REVIEW OF PROF. ORTON'S DISCUSSION OF THE LOWER COAL MEASURES OF OHIO.

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The law providing for the Second Geological Survey of Ohio was enacted in March, 1869. Under its provisions one chief Geologist and three assistants were appointed—the Chief being Dr. J. S. Newberry and the assistants E. B. Andrews, Edward Orton and J. H. Klippart.

The survey which was to begin not later than June, 1869, was, according to the act which authorized it, to be completed within three years from the date of commencement.

The results of the survey were to be embraced in two reports of progress and four final reports, the final reports to include the following subjects:

Vol. I. Geology and Palentology in two parts.
Vol. II. " " "
Vol. III. Economic Geology.
Vol. IV. Agriculture, Botany and Zoology.

The volume on Economic Geology, which was to contain a description of the mining, manufacture and uses of our coals, iron ores, clays, limes, haudralic cements, petroleum, gyptsum, building stones, etc., promised to be a volume of surpassing interest to practical men, and was long and eagerly looked for.

The foregoing plan was not carried out in the order in which it was proposed. There were three volumes of Geology prepared and published, including two volumes of Palentology, and Vol. IV, which embraced the subjects of Botany and Geology, was published before the volume of Economic Geology. This latter volume, published during the present year, appeared as Vol. V, the last of the series, and was prepared by Prof. Orton, Dr. Newberry having removed to New York before provision was made for its publication by the General Assembly.

By the provisions of the act which authorized the Geological Survey, the field work, which was to be closed within three years from the date of commencement, was subsequently extended to five years, and special appropriations were afterwards made by the General Assembly for the re-survey of important mineral fields,

so that field-work was continued till 1877. In 1881 provision was, in addition, made by law for the preparation and publication of the volume on Economic Geology, Vol. V, which was to include a re-survey of the lower coal measures of the State for the purpose of correcting the errors of the former work.

In naming the coal seams Dr. Newberry used figures; thus the lower coal was called No. 1, the next seam in ascending order No. 2, and so on to the uppermost bed of the State series. During the progress of the survey a number of seams were discovered which had been missed when the names were first applied. These beds were named No. 3a, No. 4a, No. 4b, etc., according to their position in the geological scale.

This manner of designating the coal beds of the State, which was the plan adopted by the first survey in 1837, met with general approval, not only among practical men, but among all others. By this simple and readily understood nomenclature every person could at once comprehend the place of a coal seam in the scale. In the two Reports of progress and in the three volumes of Geology this plan was universally adopted, and the method of naming the various coal seams by numbers had become part of the thoughts of every one interested either in the geology or in the development of the coal field of the State.

In Vol. V, Economic Geology, which embraces a discussion of the order of the lower coal measures, with the object of correcting the former errors of the survey, the plan of naming the coal beds by numbers has been discarded and the names which Prof. Lesley, Chief of the Pennsylvania Geological Survey, adopted in naming the coal beds of that State, have been borrowed by Prof. Orton. Thus the lower coal, No. 1, is called the Sharon coal, No. 2 the Quakerton coal, No. 3 the Lower Mercer coal, No. 3a the Upper Mercer coal, and so on throughout.

A discussion of the order of the coal seams is about as much out of place in a volume on Economic Geology as a description of the battle of Bunker Hill would be. But confusion is worse confounded in the substitution of new and foreign names for our coal beds at this late stage of the survey. It is like swapping horses on a stream. Had the Pennsylvania names been given to our Ohio coals when the survey was inaugurated in 1869 there might have been some excuse offered for doing so, but to change the names in

the last volume of the survey can admit of no possible excuse. If a change was required, as Prof. Orton insists because the numerical system is misleading and confusing and a hindrance to Ohio geology as it now stands, the adoption of the commercial names of our coals would have been a much more satisfactory substitute than the Pennsylvania nomenclature. The Briar Hill coal, the Hocking Valley coal, the Ohio River coal, etc., etc., are names generally known in every coal market in the State, and next to the numerical system, would have been acceptable to practical men.

