# COAL AND LIGNITE.

## COAL ON DAN RIVER, NORTH CAROLINA.

By R. W. STONE.

### INTRODUCTION.

On maps of the coal fields of the United States there is shown in the northern part of North Carolina a narrow belt in the Piedmont Plateau which is called the Dan River coal field. Although this small field has been known for nearly a century there is no record of coal produced from it.

Triassic sedimentary rocks extend from a point just north of the Virginia line southwestward along Dan River through Leaksville, Madison, and Walnut Cove to Germanton. High-grade coal has been found at several places in a bed ranging from a few inches to a foot thick. This fact and the belief among people in the district that black shale is a sign of coal and if followed far enough under cover will lead to coal have caused more or less extensive prospecting of the outcrop at favorable places. A bed of bright black flaky carbonaceous shale, several feet thick near Walnut Cove, has excited some interest from its promising appearance, but as it usually carries over 40 per cent ash it has no present value as fuel.

About 1907 a citizen of Winston-Salem, N. C., spent several thousand dollars in sinking a shaft on this carbonaceous bed and in a diamond-drill hole at Walnut Cove. His failure to find a workable bed led to a request for information from the United States Geological Survey as to the probability of the existence of coal in merchantable quantity near Walnut Cove. In order to comply with this request the writer spent six weeks in the field during March and April, 1910. In the course of an examination of the coal resources a stadia traverse of the main roads from Germanton to Leaksville at 1 :31,680 scale was made by means of a 15-inch planetable. Mapping was not carried farther because coal had not been found east of Leaksville. Coal prospects also were located by stadia traverse. The plan of the town of Spray was reduced from a drawing loaned by Mr. B. F. Mebane.

The accompanying map (Pl. XI, p. 164) is a one-half reduction of the original work.

All known exposures of coal in prospects and natural or artificial outcrops were examined, and a number of pits were reopened. J. Luther Mitchell, of Walnut Cove, superintended the excavating and assisted as rodman.

This examination led to the conclusion that there is no reason for expecting to find commercially valuable coal beds in the Dan River district. The beds of semianthracite are local lenses of small lateral extent and only a few inches thick. The thick bed of carbonaceous shale is valueless. It is useless, therefore, to expend money and energy in this field with the hope of developing a coal mine. A Survey press bulletin stating these results was given to the newspapers, May 31, 1910.

## GEOGRAPHY.

The Dan River coal field lies along Dan River and Town Fork in Rockingham and Stokes counties, N. C. The principal tributaries of Dan River in this field are Smith River near Leaksville and Spray, Mayo River, which joins the Dan at Madison, and Town Fork, which flows through Germanton and Walnut Cove.

The Danville & Western Railway terminus is at Leaksville. The Norfolk & Western Railway follows Dan River and Town Fork from Madison to Walnut Cove. The Sanford and Mount Airy branch of the Southern Railway crosses this field from Walnut Cove to Germanton.

Germanton, with a population of about 150, is situated at the southwestern extremity of the coal field. Walnut Cove, at the crossing of the Norfolk & Western and Southern railways, has 480 people. Stokesburg, which is mentioned in a number of reports on this district, is a small settlement on the hill opposite Walnut Cove, and has neither a post office nor a railway station. Madison has a population of 1,033 and Mayodan has 874. Leaksville is an old town near the mouth of Smith River with a population of 1,127, and Spray, which is 1 mile north of Leaksville, has about 2,000 people, mostly employed in the cotton mills.

Elevations above sea at railroad stations are as follows: Germanton, 676 feet; Walnut Cove (Southern Railway), 624 feet; Pinehall, 579 feet; Madison, 559 feet; Mayodan, 556 feet; Leaksville, 700 feet.

The general region in which the Triassic rocks occur is a dissected plateau of moderate relief. It is mainly an agricultural district, the principal crops being corn, cotton, and tobacco. Cotton mills at Mayodan and Spray are the chief manufacturing plants, being located where water power is available. A good site not utilized at present is at the falls on Dan River 4 miles northeast of Walnut Cove. These

"falls" are a series of rapids where the river crosses the contact between the gneiss and the Triassic rocks and descends about 15 feet in 300 yards.

## GEOLOGY.

Only three geologic divisions occur in this field—Triassic sedimentary rocks (Newark group), including the coal and black shale beds; Archean gneiss, which completely surrounds the sedimentary rocks; and diabase dikes.

### ARCHEAN GNEISS.

The oldest of the three formations in the Dan River valley is Archean gneiss. It is the common country rock in this part of the State and surrounds the coal-bearing formation. No attempt was made to distinguish between Carolina and Roan gneiss, both of which are present. The Carolina gneiss is commonly composed of mica and garnet gneisses and schists, whereas the typical mineral constituent of Roan gneiss is hornblende. These rocks range in color from light to dark gray. Some of the gneiss and schist is fine grained and is composed of several distinguishing minerals, as biotite, muscovite, and graphite, besides fine grains of quartz and other minerals; other rocks are composed of the same minerals in coarse grains and flakes. The presence of much pegmatitic material is a characteristic feature of the Carolina gneiss. Very commonly the gneiss and schist are banded with or cut at various angles by streaks of pegmatitic or granitic material.

The Archean rocks have undergone extreme regional metamorphism, with accompanying folding and faulting. The mashing and and recrystallization of the Carolina and Roan gneisses have been so extensive that all of the original texture has been obliterated by the intense metamorphism.

Rock weathering is so deep on the Piedmont Plateau that good outcrops are the exception. The gneiss, on partial disintegration and decomposition, commonly forms a gravelly soil with a red clayey matrix.

### TRIASSIC SYSTEM.

#### NEWARK GROUP.

The sedimentary rocks of the Dan River coal field are of the same age as those of the Richmond Basin in Virginia. The stratigraphy is similar to that of the Deep River area, conglomerates at the base being overlain by coal-bearing shale, which is succeeded by thick sandstone and fine conglomerate toward the top. Little available knowledge exists concerning the details of the bedding. The concealment of the bedrock by a thick mantle of residual soil makes it almost impossible to obtain a detailed section of the whole of the Newark group.

The coal field is commonly described as extending from Cascade, Va., to Germanton, N. C., and being from 3 to 7 miles wide. It is possible that the width of the Triassic sedimentary rocks may be close to 7 miles between Leaksville and Madison. At Madison it is nearer 5 miles. By stadia measurement the writer found the width of the outcrop of Triassic rocks at Walnut Cove to be about 3⅓ miles. The dip of the rocks averages over 20° NW. If there is no repetition by faulting, the thickness of the beds here exposed is nearly 8,000 feet. This estimate is based on the following data:

*Section of Triassic sedimentary rocks at Walnut Cove.*

| | Feet. |
|---|---|
| From base of the sedimentary rocks to base of carbonaceous shale, 1,600 feet, average dip 40° | 1,220 |
| Approximate thickness of carbonaceous shale zone | 250 |
| From top of carbonaceous shale zone to contact with gneiss, approximately 15,000 feet, average dip 25° | 6,340 |
| | 7,810 |

The belt of sedimentary rocks tapers from Walnut Cove to Germanton and pinches out at the latter locality. The lowest sedimentary rock at Walnut Cove is red shaly sandstone, which rests on gneiss. The contact is near the 16 milepost on the Norfolk & Western Railway, about a mile south of the depot. Above this red bed is a series of yellow sandstone and shale beds with a few red sandy and shaly beds interspersed. About 1,000 feet from the base is a sandstone which is in part conglomeratic, containing small pebbles of quartz.

This conglomerate, which lies just below the carbonaceous shale, is well exposed back of Cabel Hairston's house in the highway crossing Sandy Branch a mile south of Walnut Cove and also in the road about 2 miles east of Germanton and north of the fork of the road. This rock is an arkose sandstone made conglomeratic by the inclusion of fragments of mica, schist, and feldspar and subangular pebbles of quartz up to an inch in length. The general color of the fresh rock is gray mottled with white. The conglomerate was not found at Leaksville, toward the northeast end of the field.

Between the beds of conglomerate along the road 1½ miles east of Germanton silicified trunks of trees are numerous. The roots and bark of some of these old trees are changed to lignite. The trunks have been flattened and a few of the largest exceed 2 feet in diameter. Silicified wood occurs also about 1¼ miles southeast of Walnut Cove in the road which crosses Bull Run half a mile above its mouth, and also on the hill slope one-fourth mile west of the brick plant at Pinehall. In each place it is at the same horizon, just below the carbonaceous zone. At Pinehall the underlying conglomerate is exposed along the railroad.

Above the conglomerate and silicified wood horizon there is red sandstone, in part variegated, which terminates above in the shale of the carbonaceous zone.

The carbonaceous zone consists of yellow sandy shale and shaly sandstone interspersed with thin beds of black fissile shale. The entire zone is not over 250 feet thick. A 326-foot section measured in a cut on the Southern Railway on the east side of Mill Creek half a mile east of Walnut Cove probably includes the entire zone. From the bottom of the lowest black shale to the top of the highest is 227 feet.

*Section of carbonaceous shale zone in Southern Railway cut at Walnut Cove, N. C.*

| | Feet. |
|---|---|
| Sandstone: | |
| Gray, hard | 5 |
| Greenish, shaly | 12 |
| Hard, gray | 2 |
| Shale, yellow, sandy, fossil shells top and base | 5 |
| Sandstone, gray, hard, lenticular | 1 |
| Shale, greenish, clayey and sandy | 42 |
| Sandstone, green, nodular, micaceous | 2 |
| Shale and sandstone, greenish | 15 |
| Shale, black, fissile | 2 |
| Shale and sandstone, greenish | 11 |
| Shale, black, fissile | 1 |
| Shale and sandstone, greenish | 10 |
| Sandstone, greenish, micaceous, hackly face | 14 |
| Shale: | |
| Yellowish, sandy, fissile | 9 |
| Black, carbonaceous | 3 |
| Sandstone and shale, greenish, thin bedded, soft | 31 |
| Sandstone, greenish, soft | 7 |
| Shale, black, fissile | 1 |
| Sandstone, greenish, soft, shaly in middle | 17 |
| Shale, black, fissile | 2 |
| Sandstone, greenish, soft | 10 |
| Shale, black, fissile | 1 |
| Sandstone and shale, greenish | 3 |
| Shale: | |
| Black, fissile | 3 |
| Greenish, sandy | 8 |
| Black, fissile | 5 |
| Green, clayey and sandy | 3 |
| Black, fissile | 1 |
| Green, sandy | 26 |
| Black, fissile | 8 |
| Greenish, clayey and sandy | 30 |
| Black, fissile | 2 |
| Gray, sandy | 9 |
| Black, fissile | 1 |
| Grayish green, sandy | 7 |
| Black, fissile | 2 |
| Gray to green, sandy | 15 |
| | 326 |

Another section of some of these beds was measured in the Norfolk & Western Railway cut half a mile southwest of the depot at Walnut Cove.

