Mining and Metallurgical Section.

Stated Meeting, held January 8, 1902.

The Anthracite of the Third Hill Mountain, West Virginia.

By William Griffith, Mining Engineer.

SITUATION.

The Third Hill and Sleepy Creek Mountains are located in Berkley and Morgan Counties, West Virginia. They extend nearly north and south (N. 25° E.), the northerly end being about 13 miles west of Martinsburg, 7 miles east of Berkley Springs. Sleepy Creek Station, on the Baltimore and Ohio Railroad, is the nearest point by rail, being three or four miles north of the northerly end of the mountains, while Cherry Run Station (the junction point of B. & O. R. R. and Western Maryland R. R.) is 6 miles distant. This station is 124 miles by rail from Baltimore, 84 miles from Washington, 68 miles from Cumberland, 18 miles from Hagerstown and about 200 miles from Pittsburg.

TOPOGRAPHY.

As before stated, these mountains extend southward from near the Potomac River, having general direction of about S. 25° W. and are nearly parallel, being separated by the valley of Meadow Branch, which rises near the southerly end of the valley on the slope of Middle Ridge (a hill which gradually rises from the center of the valley, and increasing in height southward unites the two mountains). From Middle Ridge the Meadow Branch flows northward and empties into Sleepy Creek, a stream of considerable size, which drains the valley lying west of Sleepy Creek Mountain. The Back Creek Valley to the east of Third Hill is drained by Back Creek and its tributaries, and flows also into the Potomac west of Martinsburg. A good idea of the relative positions of these mountains can be obtained.
from the sketch map by noting that their general outline somewhat resembles a fish, Sleepy Creek Mountain forming the back, Third Hill the belly, and Middle Ridge uniting the two at base of the tail. Their southern extension, including Brush Creek Valley, forms the tail, while the nose and mouth are formed by the north end of Sleepy Creek Mountain and Short Mountain, the latter being a detached portion of the north end of Third Hill.

The crests of Third Hill and Sleepy Mountain are about 1,000 feet above the general level of Sleepy Creek and Back Creek Valleys and about 500 feet above Meadow Branch Valley, which latter, at Tom Meyer's, 11 or 12 miles south of the B. & O. R. R., is 600 feet higher than Sleepy Creek Station.

The coal beds, which are the especial object of this paper, are found in the rocks which flank the east side of Third Hill. At the southerly end, i.e., near the fish's tail, the outcrops are near the crest of the mountain; but to the north the rocks containing them gradually separate from the main hill, forming Short Mountain, above mentioned. The space between Short Mountain and the main ridge is occupied by soft red shales, forming a sort of valley, in which several mountain streams have their source, which have cut channels or passes through Short Mountain, thus dividing it into a chain of short ridges lying end to end, parallel to Third Hill proper, and as the crests of these ridges are formed by the hard and almost vertical strata in which the coal is found, it will be seen that the coal outcrop runs lengthwise of the highest crest of Short Mountain and across the passes through which the Cherry Run and other brooks flow, as above mentioned, and that the coal beds are very accessible by water-level drifts lengthwise of the vein from the creek beds.

GEOLoGY.

A knowledge of the geology of this region is of the utmost importance in determining the value of the Anthracite coal in Third Hill; for if we know positively their geological position, we have gone a long way toward
determining their economical value. The following ideal cross section will serve to illustrate:

In the first place, we find that both Sleepy Creek and Back Creek Valleys are occupied by the soft red and yellow shales and black slates of the middle and upper Devonian measures, the lowest rocks of the series being in each valley farthest from the mountains in question, while the highest rocks of the Devonian Age (the red shales of the Catskill group, or No. IX of Pennsylvania Geological Survey), are found flanking the west slope of Sleepy Creek Mountain and the east slope of Third Hill. The crest of both of these mountains is formed by a ridge or spine of hard white and gray sandstone, being the lowest rocks of the sub-carboniferous or Pocono measures, and these same rocks form the mountain-sides sloping down to Meadow Branch.

The rocks in the crest and in the east flank of Third Hill and the Black Creek Valley are overturned or inverted, as shown by their decided dip to the east, while in Sleepy Creek Mountain and Valley the rocks are regular and dip also to the east. Thus we see that the two mountains are formed by a long, narrow, canoe-shaped trough or basin of hard Pocono sandstone, resting upon the soft red rocks of the valley. And it is through this basin that Meadow Branch flows, breaking its way through a precipitous gorge at the northerly end.

Now, while there are coal openings on the west side of Meadow Branch in a number of places, those in Third Hill are particularly interesting in this paper, and we will confine ourselves to the developments along its crest.

