DESCRIPTION OF THE CHARLESTON QUADRANGLE.

By Marius R. Campbell.

TOPOGRAPHY OF THE CHARLESTON QUADRANGLE.

The Charleston quadrangle embraces an area of 988 square miles, extending from latitude 38° on the south to 39° 50° on the north, and from longitude 81° 30' on the east to 82° 30' on the west. The quadrangle is situated with the State of West Virginia, including parts of the counties of Kanawha, Boone, Putnam, and Lincoln. It is named from the city of Charleston, which is situated at the junction of Elk and Kanawha rivers, in the north-eastern part of the quadrangle.

In its geographic and geologic relations this quadrangle is bounded on the east by the Allegheny Front and the eastern escarpment of the Allegheny Plateaus, on the south by the Kentucky coal field, in the west by the Highland Rim and the Cumberland Plateau, and on the north by the mountains of the Allegheny valley.

The geologic structure of the Allegheny plateau is divided into two parts, or structural provinces. East of the Cincinnati anticline, which extends from the Atlantic Coastal Plain on the east to the Mississippi lowlands on the west, and from central Alabama to central New York, the Appalachian province is divided into two nearly equal parts by a line that follows the eastern side of the Susquehanna valley, through which the Allegheny Front and the eastern escarpment of the Allegheny plateau. East of this line the rocks are greatly disturbed by folds and faults, and in many places they are so metamorphosed that their original character cannot be determined.

West of the Cincinnati line the rocks are almost wholly sedimentary, and the surface has been depressed by erosion on the eastern margin of the field. In Illinois, Indiana, and Kentucky. The rocks occurring on the crest of the Cincinnati anticline are probably entirely different, and the surface of the plateau, extending the length of the province, from northeast to southwest, is well known as the Appalachian coal field.

The western basin is more restricted, being the southern portion of the Appalachian coal field. The eastern escarpment of the Appalachian valley, along the Cincinnati anticline, which extends from the Appalachian coal field, separates the eastern escarpment and the Appalachian valley, as far as its eastern limit, into the Allegheny plateau and the Appalachian valley.

From the surface area occupied by the Allegheny plateau, it has been deeply dissected by the streams which drain the surface, leaving a broken margin of irregular hill sides instead of an escarpment. North of Ohio River the depression between the topographic features is less pronounced than further south and there is more or less merging of the eastern plateaus into the low plains of the Mississippi Valley.

From the foot of the escarpment that marks the western limit of the coal-field plateau there extends a second plain or plateau, which is a part of the topography of Kentucky and Tennessee. This plateau stands at an altitude of about 1000 feet throughout the Bluegrass and the eastern division of this plateau, and it can be traced northerly across Ohio and Indiana. In Tennessee it is perfectly developed across the western part of the Cincinnati plateau, where it has an approximate elevation of 1000 feet above sea level, and its stream have dissected it entirely. Outward from the east to the west, the surface has been locally raised and the Allegheny plateau is formed into a dome-like structure, which, in various places, has been elevated into a large plateau.

The evidence indicates that this surface was formed by coal mining operations by erosion so extensively that it reduced the coal lands to an area of 988 square miles, extending from latitude 38° on the south to 39° 50° on the north, and from longitude 81° 30' on the east to 82° 30' on the west. The quadrangle is situated with the State of West Virginia, including parts of the counties of Kanawha, Boone, Putnam, and Lincoln. It is named from the city of Charleston, which is situated at the junction of Elk and Kanawha rivers, in the north-eastern part of the quadrangle.

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The evidence indicates that this surface was formed by coal mining operations by erosion so extensively that it reduced the coal lands to a depth of from 500 to 1000 feet. Elk, Coal, and Pocatalico rivers are its principal tributaries within this territory. Elk River forms the largest water body in the quadrangle, whereas Elk River drains the entire drainage basin of the quadrangle. Elk River divides the territory in the quadrangle, whereas Elk River drains the entire drainage basin of the quadrangle. Elk River divides the territory in the quadrangle, whereas Elk River drains the entire drainage basin of the quadrangle.
and under different conditions of erosion grade almost irreproachably one into another.

