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DIRECTOR

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The Geology and Mineral Resources of Wise County and the Coal-bearing Portion of Scott County, Virginia

BY

J. BRIAN EBY

WITH CHAPTERS BY

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G. W. STOSE

PREPARED IN CO-OPERATION WITH THE
UNITED STATES GEOLOGICAL SURVEY

WITH A CHAPTER ON

The Forests of Wise County, Virginia

BY

FRED C. PEDERSON

PREPARED IN CO-OPERATION WITH THE
OFFICE OF STATE FORESTER

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Director of the Survey and State Geologist.

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VIRGINIA GEOLOGICAL SURVEY,

UNIVERSITY OF VIRGINIA,

CHARLOTTESVILLE, DECEMBER 26, 1923.

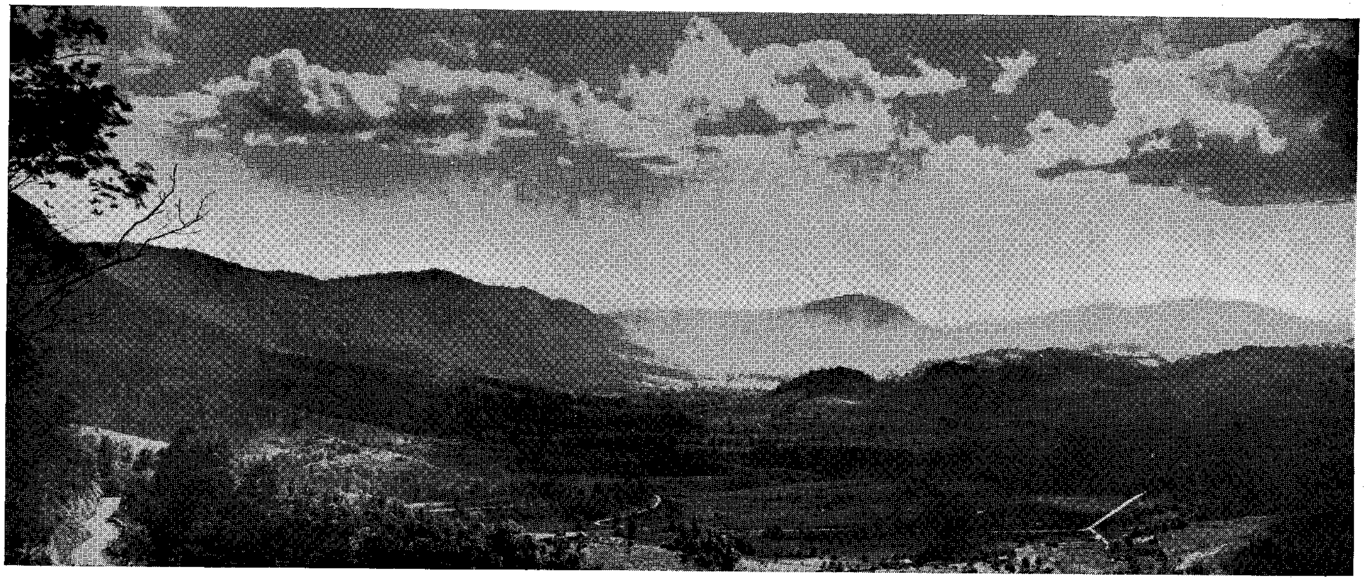
Governor E. Lee Trinkle, Chairman, and Members of the State Geological Commission:

Gentlemen:—I have the honor to transmit to you herewith, and to recommend for publication as Bulletin No. XXIV of the Virginia Geological Survey Series of Reports, a manuscript and illustrations of a report on "The Geology and Mineral Resources of Wise County and the Coal-bearing Portion of Scott County, Virginia," by Mr. J. Brian Eby, with chapters by Messrs. M. R. Campbell and G. W. Stose, and with a chapter on "The Forests of Wise County, Virginia," by Mr. Fred C. Pederson.

This report has been prepared by the Virginia Geological Survey in coöperation with the United States Geological Survey and the Office of State Forester. It is the seventh one of a series of detailed reports published by the Virginia Geological Survey on the coal resources of southwest Virginia under the coöperative agreement of the State and Federal Surveys. The report is accompanied by county topographic and geologic maps.

Respectfully submitted,

THOMAS L. WATSON,
Director and State Geologist.



POWELL VALLEY, LOOKING SOUTHWEST FROM LITTLE STONE GAP.

The relation of geologic formations to topography is strikingly shown. The soft Big Stone Gap, Portage, and Genesee shales largely make the valley floor, the hard limestone formation of the Newman makes the escarpment seen in the mountain profiles, and the easily-weathered Pennington shale forms the gentle slopes above the limestone escarpment. The distant mountain on the right is Wallen Ridge, composed of upfolded Clinch sandstone and Clinton formation.

Photo by G. D. Jenkins.

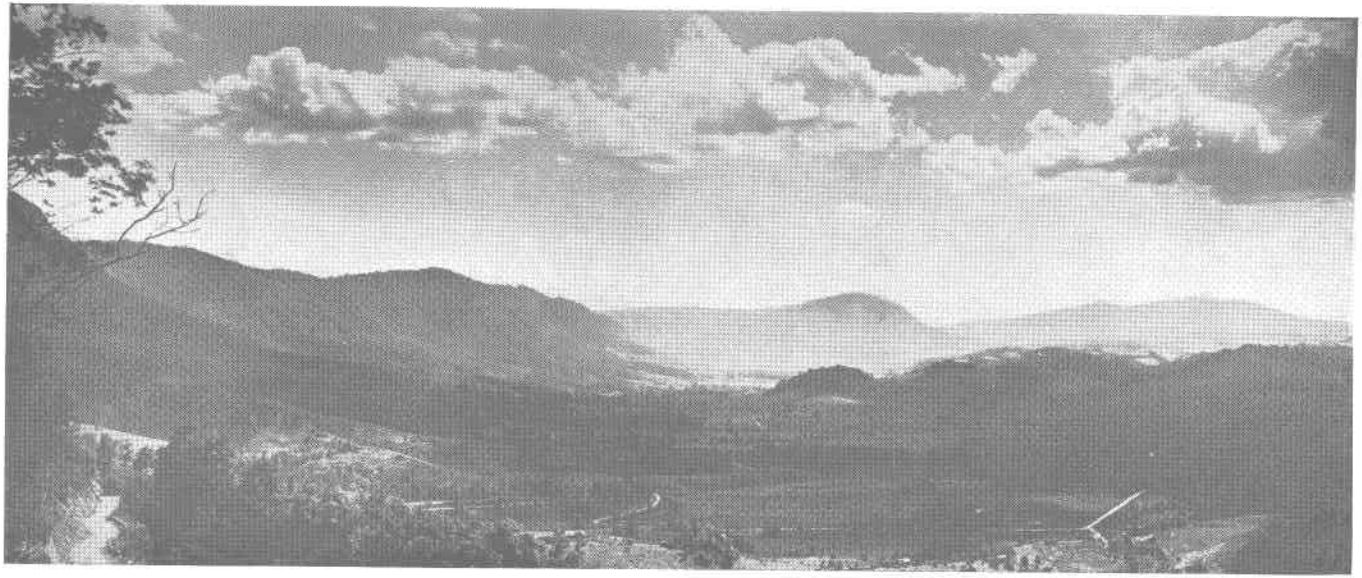


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Photo by G. D. Jenkins.

THE GEOLOGY AND MINERAL RESOURCES OF WISE COUNTY AND THE COAL-BEARING PORTION OF SCOTT COUNTY, VIRGINIA

By J. Brian Eby.

INTRODUCTION

Location and importance of the field.—The region treated in this report lies in southwest Virginia (Fig. 1), and includes Wise County which is bounded on the northeast by Dickenson County, on the northwest by Pike, Letcher and Harlan counties, Kentucky, on the southwest by Lee County, on the south by Scott County, and on the east by Russell County and a small strip of Scott County, adjacent to Wise, which in a general way is bounded on the south by the Hunter Valley road and on the west by the Southern Railway. It includes 451 square miles of coal land on the southeast border of the great Appalachian coal region, and approximately 45 square miles of non-coal land.

The wealth of mineral resources in Wise far surpasses that of any other county in Virginia. Records[1] show that the coal produced in this county in 1917 and 1918 exceeded by thousands of tons the entire amount of coal mined in the remainder of the State; the coal mined in Scott County in the same years was negligibly small, there being only 3 or 4 operating mines. It is estimated that 5,778,280,000 tons of high grade bituminous coal in beds over 14 inches thick still remain in Wise and Scott counties. Railroads, entering Wise county from the northeast, southeast and southwest, have opened for development much of the best coal land of that county, but thousands of acres containing mineral coal have not yet been reached. This is true especially of the coal in the Pound River drainage basin. The great potential value of this coal is not equaled in any of the other coal-bearing counties of Virginia. In this regard Scott County is much less fortunate, its beds being thinner, less easily accessible, and of considerably smaller areal extent.

Iron ore occurs in Wise County in sufficient abundance and purity to make it a factor in the mineral wealth of the county. It has been mined

[1] Lesher, C. E., Coal in 1918: U. S. Geol. Survey Mineral Resources, 1918, p. 803, 1920.

and smelted near Big Stone Gap, Va., for nearly thirty years. Flux for the ore is also found in quantity in the limestone strata that outcrop for

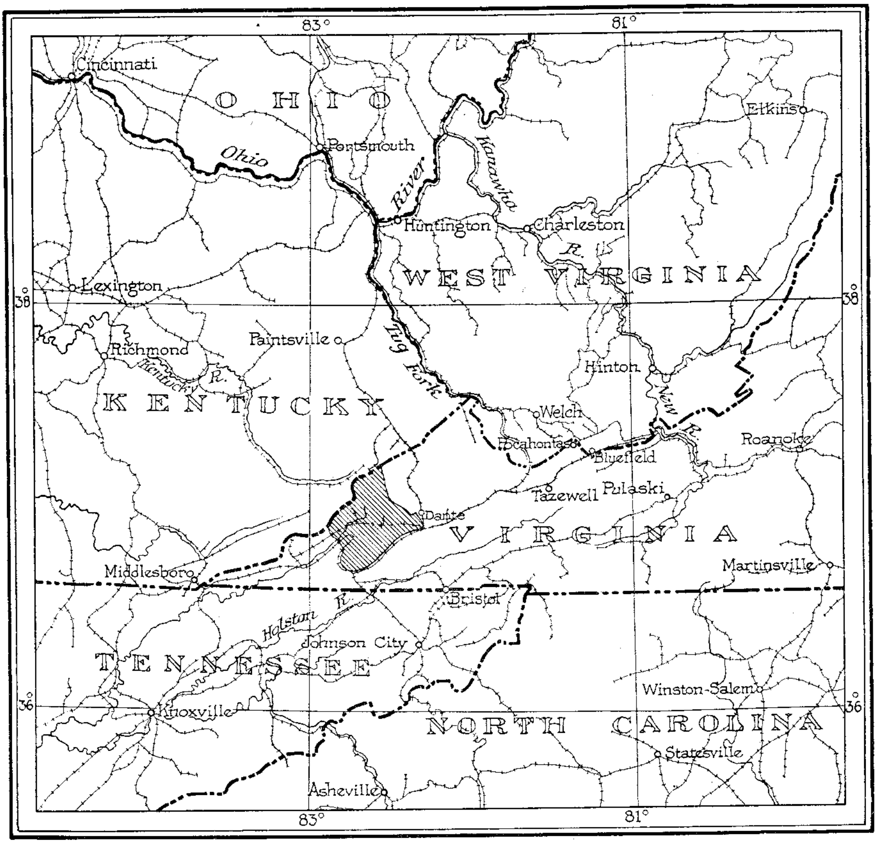


Fig. 1.—Index map showing the location of Wise County and the coal-bearing portion of Scott County, Virginia (shaded area).

many miles in the vicinity of the town. No iron ore of commercial importance is found in the coal-bearing portion of either Wise or Scott counties.

Lumbering ranks among the major industries. Large mills are operating in various parts of Wise and Scott counties, as on Dry Creek, near Dungannon, on Stony Creek above Ka, and on Pigeon Creek, near Exeter. Hundreds of small sawmills are scattered about the wooded slopes of the two counties.

Thousands of acres of farm land have been obtained by clearing the forest from the plateaus, valley bottoms and gentle slopes. This is particularly true of the broad plateau in the vicinity of Wise on which many farms are located and on the rounded swell of Powell Mountain south of Coeburn, the latter region being known locally as the "Flatwoods." The wide valley of the South Fork of Powell River and Butcher Creek is also excellent farming land. The hilly character of the northen part of Wise County restricts farming in that region mainly to the narrow valleys and clearings on steep slopes. Corn, wheat, oats, and alfalfa, are among the staple crops produced. Apples constitute the chief fruit, and are grown in abundance.

Cattle and hogs are raised in large numbers. The more gentle slopes and ridge tops afford pasture land that exceeds 100,000 acres in extent. Horses, sheep and poultry are also raised throughout the region.

Prior to the early nineties the region was sparsely settled. The inhabitants then were for the most part descendents of the earliest settlers. The great increase of population began with the coming of the railroads, and the opening of coal mines and the newcomers gathered in towns on the railroads and around the coal mines.

The population of Wise County in 1920 was 46,500,[1] consisting mainly of whites, but including several settlements of negroes in the mining districts. The white population is predominantly native American but there are many settlements of foreigners near several of the larger coal mines. The foreign element consists in the main of English, German, Hungarian and southern European stock. One-ninth of the entire population is employed in the coal mining industry and an equal number is dependent on allied industries for support. Of the remaining seven-ninths of the population the great majority are engaged in farming, fruit growing, and stock raising and are native southwest Virginians.

Norton, with a population of 3,068, is the largest town in Wise County. It is the terminus of the Clinch Valley division of the Norfolk and Western Railway, and of the Cumberland Valley division of the Louisville and Nashville Railway. Other towns of importance in the county have the following population: Big Stone Gap, 3,009; Appalachia, 2,036; Wise, the county seat, 1,071; Coeburn, 884; and St. Paul 574. No towns are located in the part of Scott county covered by this report.

[1] All figures indicating population are from the census of 1920.

Political history.—The region of southwest Virginia now included in Wise and Scott counties was the home of Indian tribes long before the advent of the white man on this continent. The earliest Indian inhabitants of which there is record were Xualans.[1] This tribe was driven out of the territory some time between 1671 and 1685 by the Cherokee Indians, and the latter were themselves soon expelled by the conquests of the Confederacy of Six Nations. For the following hundred years the county was an unsettled wilderness, entered only occasionally by nomadic bands of natives.

Exploration in southwest Virginia by white adventurers began as early as the middle of the seventeenth century. New River was first discovered and named, it is said,[2] by Colonel Abraham Wood, in 1654, who lived near the falls of the Appomattox, the present site of Petersburg. The name Woods River was given it by the discoverer, though the term New River was used at the same time and interchangeably by the explorers, expressing the fact that to the white men the stream was truly a "new" river. Exploration and settlement of southwest Virginia was encouraged by the civil and military leaders of the State, Governor Alexander Spottswood being one of the pioneer explorers. He reached the summit of one of the high peaks of the Blue Ridge at Swift Run Gap, Augusta County, Virginia, in September, 1716.

The territory now included in Wise County was very sparsely settled prior to the Revolution; Fort Blackmore had been established and another blockhouse had been built at Castlewood near St. Paul in 1775. Indian depradations discouraged the ready settlement of the region. Daniel Boone and Christopher Gist were probably the most famous early explorers to traverse the wilderness on Powell and Guest rivers.

All of that part of Virginia lying west of the Blue Ridge Mountains was originally embraced in Orange County. In 1738 it was divided into Frederick and Augusta counties, though it was not until 1745 that the latter county was organized. The present county of Wise was a portion of Augusta County. Southwest Virginia was further subdivided by an act of the House of Burgess of Virginia in 1769, in forming Botetourt County, which was to contain all the territory of Augusta County lying south and west of North River, near Lexington. The first court was held on February 13, 1770, near Fincastle. The territory drained by waters of the

[1] Summers, L. P., History of Southwest Virginia—Richmond, 1903, p. 23.
[2] Hale, John P., Trans-Allegheny Pioneers, Cincinnatti, 1886, p. 21.

Mississippi was separated from Augusta County in 1773 and organized under the name Fincastle, with its seat at the lead mines on New River, now in Wythe County.

All of that territory now called southwest Virginia was included in Washington County, as established by the General Assembly of Virginia on December 6, 1776. Court was first held at Blacks Fort, now Abingdon, which is now the seat of Washington County. After the Revolutionary War the increase of population demanded the formation of still more counties and Russell, Scott, and Lee were formed. Wise county was organized on February 16, 1856, and held its first court on July 28, of that year. The county was named for General Henry A. Wise who was Governor of Virginia from 1856 to 1860. Except for the loss, on February 27, 1880, of a magisterial district in the formation of Dickenson County, the boundaries have remained essentially the same to the present time.

The first presiding justice for Wise County was William Richmond who held his first court in a small Baptist Church about 200 yards southwest of the present courthouse at Wise. The first Grand Jury met in the open, near the church.[1] The commonwealth attorney was William B. Aston, the county clerk was Morgan T. Lipps, and the sheriff Andrew J. Dotson. The town at that time was called Gladeville and had a population of about two hundred and fifty.

The log courthouse built in the latter part of 1856 was burned by the Union forces during the Civil War. Many records of the county were lost, but those of the proceedings of the court which had been hidden were saved. The present courthouse was begun in 1896, replacing a smaller brick building that had been put up immediately after the war. Wise, or Gladeville, as it was then known, remained the chief town until after the coming of the railroads when larger centers of industry and population arose. In 1890 the number of inhabitants of Wise County was 9,346, in 1900, 19,653, and in 1910, 34,162.

Many of the names of settlements and of topographic features come from pioneer days. Powell River received its name from Ambrose Powell, one of a party of explorers that crossed the stream near Cumberland Gap in 1750.[2] Guest River takes its name from Gist, the explorer, and Toms Creek from his son, Thomas. It is interesting to note that the last recorded incursion of the Indians into southwest Virginia ended in their defeat on Stone

[1] The sessions were held on the large flat-topped sandstone which is still commonly known as "Grand Jury Rock."

[2] Summers, L. P., History Southwest Virginia—Richmond, 1903, p. 50.

Mountain, south of Dorchester. Benge, the half breed leader of the band had captured a Mrs. Livingston from near the present town of Mendota in Washington County, on April 6, 1794, and was returning westward when overtaken and killed. Benges Gap and Benges Branch take their names from this Indian Leader. Giving streams and ridges names that suggest particular physical conditions was a common practice. Thus there are several Laurel forks, Dry creeks, Glady branches, Big and Little creeks, Straight forks and Clear creeks. Gladeville was named from the "Big Glades" which occur on the top of the thick white sandstone that forms the surface of the plateau. Norton was called Prince's Flat, prior to 1890, but received its present name from stockholders in the company which owned the property upon which the town was laid out after the coming of the railroads. Coeburn was named for W. W. Coe, an official of the Norfolk and Western Railroad, who surveyed the town in 1888 and Judge William E. Burns, a stockholder in the new corporation. With the coming of large outside coal corporations, names quite foreign to southwest Virginia have been brought in for scores of the newest towns.

Development of the coal mining industry.—The presence of coal in southwest Virginia was noted by white explorers long before the Revolutionary War. Thomas Jefferson in his notes on the State of Virginia, written as early as 1782, mentions its occurrence as follows:[1]

> "In the western country coal is known to be in so many places as to have induced an opinion that the whole tract between the Laurel Mountain, Mississippi, and Ohio yields coal . . . ."

Laurel Mountain as indicated by the writer on his map of the State represents the present Cumberland Mountain. The State boundaries as drawn place the Wise County of today well into Lincoln County, Kentucky, of that day, the Virginia-Kentucky line running due north from just east of the junction of North and Middle Forks of Holston River.

The value of coal as a great natural resource was not considered in the early days. That it was used locally to considerable extent, however, is certain, and by 1835 coal in the Kanawha basin was being used in the manufacturing of salt. Rogers,[2] the eminent Virginia geologist, writing in 1835 said:

> "The importance and value of salines in this vicinity [Charleston] may be inferred from the fact that about three million bushels of salt

[1] Jefferson, Thomas, Notes on Virginia: London, 1787, p. 42.
[2] Rogers, W. B., The Geology of the Virginias, New York, 1884, p. 118.

are now made annually from them and that in the manufacture of this article alone more than twice the quantity of coal is consumed every year than is furnished by all the coal mines of eastern Virginia put together. This coal being procured from the hills adjacent to the salt furnaces is obtained at comparatively little cost; presenting an example of the fortunate adaptation of resources to each other."

Practically no coal was mined in Wise County for other than purely local use prior to the Civil War. Among the first mines to be opened were those on Toms Creek and Crab Orchard Creek. In a paper on the geology of the region, J. P. Leslie [1] reported prospect pits in a 5 to 6 foot bed at Guest's Station (junction of Big and Little Toms creeks) and on Crab Orchard Creek "in a fine six foot bed of rather handsome flaming coal, solid enough to wagon over rough roads and not making much ashes or clinker in the grates."[2]

Prof. Leslie was examining the region for the purpose of determining the nearest possible approach to a workable coal region of a railway planned to run from Harpers Ferry to Knoxville, Tennessee. He reached the conclusion [3] that the Guest River Gorge was the natural gateway for a railway line to the Wise County and Kentucky coal fields. It is interesting to note that Professor Leslie was probably the first to realize the coking possibilities of Wise County coals, reporting that [4] "It is good blacksmith coal [at Guest Station] and no doubt will make good coke. A piece of ill-made coke from what is perhaps the same bed, near Gladeville [Wise], shows that the best coke can be got from it." The coals farther east, in Russell County, the same authority asserts, were extensively mined by the Confederates during the war.

Major Hotchkiss, a mining engineer reporting on the coal fields of southwest Virginia in 1876 did much to focus attention on the coals of Wise and Scott counties. In his report to the Virginia Board of Immigration he states in part,[5]

"Nowhere else in the Union do we find the same condition of things as that existing here, 'where the limestones of the Lower Silurian, holding the brown hematite ores, directly abut against the coal beds of the carboniferous and sub-carboniferous [6] era'—the result

[1] Leslie, J. P., Amer. Phil. Soc. Proc.: vol. XII, p. 489, 1872.
[2] Op. cit., p. 492.
[3] Op. cit., p. 492.
[4] Op. cit., p. 494.
[5] Hotchkiss, Jed., Virginia—Richmond: p. 45, 1876.
[6] Leslie, J. P., Amer. Phil. Soc. Proc.: vol. XII, p. 498, 1872.

of great upheavals and downthrows that have brought . . . the most valuable ores of iron alongside the coals without an intervening mountain barrier. The line of fissure, where these formations meet, is in the valley of the Clinch River so that the branches of the stream from the west flow from the coal measures 'for about 70 miles along the valley of the Clinch, any railroad descending the Clinch from Jeffersonville to the mouth of Guest River in Wise County may have as many collieries alongside of it as it pleases.' "

In spite of these reports little effort was made to exploit the numerous resources of the county before 1880. The history of the coal-mining development of Wise County from the year 1880 is briefly and concisely stated by General Ayers of Big Stone Gap, as follows: [1]

"At a club dinner in Pittsburg in December, 1879, General John D. Imboden, of Virginia, then residing in that city, was called upon for a speech, and responding talked of the rich undeveloped iron ores and coals of Southwest Virginia, and so impressed his audience that a number of business men present at once made up a purse and sent General Imboden out to make an examination and report. General Imboden came out to Bristol, Virginia-Tennessee, the then nearest railroad point, and rode out on horseback and looked over the iron ore and coal fields of Wise and Lee counties and made his report, having taken options upon three large coal properties then for sale. The result was that a purchase was made of the Olinger survey, embracing forty-two thousand acres (42,000) by C. S. O. Tintsman, of Pittsburg, and associates.

"Some time after this E. K. Hyndman, then Superintendent of the Western Division of the Baltimore and Ohio Railroad became interested in the properties, and another large boundary, containing twenty-five thousand (25,000) acres was purchased by him from Patrick Hagan and in March, 1881, Hyndman purchased the interests of his associates and became the owner of the whole.

"Hyndman was then engaged in driving shafts and developing the now celebrated Connellsville coal for the Connellsville Coal and Iron Company, composed of leading men of Mauch Chunk and Philadelphia, Pennsylvania, John Leisenring, John C. Bullitt, Samuel Dickson, Robert H. Sayre, Samuel Thomas, J. S. Wentz, M. S. Kemmerer and others. Hyndman soon interested these people in his Virginia properties and one year later The Virginia Coal and Iron Company [1882] was chartered by the General Assembly of Virginia, and upon its organization took over Hyndman's Virginia lands. This was the first large purchase of coal lands in Wise County by coal men for development, and was the commencement of a movement which

[1] Ayers, Rufus A., History of Wise County: Crawford's Weekly, Norton, Va., October, 1920.

afterwards led to the purchase of nearly all the coal lands in Wise County by practical coal men and greatly improved the prospects and enhanced the value of its real property.

"The development of these properties was however delayed for many years for lack of transportation, and it was not until 1890 and 1891 that Wise County secured railroads. When they did come they came with a rush. The South Atlantic and Ohio Railroad (now the Southern) was completed in the spring of 1890 and the Louisville and Nashville and Norfolk and Western Railroads were completed to a junction at Norton in 1891, and the development of the coal and iron of the county commenced; few mines were opened however until 1895 and singular to say, the first iron made at Big Stone Gap was made with Pocahontas coke, although there was unequalled coking coal within a rifle shot of the plant. However from 1895, the development grew rapidly, coke ovens were built, mines opened, branch railroads built, mining towns built, other enterprises established; the population largely increased and fine school buildings and churches erected."

The first coal mined and shipped from Wise County was taken from drifts on Looney Creek in 1892, by the Virginia, Tennessee and Carolina Steel and Iron Company. The coal was shipped out over the South Atlantic and Ohio Railway (now the Southern Railway). Other mines were opened the same year at Norton and at Banner. Robert Fleming, of Norton, one of the first to develop the Banner and Norton fields, states that the No. 1 Norton bed was the first utilized and that Norton mines No. 1, No. 4 and No. 7 were opened in 1892. The operation at Banner was in the Kennedy bed and was in charge of the Virginia Gas Coal Company.

Coke was first made at Norton by Mr. Fleming. By heating coal in a two inch pipe partially stoppered at both ends he obtained a rather poor coke. Several car loads of coal were sent to Pocahontas and coked and the results were declared successful, putting an end to the prevailing impression that the Norton coals would not coke.

The Stonega Coke and Coal Company completed their first hundred ovens in the spring of 1896. This company is now the largest coal and coke producer in the county. The Tennessee Coal and Iron Company built ovens in 1897 and 1898 on Toms Creek. Following these, other operations were begun as rapidly as railroad facilities permitted.

It is interesting to note that foreign capital was conspicuous in the development of the region. English capitalists, with Swiss and Dutch were first to enter the field. Boissevain, a European banker of Switzerland, represented both Dutch and Swiss interests in the field. Robert Fleming[1]

[1] Not related to Robert Fleming of Norton, Virginia.

of Scotland also invested large sums for the exploitation of the Wise coal field. At present, however, no foreign interests are connected with mining operations in Wise or Scott counties.

Method of geological work.—The present geologic and topographic survey of Wise County and the coal-bearing portion of Scott County was carried on jointly by the United States Geological Survey and the Virginia Geological Survey. The expense of the work was shared by the two organizations.

The topographic map for this report was begun in 1911, with the survey of the Pound River and Birchfield Creek drainage basins. The Guest River basins were surveyed during the field seasons of 1916 to 1921. The geological examination of the Pound River basin was made simultaneously with the work of the topographic corps. On the drainage basins of the other major streams the geologists had the advantage of working on the finished topographic maps.

The method of geologic work was adapted to the hilly, wooded type of country so characteristic of Wise and northern Scott counties. Geologic profiles were made of roads, stream courses and ridge lines. The profile shows the vertical section of sandstones, shales, and coals, as noted by the observer along any given path, elevations being constantly read from the barometer and the profile sketched to a vertical scale in a notebook. Reference to all locations was made on the field map and in the notebook profile by letters or numbers. Where exposures permitted, measurements were made of the various strata and are given in the table of local sections, pp. 87 to 114.

The presence of distinctive coal beds and massive sandstones has greatly facilitated the work of determining the structure and the succession of formations. Thus in the Coeburn region the Upper Banner coal bed is recognizable throughout a large area by a very persistent sandstone parting, and in the Stonega field a layer of coal within the Imboden bed, showing wavy or curved fracture surfaces, and called by the miners "curly" coal, is characteristic of the bed. The sandstone bed at Wise is so massive and persistent a feature that it was named the Gladeville sandstone by Campbell,[1] and mapped by him as a formation unit throughout the entire county and into the adjacent counties. In other parts of the vertical section, sandstone strata have in many places served as key rocks.

[1] Campbell, M. R., Geology of the Big Stone Gap Coal Field of Virginia and Kentucky, U. S. Geol. Bull. 111, p. 33, 1893.

In determining the geologic structure of the coal field of Wise County, the geologists have been greatly aided by the extensive developments of the coal companies, both in their underground operations and their core drilling and prospecting. Outcrops have been traced by company engineers throughout a large portion of the field, and accurate elevations of the coal beds determined. Information of this character was cheerfully furnished by all the companies in-so-far as they were able. Outside of the area of active mining the elevation of old coal mines and prospects was determined by aneroid barometer, which was checked during the day as many times as possible by bench marks or stadia stations, thus minimizing the error due to changing atmospheric pressure. All coal prospects and blooms seen by or reported to the geologists were visited and measurements made of the coal exposed. Samples of coal were collected for chemical analysis and ash fusion tests from nearly all the important mines in Wise and Scott counties. Several samples were collected from prospect pits and wagon mines in an effort to give as wide range as possible to the stratigraphic and geographic distribution of the samples taken. The strike and dip of the beds were determined as accurately as the exposures would permit. All coal locations were plotted on a base map, including symbols showing the strike and dip of the coal beds.

The final geologic map of Wise and northern Scott counties (pl. II) was made in the office at the completion of the field season. In its compilation all the data of field notes, maps, trustworthy outcrop surveys, borehole sections and kindred records have been thoroughly digested and used.

Acknowledgments.—Much valuable information was placed at the disposal of the writer by officials and employees of the many coal corporations and companies in the Wise County field. W. D. Tyler, of the Clinchfield Coal Corporation, furnished maps of transit surveys of coal outcrops in the basins of Birchfield, Bowlecamp and Indian Creeks, and the South Fork of Pound and Upper Guest rivers. The surveys included hundreds of measured sections of coal beds, many of which are given in the following text. The Clinchfield Coal Corporation through Mr. Tyler has also permitted with qualifications, the use of the records of the many drill holes put down in or near Wise County, (Pl. III). D. D. Hull, Jr., vice-president of the Virginia Iron, Coal and Coke Co., through D. A. Patterson, general superintendent of mines at Toms Creek, furnished surveys of coal outcrops, drill-hole records and coal sections, for much of the Toms Creek, Bull Run, Russell Creek and Looney Creek basins. J. A. Deaton, chief engineer of the company, cooperated generously in supplying the engineering and coal data.

In western Wise County the Virginia Iron, Coal and Coke Co., and the Stonega Coke and Coal Co., supplied considerable important data. E. J. Prescott, vice-president of the former company, gave bore-hole records and coal outcrop surveys of the Callahan and Roaring Fork basins. Otis Mouser, vice-president of the latter company permitted the use of the records of his company. The writer is greatly indebted to J. B. Rogers, chief engineer of the Stonega Coke and Coal Co., for his helpful cooperation in furnishing data on coal surveys, bore-holes, etc.; for many valuable suggestions; and for the use of the engineering facilities of the company. A. R. Gordon and C. Bailey, of the engineering department, spent considerable time and effort in placing a great amount of data within reach of the writer. The data furnished by this company cover the Pigeon Creek and Callahan Creek basins. The Stonega Coke and Coal Co., has also given many excellent photographs illustrating different phases of mining in Wise County for publication in this report.

In central Wise County the Wise Coal and Coke Co., the Norton Coal Co., and the Blackwood Coal and Coke Co., have furnished considerable information on the coal beds of that section of the field. D. Terpstra, general manager of the Wise Coal and Coke Co., extended the use of all the records of his engineering office and every facility for the furtherance of the field work. The many bore-hole records of the company are most valuable. The Norton Coal Co., through J. K. Taggart, general manager, gave coal sections and bore-hole records of the lower portion of the Upper Guest River basin. C. J. Creveling, general manager of the Blackwood Coal and Coke Co., furnished much information on the coal beds of Black Creek and Roaring Fork, and E. L. Gobble, chief engineer, spent considerable time with the writer in supplying and arranging the data. G. C. Scarborough and F. T. Dotson, civil and mining engineers, of Norton, and D. E. Llewellyn, consulting engineer, of Wise, assisted greatly by furnishing coal outcrop maps, coal sections and general information on the Upper Guest River and Bear Creek basins.

Information of value to the report was also furnished by R. A. Ayers, R. T. Irvine, E. B. Lipps, G. V. Hughes, Malcolm Smith and others of Wise County and by C. A. Bilips of the United States Coal and Coke Co., Lynch, Kentucky. The writer is also indebted to J. L. Wells for transit work done for this report.

Free use has been made of all previous publications in the preparation of this report. The field was mapped in large part by M. R. Campbell for the Bristol and Estillville folios of the United States Geological Survey.

The field was described in 1893 from the economic standpoint by Campbell in Bulletin 111 of the U. S. Geological Survey. Campbell and Woodruff described a small part of the Powell Mountain coal field in Bulletin 431 of the United States Geological Survey, 1909. Charles Butts reported on the Geology of the Pound Quadrangle, Virginia, in Bulletin IX of the Virginia Survey and in Bulletin 541 of the U. S. Geological Survey.

The writer is greatly indebted to Mr. Campbell of the United States Geological Survey, who had general supervision of the present work, for his critical field examination in the fall of 1920 and in the spring of 1921, and his invaluable suggestions and cooperation in the office preparation of the report. As the result of his work on Black Creek, Powell River, and Upper Guest River, many of the outstanding problems in coal correlation were solved. Parts of the field were mapped by C. K. Wentworth of the United States Geological Survey and A. W. Giles of the Virginia Geological Survey. Mr. Wentworth spent part of the summer and fall of 1919 and the entire spring and summer of 1920 in Wise County mapping the Powell Mountain district, and parts of the Coeburn district. He also made many traverses in western and central Wise County. The writer received many helpful suggestions from Mr. Wentworth. Parts of the Toms Creek basin and eastern Powell Mountain were mapped by Mr. Giles in the summer of 1919.

David White, of the United States Geological Survey, spent several days in the field collecting plant fossils and later devoted considerable time in the office to studying the collection for the purpose of making correlations within the field and also with other fields of the Appalachian region. He also made a special visit to the field in company with the writer in the autumn of 1922 to determine the age of the Burtons Ford coal bed.

GEOGRAPHY

Surface Features.

General characteristics of the field.—The Wise and Scott County fields are included in what physiographers call the Appalachian Plateaus that consist of several plateaus which in some places have flat tops but in other places have been so dissected by the streams that only hills and ridges remain. These plateaus lie to the northwest of the long straight ridge of Stone Mountain from south of Cumberland Gap to Little Stone Gap in Wise County. Here the boundary swings to the south and west and encloses the plateau of Powell Mountain which forms a projecting salient in the generally straight boundary of the coal field. From the southern point of Powell Mountain the boundary of the coal field and the Allegheny plateaus is a straight northeast line to beyond the margin of the territory here described and mapped.

Southeast of the line forming the southeastern boundary of the coal field lies the Appalachian Valley province which in general consists of rudely parallel valleys and ridges, the valleys general being eroded in limestone or soft shale and the ridges being formed of the more resistant sandstone. The only part of this province that falls within the area shown on the map (Plate II) is Powell Valley in the vicinity of the town of Big Stone Gap. This will be described more fully on another page.

In general the Appalachian Plateaus consist of an upland which is highest on the east and slopes gradually westward until it reaches nearly the level of the lowland or ordinary surface in central Kentucky and Ohio. In most places the streams have cut so deeply into this upland that its plateau-like character has disappeared and the surface consists only of hills and irregular ridges rising to a fairly common level. In places the upland surface has been protected from the cutting of the streams by hard beds of flat-lying rocks and here the plateau is quite well preserved. This is particularly true of the Cumberland Plateau of Tennessee and the Allegheny Plateau of Pennsylvania. In other places mountains stood upon the surface of the upland before it was attacked by the streams and today these same mountains, though much reduced and dissected by the streams, still stand above the hill tops of the surrounding region. The mountainous part includes the Black Mountains on the border of Wise County, Pine and Cumberland mountains, and a high, irregular group of mountains in Tennessee.

Wise County is situated on the border line between the mountainous region to the southwest and the deeply dissected, but even-topped upland on the northeast and partakes of the character of both.

In some places the plateaus of this province extend unbroken to its extreme southeastern border, but in others the border is marked by a linear ridge or mountain formed of upturned rocks. Thus the border from Cumberland Gap northeastward is marked by the sharp regular crests of Cumberland and Stone mountains as far as Little Stone Gap south of Norton and on the southeast side of Powell Mountain by a similar, though not so high a ridge from the southwestern point of Powell Mountain to beyond the limits of Scott and Wise counties. Farther northeast the ridge at the southeastern margin of the field is less conspicuous, because the rocks in the lower part of the coal-bearing formation are less resistant to erosion and they have been cut down to the general level of the hilltops in the surrounding region.

Detailed characteristics of the field.—The coal fields of Wise and Scott counties contain almost all types of surface forms that are found in the Appalachian Plateaus. In most places the surface consists of an originally slightly sloping plateau which has been so completely dissected by the streams that little or no remnants of the old plain remain on the hilltops, but the dissection has not been carried on to such an extent as to produce valleys of any great width. As a consequence of this deep erosion by the streams the surface generally consists of sharply cut V-shaped valleys separated by equally sharp ridges and the slopes leading from one to the other are almost as steep as the rocks will stand.

A country composed almost wholly of steep slopes is not well adapted to agricultural pursuits for the ridge tops are generally too narrow to be farmed, the slopes are too steep, and even the valleys will permit only of small farms on the benches and limited flood plains of the rivers. For coal-mining, however, the deep dissection is very favorable as most of the coal beds crop out on the hill sides and only a slight cover of waste material needs to be removed to expose them in their full thickness. The deep valleys also permit of the opening of mines in most of the beds by simply drifting into the hill side at tipple height, or if the coal bed lies too high on the hillside by an inclined tramroad. The building and operation of railroad lines is somewhat difficult and expensive in such a country, and railroads are confined almost entirely to the valleys, but as these ramify into all parts of the field a railroad up a master stream with branches up side valleys makes almost all of the drainage basin accessible.

In places, as on Sandy Ridge and about Wise in the eastern part of Wise County and on some parts of the broad arch of Powell Mountain in Wise and Scott counties, particularly resistant beds of sandstone or conglomerate have so retarded the action of the stream that the old plateau-like surface has been retained in much the same condition that it was when this plain was developed in ages long past and today these features stand out as distinct plateaus and as good examples of what almost all of the surface of this county was like before it was cut to pieces by the streams. Most of the farming land of the coal field is found on these plateaus.

The surface forms whose tops stood above the plain that once characterized the greater part of the coal region are the Black Mountains, on the northwest, Pine Mountain on the north, and Stone, Little Stone and Powell mountains on the south. All of these except Black Mountain and Powell Mountain are linear ridges whose form is controlled largely by the upturned resistant beds that form them. Such mountains as a rule are more regular and persistent than mountains composed of horizontal rocks and hence are more formidable barriers to transportation and mining. Pine and Black Mountains form a great natural barrier between Kentucky and Virginia, with Pound Gap the only wagon route in this area over the former mountain. The northwest slope of Pine Mountain is an escarpment 1,500 to 2,000 feet high, which presents a striking front, as its crest is scarcely a mile from the valley floors of Elkhorn Creek and the North Fork of Kentucky River. No water gap pierces this divide in Wise County, the nearest one being the "Breaks of Sandy", the profound gorge of Russell Fork, in Dickenson County, 20 miles to the northeast. The southeast slope of Pine Mountain is practically a dip slope on massive sandstone beds and the streams flow off in straight structurally-determined courses into Pound River and its North Fork.

The region drained by Pound River and its tributaries is a country of narrow circuitous divides, and peaked hills, with steep slopes. Flat Gap is a low pass in the divide between the waters of Pound and Cumberland rivers. Within a radius of three and one-half miles of this gap, it is interesting to note that the waters of five different major drainage systems may be reached through the headwaters of Cumberland, Kentucky, Pound, Powell and Guest rivers.

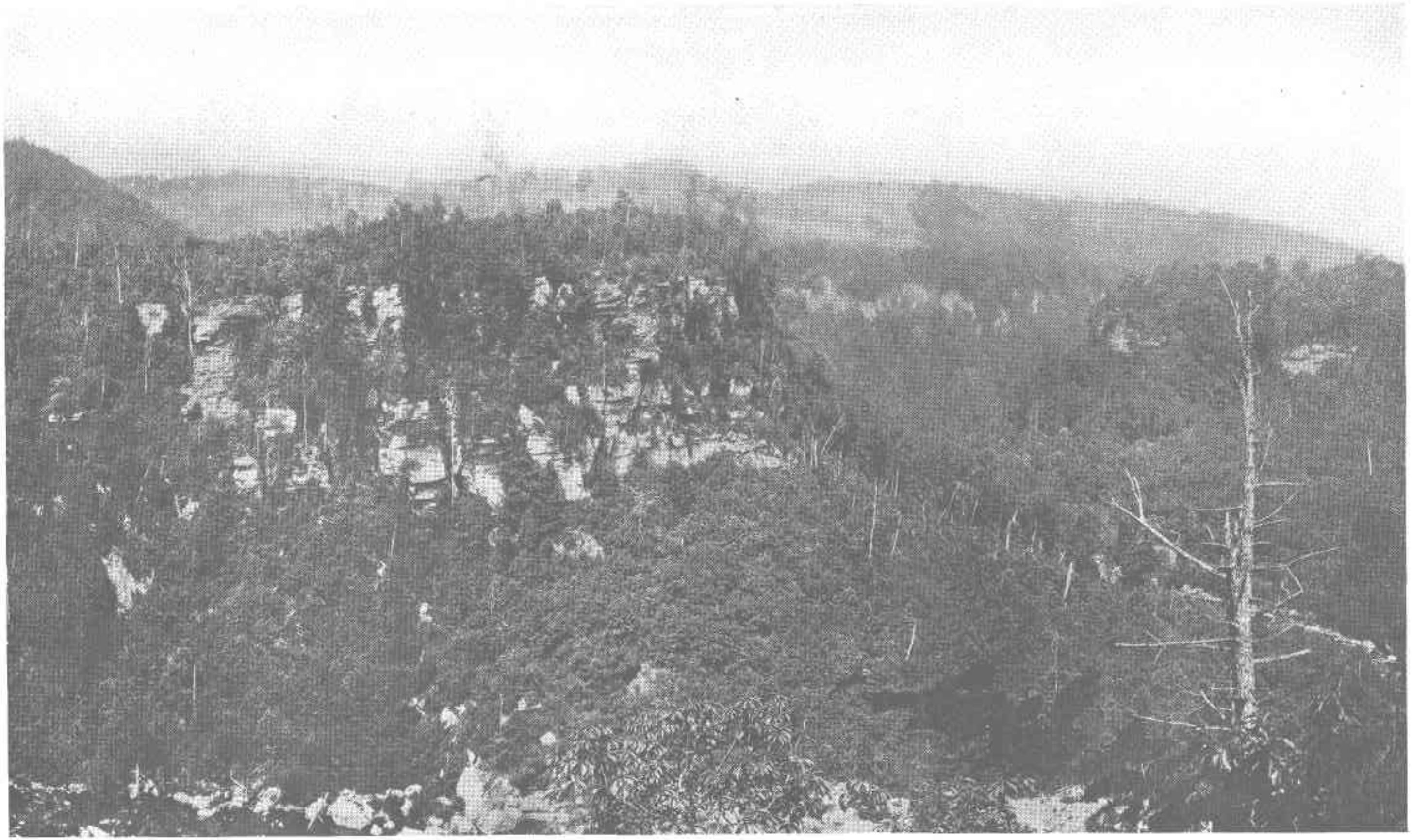
The rough, broken surface of west-central Wise County is somewhat similar to that of the northern territory. Few people live on Pigeon Creek and Bearpen Branch outside of the coal-mining settlements of Exeter and Imboden, as farming is very difficult and in many places impractical. Farther east on Callahan Creek and Roaring Fork the valleys are wider, the hills lower, and their sides less steep. This ease of approach has led to the construction of railroads up the valleys of these creeks and has thus paved the way for the present development of the coal beds. From Roaring Fork east to Norton the ridges are held up by a thick sandstone near their summits which gives this region many of the plateau features.

Strikingly different surface forms are found on Powell Mountain. Wild and almost inaccessible canyons have been cut by the streams in sandstone and conglomerate beds of extraordinary thickness. The impressive walls of these canyons, in many places, rise vertically from 100 to 300 feet, presenting the most serious obstacle to the building of transportation lines

GORGE OF GUEST RIVER, SOUTHEAST OF COEBURN.

The canyon is cut in hard conglomerate of the Lee formation and has walls 200 to 350 feet in height. Despite the fact these walls are almost bare conglomerate, an abundant growth of pitch pine, laurel, and kindred types of vegetation is sustained by rooting in joints, cracks along bedding planes, and other fissures.

Photo by C. K. Wentworth.



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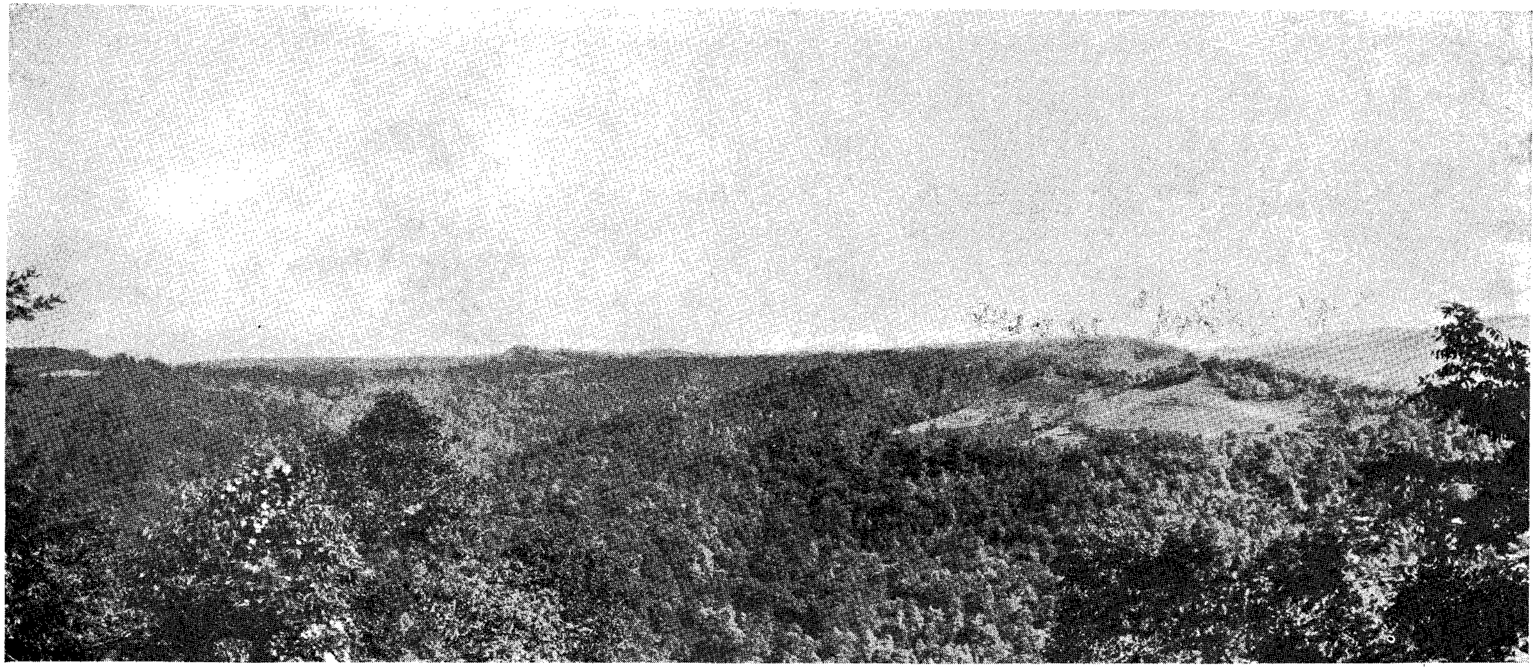
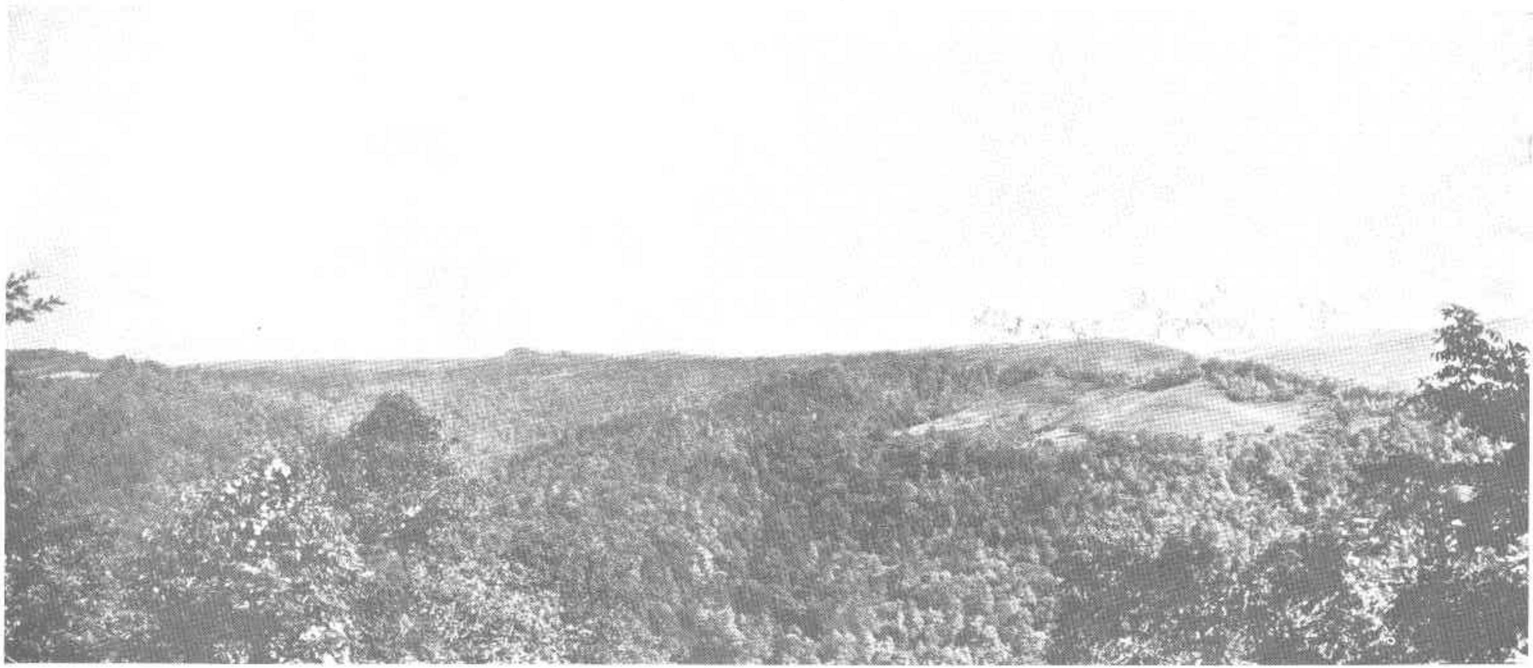


PLATEAU EAST OF BEAR CREEK.

