THE OHIO COAL FIELD.

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The Ohio coal field is the northwestern prolongation of the Appalachian coal field, which, with its outliers, constitutes by far the most important source of coal for the North American Continent. The area of the entire field is estimated approximately at 60,000 square miles. (59,105 square miles, C. H. Hitchcock, Ninth Census, U. S.) One-sixth of this area is estimated to belong to Ohio. (10,000 square miles, Newberry.)

The whole field is one of remarkable symmetry and regularity, and of its several subdivisions, the portion belonging to Ohio and Northwestern Pennsylvania is the most symmetrical and regular. There is nowhere known a more orderly series of coal measure deposits than those included in this territory.

It is traversed by a few gentle folds, but these serve to aid rather than to confuse the reading of the system. There is not throughout the Ohio field a fault worthy of the name, and there is no unconformability, except the slight amount due to overlap in the lowest portion of the series. The dip of the strata is so slight that it can be determined only by triangulation. The clinometer is a superfluous instrument in Ohio.

The physical side of the history of the growth of the Coal Measures of Ohio is strictly in keeping with the same phase of the history of the underlying formations for several previous geological periods.

At the beginning of Lower Silurian time, all of Ohio lay beneath that arm of the sea which was enclosed between the Appalachian border and the Canadian nucleus of the continent, and the dwarfed and shrunken representative of which we find in the northern portion of the Gulf of Mexico to-day.

At the end of the Lower Silurian age, a low fold had entered the State at its southwestern corner, advancing from Tennessee and Kentucky to the northeastward. It is known as the Cincinnati Axis.

The gradual growth and extension of this axis are facts of fundamental importance in the subsequent geological history of the State. It was advancing slowly through Upper Silurian and early Devonian time, but it suffered a partial relapse during the later

Devonian period, in which the Ohio Black Shale (Huron of Newberry) was formed. But early in the Sub-carboniferous age it had made a great and permanent gain, and had transformed the western half of the area of the State into dry land. The Berea Grit, a Sub-carboniferous formation, which now extends in an unbroken wall from the Ohio Valley to Lake Erie, through the central portion of the State, is as well-marked a shore line as was ever left by a retreating sea.

The Cincinnati Axis had now become conected, virtually at least, with the northern continental nucleus, and the subsequent history of the eastern half of the State depends upon the joint advance of these land masses, the western and northern borders of the gulf. Both seem to have extended themselves in the same manner by a slow and nearly uniform rise of the border, accompanied by a corresponding movement of depression in front of the advancing land. The result was the gradual expulsion of the sea from this northern arm of the gulf, and it also followed that each new and well-marked shore line must be found interior to that which had preceded it. Thus, for example, the western outcrop of the Shenango sandstone, the Waverly Conglomerate of Ohio, which marks a shore line, and which belongs 300 to 500 feet above the Berea Grit, is found between ten and twenty miles to the east, and south of the western outcrop of the Grit. In like manner the lowest coal seam was formed around the margin of a sea which had left those earlier formations behind it. The later coals never extended over the outside margins of the earlier swamps. If there had been continued subsidence without this corresponding elevation during the growth of the coal seams, the later seams would occupy constantly widening areas, but the contrary is true. The outcrop of the horizon of the Sharon coal passes through a circuit of thirteen counties, and its length, exclusive of the sinuosities due to erosion, will not fall far below 275 miles. The outcrop of the Pittsburgh coal passes through nine counties, with an opproximate length of 175 miles. At the time when the Sharon coal was forming, the area of the gulf in Ohio was not less than 10,000 square miles. In the time of the Pittsburgh coal, the area was reduced to less than 6,000 square miles.

All of the coal seams of Ohio below the Freeport horizon, and a number above, appear to have been formed as marginal swamps around the border of the sea. The earliest suggestion of this

view seems to have been made by Prof. J. J. Stevenson. It is now established that the coal vegetation grew where we find it. A coal seam is literally a buried swamp, a fossil peatbog. The facts illustrating this mode of origin, for the Sharon coal in particular, have been set forth with great clearness by Newberry in his reports upon that seam. But there are equally convincing facts in regard to many of the other seams, all of the proofs, for example, that the sea was near at hand while these seams were growing.

It is not an uncommon thing to find a coarse sandstone, and sometimes a decided conglomerate, directly overlying a seam of coal. But strong currents would be required for the transport of this kind of material, and such as belong to the sea.

At this time the floor of the gulf seems to have been brought up nearly to the sea level over a wide area, and it seems probable that numerous islands appeared throughout this area. Around their shores as well as around a main coast line, the coal-forming swamps could grow. The instability and frequent interruptions of the Freeport coals can be understood from this point of view. They nowhere show the continuity of the lower seams. They occur in basins, and not in continuous sheets, with a greater breadth of outcrop than the seams below them. They suggest an archipelago rather than a continental margin. But this period was terminated by the return of the sea in full force. The Mahoning sandstone, coarse and often conglomeratic, makes the roof of the Upper Freeport coal, and it is to the strong invading currents that brought in the sand and pebbles of this formation that the frequent and often disastrous "wants" are due, which occur even in the districts where this seam is at its best.

These are theoretical questions, but they bear directly on practical and economic interests. The amount of coal that the Ohio coal field contains turns, of course, upon the extent of the seams. If we see reason to believe that these lower seams originated in marginal swamps, with the sea near at hand, then of course we abandon the older view that the coal seams extend indefinitely towards the center of the basin. A breadth of a few miles, of a score or so, at most, would be all that could be reasonably expected for any such seam. The earlier and the later seams could no longer be looked for in the same section, and instead of concluding that the amount of coal, underlying any given county or town in the coal area, depends on its proximity to the center, and

deepest portion of the basin, it would be nearer the truth to make the amount of coal *inversely* proportional to such proximity. In other words, we should expect to find the interior of the basin filled with "*terrains mort*"—that is, with dead or unproductive rock.

Almost all of the facts that have a bearing on the question seem to support the view that is here presented.

Not only is there no instance known in the State in which the Sharon coal is *mined* under the outcrop of the Kittanning coals, for example, but there is no instance known in which the Sharon coal has been *found of mineable thickness* directly under a mineable thickness of the Kittanning coals. Not a year goes by which does not bring numerous tests of the facts involved in these statements in the shape of drill records from various parts of the coal field, but so far the testimony is all in one direction. Claims are sometimes made of discoveries of the lower coal within the limits of these upper seams, but none have yet been substantiated. The 3-feet coal in the New Lisbon well, which has been by some supposed to belong to the Sharon horizon, cannot be below the Lower Mercer horizon. The heavy deposit reported from the Post Boy borings, south of New Comerstown, seems too impure to be taken as a representative of the Block coal, nor is the depth of the deposit what should be expected for this seam.

No argument is made against the possibility of such overlap. The possibility is freely conceded, but the record of every new drilling increases the improbability of these desirable discoveries. The Sharon coal seems to have a heavier cover in Stark County than elsewhere, if the records of borings reported from there prove trustworthy. It underlies the Putnam Hill limestone, according to Newberry, in the northeastern part of the county.

Furthermore, a coal seam can often be traced toward the interior of the field along some open valley, or by means of a series of test borings. In numerous instances such seams are found to suffer gradual reduction, or frequent interruption, or to completely disappear. The Kittanning coals furnish examples of these facts in the valleys of the Connotton, of Wills Creek, and of the Muskingum. They are traced in all of these cases until they seem verging toward extinction.