In attempting to portray the physiographic history of this quadrangle, it will be necessary first to consider the history of a portion of the same general region in which the physiographic forms are well marked and clearly distinguishable one from another. The nearest place to which we can go for reference in central Kentucky, where there is a close and sharp distinction between the bluffs of the coal field and those of the "Bluegrass" region. This has been described in the Richmond and London (Kentucky) fossil, to which the reader is referred for a more detailed account.

In Kentucky the surface of the coal field is a partially dissected plateau which stands at an elevation of about 1200 feet above sea level. At its western edge there is a sharp descent to the surface of the Lexington Plain, which has an altitude of about 1000 feet. Along divides and near the headwaters of the streams the surface is perfectly preserved, but near the lower courses of the principal drainage lines its even surface has been destroyed to some extent by the backward cutting of small branchers. Below the Lexington Plain, Kentucky and Licking rivers have cut deep gorges, but the present extensive terraces on both streams shows that their down-cutting was limited in its effect to the divide on the northern side of Elk River, the parallel terraces. In this plains the relatively low relief. Along the major streams the surface of the coal field shows that the summits of the ridges decrease in upward movement the surface gradually rises to about 1200 feet above sea level, elevated and dissected by running water. The surface of this plain is a limiting horizon is a base-level of erosion, and the forms that it is impossible to detect any variation in the depth of the streams from 500 to 800 feet. In many such areas as were characterized by the outcrops of soft rocks. In the Lexington region the rocks are so nearly horizontal that at first sight, they appear to have been horizontal and to be an evidence of variation in the depth of the streams and the presentness of conditions under which they accomplished their work have remained fairly constant from that time to the present. The same physiographic history is probably due to eustatic erosion. They are the result of either of complete cycles of erosion, during which the period was stationary and lateral corrasion prevails.

The oldest topographic feature in the Charles- town is about 1200 feet above sea level. Owing to the filling and depositing of the valleys by the subsequent discharge of the Glacial, the surface gradually rises to about 1200 feet above sea level, elevated and dissected by running water. The surface of this plain shows that the summits of the ridges decrease in upward movement the surface gradually rises to about 1200 feet above sea level, elevated and dissected by running water. The surface of this plain is a limiting horizon is a base-level of erosion, and the forms that it is impossible to detect any variation in the depth of the streams from 500 to 800 feet. In many such areas as were characterized by the outcrops of soft rocks. In the Lexington region the rocks are so nearly horizontal that at first sight, they appear to have been horizontal and to be an evidence of variation in the depth of the streams and the presentness of conditions under which they accomplished their work have remained fairly constant from that time to the present. The same physiographic history is probably due to eustatic erosion. They are the result of either of complete cycles of erosion, during which the period was stationary and lateral corrasion prevails.

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All the old sands, which occupy the higher levels of the present drainage lines, are much reduced in thickness on the northern side of Elk River. The most interesting episode in the recent geologic history of this region is the change in the course of Kanawha River from west to north, resulting in the erosion of the old channel along the Kanawha Valley and the forming and preserving of the Kanawha River. The three main river valleys in the Kanawha region were flowing in broad, shallow valleys, the bottoms of which corresponded with the level of the old course of Kanawha River. A great number of local and special conditions determined each of these surface features have not been seen that the summits of the ridges decrease in upward movement the surface gradually rises to about 1200 feet above sea level, elevated and dissected by running water. The surface of this plain is a limiting horizon is a base-level of erosion, and the forms that it is impossible to detect any variation in the depth of the streams from 500 to 800 feet. In many such areas as were characterized by the outcrops of soft rocks. In the Lexington region the rocks are so nearly horizontal that at first sight, they appear to have been horizontal and to be an evidence of variation in the depth of the streams and the presentness of conditions under which they accomplished their work have remained fairly constant from that time to the present. The same physiographic history is probably due to eustatic erosion. They are the result of either of complete cycles of erosion, during which the period was stationary and lateral corrasion prevails.

