ART. XXXIV.—*The Conglomerate Series of West Virginia;* by WILLIAM M. FONTAINE.

IN the May and June numbers of this Journal for 1874, I gave some account of the strata which, on New River, West Virginia, underlie the massive sandstone exposed at the Falls of the Kanawha. This account was necessarily imperfect, since at the point examined the base of the series was not exposed, and the exposures were very unfavorable for a detailed examination.

During the past summer I revisited this field, and made further examinations, at points more to the east, with such success that I am now able to present a detailed section of this field. Since the white sandstone of the Falls is the equivalent of what is everywhere called "the Conglomerate" of the Coal Measures, it might to some seem more fitting to call the rocks in question "Sub-conglomerate," or "Lower Carboniferous." In West Virginia, the strata which occupy the interval between the floor of the productive coals and the Devonian, are so greatly expanded, and so much diversified, that these terms are not definite enough to distinguish them. Besides, this New River system occupies precisely the horizon which is elsewhere commonly filled by conglomeritic sandstone alone, lying, as it does, between the red shales of the Umbral, and the lower productive coals. For these reasons I prefer to use the name "Conglomerate Series" for it. For like reasons it will be necessary to retain the names "Vespertine" and "Umbral," of the first Pennsylvania Survey, in describing rocks equivalent to those bearing these titles in the above named survey. A single instance will show this necessity. The system about to be described contains important coals. We find also far below them, in the Vespertine of Montgomery County, Virginia, near the White Sulphur, West Virginia, and elsewhere, well developed coals. To call these Sub-conglomerate or Lower Carboniferous coals would fail to distinguish them.

In my second visit to this region I made a re-examination of the strata at Sewell Station, the point at which most of the facts given in my first paper were obtained. In this last visit I found the strata quite well disclosed in the cuttings of the "Incline," made since my previous inspection. I also made a careful and detailed examination of the same strata at Quinnimont, a point on the Chesapeake and Ohio Railroad, distant by railroad twenty-one miles to the east of Sewell Station, but about ten miles by air line.

While the base of the series is not exposed at Sewell Station, yet, owing to the fact that the westerly dip is more rapid than

the fall of the river, even the underlying Umbral red shales are fully disclosed, and the entire series in question is contained in the lofty hills at Quinnimont, while in their summits they still retain a small remnant of the lower productive coals, with one and sometimes two coal beds.

While making my examination at Quinnimont I received valuable aid from Mr. S. F. Morris, C. E., and I take this opportunity to make my acknowledgments to him. Mr. Morris had, by levelling, determined the height of many points, and examined the character of the strata around Quinnimont, in behalf of the company owning the furnace and coal mine at that point. The data which he kindly put at my disposal were of great assistance in checking my own observations.

During the same summer I also made an examination of the country to the east of the Quinnimont, especially that portion in the vicinity of the White Sulphur Springs, Greenbrier County. It will perhaps be well to give here some of the facts thus obtained, bearing on the general geology of the region, in order more clearly to define the relations of the series to be described in this paper. In order to do this I will commence at the east and proceed west along the line of the Chesapeake and Ohio Railroad, whose general course is across the strike of all the strata underlying the rocks in question.

We may for a clearer exposition commence at Lewis Tunnel, a point six miles east of the White Sulphur. Here we find Vespertine strata which run in a narrow belt along the east face of the main Alleghany range, and contain the small coal beds, and plant-bearing shales, found near the Tunnel. The main range and the country westward for twelve miles is occupied by highly disturbed Devonian strata, mainly Hamilton, Portage, and Chemung, with probably the Catskill group. In the center of this belt the Springs are situated. Six miles west of the Springs, we find, on the east side of a small creek, highly contorted Devonian strata, and on the west side within 100 yards, the upper portion of the Vespertine, dipping gently eastward toward the contorted Devonian. Just above the Vespertine, in the hill across this stream, the base of the Umbral or Lewisburg limestone may be seen. The contortions and other evidences of great disturbance which follow us from the east up to this point now cease, and throughout the wide belt of country lying between this point and the Ohio River, the strata undulate more and more gently, until before Quinnimont is reached the rolls cease to reverse the dip, but serve to keep the strata longer at the surface than they would otherwise remain in that position.