*Section of carbonaceous shale zone southwest of Walnut Cove, N. C.*

| | Feet. |
|---|---|
| Sandstone ledges in path to mineral spring. | |
| Sandstone: | |
| Yellow, soft, shaly | 10 |
| Gray, hard | 1 |
| Shale, yellow, clayey, fossil shells at top | 12 |
| Sandstone, gray, soft | 1 |
| Shale, yellow, clayey | 11 |
| Sandstone, yellow, soft, rather massive | 4 |
| Shale, yellow, sandy | 4 |
| Sandstone, yellow, soft, lowest layer hard | 6 |
| Shale: | |
| Black, fissile, and brown, crumpled | 2 |
| Yellow, sandy | 4 |
| Sandstone: | |
| Yellow, shaly | 6 |
| Green, micaceous, hackly face | 16 |
| Shale: | |
| Yellow, sandy, part micaceous, fish scales | 3 |
| Black, fissile, and drab, clayey | 1 |
| Shale and sandstone, yellow, soft, clayey, micaceous | 24 |
| Shale, black, fissile | 1 |
| Sandstone, yellow, shaly | 8 |
| Shale: | |
| Yellow, clayey | 4 |
| Black and drab, fissile | 1 |
| Concealed | 12 |
| Shale, black, fissile | 2 |
| Concealed | 40 |
| Shale and sandstone | 10 |
| Coal and carbonaceous shale in Evans pits | 4 |
| | 186 |

This section includes about 137 feet of the upper part of the carbonaceous zone. The lower portion is not well enough exposed to measure.

In the Southern Railway cut at Walnut Cove 13 beds of black fissile shale were counted, as shown in the section on page 141, and on the J. E. Willis place, near the mouth of Town Fork, the same number of black shale beds was found in the plantation road. A characteristic feature of these beds is the common occurrence of fish scales and of small cylindrical bodies about an inch long which fit loosely in cavities in the rock and which crumble readily. They are believed to be coprolites.

The sedimentary rocks lying above the carbonaceous zone are red and yellow shale and sandstone, with conglomerate at one or more

horizons. They have not been measured and the details are not known. At Walnut Cove the horizontal distance from the top of the coaly belt across these beds to the gneiss on the north is about 2¾ miles and at Madison it is about 4 miles. One place where conglomerate was seen above the coal zone is 2 miles north of Walnut Cove in a zone of purple sandy shale. The conglomerate has a coarse matrix, possibly derived from gneiss, as it contains abundant feldspar and mica, and besides pebbles of quartz and feldspar, cobbles of pink pegmatite, reddish quartzite, and green schist and gneiss.

Fossil animals and plants collected at a number of places from the black shale of the carbonaceous zone prove the Triassic age of these beds. The following determinations were made by T. W. Stanton concerning collections made by the writer and submitted to him for examination:

The fossils are all of Triassic age and the invertebrates in most of the lots belong to the phyllopod crustacean genus Estheria. Several species have been described from these beds and referred to the genus Posidonia, but these have all been referred to a single species Estheria by T. Rupert Jones, who has reviewed them. In one lot there are numerous specimens of a minute ostracod crustacean, which Jones has described as *Candona? rogersii*. The following are the determinations in the lots collected:

In highway at Neal place, 2½ miles west of Walnut Cove:
Estheria ovata (Lea).
Black shale, common near Walnut Cove:
Scales of ganoid fishes.
East end of Southern Railway trestle over Mill Creek, Walnut Cove:
Estheria ovata (Lea).
Norfolk and Western Railway cut one-third of a mile south of Walnut Cove:
Estheria ovata (Lea).
Candona? rogersii Jones.

Fossil plants from these same black shale beds were submitted to F. H. Knowlton, who has determined them as follows:

In highway at Neal place, 2½ miles west of Walnut Cove:
Fragments of a cycad leaf, possibly of Macrotæniopteris or Pterophyllum, but too fragmentary to identify positively.
Well at Dr. Jones's residence, Walnut Cove:
Ctenophyllum grandifolium Fontaine.
W. W. Roberts's well, 5 miles west of Leaksville:
Cheirolepis muensteri (Schenk) Schimper.
Actinopteris? sp. Obscure leaf.
Equisetum? sp. Mere fragment.

The conifer named above is well known in the Triassic of eastern North America.

Prof. Ebenezer Emmons[1] reports finding the bones of saurians similar to the alligator which now inhabits the southern part of the State. He discovered vertebræ and fragments of ribs embedded in

[1] Emmons, Ebenezer, Geological report of the midland counties of North Carolina: Geol. Survey North Carolina, 1856, pp. 309, 318, 322.

the black shale near Leaksville, at a point near the bridge over Smith River. As this discovery was made about 60 years ago, before the village of Spray had been built, and as the highway bridge at that time was very near the location of the present bridge, it is presumed by the writer that a more accurate description of the place where these bones were found would be at Spray near the bridge over Smith River. This part of the formation is in the midst of red sandstone and about 5,000 feet from the outcrop of the carbonaceous zone. As the dip of the beds here is 40° to 41°, the position of the bones is about 3,000 feet above the black shale.

In or near Germanton Emmons found many small bones, more or less broken, and a femur and tibia embedded in sandstone just below the carbonaceous shale. These bones were in all probability parts of the skeleton of a saurian.

## DIABASE.

Diabase is the latest intrusive rock known in this part of the State and is probably of Triassic age. It occurs in dikes which commonly cut across the strike and dip of all the older formations, filling a series of fissures which have a general northwest to north strike. The diabase is a dense hard rock of dark-green to black color, composed chiefly of augite and plagioclase feldspar with small amounts of olivine, biotite, and magnetite. The outcrop is generally marked by characteristic spheroidal bowlders scattered over the surface. The diabase dikes range from a few inches up to 100 feet or so in thickness.

The largest dike found by the writer in this field is in a railroad cut on the bank of Dan River 3 miles west of Madison and halfway between the twenty-seventh and twenty-eighth mileposts on the Norfolk & Western Railway. It has a north-south course, stands vertical, and is 130 feet wide. The rock is black, fine-grained, and in thin section under the microscope shows typical diabase structure. It is composed of lath-shaped plagioclase feldspar with augite packed in the interstices. There is also some olivine, partly altered to serpentine, with apatite, magnetite, and other accessory minerals. A similar dike, presumed to be the continuation of that in the railroad cut, outcrops in the highway half a mile west of the house of G. L. Wall, at a road fork 2 miles west of Madison.

A diabase dike of similar dark color but finer grain was found at the William Watts place, 2 miles northeast of Germanton. Its position was recognized by a train of large bowlders in the field east of the house. The course of the dike is nearly north-south.

Very much like these dikes is a sill exposed in Mayo River at Avalon, just above Mayodan. Microscopic examination of a thin section cut from this rock shows that it is composed of lath-shaped plagioclase with augite and quartz in the interstices.

Other diabase dikes and sills were found in the highway about 1⅓ miles northeast of the depot at Madison; 1 mile farther east along this road and 300 yards northwest of the home of Mrs. Lucy Trent; at the J. H. Lewis place, 5 miles east of Madison; 1,000 feet east of R. L. Carter's, 2½ miles west of Suttle Bridge; and along a road three-fourths of a mile northeast of Eagle Falls. Their dimensions and extent were not determined.

## STRUCTURE.

The structure of the Triassic area on Dan River is known only in a general way. This area is 35 to 40 miles long and 3 to 7 miles wide, tapering at both ends. The rocks all dip to the northwest at angles ranging from 15° to 50°. Along the southeast side of the field the sedimentary rocks rest unconformably on Archean gneiss, but on the northwest side they dip toward the gneiss. The rocks near the latter contact are exposed at the falls of Dan River, about 4 miles northeast of Walnut Cove. Here the Triassic beds dip 14° to 23° NW., and planes of foliation in the gneiss in the banks of the pond above the falls dip 30° SE. The strike is practically the same in both formations, N. 60° E. Rocks at the contact can be seen also about 4 miles northwest of Walnut Cove, between J. R. Shelton's and a spring at the John Reed place. The highest Triassic beds are thin red shaly grit of small pebbles in a micaceous sand. They dip at an angle of 25° NW. against mica schist.

The high westward inclination of the Triassic rocks across the whole field, and especially close to their junction with the crystalline rocks, suggests a marginal fault, and from this it is concluded that the Triassic beds in the Dan River area are the remnant of a fault block of unknown extent. The greater part of the fault block has been carried away by erosion, and this part remains because the faulting carried it below the horizon of a subsequent base level.

The hypothetical cross section in figure 3, *a*, is drawn to scale, the depth of the beds along the fault plane being assumed as approximately 7,800 feet, the calculated thickness given on page 140. The dip of the lower conglomerate is approximately 40°; of the carbonaceous shale, 31°; near the center of the field, 25°; and on the northwest side, 15° to 20°.

Further detailed work in this field may show whether the structure of this Triassic block is, as indicated in figure 3, *a*, a simple fault block with a total thickness of about 7,800 feet of sedimentary rocks, or whether some other condition exists.

Another hypothesis regarding this structure, as suggested in figure 3, *b*, is that these Triassic sediments were deposited in a basin with a receding shore line due to slow tilting. Thus the beds would be deposited farther and farther back from the original shore, and the

carbonaceous shale toward the bottom of the basin would terminate against the old shore only part way across the present basin and would not extend as far as the fault.