A gentleman interested in the success of Vol. V, Economic Geology, wittily remarked on reading the advance sheets of the book, that a proper title for the volume would be "A Supplemental Report of the Geology of Pennsylvania." When Prof. Orton, in a paper read before the Ohio Institute of Mining Engineers at the Youngstown meeting in May, 1883, first proposed the adoption of the Pennsylvania nomenclature, the idea was uniformly opposed by the most intelligent practical men in the State. In the discussion which followed the reading of Prof. Orton's paper Mr. I. G. Chamberlain said: "In regard to the designation of our coal beds, I confess a strong preference for numbers. They are retained so much more readily and tell so much more than other names. I think the missing seams should be represented by intercalated numbers."

Mr. A. B. Cornell said: "I prefer to retain numbers in naming coal beds on account of their simplicity. People who read or think little on geology have not time to master all the local names. I feel a repulsion to the Pennsylvania system and an attachment to our own."

The above views embody the general sentiment of practical men on the subject. The change which Prof. Orton has introduced will never become popular in the coal regions of the State.

As regards the Pennsylvania nomenclature, this is the third time it has been changed by the Geologists of that State, and if Prof. Lesley were to die before the present survey should close, his successor in office would doubtless have a new set of names to confer on the coal seams. It would certainly not be difficult to find more appropriate names than the present ones. The Pennsylvania nomenclature has, however, this advantage in its favor: It was adopted at the beginning of the present Pennsylvania survey, and has the

merit of conferring system to the various volumes of the geological survey. In Ohio the Pennsylvania names were borrowed after all had learned and approved of the system of notation conferred by Dr. Newberry.

No class of professional men are more intolerant of each other's mistakes than geologists. They are each morbidly sensitive of their individual reputations, delighting to belittle the work of their associates. During the progress of the survey the members of the geological corps made the State ring from side to side with personal controversies in regard to the errors and defects of each other's work. But for this unseemly display of bickering and wrangling, the field work of the survey, we verily believe, would have been continued several years longer—as it should have been—instead of being closed at the end of five years. No two members of the Geological Corps of Ohio ever went over the same ground and found the same facts. A few of the mistakes and conflicting views are here inserted in illustration of the truth of our assertion:

When the survey of Mahoning and Trumbull counties was first made the geologists insisted that there existed no coal north of the Briar Hill mines of Governor Tod. A driller who, perhaps had never heard of the Geological Survey, afterwards discovered coal ten miles north of Tod's mines, and millions of tons of the famous Mahoning Valley coal was thus made available for the purposes of the miner.

In Vol. I, Geology of Ohio, Prof. Andrews publishes an elaborate article on the parallelism of coal seams, in which he declares "that one careful measurement of the interval between two seams is so excellent a guide that either seam being found the place of the other can be readily determined. * * * When the measurement is accurate the parallelism is beautiful and perfect. There may be a little play of variation, but it is generally very slight." Further along, in the same article, he says: "So far as my observations go, I have never found an instance where two distinct seams of coal came together or conversely where a seam became divided and the parts continued to diverge for a long or indefinite distance." If the first of these quotations were true, the second would follow as a matter of course. In the very field in which Prof. Andrews was at work when he wrote the article from which we have quoted, not only were the convergence and divergence of coals seams trans-

parent, but the Nelsonville coal 6 feet thick at Hayden's, Brooks', Longstreth's, and other mines, owes its increased thickness to 8 and 9 feet at Floodwood to the union of two seams.

Prof. Orton, on pages 921–2, Economic Geology, says there is no foundation for the theory which accounts for the thickness of the great vein by the coalescence of No. 6 with No. 6a. No person ever said there was; the rider which coalesces with the Nelsonville coal is not recognized in the geological reports, but it exists all the same, and the coalescence recurs as we have stated as Prof. Orton may discover, if he will go through the mines and look at the roof.

In the report of Ohio Statistics for 1879 Prof. Orton published a review of the Geology of Eastern Ohio, in which he declares that our coal beds are only a few miles in width and are built up like the steps of an inverted stairway. "To look for the lowest coal under the Nelsonville seam, for example," says Prof. Orton, "or to look for the Nelsonville coal under the Pittsburgh seam, is as a general rule to look for the living among the dead." No search has ever been made for the lower coal under the Nelsonville seam, and owing to the limited basins in which it is deposited, it has never so far been met with there, but the Nelsonville and the Pittsburgh seams are perhaps oftener found together than any two seams in the whole series.