Anthracite coal has long been known to exist in Third Hill, and in fact has been found far to the southward and also to the northward in the same general range of Pocono rocks at various places. At Third Hill, however, more than any other one locality, the coal has been proved by many test-pits dug into the outcrop along the crest of the mountain for 12 or 15 miles, and while these provings have been very alluring to prospectors, and considerable time and money has been spent, both in shafting and boring with
diamond drills, as yet no coal beds have been found of sufficient value to warrant the expense necessary for their development. The true carboniferous formation, which includes the productive coal measures of Pennsylvania and West Virginia, are much higher in the geological series of rocks than the Pocono (in which the coal in question is found). And in Pennsylvania no Anthracite coal of workable thickness has ever been found in the Pocono rocks. It is true that in a few localities, notably in Kentucky and Tennessee, and in one or two special points in Pennsylvania, bituminous coal is mined in the low or carboniferous measures. At the same time, these beds are not so regular as to thickness and are more subject to faults and disturbances, and, consequently, are more costly to mine than beds of the true carboniferous age. As a rule, when bituminous coal exists, the measures are not much disturbed or distorted, and the coal lies flat or on moderate dips, very much as originally deposited; while in the case of Anthracite coal, the conditions are quite different, as it only occurs in highly disturbed measures, where the coal (originally supposed to have been bituminous) has been coked or distilled under the heat and great pressure, due to the distortion of the rock formation in which it exists. The Anthracite beds of Pennsylvania are therefore found to contain more slaty refuse and are more subject to faulty squeezes, crushed coal, etc., than the bituminous beds of the same age. Again, the Pocono rocks are known to be false-beded and much more irregular in their stratification and more liable to faults, crushes and other irregularities, than the rocks of the true coal measures.

As a result of the above facts and the known geological position of the beds of Third Hill, in connection with their steep dips (usually inverted) and the evident distortion and folding of the measures, we must expect to find the coal beds more or less crushed throughout the region, and in much the same state as the crushed and faulty coal of the Pennsylvania Anthracite beds. In addition to this, the beds would probably be found more irregular and erratic as to thickness and continuity, existing more or less as "pockets,"
and very uncertain as a basis upon which to make a large investment of capital necessary to development for railroad shipment.

The provings noted on Third Hill were made many years ago, the most recent provings west of Shanghi and near the source of Cherry Run, and it was impossible to get fresh samples of coal from the seam for analysis or tests. It is reported that a number of wagon-loads of coal were hauled away from the various shafts and sold, and found to give very good satisfaction as fuel, and apparently equal to Pennsylvania Anthracite. Analyses of fresh coal have been shown me, which average about as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile matter</td>
<td>10%</td>
</tr>
<tr>
<td>Fixed carbon</td>
<td>84%</td>
</tr>
<tr>
<td>Ash</td>
<td>6%</td>
</tr>
</tbody>
</table>

From this we should take the coal to be a semi-Anthracite, free-burning, white ash, approaching in quality the coals of Shamokin and Bernice, Pa., which are classed as Anthracites. It is probable that the above analysis is from picked samples of pure coal, and that the average of the vein would show much higher percentage of ash, owing to the bony coal and slate which would remain intermingled with it, even after careful preparation. The coal does not yield readily to the influence of the atmosphere, as is shown by the good condition of coal exposed ten or fifteen years at the proving shafts.

The rocks of the mountain in the south end, where the recent Shanghi provings were made, are much disturbed, and the coal bed in the proving shaft is inverted and the coal badly crushed.

At this point a distinct basin is found in the hard Pocono rocks near the crest of the mountain. This basin is about 500 feet wide, and shallow. The proving shaft was about 8 feet square, 50 or 60 feet deep, and sunk in the coal outcrop on the east margin of the basin. The writer was lowered into the shaft by means of a bucket and rope attached to the hoisting engine, and found the coal bed—which was supposed to be about 10 feet thick—much
crushed and faulty, as has before been mentioned, and practically worthless. Near the bottom of the shaft the bed seemed to be parted by layers of fire-clay or slate, and in worse condition than at the top. This shaft was shortly afterwards abandoned.

On the western outcrop of this narrow basin the rocks were regular, dipping to the east about $40^\circ$. A short tunnel had been driven westward into the hill, cutting a bed of coal about $2\frac{1}{2}$ feet thick. The writer examined this vein, after having the tunnel cleaned out, and found that though the dip was regular and bed right side up, the coal was in much the same condition as in the shaft; and that while a small quantity had evidently been mined out and used locally by the farmers in the valley, the bed was virtually valueless for general development.