The position of the beds in the Dan River field, as shown, is the direct opposite of that on Deep River, where the beds all dip southeast. It has been suggested that these two coal fields are the opposite sides of a "graben," or sunken fault block, but when the distance between them and the frequency of folds in this general region is considered it seems more probable that one or more folds or faults may have intervened and the relation between the two coal fields may not be so close.

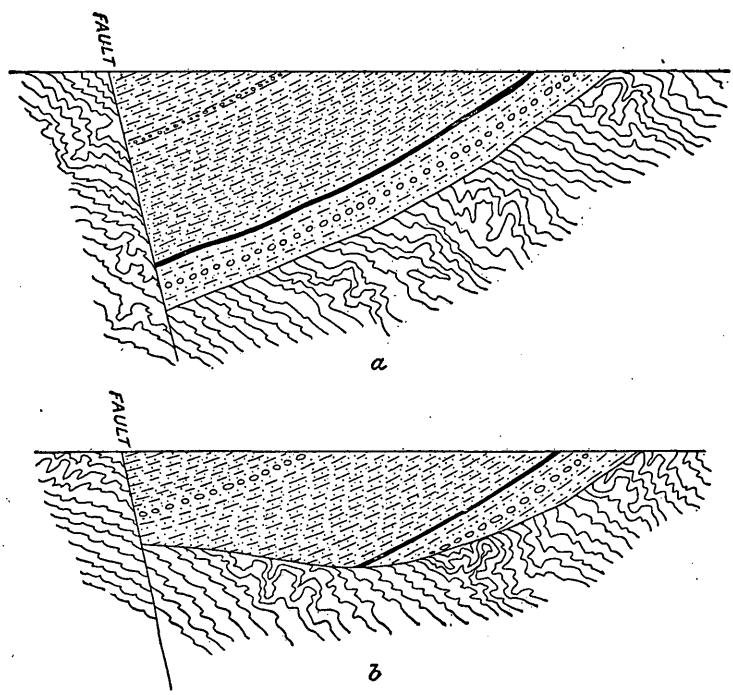


FIGURE 3.—Hypothetical cross sections through Walnut Cove, N. C.

Folding within the Triassic beds is conspicuous in the region of the big loop of Dan River, 4 to 6 miles southwest of Leaksville. The position of the outcrop of carbonaceous shale, part of which is hidden by alluvium, was observed at too few points to determine its exact course. The peculiar loop of the river, an irregularity without counterpart in this field, where the course of the sedimentary rocks is regular, suggests some abrupt change in the strike of the soft rocks which the river follows. Near Eagle Falls black shales occur at several points out of line, striking and dipping in various directions. Whether they extend farther out the loop than is shown on the map is not known, but that they do is regarded as possible.

Considering the purely economic purpose of the investigation, when it had been found that there was no coal bed of value in this vicinity the writer did not feel justified in spending time and funds in working out the structural details at this place. Further study naturally would lead to mapping the upper and lower boundaries of the Triassic directly north and south of the disturbance here mentioned to determine whether there is an offset in the contact with the gneiss corresponding with that of the carbonaceous shale. Lack of time did not permit the study of these questions and others of equal interest in regard to the structure, and they remain for whoever eventually maps the geology of this area in detail.

## COAL.

### PREVIOUS REPORTS.

The earliest record of the existence of coal in this part of North Carolina is a single sentence written in November, 1824, in which Denison Olmsted asserts the occurrence of coal in Rockingham County.[1] This must mean the coal along Dan River, for that is the only place in the county where coal might occur. The next reference is by the same writer in 1827[2] in which he makes the following statement:

> A bed of pit coal occurs only two or three hundred yards from the northern bank of Dan River, 3 miles by land below the Eagle Falls. It is seen on the side of a hill that faces the east, dipping to the northwest at an angle of about 20°, and is so situated as to afford the greatest facilities for mining. As to the quality of the coal, it is of a kind which is free from bituminous matter and which burns without flame, but my observations were too limited, and the specimens that I was able to obtain were too imperfect to enable me to speak with confidence respecting its value. Veins of coaly matter resembling lampblack are met with still farther south, not far from Germanton, and the black slate rocks of the whole district are impregnated in a greater or less degree with the same.

This coal described as 3 miles below Eagle Falls is that which was mined during the Civil War on the old Wade plantation now occupied by J. P. Wilson.

The next reference is by Ebenezer Emmons, who in 1852 spoke of the Dan River coal in his report[3] of the geologic survey of North Carolina. In a subsequent report on the midland counties of North Carolina,[4] published in 1856, he gives some short stratigraphic sections of the rocks immediately adjacent to and including the black shale in which the coal is found and describes in detail the fossils of this section. James MacFarlane in 1873, in a report on the coal fields of

[1] Olmsted, Denison, Geology of part of the western counties of North Carolina, 1825, p. 20.

[2] Olmsted, Denison, Report on the geology of North Carolina, 1827, p. 126.

[3] Emmons, Ebenezer, Report of Prof. Emmons on his geological survey of North Carolina: Ex. Doc. No. 13, North Carolina Gen. Assem., sess. 1852.

[4] Emmons, Ebenezer, Geological report of the midland counties of North Carolina, 1856, 351 pp. (Reviewed in Am. Jour. Sci., 2d ser., vol. 24, 1857, pp. 427–429.)

North Carolina,[1] quoted some of Emmons's statements, and Heinrich, in a paper on the Mesozoic of Virginia,[2] published in 1878, mentions the Mesozoic as extending along Dan River and into Virginia about 8 miles to a point a little east of Cascade village. In 1884 W. B. Rogers, State geologist of Virginia, gave some attention to the North Carolina coal localities, notwithstanding the fact that they lie beyond the geographic boundaries of his State, in order to get evidence as to the possibility of the occurrence of coal in similar areas within the boundaries of Virginia. In his report[3] he makes the following statement concerning a certain coal deposit in the Dan River area:

> The dark color and rather carbonaceous character of these shales has given rise to the opinion that they contain a valuable seam of coal, for the exploration of which operations have, it is understood, been actually commenced. At Linsey's, 3 miles above Leakesville, in shales of the same character which are here observed frequently to alternate with red and gray sandstones, two shafts have been sunk in search of coal, and a small seam of dark carbonaceous matter has been explored, consisting of alternating layers of coal and slate, the aggregate thickness of the former probably not exceeding 1 foot. It is a nonbituminous coal, generally compact and lustrous, and bearing a striking resemblance to a very common variety of the Pennsylvania anthracite. Its composition in the 100 grains is as follows:
>
> | | |
> |---|---|
> | Carbon | 83.12 |
> | Volatile matter | 7.76 |
> | Ash | 9.12 |
>
> * * * * * * *
>
> I may therefore mention as the result of these inquiries that from the facts observed no reasonable hope can be deduced of finding either at the points referred to or in the neighboring portions of the formation in Virginia any seam of sufficient thickness and extent to prove of real economical importance. The existence of carbonaceous layers containing small portions of coal, sometimes of great purity, at various points in the range of this formation, far from being improbable, is what might naturally be expected from the views already stated as to the origin of the materials composing the middle secondary strata in general. But looking to the fact already stated that the rocks in question belong undoubtedly to a later epoch than that of the great coal formation of this and other countries, an epoch marked by the deposition of strata distinguished for their barrenness of vegetable as well as animal remains, no encouragement to expensive enterprises of research can be derived from these merely local and as it were accidental accumulations of vegetable matter.

The most comprehensive report on the Dan River coal field is that made by Henry M. Chance to the State board of agriculture of North Carolina in the year 1885. In this report[4] he describes the coal and coaly beds found at a number of localities, including the vicinity of Leaksville and Walnut Cove, or Stokesburg. Four sentences are quoted from his conclusion:

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[1] MacFarlane, James, Coal regions of North America, their topography, geology, and development, 1873, pp. 516-528.

[2] Heinrich, O. J., The Mesozoic formation in Virginia: Trans. Am. Inst. Min. Eng., vol. 6, 1878, pp. 227-274.

[3] Rogers, W. B., Geology of the Virginias, 1884, pp. 324-325.

[4] Chance, H. M., Report on an exploration of the coal fields of North Carolina made for the State board of agriculture, 1885, pp. 62-66.

It should be stated at the outset that this district can not truthfully be termed a "coalfield," as the coal occurs merely as sporadic deposits of quite limited extent and is too thin, irregular, and uncertain to be of any commercial value * * *. From all the facts gathered in this examination of the Dan River district it seems certain that it will be entirely useless to expect to find workable coal beds. The small seams of coal that do exist are local deposits, without thickness, purity, or continuity. It is therefore idle to pursue the subject further.

This statement was so discouraging that after being published the State board of agriculture is said to have withdrawn the report and destroyed the larger part of the edition. In 1887 another description was published by the North Carolina board of agriculture and quoted by the United States Geological Survey.[1] This account was based largely on the statements of H. B. Robson, an Englishman, who spent several years in the field prospecting for workable coal beds. It was asserted that Robson had found coal beds from 3 to 7 feet thick and at one place nearly 9 feet thick; some anthracite and some "soft" coal as he termed it. He predicted that when developments had been carried farther there would be added to the resources of North Carolina at least 40,000,000 tons of accessible coal.

Reports of later years by other authors are compilations of previously published statements, including brief mention of localities and quoting analyses of coals found in this region. A statement by J. A. Holmes, State geologist of North Carolina, published in 1893,[2] describes the results of deep drilling done at the expense of the State Survey, as follows:

Early in 1891 the coal deposits near Walnut Cove, Stokes County, were attracting considerable attention and it was considered advisable to investigate them. As this could not be satisfactorily done in any other way the survey rented a diamond drill from the Pennsylvania Diamond Drill Co., and placed the work under the supervision of Mr. W. L. Spoon in July of that year, and the work was continued until May, 1892. Two holes were bored in this field, the deeper one going down about 1,112 feet, and no valuable bed of coal having been penetrated the work was abandoned. This negative result does not necessarily indicate the absence of valuable deposits of coal from the entire Dan River sandstone belt, but it does indicate their absence in the particular rocks penetrated by the borings. And while the result in this case is a negative one and led to no additional investments of capital, it prevented the expenditure of considerable sums of money which would have been lost in proposed mining operations.