View looking east, over Bear Creek, from the West Coal Company mine, (location 420). The plateau is held up by the resistant Gladeville sandstone. The north slope of Powell Mountain shows in the extreme right of photograph.

Photo by M. R. Campbell.



PLATEAU EAST OF BEAR CREEK.

View looking east, over Bear Creek, from the West Coal Company mine, (location 420). The plateau is held up by the resistant Gladeville sandstone. The north slope of Powell Mountain shows in the extreme right of photograph.

Photo by M. R. Campbell.

into the field. The South Fork of Powell River, at the Cracker Neck, Stock Creek and Guest River have each cut a picturesque gorge. (See Pl. V).

Powell Mountain which is the result of erosion acting on a broad arch of the rocks, which plunges toward the northeast, reaches its culmination in High Knob, 4,162 feet above sea level. From this high point the surface slopes gradually to the northeast and south in general conformity with hard beds of sandstone which dip in the same direction. West of High Knob the great arch has been breached by the cutting of Powell River, which has broadened its valley in the limestones and soft shale that form the core of the arch or anticline until it has a maximum width of 3 miles. In this valley are situated the town of Big Stone Gap and several villages that have sprung up on the line of the Southern Railway. The north limb of the anticline, composed of steeply dipping beds of sandstone and conglomerate forms a rugged mountain that separates Powell Valley from the coal field on the north. This great mountain barrier extends southwestward from the vicinity of Norton far into Tennessee and its continuity is broken only at two places in a distance of 140 miles. One of these breaks in Lee County, known as Pennington Gap, was formed by the North Fork of Powell River cutting deeply into the upturned rocks, and the other is Big Stone Gap in Wise County, which has been cut by the main stream of Powell River.

Big Stone Gap through Stone Mountain has been one of the most important factors in the development of the Wise County coal field as it has afforded a water grade for the approach of two lines of railroad, the Southern and the Louisville and Nashville railroads, into this field. It also affords an easy route for a highway which now links the principal coal mining towns north of the mountain with the town of Big Stone Gap and other towns of the limestone region on the south.

The broad basin-like depression of Powell Valley, rimmed on three sides by high, steep slopes, is a surface feature in striking contrast to the plateaus and V-shaped valleys of the coal-field of Wise County. The valley country belongs to what physiographers have called the Appalachian Valley province. The view from the rim of the enclosing mountains at Little Stone Gap down into Powell Valley is the most impressive scene a traveler sees in passing over the main roadways of Wise County, and a photograph of this view is shown as Plate IV. The floor of the valley, as may be noted in this picture, is not flat but is a rolling country featured by rounded knobs and low linear ridges. Two streams—Butcher Creek and Beaverdam Creek, carry off the surplus water and they have cut shallow channels in the main valley floor. Both empty into the South Fork of Powell River in the vicinity of East

Stone Gap. The divide separating these streams is chiefly a limestone ridge, which is characterized by sinkholes and small knobs, none of the latter being more than 50 to 100 feet high. Looked at from above, these minor topographic features of the valley appear insignificantly small in contrast to the enclosing rim that towers 1,400 feet above the general level of the valley floor.

In the middle distance a low mountain, known as Wallen Ridge, rises in the midst of the valley and grows higher and higher in a westerly direction, until it reaches its culmination in Elk Knob, 2½ miles southwest of the town of Big Stone Gap. The ridge is unsymmetrical, having a gentle slope on the southeast side, corresponding in a general way with the dip of the hard sandstone composing it, and a steep slope on the northwest side, extending down to Powell River which flows 1,600 feet below the level of its highest point.

The rolling country of the upper portion of Powell Valley is well adapted to farming and most of it is cleared and under cultivation. The soil in places, however, is rather poor, being a whitish clayey soil, derived from the weathering of black shale, and is much inferior to the limestone soil which is best suited for farming purposes. The distribution of kinds of soil in the valley country agrees closely with the outcrops of the underlying rocks as shown on the geologic map, Plate II.

The maximum relief in Wise County and the coal-bearing portion of Scott County is 3,000 feet. The largest interval recorded between bench marks is 2,829 feet, measured from High Knob in south central Wise County at an elevation of 4,162 feet, to Dry Creek, near Dungannon, in Scott County, at an elevation of 1,333 feet. Pine Mountain ranges in elevation from 2,407 feet at Pound Gap to 3,200 feet where the State boundary line turns south from the crest, and Black Mountain ranges from 3,500 feet to over 4,100 feet at the Double. High Knob of Powell Mountain is the highest point in Wise County. It is 1,557 feet lower than Mount Rogers in Grayson and Smith counties, the highest point in the State.

Drainage.—The drainage of Wise County and the adjacent portion of Scott County is divided between that flowing northeastward to Russell Fork of Big Sandy River and that flowing southward and southeastward into Clinch River. In either case the water reaches Ohio River, but in the former by way of Big Sandy River, and in the latter by way of Tennessee River. The divide between these two drainage systems is extremely circuitous, with a remarkable interfingering of branches tributary to the two master streams. The main components of the Clinch River drainage in this field are Powell and Guest rivers and Clinch River itself, which borders the southeastern edge of the coal field. Guest River empties into Clinch River where the boundary lines of Russell, Scott, and Wise counties intersect, and Powell River joins the same stream in Campbell County, Tennessee. In the Russell Fork basin, the principal streams are Pound River, including North and South forks, Birchfield Creek, and Cranesnest River, the two last mentioned joining at the boundary between Wise and Dickenson counties, two miles east of Birchfield school.

The larger tributaries of the two master rivers mentioned above are fed by innumerable smaller tributaries, ranging from intermittent brooks to permanent streams of fair size. A glance at the contour map of Wise County accompanying this report reveals at once the intricate drainage pattern. The repetition of stream names in various parts of the country is also conspicuous. To avoid confusion in this report, in all cases of repetition, the stream into which the one in question flows will also be mentioned, such as Dry Creek of Stony Creek, or Dry Creek of Clinch River.

Many of the streams in this region carry very little water except in times of rains or the melting of snow. Nearly all the smaller streams dry up and even the major streams, such as Pound, Guest and Powell rivers, dwindle to insignificant proportions during periods of prolonged drought. Water from heavy rains is quickly carried off, as the streams in most part have steep gradients which, with the sandy soil and wooded slopes, prevent the heaviest rains from giving rise to serious floods. In view of the rapid runoff of the water, the larger towns, in order to conserve a water supply, have been forced to construct reservoirs by damming the streams. Clinch River is the largest stream in the territory and carries a fairly large volume of water all the year round. The waters of a few of the streams on the south slope of Powell Mountain flow in places for miles in a mantle of water-worn boulders, which conspicuously marks the course of the stream, but conceals the water, a fact which gives rise to the popular term "dry creek."

Springs are fairly abundant and many underground streams of considerable volume come to the surface in the limestone country. The majority of the springs are persistent and do not dry up except in times of prolonged drought. The rainfall in Wise County is large, the annual precipitation averaging about 47 inches.

Accessibility of the coal field.

The development of a new coal field or the extension of workings in an old field depends almost entirely upon its accessibility to railroads. The railroads in turn must follow the valleys, as the valleys are the natural channels of ingress and egress to any hilly or mountainous field. In the Wise County field two great barriers, Pine and Stone mountains, practically inclose the coal field. Nature, however, in carving the Big Stone Gap, (See Pl. IX A), has provided a natural gateway to and from the south, the west, and the east, the advantage of which the railroads were quick to appreciate. The gorge of Guest River, long recognized as a possible railroad route to and from the basin, will soon be the site of another railroad connection to the field, as the construction down that stream of an extension of the Interstate Railroad to connect with the Carolina, Clinchfield and Ohio Railroad at Bangor is now being undertaken.

The Clinch Valley Division of the Norfolk and Western Railway enters Wise County at St. Paul. It leaves Clinch River west of St. Paul, and climbs by a steep grade, several tunnels and high trestles, to the open portion of Guest River valley west of Coeburn, reaching Norton its southwestern terminus. The Louisville and Nashville Railroad (Cumberland Valley division) follows Powell River from the county boundary through Big Stone Gap to Dorchester and crosses the low Powell-Guest rivers' divide into Norton. The Southern Railroad (Appalachian division, formerly the South Atlantic and Ohio and later the Virginia and Southwestern) enters from the southeast, through Big Stone Gap to Appalachia, and turns west into Lee County. The Carolina, Clinchfield and Ohio Railroad from Spartanburg, S. C., to Elkhorn City, Ky., follows Clinch River along the southeast border of the county crossing the Norfolk and Western at St. Paul. Towns on Callahan Creek, Roaring Fork, upper Powell and Guest Rivers are served by branches of the Interstate Railroad, the main line of which parallels the Louisville and Nashville Railroad from Norton to Appalachia. The Norton and Northern Railroad is a short line running up Yellow Creek Valley, connecting Norton with Wise.

The bulk of the coal finds its way to market over the Norfolk and Western, and Southern railways. Over the former, it is shipped, via Bluefield, to eastern and northern cities and over the latter it goes, via Moccasin Gap, to southern, eastern and northeastern points. Coal shipped by the Louisville and Nashville Railroad, goes via Middleboro, Ky., to points west and southwest.

The entire southern half of Wise County is opened by these railroads for mining development. The northern half, the Pound River drainage basin, does not possess a single railroad, to urge the exploitation of its coals. A logging road formerly ran north down Indian Creek from Glamorgan to Pound River and up Laurel Branch to Pine Mountain but it has been torn up. Several surveys have been made up Pound River from the Carolina, Clinchfield and Ohio at the Breaks of Sandy, but no construction has yet been attempted.

The coals of the Lee formation on Powell Mountain are not so accessible as are the coals to the north and east. The streams here have steep gradients including falls in many places and offer few natural advantages for the location of a railroad. A tramway for lumber has been built from Fort Blackmore seven or eight miles up Stony Creek and its branches, and another was built up Little Stony Creek from Dungannon. Some coal is carried out by the latter for shipment, but none from the former. There is very small likelihood at present of a standard-gauge spur of the Carolina, Clinchfield and Ohio Railroad on Clinch River being built up either creek. Indeed so much does the surface features retard development here that it is likely to be many years before the Powell Mountain coals, in view of their present inaccessibility, will be profitably worked.

GEOLOGY

STRATIGRAPHY.

GENERAL STATEMENT.

The rocks of this country have been divided by geologists into major systems, which in turn are subdivided into series, groups, formations, and members. A system of rocks includes all those that have been laid down within a single period of geologic time; for example, the Devonian system and the Carboniferous system. A series of rocks includes all those that have been formed within a single epoch of geologic time; for example, the Mississippian series and the Pennsylvania series. Systems and series are frequently subdivided into groups, the groups into formations, and the formations into members. The division into formations and members is based largely on the lithology of the rocks. In order that the reader may have a general picture of the division of time as the geologist sees them and under-stand the relationsip of the rocks exposed in Wise County to the entire time scale, the geologic table as accepted by the United States Geological Survey, is given below:

Era.	*Period.*	*Epoch.*
Cenozoic	Quaternary	Recent Pleistocene
	Tertiary	Pliocene Miocene Oligocene Eocene
Mesozoic	Cretaceous Jurassic Triassic	
Paleozoic	Carboniferous	Permian Pennsylvanian Mississippian
	Devonian Silurian Ordovician Cambrian	
Proterozoic and Archeozoic	Algonkian Archean	

The rocks exposed in the territory described in this report range in geologic age from the Cambrian up into the Pennsylvania, and they are described in stratigraphic sequence from the lowest to the highest. In general, they may be divided into the coal-bearing and the non-coal-bearing rocks. The recognized base of the coal-bearing rocks in this field is the base of the Pennsylvanian. A few thin and inconsequential coal beds occur in the Mississippian, but they are of no economical value. The chief outcrops of the pre-Pennsylvanian or non-coal-bearing rocks lie in Powell Valley. They have been mapped by G. W. Stose, of the United States Geological Survey, who is the author of the following section on the geology of these beds.

PRE-PENNSYLVANIAN ROCKS.

By George W. Stose.

General statement.

The pre-Pennsylvania rocks exposed in Wise County and adjoining part of Scott County embrace formations ranging in age from Cambrian to Mississippian. Most of these rocks are found only in Powell Valley, but Missis-sipian formations and Cambrian rocks that are not differentiated into formations on the map occur on the southeastern edge of the coal field. Missippian strata that are not differentiated on the map are also present in the faulted zone of Pine Mountain in the north part of Wise County. The following descriptions pertain, therefore, chiefly to Powell Valley. The Cambrian rocks that are undifferentiated on the map will not be described.

The five formations of Ordovician age described are exposed only in a small area northwest of Wallen Ridge in the vicinity of Big Stone Gap; the three formations of Silurian age form a large part of Powell Valley in southwestern Wise County; the three formations of Devonian age and one of Devonian and Carboniferous age occupy much of the lowland and lower slopes of the mountains bordering Powell Valley; and the four formations of Mississippian age occur on the higher slopes of the bordering mountains. (See Pl. IV.) The area was previously mapped in the Estillville folio of the U. S. Geological Survey by M. R. Campbell. Most of the formation units used by him have been subdivided on the map accompanying the report of Wise County, which is on a larger scale, and details of structure and geologic history are brought out by the mapping of smaller units. The recognition of these units was accomplished with the aid of E. O. Ulrich and Charles Butts, with whom the writer spent parts of two days in the field, and by the identification by E. O. Ulrich and George H. Girty of fossils collected during the field work. Mr. Ulrich identified all fossils from pre-Carboniferous rocks, including those from the black shale of Devonian and Carboniferous age, and made the correlation of these faunas with those of other parts of the Appalachians. Mr. Girty identified the fossils from the Carboniferous rocks directly above the black shale. The names and brief descriptions of the formations are given in the columnar section, figure 2, page 24.

Ordovician System.

LOWVILLE LIMESTONE.

Character and distribution.—The Lowville limestone is the oldest formation exposed in the county, and only two small areas have been observed, one at the Lee County line and another in Williams Cove 1 mile northeast. These outcrops are along the axis of greatest uplift of the Powell Valley anticline. The beds there exposed are chiefly thin-bedded fine-grained drab to light-reddish limestone, with some crystalline fossiliferous limestone and laminated argillaceous limestone which weathers buff and shaly. To the south in Lee County the formation is more completely exposed. On the Turkey Cove road one-half mile south of the county line thin-bedded

System	Series	Formation	Thickness in feet	Description
CARBONIFEROUS	PENN.	Lee formation		Massive sandstone and conglomerate
CARBONIFEROUS	MISSISSIPPIAN	Pennington shale	1025	Chiefly gray to greenish shale and some sandstone and thin conglomerate; thick sandstone at base; of late Chester age.
CARBONIFEROUS	MISSISSIPPIAN	Newman formation	830	Calcareous shale and shaly limestone and massive oolitic limestone, lower part cherty; of Glen Dean, Gasper, and Ste. Genevieve age.
CARBONIFEROUS	MISSISSIPPIAN	Maccrady shale and Price sandstone	240-300	Reddish to green shale and sandstone above; gray sandstone and shale below; of Cuyahoga age.
DEVONIAN AND CARBONIFEROUS		Big Stone Gap shale	320±	Black fissile to platy shale; contains few minute fossils.
DEVONIAN		Portage shale	400±	Interbedded drab and black shale; contains few minute fossils.
DEVONIAN		Genesee shale	200±	Fossiliferous black fissile shale
DEVONIAN		Helderberg limestone	40-135	Sandy cherty fossiliferous limestone.
SILURIAN		Cayuga limestone	225	Chiefly laminated thin-bedded limestone and some dolomite and sandstone
SILURIAN		Clinton formation	400	Fossiliferous shale and thin sandstone, with several beds of hematite iron ore; hard slabby sandstone at the top.
SILURIAN		Clinch sandstone	180-200	Hard thin-bedded quartzite and interbedded shale
ORDOVICIAN		Sequatchie formation	200±	Red calcareous sandstone; of Richmond age.
ORDOVICIAN		Reedsville shale	460±	Soft shale and nodular impure limestone; of Maysville and Eden age
ORDOVICIAN		Catheys limestone	225±	Highly fossiliferous gray crystalline limestone of upper Trenton age.
ORDOVICIAN		Cannon limestone	375±	Chiefly impure limestone with occasional beds of fossiliferous purer limestone; of middle Trenton age.
ORDOVICIAN		Lowville limestone with Moccasin limestone member at top.	540±	Reddish argillaceous limestone. Fine-grained drab limestone

H. F. C.

Fig. 2.—Generalized columnar section of the pre-Pennsylvanian rocks.

bluish to drab fine-grained limestone passes downward into shaly limestone which weathers to greenish crumbly shale with interbedded thin drab limestone containing bryozoa and some brachiopods. In the small valley at the west foot of Wallen Ridge 1 mile south of the Wise County line there are fresher exposures of fine-grained earthy drab limestone, which weathers greenish yellow and shaly, interbedded with more shaly, greenish limestone. The higher beds of the formation are generally reddish argillaceous limestones. A section at the west foot of Wallen Ridge near Deep Spring School, 7 miles southwest of the town of Big Stone Gap, measured by E. O. Ulrich, is as follows:

Section of Lowville limestone near Deep Spring School, Lee County.

(By E. O. Ulrich.)

	Feet.
Limestone, thin-bedded, with large crinoid stems. (Base of Cannon limestone.)	
Limestone or calcareous mud rock, reddish, argillaceous, finely wavy, laminated. (Moccasin red limestone member)	50
Limestone, shaly, highly fossiliferous	50
Limestone, highly fossiliferous, thick-bedded at base	50
Largely covered. Occasional layers of fine-grained drab limestone, the intervening covered spaces probably underlain by more shaly beds	200±
Limestone, granular, fossiliferous	30
Covered	100±
Limestone, fine even-grained, drab	60
Limestone, rather thick-bedded, with some chert. (Top of Stones River limestone.)	
	540±

Age and correlation.—The fossils collected from the Lowville limestone in Powell Valley in Wise and Lee counties comprise bryozoa, ostracods, brachiopods, and trilobites, and include such characteristic forms as *Tetradium cellulosum, Leperditia fabulites, Isochilina armata, Bathyurus extans,* and *Cryptophragmus antiquatum,* Raymond (*Beatricia gracilis,* Ulrich). This fauna is correlated with that of the Lowville limestone at Lowville, New York. Many of the same forms were found in the Moccasin limestone of Tennessee by Ulrich, but as the formation does not possess the red earthly character in so marked a degree as the typical Moccasin that name is not regarded as applicable. As the formation is regarded equivalent to the Lowville of New York that name is applied here, and the upper reddish beds of Moccasin type are called the Moccasin red limestone member.

Surface form and soil.—The Lowville limestone weathers readily to fertile clay soil, but as it crops out in the county chiefly on the lower rather steep slopes of Wallen Ridge, its surface is too steep for cultivation and it is largely devoted to pasturing cattle which thrive on its luxuriant blue grass.

CANNON LIMESTONE.

Character and distribution.—The Cannon limestone, which overlies the fine-grained Lowville limestone is composed largely of rather impure, shaly limestone with interbedded scattered firmer beds of pure blue and gray limestone. It is exposed in Wise County only in Williams Cove, 1 mile southwest of Cadet, on the lower slope and spurs of Wallen Ridge. The section of the formation here exposed is as follows:

Section of Cannon limestone, slope of Wallen Ridge, Williams Cove.

	Feet.
Limestone, light-gray, mainly thin-bedded and shaly, spotted with white bryozoa and containing *Stromatocerium*. (Catheys limestone.)	
Limestone, chiefly impure, which weathers dirty and contains few fossils, with some harder purer beds	140±
Limestone, blue, containing numerous cephalopods and brachiopods	10±
Limestone, chiefly impure, which weathers dirty and contains few fossils, with some harder purer beds	215±
Limestone, gray, crinoidal, containing numerous brachiopods and segments of crinoid stems	10±
	375±
Limestone, dark-drab to pink, fine-grained. (Lowville limestone.)	

The formation is also exposed on the trail over Wallen Ridge through the saddle south of Elk Knob, which leaves the Turkey Cove road 1 mile south of the Wise County line. As most of the impure shaly limestone is here concealed by soil, the harder beds only are exposed and these beds do not correspond in position with those noted in the preceding section. The section as observed is as follows:

Section of Cannon limestone on trail crossing Wallen Ridge through saddle south of Elk Knob.

	Feet.
Concealed (top not determined)	20±
Limestone, red mottled, and thin shale beds containing bryozoa and brachiopods	40±
Limestone, well-bedded	30
Concealed	110±
Limestone, rough-bedded, inclosing white crystalline limestone masses; contains many gasteropods	10
Concealed	40±
Limestone, crinoidal, crystalline, containing segments of large crinoid stems	10
Concealed	20±
Limestone, granular, gray, containing numerous brachiopods, trilobites, cephalopods, and gasteropods	90±
Concealed	10±
	380±
Limestone, fine-grained, reddish (Lowville limestone).	

Age and correlation.—The Cannon limestone contains many fossils which comprise cephalopods, gasteropods, brachiopods, bryozoa, crinoid stems, and trilobites. The following fossils have been identified from beds in this area: *Homotoma* sp., *Lophospira* sp., *Cyrtodonta saffordi, C. grandis, Rhynchotrema increbescens, Hebertella borealis, Rafinesquina* sp., and *Zygospira recurvirostra.* This fauna is of middle Trenton age and the beds are correlated with the Cannon limestone of middle Tennessee, previously described by Mr. Ulrich. In the Estillville folio it was mapped together with the underlying and overlying limestones as Chickamauga.

Surface form and soil.—The Cannon limestone forms the slope below a slight bench in the middle of the north slope of Wallen Ridge in Williams Cove, and the surface, though generally well grassed, is broken by numerous small ledges of flat-lying limestone. Most of the surface is too steep for cultivation and the land is largely in pasture, as the fertile soil grows luxurant blue grass which supports many cattle.

CATHEYS LIMESTONE.

Character and distribution.—The Catheys limestone is a highly fossiliferous gray limestone which overlies the Cannon limestone. It comprises about 225 feet of granular gray limestone, thin-bedded to shaly and nodular above, thicker-bedded below. Most of the beds are highly fossiliferous. The limestone is exposed chiefly in Williams Cove 1 mile south-southwest of Cadet, where it forms the middle part of the slope and the tops of spurs of Wallen Ridge. A small inlier of the limestone in the Reedsville shale is shown at the head of the hollow just north of the cove. The limestone also ascends to the saddle in Wallen Ridge south of Elk Knob and descends a short distance into the head of Wildcat Hollow on the east side of the divide. The section of the formation as exposed on the slope of Wallen Ridge in Williams Cove is as follows:

Section of Catheys limestone on slope of Wallen Ridge, Williams Cove.

	Feet.
Shale, gray. (Reedsville shale.)	
Concealed	100±
Limestone, gray, granular, with some irregular impure laminations which weather in relief. Some beds are crowded with fossils, including cephalopods, gasteropods, and brachiopods	75
Limestone, light-gray, rather thick-bedded, granular, spotted white by many bryozoa, and containing many brachiopods and a large sponge-like coral, *Stromatocerium pustulosum*	50±
	225±
Limestone, impure, which weathers dirty and contains few fossils. (Cannon limestone.)	

In the saddle south of Elk Knob there are exposed about 40 feet of highly fossiliferous, gray, granular limestone overlain by a hackly nodular greenish-gray argillaceous limestone, which belong in the Catheys limestone. The contact of the Cannon and Catheys limestones was not here seen because of poor exposures on the mountain slope, and the exact boundary between the two formations was not determined.

Age and correlation.—The fossils obtained from the Catheys limestone in this area include brachiopods, cephalopods, and bryozoa. The following fossils, which are all of upper Trenton age, have been identified: *Stromatocerium pustulosum, Orthorhyncula linneyi?, Lophospira* sp., *Platystrophia* sp., *Byssonychia* sp., *Pterinia* sp., and a Trenton variety of *Hebertella sinuata.* The formation is correlated with the Catheys limestone of middle Tennessee, previously described by Mr. Ulrich.

Surface form and soil.—The formation, being somewhat harder and more resistant than the underlying Cannon limestone, forms a slight bench in the middle of the slope of Wallen Ridge. Its outcrop is generally well covered with blue grass, which grows readily where the soil has sufficient depth, and supports numerous cattle. The grassed slope, however, is broken by many limestone ledges.

REEDSVILLE SHALE.

Character and distribution.—The Reedsville shale is poorly exposed in the county because its outcrops are largely covered by debris from harder formations which crop out on the slope above it. The formation overlies the Catheys limestone and its outcrop nearly surrounds the area of Catheys in Williams Cove, southwest of Cadet. It forms the lower part of the steep upper western slopes of Wallen Ridge from the Lee County line north for a distance of 2½ miles where it swings around the northeast end of the cove to the slopes of the foothills on the west side of the cove. It also crosses the low gap in the mountain south of Elk Knob, extending about 1 mile down Wildcat Hollow on the east side of the mountain. The formation is composed largely of gray to yellow crumby shale with occasional thin beds of earthy sandstone and in the upper part some fossiliferous tough sandy limestone which weathers to buff earthy sandstone. Good exposures of the shale may be seen on the Turkey Cove road, ½ mile south of the Wise County line, where Ulrich measured 460 feet of these beds.

Age and correlation.—The shale is fossiliferous but weathers readily to crumbly fragments so that fossils are poorly preserved in outcrops. The sandstones, especially the thick calcareous beds near the top, contain numerous characteristic fossils, including *Rafinesquina alternata* variety, which establish the lower Maysville age of the upper beds. The fossils in the lower beds include many forms of Eden age. The shale was called Sevier shale in the Estillville folio, but as it is not the equivalent of the Sevier shale in the type locality, Sevier County, Tenn., that name can not be used. It has also been compared with the Martinsburg shale, a similar formation that overlies the limestones of the valley east of Clinch Mountain, but the Martinsburg shale is in part of Trenton age and contains no beds of Maysville age at the top, so it is not the exact equivalent of the formation here described. The Martinsburg is an eastern type of shale whereas the shale here described is a western type, equivalent to the Reedsville shale of central Pennsylvania which includes beds of Maysville age at the top. The name Reedsville shale is, therefore, adopted for this report.

Surface form and soil.—The Reedsville shale is soft, yields readily to weathering, and is easily eroded, so that it tends to form lowlands. However, the overlying harder formations form ridges and mountains, and the shale crops out chiefly on their steep slopes where its surface is largely covered by waste from the harder beds. The steep slopes underlain by the formation are largely forested, but some of its gentler slopes on the uplands are in pasture. The soil derived from the Reedsville shale is light and fairly fertile, and on the western side of Williams Cove, where the land is less hilly, it is cultivated.

SEQUATCHIE FORMATION.

Character and distribution.—The Sequatchie is prevailingly a soft red sandstone which overlies the Reedsville shale and directly underlies the cliff-making Clinch sandstone. It is generally calcareous and crumbles readily on weathering, so that it is rather easily eroded. It occupies the upper steep slope and the base of the westward-facing escarpment at the top of Wallen Ridge, and its outcrop is largely concealed by the talus of the harder Clinch sandstone which makes the escarpment. It is composed chiefly of soft, red, calcerous sandstone and sandy shale, with reddish, greenish, and buff nodular argillaceous limestone at the base. Nowhere in the region has a measurable section been seen. On the Turkey Cove road, one-half mile south of the Wise County line, and in the small valley just east of the road, the red sandstone is well exposed, and from the width of outcrop and dip of the beds the thickness of the formation is estimated to be about 200 feet.

It crops out in a narrow belt below the west-facing cliffs of Clinch sandstone at the crest of Wallen Ridge and forms the slopes of the two spurs which flank Wilcat Hollow on the east side of the mountain, just south of Elk Knob. Northward it forms some of the spurs on the northwest flank of the mountain. It also forms the east slope of the River Ridge and other foothill ridges and spur knobs west of Williams Cove, and is well exposed on one of these at the county line.

Age and correlation.—The formation contains few fossils, and most of these are in a gnarled impure limestone near the base. The fossils consist of ostracods, bryozoa, and pelecypods which, especially the ostracod, *Drepanella richardsoni,* are regarded as of Richmond age. The formation was called Bays sandstone in the Estillville folio, but as the red sandstone to which that name has been applied in the type locality, Bays Mountain, Tenn., is of Middle Ordovician age, the two formations are not equivalent. As the formation is the same as the red sandstone beneath the Clinch sandstone in East Tennessee and in Sequatchie Valley, Tenn., there named Sequatchie formation by Ulrich, that name is here used. It essentially corresponds in age to the Juniata formation of Pennsylvania and to the Queenston shale of western New York, and is placed by Ulrich, with all other formations of Richmond age, in the Silurian system.

Surface form and soil.—The steep slopes near the top of Wallen Ridge underlain by the Sequatchie formation are generally densely wooded. Less rugged slopes composed of the red sandstone on the southeast side of the River Ridge and other foothill ridges and the tops of some of the spurs of Wallen Ridge, are cleared and in pasture. On these gentle slopes the soil is light, sandy, and fairly fertile.

Silurian System.

CLINCH SANDSTONE.

Character and distribution.—The Clinch sandstone in this area is an alternation of beds of quartzite and shale. The quartzite occurs chiefly in thin beds, 3 to 6 inches thick, but some beds are as much as 8 feet thick. The quartzite is very dense, hard, and white to bluish or greenish. It is little affected by the weather, does not disintegrate or become porous from exposure, and the coating of rust which generally forms on its exposed surfaces is so thin that a slight chip reveals the hard unstained quartzite beneath. The interbedded shales are greenish or rust-stained and are soft and crumbly. The formation caps Wallen Ridge and makes the crest of River Ridge and other foothill ridges to the west, and its more massive beds in places makes prominent cliffs and ledges. In many of its outcrops, however, only loose fragments of the quartzite are seen. The best exposure of the whole formation is that on the Turkey Cove road just south of the Wise County line. The formation there is on the northwest flank of the Powell Valley anticline which there is overturned to such an extent that the beds dip 45° SE. The pressure that overturned the fold caused considerable slickensiding of the harder beds and squeezing out of some of the softer beds, so that the original thickness of the formation is probably not preserved. There are also some minor wrinkles on the major fold which, however, have been allowed for in the following computation. The thickness of 150 feet measured here is regarded, on account of the compression mentioned above, as somewhat less than the actual thickness, which is estimated to be 180 to 200 feet.

Section of Clinch Sandstone on Turkey Cove Road, Just South of Wise County Line.

Shale, greenish, with few thin beds of quartzite and at the base a 6-inch bed of pebbly quartzite containing small quantities of pyrite, galena, and small black phosphatic nodules. (Basal beds of the Clinton formation.)

	Feet.
Shale, gray	1
Quartzite, gray, in beds 6 to 10 inches thick interbedded with shale	18
Quartzite, grayish green, in thick bed	7
Shale, rusty, with thin quartzite beds	6
Quartzite, thin-bedded, thicker bedded near top	12
Shale and clay	1
Quartzite, thick-bedded	5
Shale, olive-colored, and interbedded bluish quartzite in beds 1 to 3 inches thick	10
Shale and interbedded thin layers of quartzite	8
Quartzite, white, in beds 2 to 5 feet thick	15
Shale, green, with thin beds of gray quartzite	20
Quartzite, greenish, in moderately thick beds	3
Quartzite, thin-bedded, grayish-white, in beds 1 to 3 inches thick, interbedded with rusty shale	18
Shale, greenish, with a few beds of grayish white quartzite	8
Quartzite, gray	1
Shale, crumbly, green, with quartzite beds 1 to 3 inches thick	17
	150

Soft beds, poorly exposed. (Probably top of Sequatchie formation.)

The Clinch sandstone forms the west-facing cliff or escarpment at the crest of Wallen Ridge. It descends the east side of the mountain in two rocky spurs flanking Wildcat Hollow, and also descends into the heads of some of the other hollows. It forms the tops of linear foothill knobs and low ridges, called the River Ridge, west of Wallen Ridge, which crosses the

Turkey Cove road just south of the Wise County line. A massive bed of very vitreous quartzite exposed at the river bank near the old woolen mill at the south edge of the town of Big Stone Gap is believed to be the upper part of the formation dipping beneath the Clinton formation to the west and faulted against Helderberg limestone on the east. Thick beds of quartzite exposed in the midst of the Clinton formation in the valley of Butcher Creek, 3 miles northeast of the town of Big Stone Gap, are also believed to be Clinch quartzite brought to the surface on the axis of a minor anticline.

Age and correlation.—Few fossils have been obtained from the Clinch sandstone. Some of the massive quartzite beds contain *Arthrophycus harlani,* a fossil of doubtful relations, which is characteristic of the Clinch sandstone and of the uppermost part of the Medina throughout the Appalachians. Mr. Ulrich collected from some of the softer shaly beds exposed on the Turkey Cove road fragments of a crustacean regarded as a species of *Hughmilleria.* The formation is correlated with the Clinch sandstone of Virginia and Tennessee and the upper part of the Medina group of New York. In its typical occurrence in Clinch Mountain, 15 miles to the east, the formation is over 300 feet thick and is composed largely of massive beds some of which are 20 feet thick.

Surface form and soil.—The Clinch sandstone is one of the hardest and most resistant formations that crop out in the region, comparing favorably in hardness with the conglomerate and sandstone beds of the Lee. It however is not nearly so massive as those beds and therefore does not make such rugged mountains. It caps Wallen Ridge, a prominent mountain which has its beginning in southern Wise County and extends southwestward across Lee County. (See Pl. IV.) It also forms the top of foothill ridges, spurs, and knobs west of Wallen Ridge. These hills are not so high as Wallen Ridge because the resistance of the formation to weathering has been partly destroyed by faulting, crushing, and thinning of the beds from the intense pressure to which the rocks on the northwest limb of the anticline have been subjected. The outcrop of the formation is generally marked by many rocky ledges with waste slopes below and its soil is therefore thin. It supports a hardwood forest with scattered evergreens.

CLINTON FORMATION.

Character and distribution.—The Clinton formation is a reddish ferruginous sandstone and shale containing several workable beds of hematite iron ore. It overlies the Clinch sandstone and is the most wide-spread pre-

Pennsylvanian formation exposed in the county. Its best exposures are on the eastern dip-slope of Wallen Ridge, but no complete continuous section was seen where the thickness could be measured. A composite section, made up of several parallel sections on the mountain slopes, is as follows:

Composite section of Clinton formation on east slope of Wallen Ridge.

Conglomerate, thin, crumbly, quartzose. (Basal bed of Cayuga limestone.)

	Feet.
Quartzite, white, in thick slabby beds traversed by scolithus worm tubes and having dimpled and pitted bedding surfaces	15
Sandstone, thick-bedded, dark-red	20±
Shale, gray to chocolate and pink, and buff sandy shale, containing scattered thin gray granular sandstones with many rust-stained molds of ostracods on bedding surfaces. The upper two-thirds contains a typical development of the ostracod fauna of the *Mastigobolbina typus* zone; lower third contains fossils of *M. lata* zone of middle Clinton age	180±
Shale, soft, olive to drab, platy, with numerous strongly plicated brachiopod shells *(Anoplotheca)*, shown on Plate XXXII, and ostracods (*Zygobolba*), and thin platy sandstones marked by trails and fucoids and containing similiar shells. Fossils are of lower Clinton age, about equivalent to those in the shale at the base of the Clinton of New York	20
Iron ore, thin-bedded fossiliferous hematite, interbedded with shale, thin platy sandstone, and thin ferruginous fossiliferous limestone; the ore contains numerous segments of crinoid stems, ostracods, and other fossils replaced by iron oxide	2±
Shale, gray to brown, with few thin sandstone beds	90
Iron ore, oolitic to fine pebbly hematite interbedded with fine-grained ore and sandstone; the grains up to ⅛ inch in diameter are of quartz coated with iron oxide; larger flat pebbles, up to 5 inches in diameter, are composed of layered fossiliferous hematite; the ore from deep workings is composed of carbonate of iron	2–4
Sandstone, thick-bedded, red and gray, and shale	23
Iron ore, hard, siliceous, hematite	1–4
Shale with thin beds of fine-grained hard quartzitic sandstone, having at the base a phosphatic conglomerate containing white quartz pebbles up to ½ inch diameter, small black phosphate nodules, and small amounts of pyrite and galena	45
	398–403±

The basal bed containing the phosphatic conglomerate was seen at only one place, on the Turkey Cove road just south of the Wise County line. The rocks there are overturned so as to dip 45° SE. beneath the Clinch sandstone. The lower 45 feet contain scattered thin beds of quartzite very similar to those in the Clinch, but, because of the predominance of shale over quartzite and the presence of phosphatic and pyritiferous conglomerate at their base, these beds are regarded as part of the Clinton formation. The phosphatic conglomerate possibly marks an unconformity in the deposition and indicates that the land locally stood above the sea at the beginning of Clinton time.

The most complete record of several bore holes near Oreton, at the east base of Wallen Ridge, shows the ore-bearing middle part of the formation to have the following composition:

Partial Record of Bore Hole of Prospect No. 1, Near Wildcat Summit, Oreton.

(Condensed from record by Interstate Coal & Iron Co.)

	Thickness. Feet.	Depth of base. Feet.
Shale, gray and blue, with few thin layers of sandstone	134	134
Shale, carcareous, with thin sandstone beds containing fossils	7	141
Shale and sandstone	37	178
Iron ore and sandstone interbedded	12	190
Shale, brown, with few thin sandstone beds	83	273
Iron ore and shale	6	279
Sandstone, red	7	286
Sandstone and shale	14	300
Sandstone, red, and iron ore	3	303
Sandstone, hard, and shale.		

The detailed character and distribution of the iron-ore beds, their correlation from place to place, and their probable origin, are described by J. B. Eby under Economic Geology, pages 545 and 569.

The upper part of the formation throughout most of its exposure is marked by thick hard slabby sandstone beds containing scolithus tubes. These are conspicuously displayed at several places on the river driveway from the town of Big Stone Gap to East Stone Gap. They are first encountered at the bridge just east of town and again beyond at the swimming hole. Single layers of this scolithus-bearing sandstone are exposed at several places farther east, and an excellent section of the beds is shown in the road cut one-half mile west of East Stone Gap. Here there are 5 layers, each about 3 feet thick, of slabby white sandstone, stained red and rusty on exposed surfaces, which grades at the top into a soft crumbly calcareous sandstone having a rippled upper surface. The latter bed contains small round pebbles and coarse grains of quartz and fossils of Cayuga age, and is the basal bed of the Cayuga limestone. Similar slabby sandstones surmounted by a rippled crumbly conglomerate are exposed in the foothills at the northeast end of Wallen Ridge, ¾ mile southeast of the town of Big stone Gap. At the southeast base of Wallen Ridge the same hard slabby sandstone crops out at many places in the roads and stream banks, and its fragments are strewn on the surface, making in places very rocky ground. The sandstone at the top of the formation is however not everywhere slabby and marked by scolithus tubes, being in some places thin-bedded and contains fossils like those in lower beds of the Clinton. In the bank of Powell River at the bridge in the town of Big Stone Gap, the basal conglomerate of the Cayuga rests on such thin-bedded ferruginous fossiliferous sandstone.

The largest area of the Clinton formation is that on the east slope of Wallen Ridge, where the dip of the formation coincides with the slope of the mountain. The upper sandstone forms the sloping face of many spurs and rocky ravines are eroded in it. The larger transverse valleys expose the softer lower parts of the formation. The formation also forms the northwest slope of the ridge as far south as Williams Cove and the western slope of the River Ridge to and beyond the Lee County line. A considerable area of the formation underlies the flats in and about the town of Big Stone Gap, but few exposures are seen there because of the cover of gravel and soil. The hill in town northeast of the public school is composed of the formation, and fragments of fossiliferous ferruginous sandstone cover its slopes. The same beds accompanied by some iron ore compose the hills south of the river drive from Big Stone Gap to East Stone Gap. A narrow faulted area also forms the hills north of the river, the extreme eastern end of which is exposed by De Busk Branch in the gap through which the Southern Railway passes. In the lowland adjoining the river south of East Stone Gap the Cayuga limestone is eroded from a small oval area in which is exposed the underlying slabby sandstones at the top of the Clinton. Another rather large area of Clinton forms the hills north of the valley road to Norton, 3 to 5 miles east of the town of Big Stone Gap, where its beds are well exposed by Butcher Creek.

Age and correlation.—The formation is plentifully fossiliferous from top to bottom. The fossils are generally well preserved in the shale, but in the sandstone they are chiefly in the form of hollow molds, the calcareous or phosphatic fossil having been completely dissolved out of the weathered rock. Molds of small ostracods, trilobites, and shells are however exquisitely preserved and delicately coated with a bright-yellow rust. Where the sandstone is unweathered, the calcareous and phosphatic shells usually are retained. The forms identified comprise many kinds of ostracods, particularly species of *Mastigobolbina* and *Bonnemaia*, which resemble minute horseshoes, brachiopods, and trilobites, all of Clinton age. Excellent specimens of *Calymene clintoni*, an upper Clinton trilobite, were obtained from the upper beds, and fossils of middle and lower Clinton were found in the lower beds. The formation contains iron ore and has other lithologic characters similar to those of the Clinton formation of New York and Pennsylvania, and the correlation with that formation is well established. In the Estillville folio and other reports the name "Rockwood" was used for this formation, but the "Rockwood" in the type locality in Tennessee is a somewhat older formation.

Surface form and soil.—Many of the sandstone beds of the formation, especially those at the top, are hard enough to form ridges and rugged country covered with hard rock fragments. The formation forms the wooded rugged east and north slopes of Wallen Ridge (see Pl. IV), and the tops of many of the minor ridges. The foothill at the northeast end of Wallen Ridge is a typical example of an asymmetric ridge formed by the inclined hard upper sandstones of the formation, the east face having a gentle dip-slope and the west face having a steep slope or escarpment. Similar knobs and ridges skirt the southeast foot of Wallen Ridge. The soil derived from the shale of the formation is fairly fertile but is loose and easily gullied on steep slopes. In lowlands along the streams it is cultivated to some extent, but in most places the surface is too hilly and the soil too stony for the land to be used even for pasture, and it remains in forest. The main lumber industry of this part of the county is dependent on the forests on the Clinton formation.

CAYUGA LIMESTONE.

Character and distribution.—The Cayuga limestone is largely a thin-bedded finely laminated magnesian limestone with some thicker dolomite beds, which lies between the Clinton and older siliceous formations below and the siliceous and cherty Helderberg limestone above. It therefore generally forms fertile valleys between hills covered with chert and sandstone fragments. The formation is excellently exposed at many places on the roads in the valley, especially in and east of East Stone Gap where many of the hills are capped by the harder sandy beds of the Helderberg and on the steep slopes of which nearly horizontal Cayuga limestone crops out.

(See Pl. VIII.) The formation is about 225 feet thick. The most complete section is one measured by E. O. Ulrich at the Southern Railway trestle just south of East Stone Gap.

Section of Cayuga limestone just south of East Stone Gap.

By E. O. Ulrich.

	Feet.
Sandstone, porous. (Residual material from sandy limestone of the Helderberg formation.)	
Limestone, pure, drab, thick-bedded, containing ostracods	50
Limestone, mainly laminated, fine-grained, magnesian, of light-bluish-gray color. [Probably includes thick geodiferous dolomite and oolite beds seen at road east of East Stone Gap and described below.]	125
Covered	15
Limestone, thin-bedded, foliated, sandy, containing *Leperditia* and *Pterinia*; weathers to thin sandy plates	6
Limestone, blue, spotted with darker limestone pebbles	3
Limestone, siliceous, weathering to soft sandstone. Lower part very fossiliferous; *Spirifer vanuxemi* and other brachiopods numerous	10
Shale, sandy, chocolate-colored, and thin layers of sandstone containing *Leperditia*	5
Sandstone with ¼-inch quartz pebbles at top	4
Limestone, shaly, with thin sandy plates spotted with black; lower part contains *Leperditia, Spirifer vanuxemi, Kloedinia, Beyrichia*, and other fossils	6
Sandstone with small quartz pebbles and small round pellets of marcasite	3
Sandstone, platy, and shale, fossiliferous (Clinton formation).	
	227

Most of the beds of the formation on weathering break into thin slabs and plates. Many of the thicker beds on weathering show conglomeratic or brecciated structure. *Stromotopora* and *Favosites* corals occur sparingly throughout the formation and their silicified forms are present in the surface soil.

The basal conglomerate which generally contains small round shiny pellets of marcasite of oolitic size and appearance is a very interesting bed, and marks an unconformity, probably due to a temporary cessation of deposition during a local emergence of the land out of the sea. The marcasite-bearing sandstone decomposes readily at the surface into a black powdery earth. This basal bed may be seen just above the bridge across the North Fork of Powell River, in the town of Big Stone Gap. The section there exposed is as follows:

Section of basal beds of Cayuga limestone, Big Stone Gap.

	Feet.
Limestone, thin-bedded, impure, sandy, containing ostracods and a few brachiopods.	
Shale, black	1
Sandstone, thin, platy, with trail-markings and fucoids	12
Sandstone, with scattered small quartz pebbles and 1½ inches of fine conglomerate at the bottom containing small pellets of marcasite; contains shells of Cayuga age	3
Sandstone, thin-bedded, hard, ferruginous, weathering reddish, and containing numerous ostracods, trilobites, and brachiopods of Clinton age.	

A section of these beds was measured a few hundred feet west of the swimming hole on the river drive to East Stone Gap as follows:

Section of basal beds of Cayuga limestone, one-fourth mile east of Big Stone Gap.

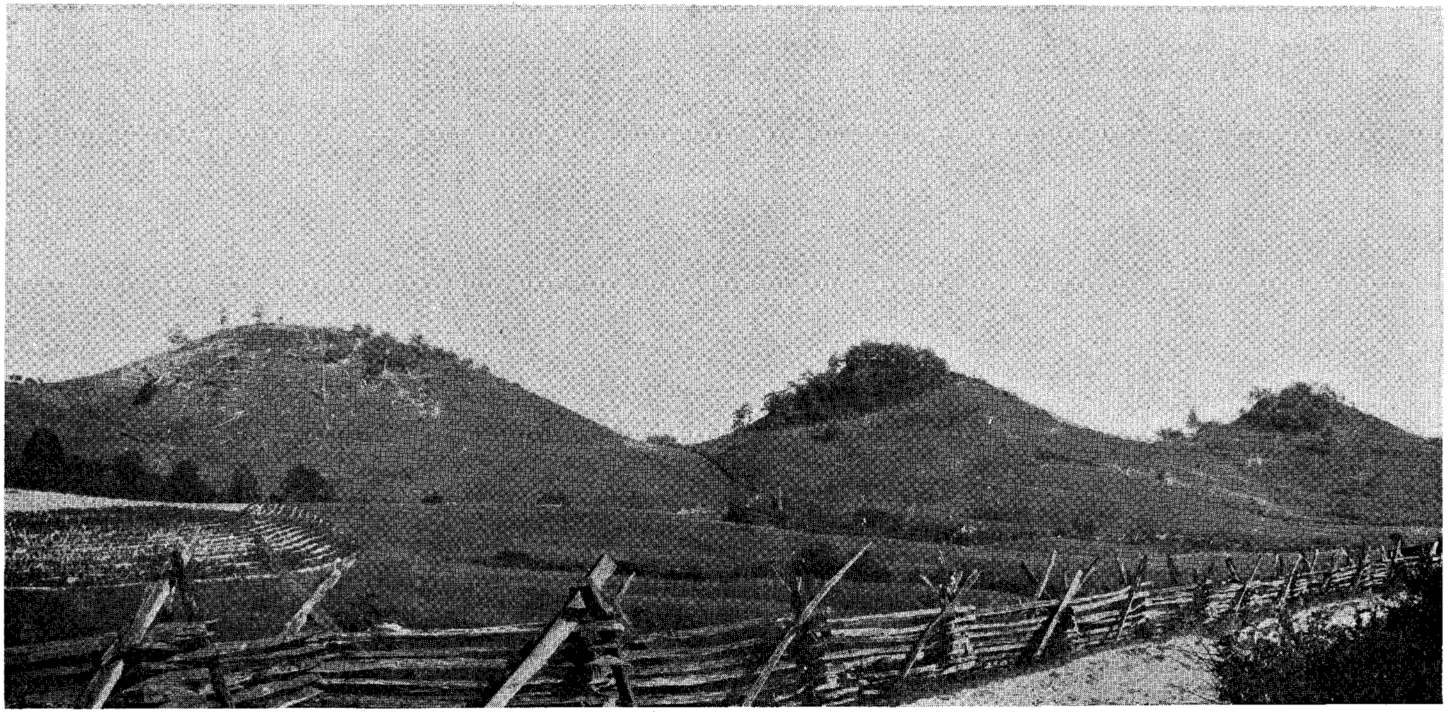
	Feet.
Chert, soft, earthy, and rusty fossiliferous sandstone	3
Sandstone, pitted by the removal of round pebbles or concretions (probably iron carbonate) which weather to soft, crumbly, rust-colored powder	8
Sandstone, thick-bedded	5
Shale, dark, and thin sandstone	6
Sandstone, dark impure, and rough-bedded fine quartz-pebble conglomerate	8
Sandstone, thick-bedded, and few interbedded shales. (Clinton formation.)	

A comparison of these sections shows how variable the basal beds are, but they are generally conglomeratic and marcasitic. The conglomerate bed has in places a rippled upper surface.

The upper part of the formation is well exposed on the road east of East Stone Gap where thick beds of well-bedded laminated sandstone and impure dolomite crop out at road level. These beds fall within the upper 100 feet of the formation. A quarry near the cemetery just east of East Stone Gap shows the following section of these beds:

Section of middle part of Cayuga limestone, one-half mile east of East Stone Gap.

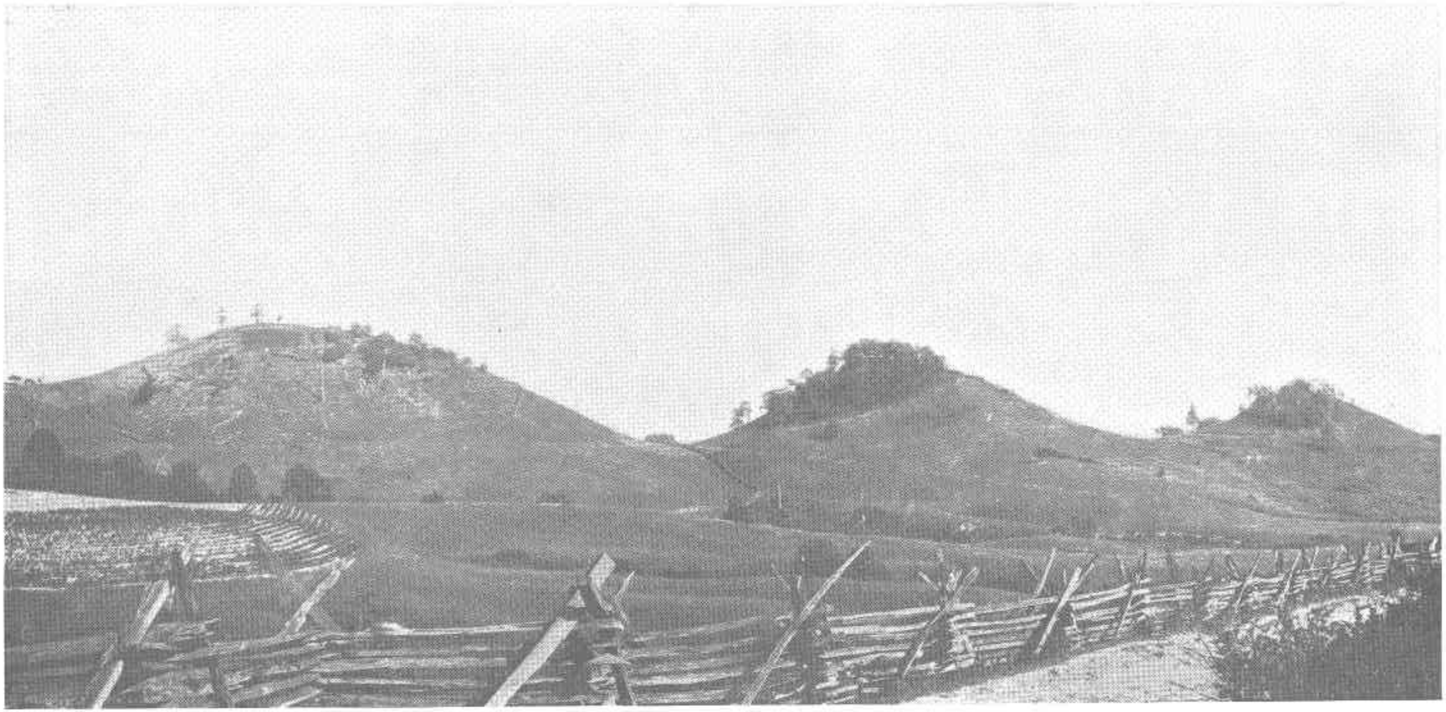
	Feet.
Limestone, thin-bedded, porous	6
Dolomite, fine-grained	2
Dolomite, hackly, and weathers dirty	10
Dolomite, dense, fine-grained, geodiferous near middle and near base and having stilolite markings in the midst	18
Dolomite, thin-bedded, dark	4
Covered	6–10
Sandstone, well-bedded in 6-inch layer and beds of gray geodiferous dolomite with wavy *Cryptozoön*-like banding	10–15



SHALE KNOBS OF THE WISE FORMATION.

