ART. XIX.—*Observations on a Seam of Coal;* by Prof. E. B. ANDREWS, Marietta College, Ohio.

THE seam of coal here described is located in the northern part of Washington Co., Ohio. It extends through the hills for several miles, and is generally of workable thickness. On Bear Creek, a small tributary of the Muskingum river, which latter stream is rendered navigable by large dams and locks, the coal is five feet in thickness. To the south the coal disappears, and evidence will presently be given to show that the original coal marsh was in that direction, skirted by open water. The geological position is near the top of the Coal Measures. I know of no other seam of coal of economic value above it in our Ohio rocks, although we find perhaps two hundred feet of unproductive sandstones and shales still higher. It is about sixty feet higher in the series than a peculiar group of limestone strata, with which is associated a seam of coal now worked at Coal Run on the Muskingum river. This group is very persistent, and, after showing itself over a considerable part of Washington

County, dips below the Ohio river to the northeast and reappears in the vicinity of Wheeling, W. Virginia, where its accompanying coal is extensively mined. In this connection it may be remarked, that there is great confusion among our geologists relative to the equivalency of the Pittsburg, Wheeling, and Pomeroy seams of coal. Dr. Caleb Briggs, who was connected with the early surveys of Western Virginia and Ohio, regards the three seams as equivalent; while Lesquereux makes the Pittsburg and Wheeling seams equivalent, to which he adds another, in a seam of coal at Athens, Ohio. My own investigations have led me to believe the Wheeling and Pomeroy seams to be entirely distinct, while the Athens coal is probably the continuation of the Pomeroy seam. The Athens coal is probably the same with the Federal Creek Coal, (Athens Co.) which, by all our Ohio geologists, is regarded as the continuation of the Pomeroy seam. The Pomeroy seam, as traced by myself, from Federal Creek into the northwestern part of Washington County, is found to be from sixty to seventy feet above the very limestone group which is so persistent, and which carries with it the Coal Run and Wheeling seam of coal. The Pomeroy seam sweeps around through the northern and eastern parts of Washington County, and is everywhere from fifty to seventy feet above the limestone group. Doubtless the seam of coal which is found in the hills above the Wheeling seam at Belleair (near Wheeling), is the equivalent of the Pomeroy coal.

The Bear Creek coal, which I propose to examine, is without doubt the geological equivalent of the Pomeroy seam. It is, however, greatly modified in structure by causes which I shall hereafter explain. Before the Bear Creek coal disappears to the south, there is evidence of a struggle in that direction between the vegetation and the water. The coal-marsh was repeatedly flooded, and over the vegetation thick deposits of sediment were made which are now fire-clay. We have these repeated alternations of coal and clay until, at last, the coal disappears, and we reach a region of unbroken water. There is nothing peculiar in the rocks associated with this coal.

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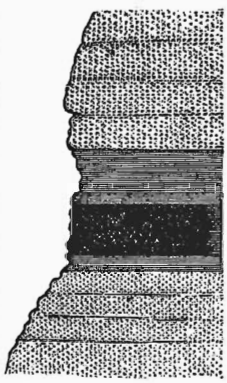

Above the coal is a thin stratum of bituminous slate. Above the slate several feet of fire-clay, and above the clay a heavy sandrock. Below the coal is fire-clay, and below that a considerable development of sandstones and shales.

The coal was analyzed by Dr. J. S. Newberry and gave:

Volatile matter,	49 to 51 per cent.
Fixed carbon,	44 " 46 " "
Ash,	3 " 5 " "

Probably this percentage of ash is a little below the average for the whole seam. The coal is hard, and breaks with an unusual conchoidal fracture, resembling cannel coal. The appearance of the laminations as seen on the surface of the polished vertical planes, resembles varnish spread with a coarse brush, thus giving a peculiar streakiness to the surface. These laminations often show themseves to be immeasurably thin layers of sedimentary matter. In the fracture these layers present the appearance of exquisitely-fine steel medal-ruled engraving. It is doubtless to these peculiar laminæ that the coal owes the property of parting with remarkable readiness with its gas or hydro-carbons, for the coal is very rich in gas and burns with remarkable freedom. In the grate it differs from the Wheeling coal, as dry wood differs from wet green wood. Why the presence of these laminæ of sedimentary matter—thinner than any tissue paper—should thus facilitate the production of gas, a fact which I have observed in some cannel coals, has not been explained so far as I know. Besides these peculiar laminations, there are the usual ones, which most geologists regard as produced by the different increments of vegetable matter, and showing perhaps periodicity in the growth and falling of the leaves and fronds of the coal vegetation. The Pittsburg coal exhibits this class of laminations in smooth and highly polished horizontal surfaces, and it is by these that this coal is readily distinguished from other Western coals. In the Bear Creek coal we find also laminæ of mineral charcoal. This is sometimes found in plates one-fourth of an inch in thickness. It exhibits a fibrous, woody structure, and is very soft and easily reduced to powder. Whether this charcoal is produced by some peculiar property in the original vegetable matter, which did not permit the usual bituminization, or the bitumen has been subsequently removed by great pressure, leaving the fibres dry like the pressed stalks of sugar cane, it is perhaps impossible to determine. The first class of laminæ, those having a sedimentary appearance, doubtless tells a tale of water, and indicates that the vegetation grew where it was very marshy and constantly inundated. This water, however, contained only the slightest possible amount of impalpable sediment, and could scarcely have been much discolored. This marshy character of the coal field and the overflow of water doubtless caused an unusual softening and maceration of the fallen vegetable matter, and produced the cannel-like character of the coal. But while the coal marsh was ordinarily more or less covered with comparatively pure water, at one time it

was flooded by more turbid water, which left a distinct earthy deposit. This thin slaty streak in the coal, now black and highly bituminous, is evenly distributed over a large area, and indicates a general overflow.