Near the southwestern end of this sandstone belt, between Walnut Cove and Germanton, the indications of the existence of workable beds of coal are more favorable than those in other portions of the region, and here they are worthy of further investigations, but in the immediate vicinity of Walnut Cove, where the borings were made, I think the negative evidence may be accepted as final.

No further development was done in the Dan River field until about 1907, when a citizen of Winston-Salem invested several thousand dollars in prospecting for coal at Walnut Cove. A diamond-drill hole about 300 feet deep and a slope driven on a thin bed of coal

[1] Day, D. T., Mineral Resources U. S. for 1887, U. S. Geol. Survey, 1888, p. 280.
[2] Holmes, J. A., First Bien. Rept. North Carolina Geol. Survey, 1893, pp. 16–17.

did not reveal any coal bed of value, and this attempt led to the present investigation of the field by the United States Geological Survey.

## OCCURRENCE OF COAL.

The Triassic beds in which coal occurs on Dan River extend northward over the State line into Virginia for about 8 miles, terminating in the vicinity of Bachelors Hall and Cascade. As the writer could learn of no occurrence of coal in this belt of sedimentary rocks north of Leaksville, plane-table mapping was not continued beyond that place, but a trip was made through the northern extremity of the area in order to find indications of the presence of coal.

### NORTH OF LEAKSVILLE.

Black fissile shale was seen at a number of places, the northernmost prospect being a small roadside pit known as McGee's hole. This pit is one-fourth mile south of R. F. Soyar's house on the road from Cascade to Bachelors Hall and about 2½ miles west of the latter place. It is now caved, but is reported to have been driven about 15 feet. The strike is N. 70° E. and the dip 24° NW. The material on the dump is black shale and sandstone carrying fossil shells and coprolites, the same as are found in abundance at Walnut Cove. There is no sign of coal. The black shale band underlies beds of conglomerate carrying pebbles of quartz and mica schist. The next locality where coal has been reported is the Sharp plantation 2 miles from Draper, N. C., on the bank of Dan River. Chance makes the following statement [1] concerning this locality:

> At a place where coal had been reported on the Sharp plantation, we cleaned out an old pit and sunk it somewhat deeper upon an entirely valueless bed of slate, which measures:
>
> | | Ft. | In. |
> |---|---|---|
> | Slate, blue, carbonaceous | 1 | 6 |
> | (*a*) Coal and slate, variable | | 6 |
> | (*b*) Slick graphitic slate with coal streaks | 1 | |
> | (*c*) Slate, blue, carbonaceous. | | |
>
> Samples were analyzed from (*a*), (*b*), and (*c*) with the following results:
>
> (*a*)
>
> | | |
> |---|---|
> | Moisture | 1.65 |
> | Volatile matter | 4.82 |
> | Fixed carbon | 55.76 |
> | Sulphur | 4.76 |
> | Ash | 33.01 |
> | | 100.00 |
> | Weight of 1 cubic yard (pounds) | 3,199 |

[1] Chance, H. M., Report on an exploration of the coal fields of North Carolina made for the State board of agriculture, 1885, pp. 65–66.

(*b*)

| | |
|---|---|
| Moisture | 2.04 |
| Volatile matter | 6.03 |
| Fixed carbon | 15.25 |
| Sulphur | 1.47 |
| Ash | 75.21 |
| | 100.00 |
| Weight of 1 cubic yard (pounds) | 3,333 |

(*c*)

| | |
|---|---|
| Moisture | 2.49 |
| Volatile matter | 6.08 |
| Fixed carbon | 2.90 |
| Sulphur | 0.53 |
| Ash | 88.00 |
| | 100.00 |
| Weight of 1 cubic yard (pounds) | 4,310 |

The writer visited this plantation, which is now owned by Thomas Sharp, and was shown a small pit sunk many years ago about one-third of a mile west of the house at a spring near a tenant cabin. The dump shows black, sandy shale only. The same rock is found in the branch a few feet away, but with no trace of coal. Mr. Sharp says that about 2 miles west of the plantation house his father sunk a shaft 125 feet deep in the river bluff prospecting for coal but found none.

### LEAKSVILLE.

The easternmost exposure of black shale in the area included in the geologic map accompanying this report is in the east bank of Smith River, about 1,000 feet above its mouth. Here black shale and gray and black sandstone are well exposed, striking N. 76° E. and dipping 40° N. There is no sign of coal in this exposure. In the bank of Dan River at the east end of the covered bridge at the south end of Leaksville several black shale beds are uncovered in the road cut. The strike is nearly east-west and the dip varies from 45° to 60° N. A careful examination of the complete section containing a number of thin black fissile shale bands failed to disclose any coal. The nearest approach to coal is a bed of carbonaceous shale about 4 inches thick. It is reported that many years ago a tunnel was driven in the bank of the river at this locality on an 8-inch bed of coal, but the writer failed to find any trace of the tunnel—which may have been obliterated in highway construction—or any sign of coal whatever.

Red and yellow shales, yellowish sandstone, and sandy bands containing quartz grains the size of a pinhead are found on the south

side of Dan River at Leaksville. No conglomerate was seen in a distance of one-half mile south of or below the black shale. The rocks lying above the black shale and extending through Leaksville to the bridge over Smith River at Spray are red and yellow sandstone and shale. In the rapids above the bridge at Spray thick beds of hard brown to black sandstone and conglomerate are exposed, possibly the same which make the rapids in Mayo River between Mayodan and Avalon. The only report of coal in the village limits of Leaksville was by J. M. Price, who says coal was found in the bed of a small branch just below the railroad track and opposite the Baptist church. In company with Mr. Price the writer visited this locality and found 6 to 8 inches of black shale. As the limits of this black streak are plainly seen, it is evident that even if the shale were coal it is too thin to be of any value. Mr. Price also kindly conducted the writer to an old pit on his land about a mile up Dan River from Leaksville, where he had found, under black shale and resting on sandstone, a bed of black material 13 inches thick, supposed to be coal. Black shale outcrops in the fields and in the plantation road at this locality, but there is no sign of coal. The same beds are exposed in the bluff of the river above an old railroad grade from this locality to Leaksville and were examined at a number of places with negative results.

### WADE PLANTATION.

Three miles west of Leaksville, on the old Wade plantation, now owned by Price & Stone and occupied by J. P. Wilson, there is as good coal as at any other place in the whole Dan River field. In the north bluff of the river and separated from it by an alluvial flat 300 yards wide are 40 or more old pits along the outcrop within a distance of less than one-half mile. Nearly all of them show the same black fissile shale that occurs through the entire length of the Triassic area, and at a few of them coal was found on the dump. It is said that during the Civil War a considerable quantity of coal was mined here by the Confederates and shipped down Dan River on flatboats. At the largest pit there is semianthracite coal on the dump and in the brush near the old loading platform. The writer made an excavation several feet deep at the mouth of an old inclined shaft and under a roof of sandstone and shale found beds as follows:

*Section of coal bed on Wade plantation.*

| | Ft. | In. |
|---|---|---|
| Shale, hard, black, carbonaceous | | 6 |
| Coal, semianthracite | | 6 |
| Shale, carbonaceous, hard, platy | | 8 |
| Sandstone, drab, clayey | 2 | |
| Shale, black, carbonaceous at bottom. | | |

Mr. Wilson says his recollection is that at one of these pits a bed was exposed having an upper bench of coal 6 inches thick and a lower bench 12 inches thick separated by 12 inches of shale. The writer did not succeed, however, in finding more than the 6-inch bench. It may be that there are two benches of coal in a near-by pit. Coal was found only in the middle of the line of 40 pits. The beds dip about 35° N. Besides the slopes there were two or three vertical shafts, but both shafts and slopes are now caved so that the bed is completely concealed. The coal seems to be in one of the lower beds of black shale, for there are several bands of the same kind of shale in the hillside above these prospects. The age of these prospects is suggested by the fact that an oak tree 10 inches in diameter is growing in one of the pits. According to Maj. Moorhead, of Spray, when mining operations stopped on the Wade plantation they were in a 32-inch bed of coal carrying 8 inches of shale in the middle. He says work was discontinued on account of trouble with water. The writer was thoroughly convinced by his examination of the prospects on the Wade plantation that the bed of semianthracite occurring here is too thin to work and extends along the strike only a few rods.

### EAGLE FALLS.

In the north bank of Dan River, at Eagle Falls, a rapid in the river having a descent of only a few feet, there is black fissile paper-thin shale, but nowhere any sign of coal. The beds at the falls strike north-south to northwest and stand at various angles. A mile and a half north from Eagle Falls, along the course of a small branch, the beds strike from N. 15° E. to N. 48° E. and dip 18° to 25° NW. The black shale was not traced from point to point nor was the south side of Dan River visited except along the highway which crosses Suttle Bridge. The strike of the beds between Eagle Falls and the Wade plantation is almost at right angles to the common course through the Triassic area, due to folding of the strata. The course of Dan River at this place, as shown on the map, also indicates some peculiarity in the structure, with which the course of the stream may be closely related. Black shale beds are exposed in the road cut just west of Suttle Bridge, but there is no indication of coal here nor at an old prospect on the T. B. Lindsay plantation about 3 miles farther west. The position of the beds at Lindsay's, and also at the end of a plantation road 2 miles farther west, was determined by stadia measurement, as elsewhere throughout the field. The strike of the beds along this portion of the river varies from N. 70° E. to N. 80° E., and the dip, which is 32° N. near Suttle Bridge, varies from 35° to 65° N. in the vicinity of Madison.

MADISON.