The Carbondale coal of Athens county is not more than four or five miles distant from some of the Hocking Valley mines, near Nelsonville. Prof. Reed and Dr. Sterry Hunt insist that these coals are separate seams, while Prof. Andrews and Orton are positive they are each the Nelsonville seam.

An amusing example of mistaken identity is recorded in the reports of the Geology of Belmont County, by Profs. Andrews and Stephenson. On page 160, vol. 2, Geology, Prof. Newberry says:

"In the report of Belmont county by J. J. Stephenson, a detailed description will be found of our upper coals and some facts of special interest are there reported in regard to the Pittsburgh seam. He apparently demonstrates that while in Belmont county it is a single seam, on the Ohio river at Bellaire, it is represented by four coals, three of which occupy the space between coal No. 8 and coal No. 9, this interval having been increased

from fifty feet at Barnesville to one hundred and fifty feet at Bellaire. * * It is Prof. Stephenson's opinion that coals Nos. 8a, 8b, and 8c, the three seams above the Pittsburgh, in the Bellaire section, are offshoots from coal No. 8, and that they all run together."

Prof. Stephenson, in his report of Belmont county, vol. 3, Geology of Ohio, page, 267, published grouped sections of the upper coal measures in Belmont county, illustrating the gradual coalescing of the four coals in question.

Prof. Andrews on the other hand, who went over the same ground, could find no coalescing of these coals. On the contrary, he traced the same seams in the same order in which he found them at Bellaire, all through the high lands of the Barnesville region. (See vol. 2, page 545, Geology of Ohio). In other words, Prof. Stephenson found coals Nos. 8a, 8b, and 8c at Bellaire, all running into the Pittsburgh seam at Barnesville, and Prof. Andrews found no coalescing whatever of such coals in going from the Ohio river west to Barnesville.

The ferriferous limestone of southern Ohio is a well-marked and well-known feature of the geology of Vinton, Jackson and Lawrence counties. In nearly every hill where it is due it has been laid bare by the furnace men of the region in mining its associate bed of iron ore; it however thins out,and disappears in the counties of Hocking, Athens and Perry. Prof. Andrews, in 1870, traced its horizon to the great vein coal field of the Hocking Valley, and located it directly over that seam—coal No. 6, of the survey; Prof. Reed, in 1877, traced it over the same ground, and located it above coal No. 5; Prof. Orton traced it a third time in 1878, and placed its horizon directly over coal No. 4.

Prof. Orton, during this investigation, discovered that the two lowermost coals of Jackson county—the Wellston coal and the Jackson shaft coal—were geologically lower and older strata than the Maxville limestone, which is supposed to lie at the base of the coal-producing rocks in southern Ohio. The Wellston and Jackson coals were therefore pronounced to be interglomerate beds, having no representatives in other parts of the coal field. Dr. Newberry, in vol. 3, page 24, Geology of Ohio, referred to this discovery of Prof. Orton as of great importance and fresh interest to geological science, explaining in an unexpected way all the

mysteries which hung around the Maxville limestone. A few months later, however, after Prof. Orton's attention was called to the mistake he had committed, he recalled all he had written on the subject, and the mysteries of the Maxville limestone fell back into the rocky strata of Jackson county.

Regarding the true place of the Jackson shaft coal or its supposed equivalent in Trumbull and Mahoning counties, the Ohio and Pennsylvania geologists have been at issue for many years. Dr. Newberry insists that though found embedded below the horizon of the conglomerate rock, the base of the true coal measures, it is a later creation of geology than the conglomerate, and therefore a true coal seam. Professor Lesley, on the other hand, insists that it is an older creation of geology than the conglomerate, and is not a true coal seam, but a sub carboniferous deposit. And now comes Professor Orton bringing up the rear of the survey, and making havoc with all former work. He has found a true scheme in regard to the order of lower coals. They are the duplicate of the Pennsylvania series. This is his reason for borrowing the Pennsylvania names. He has traced the Pennsylvania series, without a break, not only across the State line, but he has followed it "with ease and certainty" along the whole length of the lower coal measures of Ohio. He regards the order as now settled.