This sudden change in structure is not found here alone, although it seems to be more marked here than elsewhere. It

may be traced far to the southwest, and probably to the north, and is to be explained by the existence of a fault, apparently the most westerly of the system affecting the Appalachian Region in this quarter. The development of this fault seems to have, in a great measure, relieved the strata lying to the west, from the disturbing force which so highly affected them on the east and it is not necessary to suppose a gradual dying away to the westward of the lateral thrust from the east. The conditions seem to imply a certain amount of unconformability between the Devonian and Vespertine, which is not incompatible with other facts observed here.

Proceeding westward along the line of the railroad from the fault, the gentle rise of the Vespertine to the west brings into view its middle or coal-bearing portion, here also containing small coal seams. This is in the vicinity of the bridge over Greenbrier River, and explains the presence near this stream, of the coal seam mentioned by Prof. Wm. B. Rogers in his reports. The Vespertine as it crosses the stream passes into a low anticlinal, which, west of the river, finally brings down the Umbral limestone to the level of the railroad. This position it maintains for a long distance, as far as Great Bend Tunnel, near the mouth of the Hungert's Creek, Summers County, where it dips under the red rocks of the Umbral series, which in this district are greatly developed. The Umbral series seems to possess a threefold character, being at bottom blood-red shales and sandstones, in the middle, grayish, bluish and brownish sandstones and shales, mainly the former; and at top brownish sandstones, blood red and varigated shales. The shales throughout the series have the texture of marlites, and the sandstones, although chiefly argillaceous are sometimes highly siliceous, forming huge cliffs along the railroad, as seen near Richmond Falls. These three series, the Vespertine, the Umbral limestone, and Umbral shales and sandstone, thicken rapidly in proceeding from northeast to southwest. Prof. Rogers measured them in Greenbrier Mountain, Pocahontas County, a point about sixty miles northeast of Richmond Falls on New River, where the Umbral shales and sandstones are extensively exposed. With respect to the limestone I have no data for comparison but the indications are that on the railroad it is thicker than the measurement given by Prof. Rogers, viz: 822 feet. For the Umbral shales and sandstones in Pocahontas he gives a thickness of 1,310 feet. My estimates along the line of the railroad, which, however, have not the accuracy of measurements, give for this series a probable thickness of 1,450 feet in the vicinity of Richmond Falls, distributed as follows: 1. Lower red shales and sandstones, 320 feet; 2. Middle gray and greenish sandstones, 820 feet; 3. Upper red and variegated shales, 310 feet. If we com-

pare this series with the character of the Umbral in the vicinity of Blossburg, as given by H. D. Rogers, we find an almost identical distribution of similar strata. The upper portion of the Umbral continues to be shown up to a short distance west of Quinnimont, where the prevailing westerly dip takes it out of sight. These upper strata form the base of the hills around Quinnimont, contrasting strongly in all their physical features with the overlying conglomerate series. This latter, whose entire thickness lies above the level of the river at this point, gradually sinks as we pass west, down stream, being kept above water level for a long distance by several broad rolls. It finally passes out of sight two or three miles below Kanawha Falls, and is succeeded by the series of the Lower Productive coals in the Kanawha Region. In this latter series there is a four-feet bed of coal, about forty feet above the massive sandstone which closes the conglomerate series. This is the equivalent of coal B of Lesley. This bed still remains uneroded in the tops of some of the high hills around Quinnimont.

About two miles down the river, on the Raleigh County side, Piney river empties into New River. A well graded road from the mouth of this stream, passes over the outcropping edges of the entire conglomerate series, and the numerous cuttings made in grading afford excellent exposures of almost every member of the series throughout its entire thickness. My section was made along this road. It was verified by a second section taken at Quinnimont by another road, which also passed over the entire series. These two sections were compared with observations made at Sewell Station, and with measurements made by Mr. Morris. The data in the cases in the section, marked as not seen, are given on the authority of this gentleman. The dip is northwest about fifty feet to the mile.