Previous to sinking the shaft above mentioned, much money had been spent in driving a tunnel horizontally into the east flank mountain, about half-way down, all the way through red rocks of No. IX, in hopes of cutting the vertical coal bed 200 or 300 feet below the surface. The tunnel (about $7 \times 8$ feet) was driven several hundred feet into the mountain, and at its end diamond-drill holes were bored horizontally 100 feet or more, until the water-pressure forced the drills out and stopped the future progress of the work. This tunnel would not cut the coal if it had been extended clear through the mountain, as it was probably far below the bottom of the shallow basin containing the bed. A diamond-drill hole had also been bored in top of the mountain, but outside of the coal basin.

As noticed above, as we go north from the Shanghi provings, the ridge containing the eastern coal outcrop gradually separates from the main ridge, and if the same basin-structure is maintained it becomes wider and deeper, allowing an area of red shale between Short Mountain and the main range, as priorly noted, and permitting the coal to cut down as low as the bottom of the lowest creek beds in the foothills near the valley. At the provings north of Shanghai the rocks seemed to be more regular, in some places vertical or with slight westerly dip, and not being inverted, owing
perhaps to their being higher and nearer to the summit of the overturn. The coal, except on the dumps, which had been taken from the shaftings, showed slightly better fracture, though much crushed and faulted. Further to the northward, in the vicinity of the lands near the head of Cherry Run, about the same conditions are found, the strata dipping about $80^\circ$ to the eastward and inverted. The outcrop has recently been cut by a drift on the north side of Cherry Run Gap of Short Mountain, and more recently at a shaft in the gap southwest of Norrington's peach orchard. This shaft is about 5 x 8 feet, and it is said to be over 50 feet deep. Coal was struck about half-way down, and it is said to be about 4 or 5 feet thick. A number of tons were sold to the farmers nearby for upwards of $4 per ton, and was pronounced of satisfactory quality. Although this shaft was filled with water—and we were not permitted to examine the coal in places—we were able to judge of its structure and condition by the heap of coal, dirt, etc., still piled near the top of the shaft. It is unquestionably in the same crushed and faulted condition as found at every other point in the region where openings have been made.

As to the thickness and general condition of the coal in the beds north of Shanghi I cannot say, except from inference, as all the openings were long since filled. We noticed, however, that the pieces of slate exposed on the dumps had not the flat, laminated structure of the interstratified slate of the Pennsylvania Anthracite beds, but had the same shape and crushed appearance that characterized the coal, and was hard to distinguish from the coal, except by its greater weight or by breaking. This fact is an indication of the crushed, faulty condition of the beds, and of the great pressure to which they must have been subjected, as it is evident that the pressure was sufficient to crush not only the coal but the slate also, and force it out of its true stratified condition. The slate carries considerable iron and is much heavier than coal. Owing to this fact, it could be readily separated from the coal by the process of jiggling common in Pennsylvania Anthracite regions. The writer had a proving-hole dug into the outcrop of a bed of coal in
Meadow Branch Valley, west of Tom Meyer's house, and found a 3½ to 4-feet thickness, lying in good position between regular dipping rocks, but the coal was of the same crushed and slippery character referred to above; and while the coal would probably burn good, the crushed condition would cause an excessively large percentage of fine coal, such as pea, buckwheat, and dust, which would much reduce the market value of the product, as would also its soft and friable nature; on account of which it could not stand much handling, but would readily crumble, causing much fine culm and waste.

Our investigations of this curious coal field have led us to regard the coal beds of Third Hill as a sort of natural curiosity or geological freak, and, owing to uncertainty as to thickness and continuity, and probable unreliable or "pockety" and faulty nature of the beds, their economical value is small. There can be no doubt that the above-described crushed condition of the coal beds extends throughout the region, including the deeper parts of the seam, far below the surface, as well as near the outcrop. Of course, if the coal beds in Third Hill were proved to be 3 or 4 feet thick or more, continuous and reliable, the large investment required to develop for railroad shipment would be justifiable, notwithstanding the crushed condition of the coal, for the location, excellent railroad facilities, and good market, at high prices, would go a long way toward counterbalancing the loss due to poor fracture or faulty coal. But to attempt to prove the reliability of these seams as to thickness, continuity, etc., would require a considerable expenditure, which would, in the writer's opinion, be very likely to result unfavorably.

SULPHURIC ACID BY ELECTROLYSIS.

Mr. Clinton Paul Townsend, in the Electrical World and Engineer, says: "Faraday and a host of subsequent experimenters have investigated the electrolytic oxidation of sulphur dioxide in aqueous solution, and have found that under normal conditions one-half the oxide undergoes oxidation to sulphuric acid at the anode, the remainder appearing as sulphur or sulphureted hydro-