VARIATION AND EQUIVALENCE OF THE CHARLESTON SANDSTONE.[1]

THE first detailed geologic work of importance in southern West Virginia was undertaken by Dr. I. C. White[2] in the Kanawha valley in 1884, shortly after the completion of the Second Geological Survey of Pennsylvania.

In transferring his field of activity to southern West Virginia it was natural for Dr. White to look for the same key rocks that he had so successfully used in Pennsylvania, and although the coal-bearing formations increase greatly in thickness toward the south, he identified the sandstone beds showing in the river bluffs at Charleston as the southern representatives of the Mahoning sandstone. Apparently this correlation was based on the lithologic similarity of the two formations, on the division into the same number of members by shale intervals carrying well-marked beds of coal, and on the general succession of rocks upward to the great Pittsburg coal and downward to the heavy beds of the Pottsville sandstone. These correlations of Dr. White were generally accepted, even in detail, by the people of the Kanawha valley, and all of the coal beds were definitely referred to the well-known horizons of the Pennsylvania field.

In beginning areal geologic work in southern West Virginia in 1895, the writer doubtless would have accepted the determinations of Dr. White but for the fact that he was associated with Mr. David White, who was carefully studying the fossil floras of the coal-bearing rocks contemporaneously with the progress of stratigraphic work.

As fossil material accumulated, it became more and more apparent to Mr. White that the correlations then generally accepted were not in agreement with the fossil evidence, and that in the end there would be difficulty in making direct comparisons with the type Pennsylvanian section.

[1] Published by permission of the Director of the U. S. Geological Survey.

[2] *The Virginias*, Vol. VI, p. 716, 1885; also *Bulletin No. 65, U. S. Geological Survey.*

At that time Mr. White's knowledge of the floras of the northern end of the Appalachian bituminous coal basin was based entirely upon published descriptions and a personal familiarity with the Lacoe collection. He had had no opportunity to study the Pennsylvanian floras and their geologic relations in the field and establish for himself a standard section for comparison. But notwithstanding this lack of field experience, the evidence against the identifications previously made was so strong that the writer did not feel justified in accepting the name Mahoning for the sandstone of the Kanawha valley, and proposed in lieu thereof the non-committal term Charleston sandstone.[1]

In proposing the new name the writer was aware that in case the identity of the Charleston and Mahoning sandstones were established the new name would have to give way before the old and well-known term "Mahoning," but on account of the uncertainty he preferred to use the new term and trust to future work to settle the question.

Six years have now elapsed since the name "Charleston" was introduced, and by many the question is still regarded as unsettled, but in that time Mr. White has accumulated such a mass of Paleobotanic evidence against the correlation of these two sandstone formations that there is no longer any doubt except in the minds of those who would discredit entirely the evidence of fossil plants. Although in the opinion of the writer the question is virtually settled, he takes this occasion to present some stratigraphic facts which seem to explain the apparent disagreement between the paleobotanic and stratigraphic evidence.

In order to show the bearing of the facts described in this paper it is necessary to go back and review the evidence that has been presented on the different phases of the question.

In 1900 Mr. David White's study of the fossil floras of the coal-bearing rocks of the Kanawha valley had progressed to such a stage that he published a paper on "Relative Ages of the Kanawha and Allegheny Series as indicated by Fossil Plants,"[2]

[1] CAMPBELL AND MENDENHALL, "Geologic Section along New and Kanawha Rivers, W. Va." *Seventeenth Annual Report*, Part II, pp. 473–511; also *Geologic Atlas of the United States*, folios Nos. 69, 72, and 77.

[2] *Bull. Geol. Soc. Am.*, Vol. XI, pp. 145–78.

in which he stated that the Stockton coal (so-called Upper Freeport bed of the Kanawha valley) carries a flora resembling the Clarion; that the coal bed occurring in the Charleston sandstone in the vicinity of Clendenin on Elk River contains plants belonging to the Kittanning group; that fossils from a higher horizon, but still within the sandstone beds at Clay, are found in the Freeport group of the Allegheny valley, and that the Charleston sandstone is not equivalent to the Mahoning sandstone of Pennsylvania.