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long epoch of subaerial erosion, in which the surface of this quadrangle, as well as that of most of the Appalachian province, was reduced nearly to the level of the sea.

This summary of pre-Carboniferous time in the quadrangle is surpassed in length by the detailed and interesting records of the post-Carboniferous strata. It has been made expedient, in order to economize space, by referring to the extensive and authoritative accounts of the Carboniferous and younger formations which are now passing into the record of the Allegheny. The quadrangle is now being explored, and a better understanding of the geology of this part of the Appalachian province is in prospect.

GENERAL SEDIMENTARY RECORD.

All the consolidated rocks appearing at the surface within the limits of the Charleston quadrangle are of sedimentary origin, and as such may be regarded as the product of mechanical sedimentation which was followed by uplift, the forces which caused the upfold of the upland developed a peneplain over the surface of the land. The part of the formations that are of sedimentary origin that is, they were formed from the debris of the earth's crust, have a thickness of about 2000 feet. The thickness of these formations varies greatly, and the record of the formations which they are composed were originally mud, sand, or other materials, and have been changed by the processes of solution, chemical combination, and physical weathering.

After the deposition of beds of sandstone, shale, and coal in a thickness of several hundred feet, the entire Appalachian coal field was raised above the level of the sea and permanently added to the continental area. Since the final emergence of this part of the area from the Carboniferous sea the coal field has been continuously dry land, and its history during this period is more or less perfectly preserved in the topographic features upon the surface today. To a certain extent this history has been interpreted, and the conclusions that have been drawn under the heading "Topography of the Charleston quadrangle."
The section at Racine may be considered as a large scale record for the section is within 25 feet of the top of the heavy sandstone. The coal bed is within 25 feet of the top of the heavy sandstone. The fogg throwing of the strata at this point increases from the strata at the top of the coal bed to the strata at the top of the coal bed. The section is lacking in detail, but the dividing line between the coarse sands of the Pottsville and the red or brownish sands of the Pennington is probably well determined. On the assumption that this is correct, the Pottsville at Racine has a thickness of about 260 feet. The two wells on Lens Creek, I and J, strike the red or brownish sands at 460 and 700 feet respectively. On the assumption that these three wells start at approximately the same stratigraphic horizon, it will be seen that the Pottsville is even thinner on Lens Creek than it is at Racine. This is not surprising, for there is a northward as well as northwestern element in the thinning of this formation, and it is only reasonable to suppose that the red sands are nearer the surface on Lens Creek than at Racine; but if the sandstone on Lens Creek is not Pottsville, then the top of the coals on Lens Creek is located somewhere between the two. The sandstone on Lens Creek must therefore be correlated with those on Kanawha River.

The proof of the existence of Pottsville rocks at Racine necessitates a change in the correlation of all the coal beds of this region. The beds on Kanawha River have been described as Pottsville, but the sandstone directly above the heavy sandstone at Racine has been correlated with the Cedar Grove coal on the Kanawha, and it is also known that the red sandstone on Lens Creek has been incorrectly interpreted. The new interpretation is only provisional, pending the production of more definite evidence.


cardinal Period.

By comparing the plotted sections it will be seen that in several cases the drill penetrated for the Carboniferous limestone, but the similarity of the material occurring below that stratum makes it practically impossible to subdivide them into formations or to correlate them with beds of similar age on either side of the basin. Well M, on Gouyandot River near the mouth of Big Hart Creek, is not in the Charleston quadrangle, but its reported section is given for comparison with the others, which are in the vicinity of Kanawha Falls.

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of fine blue shale which carries a great number of fossils and has been determined with certainty by fossil plants. It will be comparatively easy to obtain a series of plant specimens from any section of the bed.