At Madison gneiss is exposed in the river bank at the bridge over Dan River. The strike seems to vary from N. 15° W. to N. 60° W., and the dip is 12° to 30° NE. This strike is nearly at right angles to that of the sedimentary rocks which have a nearly east-west course at Madison. The lower member of the sedimentary series is a conglomerate containing pebbles of quartz, gneiss, and schist, and showing plainly its origin from the underlying crystalline rock. This conglomerate is exposed in the curve of the railway south of the depot. Above the conglomerate is a considerable thickness of red and yellow clay and sandy shale, with some buff sandstone. North from Madison for more than 4 miles red and purplish sandstone and shale with bands of yellow shale are seen. In the upper part of this section are beds of conglomerate from 1 to 2 feet thick, which contain subangular pebbles of quartz, schist, and gneiss. The largest pebble seen is about 2 inches in diameter. About 4½ miles north of Madison outcrops of sedimentary rocks cease and characteristic soil, formed from the gneiss, is encountered. This makes the width of the Triassic belt at Madison about 5 miles.

It was reported to the writer that coal had been found at Madison, but on investigation the only prospect pit known in the locality proved to be entirely in black paper-thin shale such as is very common for many miles. This prospect is located on the Vaughan property, near Mr. Wilson's, at the southwest corner of the village. Black shale exposed in the road at Wilson's, a little less than a mile west of the depot, strikes N. 85° E. and dips 36° N. The shale bed passing close to Wilson's house probably is the uppermost of the carbonaceous zone. Black shale is well exposed also in the small branch in the yard of the Baptist Church and outcrops in a number of places in the main streets. As the supposedly coal-bearing beds pass directly through part of the village of Madison and are exposed in the street cuts, ditches, and cellars, it is reasonable to suppose that were there any coal here it would have been found long ago. There is, however, no indication of coal anywhere in the vicinity.

Southwest of Madison, between Dan River and the highway on the north, exposures are not good and the black shale was not recognized, although it is probably present. Diligent inquiry failed to disclose any prospect pits between Madison and the county line or any knowledge on the part of old residents of any coal in this vicinity. Near Reed Creek the strike changes from nearly east-west to about N. 30° E., and the dip ranges from 25° to 50° NW. The black shale zone is well exposed on the bank of Dan River at the county line in a cut made by the Norfolk & Western Railway, but although solid rock can be seen throughout much of the section, there is no coal in the exposure.

PINEHALL.

Gneiss is exposed on the south side of the river flat at Pinehall and conglomerate below the black shale is seen along the railroad between the depot and the brickyard. Black shale outcrops at the Methodist Church on the hill back of the settlement, and also in plowed fields on the Anderson plantation, and is of the same fissile character as that found throughout the field. No coal has been discovered here, however, except a few grains which might have come from seams a fraction of an inch thick, such as are sometimes found in carbonaceous shale. The beds here strike N. 55° E. and dip 40° NW. West from Pinehall the next exposure of black shale is in a small branch north of the brickyard. A small pit has been dug here on one of the black shale bands. The outcrop uncovered in the bank of the branch showed a few inches of black shale containing some specks of coal. The whole band of black shale is not over 2 feet thick.

The report that many years ago a blacksmith dug coal on the Will Hairston plantation for use in his forge led to the discovery of an old pit in the woods beside the road, about half a mile southwest of the Hairston house. It is a shallow opening, probably never over 6 feet deep, but the writer found 3 or 4 feet of black shale with about 6 inches of good coal at the top of the bed under a clay shale roof. The strike is N. 80° E. and the dip 30° NW. This in all probability is a very small lens. Thirteen distinct beds of black shale are exposed in the road on the J. E. Willis plantation just above the mouth of Town Fork and 250 yards west of the stream. The strike is N. 48° E. and the dip 42° NW. These shales carry abundant fossil fish scales and are fairly well exposed, but no trace of coal could be found in any of the beds.

WALNUT COVE.

Within a radius of 3 miles from Walnut Cove are 50 or 60 excavations ranging in size from small test pits to incline shafts 100 to 150 feet deep. The largest openings are driven down the slope of a black shale and coal bed dipping at an angle of 35°.

Semianthracite coal has been found here but in no place is it more than a few inches thick. A bed of what appears to be coal, ranging in thickness up to 10 feet, has been one cause of so much prospecting. This material is bright, black, soft, and flaky and has the appearance of coal, but on testing it is found that it will not burn and that it carries from 40 to 64 per cent ash. It is so soft that even at a depth of several feet below the surface it can be dug with a shovel. This material, which has been the source of the report concerning the presence of coal in quantity in the vicinity of Walnut Cove, is really

a carbonaceous shale whic has been subjected to so much squeezing and movement that innumerable slickensides have been produced in it, thus giving the shiny appearance to all particles. As only a small amount of carbonaceous material is sufficient under these conditions to give a glossy appearance, it is not surprising that this carbonaceous shale has excited considerable interest. Certain persons in Walnut Cove claim to have burned it, but the fact that it is not mined or used, although the main prospects are very close to the village, indicates its poor quality. The tests made by the writer (see p. 165), are conclusive that this material can hardly be classed as a fuel.

Some of the more remote pits on the east, such as that at J. H. Brown's place and the pits on Bull Run, show black shale on the dump

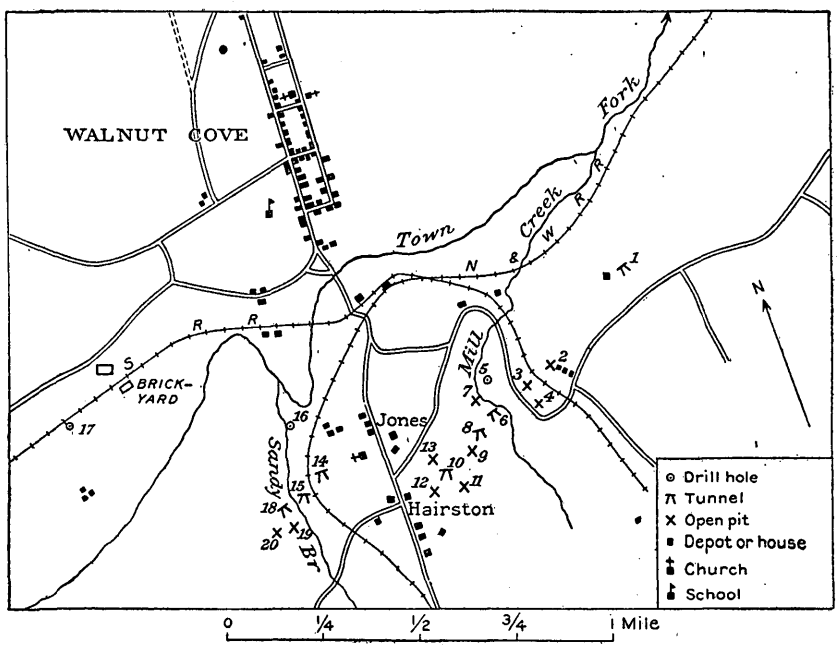



FIGURE 4.—Map showing location of prospects near Walnut Cove, N. C.

but no sign of coal. In the immediate vicinity of Walnut Cove, however, some small amounts of coal have been found. Beginning with a pit east of the village near a tenant's cabin on Cabel Hairston's land, the description will proceed west to Oldfield Creek. Reference to the accompanying figure showing in detail the position of the prospects in the vicinity of Walnut Cove will aid in understanding the relations of the exposures under discussion. Numbers on the map refer to the numbers at the beginning of the following paragraphs.

1. A tunnel about 50 feet long on Cabel Hairston's land 50 yards from a tenant cabin about 2,000 feet east of the Southern Railway bridge over Mill Creek. Here is exposed a bed of soft carbonaceous

shale 4 to 5 feet thick between roof and floor of yellow to black clay shale carrying coprolites. The bed seems to be composed entirely of a glossy black shale, but chips of good coal on the dump suggest the possibility of a few inches of true coal in the bed. If the bed does contain coal it is in such small quantity as not to be of value.

2. An old pit just east of the Southern Railway track and 800 feet south of the Mill Creek bridge shows only fissile black shale on the dump. Bedrock is not exposed here.

3. On the opposite side of the track from No. 2 is an old pit now caved and full of water, which shows pieces of coal on the dump. This pit is said to have been dug by H. B. Robson. The strike is N. 70° E. and the dip 40° NW.

4. A few rods south of No. 3 and just below the Southern Railway track is another excavation made by Robson on a band of black, slightly micaceous sandstone not over 20 inches thick. The surface exposure is black dirt and shale and the upper 5 inches of the bed contains streaks of good coal.

5. A diamond-drill hole on the east bank of Mill Creek about 300 yards above the Southern Railway bridge is reported to be about 300 feet deep, but no coal was found. It was sunk at the expense of W. T. Brown and others, of Winston-Salem, N. C.

6. On the west side of Mill Creek at this same locality is a dump at the mouth of a tunnel which is caved but is said to have been 110 feet long. No good coal was found.

7. A few rods north of the tunnel along the hillside a shallow trench has been cut for about 200 feet across the strike of the beds. It reveals several bands of black shale but no coal.

8. An incline shaft has been sunk near the bank of Mill Creek and 1,000 feet south of Dr. Jones's house in Cabel Hairston's field. This will be called Brown's shaft because it was sunk at the expense of W. T. Brown and others, of Winston-Salem, who also sunk the diamond-drill hole mentioned above. This shaft is said to be about 150 feet deep and to incline 47°, the dip of the beds at this point. It is cut nearly 9 feet wide and the soft shale roof is supported by heavy stulls and lagging. Hoisting was done by steam engine and rope cable with a broad-gage car running on timber rails. Water now fills the shaft within 10 feet of the surface. The section exposed at the mouth is as follows:

*Section in Brown's shaft.*

| | Ft. | In. |
|---|---|---|
| Shale, drab, roof. | | |
| Coal, bright, somewhat crushed | | 8 |
| Shale, sandy, carbonaceous crushed, soft, flaky | 1 | 9 |
| Shale, yellow, floor. | | |

The upper part of the lower bench is the soft carbonaceous material which has been mentioned above as resembling coal, and the lower

part of the bench next to the floor is black and sandy and also appears to have been crushed and slightly crumpled. Cabel Hairston says that in driving this shaft a horseback or roll in the floor was encountered which cuts out practically all of the bed, but that in driving through this roll nearly the whole thickness of the bed was found on the other side. A sample of the best coal on the dump, selected from a considerable number of pieces, was analyzed and shows a fairly good quality of fuel, but as the actual coal has a thickness of only 8 inches it is readily seen that this bed is of no commercial value. The analysis (No. 10391) is given on page 166.