These conclusions were not generally accepted. Dr. I. C. White maintained that land plants varied irregularly, and that when they conflict with stratigraphic evidence the latter should be given the preference and the former disregarded. He maintained that the Mahoning sandstone is continuous in outcrop from Pennsylvania to the Kanawha valley, and that consequently his original determinations are correct. In order to be certain of his position Dr. White again took the field and traced the outcrops of the formations in question across the state of West Virginia, and the result was the complete verification, in his own mind, of his former conclusions.[1]

In discussing Mr. David White's paper the present writer called attention to the fact that the Charleston sandstone is a complex formation composed of overlapping lenses of coarse sandstone, and that in tracing it in any direction from the type locality it is doubtful if the original limits can be identified and maintained. He also showed that this variation from point to point might easily explain the apparent continuity of the sandstone outcrop from Pennsylvania to the Kanawha valley, and at the same time allow the diagonal extension of the Allegheny floras across the sandy belt. The conditions which permit such phenomena are shown diagrammatically in the following sketch (Fig. 1) representing an ideal section of the Charleston-Mahoning sandstone from Pennsylvania to the Kanawha valley. The sandstone formation is conceived as being made up of a number of overlapping plates which gradually descend lower and lower in

[1] "Geological Horizon of the Kanawha Black Flint," *Bull. Geol. Soc. Am.*, Vol. XIII, pp. 119–26.

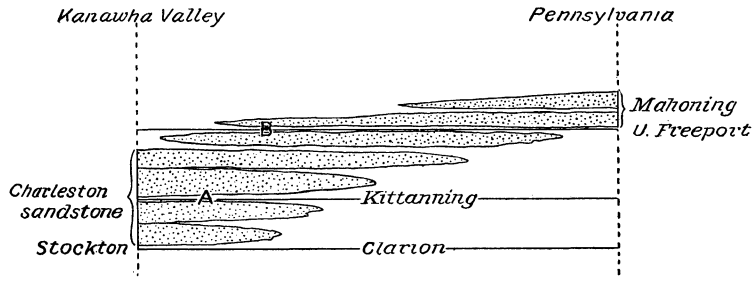

Figure 1.
Diagramatic Section of the
Charleston-Mahoning Sandstone.

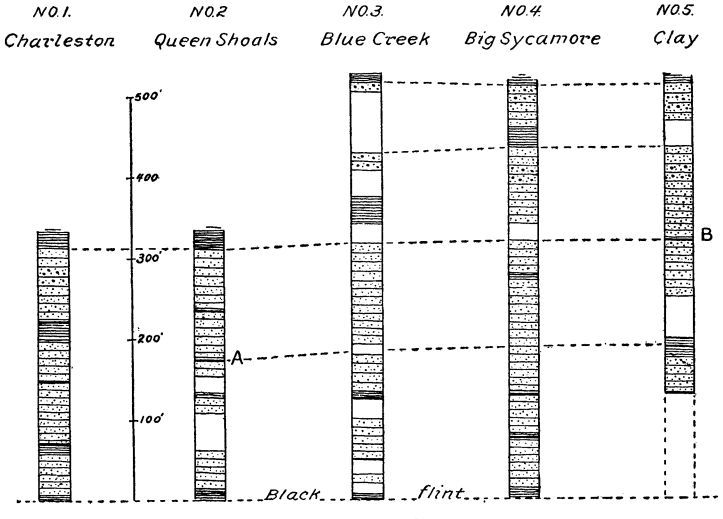

Figure 2.
Sections of the Charleston Sandstone.

the series toward the south, until it probably includes the Kittanning horizon, as shown by the fossil flora found in the coal bed (A) at Clendenin twenty miles northeast of Charleston. In support of this proposition the writer called attention to the disappearance of the uppermost bed of sandstone of this group at Sutton, W. Va., and the lowering of the upper limit south of the river by 200 feet, but this being an isolated example, was not given much weight in the discussion of the subject. Recently, however, an excellent example of the variation of these rocks has been brought to the writer's notice and incontestible evidence furnished regarding a marked change in its upper limit between Charleston and Clay. The five sections given in Fig. 2 show something of the nature of this variation, but many intermediate sections might be interpolated so as to make the transition complete.