Section from the mouth of Piney River, Raleigh County.

21. Upper conglomerate, 150–200 feet.
20. Black slate, with thin coal partings, coal not seen, 10 feet.
19. Olive gray sandstones and shales, 100 feet.
18. Dark blue slates and sandstones, 80 feet.
17. Quinnimont coal seam, or coal No. 9, consisting of semi-bituminous coal, 4 feet; fire clay, 2½ feet; and at bottom, splint coal, 14 inches, =8 feet.
16. A thick mass of rocks not fully exposed, which may be divided as follows: 16 *e*, olive gray shaly sandstones, 40 feet; 16 *d*, coal 8, not seen, given as 20 inches thick; 16 *c*, bluish sandy shales, 60 feet; 16 *b*, coal 7, not seen, given as 2 feet thick; 16 *a*, gray sandstone, 50 feet. Total, 154 feet.
15. Fire clay and a 12-inch outcrop of coal, seen imperfectly exposed, given as 2–4½ feet of imperfect splint coal, coal No. 6, =2–4½ feet.

14. Coal system; at bottom interstratifications of coal and slate, with one seam one foot thick; (coal No. 5), and on top, flags passing into firm sandstones. Good plant impressions occur here. Thickness, 80 feet.
13. Olive marlites, 40 feet.
12. Massive firm gray sandstones, 50 feet.
11. Coal No. 4, not fully exposed, given as 2½ feet thick.
10. Firm gray flags and sandstones, 90 feet.
9. Coal system, coal No. 3; at bottom interstratifications of thin coals and strata; on top, shales, flags and sandstones, 80 feet.
8. Gray sandstones, 75 feet.
7. Ferruginous limestone, 2 feet.
6. Variegated marlites, 40 feet.
5. Bright red shales and marlites, 30 feet.
4. Coal system, coal No. 2, consisting of coal 8 inches, slate 2½ feet, coal 8 inches, sandstone 8 feet, and at bottom coal and slate 1 foot; total =13 feet.
3. Olive and reddish sandstones, passing below into olive marlites, 100 feet.
2. Black slate, not seen, said to contain 18 inches of coal, (coal No. 1), given as 11 feet thick.
1. Lower conglomerate, 80 feet. Total =1,197 feet.

Under the lower conglomerate is found a transition series, of which the following is a section determined mainly at Quinnimont, where the strata are more fully exposed.

Transition Series at Quinnimont.

2. Black fissile slates and shales, 20 feet.
1. Thinly laminated gray flags and calcareous shales, with drifted leaves of Lepidodendra near the base; and near the top having numerous impressions of marine shells, while at the top it passes into carbonaceous shales with strings of coal, leaves of Lepidodendra and other impressions too much obscured for determination, 50 feet. Total =70.

To complete the section of the strata exposed in the vicinity of Quinnimont, I give below a section of so much of the Umbral series as is to be seen there.

Section of the Umbral Series at Quinnimont.

3. Variegated marlites with some nodular limestone, 70 feet.
2. Gray calcareous sandstone, 20 feet.
1. Bright red shales, seen 50 feet. Total =140 feet.

Some of the above mentioned strata merit a more particular description, which I will now give.

I make in this place no further mention of the remnant of the Lower Productive coals found in this vicinity, but refer to my former paper, where some account was given of their

character as found in the Kanawha Valley. It is not known how much farther east they extend, but it cannot be to any considerable distance. No. 21 of the conglomerate series is the only persistent member. As it is found everywhere throughout the Appalachian Coal Field, being in many places the sole representative of the series, and as it is always at a uniform distance below the lowest workable coal-seam of the Lower Productive coal it would seem to been titled to be called, as it has been, "The Conglomerate of the Coal Measures." In Raleigh County, and along New River, it is usually a coarse white sandstone, with some conglomeritic portions in its middle and upper parts. In its lower portions it is more flaggy and argillaceous. It varies in thickness from 150 to 200 feet. In the section I have in my summation taken it at the lower figure.