About 20 feet above this shaft is a shallow pit which shows a few inches of flaky crushed carbonaceous shale on one side and none on the other side of the excavation.

9. Sixty feet west of Brown's shaft is a surface cut which shows two beds of black shale. The upper bed carries from 2 to 3 inches of bright coal. The shale is slightly micaceous and contains abundant coprolites.

10. In this same field and about 250 yards east of Cabel Hairston's house and the same distance from Dr. Jones's an incline shaft is reported to have been sunk by a Mr. Evans. It has long been abandoned and is now full of water. At the mouth of this shaft is exposed a carbonaceous bed, 3 feet 11 inches thick, of which the bottom bench is 11 inches of black shale. The remainder of the bed, 32 inches thick, is composed of slaty, slightly micaceous, carbonaceous shale with streaks of bright coal and with 8 or 9 inches of coal at the top. It is all badly crushed and the lumps have bright slick faces. A roll in the shale roof nearly cuts out the thin top coal at about 6 feet below the surface, but it comes in again 3 feet below at a different angle and with good appearance. W. A. Gladwell, of Walnut Cove, who worked in this shaft, reports that it is 128 feet deep and that the section as exposed at the surface continues for about 20 feet, where it increases to about 4 feet 4 inches and then decreases to about 5 inches on account of a roll in the floor. He says that the coal, which at the surface is soft and flaky, gets harder with depth and carries a sulphur band. He reports that the whole bed is completely cut out at the bottom of the shaft. The dip is 37° to 48°.

The Evans shaft is about 8 feet wide and 6 feet high. It contains one set of stulls and lagging at the mouth. Roof and floor are shale. The bed appears to be the same as that exposed at Brown's shaft.

11. Fifty feet below the Evans shaft a small pit was reopened by the writer and shows the following section:

*Section at small pit below Evans shaft.*

| | Inches. |
|---|---|
| Roof, shale, drab. | |
| Coal, weathered, slightly micaceous | 8 |
| Shale, drab to black, micaceous, sandy | 2–6 |
| Coal, probably good, under cover | 7 |
| Floor, shale, black, micaceous, lumpy. | |

12. Fifty feet west of the Evans shaft is a pit opened by Cabel Hairston, probably on the same bed. It has a very irregular clay roof and shows about 3 feet of carbonaceous shale with a mere streak of crushed coal at the top. The excavation was driven about 15 feet and slightly down the dip until water stopped the work. At the back end of the pit the band of crushed coal at the top is nearly 6 inches thick. It is evidently very irregular, and although of good quality is so small in amount as not to warrant further prospecting.

13. About 500 feet south of Dr. Jones's house, and the same distance from Cabel Hairston's, in the latter's field, the writer reopened an old pit on a higher bed than that on which the Evans shaft was sunk. Particles of apparently good coal on the dump were the cause for the excavation of this pit, which, to judge from the size of the dump, may have been 5 or 6 feet deep. Under the sandy shale roof is a bed of carbonaceous shale of a soft flaky character, easily excavated, and of such bright appearance as to closely resemble coal. A shaft was sunk 11 feet deep and the bed found to be 10 feet 2 inches thick, practically all of bright carbonaceous shale. In spite of the promising appearance of this material several attempts to burn it both in stoves and blacksmith's forges have failed, and analyses made both by the Bureau of Mines and by the chemical laboratory of the Geological Survey show that it contains from 40 to 65 per cent ash. Although this bed has considerable thickness and may possibly continue for some little distance, its quality is such that it is of no value as a fuel.

14. On the east side of the Norfolk & Western Railway track in the rear of the church and one-half mile southwest from the railway station at Walnut Cove there is a slope about 8 feet wide and 6 feet high now full of water and of unknown depth. The writer had an excavation made in the side of the slope and found the following section:

*Section in slope near Norfolk & Western Railway track.*

| | Inches. |
|---|---|
| Roof, shale, drab: | |
| Coal, bright, flaky | 8 |
| Shale, soft, carbonaceous | 9 |
| Clay, with coal streaks | 12 |
| Shale, soft, carbonaceous | 12 |
| Floor, shale, black, sandy. | |

15. On the opposite side of the railroad track and in the bank of Sandy Branch at this same locality a tunnel has been driven on the same bed and probably connecting with the slope described as No. 14. It shows a carbonaceous bed about 4 feet thick composed mainly of carbonaceous sandstone and soft crushed flaky black coal with thin lenses of bright semianthracite coal under the shale roof. The roof is irregular and a thin band of coal exposed for about 8 feet pinches out

at one end and is cut off abruptly at the other end where it is about 5 inches thick. The strike here is N. 40° E. and the dip 34° NW. This opening is also said to be the work of Mr. Evans.

16. A diamond-drill hole was sunk by the North Carolina Geological Survey to a depth said to be 492 feet in the east bank of Sandy Branch, about 750 feet below opening No. 15 and 2 rods from a mineral spring, in an endeavor to find the character of the coals where under considerable cover. The report by J. A. Holmes,[1] who was State geologist at that time, claims only negative results. A resident of Walnut Cove said that the hole on Sandy Branch passed through beds of coal, but the diamond drill was rotating so fast that only ground-up material was found in the core. This seems to be evidence that the carbonaceous beds which the drill passed through are soft, flaky material, the same as that found at the surface, and is

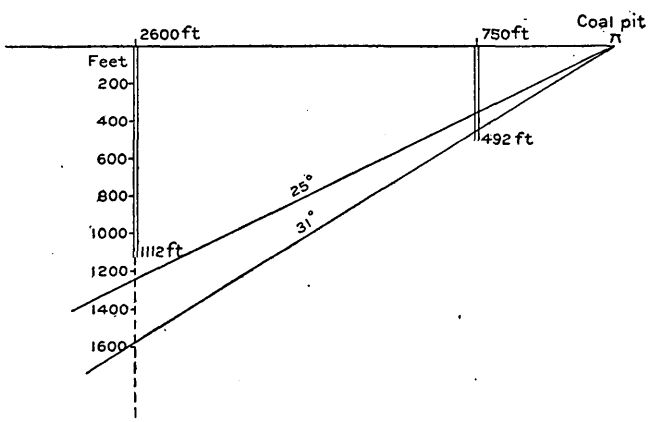



FIGURE 5.—Diagram showing relation of diamond-drill holes at Walnut Cove, N. C., to principal coal beds.

fair proof that the soft, carbonaceous shale does not become hard coal under heavy cover.

17. Another diamond-drill hole was sunk by the North Carolina Geological Survey about a mile west of Walnut Cove and on the south side of the Southern Railway track west of the brickyard. It was bored to a depth of about 1,112 feet without penetrating any valuable bed of coal. Some persons at Walnut Cove think that this drill hole is not deep enough to reach the coal beds, an idea which may be correct. The accompanying diagram (fig. 5) shows the relation of these two drill holes to the coal bed on Sandy Branch 750 feet from the lesser hole. The distance from coal pit No. 15 to the deep drill hole near the brickyard is 3,100 feet, but to a point along the strike through the drill hole and normal to the strike from the coal pit is 2,600 feet. This pit is 15 feet higher than the mouth of the shallow

[1] First Bienn. Rept. North Carolina Geol. Survey, 1893, pp. 16–17.

hole and at about the same level as the deep hole. In the Norfolk & Western Railway cut at the coal pit the dip is 31° and on the northwest side of the basin about 20°. A dip of 31° carries the coal bed to a depth of 1,560 feet at the position of the deep drill hole by the brickyard, and a dip of 25° would carry it to a depth of about 1,200 feet. The dip of the beds under the valley of Town Fork at this point probably is not less than 25°, in which event the deeper drill hole certainly would not be deep enough to reach the principal coal and carbonaceous shale bed.

18. In an open field about one-fourth mile north of the highway and on the west side of Sandy Branch is a large drift, possibly 100 feet long, which was driven many years ago and now is inaccessible, being full of water and partly caved. The mouth of this drift was reopened and disclosed the following section:

*Section at drift west of Sandy Branch.*

| | Ft. | in. |
|---|---|---|
| Roof, shale, drab: | | |
| Shale, black, sandy | | 5 |
| Shale, soft, flaky, carbonaceous | 1 | 3 |
| Dirt, black | | 1 |
| Shale, soft, flaky, carbonaceous | | 8 |
| | 2 | 5 |

The floor was not seen, but is presumed to be shale, and the impression was obtained that this bed is the one known as the soft-coal bed which has been opened at a number of places farther east.

19. At a pit 100 feet farther west, which was opened by the writer, there is 30 inches of drab and black clay shale with lenses of slaty coal. The greatest thickness of coal seen is about 3 inches.

20. In the same field and just above the pit last mentioned was an incline shaft which is now completely filled. An excavation made at the entry showed 4 feet of soft, black, flaky, carbonaceous shale. The floor was not reached. Several small pits have been sunk on other beds of black shale in the same field.

There are several small prospects a little over a mile southwest of Walnut Cove on the Hensdale land, in a ravine west of the plantation houses and about 200 to 300 yards from Town Fork. These pits are on different beds of black shale and show the same soft material as is found elsewhere, but reveal no true coal.

### DAVIS PLANTATION.

About one-fourth mile east of Ed Davis's house, which is on the road from Walnut Cove to Germanton and just east of Oldfield Creek, are three openings near the edge of the timber. One of these is a small pit on one of the lower black shale beds, but as it is now caved full the thickness of the bed was not learned. A hundred

yards from it is a slope which was driven on a bed of black carbonaceous sandstone with about a foot of crushed carbonaceous shale at the top, underlying a very irregular roof. From the little that can be seen at the mouth of the slope, which is now caved full, it is judged that the carbonaceous shale is very pockety. This is the only place in the entire Dan River field, so far as the writer discovered, where iron rails were used for track. The indications are that the original operator intended to develop a mine here, but gave it up when the shaft had been driven to no great depth. The strike is N. 60° E. and the dip 40° NW.