Throughout the region the base of the formation generally is marked by the presence of a bed of black flint which occurs only a short distance above the Stockton or Lewiston coal bed that has been regarded as the equivalent of the Upper Freeport coal. This is the only bed of flinty character known in the region, and it is easily identified by its débris, which decays so slowly that it is almost always in evidence along the outcrop of the bed. The flint is a local feature covering an ellipsoidal-shaped territory, whose longer axis lies east and west, and extends from Charleston to near Summersville, in Nicholas county. In a north-south direction it is more limited, reaching only a few miles south of Kanawha River in the vicinity of Brownstown and Montgomery, and showing on Elk River in the vicinity of Queen Shoal. Toward the north and west the horizon of the flint passes below water level, but in many places it loses its flinty character before disappearing and becomes a silicious shale which cannot be distinguished from adjacent beds. Throughout the region here discussed, which lies between Charleston and Clay the flint is generally present, and it affords an ideal datum from which to measure.

At Charleston the sandstone overlying the flint has a total thickness of about 320 feet, and its general characteristics are

shown in Fig. 2. It is composed of a number of distinct beds separated by coal and shale intervals, but the sandstone greatly predominates, and the series is essentially sandy from top to bottom. It is well exposed on the south side of the river, and the section was measured on the road which ascends the bluff from the south end of the bridge. The upper limit is marked by a bed of red shale, which is well shown in this region. Above this horizon the material is generally shaly, and the few sandstone beds which appear are generally green, micaceous sands which do not resemble the buff, coarse, sandy beds of the Charleston formation.

The rocks dip gently to the northwest, and the Charleston sandstone is well exposed along Elk River, which follows the strike of the beds to the northeast as far as Sutton in Braxton county. Owing to the crooked course of the river and to the slight undulations which affect the rocks, different parts of the formation are exposed in the river bluffs at different points, but there are only a few places where the base of the series is reached and a complete section exposed. From Clendenin to Queen Shoal the rocks rise steadily eastward up the river, so that a coal bed which is near water level at the former place is by barometer about 170 feet above the river at the latter point. It is from this coal bed that most of the fossils were obtained which Mr. David White[1] has referred provisionally to the Kittanning horizon. Although only a partial section of the Charleston sandstone was obtained at this point, it is introduced to show the position of the coal bed relative to the great mass of sandstone above and below, and to the black flint which is exposed at water level at Queen Shoal. The coal agrees, as stated by Dr. I. C. White,[2] with the North Coalburg horizon of the Kanawha valley.

The base of the Charleston sandstone shows in most of the stream valleys on the south side of Elk River, and the flint is particularly well developed on Blue Creek, which is one of the largest tributaries from this region. The third section, shown in Fig. 2, was measured on this creek six or seven miles above Elk River. Above the black flint occurs a mass of sandy beds

[1] *Op. cit.*, pp. 170–73. [2] *Op. cit.*

having a thickness of over 300 feet. These are broken in a few places by shaly intervals, one of which, about 200 feet from the base, carries a coal of workable thickness. The sandstones are more massive in this locality than in the vicinity of Charleston, and the upper part of the formation is a particularly prominent feature in the topography of the region. In comparing this with the Charleston section, which is regarded as the type, it is clearly seen that the section so far described is almost an exact counterpart, but in the Blue Creek region coarse sandstones are known above the limits just given, which appear to have no equivalents in the Charleston section. The first bed shows a thickness of about 25 feet and it occurs about 100 feet above the top of the regular sandstone section; the other appears to have a thickness of from 10 to 20 feet, and it lies approximately 200 feet above the top of the regular section. The beds of conglomerate are separated by soft shale, in which reds and greens are of common occurrence. In this section it is manifest that the upper conglomerates should not be classed with the Charleston sandstone, since they are separated from it by a distinctly shaly interval.

Along Elk River, from Clendenin to Clay, the Charleston sandstone is well developed, and gives a rough and rugged topography. The fourth section, shown in Fig. 2, was obtained by Mr. Charles Butts near the mouth of Big Sycamore Creek, where the horizon of the flint appears to be near water level. It is true that the flint does not show, and it is possible that its horizon is not exposed, but all the evidence seems to point to the fact that the horizon of the flint is either at or below the grade of the railroad. Although broken by a number of thin, shaly partings, the section consists of a sandy series from near railroad grade to a height of 510 feet. The lower part resembles that found on Blue Creek and also the typical section at Charleston. At a height of 320 feet the rocks are concealed, and it is possible that there is 15 or 20 feet of shale at this point. If such is the fact, it would seem to mark the upper limit of the Charleston sandstone as known at the type locality, but lithologically the section cannot be broken at this point, for the material above is essentially the same as that below. At

a height of 450 feet there is a small shaly interval, which is overlain by 60 or 70 feet of heavy conglomerate.