View northeast of Wise, showing low, well-rounded shale knobs rising above the plateau made by Gladeville sandstone, which underlies the road in the foreground.

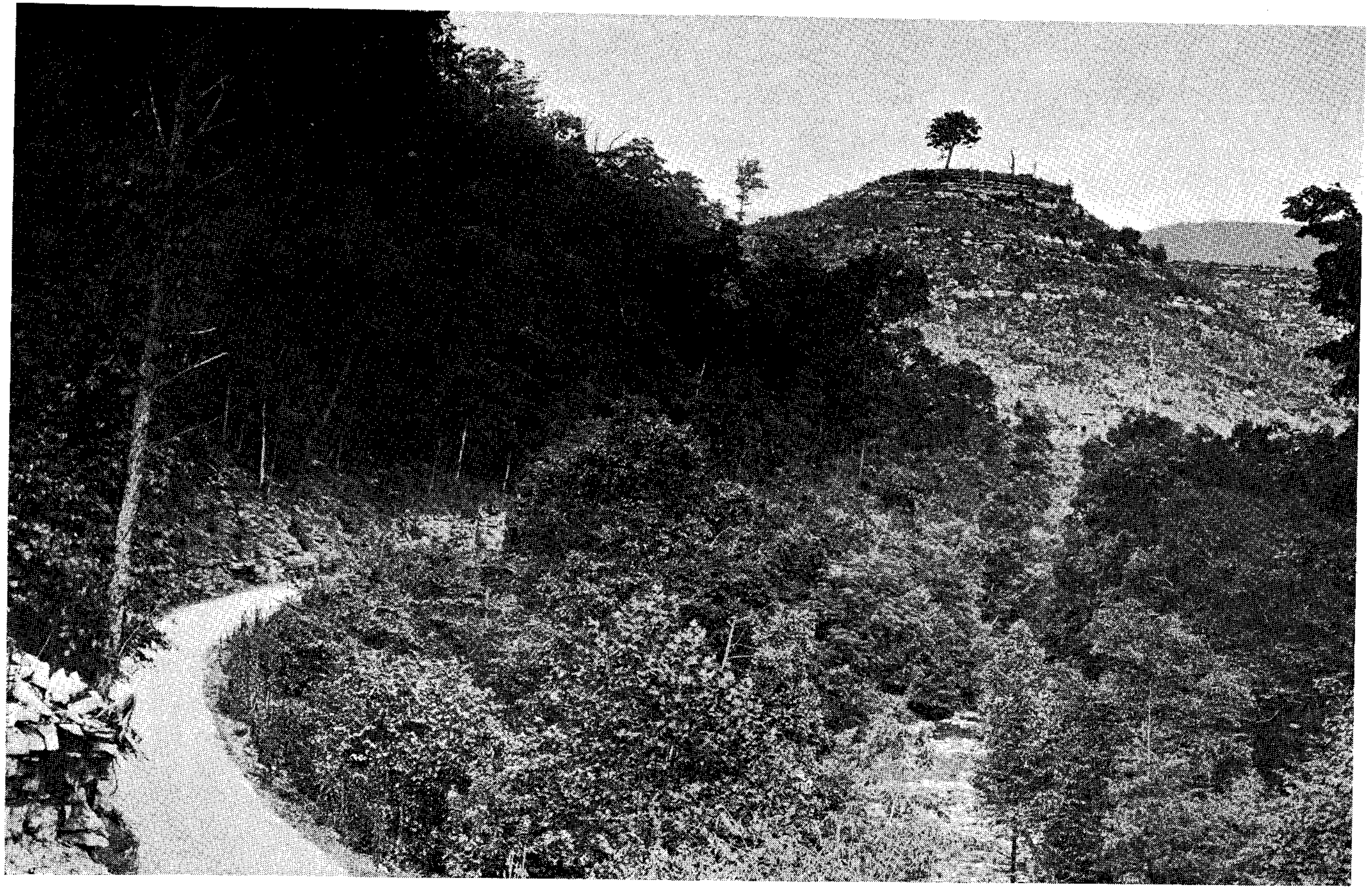
Photo by C. K. Wentworth.



SHALE KNOBS OF THE WISE FORMATION.

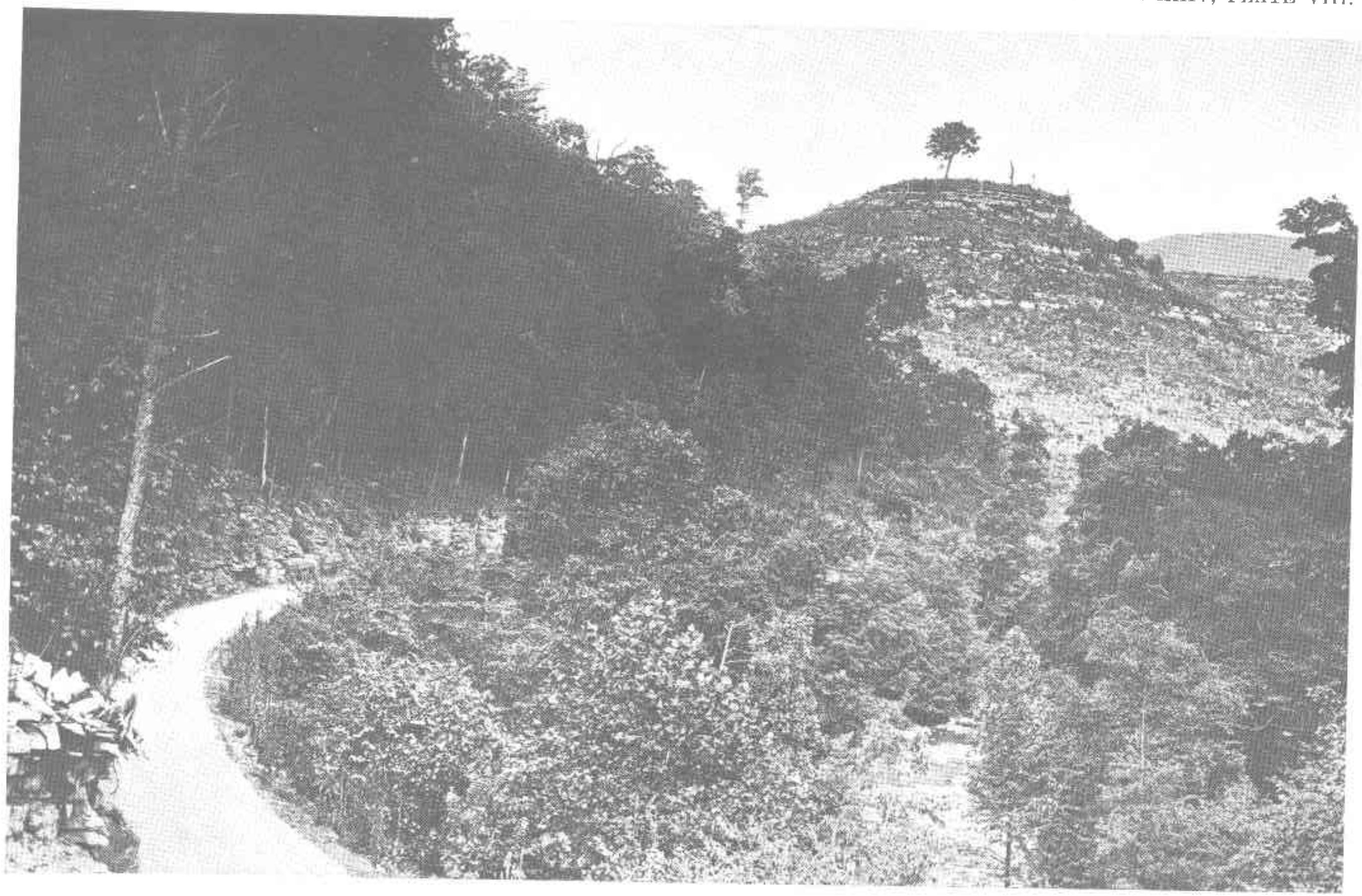
View northeast of Wise, showing low, well-rounded shale knobs rising above the plateau made by Gladeville sandstone, which underlies the road in the foreground.

Photo by C. K. Wentworth.



TURRETED HILL OF HORIZONTAL LIMESTONE OF CAYUGA AGE, NEAR EAST STONE GAP.

Photo by G. D. Jenkins.



TURRETED HILL OF HORIZONTAL LIMESTONE OF CAYUGA AGE, NEAR EAST STONE GAP.

Photo by G. D. Jenkins.

One mile farther east on this road the upper beds contain distinctive oolite, edgewise conglomerate, and *Cryptozoon*-bearing beds as follows:

Section of upper part of Cayuga limestone, one and one-half miles east of East Stone Gap.

	Feet.
Sandstone, porous, fine pebbly. (Base of Helderberg limestone.)	
Limestone, thin-bedded, light-blue	17
Limestone, wavy laminated, argillaceous, fine-grained, with *Cryptozoon* structure	3
Conglomerate with edgewise structure, and black oolite; gasteropods in upper part	2
Limestone, thick-bedded, pure, blue, with crystalline fragments of fossils and large and small *Leperditia*	3

The top of the formation is generally clearly defined by the sandy limestone beds at the base of the Helderberg, some of which weather to glistening buff sandstone. The sandy and cherty beds of the Helderberg usually cap the hills and the Cayuga limestone forms the steep slopes.

The formation forms a wide area of rolling hills in and around East Stone Gap, the tops of many of the hills being capped by the Helderberg limestone. (See Pl. VIII.) A narrow band of the formation partly encircles the area of Clinton formation in the rugged hills west of Buffalo School, and still narrower bands, more or less broken by faults, extend southwestward through the town of Big Stone Gap. One of these bands follows the south side of Powell River to the Lee County line.

Age and correlation.—The Cayuga limestone does not contain a great variety of fossils. *Leperditia alta* and a larger form of *Leperditia* occur in most of the finely laminated beds, especially in the upper part. *Kloedinia, Beyricia,* and other small ostracods are numerous in the lower part, and a few thin beds near the base contain *Spirifer vanuxemi, Meristella* sp., and other brachiopods. Corals and sponges, including *Favosites,* cup corals, and stromotoporoids, occur sparingly throughout. The fauna is correlated with that of the Cayuga group of New York and the lithologic characters correspond with parts of that group. In the Estillville folio the name Hancock limestone was applied to it together with the overlying Helderberg limestone, and farther northeast chert of Oriskany age was also included under that name in the Bristol folio. The formation is here called Cayuga limestone because of its equivalence to the New York formation of that name.

Surface form and soil.—The Cayuga limestone tends to form valleys with fertile soil, but because of harder sandy formations that border its outcrops, its surface is rolling and is scarred by occasional ledges of limestone and rocky escarpments. (See Pl. VIII.) Much of its outcrop is cultivated and the more hilly parts are used for grazing.

Devonian System.

HELDERBERG LIMESTONE.

Character and distribution.—The Helderberg limestone is a rather thick-bedded siliceous and cherty blue limestone which overlies the thinly laminated light-gray Cayuga limestone. It weathers readily to highly fossiliferous porous sandstone and dirty pitted cherty beds and to scattered hard flinty chert masses in clay soil. It is variable in thickness, ranging from 40 to 135 feet. It is thinnest in the southwestern part of the county. Few complete sections are to be seen. One of the best exposed is that on the old street railroad between the town of Big Stone Gap and the Southern Railway station, measured by Mr. Ulrich as follows:

Section of Helderberg limestone, Big Stone Gap.

BY E. O. ULRICH.

	Feet.
Shale, black. (Genesee shale.)	
Sandstone, rather coarse, calcareous, and having a considerable brachiopod fauna with few pelecypods and gasteropods but no corals	5
Limestone, readily decomposed, fine-grained, sandy, bluish or greenish. Upper seven feet carries sandy chert full of corals and some brachiopods and gasteropods. Lower half more sandy	45±
Chert, containing abundant corals	1
Sandstone, brownish, coarse, in thin and thick beds, some containing numerous brachiopods and corals	12
Limestone, laminated, sandy, weathering to shaly particles; some free silicified fossils	35
Sandstone, coarse, or fine conglomerate	3
Sandstone, soft, calcareous, argillaceous sandstone, and sandy limestone; some free silicified fossils	13
Sandstone, hard, calcareous, with molds of bryozoa	2
Limestone, shaly, full of fossils of New Scotland age	10
Limestone, massive, crystalline, blue, with thin irregular hard sandstone at base filling shallow depressions in underlying Cayuga limestone	7
	133

The formation thins southwestward down Powell River, and near the Lee County line it measures only 38 feet, as follows:

Section of Helderberg limestone on Turkey Cove road near Lee County line.

Shale, black, containing *Schizobolus*. (Genesee shale.)

	Feet.
Sandstone, crumbly, full of corals	3
Sandstone, fossiliferous, cross-bedded, calcareous	1
Limestone, impure	4
Limestone, chert-banded	3
Sandstone, soft, shaly, calcareous, containing chert	4
Sandstone, with round glistening quartz grains	5
Limestone, fossiliferous, sandy	13
Sandstone, laminated	5
	38

The glistening granular sandstone with round quartz grains, which is from 18 to 25 feet above the base in these sections, is the most conspicuous bed in the lower part of the formation and its fragments can always be found on the surface, so that where exposures are poor the presence of this bed was taken as the marker of the base of the formation.

The lower sandy beds are generally well exposed because they are resistant and cap the hills. A good section of these beds is shown at a roadside quarry about 1 mile northeast of East Stone Gap.

Section of lower part of Helderberg limestone at roadside quarry 1 mile northeast of East Stone Gap.

	Feet.
Sandstone, porous, fossiliferous, banded	10
Chert, white and black, bedded	12
Sandstone, coarse, porous, fossiliferous	10
Chert, white, fossiliferous	5
Sandstone, coarse	3
Limestone, siliceous, with black and white chert nodules and some sandstone	10
Sandstone, granular, with round glistening quartz grains	3
Sandstone, porous, laminated, with some thin blue limestone	15
Sandstone, buff, calcareous, porous, containing numerous molds of shells	10
	78

Limestone, thick-bedded, finely laminated, blue. (Top of Cayuga limestone.)

The softer beds near the middle of the formation are generally poorly exposed and seldom seen.

The uppermost beds are in places conspicuous for their prolific cup corals. Six feet of pitted cavernous cherty sandstone full of silicified cup corals, tubular *Favosites* corals, and some shells, is well exposed at the bridge across Butcher Creek at Blue Spring, 1½ miles northeast of East

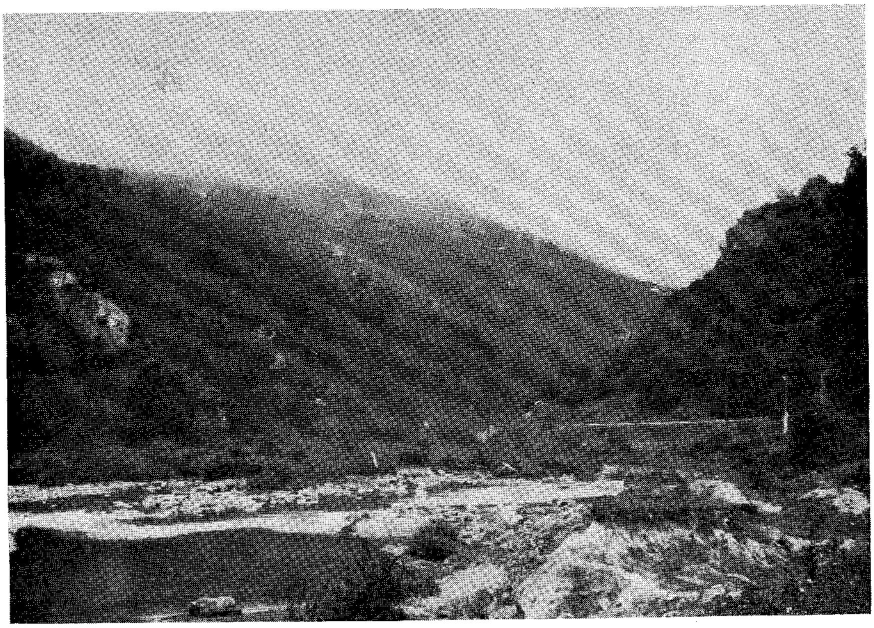
Stone Gap, and furnishes an excellent collecting ground for these fossils. In the Southern Railway cut at the old iron furnace just east of Big Stone Gap station the upper sandy beds are so decomposed that loose beautifully silicified cup corals and *Favosites* are numerous in the soil, in which there are also some large gasteropods. Similarly well-preserved silicified corals from this horizon also occur in the road cut through the hill at the church east of Buffalo school on the road to Norton.

The narrow belt of the formation which borders the large area of Cayuga limestone in the vicinity of East Stone Gap expands in width eastward along Beaver Dam Creek, where the dips become gentler on the plunging end of the main anticline. Another belt which encircles the Butcher Creek area of Clinton and Cayuga formations takes the Helderberg formation well up toward the head of Powell Valley around the plunging end of this northern anticline. Southwest of the town of Big Stone Gap, the Helderberg outcrop is very narrow, partly because the beds are nearly vertical on this limb of the fold but also because the formation is thinner here than it is to the northeast.

Age and correlation.—The Helderberg formation is very fossilferous throughout. Corals, including both the tubular *Favosites* and cup corals, are plentiful, especially in the uppermost few feet. Brachiopods, bryozoa, and gasteropods are also numerous. The lower part of the formation is correlated with the New Scotland limestone of the Helderberg group of New York on the basis of characteristic fossils. The assemblage of cup corals in the uppermost beds corresponds so closely with the coral fauna of the Onondaga limestone of New York, formerly called "Corniferous limestone," that it has been correlated by E. M. Kindle[1] and others with that formation. Ulrich found that the coral fauna occurs in several bands in the upper 50 feet or more of the formation and that the intervening beds contain an unquestionable Becraft fauna. He therefore regards these corals as representing an earlier invasion of species that are elsewhere known only in limestones of Onondaga age. The formation is therefore believed to represent a considerable part of the Helderberg group of New York and that name is used here.

Surface form and soil.—The Helderberg limestone is a more resistant formation than the overlying Genesee shale and the underlying purer Cayuga limestone. It, therefore, forms narrow ridges between valleys of these softer formations and also caps hills composed of the Cayuga lime-

[1] The Onondaga fauna of the Allegheny Region, U. S. Geol. Survey Bull. 508, p. 51, 1912.

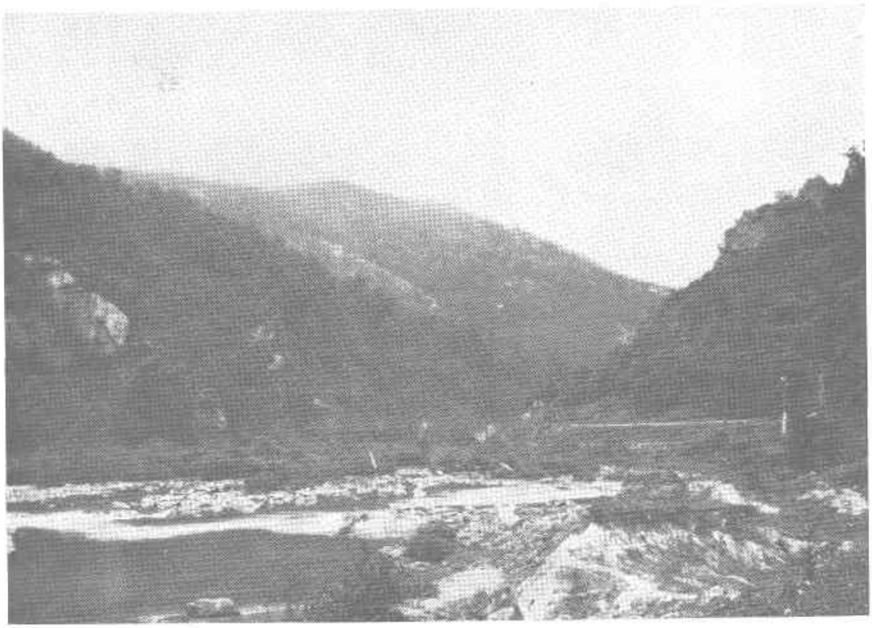


(A) Upper end of Big Stone Gap. The "Bee Rock" or uppermost stratum in the Lee formation shows in the foreground on both sides of the stream.

Photo by C. K. Wentworth.

(B) Typical weathered exposure of Genesee shale near town of Big Stone Gap. The shale is black and soft, and breaks readily on weathering into small platy fragments.

Photo by C. K. Wentworth.



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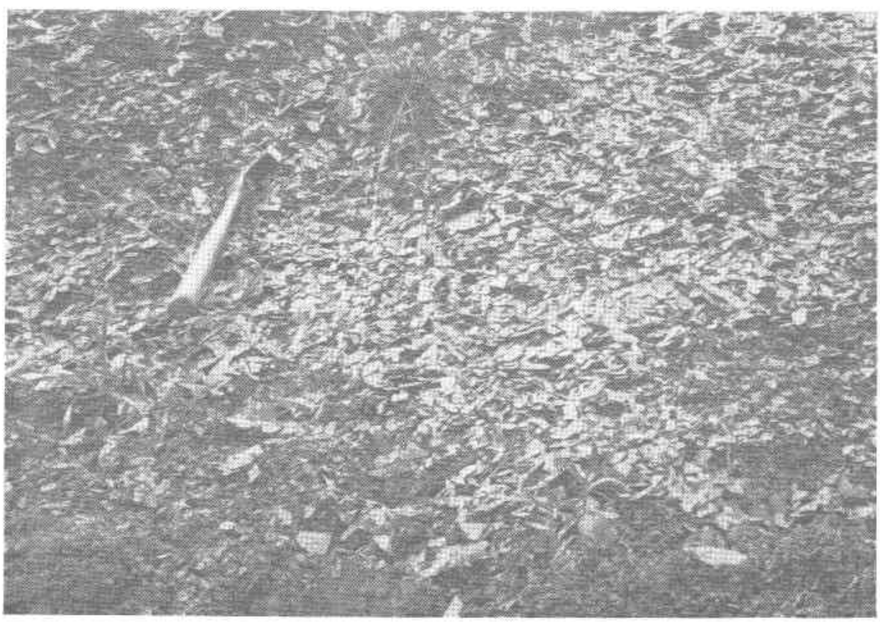
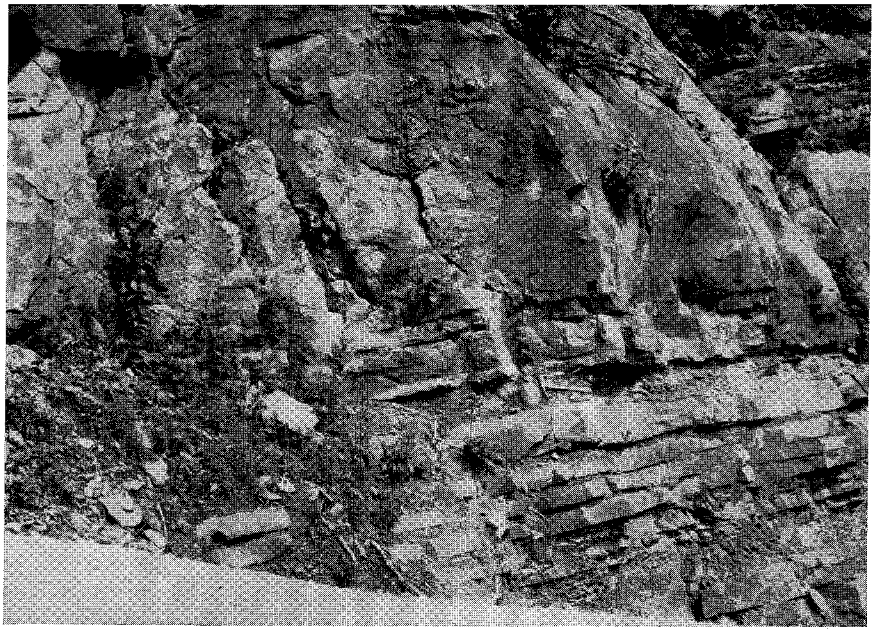


(B) Typical weathered exposure of Genesee shale near town of Big Stone Gap. The shale is black and soft, and breaks readily on weathering into small platy fragments.

Photo by C. K. Wentworth.

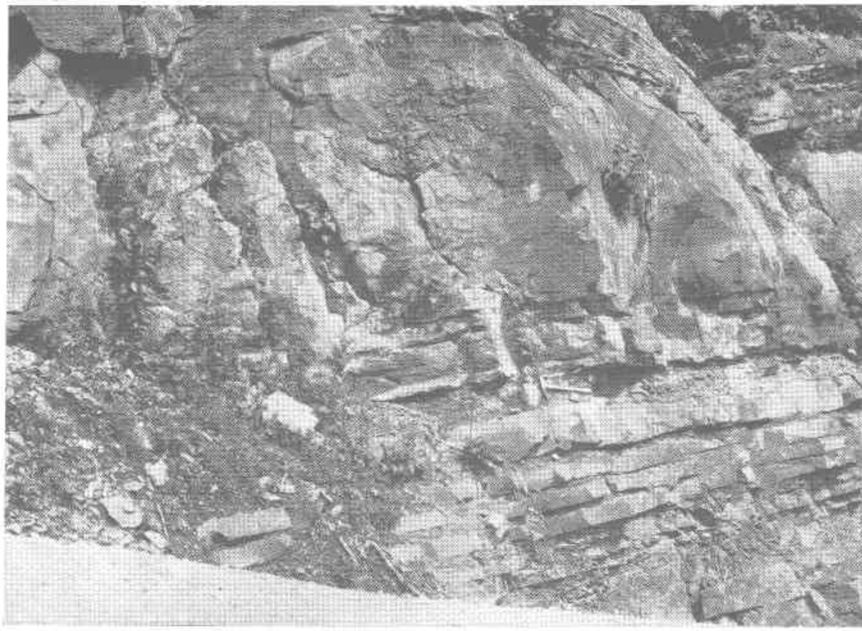


(A) Massive blue limestone at base of the Newman formation overlying thin beds of sandstone and shale of the Maccrady formation. On main road near Little Stone Gap.

Photo by C. K. Wentworth.

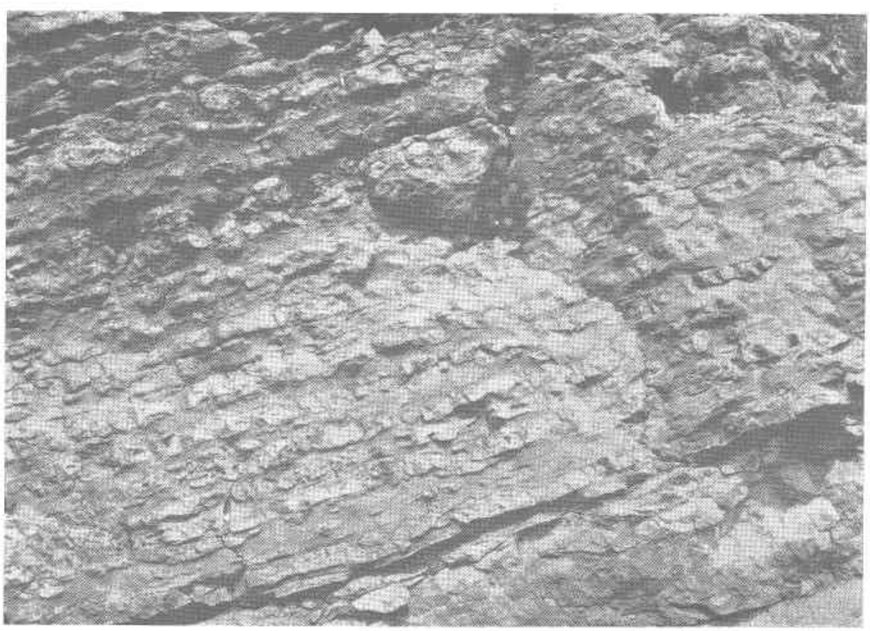
(B) Layers of nodular black chert in limestone near the base of the Newman formation. On main road near Little Stone Gap.

Photo by C. K. Wentworth.



(A) Massive blue limestone at base of the Newman formation overlying thin beds of sandstone and shale of the Maccrady formation. On main road near Little Stone Gap.

Photo by C. K. Wentworth.



(B) Layers of nodular black chert in limestone near the base of the Newman formation. On main road near Little Stone Gap.

Photo by C. K. Wentworth.

stone. (See Pl. VIII.) The soil derived from the limestone is a fertile sandy clay which contains many fragments of chert and sandstone. It is therefore better suited to grazing than to cultivation, and most of its area is in bluegrass. The steeper slopes and rocky tracts are still in timber.

GENESEE SHALE.

Character and distribution.—The black carbonaceous shale which overlies the Helderberg limestone is here called Genesee shale. It is a soft shale that falls readily to fine coaly black fragments, some of which have slickensided carbonaceous surfaces like coal, due to crushing of and movement in the shale. (See Pl. IX.) It is the lower part of a thick mass of soft shale which forms a broad lowland with few outcrops. It is distinguishable from the overlying black shale by the presence of a characteristic fossil *(Schizobolus),* a small flat thin shell but conspicuous because of its shiny dark phosphatic surface, whereas the upper black shale is almost devoid of fossils, and also by the absence of drab shale which is interbedded with the overlying black shale. The Genesee shale is about 200 feet thick but its exact upper limit can not be determined because of its generally poor exposure. One hundred and seventy feet were measured by Mr. Ulrich in the bank of Powell River at the town of Big Stone Gap. The fossiliferous Genesee shale may be seen in the bank of the stream just south of the stocking factory on the road to the Southern Railway station. This narrow band of shale runs southwestward to the Lee County line but the shale is exposed at few places in the broad lowland. It may be seen on the Turkey Cove road ½ mile north of the county line.

Northeastward the Genesee shale is exposed at few places on the northwest flank of the anticline, but is most clearly shown at the northeast plunging end of the fold, especially along the Norton road, east and northeast of Buffalo School. The narrow band on the northeast flank of the anticline is also poorly exposed in the lowland adjacent to Beaver Dam Creek, but southwest of South Fork of Powell River it may be seen at many places overlying the Helderberg limestone, especially along the road to Irondale. The compressed and faulted syncline between the two main branches of the Powell Valley anticline brings a narrow infold of the Genesee shale from Buffalo School nearly to the Southern Railway northeast of East Stone Gap.

Several small isolated areas of the black shale infolded in tightly compressed synclines have been observed in the county. One such small area lies ½ mile northeast of East Stone Gap; another is at the old woolen mill at the south edge of the town of Big Stone Gap.

At the base of the Genesee shale there is, in places, especially noticeable along the Norton road northeast of Buffalo School, a layer one or two inches thick composed of much disturbed and broken shale discolored by iron oxide and a ferruginous rock debris mixture containing some iron ore, which represents the products of decomposition of rocks on an old land surface before the Genesee shale was deposited. It therefore marks an unconformity between the Genesee shale and the underlying Helderberg limestone.

Age and correlation.—The Genesee shale in this area contains numerous fossils but they are chiefly of one form, a phosphatic very thin-shelled brachiopod, *Schizobolus truncatus.* This is a very characteristic fossil of the Genesee shale of New York, and as it has associated with it in some places in southwestern Virginia other minute thin-shelled fossils that are also characteristic of the Genesee shale of New York, the black shale is correlated with that formation. At a few places in the Big Stone Gap area a thin layer of broken up and crumpled rusty shale an inch or two thick at the base of the formation is crowded with fossil brachiopod shells of a different kind, *Tropidoleptus carinatus.* This is not a characteristic fossil of the Genesee shale but is very common in the Hamilton shale, which underlies the Genesee shale in New York and other parts of the Appalachians. At Mendota, 30 miles to the east, small remnants of similar shale containing the same fossil are associated with 27 feet of other fossiliferous beds of either Hamilton or Onondaga age. These beds are believed to be remnants of a formation once widespread in this region but most of which was removed by erosion before the Genesee shale was laid down. Remnants of this older formation that have not been worked over and redeposited in the Genesee shale, as are those in Wise County, should not be included as part of the Genesee.

In the Estillville folio the black Genesee shale was included with overlying black and gray shales under the name Chattanooga shale. The shale at Chattanooga, Tenn., in the writer's opinion, does not contain Genesee fossils and is of later age, as is fully stated under the heading Big Stone Gap shale, on pages 47-52. Genesee shale is here recognized as a distinct formation.

Surface form and soil.—The Genesee, together with overlying shales, is soft and easily eroded and everywhere forms lowlands. Outcrops are seldom seen except in road-cuts or fresh stream-cuts. It forms a shaly to clay soil, which is generally deeply covered in lowlands with fine fertile sandy loam so that it is largely cultivated.

PORTAGE SHALE.

Character and distribution.—Overlying the black shale of the Genesee are interbedded drab and black shales called Portage shale. They are generally poorly exposed in the county because they weather readily, and together with other associated shales they tend to form lowlands. The upper part of the Portage shale is well exposed on the lower slope of Powell Mountain at the head of Powell Valley on the road to Norton over Little Stone Gap, where the following section was measured:

Section of Portage shale on road to Norton over Little Stone Gap.

Shale, in platy to thick beds, and argillite. (Big Stone Gap shale.)	Feet.
Shale, drab, clay, interbedded with harder dark-gray shale with rust-stained joints	45
Shale, hard, black, thick bed of black argillite, and some drab clay shale	60
Shale, mostly drab, weathering to soft white clay, with some black shale interbedded (lower part poorly exposed and base not determined). Estimated	300±
	405±

The Portage is also exposed in the bank of Powell River, just above the town of Big Stone Gap where Mr. Ulrich measured 285 feet of these beds above the Genesee, and he regards most of the 200 feet of concealed overlying beds to be also of Portage age. The thickness of the shale is therefore estimated at 400 feet.

Age and correlation.—Few fossils occur in this shale in Wise County. Those that have been found are minute shiny teeth and plates known as conodonts, minute spore cases of plants called *Sporangites,* a few scales and bones of fish, and doubtful plant remains. The conodonts are of types found in the Genesee and Portage shales of New York and described and figured in reports by Hinde[1] and Bryant.[2] The probable Portage age is borne out by other evidence, which is more fully stated under the next formation—Big Stone Gap shale. In the Estillville folio the Portage and Genesee shales were included with the overlying shale under the name Chattanooga, but in the writer's opinion the shale at Chattanooga contains no drab shale of Portage type, nor any black shale containing Genesee fossils.

[1] Hinde, George J., Quart. Jour. Geol. Soc., London, vol. 35, 1879, republished by A. W. Grabau, Bull. Buffalo Soc. of Natl. Sci., vol. VI, pt. 2, 1899, pp. 150-158.

[2] Bryant, Wm. L., Bull. Buffalo Soc. of Natl. Sci., vol. XIII, pt. 2, 1921.

Surface form and soil.—In common with the Genesee and Big Stone Gap shales the Portage generally forms lowlands deeply covered by light fertile soil and broken by few rock outcrops. The lowlands are generally cultivated.

Devonian and Carboniferous.

BIG STONE GAP SHALE.

Character and distribution.—The Big Stone Gap shale is a thick black shale which is generally soft but contains some beds of harder platy, dry, dull-black argillite. The shale disintegrates readily to fine shaly particles and the argillite breaks up into irregular plates. The formation weathers so readily that it tends to form lowlands covered with soil, and even where it occurs on the slopes of mountains it is seldom exposed, as it is covered by the waste of harder sandy beds which form cliffs higher on the mountain. Fortunately the new well-graded highway from the town of Big Stone Gap to Norton by way of Little Stone Gap has freshly exposed this and the overlying formations on the slope of Powell Mountain at the head of Powell Valley, where the following detailed section was measured:

Section of Big Stone Gap shale on Norton highway, head of Powell Valley.

Shale and sandstone. (Price sandstone.)

	Feet.
Shale, dark-gray, fissile to platy, argillaceous, with few thin sandstone beds in upper part; black shale and dense argillite containing plant spore cases in lower part	125±
Clay shale, dark-gray, buff-weathering, thin platy, some chocolate and black shale, and thin beds of soft yellow clayey sandstone and rusty sandstone. Upper part concealed	100±
Shale, black, platy above, crumbly and shaly below, with numerous plant spore cases and some conodonts	50
Shale, black, with a little drab clay shale and thin sandstone near top	20
Argillite, dull-black, in platy to thick beds, and very black shale with red ferruginous stain on joints	25
	320±

Clay shale, drab, interbedded with harder dark-gray shale. (Portage shale.)

The formation is also exposed in a fresh stream-cut in the west bank of Powell River just above the town of Big Stone Gap, where the following section was measured by Mr. Ulrich.

Section of Big Stone Gap shale on Powell River above the town of Big Stone Gap.

By E. O. Ulrich.

Sandstone and shale. (Price sandstone.)
Shale, greenish, soft, fissile. (Probably also part of Price sandstone.)

	Feet.
Shale, dark to black, soft to medium-hard, fissile, with few nodules of iron carbonate. (Probably top of Big Stone Gap shale.) ...	70±
Shale, black, very fissile. Phosphatic nodules and pyritiferous layers at base contain fossil fragments	50±
Shale, black, reddish to rusty weathering, with white fine sandy nodular masses containing black specks at base	30±
Shale, hard, sandy, nodular, interbedded with hard black shale, containing linguloid shells and fish scales, overlain by thin soft irregular fissile greenish shale	10
Shale, black, some harder beds and micaceous argillite in upper part containing a linguloid *(Barroisella)* and a discinoid *(Orbiculoidea)*	160
Shale, mostly dark, some bluish, with thin layers of fine gray sandstone. Plant remains and fish spines in lower part.	
Shale, mainly black to dark, fissile, in part with thin laminae of fine grayish sandstone. Plant remains, grass-like leaves, and a few conodonts in lower part.	
	320±

Covered. (Probably large part Portage.)

Age and correlation.—The age of this and associated underlying shales has been a controverted question for some years. In the Estillville folio the shale formation, including in addition to the shale here described the underlying drab and black shale of Portage age and the black shale of Genesee age, was called Chattanooga shale. The thin black shale at Chattanooga, Tenn., with which it was correlated, was then considered to be of Devonian age. Mr. Ulrich, who has made a careful study of the Chattanooga formation and its scant, minute fauna, has concluded that it is of Carboniferous age, correlating it with the Sunbury and Cleveland shales of Ohio,[1] both of which he refers to the Carboniferous, though the U. S. Geological Survey still classifies Cleveland shale as Devonian. From his study of the shales at Big Stone Gap he has concluded, on the evidence of fossil content, lithologic characters, and sequence of beds, that the black shale comprising the upper 120 feet of his section quoted above in Sunbury; 30 feet of underlying reddish shale may be Bedford; 170 feet of dark shale containing linguloids, discinoids, a few conodonts, plant remains, and fish scales and spines is of Cleveland and Huron age. The Chattanooga shale

[1] Ulrich, E. O., Amer. Jour. Sci., Vol. XXXIV, pp. 157-183, 1912.

is also classed as Mississippian by Schuchert, Bassler, Grabau, and some other paleontologists, and as Devonian by Kindle, David White, Weller, Butts, and other paleontologists.

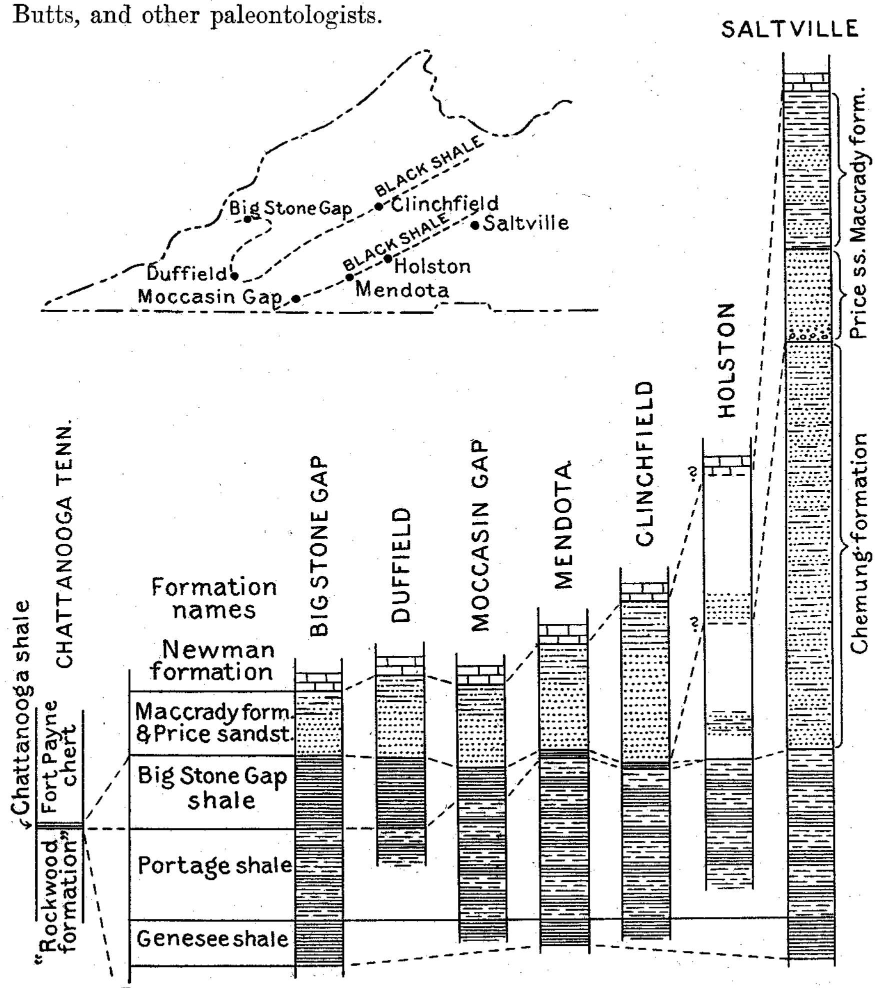


Fig. 3.—Columnar sections of the black shale and associated rocks between Big Stone Gap and Saltville and at Chattanooga, Tenn., showing correlation of formations by G. W. Stose. Location of sections shown on key map above.

The writer in an endeavor to form an opinion of his own as to the relation of these shale formations to fossiliferous Devonian beds in the vicinity of Saltville, which he had previously studied and mapped, made a reconnaissance of the black shale exposures between these two places, and measured several sections where these rocks are best exposed. The results of this study, a graphic view of which is given in the chart, fig. 3, may be summarized as follows:

The black shale is exposed in two narrow southwestward-trending belts as shown on the sketch map in figure 3, the eastern belt passing through Saltville and Moccasin Gap, the western one through Clinchfield, Duffield, and Big Stone Gap.

Shale carrying Genesee fossils is recognized in all sections in both belts, and its top is taken as the base line of the chart. It is from 160 to 200 feet thick. Overlying the Genesee shale are 400 to 700 feet of olive to drab and black shales interbedded with one another. The thickness at Mendota could not be accurately determined, but is probably at least 700 feet. In most sections only conodonts, spore cases of plants, and small fragments of fish and plants were found in these beds, but in the Saltville region other fossils, including large, thin-shelled *Goniatites,* known as the *Manticoceras* fauna and definitely of Portage age, were sparingly found. The conodonts found in all the sections are, according to Ulrich, also of distinctive types found only in the Genesee and Portage of New York and figured in published reports of Hinde and Bryant previously referred to. It seems reasonable, therefore, to conclude that these olive, drab, and black shales in all of the sections are a unit and are of Portage age. The Chemung formation, which overlies the Portage in New York, maintains its characteristic lithology and contains its distinctive fossils from its type locality in New York to Saltville, Va., where it is 1,800 feet thick. It extends but little farther southwestward, however, for only a few hundred feet of the same type of rocks was seen in the section at Holston and none at all at Mendota. The fossils of Chemung age reported in the Bristol folio as having been found in the rocks at Mendota have since been assigned to the Cuyahoga formation of Mississippian age. The Chemung thins also northwestward and is not present in the western belt of shales at Clinchfield and Dump Creek, nor to the southwest in that belt.

Overlying the Portage shale in much of Southwestern Virginia is a black shale and argillite which is 320 feet thick in the Big Stone Gap region and 355 feet thick at Duffield. It thins northeastward to 40 feet at Mendota, to 17 feet at Clinchfield, and, according to Ulrich, to 4 feet northeast of Dump Creek. None is present in the vicinity of Saltville. The distinctive lithologic character of this shale as well as its scant, minute, but characteristic fauna makes it clearly recognizable in all sections from Big Stone Gap to Clinchfield. Unfortunately it was not found in any section where Chemung rocks are recognized, and its relation to the Chemung is, therefore, not positively established. However, as it overlies the Portage shale and underlies rocks of Cuyahoga (New Providence) age in all the sections above referred to, and as there is no formation known anywhere between the Portage and the Chemung with which it can be correlated on reasonable evidence, whereas there are closely similar black shales just beneath the Cuyahoga shale in Ohio, it is concluded that the correlation of this black shale, here called the Big Stone Gap shale, with the Sunbury, Cleveland, and Huron shales of Ohio is strongly suggested on purely lithologic and stratigraphic evidence.

The few fossils obtained from this black shale in southwestern Virginia also tend to support this correlation. In the upper part of the black shale are found a *Lingula* identified as *L. melie,* a form which occurs in the Sunbury shale of Ohio, and conodonts which Ulrich finds differ from those in the Genesee and Portage shales of New York and resemble those in the Cleveland and higher shales in Ohio. In the lower part of this black shale are found a linguloid shell identified as *Barroisella* sp., another shell identified as *Orbiculoidea herzeri,* conodonts, and fish and plant remains, which are the same as, or compare most closely with, fossils from the Cleveland and Huron shales of Ohio. The Sunbury shale is undoubtedly Mississippian, and the Cleveland and Huron shales are classed also as Mississippian by Ulrich and some other geologists, but are classified by the United States Geological Survey as Devonian.

In the vicinity of Chattanooga, Tennessee, there is from 10 to 25 feet of black shale and platy argillite called the Chattanooga shale, which has the same lithologic character as the Big Stone Gap shale here described and which similarly contains spore cases, *Lingula melie,* and conodonts reported by Ulrich to be the same as those in the Big Stone Gap shale. It does not contain *Schizobolus* or other fossils characteristic of the Genesee or Portage nor does it have interbedded drab or olive shale like that in the Portage. It underlies Fort Payne chert, generally regarded as equivalent to the Keokuk formation of the Mississippi Valley. It is, therefore, either lowermost Mississippian or uppermost Devonian. The fact that it rests unconformably on the early Silurian "Rockwood formation" at Chattanooga and that, according to Ulrich and others, there is a similar marked unconformity at the base of the Chattanooga shale throughout most of Tennessee and Kentucky and in parts of the Mississippi Valley, favors the view that it is Mississippian. The typical Chattanooga shale, therefore, corresponds very closely with the upper black shale in the Big Stone Gap area, but as Chattanooga has been widely used in a broader sense to include beds of unquestioned Devonian age and as the whole Chattanooga question is a matter of controversy, it is thought unwise to apply the name Chattanooga to the shale here described, and the name Big Stone Gap shale is therefore used.

The sections on which the chart in figure 3, page 48, is based are given below:

Duffield, Va.

	Feet.
Thick-bedded sandstones, some reddish and shaly; granular below and contains ferruginous nodules at base. (Price sandstone.)	
Big Stone Gap shale:	
Covered	250±
Black shale with thick argillite at base; contains *Sporangites* and conodonts regarded by Ulrich as of Carboniferous age	15±
Black shale; spore cases at base	40±
Genesee shale:	
Black and drab shale, weathering white. (Thickness not determined.)	

Moccasin Gap, Va.

	Feet.
Thick-bedded greenish sandstone with dark crumbly shale in middle and fossils at top. (Price sandstone.)	
Big Stone Gap shale:	
Covered. (Black shale reported in this interval by E. M. Kindle.)	150±
Portage shale:	
Olive crumbly clay shale, strongly jointed and rust-stained; ferruginous nodules	60±
Covered	250±
Olive shale, weathering white, with rust-stained joints; in part covered	210±

Mendota, Va.

	Feet.
Sandy shale and platy sandstone. (Price sandstone.)	
Covered. (Probably Price sandstone.)	
Big Stone Gap shale:	
Black shale and argillite with *Sporangites* and conodonts regarded by Ulrich as of Carboniferous age	40±
Portage shale:	
Olive to gray clay shale, weathering white, rust-stained joints, and few thin sandstones. Dark-gray to green shale, weathering whitish. Contains *Sporangites* and fossil shells.	700±
Genesee shale:	
Dark-gray even-splitting platy shale with *Schizobolus*	100±
Hamilton (?) shale:	
Crushed, slickensided coaly black shale, thin calcareous sandstone, earthy micaceous, blocky shale, and crumbly fossiliferous shale	20–30

Clinchfield to Dump Creek, Va.

	Feet.
Gray to green clay shale and some shaly gray sandstone with few fossils of Cuyahoga age.	
Big Stone Gap shale:	
Black fissile shale. *Obiculoidea hertzeri, Lingula melie*	17
Portage shale:	
Thin shaly sandstone, weathering white	15
Drab sandy shale, weathering white, and thin fine-grained greenish micaceous sandstone; trail markings. Fragments of wood at base	200±
Shale and flaggy sandstone	40±
Drab to olive shale with thin sandstones; fish bones near top	20±
Covered	60±
Olive shale and thin sandstone	100±
Olive, drab, and light-chocolate clay shale and few thin sandy beds, lower part covered	200±
Black shale with thin gray sandstones	5
Dark sandstone	2
Black shale with Devonian conodonts and a fish plate	20±
Genesee shale:	
Black shale with *Schizobolus.* (Reported by Chas. Butts.)	

Holston, Va.

	Feet.
Cross-bedded gray sandstone of Cuyahoga age.	
Chemung formation (in part):	
Covered. (At Prices Mill, Roebuck postoffice, slabby irregular-bedded rusty sandstone with *Camarotoechia* of Chemung age in this interval.)	577±
Portage shale:	
Soft yellow clay shale and drab shale, weathering white Olive and drab shale	254±
Gray to yellow soft clay shale with *Sporangites.* Few thin fine-grained sandstones, weathering white	270±
Covered below.	

Saltville, Va.

	Feet.
Massive gray to faint-reddish sandstone, thin-bedded toward top; fossiliferous conglomerate at base. (Price sandstone.)	
Chemung formation:	
Massive, reddish to gray arkosic sandstone with scattered quartz pebbles, thin-bedded in lower part. Fossiliferous	195
Sandy shale with interbedded thin, fine-grained sandstone, coarser toward the top. Fossiliferous	1590
Portage shale:	
Olive to gray fissile shale with interbedded black shale at base. *Manticoceras* fauna.	735
Genesee shale:	
Black carbonaceous fissile shale	175

Surface form and soil.—The Big Stone Gap shale generally forms lowlands deeply covered by light fertile soil and in which rock outcrops are seldom seen. These lowlands are generally cultivated. The shale also occurs on the lower deeply dissected slopes of the mountains. The shale with its scant barren soil is exposed chiefly in the ravines, whereas the tops of the sloping spurs are generally covered by waste from rocks higher on the mountains. These spurs are largely in forest but partly in pasture, and in a few places are farmed. The soil is sandy and stony even where the surface is level enough to be cultivated.

