the line of the proposed road.

The change from the Upper Silurian Magnesian limestone to the Devonian Black shale is abrupt in this region. The average thickness of these shales is probably not more than 120 feet; but they give character to a belt of country proportionally broader than this thickness would indicate. In this belt the soil is clayey, and, in the bottom land, heavy, requiring drainage for successful cultivation. It is often heavily timbered, however, and the assemblage of species is, in some sense, peculiar to this formation. The much greater prominence of the Spanish oak (*Q. falcata, L.*) and of the laurel oak (*Q. imbricaria, Mx.*) among the black oaks, and of the post oak (*Q. Obtusiloba, Mx.*) among the white oaks,‡ is at once noticeable and characteristic.

\*The following tables of analyses of soils from this region are made up from the report of Dr. Peter, volume IV, first series. Nos. 805-'6-'7-'8 are from the Upper Silurian belt, in Bath county. Nos. 809-'10-'11, and 1149-'50, are from the Cincinnati beds of Bath and Montgomery counties:

	805.	806.	807.	808.	1149.	1150.	809.	810.	811.
	Woods.	Old field	Woods.	Old field	Old field	Sub-soil.	Woods.	Old field	Sub-soil of 810.
Organic and volatile matters . . .	8.165	7.639	5.024	5.118	6.172	4.171	8.376	6.308	4.108
Alumina . . . . .	4.565	5.390	3.535	5.115	5.440	6.590	5.115	5.265	5.490
Oxide of iron . . . . .	6.960	7.885	3.535	5.150	4.710	6.235	2.185	4.235	4.235
Carbonate of lime . . . . .	.570	.420	.095	.170	.420	.220	.586	.445	.170
Magnesia . . . . .	.710	.615	.385	.523	.583	.634	.660	.617	.613
Brown oxide of manganese . . .	not est.	not est.	.220	.220	.120	.295	.195	.295	.295
Phosphoric acid . . . . .	.170	.246	.118	.284	.345	.257	.315	.295	.312
Sulphuric acid . . . . .	not est.	not est.	.041	.058	.067	.041	.084	.067	.055
Potash . . . . .	.290	.249	.246	.210	.331	.372	.372	.280	.367
Soda . . . . .	.059	.073	.100	.049	.133	.139	.123	.044	.037
Sand and insoluble silicates . . .	79.145	78.270	86.980	83.320	81.476	81.370	82.525	82.270	84.920

†See report on the ores of the Red River Iron District by Mr. Moore, volume IV, new series.

‡Dr. Engelman has very properly separated the oaks of the United States into two classes, the black oaks, and the white oaks; the latter comprising all the species which grow strong and durable timber. The division is made, however, on characters which are more especially interesting to the botanist.



The shales of this formation yield petroleum, by distillation in closed retorts, in such per cent. as will doubtless bring them into notice, as a source of illuminating and lubricating oils, at no very distant day. They are the source of most of the well known mineral springs of Kentucky. The Olympian Springs, about three miles from the proposed line, is one of these. It has been suggested by Professor Safford, that copperas and alum might be derived in paying quantity from these beds.

The Waverly belt offers a soil of medium fertility. It may be said to extend from the mouth of the North Fork to the head of the East Fork of Triplet Creek. It is characterized by a great number of evenly-rounded hills or knobs, as described by Mr. Leslie, and hence the name knob-stone formation, as used by Owen in the earlier reports.

The rocks of this formation are grayish and olive-colored shales and sandstone, the latter affording the building stone widely known as the "Buena Vista" building stone. The transition from the Black shales is marked in this region by a thick bed of this building stone, as shown in the section. Near the Licking river large blocks from this bed are scattered along the foot of the hills, the wearing away of the shales above and below being a slow process of quarrying this durable rock. The lower part of the Waverly formation southward from this line carries a considerable amount of iron ore, mostly clay-stone or carbonate ore. This ore is not in demand at present.