In comparing sections 3 and 4, it is apparent that the great increase in thickness of the sandy series at the mouth of Big Sycamore Creek is not accomplished by the swelling-out of the Charleston sandstone proper, but by the addition to its upper part of about 200 feet of coarse sandstones and conglomerates, which are feebly represented in the Blue Creek section by thin and independent beds of conglomerate, and are not represented at all in the Charleston section by coarse material. If the three sections given above stood alone, the identity of the beds might be open to question, but in the areal work a score or more of intermediate sections were obtained which make the transition complete and incontestible.

From Big Sycamore Creek to Clay exposures are good along the line of the railroad, and continuous tracing proves that the coal bed which is at railroad level opposite Clay is the same as the coal shown in section No. 4, 125 feet above railroad grade, and occurs only a short distance below the coal bed which is mined between Clendenin and Queen Shoal.

Section No. 5 was obtained on the road which climbs to the upland back of Clay. Although broken by a few small shale intervals the section consists generally of coarse sandstones for a height of about 380 feet above railroad grade. If the section is placed according to the coal horizon, there is a very close agreement with the Big Sycamore section both in total thickness and in the detail of the beds.

Dr. White in discussing the coal outcrops along Elk River[1] correlates the Clendenin coal with a small coal bed 375 feet above Clay, or in other words about the top of section No. 5. It seems probable that this error in correlation is due to the assumption that the observed rise of the beds between Clendenin and Queen Shoal is continued eastward to Clay. In that case it is probable that the Clendenin coal would appear near the top of the sandstone series, but the eastward rise is an assumption which is not in accord with the facts. A broad anticline in

[1] *Op. cit.*, p. 125.

the great northward bend of the river carries the coal high in the hill slopes at Queen Shoal and then allows it to descend to near water level at the mouth of Little Sycamore Creek. The writer is very willing to testify to the general accuracy of Dr. White's work, but he is not willing to have the evidence of fossil plants impeached in the eyes of the public by stratigraphic evidence of this character.

According to fossil plants the Clendenin coal probably belongs to the Kittanning group and the plants collected near Clay[1] from a horizon about 300 feet above the flint are related to the Freeport flora. Although Dr. White calls these two beds the same, a glance at the accompanying sections shows that the stratigraphic evidence is against such a correlation, and that the plant-bearing bed of Clay is distinctly above the Clendenin coal; therefore the latter may be the representative of the Freeport group, if the Clendenin coal belongs to the Kittanning horizon.

A comparison of the sections given in Fig. 2 shows clearly that the observed increase in thickness of the sandy series in the direction of Clay is not due to the great expansion of the formation, but to the addition of coarse conglomeratic members to the top of the original section. These extra members appear first as thin beds of conglomerate in shaly material above the Charleston sandstone proper; they thicken gradually to the east, and finally merge not only with each other, but also with the underlying sandstone formation.

This gives a distinctly sandy series at Clay, which can be traced continuously in outcrop to Charleston, but which manifestly does not represent the same time interval as the Charleston sandstone at the type locality. The uppermost bed at Clay is very much younger than the uppermost bed at Charleston, and if similar changes occur north of Clay, it is possible for the sandstone to be as young as Mahoning on the Pennsylvania line.

The variation in the sandstone between Charleston and Clay appear to be limited to its upper part, but beyond the latter place the writer feels assured that a similar change occurs at

[1] DAVID WHITE, *op. cit.*, pp. 170–73.

the base of the series, except in reverse order as shown in Fig. 1.

If the writer has observed correctly (and the facts seem to be beyond question), it is possible for Dr. White to trace sandstone in outcrop from the well-known Mahoning of Pennsylvania to the Charleston of the Kanawha valley, but that does not necessarily mean that they are of the same age. Dr. White contends that he has traced the coals in a similar manner, but from the great difficulty in tracing coal beds and in identifying their outcrops from place to place, the writer declines to accept this sort of evidence when in conflict with that afforded by the sandstone beds and the fossil plants which accompany them.

MARIUS R. CAMPBELL.