Carboniferous System.

Mississippian Series.

PRICE SANDSTONE AND MACCRADY FORMATION.

Character and distribution.—A gray sandy formation, reddish toward the top, overlies the black Big Stone Gap shale. In this area its most conspicuous beds are sandstones, but sandy shale is interbedded. It generally crops out only on the lower steep slopes of mountains composed of the resistant Lee formation, and its exposures are, therefore, generally poor and discontinuous because of the cover of mountain waste. The newly graded highway from the town of Big Stone Gap to Norton over Little Stone Gap exposes the full thickness of the formation in fresh cuts. The section there exposed is as follows:

Section of Price sandstone and Maccrady formation, Norton road, head of Powell Valley.

	Feet.
Limestone, massive. (Basal part of Newman limestone.)	
Shale alternating with even-grained sandstone, upper part greenish, lower part dull-red, some shale beds banded red and green. Sandstones mostly 3 to 6 inches thick, separating layers of shale 2 to 4 feet thick; bedding surfaces of some sandstones are marked by trails	15
Sandstone, dull-red, in beds 6 inches to 3 feet thick, averaging 1 foot, separated by a few thin layers of shale, red and green mixed	20
Shale, black, crumbly, with dark micaceous sandstone layers	1
Sandstone, gray and red banded, in two thick beds	6
Shale, black, crumbly, with thin dark micaceous and red nodular sandstone layers	1
Sandstone, massive, bluish-gray, in beds 3 to 5 feet thick, with thin shale and thin micaceous shaly sandstone partings	15
Sandstone, thin-bedded, platy to shaly, gray, with some thin shaly partings; few beds reddish and laminated; some thicker beds up to 3 inches weather into spheroidal form	25
Sandstone in beds three feet thick	6
Sandstone, thin-bedded to shaly, with some shale and shaly micaceous sandstone partings. Some sandstones slabby and platy with smooth mica-coated bedding surfaces. Some bedding surfaces marked by trails, mud-flows, small ripples, fucoids, and carbonized plant remains. Few fossil shells in rough-bedded sandstones	20

	Feet.
Sandstone, thin-bedded, with many shaly partings. Fossil shells 12 feet above base	38
Sandstone, laminated, platy, gray, interbedded with shale in equal parts. Sandstone micaceous, contains carbonized plant remains and some thin black crumbly shale resembling the underclay of a coal bed	10
Shale, crumbly, gray, and some thin micaceous sandstones 2 to 4 inches thick which contain carbonized plant fragments	30
Sandstone in beds 1 to 2 feet thick with thin shale partings	10
Shale	1
Sandstone, gray, in thick bed, with fine irregular worm tubes in upper surface	3
Sandstone, gray, thin-bedded	8
Shale and thin beds of gray sandstone, thicker bedded near base	10
Sandstone, gray, in thick bed	2
Shale, with few thin sandstone beds 3 inches thick which contain plant remains	15
Sandstone, gray	2
	238

Shale, dark-gray and black, fissile to platy. (Big Stone Gap shale.)

These beds may be grouped into the three following units:

Shales, red and green, and trail-marked sandstone, interbedded with some dark crumbly shale at base, 42 feet thick. (Maccrady formation.)

Sandstone, chiefly thin-bedded and in part micaceous, and some shale, 115 feet thick. (Price sandstone.)

Shale, crumbly, gray, with some sandstones, mostly in thin beds, 81 feet thick. (Included with Price sandstone.)

The upper reddish beds are regarded as a separate formation, called originally the "Pulaski shale" in the Pocahontas folio and Maccrady formation in the Saltville region. Its outcrop is so narrow and it is generally so poorly exposed that it is not separately mapped. The middle and larger part of the mapped unit is regarded as the Price sandstone, and the lower shale and sandstones are included with the Price.

In the fresh exposure of these formations in the west bank of Powell River, just above the town of Big Stone Gap, the sandy shale is so hard that it appears as sandstone. The same threefold division, is however, there observable. The upper part is composed of fine-grained light-gray sandstone weathering reddish. The middle is thin-bedded gray sandstone with thin bluish shale partings and heavy-bedded greenish sandstones weathering rusty at the base. The lower 60 feet or so is soft greenish fissile shale. The section is estimated by Ulrich to be 260 to 280 feet thick.

The Price sandstone and Maccrady formation together outcrop as a narrow band near the foot of the slopes of the mountains encircling Powell Valley, but good exposures are not numerous. Along the outcrop at the southeast foot of Stone and Little Stone Mountain the formations are best exposed where Powell River cuts through them just above the town of Big Stone Gap. At the head of Powell Valley they are again excellently exposed on the highway to Norton. At the northwest foot of Powell Mountain they are again well exposed on the road from Minton to Maple Gap. There are some irregularities in the distribution of the formations due to structure. A slight transverse synclinal depression brings the Price sandstone to the the valley road in a small hill east of Minton. Toward the northeast the Price sandstone again descends into the valley and reaches the road to Norton at Buffalo School.

Age and correlation.—The formation here described is sparsely fossiliferous in this area and only a few fossils were obtained from beds about 110 and 140 feet below the top of the formation on the road to Norton. From better collections obtained by the writer and by Chas. Butts from these beds at Dump Creek near Clinchfield, Va., the following fossils were identified:

Conularia Newberryi.
Fenestella sev. sp.
Polypora sp.
Cystodictya sp.
Rhipidomella pulchella ?
Chonetes Shumardianus var.
Productus aff. Crawfordsvillensis.
Spirifer aff. Milleranus.
Spirifer aff. carinatus.
Spirifer aff. Grimesi.
Reticularia Cooperensis.
Spiriferina aff. subelliptica.
Athyris lamellosa.
Paleoneilo sp.
Myalina aff. Keokuk.

Other collections made by David White at Moccasin Gap and near Hilton and by the writer at Moccasin Gap yielded the following forms:

Cladochonus sp.
Paleacis ? sp.
Polypora sp.
Fenestella sev. sp.
Rhombopora sp.
Cystodictya aff. lineata.
Chonetes Shumardianus.
Chonetes n. sp.
Productus sp.
Pustula gradata
Camarotoechia sp.
Spirifer sp.
Brachythyris ? sp.
Spiriferina sp.
Cyrtina ? sp.
Syringothyris aff. texta.
Athyris lamellosa.
Aviculipecten sp.
Pleurotomaria sp.

E. M. Kindle,[1] who previously collected fossils at Moccasin Gap, correlated the rocks with the "Knobstone group" of Indiana, and Chas. Butts[2] more recently expresses the view that they are equivalent to the New Providence shale of Indiana and to the Cuyahoga shale of Ohio. G. H. Girty from a study of the fossils enumerated above provisionally accepts this

[1] U. S. Geol. Survey Bull. 244, pp. 30, 31, 1905.
[2] Ky. Geol. Survey Series VI, Vol. 7, p. 66, 1922.

correlation. It is of interest to note that the rocks at Moccasin Gap and Dump Creek in which the fossils occur are glauconitic sandstones containing phosphate nodules.

In the Pocahontas folio sandstones at this horizon were called by Mr. Campbell Price sandstone, from Price Mountain, Montgomery County, and overlying reddish beds were called "Pulaski shale," from Pulaski, Va. As the name Pulaski was already in use for another formation, the name Maccrady was later substituted for this red shale, which at Saltville contains deposits of gypsum and salt of commercial value. The names Price sandstone and Maccrady formation are, therefore, here used for the sandstones and overlying reddish sandstone and shale in the Big Stone Gap area.

Surface form and soil.—The Price sandstone, where it occurs in a lowland of shale, forms low sandy hills because the sandstone is more resistant than the soft shale. Such hills may be seen at only a few places in the county. A low hill east of Minton and another at the mouth of Cracker Neck Hollow, are formed of these beds, and southeast of Buffalo School low ridges rising higher as they join spurs from the mountains are composed of the Price sandstone. The soil is sandy and in part stony, and is farmed in only the lower less rugged areas. On the slopes of the mountains the narrow belts of the Price and Maccrady formations are covered by waste from rocks above, and the formations are actually exposed only in ravines. The larger part of the outcrop of the formations, therefore, is on the forested slopes of the mountains.

NEWMAN FORMATION.

Character and distribution.—The Newman formation is characterized by the presence in it of calcareous matter in the form of limestone and calcareous shale and may, on lithologic grounds, be readily divided into two parts: a lower part about 400 feet thick of massive, light-blue to white limestone and an upper part of about the same thickness of calcareous shale and shaly limestone.

Much of the massive limestone is oolitic in structure and the lowest beds contain considerable chert. (See Pl. X.) The type section of the formation, measured 30 years ago by M. R. Campbell, on the northeast side of Powell River in Big Stone Gap is as follows:[1]

[1] U. S. Geol. Surv. Bull. 111, p. 38, 1893.

Section of Newman formation, Big Stone Gap.

By M. R. Campbell.

	Feet.
Sandstone, thick-bedded. (Base of Pennington shale.)	
Shale, dark-blue, calcareous	4
Sandstone, dark	3
Shale, black	6
Sandstone, blue, calcareous	5
Shale, dark-blue	18
Shale, calcareous, with beds of limestone	8
Shale, dark	6
Sandstone, green	6
Shale, green	12
Shale, sandy	19
Sandstone, dark-blue, calcareous, and shale	28
Limestone, dark, very impure	17
Shale, blue	22
Limestone, impure	26
Shale, blue, purple, and black	88
Shale, calcareous	34
Limestone, earthy, thick-bedded	17
Shale, green	4
Limestone, impure	2
Shale, green	3
Limestone, impure	22
Shale, green and brown	23
Shale, blue, with beds of limestone	10
Shale, calcareous	11
Limestone, blue, seamy	17
Limestone, argillaceous	39
Limestone, massive, blue, becoming cherty towards base	379
	829
Sandstone, red, calcareous. (Maccrady formation.)	

The thick limestone at the base is now well exposed in the quarry and in the Southern Railway cut at the southeast entrance to the gap, and a more detailed section, measured by Charles Butts and E. O. Ulrich, is as follows:

Section of the limestone beds at base of the Newman formation in Southern Railway cut and quarry, Big Stone Gap, Va.

By Chas. Butts and E. O. Ulrich.

	Feet.
Limestone, impure, argillaceous, shaly.	
Limestone, oolitic, blue, in part weathers granular. Contains *Talarocrinus* sp. and *Pentremites pyriformis*	136
Limestone, white, oolitic above and dark below, with beds of fine-grained argillaceous buff-weathering limestone, each about 2 feet thick, at the top and bottom and another near the middle. Oolite beds contain *Platycrinus penicillus (huntsvillae,)*	28
Limestone, white, thick-bedded, granular, in part oolitic	184
Limestone, massive, fine-grained, dark-drab, weathers white to creamy, with round black to red flints of 3-inch diameter	30
	378
Shale, reddish and gray, sandy. (Maccrady formation.)	

The basal part of the formation is also well exposed on the road to Norton south of Little Stone Gap. The section as measured is as follows:

Detailed section of basal part of the Newman formation, Norton road, south of Little Stone Gap.

	Feet.
Limestone, massive, light-gray, fossiliferous, oolitic; base deeply pitted by weathering	20±
Limestone, impure, gray, earthy weathering	7
Limestone, very massive, blue-gray, granular, oolitic	15
Limestone, crumbly, earthy, gray, with round, tough drab flints with red spots. Sandy and shaly near base	15
Limestone, fossiliferous, gray, granular	5
Limestone, earthy, containing dark-gray flints and small odd-shaped clay nodules. Contains *Productus*	8
Limestone, blue, containing black chert and *Platycrinus* plates and brachiopod shells	1
Limestone, massive, dense, earthy, gray, containing layers of gray to reddish round cherts and a spongelike fossil, *Gervanella*	25
Shale, green, sandy. (Maccrady formation.)	

The formation can be conveniently studied at few other places in the county because it outcrops chiefly high up on the steep slopes of Stone, Little Stone, and Powell mountains which are crossed by few trails and by almost no roads. It outcrops on the Maple Gap road above Minton and on the road up Cracker Neck Hollow. Elsewhere it may be found in the steep ravines high up on the mountain slopes. The limestone at the base of the formation, which makes a cliff in many places, may be seen from the valley floor, where not too densely forested, but its exact location on these steep slopes was determined at few places, largely from traverses over the mountains by J. B. Eby in the study of the coal measures. The mapping of the boundaries of the formation on these steep slopes is therefore more or less arbitrary. The limestone at the base of the formation is mapped as a narrow band covering an interval of about 400 feet on the mountain slopes surrounding Powell Valley except at a few places where it is known to widen out because of local folds or of difference in topography. South of Minton a slight change of strike, due to a small sharp fold probably accompanied by minor faulting, carries the limestone into a rather wide-open valley back of a low front spur, where the outcrop is locally ¾ mile wide. Again, at the head of Powell Valley above the Norton road where the rocks are nearly horizontal on the end of the anticline, the limestone locally covers a wider area.

Age and correlation.—The Newman formation here described is named from Newman Ridge in southwestern Virgina. This name was used by Mr.

Campbell in the Estillville folio and the type section measured by him at Big Stone Gap is given on a preceding page. Chas. Butts[1] and E. O. Ulrich,[2] who have studied the rocks of this age and collected fossils from the Mississippi Valley across Kentucky to Virginia, regard the limestone at the base of the formation in the Big Stone Gap area to be of Ste. Genevieve and Gasper age. The limestone quarried on the Southern Railway at the southeast entrance to Big Stone Gap is, according to him, of Ste. Genevieve age, as it contains *Platycrinus penicillus (huntsvillae),* the characteristic fossil of that age. *Talarocrinus* sp., and *Pentremites pyriformis,* characteristic fossils of the Gasper, first appear in oolitic beds at the upper northwest edge of the quarry. At Dump Creek near Clinchfield, 40 miles northeast of this area, cherty limestone in the lower part of the Newman contains numerous silicified brachiopod shells and a columnar coral, *Lithostrotion,* which is regarded by Butts and Ulrich as a characteristic fossil of the St. Louis limestone. It is possible, therefore, that the lower 25 feet of the formation in the Big Stone Gap area, which contains more chert than and differs in other lithologic characters from the limestone above but contains no distinctive fossils, may be of St. Louis age. Some of the shaly limestones in the upper shaly part of the formation are highly fossiliferous, and these beds are correlated by Mr. Butts[3] with the Glen Dean limestone of Kentucky as they contain *Prismoporo serratula* and other fossils characteristic of that formation.

Surface form and soil.—The limestone at the base of the Newman formation is harder and more resistant to erosion than either the thin-bedded sandstone and black shale below it or the calcareous shale of the Newman and the Pennington shale above, so that on the steep slopes of the mountains encircling Powell Valley it makes cliffs, ledges, and benches, above which the slope is gentler. In some places its nearly white cliffs are of sufficient prominence to be observed from the valley below (see Pl. IV), but in the summer months they are generally concealed by dense foliage. Southeast of Minton the limestone caps the sloping spurs on the sides of Cracker Neck Hollow, and the gentle slopes of the valleys back of them have good clay soil residual from limestone, which is in part cultivated and part in pasture. A similar limestone area of sufficiently gentle slope to have good residual soil which is in part cultivated lies on a bench east of the Norton road at the head of Powell Valley.

[1] Ky. Geol. Survey Series VI, vol. 7, pp. 152 and 161, 1922.
[2] Geol. Soc. Amer. Bull., vol. 33, p. 823, 1922.
[3] Chas. Butts, op. cit., p. 178.

PENNINGTON SHALE.

Character and distribution.—The Pennington is a gray to greenish or yellow crumbly shale with some sandstone and a few thin beds of limestone and calcareous shale, and a thin bed of conglomerate near the middle. The type section measured in Big Stone Gap by M. R. Campbell[1] 30 years ago is as follows:

Section of Pennington shale, Big Stone Gap, Va.

By M. R. Campbell.

Coarse conglomerate. (Base of Lee formation.)

	Feet.
Shale, green, calcareous	6
Sandstone, green and red	2
Shale, blue	6
Coal	1
Shale, bluish	10
Sandstone, green	3
Shale, olive-green	7
Shale, soft, nonfissile, variegated	10
Sandstone	4
Shale, soft, red	8
Shale, sandy	4
Sandstone, bluish	19
Concealed, probably shale	507
Sandstone, white, cross-bedded	49
Conglomerate, white quartz pebbles	8
Shale, bluish yellow, calcareous	27
Shale, blue, sandy	10
Limestone, very impure and fossiliferous	4
Sandstones, calcareous and argillaceous	8
Shale, calcareous, very fossiliferous	6
Sandstone, blue, cross-bedded	12
Shale, purple and green	9
Shale, slightly sandy	4
Shale, green and purple	5
Sandstone, argillaceous	8
Sandstone, fine-grained	14
Sandstone, regularly bedded	80
Sandstone, much cross-bedded	107
Shale, dark-blue, calcareous	9
Shale, sandy	8
Shale, argillaceous	3
Sandstone, thick-bedded [cut by Southern Railway tunnel]	67
	1,025

Shale dark-blue, calcareous. (Newman formation.)

A section of the formation exposed on the road to Norton at Little Stone Gap, measured by David White and J. B. Eby, is as follows:

[1] U. S. Geol. Surv. Bull. 111, p. 37, 1893.

Section of Pennington shale in Little Stone Gap.

By David White and J. B. Eby.

Conglomerate, massive. (Base of Lee formation.)

	Feet.
Shale	16
Sandstone, greenish	18
Shale, red	10
Sandstone, greenish	7
Shale, red	11
Shale, yellowish	26
Sandstone	3
Shale	178
Sandstone, hard, irregularly bedded, greenish	29
Shale, soft, friable, greenish-white with yellow bands; sandy at base	200
Sandstone, irregular, hard, with conglomerate of angular and sub-angular shale pebbles	25
Shale, thin platy, sandy, yellowish; coaly layer at top with fossil plants of Mississippian age	22
Shale, partly concealed	20
Sandstone, massive, hard, conglomeratic near base with white quartz pebbles. (Princeton sandstone.)	54
Shale, greenish, calcareous	3
Shale, very coarse and nodular, containing invertebrate fossils	3
Shale, partly concealed	87
Sandstone, coarse, resistant	54
Shale, yellow	3
Sandstone, soft, brown	17
Concealed, probably largely shale	148
Sandstone, with shale partings	43
Sandstone, with few thin shaly partings	34
Shale, with shaly sandstone at base containing angular shale pebbles	32
Sandstone, massive	120
	1,163

The formation may be summarized as consisting of thick massive sandstone at the base, overlain by soft yellow and greenish shale and sandstone, and about 60 feet of sandstone and conglomerate near the middle, overlain by green, yellow, and red shale and sandstone with a thin coal bed in the upper part.

The Pennington shale is mapped as a nearly uniform band along the upper southeast slope of Stone and Little Stone mountains, the crest of the mountains being formed of the basal massive conglomeratic sandstone of the Lee. The thick-bedded sandstone at the base of the formation caps a line of knobs, spur tops, and benches on the upper south slope of the mountain, which, toward the head of Powell Valley, becomes the main crest of Little Stone Mountain and forms the divide at Little Stone Gap. The basal sandstone also caps the northwest ridge of the dissected plateau called

Powell Mountain, the basal conglomerate of the Lee capping a second parallel line of ridges or knobs on the plateau and the middle sandstone of the Lee a still higher ridge on the plateau. The belt of the Pennington formation on the southeast side of the valley is wider than that on the northwest side because the dips are more gentle, and it is also more irregular in outline because of deep reentrant valleys.

Age and correlation.—The Pennington shale was so named from Pennington Gap, Va., and that name was used in the Estillville folio. The type section measured by Mr. Campbell at Big Stone Gap is given on a preceding page. The formation is sparingly fossiliferous, and is correlated by Butts and Ulrich with the upper part of the Chester group of the Mississippi Valley.

Surface form and soil.—The steep slopes and ridges are covered with vegetation and in places are densely forested. The shale of the formation forms a part of the hilly surface of the plateau back of the front ridge of Powell Mountain. Small areas of this mountain-top shale land are cleared and cultivated in a crude way, but most of it is too stony and rough for cultivation and is in forest.

POST-MISSISSIPPIAN ROCKS.

By J. B. Eby.

Pennsylvanian Series.

GENERAL STATEMENT.

The rocks of the coal-bearing portions of Wise and Scott counties, exclusive of residual soil and alluvium, belong to the Mississippian and Pennsylvanian series of the Carboniferous system. As the Mississippian series is barren of workable coal, it is described by Mr. Stose with the older non-coal-bearing formations. (See pages 22 to 62.) The rocks in the coal field are widely covered by a thin mantle of residual soil, and many of the valleys are filled with alluvium, but these surficial deposits are not extensive or important enough to warrant mapping. The bed rock is usually well exposed in the headwater channels of streams and on the spurs.

The Pennsylvania series in Wise and Scott counties consists of sandstone, shale, clay and coal beds and is about 5,750 feet thick. These rocks, all of Pottsville age, were divided by Campbell[1] into the following formations named in ascending order; Lee conglomerate, Norton formation,

[1] Campbell, M. R., Geology of the Big Stone Gap coal field of Virginia and Kentucky; U. S. Geol. Survey Bull. 111, pp. 33-36, 1893.

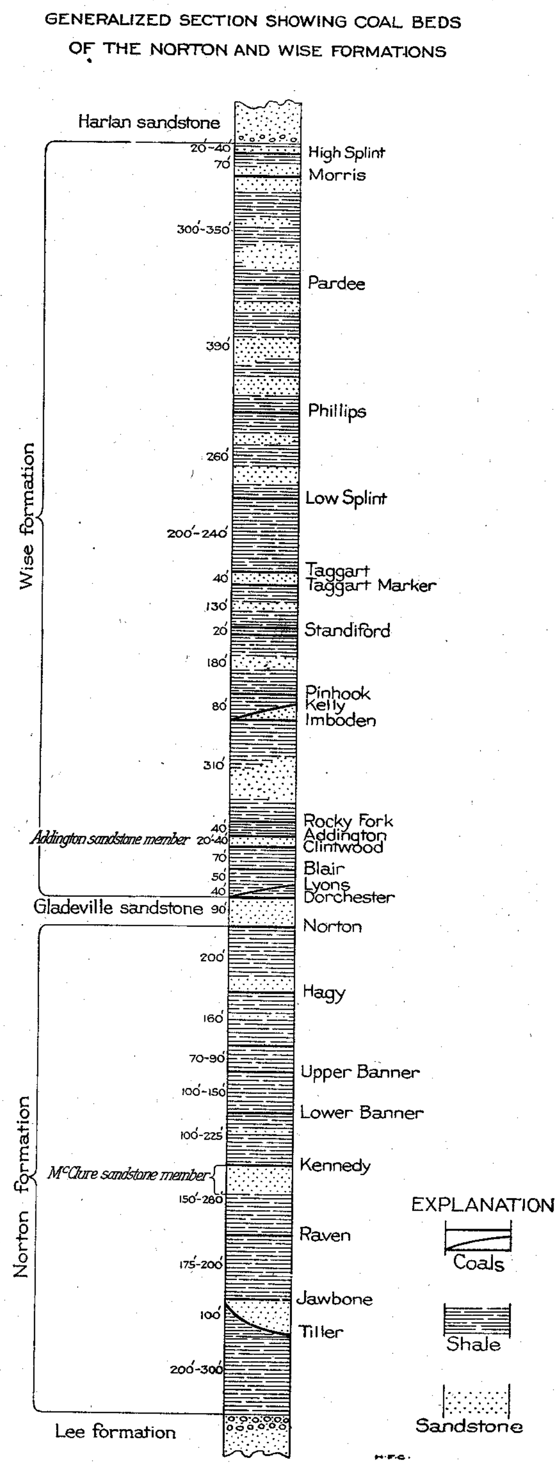


Fig. 4.—Generalized section showing coal beds of the Norton and Wise formations.

Gladeville sandstone, Wise formation and Harlan sandstone. The Lee formation was named for Lee County, but is typically developed in Big Stone Gap. The Harlan sandstone is best developed on Big Black Mountain and hence was named for Harlan County, Kentucky. The other formations were named for type localities in Wise County. The character of the rocks, the sequence and relative thickness of the formations, and the number, position and succession of coal beds are shown in figure 4. This section is generalized and shows the average section of the formations, rather than any particular measured section. Detailed sections are given on pages 87 to 114.

The formations are differentiated largely on a lithologic basis. Thus the Pennington shale consists largely of shale which may be identified generally by its red and green colors. The Lee formation consists of massive beds of sandstone containing in places layers of rounded white quartz pebbles, 1/8 to 1 inch in diameter. (See Pl. XII B). The Gladeville is a massive bed of coarse white sandstone. The Harlan sandstone is featured by the great thickness and massiveness of the basal sandstone in the formation. The intervening Norton and Wise formations consist of a heterogeneous mass of rocks, largely shale, clay, soft sandstone and coal beds. For purposes of identification and correlation the coal beds and sandstones are the most important members of the Wise and Norton formations, the latter particularly being traceable in parts of the field for a distance of many miles. As the region is one of sharp relief, surficial materials rarely conceal the outcrop of sandstone occurring in the ridges. The coal beds of the Pennsylvanian series here described are of such economic importance that they are described separately and in detail in later sections of the report.

The Pennsylvanian rocks of this region are composed of nearly equal parts of sandstone and shale, with sandstone more abundant at the base and top of the section. Much of the sandstone is coarse, hard and conglomeratic, such as the massive beds of the Lee, and the hard sandstones of the Gladeville and Harlan. These beds make prominent cliffs and ledges, the weathered surface acquiring a dull gray color. On freshly cut surfaces this type of sandstone is white to pinkish but stains readily from iron that is usually present in considerable amount. The greater mass, but less conspicuous type, of Pennsylvanian sandstones is a fine—to coarse—grained thin-bedded rock that on weathering has the appearance of sandy shale. It is usually cross-bedded and contains much clay indicating irregular and disturbed conditions of deposition. The sandstone is usually friable from the presence of considerable decomposing feldspar. Quartz and mica are present in large quantity. Upon disintegration this type of sandstone furnishes a micaceous sandy soil; usually quite fertile from the clay present.

Shale is a common rock type of the Pennsylvania series. It is usually sandy grading through sandy shale to sandstone, and more rarely is a true clay shale (see pages 576-578). The common color is drab, and yellow and, to a lesser extent, red and brown. Hard shale, usually found near coal beds, is steel-gray in color with a bluish tinge.

A thin fossiliferous limestone was seen in the upper part of the Pennsylvanian rocks in Black Mountain. The bed is 8 inches thick and lies 210 to 225 feet above a coal described as the Phillips bed. This is the only limestone found in the coal-bearing rocks of Wise County.

LEE FORMATION.

The Lee formation is composed of three thick, massive sandstone members that usually are markedly conglomeratic and are separated by shale and thin-bedded sandstones containing several thin coal beds. To the upper conglomerate Stevenson in 1881 applied the name "Bee Rock." The middle conglomerate is here named the Bald Rock conglomerate member from a prominent feature in the vicinity of Miller Yards, about 4 miles west of Dungannon, locally called the Bald Rock. The lower conglomerate member is herein referred to as the basal sandstone of the Lee. The three beds are hard, massive, and the most prominently mountain-making sandstone beds in the Carboniferous system of rocks in this field. The formation is named for Lee County, Va., although the type section as described by Campbell is in Big Stone Gap.

The Lee formation is 1,530 feet thick at Big Stone Gap and 1,800 feet thick at Little Stone Gap. The formation thins rapidly to the west and northwest and is but 784 feet thick in a deep boring put down on Cranesnest River, near Birchfield Creek (see borehole 72, Pl. III.) On the western margin of the Appalachian coal field, in Menifee County, Ky., Crandall[1] describes the conglomeratic sandstones of the lower Pennsylvanian as ranging in thickness from 20 to 100 feet.

The "Bee Rock" of the Lee is a massive conglomerate 95 to 120 feet thick. It makes sharp overhanging crags along the entire north slope of Powell, Stone, and Little Stone Mountains west of Tacoma. (See Pls.

[1] Crandall, A. L.: Kentucky Geol. Survey, vol. II, new series, pp. 353-357.

IX A and XI A). The bed is the resistant sandstone that makes much of the surface of Powell Mountain south of Coeburn, Tacoma and Ramsey. The middle and lower sandstone members are usually considerably thicker than the top member and are conglomeratic in zones. The Bald Rock is 200 feet thick in Big Stone Gap and 160 feet thick in Little Stone Gap. The basal conglomerate ranges in thickness up to 250 feet. The three beds are composed of hard, clean sandstone, with pebbles of purest white quartz. The sandstones of the Lee as a rule are much less arkosic than those of the higher formations and contain a much larger proportion of quartz grains.

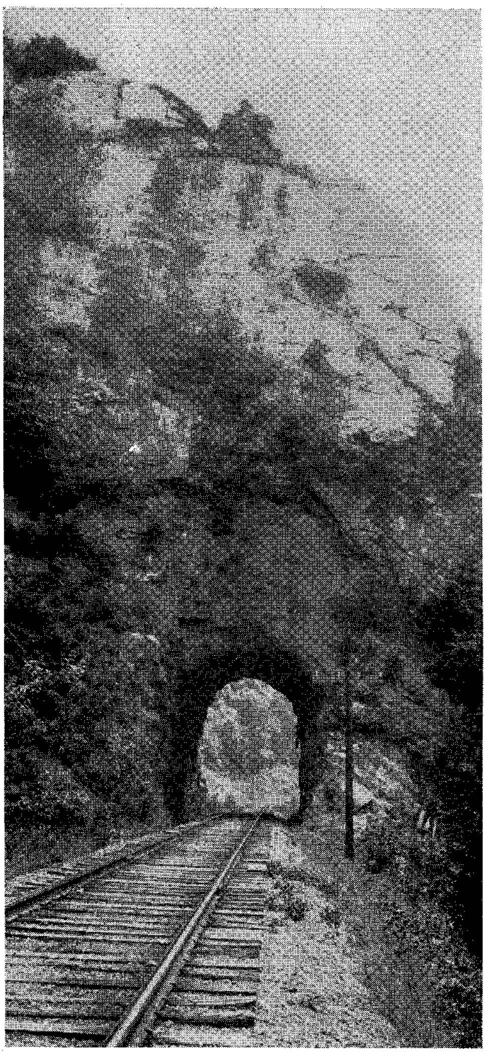
A conglomeratic sandstone that forms a low hogback in the lower slope of Pine Mountain in Wise County has all the characteristics of a Lee conglomerate member and was called the "top of the Lee" in reports by Stone and Butts previously mentioned. Work in Dickenson County and farther northeast, however, confirmed by a study of fossil plants by David White, has shown that this bed is the rock directly beneath the Kennedy coal bed in the Norton formation, and that its top is 400 to 550 feet above the top of the Lee. This bed is here called the McClure sandstone for McClure River in central Dickenson County. The sandstone outcrops extensively and typically along the banks of McClure River from Caney Creek south to Sandy Ridge, and the towns of Nora and Stratton are underlain by it. The Carolina, Clinchfield and Ohio Railroad runs along the outcrop of this bed and McClure River for a distance of approximately 11 miles.

The rocks between the thick sandstone beds are shale, sandy shale and a very small percentage of clay and coal. The shale is soft and weathers out readily between the beds of sandstone where the rocks are turned up at a high angle, resulting in the formation of narrow valleys with one steep or overhanging wall.

NORTON FORMATION.

The mass of sandstone, shale and coal beds lying between the Lee formation and the Gladeville sandstone are grouped into a formation to which the name Norton was given, for Norton, the largest town in Wise County. The formation crops out in two principal belts or zones; one just north of Powell, Little Stone and Stone mountains, and the other south of Pine Mountain. The formation consists of alternate beds of sandstone and shale interbedded with coal.

The Norton formation varies in thickness from 1,300 to 1,500 feet, with the thinning in a northerly direction. The formation is 1,475 feet thick in the vicinity of Coeburn and 1,460 feet in the southwestern part of Dick-

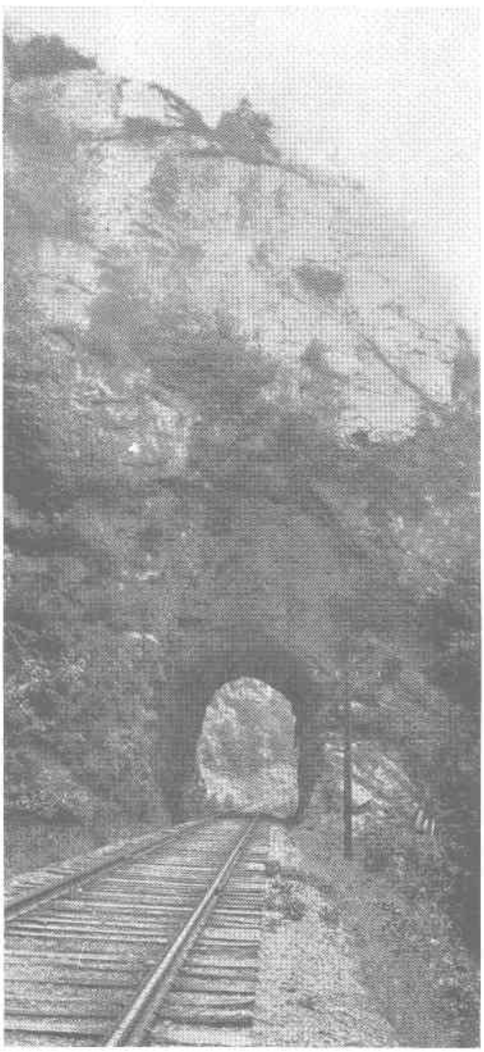


(A) The "Bee Rock" at upper end of Big Stone Gap, looking south into tunnel of Louisville and Nashville Railroad.

Photo by C. K. Wentworth.

(B) Massive Lee conglomerate upturned in Little Stony Creek Valley, ½-mile north of Clinch River.

Photo by J. B. Eby.



(A) The "Bee Rock" at upper end of Big Stone Gap, looking south into tunnel of Louisville and Nashville Railroad.

Photo by C. K. Wentworth.

(B) Massive Lee conglomerate upturned in Little Stony Creek Valley, ½-mile north of Clinch River.

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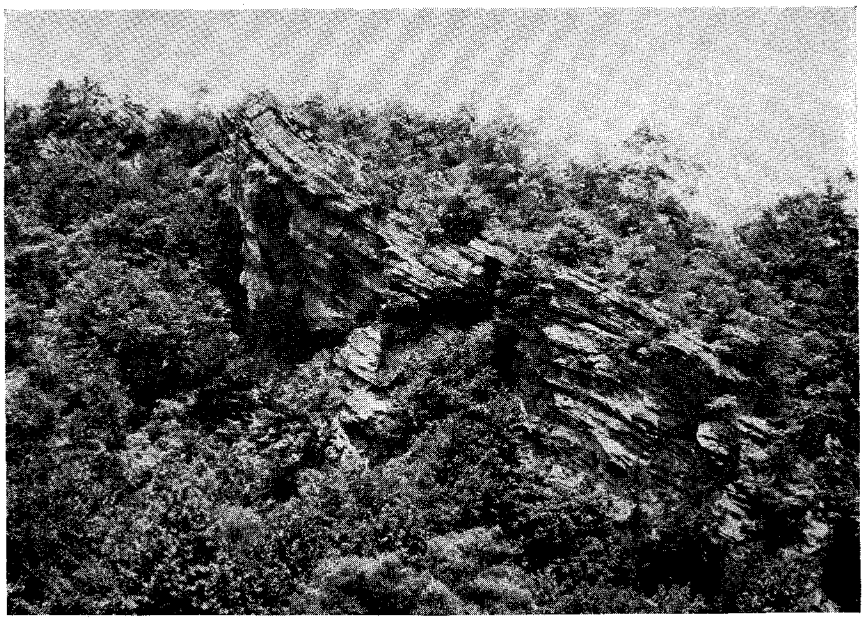
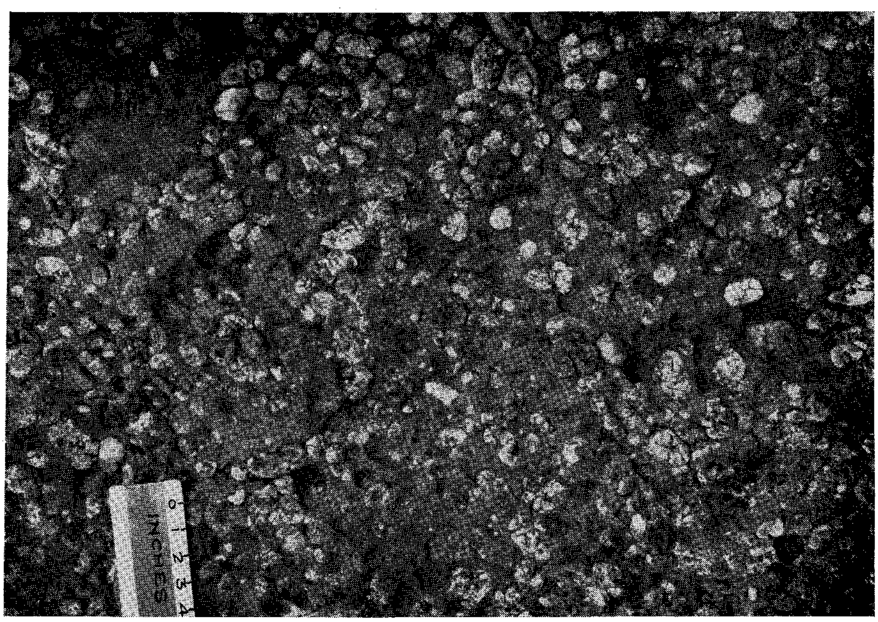


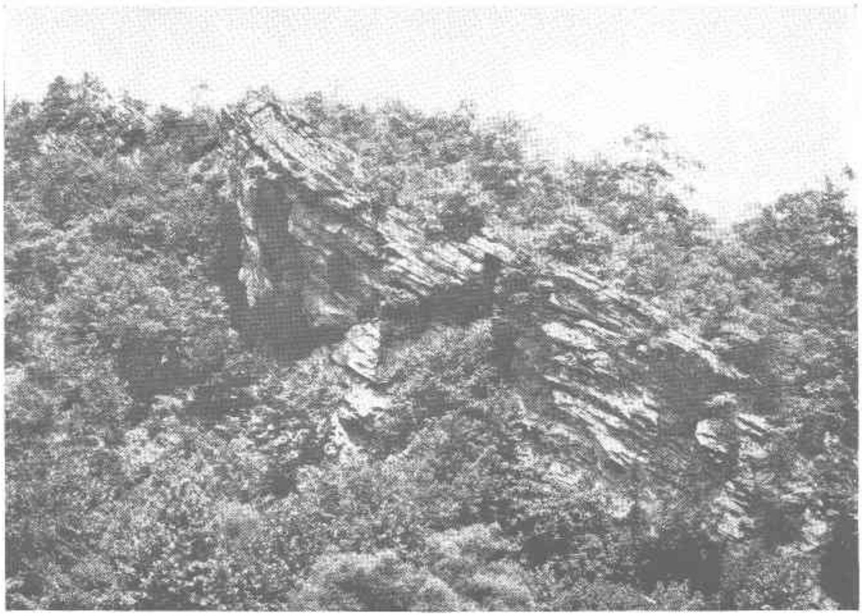
(A) Overturned Lee conglomerate near Clinch River, forming crest of ridge, one mile east of Shannon, looking east.

Photo by C. K. Wentworth.



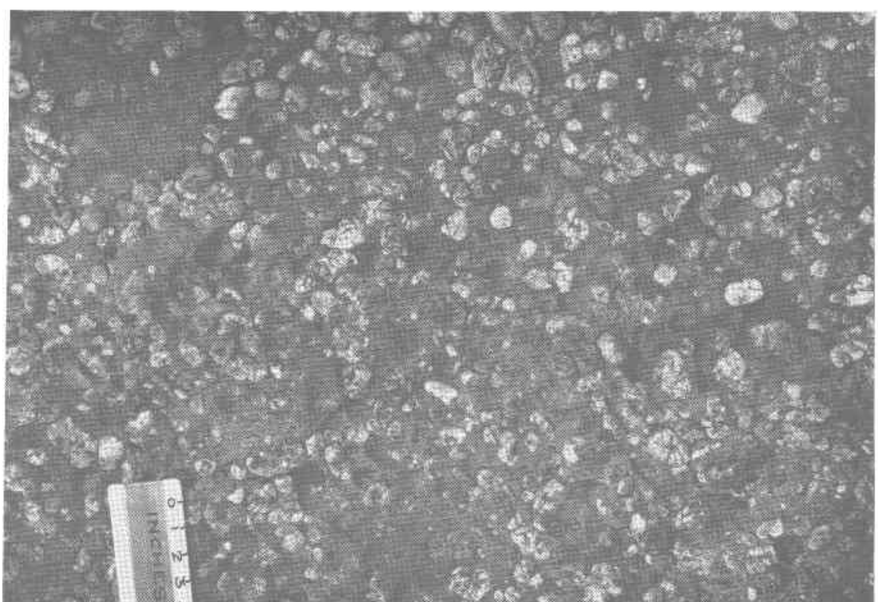
(B) Detailed view of Lee conglomerate, showing white quartz pebbles in clean, medium-grained hard sandstone matrix.

Photo by C. K. Wentworth.



(A) Overturned Lee conglomerate near Clinch River, forming crest of ridge, one mile east of Shannon, looking east.

Photo by C. K. Wentworth.



(B) Detailed view of Lee conglomerate, showing white quartz pebbles in clean, medium-grained hard sandstone matrix.

Photo by C. K. Wentworth.

enson County. The disturbed condition of the rocks along the foot of Powell and Stone mountains west of Tacoma has been the cause of many discrepancies in published accounts of the thickness of this formation. Many low folds in the main coal basin have also added to the difficulty of correctly identifying and measuring this formation. The name Norton was given to the formation by Campbell under the impression that the Gladeville sandstone is the coarse sandstone capping the ridge back of the town of Norton and hence that the formation in question is at the surface in the entire town site. Recent work has shown this conclusion to be in error, and it is now known that the Gladeville sandstone instead of capping the ridge is below the surface in all that part of the town lying west of the railroad and consequently the town is in reality on the Wise formation instead of the Norton as was originally supposed. The only rocks belonging to the Norton formation near the town are those between the railroad and the uppermost conglomerate of the Lee formation, and these rocks are practically on edge as they were upturned in the great fold of Powell Mountain. As the full thickness of the Northern formation may not be present at Norton, the type locality for measurement and study of this formation should be taken farther east, where the dips are more gentle and the rocks are more fully exposed. These conditions prevail at the towns of Coeburn and Virginia City and consequently these places may be taken as the type localities. No satisfactory measures of the thickness of the Norton formation was made on the slope of Pine Mountain because on very long dip-slopes it is extremely difficult to measure thickness accurately. Many sections of the Norton formation are shown in borehole records (Pl. III) and in the generalized section in Fig. 4.

Several sandstone beds in the Norton formation are persistent and can be traced without great difficulty (Fig. 4). Among the most easily identified beds is the McClure sandstone which is associated with the Kennedy coal bed, near the middle of the formation. The coal is underlain everywhere by coarse sandstone, 50 to 200 feet thick, that forms ledges and, especially along Pine Mountain, high cliffs. Generally the McClure sandstone is an ordinary coarse sandstone, but on Pine Mountain it is sparingly conglomeratic. A sandstone of much less prominence and importance as a marker is found between the Tiller and Jawbone coal beds, both of which lie in the lower part of the Norton formation. Another massive sandstone lying 100 to 150 feet below the Gladeville sandstone has a conspicuous outcrop in east-central Wise County. It overlies a coal bed known as the Hagy. The sandstone beds described above are of the Gladeville type,—hard, gray and quartzose.

Shale is the predominating rock between the prominent sandstone members of the Norton, but soft micaceous sandstone is not uncommon. Taken as a whole, however, sandstone constitutes less than 1/4 of the Norton formation. The shale is largely clayey and non-fossiliferous, except for fossil plant found in association with the coal beds. Clay is not common, and limestone or calcareous shale has not been found in the Norton formation.

GLADEVILLE SANDSTONE.

The most important key-rock in Wise County above the "Bee Rock" of the Lee is the Gladeville sandstone. (See Pl. XV.) The bed received its name from Gladeville, the former name of the town of Wise, where the sandstone is well exposed. Here the bed is a hard gray quartzose sandstone ranging in thickness from 90 to 110 feet. It makes the plateau upon which the town of Wise stands, and which extends eastward as far as Steele Fork. Southwest and west of the town many of the ridges are capped by this sandstone, but in small outcrops on ridge tops it is sometimes difficult to distinguish it from other sandstones which locally attain its thickness and characteristics. To the east, Sandy Ridge, in large part, is held up by this massive stratum. In the central and eastern part of Wise County the bed is not conglomeratic, but in the western part, as shown by a deep boring on Preacher Creek, the Gladeville, (see Plate III Location No. 13), has a thickness of 130 feet with the lower 50 feet conglomeratic. It extends westward beyond the limits of the county and makes high cliffs of conglomerate on the North Fork of Powell River in Lee County. The Gladeville sandstone does not hold its massive character throughout the county for in some places the logs of test holes show only sandy shale. A few borings show thin coal beds in the Gladeville.

The Gladeville sandstone at Wise is a fairly pure quartzose sandstone. To the north it is more clayey, contains feldspar and mica, and is iron-stained. It does not resist weathering so effectively in northern Wise County, and breaks down into a coarse sandy soil. The sandstone at Wise is water-bearing and supplies many wells of the town and vicinity, but its area of intake is small and the supply of water is not large.

WISE FORMATION.

The Wise formation consists of a great mass of coal-bearing rocks lying between the Gladeville sandstone and Harlan sandstone, including beds of sandstone, shale, clay, coal and one or more thin limestones. The formation is fully exposed in this field and was named for Wise County. The rocks of this formation do not differ essentially from the rocks of the Norton formation, but the coal beds are more abundant and, in one case at least, considerably thicker than the coal beds of the Norton. The Wise formation has an extensive outcrop in the slopes of Black Mountain, in west, central, and north-central Wise County. Its outcrop covers at least half of the area of Pennsylvanian rocks in Wise and Scott counties.

The Wise formation in western Wise County is 2,300 feet thick, but it thins gently to the northeast as shown by a section 2,070 feet thick measured by Butts on the South Fork of Pound River.

The rocks of the formation are about one-third sandstone, but few of the beds of sandstone are persistent enough to make good horizon markers. The beds best adapted to this purpose are three in number—a hard white sandstone, 20 to 50 feet thick, about 180 to 200 feet above the base of the formation, and here named the Addington sandstone member—a thick coarse micaceous sandstone just above the noted Imboden coal bed; and a hard fine-grained sandstone bed lying between the Taggart and Taggart Marker coal beds and about 1,000 feet above the base of the Wise formation. Of these beds the Addington sandstone is undoubtedly the best marker of the three. It is named for Addington, a station on the Interstate Railroad on Rocky Fork, 1½ miles south of Glamorgan, where it forms great ledges, resembling those of the Gladeville sandstone in its best development, but is not so thick. The Addington sandstone is less valuable as a horizon marker in the western part of the field, because a similar sandstone is found below the Imboden coal bed, and both change their character considerably within the field. The sandstone between the Taggart and Taggart Marker coal beds is of value as a marker only in the western part of the field. Taken as a whole, however, the Wise formation presents a monotonuos repetition of beds of sandstone and shale, no one of which is of sufficient lithologic individuality and continuity to be worthy of representation on the geologic map.

The shale of the Wise formation in large part is drab in color and weathers to a yellow sandy soil, but a thick bed of reddish brown shale which weathers to a thick, clayey, and fertile soil lies beneath the sandstone below the Imboden coal bed. Many beds of clay occur in the Wise formation. They are seldom mono-colored, but in many places show beautifully tinted laminae curved into delicate and intricate patterns.

Marine fossils, *Spirifer* and *Productus*, have been found at two localities and at two horizons. One locality is the bank of the South Fork of Pound River a short distance west of the point where the river is crossed by the

Norton pike. The horizon of the bed containing them is about 60 feet below the Imboden (Lower Bolling) coal. The second locality is a cut on the pike a short distance north of and about 50 feet below the summit of Fox Gap at the head of Guest River. The horizon is believed to be that of the Low Splint coal, for marine fossils are reported by Crider[1] in the roof of that bed in Kentucky.

In Kentucky on the west side of Black Mountain and probably only a mile or two distance from Virginia, a fossiliferous limestone reaching a thickness of 3 feet is present 50 to 100 feet above the Pardee coal. This bed is said by Hodge[2] to have been detected in Virginia only on Pot Camp Fork where it is more nearly a sandstone than a limestone. The chief interest in these occurrences of marine fossils is the light they cast on the geographic conditions of the region during the time of the deposition of the Wise formation and their value in a correlation of the coal beds. The region was evidently a vast swamp near sea level. During the time of the accumulation of the vegetal matter of the coal beds the region was slightly above sea level for the plants were such as could grow only on land or in fresh water swamps where their remains were protected from decay by being partly or wholly submerged by water, as in a modern peat bog. At times, however, the region, was in part at least submerged by the ocean water, as proved by the presence of the fossil remains of marine organism, as described above.

HARLAN SANDSTONE.

Black Mountain and its many high spurs radiating into western Wise County, are capped by a massive cliff-making sandstone, in places conglomeratic, and 40 to 60 feet thick. This bed, overlying the High Splint coal near the top of the Wise formation by 30 to 40 feet, is regarded as the basal bed of the Harland sandstone. The formation is named for Harlan County, Kentucky, and is called "sandstone" because of the great predominance of sandstone in the formation. Coal is reported at two horizons in the formation, one about 70 and the other 270 feet above the base of the formation.

The lowest part of the basal sandstone consists of about 20 to 30 feet of arkosic[3] sandstone which weathers into layers 1 to 2 inches in thickness.

[1] Crider, A. F., The coals of Letcher County, Kentucky Geological Survey, 4th ser. vol. 4, Pl. 1, p. 21, 1916.

[2] Hodge James M., Report on the Upper Cumberland Coal Field, Kentucky Geological Survey, Bull. 13, Serial No. 16, p. 27, 1912.

[3] A *pure* sandstone contains only quartz, an *arkosic* sandstone contains the mineral feldspar in addition to quartz. The feldspar weathers more readily than quartz and an arkosic sandstone is therefore usually more friable than pure sandstone.

The bed makes a striking wall along the ridge crests, and in many places it has, owing to the horizontal layers of differential weathering, the appearance of human artifice. Above this "wall rock" lies a very massive conglomeratic sandstone about 100 feet thick, that forms at many places impassable cliffs. The bed is extremely hard and pinkish on fresh surfaces. At the head of Ison Rock and Looney ridges this bed stands out with extraordinary prominence.

At some places on the crest of Black Mountain as much as 750 feet of sandstone and shale overlie these basal members. Above the lowest sandstone beds just described lie 550 feet of sandy shale and thin-bedded sandstone. These sandstone beds are fossiliferous, being full of plant remains that weather out in profusion. A thick bed of sandstone makes the high summit of the Double, and sheds great blocks of sandstone down the mountain slope. North along Black Mountain, higher in the formation, a coarse white sandstone, 60 feet thick, crops out 780 feet above the base of the formation. A thin band of shale with a water seep, indicating the presence of coal, and a 40-foot bed of thick-bedded sandstone mark the top of the Harlan formation in Wise County and are the highest rocks stratigraphically in the region.

Quaternary System.

ALLUVIUM.