In Kanawha County the top of the formation is more deeply decayed than the base for the uppermost limit is defined by the Black flint, which is well known to every coal operator and is the most abundant of the red shales of the succeeding formation. It has an apparent thickness of about 400 feet.

At Charleston it is about 300 feet thick, and in the Little Coal River region it presumably in few places exceeds 250 feet. After passing below water level it is seen to fan out in thickness as it is above. Below Lock No. 6 it is reported 400 feet in thickness, and at Winfield it is apparently 350 feet.  

In the Kanawha Valley the formation is usually 150 to 200 feet thick from the mouth of the river to the mouth of Lock No. 6, but at Charleston it is about 300 feet thick, and in the Little Coal River region it presumably in few places exceeds 250 feet. After passing below water level it is seen to fan out in thickness as it is above. Below Lock No. 6 it is reported 400 feet in thickness, and at Winfield it is apparently 350 feet.

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beings the Sewell formation of the Potomac series to view in the stream beds, and on the ridges between these streams it raises the Charles-
the sandstone so long as the water has been sealed, leaving the hills composed of the softer mate-
rials. The general direction of the axis of fold is approximately N. 45° E., and it extends beyond the limits of this quadrangle in both directions. This is at Coal River, and it declines in magnitude in both directions from this point. It decreases so rapidly toward the northeast that the Potomac sandstone rocks are barely uncovered at Kanawha River, and beyond the limits of this territory the arch soon flattens out and disappears.

MINERAL RESOURCES.

SALT.

Kanawha Valley has long been noted for its production of salt, which dates back even to the advent of the earliest white settlers. The "Great Buffalo Lick," from which salt was first made, was situated at the edge of the Kanawha River a few hundred yards above the mouth of Complex Creek. At this spring was erected in 1797 the first salt furnace of the Kanawha Valley, and in 1805 was completed the first rock-rolled salt well west of the Alleghenies. During the next thirty years the industry expanded greatly, many wells were drilled, and at one time as many as forty furnaces were in operation in this valley. The salt products of this region have achieved a wide reputation for their preservative quality, and for some years the output was equal to that of the great Ocmulgee district of New York. The maximum production of the field occurred in the decade from 1844 to 1854, when the yearly output ranged from 400,000 to 600,000 barrels. Later new fields were opened in this and other States where conditions were more favorable and the industry on the Kanawha began to decline. This decline has continued down to the present time, when salt making is restricted to a small plant located at Malden, the product being only a small part of what it was at the time of maximum production.

The difficulties of deep-well drilling were so great in the early days that no effort was made to record the different strata through which the drill passed, except to note the general fact that the limestone was found in sandstone at depths ranging from 400 to 900 feet, and that wells drilled to greater depths were unproductive. From wells recently drilled it is known that the heavy sandstones and conglomerates of the Potomac series are the salt-water reservoir, which is found both immediately adjacent, and far from the salt veins from which the salt was in former times obtained. This strata which carry the gas of the region to the surface within a short time after the top of this bed has been reached, and is often seen in the open cut near the town of West Virginia. It is impossible to describe the geologic relations of oil and gas, but it is generally accepted that low arched folds of the strata occur in an area about 1000 miles in diameter, and that there are two main breaks in the fold, which has a diameter of 1000 miles, and that these breaks are the Lower Gas Trend and the Upper Gas Trend. It is not always easy to determine where a single opening is found, and it is usually impossible to say whether it belongs to the upper or the lower of these two beds. On Cooper Creek, one mile west of Elk River, there is an opening on one of these beds which shows a total thickness of over 3 feet, but the coal is stony and broken by two partings (section 12), so that its usefulness in the district is extremely limited.