North or back of Davis's house there are six pits and slopes which were sunk many years ago on a bed of soft carbonaceous shale, but which have long been abandoned. The largest of these, the middle one, is a slope driven 30 or 40 feet down the dip with one small room turned to the right. A lens of soft carbonaceous shale 13 inches thick is exposed at the upper end, but about 18 feet down the dip it pinches out completely. It is no harder at the lower end where under several yards of cover than it is at the mouth. This slope evidently was driven with the hope that the black shale would become coal and increase in thickness under greater cover. The westernmost of the six openings, almost directly behind Davis's house, is a slope driven down the dip on a 2-foot bed of carbonaceous shale. It was probably found, after considerable energy had been expended, that this shale would not burn, nor did it turn to coal at greater depth, and operations were abandoned.

### OLDFIELD CREEK.

Near an old dam site in the bank of Oldfield Creek, about halfway between the highway and Town Fork, where the black shale zone crosses the stream, several openings were made many years ago. They are now completely filled and only slight traces of them can be found. Black shale but no coal was discovered on the dumps. A few rods west of the creek bank and at the end of a road which runs nearly parallel with the west bank of the creek there are four old pits. Numbers heading the following paragraphs correspond with those on figure 6.

1. The northernmost pit is driven S. 65° W. on a bed which dips 22° NW. It is full of water and its length could not be determined. The roof is buff sandy shale, under which is about 42 inches of carbonaceous material. At the top of the bed is 7 or 8 inches of semi-anthracite and the remainder is anthracitic but high in ash. It has a bright, coaly appearance, but is so badly crushed that it crumbles to small flakes. The floor is micaceous carbonaceous sandstone. It

is said that coal taken from this pit was screened and burned at Walnut Cove.

2. About 75 feet south of the pit above described an open cut has been run into the coal bed and turned in both directions. This was reopened by the writer and in the drift on the left there was found 9 inches of bright fairly hard coal under a sandy shale roof and underlain by 28 inches of bright coal having the same soft flaky character as the carbonaceous shale at Walnut Cove but of brighter, less ashy appearance. Analyses given on page 166 show that the upper 9 inches of coal is semianthracite and that the lower bench carries over

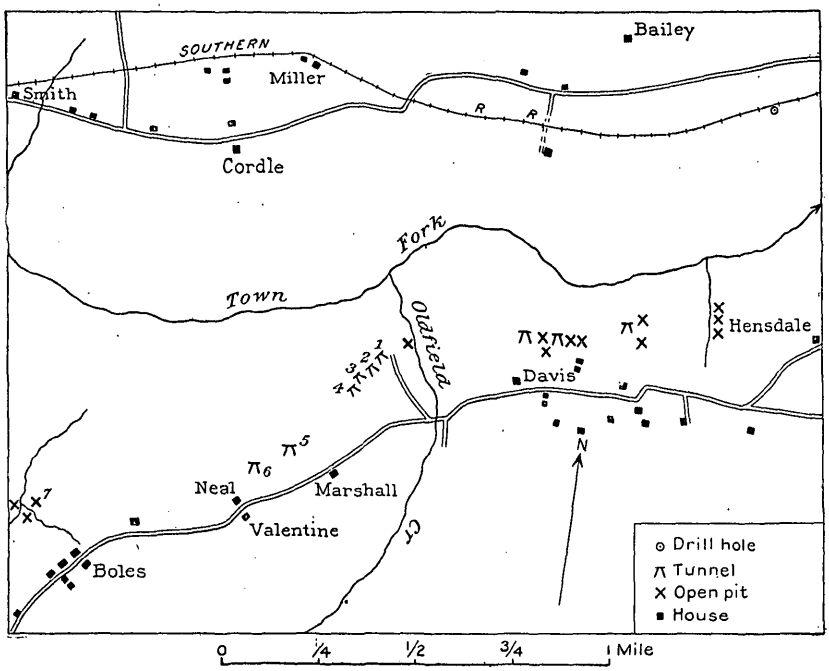



FIGURE 6.—Map showing location of prospects near Oldfield Creek, N. C.

20 per cent ash, which together with its crushed flaky condition makes it a poor fuel.

3. The third pit, distant about 25 feet, is completely caved. There is coal on the dump, but the pit was not reopened.

4. The fourth pit also was completely caved, but the writer had it reopened and found under a yellow, sandy shale roof a coaly bed 37 inches thick. The roof is irregular with slick rolling faces, which appear also in the coal itself, suggesting considerable movement. The upper 8 inches of the bed is bright coal crushed so that pronounced prismatic cleavage is developed. The middle part of the bed is soft bright coal crushed to a soft flaky condition, and the lower part is both slaty and bright coal like the top bench. The bed dips

very irregularly at angles ranging from 25° to 45° NW. These four openings are on the same bed and show that although there is semi-anthracite here the hard clear coal is nowhere more than a few inches thick and is underlain by 2 to 3 feet of crushed ashy coal of promising appearance but of little value. These are the best showings of coal in the whole Dan River field.

5. On the Morris plantation, formerly Poindexter, opposite J. V. Marshall's house, is a slope now completely caved, which is said to have been nearly 150 feet long. A few pieces of coal were found on the dump, and it is believed that this is on the same bed as that which has been prospected so extensively in the bank of Oldfield Creek.

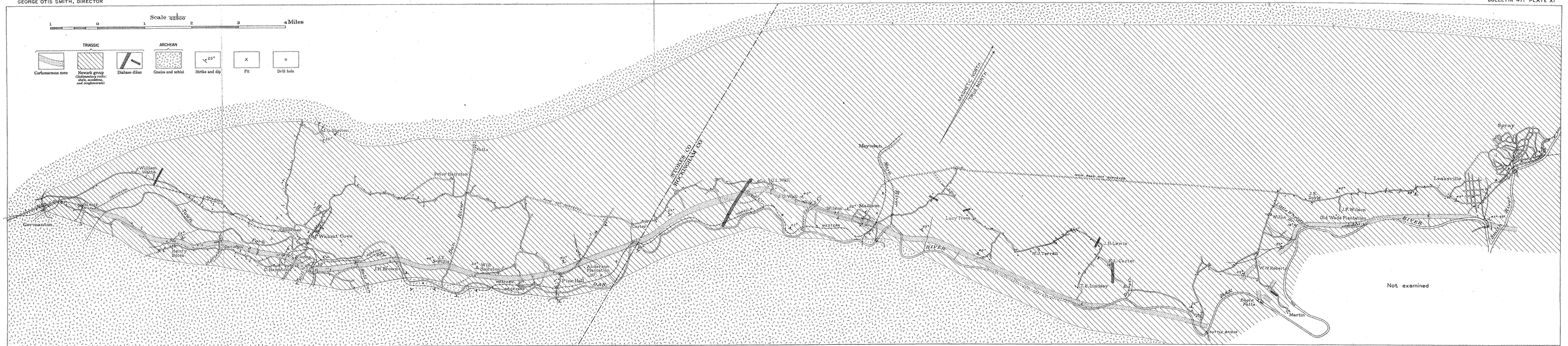
6. Three hundred yards west of Marshall's house, on the Morris plantation, is a drift driven S. 65° W. about 80 feet with a bend to the left. At the face of this drift there is a coaly bed 42 inches thick, a little of which is hard and bright coal, but most of it soft flaky carbonaceous shale. Throughout the length of the drift the bed is soft and breaks in lenses suggesting severe crushing. It seems no harder at the face of the drift than at the surface. This prospect affords one of the best opportunities for examining the bed under cover, and the writer had the drift reopened and cleaned out in order to obtain an idea of the character of the coaly material.

On the H. T. Boles plantation, 3 miles west of Walnut Cove, several small pits have been sunk in the wood lot northwest of the house. Black carbonaceous shale of bright promising appearance is exposed and a little coal may be found, but as the true coal nowhere has a thickness of more than 2 inches none of the prospects show anything of value. At one of the prospect pits (No. 7 on fig. 6) in the bank of a branch in front of Boles's house, where the strike of the beds is N. 40° E. and the dip 23° NW., after reopening the pit the following section was measured:

*Section in pit on Boles plantation.*

| | Inches. |
|---|---|
| Roof, sandstone, shaly. | |
| Shale, paper-thin, carbonaceous | 5 |
| Dirt, black | 10 |
| Shale, soft, flaky, carbonaceous | 12–15 |
| Floor, sandstone, carbonaceous, and shale, drab. | |

It is reported that several small pits have been reopened between the Boles plantation and Germanton on the same black shale beds, but the writer failed to discover more than one or two in the brush and timber. These were only shallow pits, dug so many years ago that it is impossible to tell anything about them without considerable excavation. Only fragments of black shale could be found on the dumps, and it is presumed that there is no coal.




# GEOLOGIC MAP OF THE DAN RIVER COAL FIELD, NORTH CAROLINA

By R. W. Stone,

ENGRAVED AND PRINTED BY THE U.S.GEOLOGICAL SURVEY

### GERMANTON.

It is reported that coal has been found at Germanton, and a section is quoted by Woodworth[1] showing two beds of coal, each 18 inches thick, separated by 1 foot of "slate." Inquiry failed to locate these beds and led only to a report of coal being found in the wheel pit of Slate's mill. Although the mill was visited when repairs were being made and the water was out, the wooden case in which the water wheel stands concealed the bedrock. Conglomerate and sandstone are exposed between the mill and the highway on the south. The black-shale zone probably lies under the alluvium of Town Fork at this point and certainly must terminate close to Germanton, for gneiss is found on the southwest, west, and north sides of the village and is exposed in the village streets.