Prof. Orton's claim that he has traced the series of the lower coals around the entire margin of the coal field from the Pennsylvania line, is the ordinary language of a geologist in regard to the identity of his own work. We believe he has done no such thing; and for the best of reasons. The Pennsylvania series does not exist around the entire margin of the Ohio coal field.

According to Prof. Orton's showing, Dr. Newberry blundered egregiously in the former work of the survey. In Summit county, in Tuscarawas county, in Columbiana county, in Stark county, in Carroll county, in Jefferson, in Mahoning—in short, wherever Dr. Newberry went he erred in regard to the identity of some one or another of the coal beds; and all this among common and recognizable elements which are maintained from point to point, and which, Prof. Orton tells us, can be followed with ease and certainty from Youngstown to Ironton. All Prof. Orton's predecessors in the coal field, equally with Dr. Newberry, are at fault with their work.

We accord to Prof. Orton great ability, honesty of purpose, and indefatiguable industry as a strategraphical geologist, but we believe that with all the time and labor spent upon the coal field by himself and his predecessors he has not yet recognized the facts of nature as they are represented in the structure of the rocky strata of the lower coal measures of the State.

That a skeleton of frame work runs through the coal measures of Pennsylvania and Ohio as well as along the whole length of the great Appalachian coal belt is readily admitted by every geologist and mining engineer who has given the subject any attention. But that is the extent of our positive knowledge. Such practical facts as the yet meager developments of the mineral resources of Ohio have brought to light, favor the conclusion that the coal beds of the lower coal measures are one and all deposits, disposed upon wavy and uneven basins or troughs which have been scooped out of comparatively level plains by erosive agencies anterior to the deposition of the vegetable material from which the coal is derived. Some of the basins are of very limited extent, holding only a few acres of coal, and some of them are quite large, entending from one county to another, but not one of them stretching in an unbroken sheet along the whole line of the coal field. We all know the shape and structure of the basins in which the lower coal is found. We have emptied so many of these dishes that their absolute shape is as familiar to practical men as the sitting rooms of their own houses.

In ascending the scale we find the same conditions wherever sufficient mining has been done to allow an examination to be made that we find in the Mahoning Valley. At Del Carbe, in Muskingum county, the few and small dishes which hold coal No. 5, have been emptied and the mines abandoned. At Salineville, in Columbiana county, the big vein rises on hills in the mines and thins out to a feather-edge exactly as the coal does in the Mahoning Valley. Trial entries have been advanced on the hills, and bore-holes put down beyond the limits of the basin, but only barren ground met, not a trace of coal being present. Three of the wrought out mines yielded less than 100,000 tons of coal. At Coshocton, hills twenty-five feet in height have been encountered, the coal gradually losing height with every yard of ascent. In the Sunday Creek Valley, the great vein rises on hills and disap-

pears. The Wellston coal of Jackson county, is lost three-fourths of a mile north of Wellston. The Coalton mines will reach the limits of the basin on both sides, on the north at Wilson's school-house, and on the south at Petrea. All over the coal field similar conditions are met in the mines. Beginning at the bottom of the scale we know that the block coal mines of the Mahoning Valley are all opened on one seam. But do we know that the Briar Hill coal and the Massillon coal are one and the same seam? In the Mahoning Valley the coal rests in basins cut into the Cuyahoga shale fully 150 feet deep. The Massillon coal rests in basins on top of the conglomerate rock. There is no conglomerate underlying the coal of the Mahoning Valley except thin and limited patches which conform to the waving of the coal seam, showing that this rock was deposited where we find it, after the troughs in which it rests had been eroded. The horizon of the conglomerate rock which represents the strata upon which the Massillon coal is built lies 150 feet above the coal swamps of the Mahoning Valley.

These two coals are as dissimilar in character as any two separate seams in the State. The Briar Hill coal is long-grained, possesses a laminated structure, splits into thin sheets, but will hardly break at all on the opposite side of the lamina. The coal is composed of bright and dead-looking layers, the faces of which are covered with mineral charcoal. It is hard and compact and might be shipped around the world. It is a typical furnace coal. The Massillon coal is short-grained, breaks as well one way as the other; is impregnated all through with a thin, white substance, like alum; it is tender and will not bear handling well, and is not well fitted for furnace use.