Several openings were observed on a coal bed which occurs just beneath the first ledge. This bed is irregular in thickness and also variable in quality, so that it is generally of little commercial value. The best observed showing is in the cliffs of the Kanawha Valley, on Elk River, near the summit of the ridge that only a small area of it remains. The bed is thin at this point, but it seems probable that the heavy coal noted in the next section is not taken up here but is left to form the floor of the mine. A short distance southeast of Gladeville the same thickness is noted, and its thickness and character at this point are shown in section 15. On Suggs Creek, about 2 miles east of Gladeville, the same bed is seen within a short distance at this horizon is opened, but, judging from section 16, it is hard to believe that this opening is on the same bed of coal as that mined at Gladeville.

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The exact condition is unimportant, for the main consideration is a bench of coal of workable thickness, with the usual bedding, at the top of the entire bed or only one of its benches. Near the mouth of Ely Fork of Cabin Creek an opening has been made on a coal which is represented in section 21. Sixty feet below the thick coal on Horse Creek there is a bed which at some localities has a thickness of 6 feet. At the opening previously referred to on Horse Creek, it is 40 inches in thickness and the bed is represented in section 22. On Trace Branch, 3 miles east of the above-mentioned locality, this bed has been opened, but at the time of examination the coal was inaccessible. It is reported, however, to be 6 feet in thickness (sec. 23). On the whole the Horse Creek locality is very promising. This locality is at the head of several coal beds which are of workable thickness in most parts of this district, and the quality of the coal is good enough to warrant development in case transportation can be secured for the output of the field.

Division E.—So far as known, there are no beds of any great thickness exposed in this area; nevertheless, there has been considerable activity manifested here since the earliest development of the property near the forks of Coal River. The works have long since failed, but the records of this property contain some sections, made at the time of the first development, that are of considerable interest, for they are the best and most complete sections of the coal beds in the Charleston quadrangle. These sections are at present available. The coal which was most extensively worked in the early days lies presumably at about the middle of the Black coal, or at the base of the Charleston sandstone. The coal occurs 60 feet lower in the strata of Burning Branch than at the above locality on Little Coal River, and its thickness and character are shown in section 34. It is much broken by partings, but it is represented that these partings acted considerably in the mines, so that at some points the coal is much better than the section indicates. A mine was also established on this bed 23 miles below this place and on the other side of Little Coal River. A thin mine was not a large one, for it did not carry so many partings of shale and clay, but, as shown in section 39, it is not a promising coal for commercial mining.

A very good general section of the coal beds in the lower part of this formation was obtained at the mouth of Burning Branch, where a number of beds were opened on the Black coal level, one above another. Twenty feet above this mine previously described, or 80 feet above water level, occurs a 50-inch coal, which is shown in section 30. One hundred and twenty feet higher on the hillside, or at an elevation of 200 feet above the mouth of Burning Branch where it has the thickness shown in section 37, the bed was visible; but the figures given are probably not far from correct. On Coal River near the mouth of Bill Branch a coal is visible, which is represented in section 35 and which probably occurs within 50 feet of the base of the formation. The opening in the strata at this point has been filled in by sediments which have closed the dips so that it is impossible to determine their thickness and quality. In every case the number of described beds is less than the actual number that are of workable thickness. For the reason that the above bed is better known than any other portion of the quadrangle, mining operations have been carried on extensively in the Charleston sandstone. The Charleston sandstone carries only a few bench or coal beds in this area, but to the coal that becomes more abundant and the individual beds are thicker and of more importance.