No. 20, near Piney River, shows at its outcrop only black slate. It has been opened near Quinnimont, and is said there to contain thin strings of coal. Nos. 20, 19, and 18, have no features of special interest.

No. 17. This is the coal-seam which is worked extensively at Quinnimont, where it is coked and used in the furnace at that place. It is the most persistent and best developed seam of the series, being easily recognized everywhere in this region by its peculiar structure. From the flaggy sandstones over this bed at Sewell Station were obtained the plants of Devonian type mentioned in my former paper. At Quinnimont I could find none of these, and it is there remarkably free from plant-impressions of all kinds. In Raleigh also it showed no plants. At Sewell Station, this seam was at first opened for the purpose of working it, but was soon abandoned, owing to an apparent thinning out which was in fact caused by a slide.

No. 16, on the Raleigh road, was not fully exposed owing to slides, which also obscure its outcrop at Quinnimont. It presents the subdivisions founded on the character of the sandstones given in the section, but the coal beds are given on the authority of Mr. Morris, and others, who claim to have opened them. I have no doubt of their existence, for at Quinnimont the black slate accompanying 16 *d*, or Coal No. 8, was seen.

No. 15 was only partially exposed at its outcrop on the Raleigh road. Next to the Quinnimont seam, it appears to me to be the most promising seam of the field. The fire-clay is of fine texture, and sharply distinct from the coal, features not usually seen in the coals of this series.

No. 14, (Coal 5.) This presents in a marked manner a feature very common in this field. The coal at its base exists in the form of numerous interstratifications of coal in thin partings, and black carbonaceous shales; the whole being topped by strata which become more and more siliceous, and firmer as they ascend. There is enough carbon diffused through the

base of this mass to make an important bed of coal, were it collected in one mass. The condition of things here shown indicates that there was no deficiency of vegetable matter, but that the alterations of level were too rapid to permit a great accumulation of coal in one mass. The same features to a greater or less extent are shown in every coal bed of the series, and it is safe to say that the instability alone of the surface, prevented the accumulation, in this series, of coal beds as thick as those found in the more productive series which lies above it. Many good plant impressions occur here.

No. 11, from its outcrop, seems to be a promising bed of coal. Its thickness was not fully disclosed. Mr. Morris gives it as two and one-half feet thick. It shows at its base Stigmaria rootlets.

No. 10, stands out in high cliffs. Some of the other sandstones of the series also present firm perpendicular outcrops.

No. 9, is well exposed on the road in a high cliff. It presents the same features as number fourteen, even more strikingly. Numerous thin seams of coal, intermixed with carbonaceous shale, some of them three or four inches thick, form the lower portion for a space of seven feet. Vegetable matter in the form of films of coal, and impregnations of the sandstones and shales, occur to the height of thirty feet. Only a few Lepidodendron leaves were found here.

No. 8, is a massive and siliceous sandstone, forming high cliffs, and resembling to some extent No. 21.

Nos. 6 and 5, are interesting for the recurrence here, in the middle of this coal-bearing series, of the same conditions which prevailed in the formation of the upper part of the Umbral series. These two strata are most strikingly like the red and variegated marlites and shales, found in that portion of the Umbral, and might easily be mistaken for them.

No. 4, is well exposed on the Raleigh road. No plants were found in it.

No. 2, is not exposed anywhere so far as I have seen. The interval occupied by it, lies between the massive rock, No. 1, and the crumbling strata of No. 3, which are especially prone to slide down over the precipitous cliffs formed by No. 1. Hence at all the places examined by me, this portion was buried under a mass which had come down from above. Its character is given on the authority of Mr. Morris.

No. 1. This member of the series I consider to be the base of the conglomerate series. It is one of the most prominent features in the hills, standing out as it does, not far above their bases, in immense precipitous ledges. It forms the first stratum, which indicates a decided change from marine to terrestrial conditions. It is much nearer a true conglomerate than No. 21, for many of the layers contain pebbles, a half inch in diameter.