The timber growth of this belt is similar to that of the coal measures, except that the chestnut oak (*Q. prinus var. monticola, Mx.*), which supplies the tan-bark trade of Eastern Kentucky, is less abundant or entirely wanting.

The limestone member of the lower Carboniferous period has its greatest thickness in the main valley of Tygert's creek, where it reaches a thickness of nearly 100 feet, and where it is overlaid by more than 200 feet of Carboniferous rocks. Along the western outcrop of the coal measures in this region it is rarely five feet. It does not, therefore, predominate in any part of the line. Where it is present in considerable

thickness, however, its horizon is marked by characteristic cliffs and benches along the hillsides. It supplies a very pure limestone for the furnace and the kiln, and thin beds of it have proved suitable for use in lithography. At the top of this formation is found the "lower limestone ore" of Eastern Kentucky. It is known as the Red River ore in the Red River iron-region. Very little has yet been done to develop this ore along the line in question.

The section upward from the lower limestone ore is that of the coal and iron-bearing rocks of Eastern Kentucky, the successive beds of which are exposed along the line to the eastward to an aggregate thickness of about 950 feet, as previously stated. For convenience of reference this section may be described as being made up of six members\*—divisions which are easily recognized in the rocks of this region—as follows: the shale beds above the Sub-carboniferous limestone, and below the Conglomerate sandstone, 10 to 50 feet; the Conglomerate sandstone, from 20 to 100 feet; the shales above the Conglomerate sandstone, 30 to 60 feet; a middle sandstone series, 300 to 350 feet; the greenish shale beds, 90 to 120 feet; and the upper sandstone series, beginning with what is generally regarded as the equivalent of the Mahoning sandstone, and including the rocks above, to a thickness of about 350 feet.

The beds of economic value in the valley of Tygert's Creek are those which occur in the Sub-conglomerate shales. They are the limestone ore† mentioned above, a non-plastic fire-clay, a coal bed, and a block ore. The distribution of these beds is not well shown in the section, as they are somewhat irregular from changes of the character and thickness of the including rocks. The fire-clay will eventually prove a valuable deposit. It is the equivalent of Sciotoville clay, and from four to six feet in thickness where seen in this region. The coal bed is suitable, from its quality, for local use. It is not,

\*See report on the Geology of Greenup, Carter, and Boyd counties, &c., volume II, second series, Reports of Kentucky Geological Survey.

†For special notice of the ores of this region, see report of Mr. Moore on the Ores of Greenup, Carter, and Boyd counties, volume I, second series, Reports of Kentucky Geological Survey.

however, thick enough to be mined extensively with profit. The ore is a limonite of good quality, and at one point it shows a thickness of 15 inches. This is probably greater than the average thickness of the bed.

The valley of the Little Sandy river, as crossed by this line, shows all the remaining important beds of this section, or nearly all the important coal, iron, and clay beds in the general section for Greenup, Carter, Boyd, and Lawrence counties.\*

The Conglomerate sandstone, after giving rise to the rugged cliffs, and the picturesque scenery of the Sinking creeks, falls below the drainage line east of the Little Sandy river. The shales above the Conglomerate cap the hills in the valley of Tygert's Creek, and fall below the drainage at the Little Fork of Little Sandy. These shales include Coal No. 1 and a block ore. The latter has proved a valuable bed where worked. The former is not known to be thick enough along this line to be profitably worked. It is a pure coal, and has been found in both Greenup and Carter counties, locally from 3 to 4 feet thick.

The sandstone series above caps the hills near the head of Little Sinking Creek, and falls below the drainage towards the head of the Left Fork of Straight Creek. This set of rocks includes in their order the following beds: 1st. Coal No. 2, a bed not opened in this region sufficiently to determine its value, but which does not appear, from the exposures noted, to have more than a local value. 2d. A "rough block" ore, which is generally inferior in quality to the average ores of the region, but which, in places, has proved valuable. 3d. Coal No. 3, a bed that has been scarcely touched along this line, but which is generally known as having a workable thickness of good grate coal. It has not proved, in this region, a good iron-making coal. 4th. The "little block" ore, an ore that is used largely in all the furnaces of the Little Sandy Valley. Its place in the series is about 35 feet above Coal 3.