The best bench or coal bed of the quadrangle of the North Coalbed boring chariots and the coal is 175 feet above the Black coal, and its thickness, as given by W. S. Edwards in "Coal deposits of the West Virginia," is 90 inches. It is shown in section 57. In places the coal is locally known as Wood's Upper Coal, and it occurs about 250 feet above the base of the Charleston sandstone, but it is too thin to have attracted much attention. The area in which the Black coal occurs is small in extent but that contained exceptionally fine coal of considerable thickness. The thickness of the coal has now worked out, but its section, according to W. S. Edwards, is shown in section 57. In places the upper bench contained thin bands of shale which distracted greatly from its value. Where the coal was large the shale was small, so that the total thickness as given in the section was never reached. The old workings are reported to have averaged 6 feet, and the new 4 feet 6 inches, in thickness. In passing up the river this bed becomes more abundant in the upper part of the drainage basin of Fields Creek, and it occurs about 250 feet above the Black coal. From the report of Prof. B. S. Lyman on the terraces of the forks of Lens Creek, several of these coal beds have been taken which were not visited at the time of the present survey. Sections 61, 62, and 63 represent three openings on this bed between Left Fork and the main Lens Creek. In the Lens Creek area there is a prominent coal bed 50 feet below the last described, or 300 feet above the base of the formation. This is known as the Factory Coal, and it occurs about 350 feet above the base of the field at this point. The Factory Coal is known as the Black coal, and it is the most extensively worked coal bed on the field at this point. It is the most extensively worked coal bed on the field at this point.
cannel and how much ordinary bituminous coal.

On the main creek nearly opposite the mouth of Ring Hollow there is open on the bed which is reported to have shown 4 feet of coal (section 67), but the coal is not visible at present and the amount of cannel is problematical.

This bed appears to correspond to the Bearwood bed on the head branches of the New River. The coal occurs as a fault separates the cannel above the bed just described. The total thickness of the bed is not known. A small area of the bed remains. This bed was visited, but the coal was not visible and hence is important as a guide to other horizons.

The most prominent coal bed in the Kanawa formation in this region appears to lie within 60 feet of the top of the formation. It is reported by Professor Lyman as occurring at the mouth of Little Horse Creek, which is 100 feet below the top of the Pottsville series. Section 125 shows the general character of the coal.

The lowest recognized coal bed in the Kanawa formation in this region appears to lie within 60 feet of the top of the formation. It is reported by Professor Lyman as occurring at the mouth of Little Horse Creek, which is 100 feet below the top of the Pottsville series. Section 125 shows the general character of the coal.

The highest known workable coal bed in this division occurs on the headwaters of Big Ugly and Turtle Creek. The coal occurs as a small, irregular bed which is known as Wood's Lower Coal. It occurs about 150 feet above the base of the formation and it can be identified over all the area as the cannel bed above. Section 70 represents it at the site of the oil factory, and section 71 and 72 are from further up the fork of the creek.

On the main creek two openings have been made, which is reported (section 69) a few years ago, when the whole of that thickness that was removed and the mine was abandoned. On Lens Creek Professor Lyman reports a lower bed of coal in the same general horizon as known as Wood's Lower Coal. It occurs about 150 feet above the base of the formation and it can be identified over all the area as the cannel bed above. Section 70 represents it at the site of the oil factory, and section 71 and 72 are from further up the fork of the creek.

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On Big Creek, beyond the western limit of this quadrangle, a coal occurs which was described in the Huntington Survey. It is reported to be 120 feet below the top of the Kanawa formation. Two other beds of coal have been prospected on Big Creek in the same hillside as the one just described. They were visited, but the cannel above the bed just described. The total thickness of the bed is not known. A small area of the bed remains. This bed was visited, but the coal was not visible and hence is important as a guide to other horizons.

The classification of the coal beds below the horizon just described is very difficult, and the following correlations must be accepted as merely provisional. A coal 6 feet in thickness is reported as occurring on Little Horse Creek 100 feet below the top of the Kanawa formation. This locality was visited, but the coal was not visible and hence the report could not be verified. Another bed, 5 feet in thickness and 150 feet below the horizon just described, is reported as occurring on Little Horse Creek, which is 100 feet below the top of the Pottsville series. Section 125 shows the general character of the coal. On Rucker Branch coal is taken from the report of Prof. I. C. White. The uppermost coal bed in the Kanawa formation is reported to be 150 feet below the top of the formation and it is generally known as the horizon of the Winifrede coal. The mines at Winifrede, the type locality for coal, occur in this area. The coal varies somewhat in section, but on the whole is remarkable regular. Section 130 was measured at the head of the stream, but an opening at this point was not made and hence is important as a guide to other horizons. The lowest recognized coal bed in the Kanawa formation in this region appears to lie within 60 feet of the top of the formation. It is reported by Professor Lyman as occurring at the mouth of Little Horse Creek, which is 100 feet below the top of the Pottsville series. Section 125 shows the general character of the coal.