The smaller streams flowing down the steep slopes of Wise and Scott counties have great cutting and transporting powers. Soil, sand, and clay, washed into these streams, are carried along with the fragments of sandstone and shale derived from stream erosion. Where a headwater branch enters its master stream, the gradient of the stream beds decreases, and much of the stream's burden is dropped. Alluvium is the term applied to the unconsolidated mass of sand, clay, gravel, and rock fragments so deposited. Alluvial deposits, making narrow floodplains, are found to a limited extent in this territory, the chief accumulations occurring along Clinch, Pound, and lower Powell rivers. The alluvium that has collected in such large quantities along Clinch River is a fertile sandy loam.

Alluvium is mapped only in Powell Valley[1] where broad areas of lowland are so deeply covered with stream deposits that the bed-rock is concealed. This condition exists not only along Powell River from Big Stone

[1] Mapped by George W. Stose.

Gap south to the county line but also in the valley of Beaver Dam Creek and at the head of Butcher Creek. At the foot of Stone and Little Stone mountains low terraces covered with mountain waste merge into the alluvium of the lowland and this material is mapped with the alluvium.

ALLUVIAL CONES AND STREAM TERRACES.

At the mouths of ravines and valleys in the steep slopes of mountains alluvial cones are built up. These have been mapped only in Powell Valley where several are conspicuously present. At the mouth of Cracker Neck Hollow such coarse alluvium and gravel, containing many large boulders of mountain rock, are strewn over the valley floor for a distance of one-half mile. This is a very flat cone, or fan, the material being spread out rather evenly and covering a wide area. At the mouths of smaller ravines in Stone and Little Stone Mountains the cones are narrower and steeper, and are generally trenched by the present stream. In the town of Big Stone Gap there are gravel terraces 20 feet above the present streams which were formed when the stream beds were at a higher level, in an earlier stage of their history. These are mapped with the alluvial cones.

SOIL.

The soil of this region is the direct result of the weathering and disintegration of underlying formations and its character is therefore largely dependent upon the nature of the parent rock. The Pennsylvanian rocks give rise chiefly to a sandy loam due to the great amount of sandstone and sandy shale in the coal measures. The best soils of the region lie on the flat-topped ridges and near the base of the slopes or in general where erosive action is not so strong. Thus on Sandy Ridge and the Flatwoods of Powell Mountain, the soil is deep and rich and many small tracts are cleared and under cultivation. The Flatwoods country is especially fertile. On the hillsides the soil is good in localities, but often mixed to such an extent with sandstone debris as to render it unsuitable for farming. Some slope-farming is carried on in Wise County but once a steep slope is cleared, it is rapidly denuded of its soil mantle and the site must be abandoned for reforestation. The soils of the pre-Pennsylvanian rocks are described with the descriptions of the formations from which they were derived.

HISTORY OF GEOLOGIC WORK IN THE WISE COUNTY COAL FIELD AND OF THE CORRELATION OF THE COAL BEDS

By Marius R. Campbell.

GENERAL STATEMENT.

In working out the geology of a coal field one of the most important phases of the work is the correlation of the coal beds, and this also implies the correlation of beds other than coal, that have distinctive characteristics, because in many cases the best key rocks are not coal beds, but are the associated sandstones, limestones, etc. This correlation of coal beds and their correct placing in the geologic column is not only of great importance in determining the geological history of the formation of the coal and the coal-bearing rocks, but it also has, in most fields, great economic importance for certain beds of coal are more valuable than others or have a reputation in the trade which makes it of the greatest moment to know their areal extent and their equivalent in other fields or in other parts of the same field.

Coal beds are notoriously irregular in thickness and composition and, in many cases, are mere lenses, though the lenses may occur at about the same horizon and thus give the impression of a continuous bed, or the lenses may not occur at the same horizon and then the coal bed appears to ascend or descend in the formation, shifting its position relative to other beds. This is not to be wondered at when one takes into account the manner of their probable formation. It is generally agreed by geologists, in this country, at least, that coal is the result of the accumulation for untold ages of vegetal material, the burying of this vegetal material in water, and later in mud and sand, and the metamorphism of this accumulation of vegetal matter into coal by the movements and heat that have been developed within the crust of the earth.

As all known swamps at the present time range in size from a few acres to many miles in extent, but all are limited, it naturally follows that coal swamps and the coal beds resulting from these swamps must have had similar limitations. Most of the coal beds are restricted to rather small areas, but occasionally one finds a bed that is very extensive, implying an equally wide or even wider extent of the swamp in which it was formed. One of the best known examples of a widely extended coal bed is the Pittsburg coal bed of Pennsylvania, Maryland, West Virginia and Ohio. This bed is known to underlie thousands of square miles and it is probable that the swamp in which it was formed was even more extensive, as much of the bed has been eroded and its original limits can not now be determined. One might say, therefore, that, as a rule, coal beds are really lenses, large or small, and the lenses may be connected by a thin sheet of coal or they may slightly overlap, but still continue at about the same horizon.

Coal beds are also known to split or two coal beds come together, the interpretation depending upon the direction in which the problem is approached. Splits of 40 feet are recorded in a number of places in actual mining operations and it seems altogether probable that if a coal bed splits to the extent of 40 feet it may just as readily extend the split to even a hundred feet and possibly more. The conditions in the coal swamp which permitted of a split are hard to conceive. A split evidently means a great influx of sand and mud into one part of the swamp while in another part the vegetal growth was undisturbed and also seemingly it implies a sinking of that part of the swamp into which the earthy material was poured.

On account of the irregularities of coal beds mentioned above, and of the further fact that partings in coal beds which really mark small splits, vary from place to place and also that the quality of the coal itself may be different in one part of the swamp from what it is in another, it is not always easy to recognize a given coal bed from field to field or even in different parts of the same field. Some beds may be marked by a parting of a peculiar composition, such as the sandstone parting in the Upper Banner bed in the southeastern part of Wise County, which renders it easy to recognize, but when followed far enough all distinguishing features are liable to die out and the bed becomes indistinguishable from other beds in the same general part of the geological column.

Other rocks are fully as unreliable as the coal, unless they are of marine origin, and hence they can not be relied upon implicitly in making correlations. Aside from limestones which are relatively rare in coal-bearing formations, the sandstones are the best key rocks, but they are seldom regular in composition or thickness for long distances. As most of the beds of sandstone were evidently laid down either in shallow water or were depositied on the land by streams of water, their irregularities are not to be wondered at, and when used as key rocks they should be traced with the greatest care to detect, if possible, differences in their composition and thickness. When this is done some beds of sandstone may be found to be good key rocks throughout considerable areas, but not indefinitely.

As all the coal-bearing rocks tend to change in thickness from place to place the thickness of the intervals between coal beds can not be relied upon implicitly in making correlations. After the position of a coal bed has been fixed in the geologic column, one naturally expects to find it everywhere at a given distance above or below some other well marked bed, but such an expectation is seldom realized. A given interval may hold throughout a considerable territory, but as all of the members of the column are liable to vary in thickness, sooner or later the interval referred to will change and in places the change may be abrupt.

Before the correlation of a coal bed is accepted it should be checked in every way possible. The coal beds themselves should be traced on their outcrop, adjacent beds should be traced and correlated, and finally fossils, both plants and animals, should be collected and studied to determine the correct position of the coal bed or to confirm a determination made in some other way. In critical cases nothing should be overlooked that could possibly furnish any evidence bearing on the case. In no other coal field in the country is the question of the correlation of the coal beds more important than it is in the Wise field. This is shown in the following brief history of the commercial development of the field and the development of geological ideas regarding it.

HISTORY OF GEOLOGICAL EXPLORATION.

The history of exploration of the coals of Wise County, in so far as it has appeared in print, began with an examination by J. P. Lesley[1] in 1871 of that part of the field lying east and southeast of Toms Creek. Lesley's opening sentence is as follows:

> "I was called upon recently to examine a part of the Allegheny Mountain Range, between the New River (Kanawha) in Middle Virginia and the north line of the State of Tennessee, for the purpose of determining the nearest possible approach to a workable coal region of a contemplated railway from Harper's Ferry on the Potomac to Knoxville in Tennessee."

Lesley recognized the sandstone now called Gladeville on the summit of "Robert's Butt," the end of the spur lying between Toms and Little Toms

[1] Lesley, J. P. The geological structure of Tazewell, Russell, and Wise counties, Virginia: Am. Phil. Soc., Proc., vol. 12, pp. 489-513 1871-72.

creeks, just north of Coeburn. He did not definitely name this sandstone, but refers to it by its local name of "Sheep Rock." He also examined a number of prospects on the Kennedy coal bed in the vicinity of Guest's Station (Coeburn). He described the Hunter Valley fault in the vicinity of St. Paul, but unfortunately he correlated the bed of conglomerate (Lee) which he found in the overturned rocks just northwest of this fault with the "Sheep Rock" (Gladeville sandstone), thus making his interpretation of the structure between Coeburn and St. Paul entirely incorrect. He also was in error in describing a fault in Little Stone Gap, but as his statement regarding this fault was based on hearsay evidence, it has not much weight. As Lesley omitted any mention of the Banner coal beds they could not have been known at the time of his examination.

The next report on any part of this field is one made by Prof. John J. Stevenson[1] in 1880. In this report Prof. Stevenson makes the following statement:

> "During the winter of 1880 [1879-1880], General J. D. Imboden discovered valuable coal beds near the Big Stone Gap in Wise County, Virginia, at about 60 miles from the Tennessee line. The property soon passed into the hands of northern capitalists, for whom I have investigated its economic value. The facts obtained may be of interest, as the only attainable information respecting Southwest Virgina is contained in the brief memoirs by Prof. J. P. Lesley and in Prof. Safford's geology of Tennessee. I am under very special obligations to General Imboden, who, previous to my arrival, had studied the general geology with much care."

From this it will be seen that the exploitation of the field adjacent to Big Stone Gap began in the winter of 1879-1880. General Imboden was the pioneer and he gave his name to one of the most important coal beds of the region, and one about the stratigraphic position and correlation of which there has been greater differences of opinion than about any other coal bed in the field.

This report was followed in the course of a few months by another from the pen of the same author[2] which gives the results of additional field work and more mature consideration of the evidence collected by others as well as himself. His statements regarding the coal field are changed but little,

[1] Stevenson John J. Notes on the geology of Wise, Scott and Lee counties, Virginia: Proc. Am. Phil. Soc., vol. XIX, pp. 88-107, 1880.

[2] Stevenson, John J. A geological reconnaissance of parts of Lee, Scott and Washington counties, Virginia: Proc. Am. Phil. Soc., vol. XIX, pp. 219-262, 1881.

but names of coal beds are here introduced for the first time—names which have been in current use in the field from that day down to the present time. It is worthy of note that Stevenson in his second paper recognized the correct relative positions of the Imboden, Kelly, Low Splint, High Splint, and Cannel beds and also that he considered the Imboden bed as being 600 feet above the "Bee Rock" or top of what is now known as the Lee formation. In his previous paper he stated that this distance is 430 feet, but the change to 600 feet is due to further information on the subject. Although it is now known that Stevenson's determination of the interval between the Imboden coal bed and the "Bee Rock" is very much in error, his paper is valuable as it contains the first detailed stratigraphic section of the coal-bearing rocks of the field that was published and therefore it had a profound effect on subsequent workers in the field.

The prospective value of the Wise County field was evidently soon brought to the attention of the railroad companies in this part of the country with the result that the Louisville and Nashville Railway Company instituted investigations before it would consider seriously the building of a branch line into the field. Accordingly it employed the well known Pennsylvania engineers S. A. McCreath and E. V. D'Invilliers[1] to make a geological survey of the western part of this field, extending as far east as Big Stone Gap. This report, which was published in 1888, is the first detailed economic report concerning the coals of the field that was published. It is true that these authors made little attempt to work out either the geological structure or the stratigraphy of he coal field, but, in the light of more recent work, one statement of theirs deserves more than passing notice. The remark in question on page 18 concerns the presence of a fault on the northwestern side of Stone Mountain, and is as follows:

> "There was no opportunity to study this structure in detail; but there is good evidence of a fault along the north side of Brush Mountain [near Cumberland Gap], extending along the Cumberland and Stone mountains to Pennington's Gap, but expiring before reaching Big Stone Gap. The existence of this fault is maintained by some observers and denied by others. Its presence would explain several phenomena, but as yet its full effect has not been determined or its presence actually proved."

[1] McCreath, A. S. and D'Invilliers, E. V. Mineral resources of the upper Cumberland Valley of southeastern Kentucky and southwestern Virginia, tributary to the proposed Cumberland Valley extension of the Louisville and Nashville Railroad: Louisville, Ky., pp. 152, 1888.

Ashley and Glenn[1] found no trace of this fault at the northern base of Cumberland Mountain in Kentucky, but such a fault has been definitely proved at Pennington Gap, Virginia, and as shown in another part of this report is established with equal certainty at Big Stone Gap and for some distance east of that place. The reader may think it strange that so much attention should be given in this place to the question of whether or not there is a fault at the northern foot of Stone Mountain, but as a matter of fact this fault which is now clearly established has largely affected the determination of the stratigraphic position of the Imboden coal bed in the minds of most geologists and thus is one of the most important factors in this complicated problem.

In 1891 the writer made a hasty geological examination of the Big Stone Gap coal field, as a part of the Survey of the Estillville quadrangle, which embraces an area of nearly 1,000 square miles. As all of the territory was examined in a few months by only two geologists, it is needless to say that the coal field was not studied with as much thoroughness as it should have been. When the writer entered the field it was the current belief that the Imboden coal bed is 350 to 400 feet above the "Bee Rock," the topmost member of the Lee formation. This measurement was apparently obtained by adding to the thickness of the upturned rocks above the "Bee Rock" at the head of the gap the thickness of the horizontal beds between the Imboden coal and the bed of Looney Creek. The estimate of 400 feet between the Imboden coal and the "Bee Rock" was obtained on the assumption that the horizontal coal-bearing rocks on Looney Creek were once abruptly turned up nearly 90 degrees without breaking or causing a dislocation of any kind.

In conformity with this determination the Imboden coal bed was correlated by McCreath and D'Invilliers[2] with an insignificant coal bed at about the same height above the Lee formation in the vicinity of Tacoma and Coeburn. The writer was not satisfied with this determination, so he spent considerable time in trying to determine the true relations of the beds at the head of Big Stone Gap. As the examination was made soon after the building of the Louisville and Nashville and the South Atlantic and Ohio (now the Southern) railroads the exposures were better than they are to-day, for at that time there was only one lone

[1] Ashley, G. H., and Glenn, L. C., Geology and mineral resources of part of the Cumberland Gap coal field, Kentucky: U. S. Geol. Survey, Prof. Paper 49, pp. 225, 1906.

[2] McCreath, A. S., and D'Invilliers, E. V., Report on a portion of the Virginia and Tennessee Coal and Iron Company's Property, Wise Co., Va. Abingdon, Va., pp. 5-6, 1892.

farmhouse where the present town of Appalachia is situated. Upon close examination the writer was convinced that there is a small longitudinal fault at the upper end of the gap and this conclusion was published by him in 1893.[1] The writer was at a loss to explain the origin of this fault, but finally assumed that the nearly horizontal beds in the main syncline to the northwest were so resistant that they were overthrust onto a subordinate syncline that was formed immediately north of Stone Mountain. It is now known that this explanation is erroneous and that there is no such thickness of upturned rocks at the head of the gap as the writer supposed. The writer pieced together various observations at the head of the gap and came to the conclusion that the Norton formation is 1,275 feet thick (p. 36) and as the Imboden coal was supposed to be 190 feet below the top of this formation (p. 64) the interval between that coal bed and the "Bee Rock" is 1,085 feet. At that time the writer thought that the amount of displacement on the fault plane was only a few feet, but now it is known that it must be at least 1,500 feet at this place.

The writer made an attempt to trace the Imboden coal bed from its type locality on Looney Creek eastward to Tacoma where all the rocks dip lightly and there are no faults to interfere with the measurement or the determination of succession of the beds. The coal bed was easily traced as far as Black Creek, but beyond that creek the succession of coal beds seemed entirely different and the writer, in common with most others who had attempted to solve this problem, failed. His best guess was that the Imboden coal is about at the same position in the geologic column as the Edwards coal in the vicinity of Tacoma and hence is about 160 feet below the Gladeville sandstone. In the face of Hodge's[2] determination of the position of the Imboden coal bed as 275 feet above the "Bee Rock" and McCreath and D'Invilliers' statement that it is 325 feet the determination of 1,085 feet by the writer seemed rank heresy and it was bitterly attacked by Hodge in a paper presented to the American Institute of Mining Engineers in 1895. In this paper Mr. Hodge[3] pointed out many errors that the present writer made in his hasty attempt to trace the coal and sandstone beds throughout the Big Stone Gap field and he also stoutly maintained that the Imboden coal bed is not more than 400 feet above the "Bee Rock". His statement on pages 7 and 8 is as follows:

[1] Geology of the Big Stone Gap coal field of Virginia and Kentucky, U. S. Geol. Survey, Bull. 111, 1893.

[2] Op. cit., p. 925.

[3] Hodge, J. M. On the correlation of the Kentucky coals with those of Big Stone Gap, Virginia: Eleventh Report, Inspector of Mines, State of Kentucky, pp. 1-15, 1895.

"My impression has always been that about the same distance [400 feet] intervenes [between the Imboden bed and the top of the Lee] in the neighborhood of Big Stone Gap, though a long familiarity with the region has failed to bring to light any means by which it could be positively fixed. In fact, nowhere between Pennington Gap and Norton are there any exposures from which reliable measurements may be taken. It is possible that beyond Norton, on the mountain fronting Tacoma, they may be made, but as yet it has not been attempted there. The difficulty lies not so much in determining the succession and thickness of the various strata, as in deciding what is the top of the conglomerate series [Lee formation]."

The writer has found no difficulty in identifying the topmost member of the Lee formation—the "Bee Rock"—all along the north face of Stone Mountain from the west edge of Wise County to Norton and thence around the plunging anticline along Guest River to the upturn at the Hunter Valley fault and consequently he does not regard this part of Hodge's criticism seriously.

Since 1895 several brief accounts of the geology of the Wise field have been published,[1] but the authors of these papers have generally made no attempt to settle the question regarding the stratigraphic position and the correlation of the Imboden coal bed, merely contenting themselves with accepting one or the other of the views given above.

Results of present survey.—The present cooperative survey of the Wise County coal field by the State and Federal geological surveys has enabled the writer to again study the geology of the field under far better conditions than those that prevailed at the time of his previous work. Today the geologist has at his disposal maps showing the outcrops of the coal beds as traced by the large operating companies, many core-drill records in critical parts of the field, mine maps of the extensive workings in almost all parts of the Big Stone Gap and Norton districts, and an excellent contour map of the surface. With all of these accessories there seems to be no excuse for not settling the questions concerning the stratigraphic position of the Imboden coal bed and of its equivalent in other parts of the field.

In 1920 the present geological survey of the Wise County coal field was begun by C. K. Wentworth and J. Brian Eby under the general direction of George H. Ashley, all of the U. S. Geological Survey, working

[1] Bache, Franklin. Coal sections developed by recent operations in Wise County, Virginia: Am. Inst. Min. Eng., Trans., Vol. XXIV, pp. 70-80, 1895. Pultz, John L., The Big Stone Gap coal field of Virginia and Kentucky: Eng. Mag., vol 28, pp 71-85, 1901.

in cooperation with the State Geological Survey of Virginia. Before the field work was completed Mr. Ashley withdrew from the administration of the work and Mr. Wentworth left for work in the University of Iowa. The writer then took over the administration of the work and his first duty was to visit the field and satisfy himself regarding the tracing and correlation of formations that had been done by Mr. Wentworth. In conducting this work the writer was obliged to change some of the conclusions previously reached and consequently Mr. Wentworth should not be held responsible for the correlations here stated nor for the mapping of the Gladeville sandstone west of Wise.

In attempting to solve the question of the stratigraphic position and equivalence of the Imboden bed the writer followed the suggestion of Mr. Hodge, previously noted, and carried his tracing from the extreme southeastern part of the county westward. There is, the writer believes, general accord among geologists regarding the succession and stratigraphic position of the coal beds in the region east and southeast of Coeburn. Here the Lee formation caps the flat arch of the Powell Mountain anticline, dipping in general about 10 degrees to the north and northeast. The top of the formation is clearly marked on Guest River and the writer can see no reasonable doubt that the uppermost member here is the same as the "Bee Rock" at Big Stone Gap. Even as far back as 1892 the stratigraphic position of the coal beds in the vicinity of Coeburn had been worked out by McCreath and D'Invilliers and their results are about the same as those given in this report, which are based upon much more data, almost innumerable prospect entries whose elevations have been accurately determined, and some deep drill holes. In the recent work the distance between the top of the Lee formation and the Upper Banner coal bed was determined to be 1,050 feet. Similarly the distance between the Upper Banner coal bed and the top of the Gladeville sandstone was determined at a number of places on Sandy Ridge by a comparison of mine elevations with elevation of the top of the sandstone directly above to be 450 feet. On this basis the distance from the top of the Lee formation to the top of the Gladeville sandstone is about 1,500 feet. As the thickness of the Gladeville varies from 50 to 110 feet, the thickness of the Norton formation is about 1,425 feet. Thus it will be seen that the present accurate measurement of the thickness of the Norton formation practically substantiates the early estimate of the writer which was 1,280 feet, but with a tendency to increase rather than to diminish the estimated thickness of the formation. As far as the geologists have been able to check the interval between coal beds or other members of the formation there seems to be no indication of a change in a westerly direction and hence it is assumed that the Norton formation has approximately the same thickness at Big Stone Gap that it has at Coeburn.

From Sandy Ridge north of Coeburn the Gladeville sandstone can be traced almost continuously on the surface of the dissected plateau to Wise and hence the next important procedure is to carry the tracing and correlation from Wise westward. In this region the tracing had to be done across the north-south anticlines and synclines that characterize this part of the field. In this tracing a sandstone lying about 150 feet above the Gladeville was the principal dependence, as in most of this district the Gladeville sandstone is under too much cover to be used as a key rock. The bed of sandstone referred to is herein named the Addington sandstone member on account of its fine showing at Addington on Rocky Fork of Guest River.

The Gladeville sandstone rises westward from Wise to the crest of the Gladeville anticline ½ mile west of the town, as shown on the geologic map. From this crest it dips rapidly westward and in a short distance passes below the tops of the ridges. Under the influence of the widening of the Gladeville anticline southward toward Powell Mountain the Gladeville sandstone forms an escarpment facing Bear Creek, descending westward to Esserville where it shows in typical form. The tracing northward from Wise and westward to Guest River proved conclusively that the coal mined at Glamorgan, which lies directly above the Gladeville sandstone, is the same as the Dorchester coal, formerly known as Haskell No. 3 bed at Esserville. The importance of this correlation can scarcely be overestimated, and it was verified by tracing down the Interstate Railroad from Glamorgan to Esserville, along the road running directly east from Addington, over the direct county road from Wise to Esserville, and along the face of the escarpment overlooking Yellow and Bear creeks from Wise to the Norfolk and Western Railroad about a mile east of Norton. At the place last mentioned the coal above the Gladeville was again tied with the Dorchester bed, and the Yellow Creek bed, which underlies the Gladeville at Wise, was identified as the Norton (formerly called Middle Norton) bed in the vicinity of Norton. As exposures on these lines are fairly good and as the results of the tracing agree, it is safe to accept this correlation as fixed.

From Esserville the coal beds both above and below the Gladeville sandstone can be traced continuously by mine workings across the Dorchester syncline to Needmore and almost to the head of Bearpen Branch. West of Needmore the tracing on the surface is very satisfactory as the Addington sandstone rises westward at almost the same rate as the valley of Bearpen Branch and the sandstone is either visible in the road or in cliffs just above the road to the summit of the ridge on the south at the place where the road crosses the ridge into the head of the valley of Thacker Branch. The Addington sandstone rises a little more to the westward and caps the plateau on the trail or farm road which leads from the summit of the ridge between Bearpen and Thacker branches to near the head of Black Creek. A short distance beyond the place where this trail begins its descent into the valley of Black Creek it cuts through the Addington sandstone which forms cliffs on the sharp spurs and the trail descends to another coarse sandstone, the top of which is about 60 feet above Black Creek. This is the Gladeville sandstone and almost immediately above it is a natural outcrop of the Dorchester coal bed.

The Gladeville sandstone rises above water level where Black Creek changes its course from nearly due east to south, 1⅛ miles above Black Creek School. From the place where it rises above the creek, as just described, the Gladeville sandstone may be traced continuously down the creek, by means of cliffs and ledges in the hillsides or by angular blocks which cumber much of the bottom land, as far as the old mine that was opened in the early days on the west side of the road and creek at a place nearly a mile below Black Creek School. Near this old mine on the Dorchester coal bed, the sandstone passes below the level of the creek and is not seen again on the highway to Blackwood, but, owing to its rise eastward on the Buck Knob anticline, it can be found in a short distance to the east in ravines or on the slopes of the ridge.

In much the same manner the Addington sandstone can be traced from the place where it appears in the bottom of the valley at the road crossing almost at the head of Black Creek, along the west slope of the valley, practically continuously to the old mine previously mentioned, nearly one mile below Black Creek School. Here the sandstone is thick-bedded and coarse, resembling the Gladeville, and it makes a decided bench on the hillside whose top is about 150 feet above the valley road. From this place the Addington sandstone descends gently down the valley and is but little above creek level at the mouth of Black Creek.

The rocks on the end of Black Creek Ridge at Blackwood are well exposed and it is apparent that the flat or plateau-like character of this ridge is due to a thick plate of sandstone at a little above the 2,250-foot contour. This sandstone is evidently the same as the one that caps the ridge just across the ravine of Bearpen Branch and this sandstone can be traced up

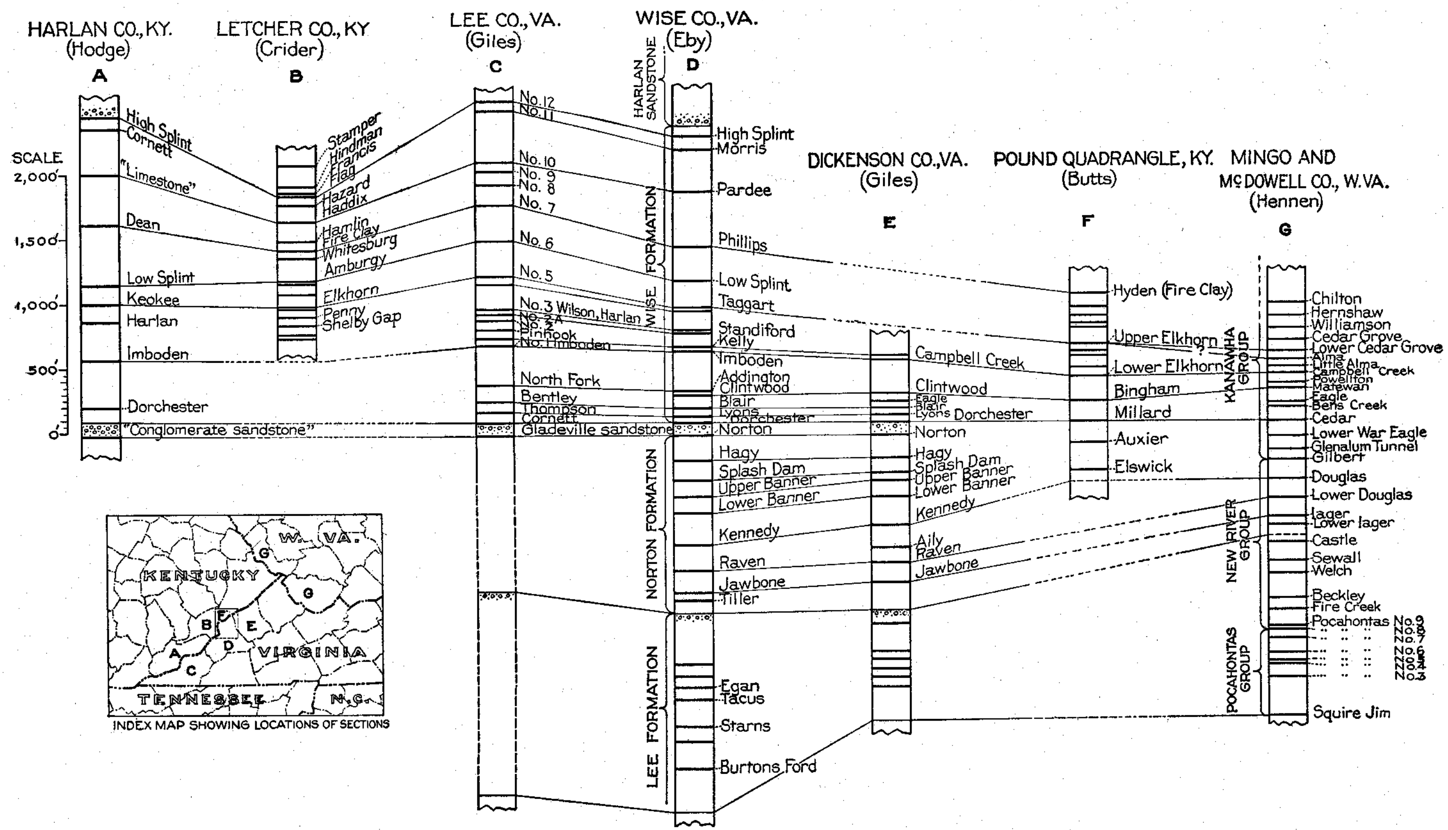
Bearpen Branch to the northwest where it is found to be the sandstone underlying the Imboden coal bed. The tracing northward up Black Creek Ridge shows that the sandstone just mentioned which caps the south end of the ridge and which underlies the Imboden coal bed rises gently northward, capping all of the highest parts of the ridge, until at the head of Black Creek it is again identified as the sandstone underlying the Imboden coal.

The tracing, therefore, from every direction in which it is possible to trace the beds, shows that three sandstones are present in Black Creek Ridge and that the difficulties in the past were largely due to the lack of appreciation of the anticlinal structure just east of Black Creek which causes all the beds to dip rather steeply to the west or to rise to the east, as the case may be. This eastward rise causes the Imboden coal bed, which is present in the ridge west of Bearpen Branch, to rise over the top of the Black Creek Ridge, except at one place near the head of Bearpen Branch, and in fact all of the country to the east, at least as far as Powell River. Even in 1891 at the time of the writer's previous work in this field, the absence of the Imboden coal bed in Black Creek Ridge was a matter of great concern. Vigorous efforts were made to find it without avail, as stated in the writer's[1] report:

> "The prospectors in endeavoring to solve the problem of the absence of the Imboden bed trenched the hill from summit to base on the east side of the Bearpen, just north of this trail [about a mile above the mouth of the branch], and found nothing but sandy shales. Then in order to make assurance doubly sure a diamond drill was put down at the point where the trail crosses Bearpen Branch, through coarse, extremely hard white sandstone, until 220 feet below the surface the drilling became so difficult and the prospect of coal so poor that the drill was stopped without penetrating this bed of sandstone."

The anticlinal structure explains this absence of the coal in Black Creek Ridge and shows conclusively that the Imboden coal is far above the Gladeville sandstone, instead of below that bed as the writer placed it in 1891. The best determination of the distance between the Gladeville sandstone and the Imboden coal bed, as determined by data secured east of Black Creek, is 650 feet. Later this relationship of the Gladeville sandstone to the Imboden coal bed was corroborated by the record of a diamond drill hole put down at Inman which revealed the Gladeville as a massive conglomerate about 650 feet below the Imboden bed. This identification makes the Imboden and Kelly coal beds the same as the Bolling coal beds of Butts, as described in another part of this report, and places the Imboden bed at

[1] Op. cit., p. 72.



SECTIONS SHOWING CORRELATIONS WITH ADJOINING AREAS.

least 2,100 feet above the "Bee Rock" instead of 400 feet, as maintained in the early reports and 1,085 feet as determined by the writer in his previous work in this field.

CORRELATIONS WITH ADJOINING AREAS.

The correlations of the Wise County coal beds with those of adjoining coal fields in Virginia, Kentucky, and West Virginia are shown in Pl. XIII. The correlation of the coal beds of Kentucky with those of Wise County across the Pine Mountain fault was accomplished by Hinds and the results were published in Bulletin XVIII of the Virginia Geological Survey on the geology and coal resources of Buchanan County. Detailed private surveys in southeastern Pike County, Kentucky, confirmed Hinds' conclusions as did also the examination of fossil plants by David White.

The correlation of the coal beds of Lee County, Virginia and Harlan County, Ky., with those of Wise County depends largely on several important correlations of coal beds made within Wise County itself during the course of the present survey. As the result of detailed examinations at the head of Black Creek, Campbell, assisted by the writer, established the equivalence of the noted Imboden bed with the "Lower Bolling" bed of Butts' report on the Pound quadrangle. The second major correlation is that of the Dorchester bed at Dorchester with the Glamorgan bed of Butts. With these major correlations in hand the problem of tying in the intermediated beds has been greatly simplified. The position of the Jawbone bed near the base of the Norton and its relation to the top of the Lee has been accurately determined in eastern Wise County, and the identification of the "so-called Imboden" as the Raven bed follows at once. Following the correct identification of coal beds in Wise County, the correlation of these beds with the ones found by Giles in Lee County, Virginia and by Hodge in Kentucky, is made possible. Giles[1] correlates No. 5 bed of the Pocket in Lee County, with the Keokee bed of Keokee, and accurate private surveys establish the identity of the Keokee bed with the Taggart of Wise County. On the basis of this correlation coal bed No. 1 of the Pocket would be equivalent to the Imboden, No. 6 to the Low Splint, No. 10 to the Pardee and No. 12 to the High Splint. Coal bed No. 3 of the Pocket is thought to be the same as the Wilson bed of the Keokee district and equivalent to one of the Standford coal beds of Wise County.

Carrying the correlation of coal beds across Black Mountain has been relatively simple and the section given by Hodge[2] for the headwaters of

[1] Giles, A. W., The Geology and Coal Resources of Lee County, Virginia, unpublished manuscript.

[2] Hodge, James M., Report on Upper Cumberland Coal Field, Kentucky Geological Survey, Bulletin 13, Serial No. 16, 1912, p. 3.

Clover Fork, Harlan County, Ky., is essentially the same as that measured on the east side of the mountain. The conglomeratic sandstone of Hodge is the Gladeville sandstone and the Dorchester bed in his section is probably the Clintwood bed of Wise County. The Dean bed is everywhere identified by its clay parting and the limestone bed by the proximity of an overlying fossiliferous limestone. Mining operations have since verified the correlations of Hodge, as mine entries have been driven under Black Mountain into Kentucky in both the Taggart and Pardee coal beds.

A section of the coal beds of Letcher County, Ky., by Crider,[1] is given on Pl. XIII B and lines of probable correlation are drawn to the Wise county coal beds. The basis of these correlations are the sections of Hodge on the southwest and the work of Hinds and others on the northeast. The Haddix coal bed is overlain by a thin fossiliferous impure limestone which Crider notes[2] "is apparently the only fossiliferous limestone in the upper strata of the Pennsylvanian series in Letcher County." The correlation of the Haddix with the limestone coal of Hodge and the Pardee bed of Wise County is firmly established. The correlation of the Upper Elkhorn with the Taggart has been established by Hinds in his work in Buchanan County, and Pike County, Ky. The Fire Clay bed of Crider has the characteristic clay parting of the Dean coal of Hodge. Above the Flag coal bed Crider[3] describes a massive cliff-making sandstone that is probably the basal bed of the Harlan sandstone, as known in Wise County. On the strength of the foregoing ties the indicated correlation of intermediate beds has been made largely on relative intervals.

Further correlations of the Kentucky coal beds with the Virginia coal beds, on the authority of Hodge, Crider, L. A. Bilips,[4] and others are given as follows: the Taggart coal bed with the "C" bed, (at Lynch), the McConnell, the Creech, and the Mingo; the Low Splint, with the "E" bed; the Phillips, with the Dean, Fire Clay, Poplar Lick, No. 4, Hyden, and Flatwoods; and the Pardee, with the Haddix, Limestone, Hignite, and Lynch. Bilips correlates the "A" bed at Lynch with the Harlan bed of Hodge, the Imboden bed of Wise County and with the Hance bed. The "A"

[1] Crider, A. F., The coals if Letcher County; Kentucky Geol. Survey, Series IV, Volume IV, Part I, 1916, p. 74.

[2] Op. cit., p. 36.

[3] Op. cit., p. 38.

[4] Division engineer, United States Coal and Coke Company, Lynch, Ky.; personal communication.

bed, according to Bilips, lies 220 feet below the Taggart, an interval less than one-half the Imboden-Taggart interval found by Hodge on Clover Fork or on the east side of Black Mountain in Wise County, and the correctness of the "A"-Imboden correlation is greatly questioned.

The coal beds of northern Wise County have been traced into Dickenson County and thence northeastward into Buchanan County and West Virginia. The most important correlation is that of the Imboden with the Campbell Creek coal or No. 2 gas coal of the West Virginia Geological Survey. This bed is locally called the Lower Elkhorn, Lower Marrowbone, Warfield, Freeburn, Burnwell, Van Lear, Vulcan, Majestic, and Upper War Eagle in Pike County, Kentucky, and Mingo County, West Virginia. The Lower War Eagle bed of Tug Fork is the same as the Hagy bed of southwest Virginia. Hinds refers the Taggart or Upper Elkhorn coal bed to either the Alma or Lower Cedar Grove beds of West Virginia. The Eagle bed, prominent in Dickenson County but of no importance in Wise County, is locally known as Middle War Eagle and Mohawk on Tug Fork.

LOCAL SECTIONS.

The following sections are inserted to show the distance between coal beds and the character of the intervening rocks in various parts of the field. They have been chosen from among many chiefly because they show an exceptional number of beds and were made where dips are low. Two of the sections (Nos. 11 and 15) were measured across the outcrop of upturned beds. In general the local sections should be used with caution, as parts of every one of them are poorly exposed and, with an exception of the two sections mentioned above, the elevations upon which the intervals are based are chiefly barometric readings subject to error. Many of the sections are corrected for dip and the thickness of the beds and the intervals between them are true thicknesses and not the apparent thicknesses found in the barometric profile section. Some thin and poorly exposed beds, such as many "underclays" and "roof-shales" of coal beds, are not given. Partings in coal beds are not usually given and the thickneses of other beds are commonly generalized to the nearest multiple of 5 feet. Detailed description of coal beds and their contiguous beds is reserved for a fuller treatment by drainage basins.

Local Section 1.

Section measured from westernmost exposure of Imboden coal bed at Exeter, northwestward along the Keokee-Exeter pike to the Wise-Lee

County line, and north along the county line to the top of Black Mountain, and northeastward one-eighth of a mile to top of knob on mountain crest.

	Thickness. Ft.	In.	Interval. Ft.
Harlan sandstone:			
Shale, elevation at top, 3,820 feet	20		100
Conglomerate, massive	80		
Wise formation:			
Shale	132		
Sandstone	25		
Shale	38		
Sandstone, steep cliff at top	125		
Shale	102		
Sandstone, thin-bedded	91		
Shale	38		
Sandstone	22		
Shale	50		
Sandstone, thin-bedded at top	10		
Shale	10		
Sandstone, very hard, ledge-making	10		
Shale	44		
Sandstone, soft, medium-grained	10		
Shale	130		
Sandstone	20		
Shale	40		1,453
Sandstone	5		
Shale, sandy	55		
Sandstone, massive, ledge-making	10		
Shale	75		
Sandstone, massive	15		
Shale	75		
Sandstone	8		
Shale	155		
Sandstone, soft, with hard cap-rock	40		
Shale	23		
Sandstone	5		
Shale	10		
Sandstone	8		
Shale	2		
Sandstone	10		
Shale	60		
Coal, Taggart, caved pit, elevation 2,385 feet.			
Shale	44		
Sandstone, soft	5		
Shale	55		
Sandstone, soft, coarse-grained	18		
Shale	82		
Sandstone, coarse-grained	5		
(Keokee-Exeter road, B. M. 2,194 feet.)			
Sandstone	20		
Shale	10		445
Coal, bloom			
Shale	10		
Sandstone	95		
Shale	75		
Sandstone, coarse, hard, gray	20		
Coal		6	
Clay		6	
Shale	5		
Coal, Imboden, caved pit, elevation 1,958 feet			

Local Section 2.

Section measured west from Laurel on Looney Creek to summit of Black Mountain at the Double.

	Thickness. Ft.	In.	Interval. Ft.
Harlan sandstone:			
Shale, elevation at top, 4,150 feet	10		
Sandstone	20		
Unexposed	45		
Sandstone	30		
Unexposed	20		
Sandstone	32		580
Unexposed	45		
Sandstone	63		
Unexposed	52		
Sandstone, massive, buff	158		
Unexposed, probably sandstone	105		
Wise formation:			
Unexposed	150		
Sandstone	10		
Unexposed, probably shale	255		
Sandstone	105		
Shale	25		
Coal, hard	8		
Shale, sandy	30		
Coal	1	3	
Clay		3	
Coal		4	
Clay	3		
Shale	25		
Sandstone	20		
Unexposed	125		1,145
Shale, sandy	32		
Shale	32		
Sandstone	105		
Coal, Phillips (?), elevation 2,700 feet	2		
Sandstone, fine-grained	84		
Coal, splint		2	
Sandstone, thin-bedded	20		
Shale	20		
Shale, sandy	42		
Sandstone	10		
Shale, sandy	20		
Unexposed	20		
Coal, Low Splint, elevation 2,450 feet	1		
Shale	10		
Sandstone	95		
Coal	2	4	
Sandstone	42		
Shale	15		
Sandstone	10		
Clay, hard	10		309
Coal	2	4	
Shale	3		
Sandstone, massive	42		
Unexposed	48		
Sandstone	20		
Shale	5		
Coal, Taggart, elevation 2,200 feet	3	7	

Local Section 3.

Section measured from Andover up Preacher Creek to summit of Black Mountain.

	Thickness. Ft.	In.	Interval. Ft.
Harlan sandstone:			
Shale, elevation at top, 3,550 feet	10		130
Sandstone, hard, quartzose	120		
Wise formation:			
Unexposed	92		
Sandstone, thin-bedded	58		
Unexposed	25		
Sandstone	15		
Unexposed	103		
Shale	23		
Unexposed	23		
Sandstone	23		
Unexposed	10		
Shale	20		
Sandstone	25		
Unexposed	34		
Shale	20		
Sandstone	28		
Unexposed	80		
Shale	10		
Sandstone	10		
Unexposed	110		
Sandstone	5		
Shale	28		
Coal, bloom	1	2	
Shale		10	
Coal		1	
Shale, sandy	35		
Sandstone, arkosic	45		
Shale	22		1,247
Sandstone	10		
Unexposed	10		
Sandstone, arkosic	45		
Shale	5		
Coal		9	
Shale	5		
Sandstone	35		
Shale, sandy	25		
Shale, with sandstone partings	10		
Coal, with bone partings	1	10	
Shale, with sandstone partings	10		
Sandstone, soft	52		
Shale	20		
Sandstone, thin-bedded	22		
Shale, with sandstone partings	15		
Sandstone	15		
Shale, dark-blue	20		
Sandstone	5		
Shale, sandy	15		
Sandstone	22		
Coal		6	
Clay		4	
Coal		2	
Shale	10		
Sandstone	46		

	Thickness. Ft.	In.	Interval. Ft.
Coal, Low Splint, elevation 2,360 feet	2	3	
Sandstone	10		295
Coal	1	1	
Sandstone	34		
Shale	10		
(At fork near head of Preacher Creek. Section above, measured on south fork. Elevation 2,310 feet.)			
Sandstone	25		
Shale, sandy	34		
Shale	25		
Shale, sandy	14		
Coal		6	
Shale		1½	
Coal		1½	
Clay	1		
Sandstone	80		
Coal, Taggart	3	6+	
Sandstone	57		
Coal, Taggart Marker, elevation 2,110 feet	3	4	
Sandstone	230		400
Unexposed	30		
Shale, clayey	20		
Shale	30		
Sandstone	70		
Sandstone and shale	20		
Coal, Imboden, elevation 1,780 feet	6		

LOCAL SECTION 4.

Section measured from Roda up Mudlick Creek to crest of Black Mountain.

	Thickness. Ft.	In.	Interval. Ft.
Harlan sandstone:			
Shale, elevation at top, 3,520 feet	10		387
Shale and sandstone	325		
Sandstone	10		
Coal, bloom	2	1+	
Sandstone	40		
Wise formation:			
Unexposed	115		410
Sandstone, fine-grained arkosic	40		
Shale	65		
Shale, sandy	15		
Shale	15		
Sandstone	55		
Shale	105		
Coal, Pardee, elevation 2,760 feet	4	2	
Shale	2		
Sandstone	10		
(Fork at head of Mudlick Creek. Section above measured on east fork)			
Unexposed	60		
Sandstone	10		
Coal		8	
Shale	10		
Coal, thickness reported	3		
Shale	10		

	Thickness. Ft.	In.	Interval. Ft.
Sandstone	48		
Shale	32		
Sandstone	10		
Coal		8	
Shale		1	
Coal	1	6	
Shale	20		
Unexposed	55		
Sandstone	5		560
Coal	1+		
Shale	15		
Sandstone	20		
Coal		10	
Shale, clayey	55		
Sandstone, hard	40		
Unexposed	65		
Sandstone	85		
Coal } Low Splint, elevation 2,230 feet		6	
Clay		3	
Coal	1	6+	
Sandstone, and sandy shale	75		
Sandstone, massive	55		
Shale	20		200
Sandstone	40		
Shale	10		
Coal, Taggart, elevation 2,040 feet	5		

Local Section 5.

Section measured on Halls Branch of Mudlick Creek to crest of Bluff Spur.

	Thickness. Ft.	In.	Interval. Ft.
Harlan sandstone:			
Shale, elevation at top, 3,750 feet	50		
Shale, with sandstone beds	365		495
Conglomerate, massive	65		
Sandstone, massive	15		
Wise formation:			
Unexposed	40		
Sandstone, thin-bedded	12		
Shale	75		
Sandstone	5		
Shale	80		
Sandstone, thin-bedded	10		
Unexposed	110		
Sandstone, arkosic	8		
Shale	130		
Sandstone	15		
Shale	75		979
Sandstone, arkosic	10		
Unexposed, probably shale	110		
Sandstone	190		
Coal	2	2	
Shale	15		
Sandstone, gray	10		
Shale, sandy	10		
Shale	20		
Coal	2		
Sandstone, massive	50		

	Thickness. Ft.	In.	Interval. Ft.
Coal } Low Splint, elevation 2,360 feet		6	
Bone }		2	
Coal }	2	10	
Shale	20		202
Sandstone, thin-bedded	20		
Sandstone	34		
Shale, sandy	20		
Sandstone	88		
Shale, with fossil plants	20		
Coal, } Taggart, elevation 2,172 feet		11	
Bone }		6	
Coal }	4	3	
Shale and clay	5		356
Sandstone, coarse, arkosic	40		
Unexposed	5		
Sandstone	150		
Coal	2	4	
Sandstone	10		
Shale	5		
Coal		6	
Shale, drab	10		
Sandstone	45		
Unexposed	15		
Sandstone, thin-bedded	18		
Shale, clayey	20		
Shale	20		
Sandstone, coarse	10+		

LOCAL SECTION 6.

Section measured up hill to summit on Roda spur starting from near the junction of Mudlick and Callahan creeks.

	Thickness. Ft.	In.	Interval. Ft.	In.
Wise formation:				
Summit of hill.				
Sandstone	45	6		
Coal, Taggart	6	6		
Sandstone, thin-bedded	29		439	1
Coal, Taggart Marker (?)	1	6		
Unexposed	58	6		
Shale	16	6		
Shale, sandy	13	6		
Coal	2			
Shale	25			
Sandstone, thick-bedded	71			
Shale, sandy	26			
Coal	2			
Unexposed	45			
Shale	13			
Unexposed	24			
Shale	29			
Coal, Kelly (?)	1	6		
Unexposed	75			
Coal, Imboden	6	7		

Local Section 7.

Section above Imboden coal bed at Stonega, measured on west side of Callahan Creek, at location 46.

	Thickness. Ft.	Thickness. In.	Interval. Ft.
Wise formation:			
Sandstone	35		
Shale	30		
Coal (Kelly)	1		
Shale, carbonaceous (Kelly)		6	
Coal (Kelly)		2	
Shale (Kelly)		10	
Coal (Kelly)		8	
Shale	2	6	
Shale, carbonaceous	1		
Shale	15		86
Sandstone, coarse, micaceous	60		
Shale, concretionary	8		
Coal, Imboden, elevation 1,932 feet (L)	6		
Shale	4		
Sandstone, massive	10		
Sandstone, thin-bedded	8		
Shale, clayey	15		

Local Section 8.

Section from Imboden coal outcrop at Stonega northward along Callahan Creek to crest of Black Mountain.

	Thickness. Ft.	Thickness. In.	Interval. Ft.
Harlan sandstone:			
Sandstone, massive, elevation at top of bed, 3,305 feet	25		81
Shale and sandstone	56		
Wise formation:			
Shale	50		
Coal, High Splint	4	2	
Shale	25		
Sandstone	25		140
Shale	17		
Sandstone	6		
Shale	13		
Coal, bloom		6	
Shale	13		
Shale, sandy	26		
Shale	126		
Unexposed	25		
Shale	50		
Sandstone, thin-bedded	64		405
Shale	25		
Coal bloom			
Shale	13		
Sandstone	50		
Clay and shale	13		
Coal, bloom		6	

	Thickness. Ft.	In.	Interval. Ft.
Clay and shale	13		
Sandstone, massive, hard, micaceous	88		
Unexposed	25		
Sandstone	13		
Clay, hard, fossil plants	5		
Shale	32		
Coal bloom			
Sandstone	5		
Shale	12		442
Sandstone, gray, micaceous	75		
Unexposed	32		
Shale	12		
Unexposed	25		
Sandstone	25		
Shale	12		
Sandstone	63		
Shale	5		
Coal, bloom, Low Splint, elevation 2,450 feet.			
Sandstone	13		
Shale	50		
Unexposed	37		
Sandstone, thin-bedded	13		
Sandstone, arkosic	75		287
Unexposed	50		
Sandstone, shaly	5		
Unexposed	44		
Coal, bloom, Taggart, elevation 2,220 feet.			
Shale	25		
Sandstone, fine-grained	50		
Coal, bloom, Taggart Marker			
Unexposed	12		
Sandstone	75		
Unexposed, probably shale	75		298
Sandstone, hard, ledge-making	37		
Sandstone, clayey	1		
Coal	4		
Clay	13		
Sandstone	6		
Coal, Imboden, elevation 1,947 feet.			

Local Section 9.

Section on Nine Mile Spur, measured northeastward from the northern end of Stonega to the crest of the ridge.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Sandstone, hard, elevation at top, 3,005 feet	20		
Shale, sandy	135		
Sandstone, hard, micaceous	20		
Shale, clayey	185		
Sandstone, hard	15		
Shale, soft	90		667
Sandstone, soft, micaceous	20		
Shale, dark	120		
Sandstone	10		
Shale	52		

	Thickness. Ft.	In.	Interval. Ft.
Coal, Taggart, caved, elevation 2,338 feet.			
Sandstone	20		406
Shale, sandy, light	90		
Sandstone	5		
Shale	90		
Sandstone, soft, coarse, micaceous	55		
Shale	65		
Sandstone	20		
Shale	61		
Coal, Imboden, elevation 1,932. (Callahan Creek.)			

Local Section 10.

Section measured due east from junction of Mudlick and Callahan creeks, up side of Nine Mile spur to 620 feet above the Imboden coal bed at location 52.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Shale, top of section, elevation 2,460 feet	60		620
Unexposed, probably shale	140		
Sandstone, hard	10		
Unexposed	50		
Sandstone	20		
Unexposed	30		
Sandstone	20		
Unexposed	25		
Sandstone	10		
Shale	30		
Sandstone, thin-bedded	25		
Shale	15		
Sandstone, thin-bedded	50		
Sandstone, and sandy shale	70		
Sandstone, arkosic	30		
Shale and sandstone	35		
Coal, Imboden, elevation 1,840 feet	5	11	

Local Section 11.