\* See general section (plate 1), report on the Geology of these counties, volume II, second series, Reports of Kentucky Geological Survey.



and 10 feet below Coal 4, the Hunnewell cannel, when that is present. Coal No. 4 has not been seen on this line. It is present, however, a few miles north, on Little Fork and on Stinson Creek. 5th. Coal No. 5, which is irregular in both thickness and quality. It is not regarded as a promising bed, at present, on that account. 6th. The "Ferriferous limestone" and the "limestone ore." The limestone is usually wanting along this line. Where found, it serves as a flux in reducing the ores of the region. The associated ore, which normally rests on this bed, is present in a continuous bed. In thickness and quality it is similar to the "lower limestone ore." It is, therefore, one of the principal ores of this region. The place of the Ferriferous limestone is about 100 feet above the little block ore, and about 20 to 25 feet below Coal No. 6, when that is present. 7th. The fire-clay bed, overlying the limestone ore, a bed usually 2 to 3 feet of No. 1 fire-clay, and an equal thickness of potter's clay at the top. Coal 6 is generally wanting, or thin, on this line. It is the uppermost bed of this series. Near the Big Sandy it would be found of workable thickness by a shaft 40 to 50 feet deep.

The greenish shale beds begin 20 feet above Coal 6. They extend along this line from the valley of the Little Fork to the Big Sandy river, falling below the drainage at the two principal summits. These shales, though comparatively thin, include some of the most important beds of Eastern Kentucky. They are—1st. The so-called "yellow kidney" ore, which is found near the base of these shales, distributed through 5 feet or more of shale rock, or at some points bedded in part between the upper layers of the sand rock overlying Coal 6. 2d. Coal No. 7, 25 feet above the yellow kidney ore. This is the well known Coalton coal. It shows thickness of 6 feet on Straight Creek. Four feet of this bed has proved at other points suitable for use in the furnace without coking. 3d. The red kidney ore, as it is generally known in this region, which follows, 25 feet above. It is similar in character and surroundings to the yellow kidney ore. They are regarded by furnace men as among the best ores of the Hanging

Rock region. 4th. Coal No. 8, 40 to 50 feet above Coal 7. It is best shown on Garner Creek, where it has been opened near the bed of the creek, Coal 7 being below the drainage. As shown here, Coal 8 is 4 feet in thickness, without any considerable parting. 5th. Again, 20 to 25 feet above Coal 8 is a bed of ore, which is known at some of the furnaces as the "bastard limestone" ore. It rests on an impure limestone in some localities, and resembles the other limestone ores; but more commonly the limestone is wanting, and the ore is like the kidney ores of this region. Still another kidney ore is found above, at points where the thickening of the shales extends this series upward for a limited distance.

The upper sandstone series caps the hills east of Little Fork, and occupies the greater part of the section eastward from the head of Garner Creek. It contains no beds of so great economic importance as these already described. Those that have been observed on this line are Coal No. 9, 55 feet above Coal 8, opened at the mouth of Garner Creek, and showing 2 feet of coal between heavy masses of coarse sandstone; and the so-called Rough and Ready ore, which rests upon a band of impure limestone, 70 to 80 feet higher up. This ore is generally regarded as inferior in quality to the other limestone ores.

The soil of the coal measures is of medium fertility. The surface of the country is hilly and broken, reducing the percentage of land that is easily cultivated, and increasing the proportion of land that should be held for timber growth\* or for pasturage. The climate, surface, and soil all combine to make this region exceptionally well adapted to the raising of fruits.

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\* See report on the Forests of Greenup, Carter, Boyd, and Lawrence counties, volume I, second series. Reports of the Ky. Geol. Sur.