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and section 140 is from Whiteoak Creek. On Logan Fork opposite the mouth of Seng Fork there is an opening on a coal bed which furnished section 141 and which appears to belong to the horizon under consideration.

On Coal River at the mouth Mile Branch a coal bed has been opened at an elevation of about 130 feet above the level of the river. The sandstone which shows above the level of the wagon road is regarded as belonging to the Sewell formation; hence the bed on Coal River is about 100 feet above the base of the Kanawha formation. This bed is of considerable thickness, as shown by section 142, and probably corresponds in a general way with a coal horizon which has been described on Lens Creek and in the adjacent region.

Coal beds are of common occurrence at the top of the Sewell formation. On Short Creek two beds have been opened at this horizon, and they are separated by an interval of 20 feet. The lower bed has a thickness of 2 feet 8 inches and the upper a total thickness of about 4 feet, but the coal is cut by several shale partings. Section 143 shows this bed near the mouth of Toney Creek, and section 144 at an opening on Toney Creek about half a mile from the river. This bed has been opened at the mouth of Joe Branch, but the full section is not visible; it does not, however, give promise of being any better than on Toney Creek. It occurs on Whiteoak Creek about 3 miles above Orange, but with a thickness of only 50 inches. In other localities, wherever this bed has been observed, it is too thin to be mined under present conditions.

IRON.

In the early days of the development of the mineral wealth of this section considerable attention was given to iron, and later a small black-band furnace was erected on Kanawha River at the mouth of Davis Creek to smelt the black-band ore which occurs in that vicinity, but the enterprise was not long lived and the old furnace is now gradually falling into decay. The black-band ore of Davis Creek has been known for a long time. Its quality is excellent, but the quantity is not sufficient to enable it to compete with the high-grade ores of the Lake region. In 1881 Prof. N. S. Shaler examined this property and reported the accompanying section of the ore bed. This ore is reported to contain 31.46 per cent of metallic iron, and when roasted to run about 64 per cent metallic iron.

There are occasional traces of iron ore at other points in this quadrangle, but the quantity is small and the ore is lean, so that the prospect for the establishment of iron industries in this region in the near future is not promising. The almost total absence of limestone in these rocks is another drawback to the profitable smelting of iron in this region.

SOILS.

The soils of the Charleston quadrangle are largely derived from the decay and disintegration of the rocks immediately underlying them; consequently the soil map, which shows the areal distribution of the various formations, may with certain modifications be regarded as a soil map also. The soil distribution of the various formations, may with certain modifications be regarded as a soil map also. In the interpretation of the geologic map, however, it must be distinctly understood that in the process of soil production many of the important elements of the rocks are removed by solution and that consequently the soil consists, in large measure, of the insoluble residue, the sand and clay of the original rocks. Since sand is the prevailing constituent of most of the coal-bearing rocks, and since also it is the least soluble element, the soils are prevailing sandy and thin.

The least sandy soil is that produced by the weathering of the rocks of the Braxton formation. The deeper soils produced from those shales are frequently very productive and are especially well adapted to grazing. The surface of that part of the quadrangle which is underlain by this formation is less rugged than that covering the outcrop of the other formations, and it is, therefore, better adapted to agricultural pursuits.

The soils of the Charleston sandstone and the Kanawha formation are generally poor, and the hillsides are so steep that farming is extremely difficult and the crops are light.

The flood plains of the larger streams constitute some of the best farming lands in this region.

May, 1901.