Section measured on east side of Big Stone Gap showing character of Lee formation.

	Ft.	In.
Lee formation:		
Sandstone, massive, "Bee Rock"	95	
Shale, black carbonaceous	31	
Shale, dark, sandy	14	
Shale, brown and green	10	
Unexposed, probably shale	85	
Shale, dark	210	
Sandstone with thin beds of shale	366	
Sandstone, Bald Rock member	200	
Coal	4	10
Shale with thin beds of sandstone	112	
Coal	3	
Shale	150	
Conglomerate	250	
	1,530	10

LOCAL SECTION 12.

Section from Taggart coal outcrop at Dunbar north to Pardee and east up ridge to Pardee mine No. 4, and to top of Black Mountain.

	Thickness. Ft.	In.	Interval. Ft.
Harlan sandstone:			
Shale and sandstone, elevation at top, 3,450 feet	250		250
Wise formation:			
Unexposed	90		
Coal, High Splint	2+		
Shale	5		
Sandstone, dark, gray	5		
Unexposed	80		
Sandstone, arkosic	40		
Shale	10		480
Sandstone, arkosic	63		
Unexposed	78		
Sandstone	5		
Unexposed, probably shale	72		
Sandstone	15		
Shale	15		
Coal, Pardee, elevation 2,880 feet	10		
Shale	78		
Sandstone	52		
Unexposed	135		
Sandstone	20		
Shale	30		
Coal		3	
Shale, sandy	46		
Coal		10+	
Shale, sandy	15		
Coal	1	2	
Shale, sandy	40		
Coal		8	
Shale	20		733
Coal		3	
Shale	25		
Sandstone, gray, arkosic	5		
Shale	5		
Sandstone, thin-bedded	52		
Shale	5		
Coal		3	
Shale	3		
Coal		10	
Sandstone, thin-bedded	68		
Unexposed	78		
Sandstone, arkosic	52		
Coal, Low Splint, elevation 2,310 feet	3	10	
Shale and thin-bedded sandstone	40		
Coal	3	7	
Shale	14		
Sandstone	40		150
Shale	25		
Sandstone	12		
Shale	15		
Coal, Taggart, elevation 2,200 feet.			
Sandstone	60		
Coal, Taggart Marker	2		

Local Section 13.

Section from head of Roaring Fork, at junction of Creger, Straight, and Osborn Forks (B. M. 2,183 feet) northeast up Osborn Fork to B. M. 3,399 feet and southeast to high knob of Black Mountain (B. M. 3,765 feet.)

	Thickness. Ft.	In.	Interval. Ft.
Harlan sandstone:			
Shale, elevation at top, 3,765 feet	80		421
Coal hard, splinty, caved pit	2+		
Shale and thin sandstone beds	274		
Sandstone, massive	10		
(B. M. 3,399 feet.)			
Sandstone, massive, hard	55		
Wise formation:			
Unexposed	225		1,161
Shale	80		
Unexposed	130		
Sandstone, thin-bedded	10		
Sandstone	80		
Conglomerate, arkosic	50		
Shale	20		
Sandstone	20		
Unexposed	20		
Sandstone	10		
Unexposed	15		
Sandstone	5		
Shale, sandy	5		
Sandstone	40		
Unexposed	30		
Sandstone	50		
Shale	4		
Sandstone	15		
Unexposed	50		
Sandstone, massive	30		
Shale, with 1" to 2" lenses of coal in 2-foot zone	5		
Sandstone, thin-bedded near base	70		
Shale	20		
Sandstone	10		
Shale and sandy beds	40		
Sandstone, massive	20		
Shale and thin sandstone beds	90		
Sandstone	17+		
(B. M., 2,183 feet.)			

Local Section 14.

Section from mouth of Gabe Branch of Roaring Fork east one-half mile and southeast along trail to gap in Fork ridge.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Shale, elevation at top, 2,330 feet	150		
Coal } Imboden, elevation 2,180 feet	4	2	
Clay } Imboden, elevation 2,180 feet		8	
Coal } Imboden, elevation 2,180 feet	4	6	
Shale and clay	50		365
Sandstone	15		
Unexposed, probably sandstone	55		
Shale, clayey	100		
Sandstone, hard	5		
Shale	35		
Sandstone, massive	25		
Unexposed, probably shale	75		
Coal, caved pit			
Shale	5+		
(Roaring Fork.)			

Local Section 15

Section of Lee formation through Little Stone Gap.

	Thickness. Ft.	In.	Interval. Ft.
Lee formation:			
Sandstone, massive, slightly conglomeratic	80		
Shale	20		
Coal, bloom			
Clay	4		
Shale, dark, gray	25		
Coal		6	
Shale	10		
Coal, bloom			
Shale, carbonaceous	3		
Shale	30		
Sandstone, arkosic	20		
Coal		3	
Clay		2	
Coal	1	11	
Clay	10		
Sandstone, arkosic	50		
Shale, thin-bedded	50		
Shale, clayey	35		
Coal		3	
Clay		2	
Coal	1	6	
Sandstone, light gray	30		
Unexposed, probably shale	260		
Conglomerate, massive	80		
Shale, dark gray	40		
Coal	2	6	

	Thickness. Ft.	In.	Interval. Ft.
Clay		2	
Shale, sandy	70		
Conglomerate	75		
Unexposed	40		
Shale	15		
Shale	6		
Coal	3		
Shale, gray, clayey	1		
Shale, sandy	60		
Sandstone	10		
Sandstone (?) not clearly exposed	60		
Conglomerate Bald Rock member	160		
Shale	10		
Sandstone, gray	20		
Shale	70		
Coal		6	
Sandstone	5		
Shale	90		
Sandstone	10		1,851
Shale	100		
Coal	1		
Shale	60		
Sandstone	30		
Shale, sandy	5		
Coal	2	4	
Shale, sandy	9		
Sandstone	10		
Shale, clayey, squeezed	3		
Sandstone, soft, lumpy	7		
Shale, dark, fossil plants (*Neuropteris Pocahontas)*	5		
Shale, sandy	7	6	
Sandstone	10		
Shale, sandy, coal streak 12 feet from top	33		
Conglomerate, massive, greenish	21		
Shale	50		
Conglomerate	37		

Local Section 16.

Section on Powell River, 1 mile west of Josephine from Interstate Railroad tracks up north slope to Intermont Mine No. 6 (location 300.)

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Coal, Dorchester, elevation 2,230 feet	4	4	
Clay and shale	5		
Gladeville sandstone:			
Sandstone, massive	50		
Norton formation:			
Shale	148		158
Sandstone	10		
(B. M., 2,017 feet.)			

Local Section 17.

Section from B. M. 2,309 feet on Powell River road one-fourth mile west of Garden school, due west to summit of Rogers Ridge.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Shale, elevation at top, 2,735 feet	25		237
Sandstone, arkosic, gritty	20		
Shale	2		
Sandstone, white, med.-grained	110		
Sandstone, thin-bedded	15		
Shale	65		
Coal, caved pit, elevation 2,500 feet.			
Shale, sandy	20		160
Shale	50		
Sandstone	10		
Shale	40		
Sandstone, red	10		
Sandstone, white, micaceous	20		
Shale and clay	10		
Coal, elevation 2,340 feet	2		
Shale	30		
(B. M., elevation 2,309 feet.)			
Gladeville sandstone.			

Local Section 18.

Section on upper Powell River, two-fifths of a mile south of B. M., 2,385 feet measured westward up stream valley to crest of Amos Ridge.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Sandstone, elevation at top, 2,920 feet	20		319
Unexposed	80		
Shale	30		
Sandstone	20		
Shale	60		
Coal, bloom	1	3+	
Shale and clay	8		
Sandstone, coarse, arkosic	50		
Shale	20		
Sandstone	30		
Coal, Low Splint, caved pit.			
Shale	50		130
Sandstone, arkosic	50		
Shale	10		
Sandstone	20		
Coal, Taggart, elevation 2,465 feet	4	4	
Clay	3		129
Sandstone, hard	50		
Coal, Taggart Marker, hard, bony, splinty	1	8	
Shale, sandy	10		
Shale	4		
Sandstone	55		
Unexposed	5		
(Powell River.)			

Local Section 19.

Section on upper Powell River measured northward from B. M. 2,385 feet along trail to crest of divide between Powell and Guest rivers.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Shale, elevation at top, 2,810 feet	60		347
Shale, with sandstone beds	180		
Sandstone	5		
Shale	15		
Sandstone	75		
Shale and clay	12		
Coal, Taggart, elevation 2,465 feet	3	6	
Clay	5		
Sandstone	60		
Unexposed	15		
(B. M., 2,385 feet.)			

Local Section 20.

Section on upper Guest River, 1 mile south of Lipps, at B. M. 2,157 feet measured southward along road toward Garden to crest of Divide Ridge.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Shale, elevation at top, 2,455 feet	55		185
Unexposed	50		
Shale	80		
Gladeville sandstone:			
Sandstone, massive	90		
Norton formation:			
Unexposed (B. M., 2,157 feet.)	23		

Local Section 21.

Section from Donald School near head of South Fork of Pound River (B. M. 1,918 feet) southwestward to gap in Black Mountain at B. M. 3,399 feet.

	Thickness. Ft.	In.	Interval. Ft.
Harlan sandstone:			
Sandstone, elevation at top, 3,399 feet	22		
Wise formation:			
Unexposed	9		460
Coal, High Splint, bloom	1		
Shale	33		
Coal	2	2+	
Sandstone	75		
Shale	340		
Coal, Pardee, elevation 2,978 feet	6		
Shale, with thin sandstone beds	385		474
Conglomerate	10		
Coal	1	6	
Sandstone, thin-bedded	12		
Shale	66		
Coal, Phillips, elevation 2,560 feet	2	2	

	Thickness. Ft.	In.	Interval. Ft.
Shale	5		
Sandstone	115		
Unexposed	33		
Sandstone	49		287
Coal	1+		
Sandstone	66		
Shale, sandy	18		
Coal, Low Splint, elevation 2,303 feet	2	6	
Clay	2		
Shale	5		
Unexposed	55		
Sandstone	8		153
Unexposed	45		
Sandstone	5		
Shale, sandy	33		
Coal, Taggart, elevation 2,160 feet	2	10	
Shale	6		
Coal	2	6	
Clay		6	
Shale	1		
Sandstone	4		
Shale	22		
Sandstone	5		
Shale, sandy	5		
Coal, caved pit.			
Sandstone, massive	38		260
Shale, clayey	8		
Coal, Taggart Marker	2	2	
Shale		½	
Coal		11	
Clay	2		
Sandstone	15		
Unexposed	22		
Sandstone	15		
Unexposed	45		
Sandstone	66		
(B. M., 1,918 feet.)			

Local Section 22.

Section near head of North Fork of Pound River at B. M. 1,772 feet, south to Flat Gap and east along road one-eighth of mile to gap in spur of dividing ridge.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Shale, elevation at top, 2,070 feet	20		
Coal	1		
Shale	20		
Coal, Kelly	2	1	
Shale	30		
Sandstone	10		
Coal, Imboden (?)		6+	

	Thickness. Ft.	In.	Interval. Ft.
Shale	40		
Coal		4	
Shale		4	
Coal		2	
Shale	10		
Sandstone	10		
Shale	20		
Coal		2	410
Shale	20		
Sandstone	10		
Shale, brown and gray	240		
Sandstone	8		
Shale	20		
Sandstone	10		
Shale, sandy	21		
Coal, Clintwood, elevation 1,825 feet	2		
Sandstone	21		
Shale, sandy	80		
(B. M., 1,772 feet.)			

Local Section 23.

Section on Rocky Fork of Upper Guest River, measured northwestward from B. M. 2,182 feet to Pinnacle Gap, B. M. 2,490 feet.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Shale, elevation at top, 2,490 feet	30		
Sandstone, hard, fine-grained	30		185
Shale	125		
Sandstone, massive, Addington member	55		
Shale	68		
(B. M., 2,182 feet.)			

Local Section 24.

Section from Norton and Northern railroad, one and one-half mile north of Ramsey due west to crest of ridge.

	Thickness. Ft.	In.	Interval. Ft.
Gladeville sandstone:			
Sandstone, massive, ledge-making	35		
Norton formation:			
Coal, Norton, West Co. mine, elevation 2,520 feet	2	6	
Shale, soft, yellow	80		
Sandstone	20		
Shale, hard, clayey	100		415
Sandstone	15		
Shale	200		
(Railroad level.)			

Local Section 25.

Section from Norton and Northern railroad, one and one-half mile north of Ramsey, north along county road to Esserville—Wise Pike, at B. M. 2,410 feet.

	Thickness. Ft.	In.	Interval. Ft.
Norton formation:			
Shale	25		328
(B. M., 2,410 feet.)			
Sandstone	40		
Shale	70		
Sandstone, hard, ledge-making	65		
Shale	65		
Conglomerate	10		
Shale	15		
Sandstone, soft	8		
Unexposed	30		

Local Section 26.

Section one and one-half miles east of Tacoma, measured northward from B. M. 2,000 feet on Norfolk and Western Railroad, up face of plateau to Wise-Coeburn pike.

	Thickness. Ft.	In.	Interval. Ft.
Norton formation:			
Shale, sandy, elevation at top, 2,790 feet	40		380
Sandstone, massive	75		
Shale, sandy	50		
Sandstone, massive, arkosic	160		
Shale	55		
Coal, Upper Banner, elevation 2,440 feet	4	6½	
Shale	150		150
Coal, Lower Banner, elevation 2,325 feet	3	9	
Shale	20		430
Sandstone	20		
Shale	40		
Sandstone	15		
Shale	105		
Coal, Kennedy, caved pit, elevation 2,180 feet.			
Shale with thin sandstone beds	170		
Coal, Raven, caved pit.			
Shale	60		
(Railroad, B. M., elevation 2,000 feet.)			

Local Section 27.

Section measured due west from Coeburn one and one-half miles along the Wise-Coeburn pike, and north to summit of ridge.

	Thickness. Ft.	In.	Interval. Ft.
Gladeville sandstone:			
Sandstone, massive, elevation at top, 2,835 feet	85		85
Norton formation:			
Concealed	20		
Shale	20		
Sandstone	5		
Shale	30		
Coal, elevation 2,675 feet		6	
Shale	4		
Sandstone	65		
Shale	16		
Coal, elevation 2,590 feet		8	
Shale	5		
Sandstone	25		362
Shale	5		
Sandstone	20		
Shale	35		
Coal, bloom, elevation 2,500 feet		10+	
Shale, sandy	25		
Coal, bloom.			
Shale, sandy	60		
Sandstone, thin-bedded	15		
Shale	10		
Coal, Upper Banner, elevation 2,390 feet	5		
Shale	5		
Sandstone	4		
Shale	36		66
Sandstone	8		
Shale	13		
Coal, Lower Banner, elevation 2,320 feet	4		
Shale	80		
Sandstone	20		
Shale	125		280
Sandstone, thin-bedded	20		
Shale	35		
Coal, Kennedy, caved pit, elevation 2,040 feet.			
Sandstone	15		
Shale	20+		

Local Section 28.

Section from bench mark 2,000 feet on Toms Creek at mouth of Cranesnest Hollow, measured due north along road up spur to summit of ridge.

	Thickness. Ft.	In.	Interval. Ft.
Wise formation:			
Shale, elevation at top, 2,720 feet	30		50
Sandstone	10		
Shale	10		
Gladeville sandstone:			
Sandstone	30		110
Shale, sandy	5		
Sandstone	35		
Sandstone, thin-bedded	40		
Norton formation:			
Shale, sandy	80		281
Sandstone, massive	30		
Shale	5		
Sandstone, thin-bedded	10		
Sandstone, massive	25		
Shale, carbonaceous		6	
Sandstone, shaly	20		
Shale, sandy	55		
Coal		8	
Sandstone	15		
Shale, sandy	10		
Sandstone, arkosic	20		
Shale, sandy	10		
Coal, Upper Banner, elevation 2,276 feet	1+		
Shale, sandy	98		98
Coal, Lower Banner, elevation 2,178 feet	1+		
Sandstone	8		
Shale with thin bed of sandstone	80		
Shale, elevation at base, 2,000 feet	90		

DIAMOND DRILL PROSPECTING.

Many drill holes have been put down in Wise County for the purpose of testing the thickness and character of the coal beds. The chief companies or corporations that have made such borings are the Stonega Coke and Coal Co., the Virginia Iron, Coal and Coke Co., the Virginia Coal and Iron Co., the Clinchfield Coal Corporation, the Norton Coal Co., the Wise Coal and Coke Co., and the Interstate Coal and Coke Co. All of the above organizations have permitted the graphic reproduction of the logs of their borings and this has been done on Plate III, in pocket. As will be seen by consulting this plate the records of coal thicknesses disclosed in the borings of the first five organizations are confidential and hence not made public.

The graphic sections of the boreholes are numbered serially west to east from 1 to 75, inclusive. The sections of boreholes Nos. 45 and 50 are relatively non-important and are not given in graphic section form. The name of the company drilling the hole and company number appear below the map serial number.

The Gladeville sandstone has been taken as the basis of correlation for Plate III and hence is shown as a level bed or datum plane. As most of the boreholes either pass through the Gladeville sandstone or are in rocks the relation of which to the Gladeville is well known, they have been plotted directly with reference to that datum bed. In the western part of the county, however, the majority of boreholes are in rocks entirely above the Gladeville and in most cases it has been impossible to make a direct reference to the datum formation. In such cases the reference has been made indirectly by first grouping the sections with reference to the Imboden coal bed and then determining their relation to the top of the Gladeville sandstone on the basis that the Imboden coal is 650 feet above the Gladeville. The first 69 borehole sections appearing on Pl. III are plotted on the basis of the Gladeville sandstone as a reference horizon. Boreholes 70 and 71 are correlated on the top of the Lee, and are separated from the other sections. Boreholes 72 to 75, inclusive, are correlated on the base of the Lee and form a third division of the plate. A heavy line separating the last two divisions from one another and from the remainder of the plate indicates the breaks in correlation between the three divisions.

The sections appearing on Pl. III have been drawn as accurately as the degree of reduction in reproducing would permit. For that reason the logs of the boreholes will not be given in this report except for the following instances. Coal sections, measured in borings of the Wise Coal and Coke Co., and the Interstate Coal and Coke Co., will be given under the detailed description of coal beds, by drainage basins. The logs of three boreholes, each of which are of vital importance in correlating the coal beds within the county, will be given below. The purpose of giving the sections in detail is to show the basis for the correlations used in this report. The three borings given below are located as follows: At Inman, on Looney Creek, at Andover, on Callahan Creek, and near the mouth of Lick Creek on Cranesnest River. All are deep borings and have made it possible to interpret the underground geology of their field. In all three cases the thickness of coal beds is omitted and distributed to the thickness of adjacent beds to prevent error in the section.

Boring at Inman, on Looney Creek, 1 mile northwest of Appalachia.

(V. I. C. & C. Co.-DH-1.[1])

(Location No. 13, elevation 1,722 feet, L.[2])

	Thickness. Ft.	In.	Interval. Ft.	In.
Alluvium:				
Gravel and boulders	21		21	
Wise formation:				
Shale, gray	53	3	74	3
Coal				
Clay	2	9	77	
Sandstone, with sulphur bands	22		99	
Shale, gray	2		101	
Sandstone	35		136	
Shale, gray	29	5	165	5
Coal				
Shale, black	8	3	173	8
Coal				
Shale, gray	7	4	181	
Sandstone, medium soft	48		229	
Shale, dark gray	14		243	
Sandstone, medium soft	54		297	
Shale, gray	5		302	
Coal, Clintwood				
Shale	3		305	
Sandstone with shale partings	40		345	
Shale, gray	4		349	
Sandstone, hard	22		371	
Shale, dark gray	9	10	380	10
Coal, Blair				
Clay	1	2	382	
Shale, gray	8		390	
Sandstone	38		428	
Shale, gray	9		437	
Sandstone, medium	12		449	
Shale, gray	4		453	
Sandstone, gray	31		484	
Shale, gray	8		492	
Gladeville sandstone:				
Sandstone	82		574	
Conglomerate	51		625	
Norton formation:				
Shale	23		648	
Clay	2		650	
Sandstone, medium soft	57		657	
Sandstone, clay, and shale	8		665	
Shale, black	17		682	
Sandstone, medium soft	7		657	
Sandstone, with coal bed	9		744	
Sandstone, gray, hard	40		784	
Shale, dark-gray	19		803	
Sandstone, soft	59		862	
Sandstone, clay, and shale	26		888	
Sandstone, gray	27		915	
Shale, dark-gray	4		919	
Sandstone, gray, very hard	24		943	
Sandstone, medium soft	5		948	
Sandstone	63		1,011	

[1] "DH-1" refers to drill hole No. 1, the number representing the company serial number.

[2] "L" refers to elevations determined by Y-level, transit, or lock level.

Boring at Andover, on Callahan Creek, 1 mile north of Appalachia.

(V. C. and I Co.-DH-Andover.)

(Location No. 15, elevation 1,680 feet approx.)

	Thickness. Ft.	In.	Interval. Ft.	In.
Alluvium:				
Drift	11	6	11	6
Wise formation.				
Shale	19	6	31	
Coal				
Shale and clay	11		42	
Sandstone, hard	3		45	
Shale	5		50	
Sandstone, hard	8		58	
Shale	3		61	
Sandstone, hard	3		64	
Sandstone with shale partings	9		73	
Shale	5		78	
Clay	8	1	86	1
Coal, Clintwood				
Clay	7	11	94	
Sandstone, gray	1		95	
Shale with sandstone partings	11		106	
Sandstone, gray	6		112	
Shale		4	112	4
Coal				
Shale	2	8	115	
Clay	2	6	117	6
Shale and clay	2	7	120	1
Coal				
Clay	1	11	122	
Sandstone with shale partings	7		129	
Shale, sandy	2		131	
Coal, Blair				
Shale, sandy	5		136	
Sandstone, shaly	2		138	
Sandstone, gray	44		182	
Sandstone, shaly	5		187	
Shale, sandy	5		192	
Sandstone, shaly	2		194	
Shale, clayey	9	4	203	4
Coal, Lyons				
Shale	3	8	207	
Shale, sandy	13		220	
Shale, clayey	11		231	
Shale, sandy	7		238	
Sandstone, hard	22		260	
Shale	7		267	
Coal, Dorchester				
Clay	2		269	
Shale	5		274	
Gladeville sandstone:				
Sandstone, fine-grained, gray	26		300	
Sandstone, coarse, soft	25		325	
Shale, dark	13	3	338	3

	Thickness. Ft.	In.	Interval. Ft.	In.
Norton formation:				
Coal				
Shale and clay	14	9	353	
Shale, dark	1	1	354	1
Coal				
Shale with clay	2	11	357	
Shale	28		385	
Coal				
Clay and shale	12	6	397	6
Coal				
Shale and clay	5	6	403	
Sandstone, shaly	3		406	
Shale	9		415	
Sandstone	3		418	
Shale	2		420	
Clay	4	11	424	11
Coal				
Sandstone	11	1	436	
Clay	7		443	
Shale, sandy	8		451	
Sandstone, shaly	10		461	
Shale, sandy	41	6	502	6

Boring on Cranesnest River, below mouth of Lick Fork, Dickenson County.

(C. C. C., DH, Sl.)

(Location No. 72, elevation 1,492 feet, L.)

	Thickness. Ft.	In.	Depth. Ft.	In.
Alluvium:				
Sand and gravel	14		14	
Norton formation:				
Shale, sandy	63		77	
Sandstone	5		82	
Shale, sandy	10		92	
Sandstone	39		131	
Shale, sandy	6		137	
Sandstone	67		204	
Shale, dark	3		207	
Sandstone	1	11	208	11
Coal, Kennedy				
Sandstone	25	1	234	
Shale, sandy	11		245	
Sandstone	4		249	
Sandstone with shale partings	12		261	
Shale, sandy	25		286	
Shale	13		418	
Coal, Raven				
Shale and bone	1		419	
Shale, gray	4		423	
Sandstone	72		495	
Shale, dark	25		520	
Sandstone	4		524	
Shale, sandy	21		545	
Sandstone	3		548	

	Thickness. Ft.	In.	Interval. Ft.	In.
Shale, sandy	18		566	
Shale	46		612	
Sandstone	153	6	765	6
Shale	2	6	768	
Shale, sandy	7	0	775	
Shale	24	11	799	11
Coal				
Shale	1	1	802	
Coal				
Shale	1		803	
Coal and shale				
Shale	5		808	
Sandstone with coal partings	26		834	
Shale, sandy	3		837	
Sandstone with shale partings	13		850	
Sandstone with coal partings	10		860	
Lee formation:				
Sandstone	99	1	959	1
Coal				
Sandstone	1	8	960	9
Shale, sandy	27	3	988	
Sandstone	126		1,114	
Shale with ½″ coal parting	6	5	1,120	5
Sandstone	18	7	1,139	
Shale, dark	11	5	1,150	5
Coal				
Shale	1	6	1,151	11
Coal				
Shale	2	8	1,154	7
Sandstone	19	5	1,174	
Shale, sandy	29	1	1,203	1
Coal				
Shale, sandy	5	11	1,209	
Sandstone	49		1,258	
Shale	18		1,276	
Coal				
Bone	1	8	1,277	8
Coal				
Sandstone	40	10	1,318	6
Sandstone, shaly	1	6	1,320	
Shale	4	1	1,324	1
Shale, sandy	3	6	1,327	7
Shale		9	1,328	4
Coal				
Shale, dark	3	8	1,332	
Sandstone	13		1,345	
Sandstone	47		1,392	
Sandstone, hard	10		1,402	
Conglomerate	8		1,410	
Sandstone	1	6	1,411	6
Shale		6	1,412	
Conglomerate		6	1,412	6
Sandstone	15	6	1,428	
Conglomerate, hard with white pebbles	19		1,447	
Sandstone, hard	18		1,465	
Shale, dark	4		1,469	

	Thickness. Ft.	In.	Interval. Ft.	In.
Conglomerate, hard with dark pebbles	7		1,476	
Sandstone	77		1,553	
Conglomerate	3		1,556	
Sandstone	8	6	1,564	6
Shale, sandy	1		1,565	6
Sandstone	2	6	1,568	
Conglomerate, with white pebbles	19		1,587	
Conglomerate	9		1,596	
Sandstone	8		1,604	
Conglomerate	1		1,605	
Conglomerate, hard, with pebbles	9		1,614	
Sandstone	2		1,616	
Conglomerate, hard, with white pebbles	7		1,623	
Sandstone	17	8	1,640	8
Conglomerate	3	6	1,644	2
Pennington shale:				
Coal				
Shale	2	10	1,647	
Shale, sandy	28		1,675	
Sandstone	15		1,690	
Shale, greenish	13		1,703	
Shale, red	8		1,711	
Shale, light-colored	20		1,731	
Shale, red	19		1,750	
Shale, light-colored and sandy	9		1,759	
Shale, red	3		1,762	
Shale, light-colored	7		1,769	
Shale, red	2		1,771	
Shale, light-colored	8		1,779	
Sandstone	78		1,857	
Sandstone with shale partings	6		1,863	
Sandstone	19		1,882	
Conglomerate	2		1,884	
Sandstone	8		1,892	
Sandstone with shale	62		1,954	
Shale, dark, sandy	12		1,966	
Shale, dark	10		1,976	
Shale, dark, sandy	10		1,986	
Shale, dark	99		2,085	
Shale, sandy	16		2,101	
Shale, dark	11	8	2,112	8
Coal				
Shale, light-colored	10	4	2,123	
Sandstone	6		2,129	
Shale, light-colored sandy	8	6	2,137	6
Shale, green	1	6	2,139	
Sandstone	17		2,156	
Shale, sandy	6		2,162	
Shale	47		2,209	
Shale, red	43		2,252	
Shale, light-colored sandy	3		2,255	
Shale, red	24		2,279	
Sandstone	5		2,284	
Shale, red	5		2,289	
Shale, light-colored, sandy	1		2,290	
Shale, light-colored	17		2,307	

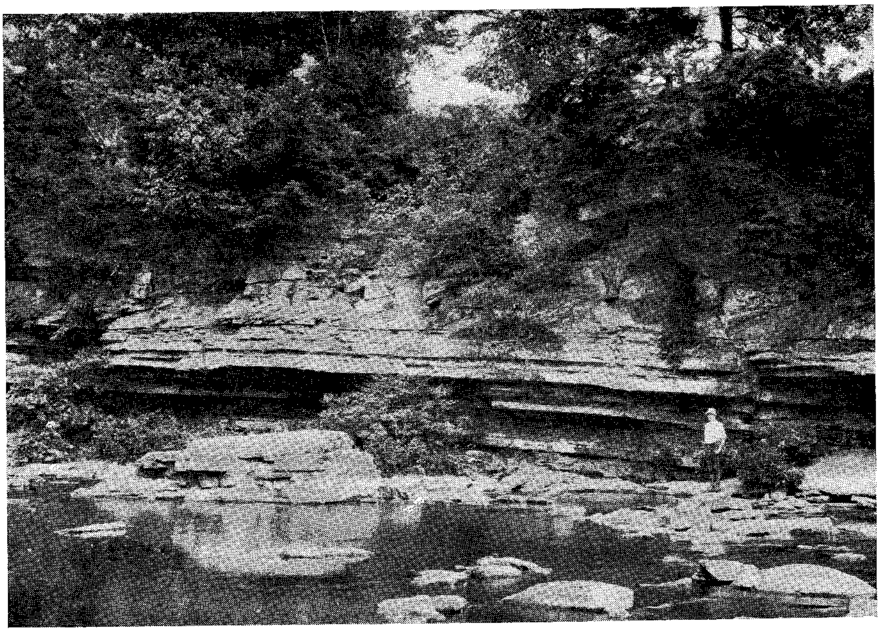
	Thickness. Ft.	In.	Interval. Ft.	In.
Sandstone	5		2,312	
Shale, red	8		2,320	
Shale, light-colored	2		2,322	
Shale, red	23		2,345	
Shale, light-colored	6		2,351	
Sandstone	37		2,388	
Shale, dark	7		2,395	
Shale, light-colored, sandy	3		2,398	
Shale, dark	17		2,415	
Shale, dark, sandy	19		2,434	
Shale, sandy	10		2,444	
Shale, dark	15		2,459	
Shale, sandy	9		2,468	
Sandstone	7		2,475	
Sandstone, broken	7		2,482	
Sandstone	9		2,491	
Sandstone with shale streaks	9		2,500	

GEOLOGIC STRUCTURE.

DEFINITION.

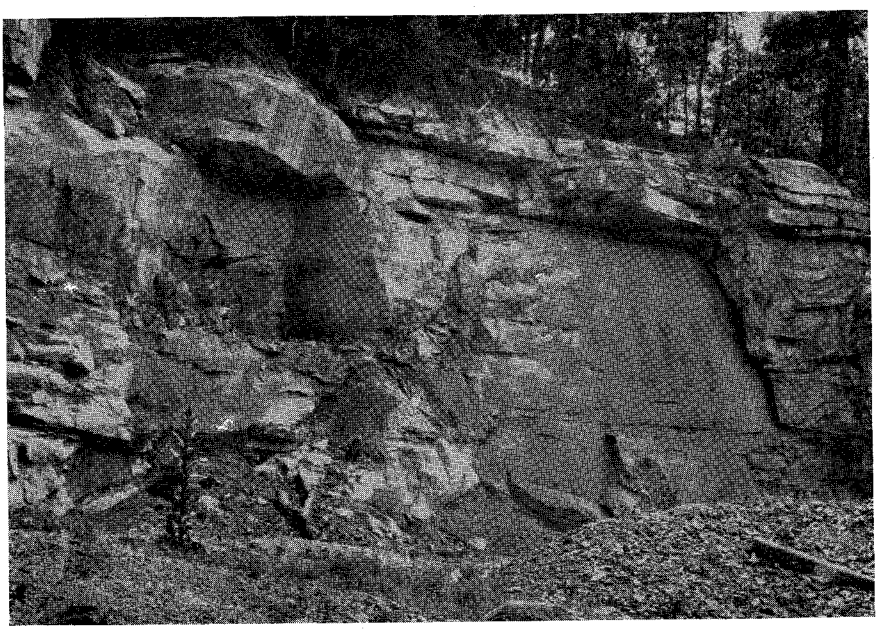
By the term "geologic structure" is meant the attitude or lay of the rocks. The rocks of Wise County, consisting of limestone, shale, sandstone, clay and coal beds, are all of sedimentary origin and were originally laid down in a horizontal or nearly horizontal position. Following the deposition of the materials now forming the rocks, compressive stresses developed in the crust of the earth which exerted great pressure on the rocks, folding them into anticlines and synclines where the pressure was of moderate intensity and shearing them and forming faults where the pressure was greatest or where it was exerted at right angles to the bedding planes. In passing from the coal field at Appalachia through Big Stone Gap, one is generally impressed with the idea that he passes from a region in which the rocks are flat or structureless to one in which they are highly tilted, forming pronounced structures. It must not be inferred, however, from this statement that only tilted rocks exhibit geologic structure and that flat-lying rocks are without structure, for this is not the case. Structure, as defined above, is the "attitude" of the rocks and hence it must apply to rocks that are nearly horizontal as well as to rocks that stand on edge.

As geologic structure controls the attitude of a coal bed and as it has had a profound effect upon the work of the streams, it is one of the principal geologic conditions that has helped to give the surface its present configuration, and as the present configuration is an all-important factor in the development of coal mines, the more important features of this structure will now be described in some detail.



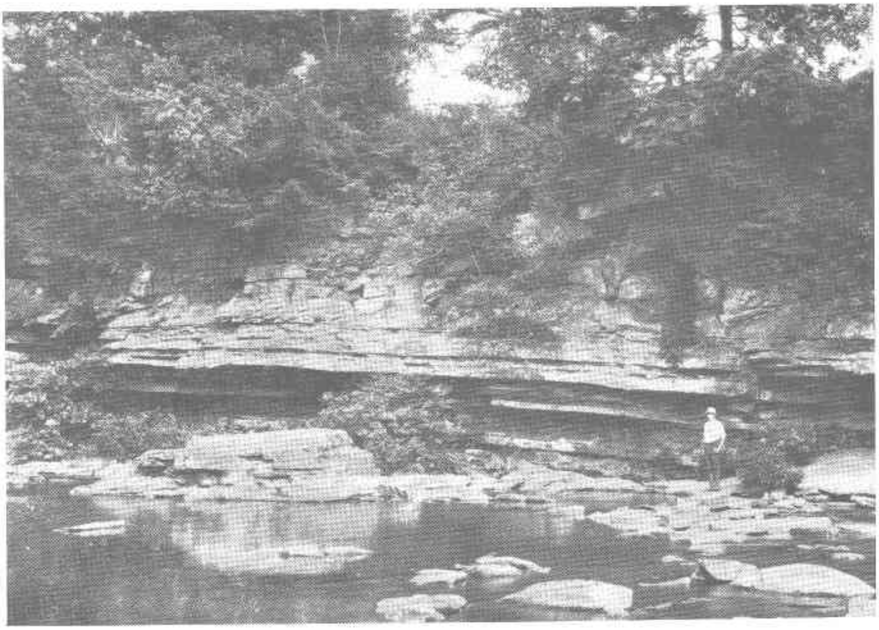
(A) "Bee Rock" of Lee formation, 1 mile south of Coeburn. Guest River at this point has cut only about 30 feet into this bed, exposing a layer of crossbedded sandstone near the top and shaly layers below.

Photo by C. K. Wentworth.



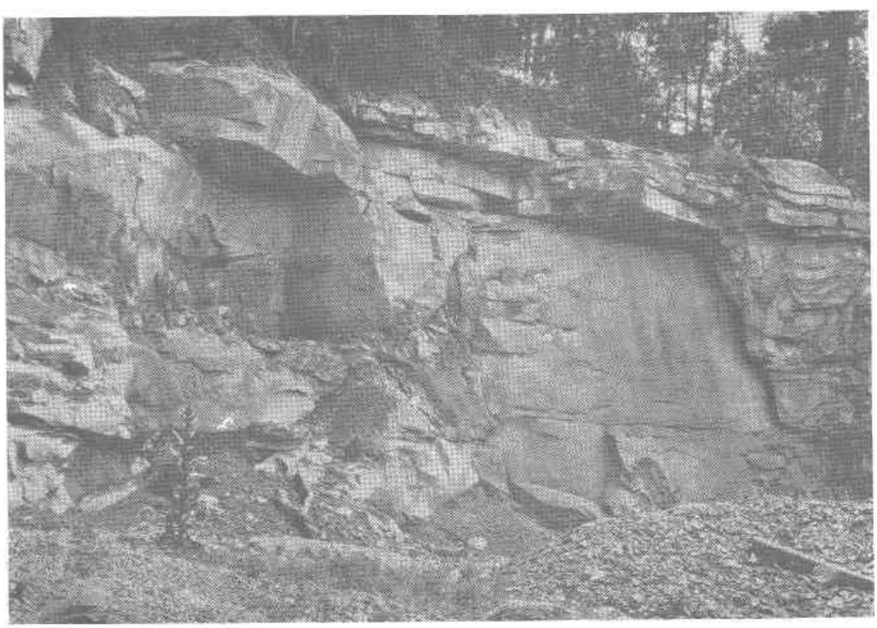
(B) Sandstone in Norton formation, medium grained, breaking with conchoidal fracture on fresh surfaces.

Photo by C. K. Wentworth.



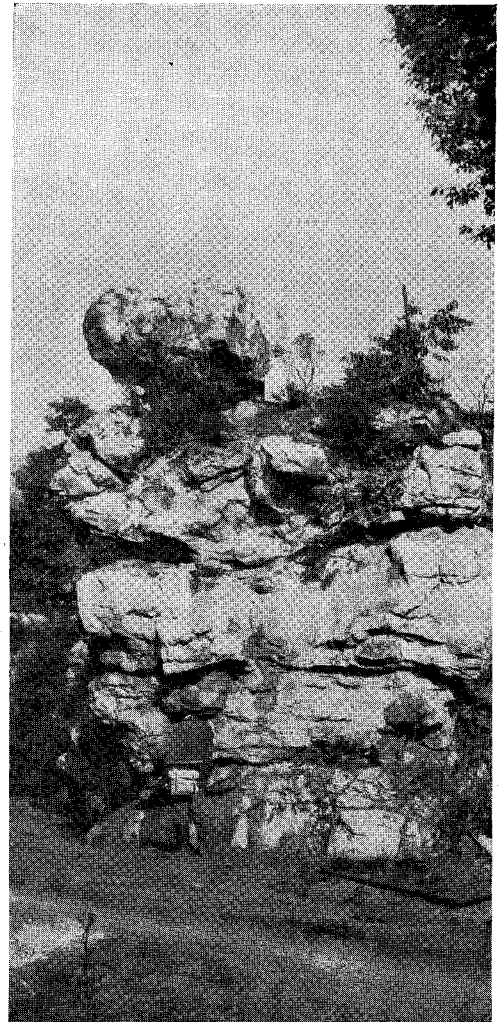
(A) "Bee Rock" of Lee formation, 1 mile south of Coeburn. Guest River at this point has cut only about 30 feet into this bed, exposing a layer of crossbedded sandstone near the top and shaly layers below.

Photo by C. K. Wentworth.

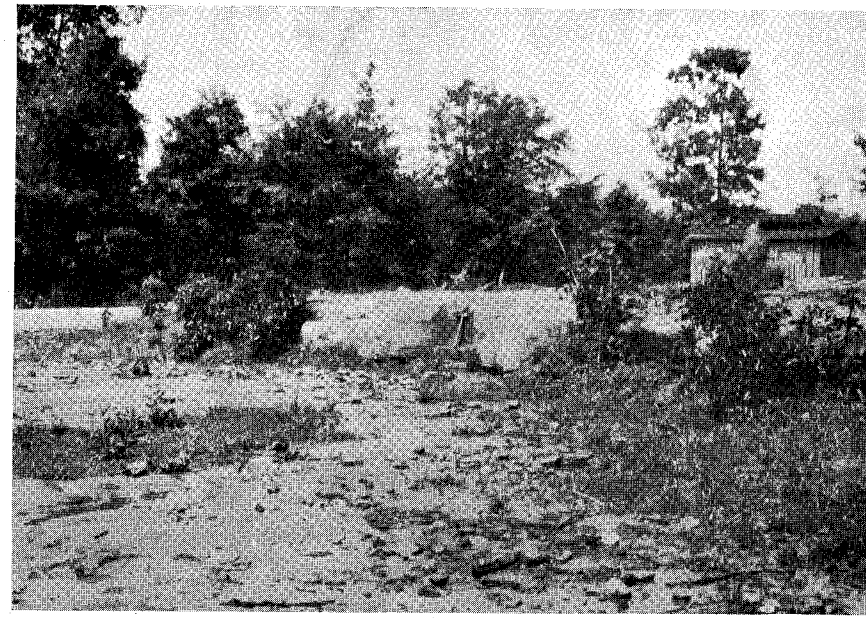


(B) Sandstone in Norton formation, medium grained, breaking with conchoidal fracture on fresh surfaces.

Photo by C. K. Wentworth.

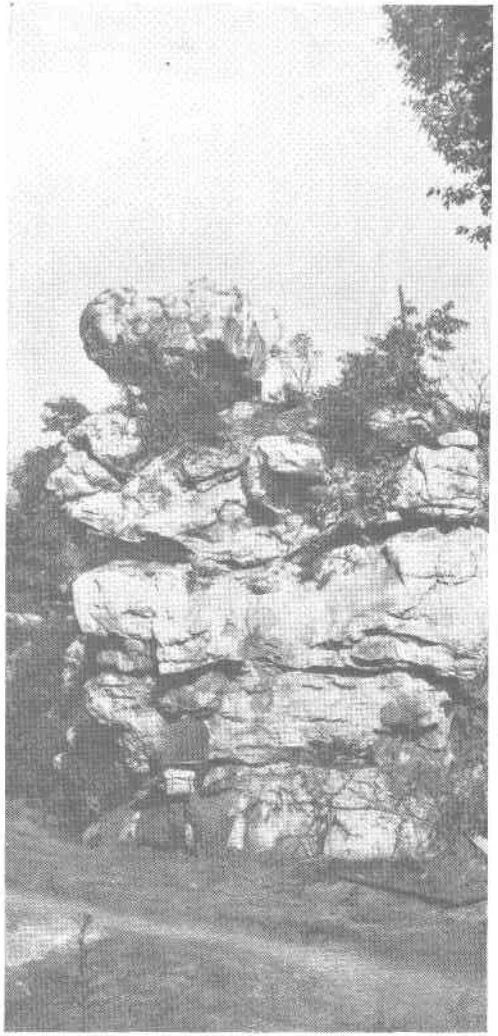


(A) Cliff of Gladeville sandstone at Glamorgan, massive on fresh exposures and weathers into irregular masses.

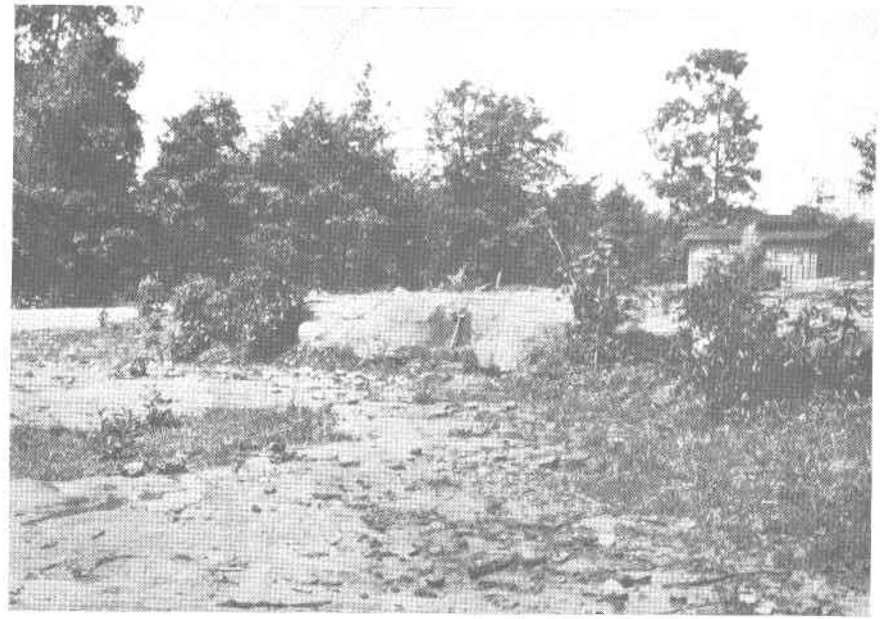


(B) Flat surface made by Gladeville sandstone near Esserville. Such surfaces are common in eastern Wise County.

Photo by J. B. Eby.



(A) Cliff of Gladeville sandstone at Glamorgan, massive on fresh exposures and weathers into irregular masses.



(B) Flat surface made by Gladeville sandstone near Esserville. Such surfaces are common in eastern Wise County.

Photo by J. B. Eby.

METHODS OF REPRESENTATION.

General statement.

As the rocks composing the earth's crust are seldom found in a strictly horizontal position, one of the most important duties of a geologist in making a field examination is to determine the attitude of the rocks and his second duty is to portray in his report, that attitude so that everyone who reads the report may be able to have a clear conception of the geologic structure, as it is generally called. There are two general methods of representing structure, both of which are useful and both used in this report. These are known as (1) representation by means of structure sections, and (2) by means of structure contours.

Structure sections.

Structure sections are supposed to show the lay or attitude of the different strata as they would appear in the side of a deep trench dug across the country, generally in a straight line. Such sections, shown on the general map, Pl. II and in many figures in the text give the reader a clear picture of the dip of the beds, the folds into which they have been thrown, and the effect of particularly hard rocks in forming hills, ridges, and mountains. The chief defect, however, is that each section shows the geologic structure along a single line only and frequently gives no clue to complications that may be present in adjacent localities. To the engineer they are qualitative but not quantitative in that they suggest what the geologic structure may be but give him no absolute data by which he can determine it at any particular point off the line of the section.

Structure contours.

The most important work that a geologist can perform in a coal field is to determine the depth of all important coal beds beneath the surface and the direction and amount of their dip. If this is done and represented in such a way that the engineer may intepret it for every point in the field, he will have little difficulty in prospecting for the coal beds that lie beneath the surface, in laying out new mines and in so planning his surface work as to mine the coal and get it ready for shipment at the lowest cost possible.

The most effectual way of meeting these needs of the mining engineer is for the geologist to represent the geologic structure of the field by what is generally termed structure contours. These are lines so drawn that each one connects points of equal elevation on some particular and recognizable reference bed. Surface contours show the size and shape of hills and valleys on the surface of the ground and structure contours show the "hills and valleys" of the surface of an underground stratum of rock, as they would appear if the overlying rocks were stripped away.

In the Wise County field the great length of the stratigraphic section involved has made it impractical to contour the whole area on any one bed and it was decided therefore that it would be of much greater practical value to use different beds in different parts of the field or four in all for this purpose. The reference strata used in this report are as follows: In western Wise County the Imboden coal bed; in central and northern Wise County, the top of the Gladeville sandstone; in eastern Wise County, the Upper Banner coal bed; and in southern Wise and northern Scott counties, the top of the Lee formation. The contour interval—the vertical distance between the horizontal planes of two successive contours—used in this report is 50 feet. The major intervals between the four sets of structure contours are all multiples of 50 feet and hence there are no breaks in the contours in passing from one reference bed to another, but there is a break in the elevations above sea level. The contours on the different beds are indicated by lines of different colors and the figures representing elevations are for the bed upon which the contour is drawn (see Pl. II). From the structure contours the magnitude of the dip of the reference bed in feet per mile and also the direction of dip can readily be ascertained from the map. The dip so determined for the reference bed would apply equally well to other beds of rock were it not for the fact that the intervals between the beds of the various formations are not constant and consequently the beds are not strictly parallel, but in a general way the difference is not so great but that the structure determined for one particular bed may be regarded as applying also to others either above or below it. If the beds thin in the direction of the regional dip, the dip of beds above the datum surface will be greater than that indicated on the map and the dip of beds below the datum surface will be less; and if they thicken in the direction of the regional dip the converse will be true.

A second important use for structure contours is to determine on the map the position of the outcrop of any bed or to calculate the depth of the bed below the surface where it is not exposed. The simplest case of this kind is the one in which the bed in question is the key rock upon which the structure contours are drawn. Thus if it is desired to find a point at which the Upper Banner coal bed crops out on the sides of the valley of Toms Creek at a certain place, it is necessary to note only the elevation of the Upper Banner structure contour, through or nearest the point, and find where it intersects a surface contour of the same elevation. Such a point will then lie on the outcrop of the bed (A C and E Fig. 5). If all the surface contours at or near the point are higher than the structure contours (B Fig 5) the bed will lie below the surface and the distance necessary to drill for it can readily be obtained by subtracting the structure contour elevation from the surface elevation at that point. If all of the surface contours at or near the point lie below the structure contour (D. Fig. 5) it is at once obvious that the position of the bed is above the surface and that the bed has been eroded away. If it is desired to find the position of a higher

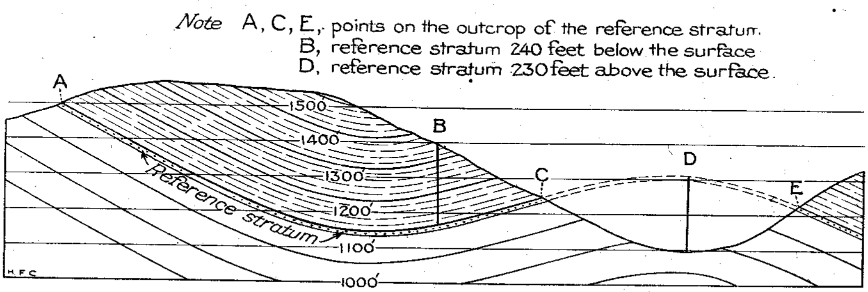


Fig. 5.—Diagram to illustrate the meaning and use of structure contours.

or lower bed it is only necessary to add or subtract the interval between the bed in question and the reference bed and proceed as in the case just described.

If, for example, it is desired to find the depth below stream level of the Kennedy coal bed at the town of Toms Creek, the following procedure would apply. Locate the intersection of the stream and the nearest Upper Banner structure contour on the geologic map. The Upper Banner contour indicates that the Upper Banner coal is here at an elevation of 2,200 feet above sea level, and the surface contour indicates that stream level is 2,025 feet above sea level. The Kennedy coal bed lies about 325 feet below the Upper Banner coal bed (see fig. 4); hence its elevation, above sea level is 2,200 feet minus 325 feet, or 1,875 feet. The difference, therefore, between the surface elevation or 2,025 feet and the Kennedy coal elevation or 1,875 feet is 150 feet, or in other words the Kennedy coal bed at Toms Creek is about 150 feet below the surface. For a coal lying above the Upper Banner the procedure is identical except that the interval is added to the elevation of the Upper Banner contour.

The usefulness of structure contours naturally depends upon the accuracy with which they are determined. There will always be a certain amount of uncertainty in contouring a bed concealed by overlying rocks and the possible sources of error may be large, but if many well logs are available the error in the location of the contours may be very small. For eastern, central, and western Wise County abundant material is available, and it is believed that errors of as much as 50 feet are rare. The northern and southern sections of the region have not been drilled or explored so thoroughly and the contouring of necessity does not attain so high a degree of accuracy. No contours are drawn in the areas of greatly disturbed rocks, as along the north face of Stone and Little Stone Mountains, or in the area of upturned rocks adjoining the Hunter Valley fault, for in such places the chances of error are tremendously increased and even if drawn the contours would have little or no practical value.

MAJOR STRUCTURAL FEATURES OF THE FIELD.

General statement.