It is usually a coarse, open-grained, purely siliceous sandstone, lying in very thick beds. Near the bottom it is brownish in color, but above it is white, having many ferruginous stains. In many parts of this sandstone, particles of carbonaceous matter, in the condition of charcoal, are seen, produced from drifted fragments of trunks and limbs of trees. This condition of the vegetable matter is no doubt due to the ready escape of the bituminous matter from the porous sandstone. Sometimes pretty large angular fragments of the brown sandstones of the Umbral are found associated with these fragments of trees, and in some cases the pebbles of the conglomerate portions are of limestone. This rock is no doubt the heavy sandstone mentioned by Professor Rogers as found some distance to the east of this point, forming the summit of Little Sewell Mountain.

Underlying this rock is found a series of beds which are evidently the products of a period of transition. They are well exposed near Quinnimont, and exhibit some interesting features. No. 1 of this series is a thinly-laminated, argillaceous, gray sandstone in its lower part, but becomes more and more calcareous toward its upper portion, where numerous impressions of shells are found, a list of which will be given farther on. At its summit, which is not seen at Quinnimont, but is well exposed on the Raleigh road, there is a good deal of vegetable matter mixed with the shale, and which is the product of plants which have grown on the spot. This is the lowest indication of an attempt at coal formation, seen in this region. From the indications, there is little doubt that in some places this horizon may show a little coal. Professor Rogers mentions that near the top of Little Sewell, and immediately over the red shales of the Umbral, he saw a small coal-bed. It is no doubt the stratum now described. The other strata given in the sections above present no points of interest.

From this account of the coal-bearing series in question it will be seen that it occupies the horizon of the so-called "Coal-measures Conglomerate," and it would seem to be simply a greatly expanded portion of this widely extended formation. Lying between two huge plates of massive sandstone, either of which has equal claims to the title of conglomerate, the name which I have given it seems justified.

Almost no exploration has been made in the country to the east of Quinnimont, and hence the limits in that direction of this series cannot be given. That it does extend farther east is known. Since my inspection last summer, I have been informed that a five-foot bed of coal is found near Hinton, 800 feet above the level of the river. Hinton is near the mouth of Greenbrier river, about fifteen miles farther east than Quinnimont, measured in an air-line across the strike of the strata.

To the southeast and south, it is found in the counties of

Wise, Russell, and Tazewell, as may be seen from the account of these counties given by Professor Lesley, in his paper read before the Am. Phil. Soc., April 21, 1871. Professor Lesley shows that under the so-called "Sheep Rock" in Wise county, about 700 feet of coal-bearing rocks are disclosed, with the base not shown. The "Sheep Rock" is No. 21 of the Piney River section. In this space two coal beds are to be seen; one, a six-foot bed, lies at the very base of the hills, and the other, a two-foot bed, is a short distance above it. A similar formation exists in Russell and Tazewell counties. These coals are not to be confounded with the beds seen in Montgomery county, for the latter are found in the Vespertine strata, and are of the same age with those near the White Sulphur in Greenbrier county. The basin, in which these conglomerate coals were formed, evidently extended still farther east than the counties described in Professor Lesley's paper, as the considerable development of this series in them shows. But in the more easterly extension of the field, the number of seams have diminished, especially in the upper part. On New River in Raleigh county the most important coals are found within 700 feet below the upper ledge.

As we proceed northward, along the eastern outcrop of the series, it has been more extensively affected by erosion, and has been swept off from the greater part of Monroe and Greenbrier counties, these being occupied mainly by the Umbral shales and limestone. Professor Rogers mentions finding at the top of Greenbrier Mountain, in the northeast part of the county of that name, a massive sandstone resembling the conglomerate. This is no doubt a remnant of the series. North of this point, in Rich Mountain, in Randolph county, the entire series is presented, capping the mountain, according to Dr. Stevenson. But here it has undergone an important modification, from the loss of the shaly central portion, and the almost entire disappearance of the coals.