Above the Briar Hill seam there are three or four distinct seams of coal before the geological level of the conglomerate is reached. In the Garfield shaft, in Trumbull county, there are three seams each upward of one foot in thickness, as follows: Sixty-six feet above the main coal a seam 22 inches thick is met; nine feet higher another seam, 18 inches thick, is present; ten feet higher a 15-inch vein appears. These are thin seams, occupying basins of very limited extent. But do they reappear in other parts of the coal field? Is one of them the representative of the Wellston coal of Jackson county? If so, which one? or has

the Wellston coal a representative in the State outside of Jackson and Vinton counties? None of the coals in the Garfield shaft represent coal No. 2—that seam being due 30 to 40 feet lower, and none of them represent No. 3.

In ascending the scale from the bottom to the top of the lower measures we find at one point or another, not indeed 13 different coal seams, but 20 to 25. Nature was a prolific worker in building up the coal strata. Each one of these coals represent a subaerial surface, but the swamps in which the coal beds were formed were often very small, for as we have stated, some of the deposits occupy only a few acres of area. Conditions favorable to the growth of coal vegetation existed in Trumbull county and not in Mahoning county, and vice versa, and so on throughout the area of the coal field; hence, while we had 20 to 25 subaerial surfaces during the coal-forming period upon which coal grew at one place or another, few sections in the lower coal measures contain one-fourth of the series. The places of the new coal marshes shifted about with every subaerial formation, one seam being deposited above another for two or three succeeding subaerial pauses in some districts, while in others conditions favorable to the growth of coal were not present until the land had sunk several hundred feet.

Prof. Orton's scheme of the order of the lower coals is based upon the theory that each seam is, as a general rule, a continuous sheet, stretching across the coal field from outcrop to outcrop, that all the seams wese deposited upon low, level and marshy plains, around the borders of an ancient retreating sea, which fell back with the formation of each subaerial surface upon which a bed of coal was grown, that none of the beds are more than a few miles in width, and that they exist one above another like the steps of an inverted stairway. There never was a greater mistake, and any intelligent observer who will travel through the coal mines of the State will soon satisfy himself of the fallacy of this theory. He will find subterranean hills 60 and 70 feet in height, in the hollows of which the coal was deposited; he will see the coal climbing these hills at an angle of 15 and 20 degrees, the bed growing gradually thinner with each yard of advance until it disappears altogether; he will learn that the top of these hills stretch out in extended level plains containing not a trace of the lost seam of coal; he will see, if he digs into the sides of these hills, that while

the seam of coal is pitching upward at the rate of 15 or 20 degrees, the seams of rock and shale below are comparatively level, and that only in the swamps in which we find the coal were there marshy conditions favorable to the growth of the vegetation from which the coal is derived.

Prof. Orton has observed in the coals overlying No. 6 a disposition to thin out and disappear at frequent intervals, but he does not comprehend the cause of these frequent events. He calls these seams sparodic coals. They are no more sparodic than any of the beds which underlie No. 6. This seam, the representative of the great vein of the Hocking Valley, is perhaps the steadiest of all the lower coals; but this coal, of magnificent development and extent in the Hocking Valley, thins out and disappears on the hills of the mine in the Sunday Creek Valley and is seen no more in the district.

Prof. Orton supports his claim that he has established his scheme of the true order of the lower coal series with numerous sections. They prove nothing. Prof. Stephenson published sections showing that the three coals above the Pittsburgh seam at Bellaire all run into the Pittsburgh coal at Barnesville. Prof. Andrews published sections showing that they do no such thing, but that the section at Bellaire is duplicated at Barnesville with almost mathematical exactitude. Prof. Andrews published sections to prove that the Nelsonville coal and its underlying seam in the Hocking Valley are the equivalents of the grey limestone coal and the seam immediately underlying the grey limestone in Lawrence and Jackson counties. Prof. Orton published sections to prove that the two Nelsonville coals and the two Lawrence county coals are *not* equivalent seams, but the place of the grey limestone coal is geologically 70 feet, more or less, lower than the Nelsonville coal. It would not require a very lively imagination to furnish sections to show that the coal beds of the Illinois field are the representatives of the lower seams of the Ohio coal measures.