The rocks of the coal-bearing portion of Wise and Scott counties, in general, lie in the bottom of a broad shallow trough or elongated basin, which has been the means of their preservation from erosion. This general trough, however, is notably modified in southern Wise and Scott counties by a broad, gently westward-rising anticline that has elevated the coal-bearing rocks in this region, with the consequent loss by erosion of the higher, more valuable coal beds. The rocks in that portion of the Wise and Scott counties field affected by this anticline are so notably barren of coal beds and so different from those in the main coal field that it is generally regarded as a distinct field called the Powell Mountain coal field. The line of demarcation between the Powell Mountain field and the important coal-producing field on the north agrees in general with the course of Guest River from its mouth at Clinch River northwest and west to Norton and from Norton with the course of Powell River and Pigeon Creek along the north face of Powell, Little Stone, and Stone mountains, in a westerly direction to the Lee County line. With a few minor exceptions, all the coal shipped from Wise County is taken from beds occurring in the structural trough north of Powell Mountain, indicating the present relative non-importance of the Powell Mountain field.

The southeastern limit of the Wise and Scott counties coal field is marked in part by a fault and in part by the normal upturning of the beds on the flank of a sharply folded syncline. In eastern Wise and Scott counties the coal field is abruptly cut off by a fault and in western Wise County and eastern Lee County the beds are upturned along Stone Mountain without any evidence of an extensive and profound fault. These major structural features that affect not only the rocks of Wise and Scott counties but extend into the adjacent counties, are described in detail. A serial diagram is given in fig. 10 showing the development of the major folds and faults.

Powell Valley Anticline.

By G. W. STOSE.[1]

The great arch formed at the same time that the Middlesboro syncline was produced is called the Powell Valley anticline from the great valley that has been eroded in its crest. The axis of this fold enters Wise County from the southwest near the town of Big Stone Gap and then passes about 1 mile south of Little Stone Gap. It continues due east to Guest River where the flattening out of the anticline makes it difficult to exactly locate the axis. The axis of the fold decreases in elevation 3,000 feet from a point south of Little Stone Gap eastward to Guest River, a distance of 13⅕ miles or at a rate of 227 feet per mile. A prolongation of the fold extends northeastward into Russell County from the vicinity of the mouth of Hurricane Creek of Guest River, and the name Powell Valley anticline is applied also to this fold in Russell County. A second and minor prolongation of the anticline branches from the main fold south of Coeburn and trends southeastward towards Carfax.

Like most folds in the Appalachian region, this anticline is unsymmetrical; the rocks on its northern side, forming Stone and Little Stone mountains, dip from 50 to 80 degrees to the north, whereas the rocks on its southern limb dip gently away from the axis and gradually merge into a shallow syncline on the south. The steep dips of the north limb become more gentle from Ramsey east, ranging at Tacoma from 15 to 25 degrees and at Coeburn 5 to 10 degrees. The minor syncline on the south is in large part lost by the crushing and folding back on themselves of the rocks which originally formed the southeastern limb of the syncline. The structure sections of Powell Mountain (see Pl. II) show the form of the anticline and the relation and dip of the beds below the surface.

The pre-Pennsylvanian rocks of Powell Valley in Wise County are exposed at the surface by reason of the Powell Valley anticline, a broad compound anticline or anticlinorium, which strikes east-northeast and plunges northeastward. It is strongly unsymmetrical, as shown by the steep north-

[1] The first two paragraphs are by Mr. Eby.

west dip (60° to 90°) of the basal conglomerate of the Lee formation in Stone and Little Stone mountains and gentle southeast dip (20° to 40°) of the same sandstone on Powell Mountain. (See structure sections, Pl. II.)

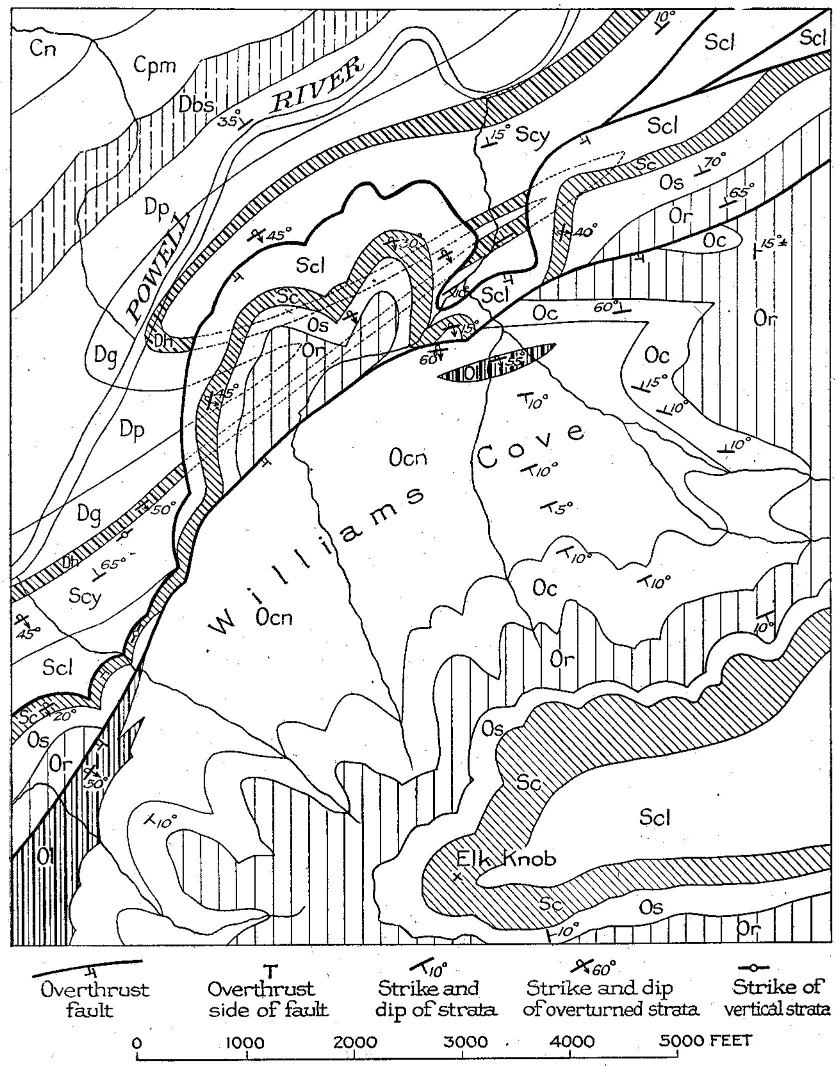


Fig. 6.—Geologic map of the vicinity of Williams Cove, showing the thin overthrust mass of the main faulted anticline cut through by the Williams Cove stream, exposing the folded overridden formations beneath.

Cn, Newman formation; Cpm, Price and Maccrady formations; Dbs, Big Stone Gap shale; Dp, Portage shale; Dg, Genesee shale; Dl, Helderberg limestone; Scy, Cayuga limestone; Scl, Clinton formation; Sc, Clinch sandstone; Os, Sequatchie sandstone; Or, Reedsville shale; Oc, Catheys limestone; Ocn, Cannon limestone; Ol, Lowville limestone.

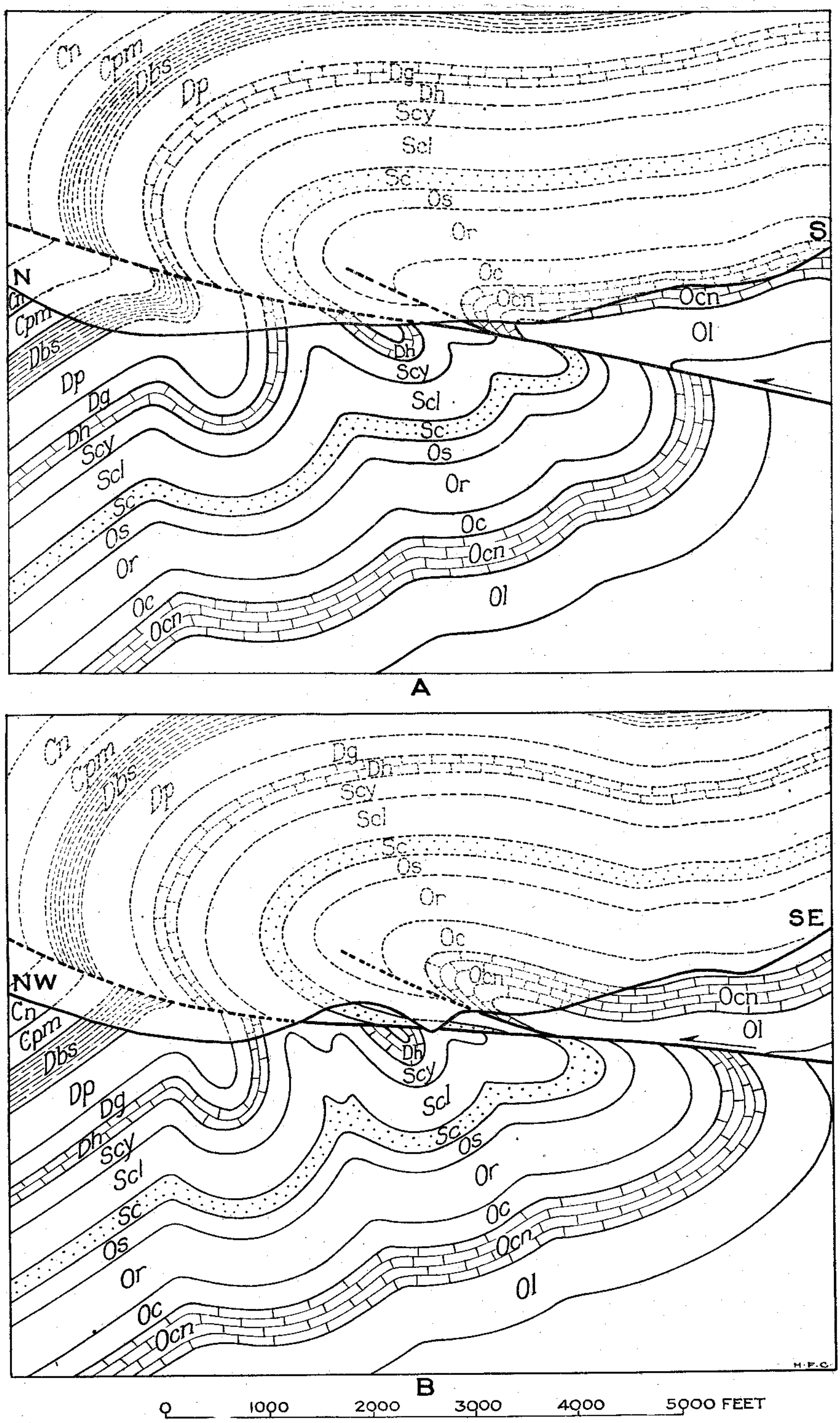
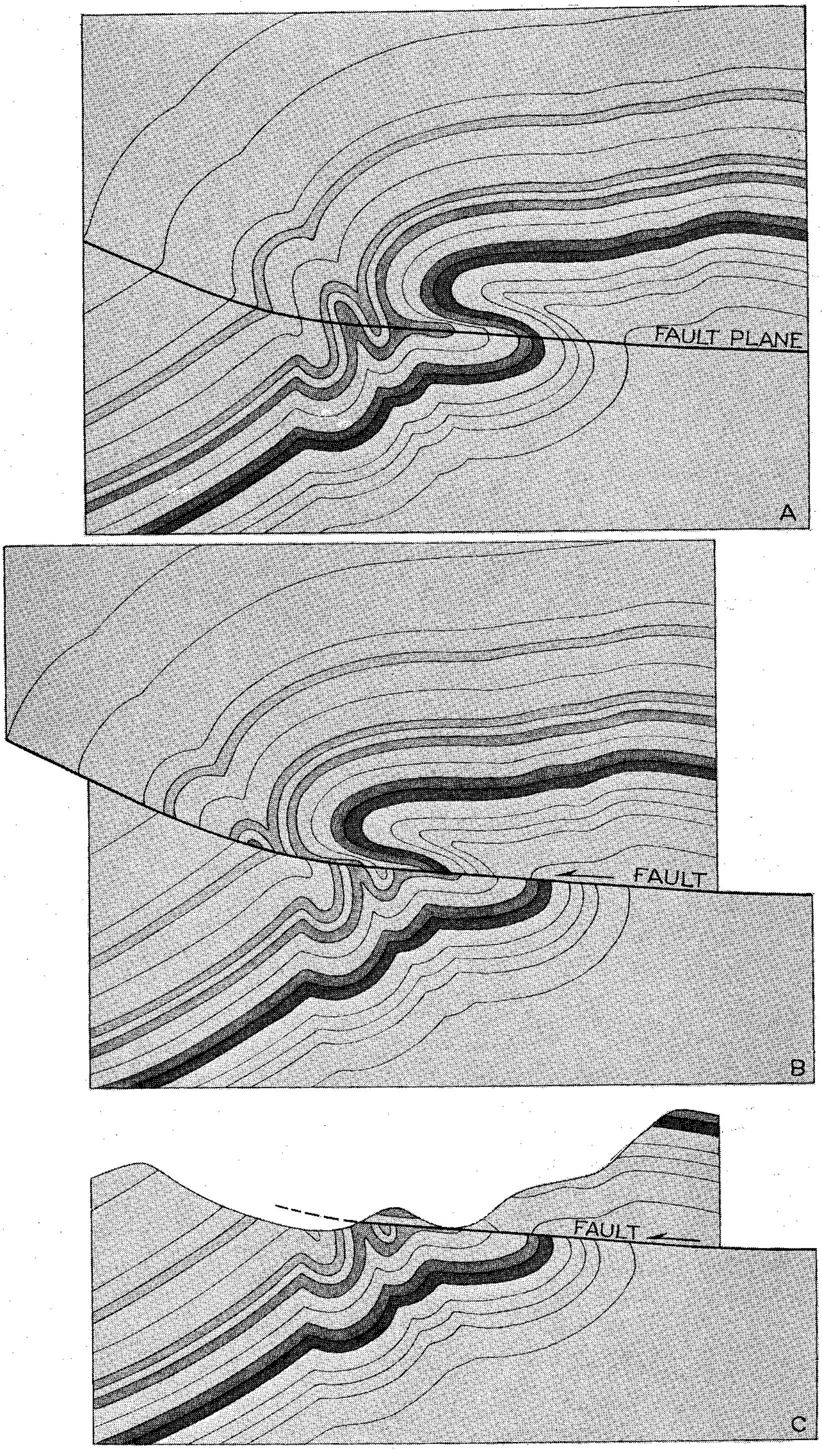


Fig. 7.—Structure sections across the overthrust mass in Williams Cove showing the relation of the faulted rocks underground and the restoration of the eroded strata.
Section A, through the gorge cut by Williams Cove Stream. Section B, through the ridge of overthrust rock, west of the gorge.
Letter symbols same as those in Figure 6.

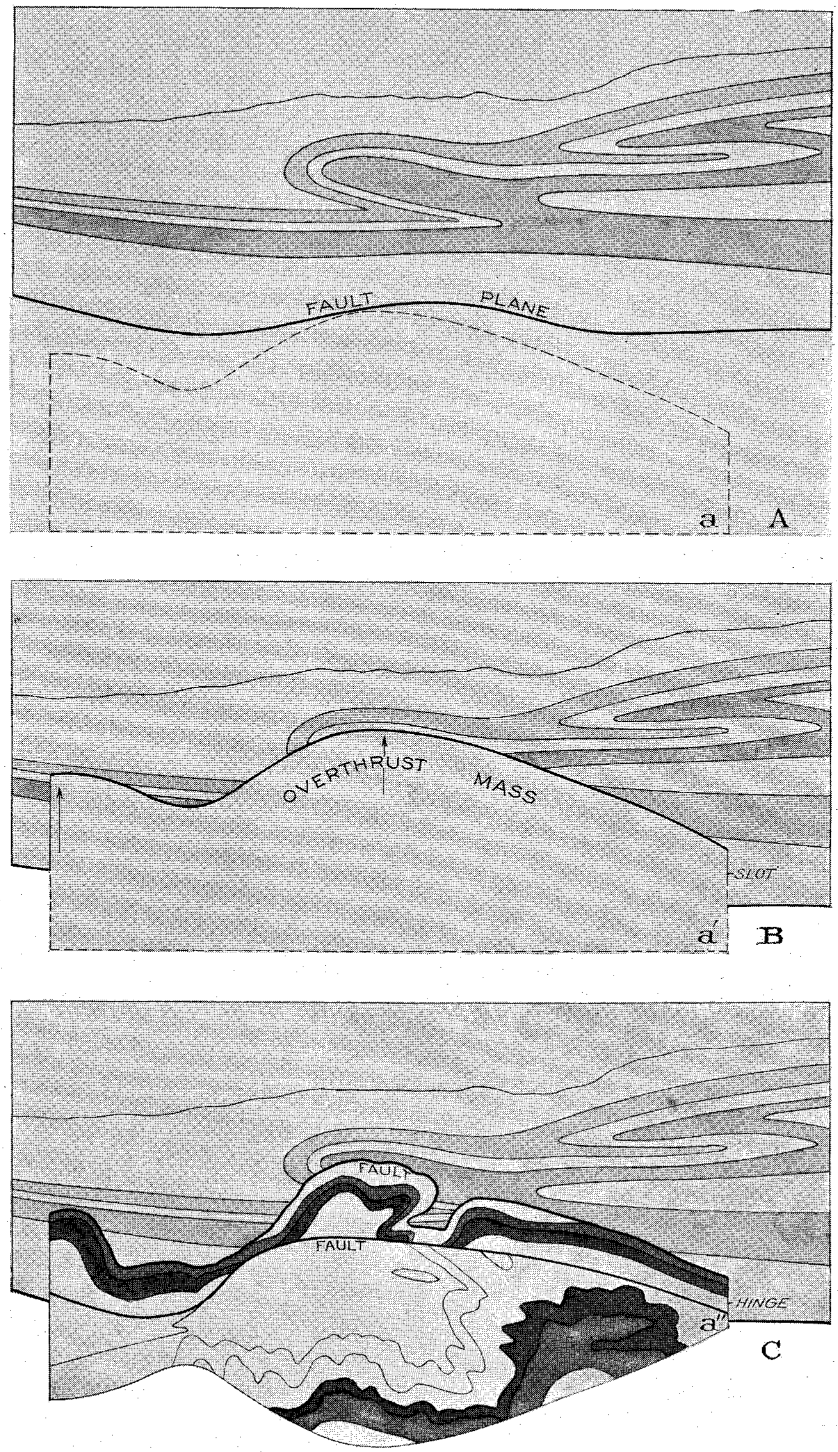
The compound character of the anticlinorium is not displayed by the outcrops of the conglomerate at the base of the Lee formation, for it not only dips away from the axis on the flanks of the fold but also at its northeast plunging end at the head of Powell Valley around which it swings with few irregularities of minor character. The complexity of the anticlinorium, however, is indicated by the sinuous outcrop of the Helderberg limestone, which shows the fold to be composed of several secondary anticlines and synclines. These secondary folds are still more accentuated in the outcrops of the deeper-lying Clinton formation, which is also broken by thrust faults. The Powell Valley anticlinorium in Wise County somewhat resembles a human hand. Its main anticline, short and stout and highly elevated, culminating in Elk Knob of Wallen Ridge, represents the thumb, and the minor folds to the northwest represent the fingers. One of the middle fold is long and attenuated, like one's second finger, reaching well into the head of the valley. A small, short anticline on the extreme northwest represents the little finger. These folds are so closely compressed and faulted that some of them can not be clearly distinguished on the map, but on the plan of the working model, Plate XVII, they are partially restored and simplified. The various units of the anticlinorium will be described in detail.

The main secondary anticline of the anticlinorium enters the county from the southwest as a high unsymmetrical fold which is strongly overturned and faulted. This will be referred to as the Williams Cove anticline because the greatest uplift occurs in Williams Cove. The Clinton formation, which on the southeast limb dips in general 5° to 10° SE and at the plunging north end of the fold dips 5° to 10° NE, changes abruptly to a 70° or 80° NW dip on the northwest limb, and further southwest the strata are vertical or even overturned. The hard beds of the Clinton and Clinch formations, which form the crest and southeast slope of Wallen Ridge, make only a narrow discontinuous ridge, called the River Ridge, on the northwest limb of the anticline because there they stand on end and are weakened by crushing. Near the Lee County line, where the uplift within the county was greatest, these beds are so greatly overturned that they dip 35° SE and in places as low as 15° SE. This extreme overturning is accompanied by an overthrust fault whose plane of faulting dips about 10° SE, which is so flat that it is cut through by the stream that issues from Williams Cove at the small gap in the River Ridge, exposing there an overridden closely compressed syncline of Helderberg limestone and Genesee shale. (See map, fig 6.) The overthrusting did not take place along a single fault plane but is



Photographs of a working model made of cardboard reproducing mechanically in section the thrust faulting on the west limb of the Williams Cove anticline.

A. The overturned recumbent fold before the faulting took place. B. The displaced strata after faulting. (The cardboards have been moved past each other.) C. The result after erosion, reproducing the existing conditions. (The eroded parts are concealed by folding a piece of white cardboard down from above.)



Photographs of a working model made of cardboard reproducing mechanically in plan the thrust faulting on the west limb of the Williams Cove anticline.

A. The folds of the overridden mass exposed on the plane of faulting. (a, is the cardboard representing the overthrust mass before faulting.) **B.** The folds concealed by the overthrust mass. (a′, has been pushed forward through a slot in the cardboard.) **C.** The result after erosion, reexposing, as they appear to-day, parts of the overridden folds. (a″, has been folded back along a hinge in the cardboard, exposing the geology on the reverse side.)

distributed along several planes between the formations, and for a short distance at the south edge of the county the Clinch and Sequatchie sandstones are drawn out into such thin belts that they are not really continuous as shown on the map but are lenticular. This thinning, stretching, and breaking apart of these harder resistant beds was caused by the locally great forward thrust of the overriding mass at this place. (See fig. 8.)

The relation of this overthrust mass to the overridden rocks is so well exposed along the sides and at the ends of the River Ridge, especially where the overthrust rocks are cut through by the small stream, and their relation to the Williams Cove anticline is so clearly shown, that the fault can be accurately drawn in sections for some distance underground. (See structure sections, fig. 7.) From a study of several such sections that show existing relations of the rocks, an attempt was made to restore the recumbent overturned anticline before the shearing stress exceeded the breaking strength of the rocks, and a working model of cardboard to show the process of faulting was constructed. Although such faulting can not be satisfactorily demonstrated by a working model of this kind because it is necessarily so mechanical in its action that the faulting is accomplished by the sliding of one part over the other, and the further bending of the strata which undoubtedly accompanied the faulting can not be shown, it is believed to be helpful in understanding the structure. A similar working model showing the faulting in plan was also made. (See working models, Plates XVI and XVII.) The cause of this overturning and thrust faulting is explained on a later page. (See fig. 8.)

What took place in the rocks that formerly covered those now exposed at the surface and which have been removed by erosion is of course problematical. It has been suggested from results observed in the coal fields west of Stone Mountain that, as the Lee formation is so massive and resistant, it was probably not broken by the fault but bulged up in a great arch which permitted the differential movement to be taken up by the crumpling of and movement within the soft shales below it. Undoubtedly such adjustment did take place to some extent in the shale, but probably not enough to accommodate the full amount of faulting that took place in the lower rocks near the Lee County line. In the plunging part of the fold near the head of Powell Valley simple bowing up of the sandstones of the Lee is indicated for the conglomerate beds on the northwest limb, as for instance at Little Stone Gap, are vertical, as they should be in a compressed but unbroken fold. Near the Lee County line, however, the breaking and faulting of the conglomerates of the Lee formation by the overthrust is indicated by the less steep and almost gentle dips in the Lee and overlying coal measures on the northwest limb of the fold, as they should be if relief from compression had been accomplished by thrust faulting.

The Williams Cove anticline plunges gently northeastward, carrying successively the Clinton, Cayuga, and Helderberg formations beneath the surface. The pitch of the crest of the fold is so gentle that an inlier of Clinton in the Cayuga is exposed in the valley of the South Fork of Powell River just south of East Stone Gap, and outliers of nearly horizontal Helderberg limestone cap hills in the Cayuga area to the northeast. A striking example of such an outlier is shown in the circular butte in the photograph reproduced in Plate VIII. The fold dies out in the Devonian and Carboniferous shales and sandstones which form the low hills to the northeast and the slopes of Powell Mountain.

The next most conspicuous secondary anticline of the anticlinorium is one that brings a large area of the Clinton formation and some Clinch sandstone to the surface near the head of Powell Valley. The Clinch sandstone is exposed at the point of greatest uplift in the gorge of Butcher Creek, and the fold, therefore, will be referred to as the Butcher Creek anticline. The rocks on the northwest limb dip about 25° NW and those on the southeast dip about 55° SE, showing that the axis of the fold is inclined to the northwest. This overturning was accompanied by overthrust faulting on a steeply inclined plane on the southeast side of the fold. Southwestward the Clinton in this fold shows at the surface only in a narrow discontinuous faulted band. It first appears in a small area in the gorge of the De Busk Branch northwest of East Stone Gap where its anticlinal character is shown. It next appears to the southwest as a long slender area which passes south of the Big Stone Gap reservoir and north of the cemetery. The latter area apparently expands into a wider lenticular area between two faults in and southwest of the town of Big Stone Gap, but the details of structure there cannot be determined because of lack of outcrops.

The other secondary anticlines appear to be minor folds of this order or tertiary anticlines on the northwest flanks of the larger secondary folds. One such anticline, which brings the Clinton to the surface in the hills south of the South Fork of Powell River between the towns of Big Stone Gap and East Stone Gap, is on the northwest flank of the Williams Cove anticline northeast of where that fold is overturned and faulted. Small narrow lenses of Genesee shale are inclosed in the closely compressed syncline between these two anticlines, one at the river's brink in South Big Stone Gap and another north of East Stone Gap. Another small anticline, one that brings the Clinton to the surface in the belt that passes through the Big Stone Gap public school grounds and the hill to the northeast, is on the northwest flank of the Butcher Creek anticline.

All of these secondary and tertiary folds are faulted and the faults appear to converge at the surface southwestward. In the vicinity of the town of Big Stone Gap the rocks in the lowland are so largely concealed by river gravel and soil that most of the details of the geology can not be observed and the faults are necessarily hypothetically drawn on the map.

The relations of these faults to the anticlines with which they are associated are not so clearly observable as are those in the overthrust block of the Williams Cove anticline, but some data are definitely determinable. In the most compressed parts of all these secondary anticlines the rocks on the northwest limb dip steeply northwest and the rocks on the southeast limb are in general cut off or concealed by overthrust faulting. Although the planes on which the faulting took place can not be actually seen, they are beyond doubt not flat overthrusts, like that associated with the Williams Cove anticline, but are apparently steeply inclined toward the northwest, approximately parallel to the beds in the associated anticlines. They probably resulted from closely compressed folds which broke in such a way that the Clinton formation and Clinch sandstone in the middle of the anticlines were thrust up steep fault planes on to younger beds on the southeast, in some places overriding tightly compressed synclines of soft Genesee shale. (See sections A to E, fig. 9.)

Although the direction of movement in these faulted folds is the reverse of that of the overthrust mass in the Williams Cove anticline, both structures were probably produced by the same compressive force. The force came from some remote source to the southeast and was transmitted through the rocks tangential to the earth's surface, or horizontally at any point. The intensity of the force gradually increased in the area until it reached a sufficient degree to cause the rocks to yield by folding and crumpling, the hard, rigid beds bending into great arches and troughs whose axes were at right angles to the direction of the force, and the softer, more yielding beds crumpling into minute folds between the harder beds. There are several beds exposed in the Powell Valley anticline that are sufficiently massive and resistant to transmit the tangential thrust that produced the folds. The Lee formation, the uppermost massive formation, is composed of three or more thick beds of very compact conglomeratic sandstone that are competent to carry such a stress. It is part of the cover of the deeper-seated rocks exposed in the heart of the anticline, and no doubt formed a broad

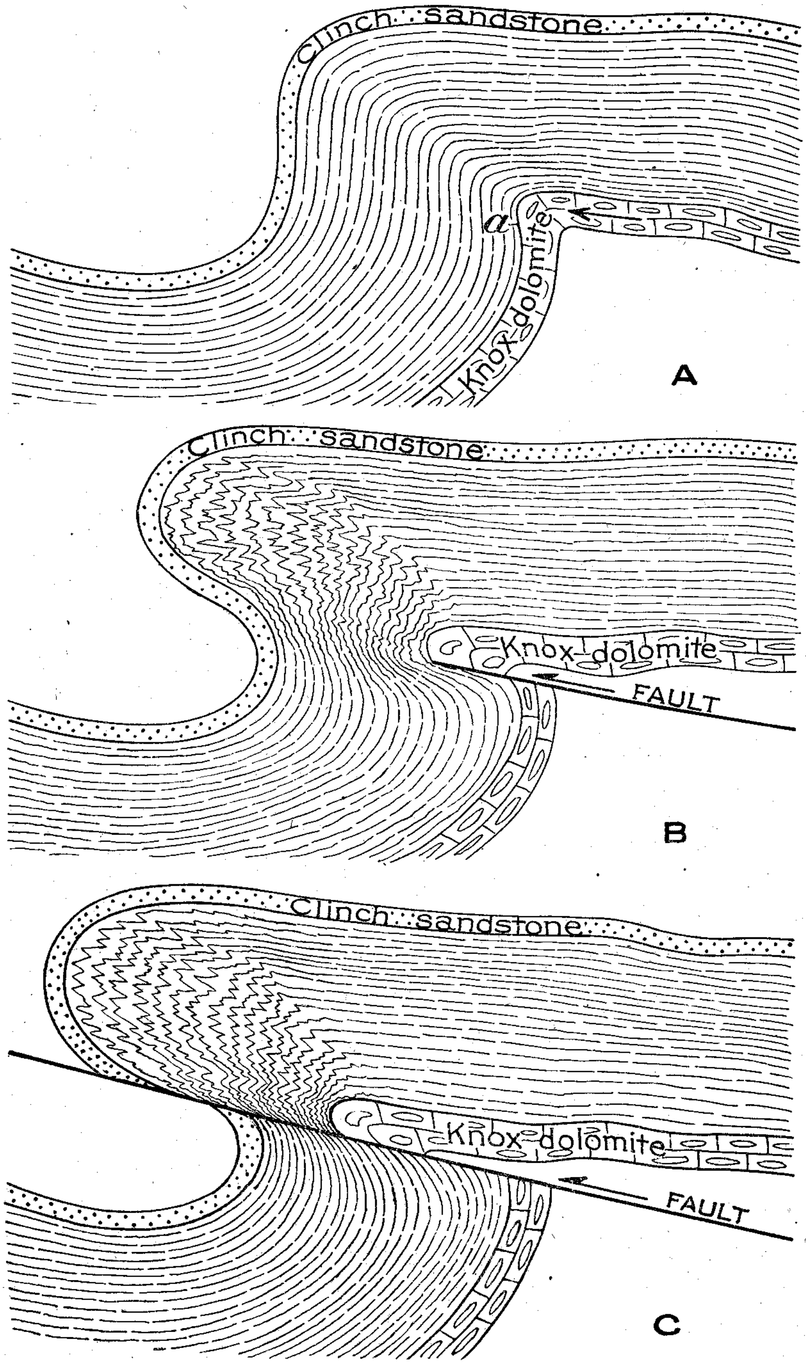


Fig. 8.—Progressive diagrammatic sections showing mode of overthrust faulting in the Williams Cove anticline.

A, first stage of folding, where the thrust acts as a shearing force at the point (a) in Knox dolomite. B, second stage, where the Knox dolomite has been sheared and the movement is taken up by crumpling of the overlying shales. C, third stage, where Clinch sandstone is greatly overturned and faulted by being torn apart.

arch over the whole anticlinorium which supported a great thickness of higher beds. As it did not partake of the intricate folding of the deeper-lying rocks its line of outcrop is regular. It was, however, probably broken through in some places by the thrust faults that emanted from the deeper-lying rocks.

The Clinch sandstone is the next lower resistant formation, and, although it is not so massive as the same formation in many other parts of the Appalachians, it comprises an aggregate thickness of 90 feet of quartzite, some beds of which are 10 feet thick. This formation underlies most of this part of Powell Valley and was probably the thrust bearer for most of the structures now exposed at the surface in Wise County. At the center of greatest uplift in Lee County are exposed still lower resistant rocks, massive Knox dolomite and overlying Ordovician limestones. They undoubtedly were the thrust bearer for this part of the anticline, as they were also for most of the other large folds of the Appalachians. In southern Wise County the Ordovician limestones are brought to the surface along the axis of the anticline and the Knox dolomite lies not much below the surface.

In the Williams Cove anticline the deeper-lying massive rocks—the Knox dolomite and associated Ordovician limestones—were raised so high that the plane of thrust along these beds on the southeast limb of the anticline passed above the next higher layer of resistant rocks—the Clinch sandstone—in the adjacent syncline to the northwest, and when the transverse breaking strength of the thrust-bearing Knox dolomite was exceeded, these hard rock layers broke at the point where the sharp downward bend caused the force to act as a shear across the beds. (See fig. 8 A.) Faulting of the Knox dolomite caused the overlying beds to yield by crumpling and bulged out the resistant Clinch sandstone until it was overturned nearly to an inverted position, forming a great recumbent loop. (See fig. 8 B.) The Clinch sandstone was stretched and drawn out in this process until its breaking strength was reached and then it also was faulted. (See fig. 8 C.) The stresses in the rocks due to the compressive force thus found relief in a marked forward movement of the overthrust mass, accompanied by the complete overturning of some of the beds.

To the northeast the massive Knox dolomite in the plunging fold was not so greatly uplifted and therefore did not break and give relief to the stresses in the rocks by faulting. Instead, the middle resistant layer—the Clinch sandstone—bore the thrust and was folded into several tightly compressed folds on the northwest side of the main anticline. Apparently the fact that one of the northwestern folds (the long middle finger) rose higher

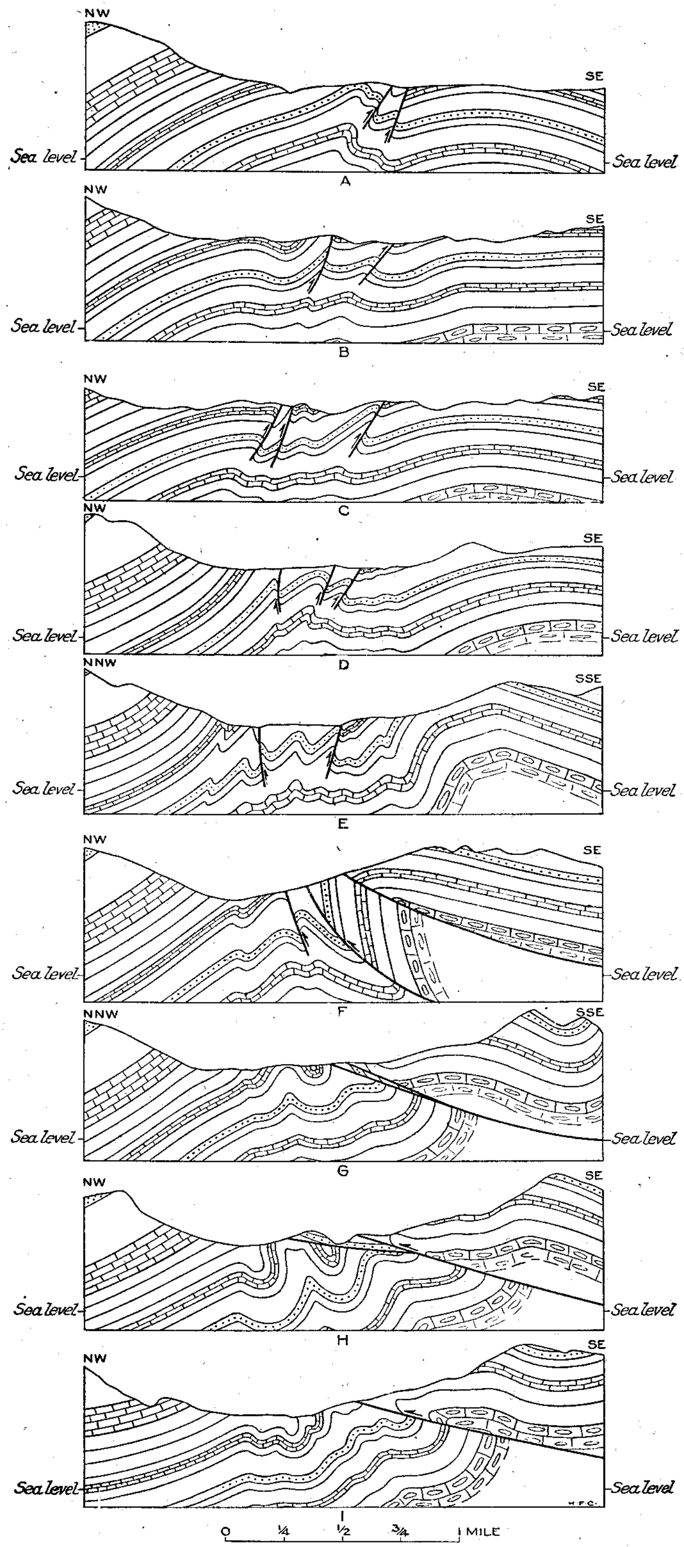


Fig. 9.—A series of structure sections at intervals across the Powell Valley anticlinorium, showing the change in form of the compound fold and the change in mode of faulting from minor steep upthrusts of Clinch sandstone from the northwest to nearly flat overthrust of deeper rocks from the southeast.

Section A, one mile southwest of Buffalo School; B, through East Stone Gap; C, one-half mile east of Big Stone Gap; D, through town of Big Stone Gap; E, through south edge of town; F, one mile southwest of town; G, through gorge of Williams Cove stream; H, through ridge south of gorge; I, through Elk Knob.

than the others, as is shown by the Clinch sandstone appearing at the present surface in the Butcher Creek anticline, caused the Clinch sandstone in that fold to act as a local elevated buttress. As the fold became closely compressed it was somewhat overturned toward the narrow, deep syncline to the southeast, in which Genesee shale is inclosed. The smaller adjacent anticlines were likewise influenced by this elevated buttress and were similarly slightly overturned toward the southeast. Further compression of these minor anticlines to the stage of breaking caused the Clinch and Clinton formations to be upthrust along steeply inclined fault planes against younger strata on the southeast. (See sections A to E, fig. 9.) Relief of pressure in this part of the anticlinorium was thus obtained by the general northwestward movement of the rocks and thus compacting into close faulted folds.

Middlesboro syncline.

The broad shallow trough that extends through northern Wise County in a northeast-southwest direction is called the Middlesboro syncline. This

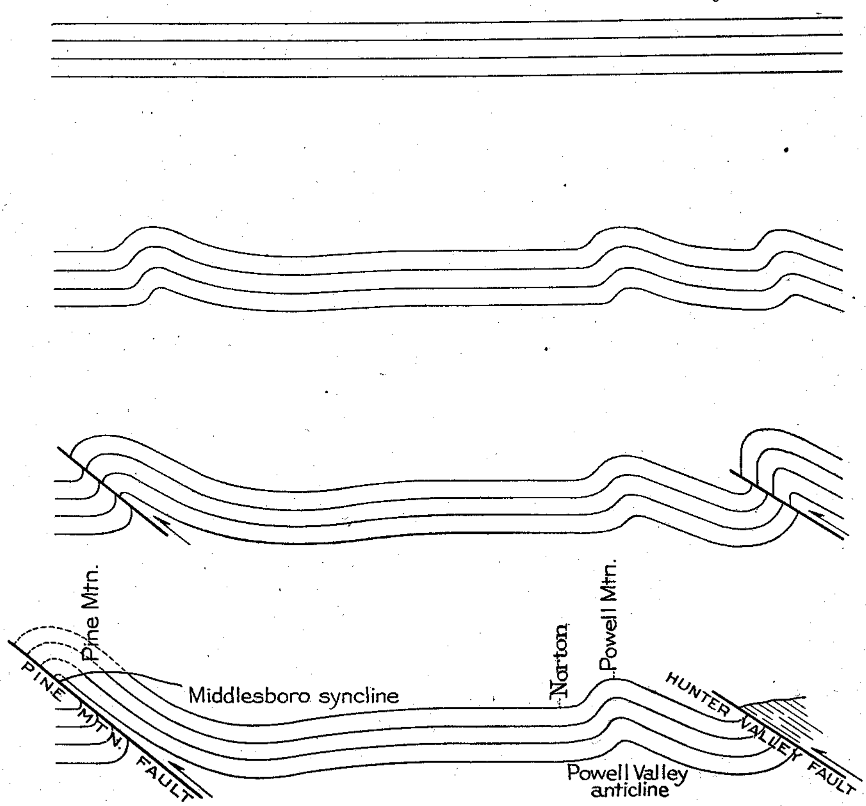


Fig. 10.—Serial diagram showing development of major folds and faults.

great trough has a width in the vicinity of Norton of about 14 miles and a length of about 140 miles, extending from the Breaks of Sandy to the southwestward far into Tennessee. It is a structural feature of great economic importance to Wise County as in it lie the thickest and purest coal beds of the Wise and Scott counties field, that elsewhere have been eroded away. It receives its name from Middlesboro, Kentucky, near Cumberland Gap, where the syncline is well developed.

In Wise County the Middlesboro syncline is unsymmetrical, the deepest part or the axis lying only a few miles southeast of Pine Mountain, and corresponding in a general way with the course of Pound River and the South Fork of Pound River. On acount of its unsymmetrical shape, the northwest side of the trough is considerably steeper than the southeast side, the rocks rising uniformly toward the high linear crest of Pine Mountain. The formation of the syncline was brought about by long continued and intense pressure from the southeast which bent the rocks into great folds similar to the folds produced in a pad of paper when pressed with great force from either side. The rocks on the southeast of the Middlesboro syncline were raised into a great arch known as the Powell Valley anticline and the rocks on the northwest into a similar arch which may be called the Pine Mountain anticline. Upon the continuation of the intense pressure as indicated by the arrow in Fig. 10 the arches broke and the southeast limbs of the anticline were thrust over and upon the northwest limbs. Since the folds were produced erosion has worn the rocks down until the relief is comparatively slight and the position of the folds are indicated by the hard rocks of Stone and Pine mountains. Along the crest of Pine Mountain the southeast dip of the rocks ranges from 20 to 40 degrees and in the Middlesboro syncline the dips range from zero at the axis to about 10 degrees near the foot of Pine Mountain.

West of Norton the Middlesboro syncline is quite definite being bounded on the northwest by the Pine Mountain faulted anticline and on the southeast by the Powell Valley anticline, but east of Norton the syncline grows broader and broader as the Powell Valley anticline dies out until near the east line of Wise County it extends entirely across the coal field from Pine Mountain on the northwest to the overturned rocks forming the southeast rim of the syncline in the vicinity of St. Paul. In this expanded part the axis still holds it position near the base of Pine Mountain and from this line the rocks rise gently but irregularly with many slight subordinate folds or wrinkles to the southeast margin of the field. The general relation of the Middlesboro syncline to the geologic structure of Wise and Scott counties is shown graphically in structure cross sections on Pl. II. In the Middlesboro syncline generally there is little disturbance of the rocks in the middle of the trough, the massive formations underlying the trough seem to have been competent to transmit the thrust that was not used up in producing the great fold of the Powell Valley anticline. In Wise County, however, this great fold began to die down and the thrusts that in other places had been relieved by the production of the big fold here found expression in a number of minor folds or wrinkles that extend nearly across the syncline in a north-south direction. In other words the northwestward thrust here has been resolved into two components, one producing the diminishing extension of the main fold in nearly an east-west direction, and the other, the north-south wrinkles, here being considered. In these folds the western limbs of the anticlines are usually steeper than the eastern limbs and in places, such as in the vicinity of Wise and Glamorgan, the western limb approaches verticality and the eastern limb is nearly flat.

Gladeville Anticline.

The most pronounced of the minor folds is one that branches from the main Powell Valley anticline just east of Ramsey. This fold was named by Campbell[1] the Gladeville anticline for the town of Gladeville (now Wise) which is located nearly on its crest. The Gladeville anticline is the sharpest fold in the rocks of the coal basins north of Powell Mountain and is the only fold in this region bringing to the surface the massive sandstone beds of the Lee formation. The anticline extends north as a protuberance on the flank of the great arch of the Powell Valley anticline. The up-folding of the Gladeville anticline has brought the thick conglomeratic "Bee Rock" of the Lee to the surface considerably north of its normal boundary at the north foot of Powell Mountain. This is well shown in the valley of Guest River, one-half mile east of Ramsey, where the river has been crowded far to the north by having slipped down the conical surface of the "Bee Rock."

The axis of the fold from ½ mile east of Ramsey where it enters the rocks of the coal basins, extends slightly west of north, crossing the Norton-Wise pike ½ mile west of Wise and thence due north through Glamorgan to Pound.

This fold where it branches off Powell Mountain is quite symmetrical, but further north it develops into a very unsymmetrical anticline with the steeper dips on the west limb of the fold and very slight dips on the east

[1] Op. cit.

limb. In fact the wrinkle in many places develops into a sharp monoclinal fold with little or no descent east of the axis, but a sharp dip on the west side into the Dorchester syncline. In another respect this fold is very peculiar, for its crest is marked in two places by very marked local elongate domes which carry the crest several hundred feet higher than it is either to the north or the south. One of these local domes, occurring directly west of Wise, is very striking for it is capped by the massive Gladeville sandstones and so makes a pronounced elevation in the surface. The dips on the west side of this dome are so sharp that a small stream heading a little north of the dome and joining Guest River at Esserville has cut through the massive Gladeville sandstone destroying the western half of the dome, as a surface feature.

North of the dome just mentioned the Gladeville anticline takes mainly the form of a monoclinal fold which passes through the coal-mining town of Glamorgan and across the divide about ½ mile to the north. On the north side of this divide another elongate dome has developed with dips of 20 to 50 degrees on either limb. This dome reaches its maximum development in Indian Gap, and north of that place dies down even more suddenly than it appeared at the other end. Here again the Gladeville sandstone is the principal rock of the dome, but in Indian Gap another and higher sandstone—the Addington member—forms the surface.

North of Indian Gap the Gladeville sandstone dips suddenly to the north at about the same rate as the surface slopes in the same direction and at the mouth of Tank Hollow it passes below creek level, but it is probable that at no place is it more than 10 feet below the bed of Indian Creek. From Tank Hollow to Lick Branch the Gladeville is at, or just below, creek level and the fold is a sharp monocline, though dying down in magnitude gradually toward the north. Below Lick Branch the Gladeville sandstone has been cut into by Indian Creek and the top of this massive bed is from zero to 50 feet above creek level.

The most striking features of the Gladeville anticline are the domes already described and the wonderful straightness of the axis for a distance of at least 12 miles. The writer is at a loss to explain the meaning of the sharp domes on this fold. Why the forces should be localized at these places is a question that is apparently unanswerable, as the surface rocks are no different here from what they are at other places, and there seems to be no compensating constrictions in the adjacent syncline on the west. The extreme straightness of the fold is also peculiar. South of Indian Gap the fold has had only a slight effect on the surface features, but north of the gap it has apparently determined the course of Indian Creek, which at once attracts the attention of one examining the map (Pl. 1), because of its straight course which is so different from the streams in adjacent territory.

Buck Knob Anticline.

A second pronounced anticline crosses the coal basin in a nearly north-south direction, the axis of the fold starting at the belt of upturned rocks at the mouth of Lick Branch of Powell River and running in slight curves north over the crest of Buck Knob and continuing across the forks of Pound River. This fold is called the Buck Knob anticline. The dips on the west side of the fold are steeper than those on the east side, and on the west side are considerably steeper on Black Creek than they are farther north on Upper Guest River or in the Pound River drainage basin. The form of the Buck Knob anticline is decidedly unsymmetrical, the greatest descent to the east or to the axis of Dorchester syncline being less than 500 feet, whereas the greatest descent to the west or to the axis of the Middlesboro syncline is more than 1,500 feet, considering only the rocks in Wise County. On the anticlinal axis north of Buck Knob the Imboden and Kelly coal beds are about 2,200 feet above the sea; on the Dorchester synclinal axis they are 2,000 feet, the eastward descent being 200 feet in 2 miles; on the Middlesboro axis west of Dewey the same beds are about 1,900 feet above sea level, giving a westward descent of 300 feet in about 2 miles. East and north of Dewey in the prolongation of the Buck Knob axis, the anticline flattens out rapidly.

Dorchester Syncline.

Between the Buck Knob anticline on the west and the Gladeville anticline on the east lies the Dorchester syncline, named for the town of Dorchester, through which the axis of the syncline passes. The syncline is a shallow trough with its axis running through Josephine in a general northerly direction to the south slope of Pine Mountain. It is unsymmetrical, the west side having gentle dips and the east side steeper dips, with very steep dips locally. At Glamorgan the westerly dip of the east limb is 10 degrees and ¾ miles north, at the intersection of the highway with the old tram-road it is 40 degrees. On the west side of Indian Creek, 5 miles above the mouth, the Clintwood coal and overlying Addington sandstone dip 10 degrees west. The synclinal axis crosses the Middlesboro synclinal axis 1½ miles southwest of Pound, making a structural depression more than 250 feet deep. The rocks rise rapidly to the north out of this depression and all vestige of the syncline is lost at the base of Pine Mountain.

Pigeon Creek Fault.

The contact of the upturned rocks with the horizontal rocks along the north face of Stone, Little Stone and Powell Mountains, from Blackwood east, is apparently a very abrupt but unbroken fold, and from the vicinity of Blackwood west, a fault ranging in displacement from nothing to a maximum at Big Stone Gap of about 1,500 feet. The trace of the fault coincides with the lower course of Pigeon Creek and as the fault here has its greatest displacement, it is called the Pigeon Creek fault. (See Fig. 11). Southwest from Big Stone Gap the fault gradually decreases in throw to the Lee County line where no fault could be detected. A fault at the same relative position as the Pigeon Creek break begins a short distance west of the Olinger Gap road in Lee County and continues beyond Pennington Gap. Although the faults are in line they do not join, and the one in Lee County has been called the North Fork fault.[1]

The Pigeon Creek fault was first recognized by Campbell as stated on page 79, but he thought the fault was limited to the vicinity of Big Stone Gap and was of slight stratigraphic displacement. It is now known that the maximum stratigraphic displacement of this fault is about 1,500 feet, and hence it is no wonder that in the days of the early development of this field, the geologists, with no conception of a fault at the upper end of Big Stone Gap, should have arrived at a totally erroneous idea of the magnitude of the interval between the "Bee Rock" and the Imboden coal bed. The key to the whole situation is revealed, however, when one sees the Gladeville sandstone disappear below drainage level at Blackwood and reappear only on Laurel Fork of Pigeon Creek. He then begins to realize that the break is of considerable magnitude and is a most important feature of the geology of the coal field.

The presence of the Pigeon Creek fault, as shown on the geologic map, Pl. II, has been established beyond question, but the exact mthod of its formation may be regarded as still a matter of doubt. Every geologist who has worked in this coal field has been impressed with the great amount of crumpling, crushing, and slipping on bedding planes that has taken place in the disturbed belt at the northwest foot of Stone Mountain, but in such a place it is difficult to recognize faults. The writer doubtless would not have been able to do so at the present time were it not for the logs of diamond drill holes and other exact data that are available.

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[1] Giles, Albert W., The Geology and Coal Resources of the coal-bearing portions of Lee County, Virginia. Unpublished manuscript.

The key to the explanation of the method of faulting was found in a comparatively recent deep cut on the Interstate Railroad in the vicinity of Blackwood. A general view of the cut is shown in Pl. XXI and a detailed view of a part of the cut is shown in Pl. XXII A. So far as known there is no fault of any considerable amount of displacement at Blackwood, the fault evidently developing southwestward from this place and the condition shown in Pl. XXI should be regarded only as an incipient fault, indicating the possible method of formation of the larger fault to the southwest.