## PRACTICAL TESTS.

The bright black carbonaceous shale exposed in a number of prospects at Walnut Cove is believed by some of the residents of that village to have fuel value, although none of them use it. To test its character the writer endeavored to burn in an open hearth some of the freshly mined material from the 11-foot shaft near Cabel Hairston's house. Although the brightest, blackest lumps were kept red-hot on a wood fire for several hours, they could not be made to burn. A similar attempt was made in a sheet-iron box stove with a good draft produced by a hot wood fire, and chunks of this glossy black shale were kept red-hot for three hours, at the end of which time the chunks were taken out and found to be of the same size as when put on the fire and changed only in part to a reddish color. Lumps of the brightest black shale placed in a crucible and kept at white heat in a furnace fire for an hour gave off flame for the first few moments after becoming heated, but after that seemed dead and did not diminish in bulk. When removed from the fire they were of the same size and shape, but had changed from black to gray and red. The same experiment in the laboratory over an air blast gave the same result. The platinum crucible quickly brought to white heat ignited the shale so that it gave off a flame for a moment, but seemingly after the carbon on the slick faces had burned off there was no more combustion. When anthracite of the same bulk would have been consumed the shale remained intact without loss of bulk.

A blacksmith at Walnut Cove, Mr. Clodfelter, claimed to have burned this coal in his forge and did so to his own satisfaction at the request of the writer. A fire was started on the forge with shavings

[1] Woodworth, J. B., The Atlantic coast Triassic coal field (in North Carolina): Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, pp. 50, 51.

and the carbonaceous shale applied. By mixing with the fire some of the ashes or coke from a former fire Mr. Clodfelter soon heated a small bar of iron to white heat. In order to have impartial tests, some of this carbonaceous shale was taken to Madison and tested at two separate blacksmith shops by men who were not familiar with it. In each test the forge was cleaned completely and a fresh wood fire made. The substance was brought to a red heat and kept so for some time by blowing with the bellows, but the conclusion of both blacksmiths was that it was not coal; it was only rock. The writer, therefore, is convinced that Mr. Clodfelter was able to heat iron by the coke mixed in with the wood rather than by the carbonaceous shale. Even if this shale would burn, the fact that it crumbles to small flakes is enough to condemn it as a shipping fuel.

## ANALYSES.

In the following table are given five analyses made by the United States Geological Survey.

All the samples from which these analyses were made were collected by the writer, as described below:

*Analyses of coal samples from the Dan River coal field, North Carolina.*

[A. C. Fieldner, chemist in charge.]

| Laboratory No. | Location. | Thickness. | | Air-drying loss. | Form of analysis. | Proximate. | | | | | Heat value. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Coal bed. | Part sampled. | | | Moisture. | Volatile matter. | Fixed carbon. | Ash. | Sulphur. | Calories. | British thermal units. |
| | | *Ft. in.* | | | | | | | | | | |
| 10393 | Oldfield Creek | 3 1 | 9 inches at top. | 3.1 | A | 4.0 | 9.6 | 80.8 | 5.6 | 2.70 | 7,790 | 14,020 |
| | | | | | B | .9 | 9.9 | 83.4 | 5.8 | 2.79 | 8,040 | 14,470 |
| | | | | | C | ..... | 10.0 | 84.1 | 5.9 | 2.81 | 8,115 | 14,600 |
| | | | | | D | ..... | 10.6 | 89.4 | ..... | 2.98 | 8,620 | 15,510 |
| 10391 | Walnut Cove.. | 8 | Best coal from dump. | 1.9 | A | 3.0 | 9.1 | 65.8 | 22.1 | .82 | 6,235 | 11,220 |
| | | | | | B | 1.1 | 9.3 | 67.1 | 22.5 | .84 | 6,355 | 11,440 |
| | | | | | C | ..... | 9.4 | 67.8 | 22.8 | .85 | 6,430 | 11,570 |
| | | | | | D | ..... | 12.1 | 87.9 | ..... | 1.10 | 8,330 | 14,990 |
| 10395 | .....do..... | 10 2 | Best coal from dump. | 1.9 | A | ..... | ..... | ..... | 39.4 | ..... | ..... | ..... |
| | | | | | B | ..... | ..... | ..... | 40.1 | ..... | ..... | ..... |
| 10392 | .....do..... | 4 0 | 4 feet..... | 2.1 | A | ..... | ..... | ..... | 22.1 | ..... | ..... | ..... |
| | | | | | B | ..... | ..... | ..... | 22.6 | ..... | ..... | ..... |
| 10394 | Oldfield Creek | 3 1 | 2 feet 4 inches of lower part. | 7.2 | A | ..... | ..... | ..... | 20.5 | ..... | ..... | ..... |
| | | | | | B | ..... | ..... | ..... | 22.1 | ..... | ..... | ..... |

*Laboratory No. 10393.*—Taken from pit on Oldfield Creek reopened and marked No. 2 on figure 6. Sample represents a top bench 9 inches thick which overlies 28 inches of crushed, flaky coal.

*Laboratory No. 10391.*—Sample represents 8 inches of coal at top of bed exposed in Brown's slope at Walnut Cove, marked No. 8 on figure 4. Sample made by selecting best pieces on the dump, exposed to weather two years.

*Laboratory No. 10395.*—From a shaft 11 feet deep sunk by the writer at Walnut Cove and marked No. 13 on figure 4. This shaft exposed 10 feet 2 inches of carbonaceous shale and the sample was taken by selecting the best-looking material on the dump.

*Laboratory No. 10392.*—From a tunnel at Walnut Cove on Sandy Branch, near the Norfolk & Western Railway track, marked No. 15 on figure 4. The sample represents the entire thickness of a crushed, flaky coal.

*Laboratory No. 10394.*—Taken from pit on Oldfield Creek reopened and marked No. 2 on figure 6. Sample represents 28 inches of crushed, flaky coal which underlies a 9-inch coal bed.

In the table the analyses are given in four forms, marked A, B, C, and D. Analysis A represents the composition of the sample as it comes from the mine. This form is not well suited for comparative purposes, for the amount of moisture in the sample as it comes from the mine is largely a matter of accident, and consequently analyses of the same coal expressed in this form may vary widely. Analysis B is of the sample after it has been dried at a temperature a little above the normal until its weight becomes constant. This form of analysis is best adapted to general purposes of comparison. Analysis C represents the theoretical condition of the coal after all the moisture has been eliminated. Analysis D represents the coal after all moisture and ash have been theoretically removed. This is supposed to represent the true coal substance, free from the most important impurities. Forms C and D are obtained from the others by recalculations. They should not be used in comparison, for they represent theoretical conditions that never exist.

Analyses 10393 and 10391 give fuel ratios of 8.4 and 7.3, respectively, which shows that the coal is a semianthracite. Analysis 10395 is of the bright flaky carbonaceous shale which has been the principal cause for the extensive prospecting near Walnut Cove. The high percentage of ash from a sample of the best parts of the 10-foot bed removes this shale from any present consideration as a fuel. Another analysis of the average run of this shale from the same shaft, made by George Steiger in the chemical laboratory of the United States Geological Survey, gave 64.68 per cent ash. Analyses 10392 and 10394 are of coal which is so thoroughly crushed that it is very much like the carbonaceous shale in appearance. Its crumbled condition and high percentage of ash spoil it for fuel.

The following analyses, quoted from Chance [1] give some information about the quality of the thin bed of true coal. Chance says that the average section of the bed on the Wade place near Leaksville is an upper bench of coal a foot thick separated from a lower bench of coal 1 foot 1¾ inches thick by 7 inches of slate, and gives the following tables:

[1] Chance, H. M., Report on an exploration of the coal fields of North Carolina made for the State board of agriculture, 1885, pp. 62–66.

The analysis of the upper bench shows:

| | |
|---|---|
| Moisture | 11.67 |
| Volatile matter | 30.19 |
| Fixed carbon | 48.00 |
| Sulphur | 0.49 |
| Ash | 9.65 |
| | 100.00 |

The high percentage of moisture is evidently accidental.

The lower bench shows, on analysis:

| | |
|---|---|
| Moisture | 5.35 |
| Volatile matter | 9.49 |
| Fixed carbon | 64.31 |
| Sulphur | 0.58 |
| Ash | 20.27 |
| | 100.00 |

An average sample from both benches gave, on analysis:

| | |
|---|---|
| Moisture | 3.92 |
| Volatile matter | 5.47 |
| Fixed carbon | 73.95 |
| Sulphur | 2.44 |
| Ash | 14.22 |
| | 100.00 |

A sample picked from the best coal that could be found here gave, on analysis:

| | |
|---|---|
| Moisture | 3.70 |
| Volatile matter | 4.67 |
| Fixed carbon | 81.58 |
| Sulphur | 2.23 |
| Ash | 7.82 |
| | 100.00 |

These analyses are of coal which occurs in a bed too thin to be mined with profit and which has a lateral extent of only a few hundred feet, if indeed it is more than a few rods.

Woodworth[1] gives the following analyses of coal at Walnut Cove:

*Analyses of coal from Dan River area.*

| | 1 | 2 | 3 |
|---|---|---|---|
| Fixed carbon | 75.96 | 76.56 | 55.47 |
| Volatile matter | 11.44 | 13.56 | 17.99 |
| Ash | 12.00 | 12.00 | 26.16 |
| Sulphur | ..... | ..... | 5.56 |
| Water | ..... | ..... | .38 |

1 and 2. Analyses by Dr. Genth, about 1871, from coal near Stokesburg.
3. Coal from Walnut Cove, Stokes County. Analysis by J. E. Whitfield, in Bull. U. S. Geol. Survey No. 42, 1887, p. 146.

Undoubtedly analyses 1 and 2 represent coal from the 8-inch bed which lies on top of the carbonaceous shale in some pits at Walnut

[1] The Atlantic coast Triassic coal field (in North Carolina): Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, p. 51.

Cove. It is very evident that No. 3 is too high in ash and sulphur to be classed as a desirable fuel.

## CONCLUSION.

After a thorough and careful examination of the Triassic beds in the Dan River field the conclusion is reached that there is no reason to expect to find commercially valuable coal beds in this district. The beds of semianthracite found near Walnut Cove and near Leaksville are only a few inches thick and of small lateral extent. Being both thin and discontinuous they are wholly unimportant. It is therefore useless to expend money and energy in this region in the hope of developing a coal mine.

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[1] Bull. North Carolina Geol. and Econ. Survey No. 18, 1909.