Another interesting feature of the Bear Creek coal is the presence, in various parts of the seam, of drifted and beach-worn wood. This is generally found in small fragments with the ends rounded, as if long water-tossed. Though now changed into sulphuret of iron, they show plainly a woody structure, and are entirely unlike the flat plates of sulphuret of iron which are formed within all coals by chemical affinity. I have found them showing the bark-markings of the original tree.

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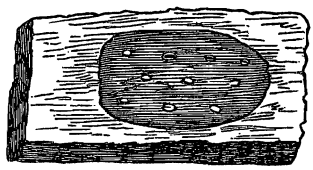

In some instances they are sticks six or eight inches long, an inch and a half in diameter, and rounded at the ends. They are not confined to any particular part of the seam, but may be met with any where, even in the very purest portions of coal. This would indicate that the coal was formed under circumstances allowing these vegetable waifs to be floated in and lodged among the vegetation. But the water on which they were borne could have been only slightly charged with sediments, as no such sediments, with the exceptions of the extremely thin laminæ previously alluded to, are found in the coal. I doubt whether these bits of drifted wood are to be found in the coal very far inland from the water edge of the coal marsh. I have not noticed them in the same seam of coal where it is mined, a few miles northeast of Bear Creek. There is, moreover, evidence to show that the coal changes in character as it recedes from the water's edge of the original marsh. It becomes more soft and caking, and less like cannel in fracture and behavior in the fire. These facts are interesting, as tending to verify Dr. Newberry's theory, that cannel coal is produced by the action of water in rendering the vegetable matter more soft and pulpy.

Vertical planes.—The existence of vertical planes in all coal has long been known. I have improved many opportunities of studying these planes, and have, so far as our Western coal fields are concerned, verified a conclusion which I presented in a paper read before the American Association for the Promotion of Science, at the meeting in Springfield, Mass., viz: that these planes have a uniform direction—nearly east and west. I have examined seams of coal in all parts of the Coal Measures, from the bottom to the top, as well as seams far apart geographically, and have invariably found the general direction of these planes the same. So confident have I become in this conclusion, that,

in my geological rambles among the hills and mountains, I have often taken my points of compass from the coal, as I have found the seams exposed in the various hillsides.

In the Bear Creek coal the principal planes lie in the direction S. 80° E. Besides these principal or primary planes there are local developments of other planes, which make an angle with the first. The secondary planes are parallel with each other, and constitute at the point where exhibited a perfect and beautiful system, and as distinctly marked as the primary system. The accompanying figure, (fig. 3,) shows the systems of planes in a block of the Bear Creek coal. The lines marked *a* represent the primary planes; those marked *b* the secondary ones.

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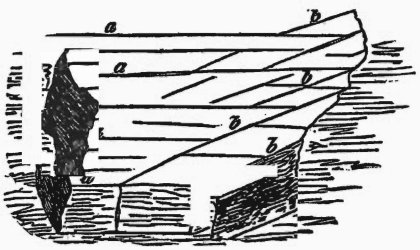

In very rare instances the plane *b* curves into the plane *a*, but generally there is a sharply defined angle of intersection. These angles vary in different localities in the same mine; but wherever the secondary planes appear, they are parallel and true to their own local system. The highest angle I have measured is over 30°, but generally the angles are less. So far as I have examimed the Bear Creek coal, the secondary planes cross the primary ones in the direction of south-of-west and north-of-east. This brings the primary planes on one side of the east and west line, and the secondary planes on the other (see fig. 4). If these

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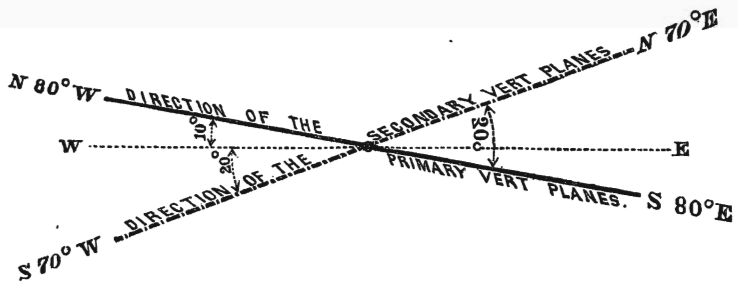

may be called crystalline planes, as their regularity and polish would indicate, they were doubtless formed at the time of the solidification of the coal, and their direction determined by terrestrial electricity. The great east and west currents of thermal electricity might induce a sort of polarity in the particles of coal,

causing them to part in the magnetic directions north and south. The presence of iron in the coal might have facilitated this action. The divergence of these planes from an east and west line are not greater than the aggregate secular variations of the needle, and may have been produced by the same cause. That these planes are entirely unlike slaty cleavage and jointed structure, seen in other rocks, is, I think, sufficiently apparent. There are no such planes, nor jointed structure of any kind, in the bituminous slates and shales accompanying the coal. A thin lamina of coal, not thicker than paper, shows these planes perfectly, while nothing of the kind is found in the bituminous slate above and below. There is no jointed structure to be found in any of our rocks associated with the coal. So far as I have observed, these joints are generally found in rocks which have been subjected to heat as well as pressure. If this is so, we should not expect such joints in the coal; as in the West, it has never been subjected to any heat, the coal still retaining its full and normal quantity of bitumen.

Other lessons may be learned from this seam of coal, but I defer their consideration to another time.