In Pl. XXI the relation of the upturned bed to the undisturbed beds is well shown. It is plainly apparent that in the upturning of the beds on the right the bed of sandstone lying horizontally on the left has served as a buttress against which the other beds were thrust and crushed. It also shows that the part of the sandstone bed that was partly upturned was badly crushed, although probably more resistant than the adjacent shale and coal beds, and that instead of bending in response to the thrust it was crushed and offset to the left. The offset or fault is more clearly shown in Pl. XXII (A). The writer believes that the buttress effect of the horizontal beds in the Middlesboro syncline is the key to the interpretation of this fault. In accordance with this idea he has prepared Fig. 11 in an attempt to show how the fault may have been produced, but as no one diagram can correctly represent the conditions of faulting, slipping on bedding planes, and mashing, Fig. 11 must be regarded only as suggesting rather than representing, the actual origination of the fault.

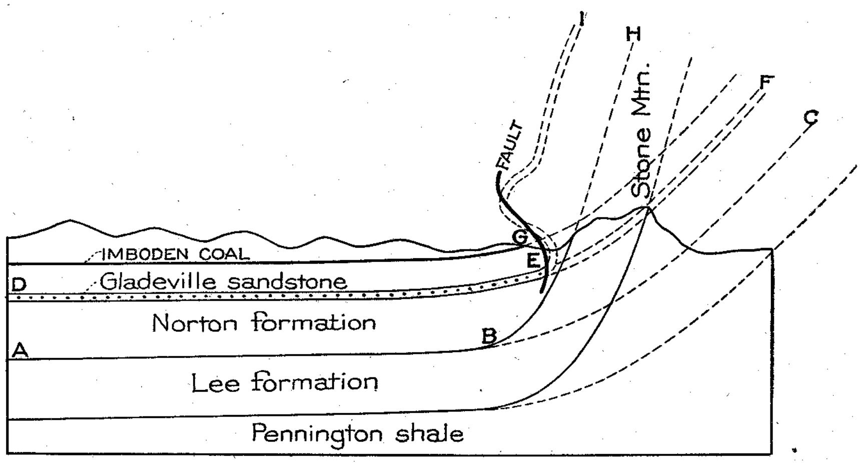


Fig. 11.—Structure section across Pigeon Creek fault.

In Fig. 11, A B C represents an assumed position of the top of the Lee formation before a fault had developed. D E F represents the Gladeville sandstone, and the heavy line above, the Imboden coal bed. In the further development of the great anticline on the right—(Powell Valley anticline)—the Lee formation was bent abruptly at B and in the relatively soft rocks of the Norton and Wise formations overlying it, there was a great amount of crumpling, crushing, faulting, and slipping on the bedding planes to accommodate the formations to the reduced arc of the curve. In this crushing the nearly flat-lying beds in the bottom of the Middlesboro syncline served as a buttress against which the crushing and crumpling took place (see Plates XXI and XXII (A)). Thus the Gladeville sandstone (D, Fig. 11) being the most resistant of the formations above the Lee received the brunt of the thrust. As it was not closely confined by a great mass of relatively weak material, it early broke at E and then as the Lee formation was crowded farther and farther toward the northwest the beds of the Norton formation were almost squeezed out between the advancing resistant plate of the "Bee Rock" and the resistant and practically immovable horizontal plate of the Gladeville sandstone. The effect was the same as though the Gladeville sandstone had been underthrust against the flank of the rising arch and a "crush fault"[1] was produced.

That part of the Gladeville sandstone which lay on the flank of the arch had in the meantime to adjust itself to a shorter arc and it is assumed that this adjustment was made by a minor sigmoid curve as shown in fig. 11, but as the Gladeville is a hard, brittle stratum in the midst of much softer rocks, it is probable that instead of bending in a regular curve it was broken into blocks which adjusted themselves roughly to the form indicated in figure 11. The net result of the adjustment of the various beds is a crush fault zone about as indicated in fig. 11, the fault dying out at each extremity in movement along bedding planes.

The amount of stratigraphic displacement is determined by the relation of the Gladeville sandstone to the "Bee Rock" of the Lee formation at the point E. As indicated in the diagram the Norton formation has been practically crushed out at this point and as that formation has a thickness of about 1,425 feet, the stratigraphic displacement is about the same amount, but being different at different places along the trace of the fault.

The explanation of the origin of this fault seems to be more nearly in accord with the observed facts than any yet suggested, but it is put forward

[1] A term suggested by M. R. Campbell.

by the writer in a tentative way only, with the hope that geologists having experience with similar structures may analyze it carefully and if it appears to them unsatisfactory, to suggest other modes of origin or modifications of this method. This fault is of the overthrust variety as the older rocks on the southeast side of the break have been thrust against and even upon the younger rocks on the northwest side of the break. Although this fault has some of the characteristics of the great overthrust faults for which the Appalachian region is noted, it apparently has not developed from an overturned fold as is generally the case with faults of this kind.

Hunter Valley fault.

When the coal-bearing rocks were formed they extended much farther to the southeast than they do today, but the parts east of the present coal field were lifted so high by the forces that produced the great folds and faults that they have been eroded and have left little or no trace of their former extent in this direction. As shown in Fig. 10 the present coal field was originally bounded on the southeast by a great anticline, which under the continued pressure from the southeast, finally broke and the rocks on the southeast side of the break were shoved forward and upward a great distance, probably many miles, until the limestones of Clinch Valley now rest on top of the coal-bearing rocks. The rocks forming the syncline to the northwest of the fault were so greatly thrust from the southeast that the southeastern limb of the fold was overturned until now the Lee formation back of St. Paul is completely overturned and it is little wonder that Lesley thought that it was the same bed as the Gladeville sandstone.

The course of the profound break, cutting off sharply the coal-bearing rocks of Wise and Scott counties at the south foot of Powell Mountain, conforms in general with Hunter Valley, from whence it receives its name. The fault zone is one of the most extensive in the Appalachian province, having a length of 370 miles and a stratigraphic displacement in eastern Wise County of 15,000 feet. The fault zone extends from near Rome, Georgia, to New River, Virginia, and is the southeastern limit of all known coal measures of Pennsylvania age.

The overturned rocks adjoining and lying northwest of the fault zone generally involve hard beds and form ridges which mark the margin of the coal field throughout Scott and Wise counties. Commonly the coal beds in these upturned rocks are so badly disturbed and crushed that they can not be profitably mined, but in places mines have been opened and considerable coal produced.

At Burtons Ford (Russell County) coal is now being mined from an overturned coal bed beneath an over-burden of Cambrian limestone. Such overturning is evidence of the great thrust from the southeast that at one time must have developed in this field. The magnitude of the Hunter Valley fault decreases towards the southwest and Mississippian rocks are exposed between the Cambrian and Pennsylvanian beds west of St. Paul. West of Dry Creek of Clinch River, Devonian beds are exposed continuously as far as Stony Creek; here the Devonian rocks are bounded by faults on the north and south sides of their outcrop, and a transverse break cuts off their westward extension. Southwest of Stony Creek the Hunter Valley fault is a single clean-cut fracture bringing the massive Cambrian limestone in contact with the Pennington shale. West of Cove Creek a small block of Big Stone Gap shale is faulted up between the limetsone and Pennington shale. The main fault passes southwest through Horton Summit or Sunbright into the non-coal-bearing portion of Virginia. The Newman formation which is widely exposed north of the fault at Sunbright, is the lowest formation shown on the map north of Hunter Valley fault. The fault is represented throughout its entire extent in this field.

Pine Mountain fault.

The great anticlinal fold which originally developed along the present Pine Mountain, as shown in Fig. 10, was affected by the thrust from the southeast transmitted through the flat-lying rocks of the Middlesboro syncline. The first effect was to push the fold over toward the northwest and then when the rocks could no longer withstand the pressure to break along the overturned limb. This breaking relieved the rocks of the intense stress and the whole Middlesboro syncline was doubtless thrust far over the nearly horizontal coal-bearing rocks of Kentucky.[1] The fold and the fault are shown diagrammatically in Fig. 10 and accurately in the cross-section on the margin of the geologic map, Pl. II.

The Pine Mountain fault took place in a straight line paralleling and lying about ½ mile northwest of the crest of Pine Mountain. As the State line follows the crest of the mountain the fault does not at any point

[1] For a more extended consideration of the mechanics of faulting in this region the reader is referred to a chapter on the "Russell Fork fault," by Chester K. Wentworth, Geology and coal resources of Dickenson County, Virginia, Va. Geol. Survey Bull. XXI, pp. 53-67, 1921. *Idem*, Jour. of Geol., vol. 29, No. 4, pp. 351-9, 1921.

enter Wise County. The far-reaching effects of this break, however, in the rocks of Wise County connects it intimately with the geology of this field and hence the fault will be described somewhat in detail.

According to recent work by Butts and Keith the fault is compound in places, breaks having occurred on two or more planes that are close together everywhere and joined in some localities. The breaks for purposes of description may be considered as having occurred at different times. By the earlier break the Lee conglomerate, extending from Jewell, Kentucky, southwestward along the mountain front, was thrust into contact with rocks about 2,400 feet higher than the top of the Lee. Later another break occurred along which the displacement varies; west of Pound Gap road the Mississippian is in contact with the wedge brought up by the earlier fault; north of Indian Grove Gap the fault brings Devonian black shale in contact with the Lee formation; and farther to the northeast the movement was so great that the upper 800 feet or so of the black shale has been thrust over the earlier fault plane and is in contact with Pennsylvanian rocks, the total displacement here being about 4,900 feet.

The two great breaks—the Pine Mountain and Hunter Valley faults,—are respectively, the northwest and the southeast faults bounding two sides of the "Cumberland block" as described by Wentworth.[1] The formation of these folds and faults has resulted in the lifting and loss of great areas of coal-bearing rocks. How far the coal fields originally extended southeast of the Hunter Valley fault is not known, and there is no means of determining the vast amount of coal lost by erosion following the thrusting up of the coal-bearing rocks over the plane of the Pine Mountain fault. No geological phenomena have so profoundly modified the coal fields of southwest Virginia as the thrusts which produced these great folds and faults.

[1] Loc. cit.

ECONOMIC GEOLOGY

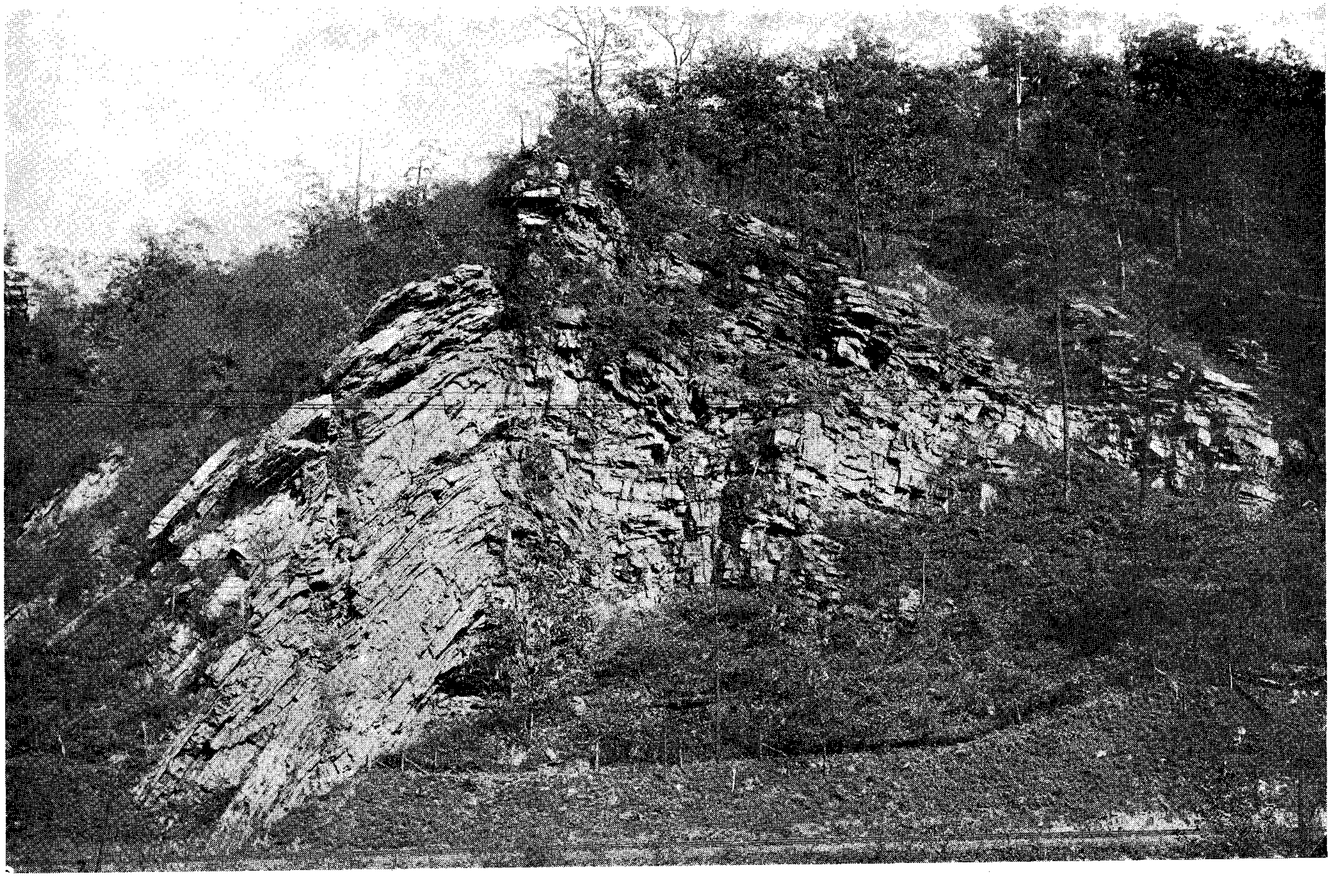
GENERAL DESCRIPTION OF COAL BEDS.

INTRODUCTION.

The total thickness of coal-bearing formations in Wise and Scott counties ranges from 4,800 to 5,570 feet, every portion of which is exposed in either one or the other or both of the counties. At least 26 coal beds, 30 inches or more thick, consisting of high-grade bituminous coal, occur in these formations in sufficient acreage to justify mining. Of the 26 beds 23 outcrop in Wise County and 3 in Scott County. Thinner coal beds occur in scattered localities in the field and there are at least five beds in addition to the 26 major coals that are locally thick enough to mine to advantage at the present time. In general, however, these thinner beds can not be profitably mined until the thicker beds have been exhausted and the demand for coal is greatly increased. The total tonnage of coal now found in beds that are workable under present conditions and in thinner beds that will be minable in the future, is enormous as indicated in the tables on later pages of this report.

The physical features of the coal beds of Wise and Scott counties, as of nearly all the beds in southwest Virginia, are so different in different districts that no bed can be identified throughout its entire extent, or even in small areas, by means of these features alone. The beds vary in thickness, character and size of partings, floor and roof, and to a certain extent in character and quality of coal. One marked exception to this general statement is found in the Upper Banner bed in Wise County which has a persistent thin sandstone parting that occurs throughout many square miles of the coal field. In prospecting the bed was largely identified by means of this parting. To a lesser extent the Imboden coal bed of western Wise County can often be distinguished from higher beds by the presence of zones of crushed or "curly" coal.

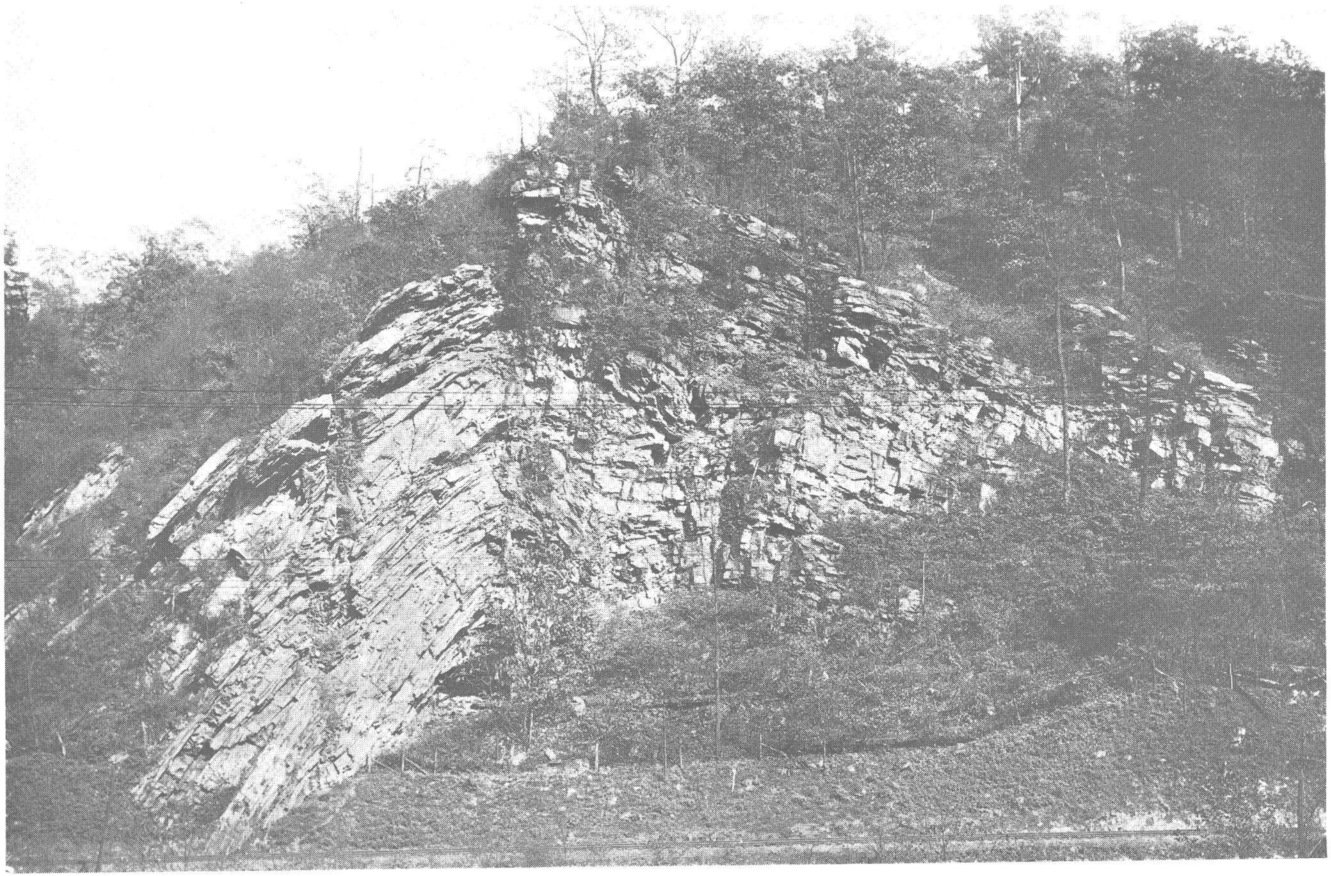
In addition to making use of the physical features of the coal, the outcrop of coal beds can often be traced by seeps or springs of water at the surface where the natural outcrop of the bed is hidden by surface soil; or by tracing adjacent distinctive strata, such as an overlying or underlying prominent sandstone. The thickness and character of the bed can then be fully



MINOR FOLD IN SANDSTONE OF THE LEE FORMATION ON EAST SIDE OF BIG STONE GAP.

The regional dip of the rocks in Little Stone Mountain is 70 degrees north, which is that of the steeper side of the anticline shown above. The southward-dipping limb of the anticline is terminated just beyond the limits of the photograph where the beds are upturned. The bed involved in the fold is the first sandstone in the Lee below the "Bee Rock."

Photo by G. D. Jenkins.



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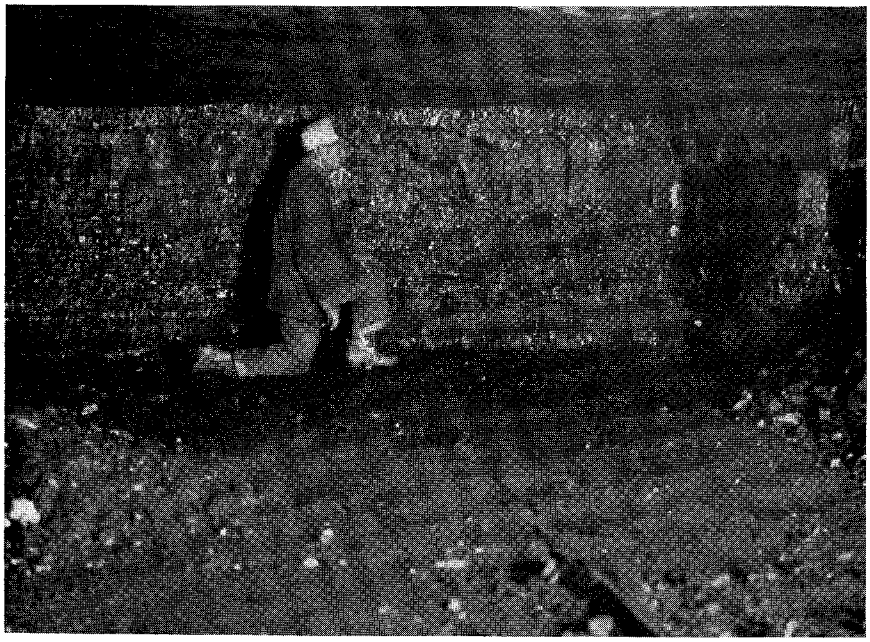

(A) Mining face of coal in a mine, showing thickness and well-developed cleavage of coal and solid roof which needs no sustaining timbers. This is a representative thickness of the coal beds now being mined in the county.

(B) View in a room of a mine showing loaded car and miner. The car is low, being adapted to a bed of coal 2½ to 4½ feet thick. In thicker beds the cars have higher sides.

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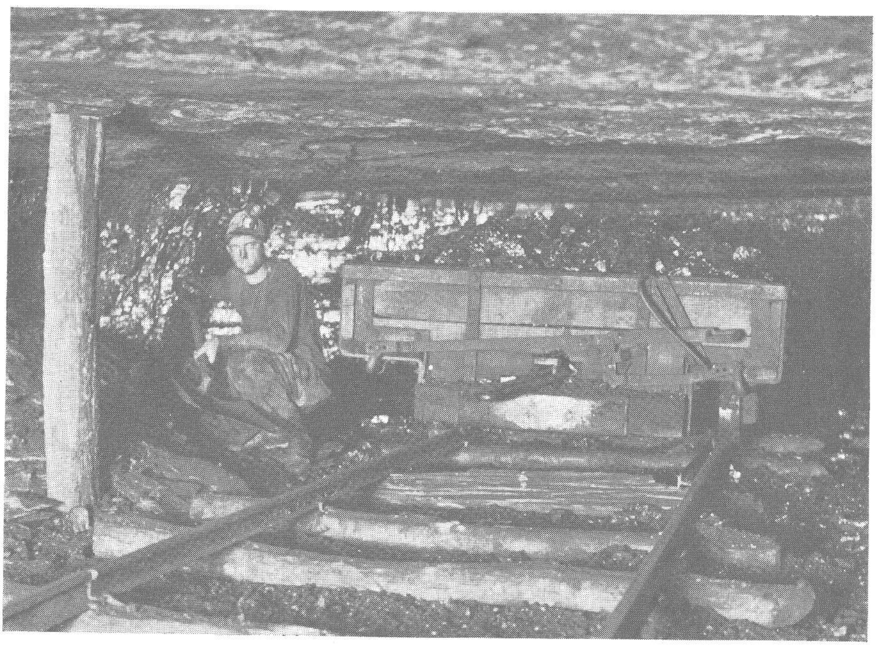


(B) View in a room of a mine showing loaded car and miner. The car is low, being adapted to a bed of coal 2½ to 4½ feet thick. In thicker beds the cars have higher sides.

determined by a carefully dug pit into the fresh coal. Drill holes can be put down in the valleys to explore the beds that do not outcrop in the ridges. The workable coal beds of Wise County are prospected by surface pits over fully 80 per cent of the county, disclosing invaluable information for anyone now seeking, or who will seek in the future, to exploit these beds. Through the courtesy of the prospecting agencies, practically all of this information was available and is incorporated in the following divisions of this report.

The impurities most generally present in coal beds are shale, hard clay, bone, "rash," and sandstone. "Bone" is a term that in the field was found to have a variety of local uses. As used in this report it means a layer of hard impure coal which in places grades uniformly into the adjacent soft clear coal and in other places is sharply separated from it. Bone is due to the presence of a considerable number of well distributed clay particles. "Rash" is an intimate admixture of coal and shale, formed in most cases by a differential movement of adjoining coal and shale beds, with a consequent crushing, "flaking", and mixing of coal and shale. The "flakes" of coal and shale in many places show slickensided surfaces. "Laminated" coal is composed of very thin alternating layers of shale or bone and coal, or of thin alternating layers of different quality coal, such as hard and soft or bright and dull coal.

Partings range in thickness from a fraction of an inch to several feet. Where partings exceed two feet it is seldom that more than one bench of the bed is recovered and the coal bed is said to be "split". A typical example of splitting of a coal bed occurs at Glamorgan, as described on page 312. The floor of most mines and prospect drifts consists of a hard gray sandy clay, and the roof, in the majority of cases, is a firm shale or sandstone. In many instances a thin layer of shale occurs between the top of the coal bed and the solid roof, called "draw slate." This must either be removed or timbered in place in mining the coal bed beneath. Failure on the part of the miner to detect the presence of "draw slate" may result in serious accidents from falling roof. The character of a mine roof is rarely constant, even throughout small areas, and hence it is impractical to predict the type of roof likely to be encountered in new operations.

The minable coal beds of Wise County now exposed at the surface range from younger to older in a west to east direction. Thus the valuable Pardee bed on Roaring Fork is more than 3,000 feet stratigraphically above the Jawbone bed on Russell Creek, whereas the Norton and Dorchester coal beds of central Wise County lie nearly midway between the two beds at the extremes of the geologic column of the Norton and Wise formations. The occurrence of the successively older coal beds from west to east is brought about by the general northwesterly dip prevalent throughout much of Wise County. The tendency of the lower beds to thin and deteriorate toward the west and northwest is a notable characteristic of the Wise County field. The Jawbone, Upper Banner, Norton and Dorchester are among the best examples of beds thinning towards the west.

The thicknesses of coal beds, the intervals between them, and the detailed description of the various beds where opened by mines or prospects, appear in a later section of this report and only brief summaries of the features of the larger beds will be given here. Maximum and minimum intervals between beds in different parts of the field are shown in the generalized section in Fig. 4. Measured intervals are given in local sections (pp. 87-107) and in the detailed description of basins.

The coal beds of the Lee formation are fully described in general and detailed characteristics in a later section of this report (pp. 463-493). The general features of the chief beds in the Norton and Wise formations are given in ascending order below.

Coal beds in the Norton formation.

TILLER COAL BED.

The lowest coal bed of much commercial importance in the Norton formation is the Tiller bed, which lies about 200 to 300 feet above the top of the Lee formation. The bed outcrops in workable thickness only on Russell Creek, on the Left Fork of Lick Creek and on Bull Run in eastern Wise County. The bed lies beneath the Jawbone, the interval ranging from a few inches to over 100 feet, with sandstone usually forming the intervening material.

The Tiller bed makes its best showing on Russell Creek and the Left Fork of Lick Creek, where it unites with the Jawbone to form a 9-foot bed. The two coal beds here go by the name Jawbone. On Bull Run, a bed of coal that is questionably referred to the Tiller is a bed of clear coal 5 feet thick. As the Tiller coal bed is so intimately associated with the Jawbone and so few openings have been seen on the Tiller bed, where it is separated from the Jawbone, the outcrop of the lower bed is not indicated on the geologic map.

The name Tiller was first applied by Stone[1] to the thick coal bed on Upper Indian Creek of Buchanan County. The upper part of this bed is

[1] Stone, R. W., Coal Resources of the Russell Fork basin in Kentucky and Virginia: U. S. Geol. Survey Bull. 348, 1908, p. 92.

now known to be the equivalent of the Jawbone, and the name Tiller is therefore restricted exclusively to the lower bench or bed. Hinds[1] suggests the correlation of the Tiller bed with the Lower Iaeger of the West Virginia Geological Survey.

JAWBONE COAL BED.

The coal bed overlying the sandstone above the Tiller bed is persistent throughout all eastern Wise County and is named the Jawbone bed, from Jawbone Hollow, a branch of Bull Run (see fig. 12). The interval between the Jawbone and the Raven bed, above it, is 175 to 200 feet, and is fairly constant.

The Jawbone bed ranges in thickness from 4 to 10 feet. Wherever the Tiller unites with the Jawbone to form a 10-foot bed, the resulting double bed will be called Jawbone for simplicity of nomenclature and the impracticability of separating the beds. Strictly speaking, therefore, it may be said the Jawbone proper, as shown by sections measured on Bull Run, where the Tiller is undoubtedly absent, ranges only from 4 to 6 feet. At Virginia City on Russell Creek the Jawbone bed ranges from 4½ to 5 feet thick. It is exposed in the upturned rocks along the south side of the field from a little east of Virginia City to the Russell County line. As exposed in the Ac Gose mine on Left Fork of Lick Creek the bed shows 9 feet of clear coal in one section, and a small nearly middle parting in another section. If the small parting near the middle of the bed indicates the line of separation between the Jawbone and Tiller beds, the Jawbone proper is about 4 feet thick at this locality. West of Craborchard Branch of Guest River the bed is thin and so parted as to be worthless. The bed south of Coeburn and west of Craborchard Branch outcrops practically at river (Guest River) level, and is of little value.

Many samples of the Jawbone were collected for analysis and the results are given in the table of coal analyses, all of which show an ash content from 15 to 19 per cent (pp. 508-509). This ash content is due to the presence of numerous bony streaks in the bed.

The Jawbone bed has been traced by its outcrop into Dickenson, Russell, Tazewell, and Buchanan counties, where it is found to be a persistent bed and usually workable. It is correlated by Harnsberger with the Iaeger bed of the West Virginia Geological Survey.

[1] Hinds, Henry, Geology and coal resources of Buchanan County, Va.; Virginia Geol. Survey Bull. XVII, 1918, p. 64.

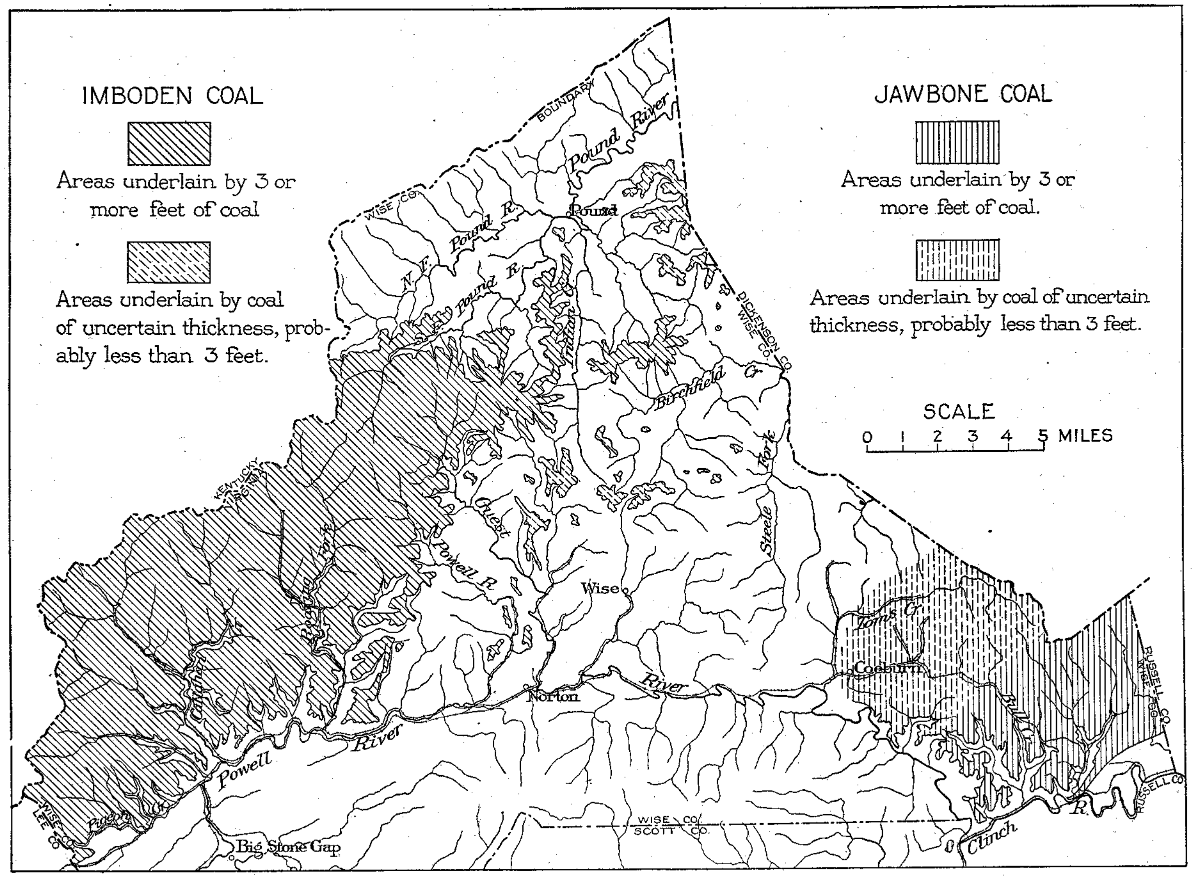


Fig. 12.—Sketch map of Wise County showing areas in which the Jawbone and Imboden coal beds contain 3 feet or more of minable coal.

RAVEN COAL BED.

The Raven coal bed is about 475 feet above the top of the Lee formation and from 175 to 200 feet above the Jawbone coal bed (see fig. 13). The bed was first called "Garden Hole" from exposures of the coal bed at the Garden Hole on Russell Fork. In the early years of mining in Wise County the Raven bed at Tacoma was correlated with the Imboden coal bed on Callahan Creek. The correlation was quickly disproved, but the term "so-called Imboden" still remains and is often applied to the Raven in that section of the field. The name Raven was given to the bed in Tazewell County, where it has been mined for many years at Red Ash, near the town of Raven. This bed is the same as the Lower Douglas coal bed of the West Virginia Geological Survey.

The Raven coal bed has an average section of 3½ feet of coal, with 3 inches of parting on Russell Creek. The bed in the extreme eastern part of Wise County is shaly in places, to the extent of not being minable, hence it is of little present commercial value. The Twin City mine near St. Paul is in the Raven bed which shows 3½ feet of coal, as the average section. The bed is worked to a small extent on Bull Run, where it contains not to exceed 2½ feet of coal. From Tacoma to Coeburn it is variable in thickness and character. At Tacoma the coal is 3 feet thick, split by 1 foot of clay and "rash." The coal is not uniform within the bed, showing zones of hard and soft coal, although the quality of the coal does not seem to be altered by zonal induration. Towards Coeburn the bed increases to more than 4 feet in thickness. South and southeast of Coeburn the bed is impure and of doubtful value. A massive, thin-bedded sandstone that outcrops 10 to 20 feet below the bed is found throughout much of eastern Wise County and has been of much assistance in tracing the outcrop of the coal bed.

KENNEDY COAL BED.

No coal beds of workable thickness are found in the interval between the Raven bed and the Kennedy bed. The Kennedy coal bed, or, as sometimes locally called, "Widow Kennedy," is 150 to 170 feet above the Raven in the vicinity of Tacoma and from 200 to 280 feet above the Raven on Russell Creek and Left Fork (see fig. 14). The interval between them on Little Toms Creek reaches the minimum thickness of 150 feet. A thick sandstone, sparingly conglomeratic, called the McClure sandstone, one of the few prominent sandstones in the lower part of the Norton formation,

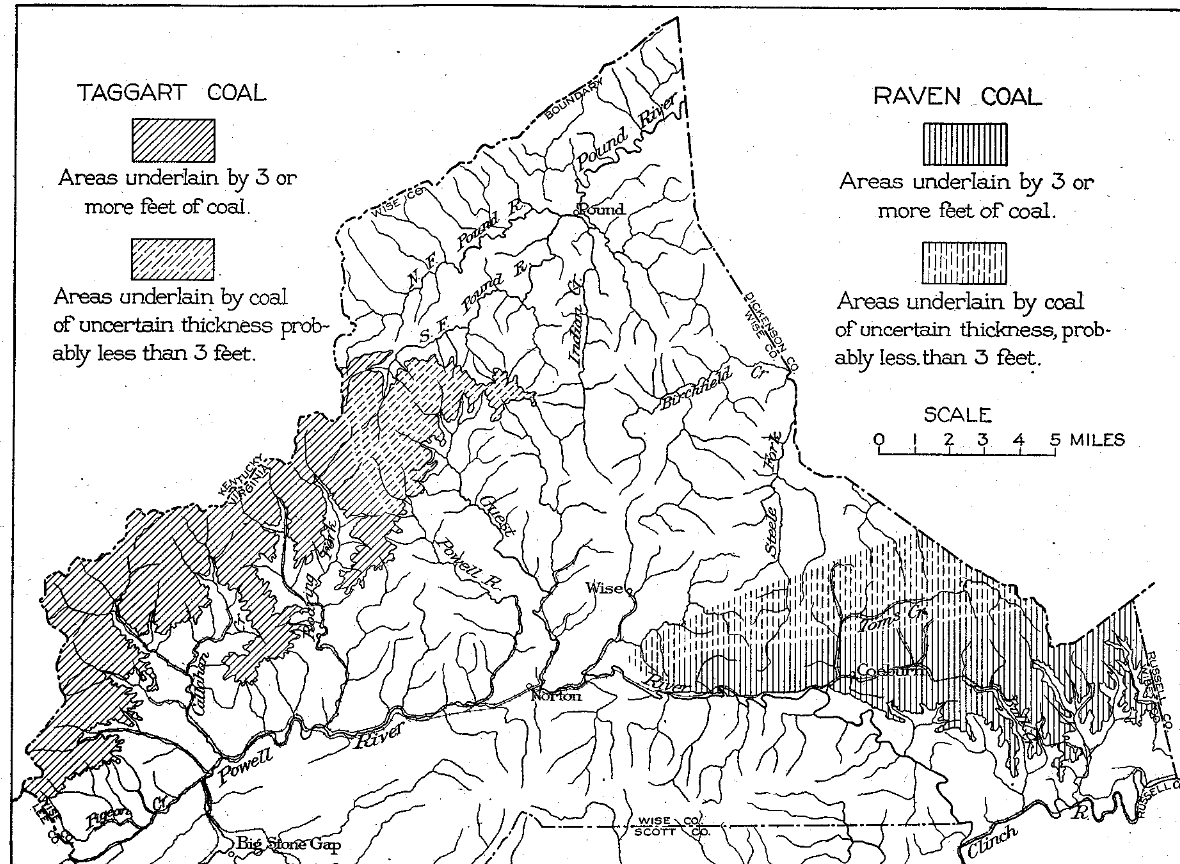


Fig. 13.—Sketch map of Wise County showing areas in which the Raven and Taggart coal beds contain 3 feet or more of minable coal.

lies beneath the Kennedy coal bed. The Kennedy coal bed is the same as the Douglas bed of the West Virginia Geological Survey.

Throughout much of its extent in eastern Wise County (see fig. 14) the Kennedy bed consists of crushed, laminated coal; a characteristic feature of the bed in the Virginia coal-bearing counties to the Northeast. It has a long circuitous outcrop in eastern Wise County occurring low in the ridges and running from the noses of the spurs to the heads of the many long valleys. However, whereas the bed is readily accessible, it is not of sufficient thickness or excellence to enable it to compete with the higher and better coal beds, with the result that the bed is now being mined at only a few places. The average thickness of the bed at Tacoma is 2½ feet of clear coal. Near Coeburn, in the mine of the Standard Coal Company, the bed is 44 inches thick and without a parting. It is uniformly overlain in this vicinity and towards Tacoma by a 15-foot bed of sandstone. East of Coeburn the Kennedy ranges from 2 to 4 feet thick, usually consisting of laminated or "rashy" coal. The bed in workable thickness is reported to have been recently opened on Meade Creek, a branch of Russell Creek. It is undoubtedly workable throughout the larger part of eastern Wise County, but it can not rank in importance with the Upper Banner bed.

LOWER BANNER COAL BED.

The Lower Banner coal bed is one of the most uniform beds in eastern Wise County, ranging from 30 to 45 inches in thickness, without partings (see fig. 15). In the neighborhood of Tacoma it is 180 feet and on Russell Creek 200 to 225 feet above the Kennedy. At Banner, on Little Toms Creek, the type locality of the two Banner coals, the lower bed is only 100 feet above the Kennedy bed. The Lower Banner bed is supposed to be the same as the Silbert bed of the West Virginia Geological Survey.

There are several mines operating in the Kennedy bed near Tacoma, where it is 40 to 50 inches thick and without partings. The bed is featured by zones of hard and soft coal, of good bituminous rank. In a mine at Coeburn the Lower Banner shows 52 inches of coal with 2 inches of parting. On Little Toms Creek the bed is thinner and more parted. At the Robert Fleming mine N. 1 at Banner the bed is 2½ feet thick. The Lower Banner bed is thicker at Pine on Bull Run, showing 5 feet of coal. To the east, however, it thins and is but little more than 2 feet thick in the Russell Creek drainage basin. The areas in Wise County underlain by workable Lower Banner coal are graphically shown in figure 15.

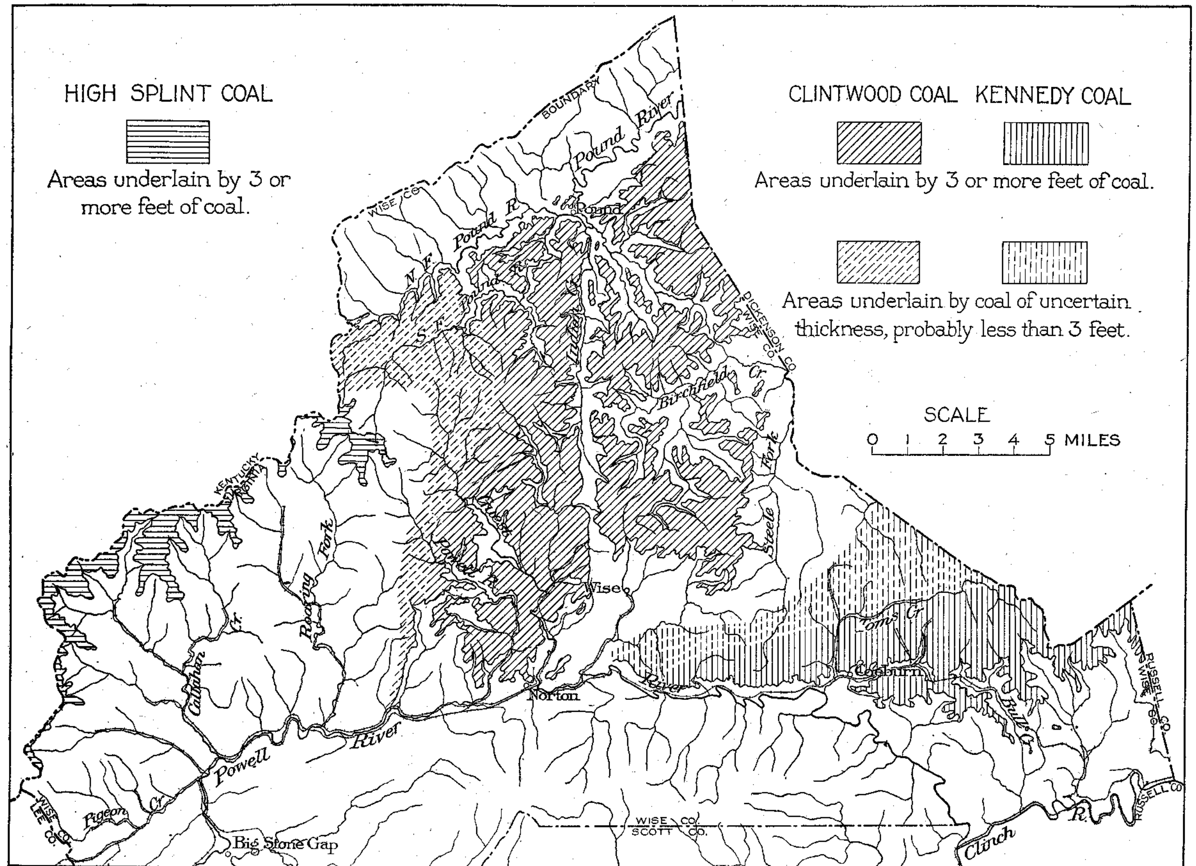


Fig. 14.—Sketch map of Wise County showing areas in which the Kennedy, Clintwood and High Splint coal beds contain 3 feet or more of minable coal.

Analyses of Lower Banner coal samples, collected in Wise County mines, are given on page 510.

UPPER BANNER COAL BED.

One of the best known and most important coal beds in southwest Virginia is the Upper Banner bed (see fig. 16). It is mined extensively at Toms Creek, Banner and Pine in Wise County, and at Dante and Wilder in Russell County. The bed is 1,050 feet above the top of the Lee formation 400 to 425 feet below the base of the Gladeville sandstone, and, in general, is 150 feet above the Lower Banner coal bed. Locally, a bed of coarse-grained sandstone outcrops about 20 feet above the bed, but in Sandy Ridge and its spurs a massive, ledge-making sandstone lies 160 feet above the coal bed.

The Upper Banner coal bed makes its best showing in Sandy Ridge. West from Tacoma the bed rapidly splits into thin and worthless benches. East of Tacoma, throughout the Toms and Little Toms creeks basin, the Cranesnest River basin, and the head of the Bull Run basin, the bed ranges up to and in places more than 8 feet in thickness, with an average of 6 inches of partings. Its average thickness is about 6 feet. The bed is thickest in Sandy Ridge north of Toms Creek postoffice, or 2 miles north of Coeburn. In this locality it averages 7 feet in thickness. In the ridge dividing Steele and Trace forks from Guest River drainage the bed is considerably thinner, ranging up to 4½ feet thick. Throughout much of its extent the Upper Banner is parted usually near the middle by a characteristic bed of sandstone 1 to 2 inches thick. At some localities it is divided by two or more partings, usually of the same type of hard, carbonaceous, sandstone.

The largest economic development of the Upper Banner coal is taking place on Toms Creek, where the Virginia Coal and Iron Co. has several large mines. The Clinchfield Coal Corporation, which operates the large plants at Dante and Wilder, also has a mine opening on Guest River drainage, that serves as an outlet for Upper Banner coal mined by this company on Hurricane Fork and Caney Creek in Dickenson County. The coal is an excellent coking coal of high heating value and a large percentage of the coal mined at Toms Creek is coked at that town.

Many samples of the Upper Banner were collected in eastern Wise County mines for chemical analysis. The analyses are given on pp. 511-513. Steaming tests, producer-gas tests, and coking tests of Upper Banner coal are given on pp. 537-539.

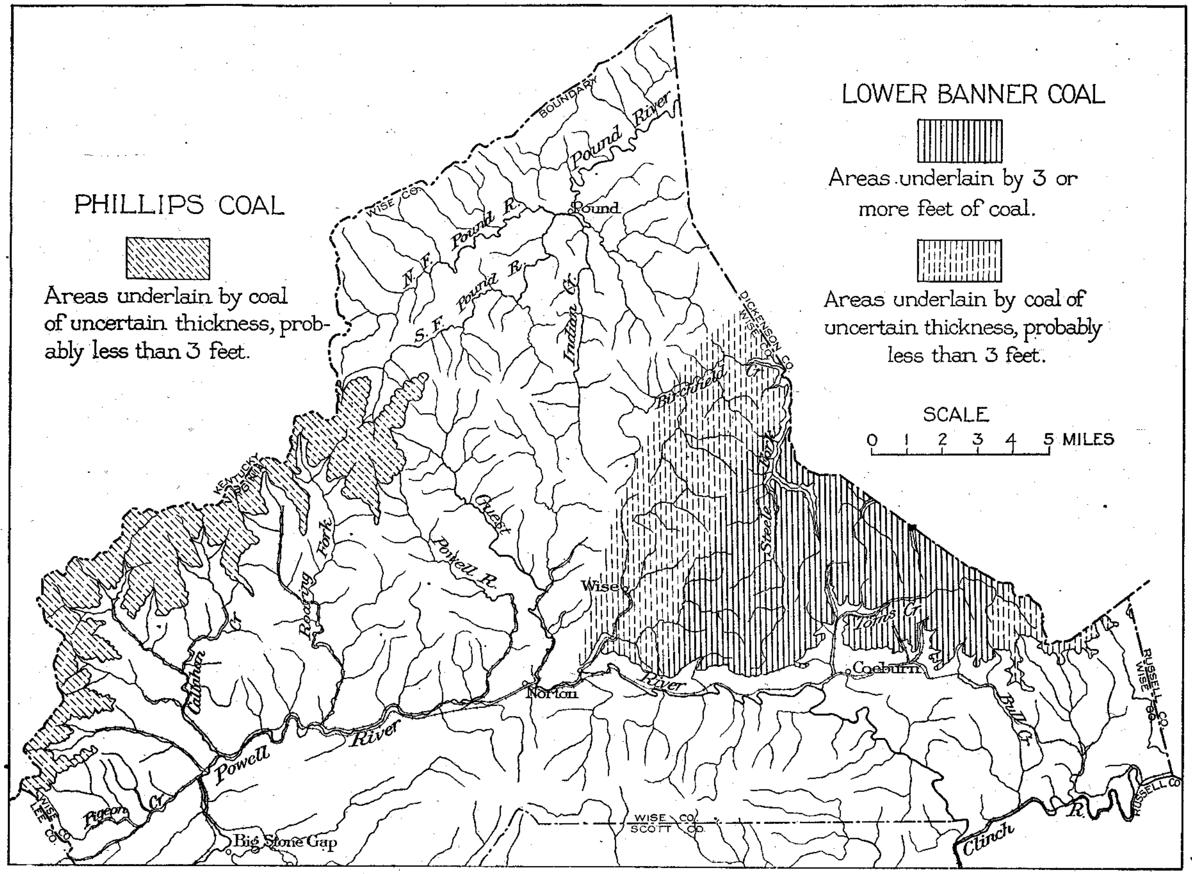


Fig. 15.—Sketch map of Wise County showing areas in which the Lower Banner and Phillips coal beds contain 3 feet or more of minable coal.

SPLASH DAM COAL BED.

A coal bed lying 70 to 90 feet above the Upper Banner bed is well developed in southwestern Dickenson County and is called the Splash Dam coal bed. It is of workable thickness in Russell County, but was seen only at a few localities as a thin bloom or a bed of carbonaceous shale in eastern Wise County.

HAGY COAL BED.

The Hagy coal bed is very poorly developed in Wise County and is not a workable bed. The Hagy coal bed lies approximately 160 feet above the Upper Banner bed and beneath a massive sandstone. It is named from exposures at the type locality in the Hagy mine on Trace Fork of Prater Creek and near Hagy School at Leemaster, in Dickenson County. The bed is exposed 1 mile north of Banner showing 2 feet, 8 inches of coal, but nowhere else was it found to be over 1½ feet in thickness.

NORTON COAL BED.

The Norton coal bed is at or near the top of the Norton formation, cropping out with great regularity directly beneath the Gladeville sandstone (see fig. 17), although shale and clay beds in many places separate the coal and sandstone by an interval ranging up to 10 feet on the average, and as high as 40 feet at a few isolated localities. The bed was originally called the "Middle Norton" bed in the vicinity of Norton and Dorchester, and later the "Yellow Creek" bed near Wise. The former name was for a small settlement midway between Norton and Dorchester, near which the bed was first opened, and the latter name for Yellow Creek on which the bed was opened many years later. As the correlation of the "Middle Norton" with the "Yellow Creek" is established in this report, the latter name is dropped, and as the village of Middle Norton is now incorporated in the town of Norton, the modifying term "middle" is also dropped.

The Norton coal bed is best developed in the Upper Guest River basin in central Wise County, where it is thickest, ranging from 2½ to 5 feet of usually clear coal. On Bear Creek drainage the bed thins to an average of 3 to 4 feet of coal with partings up to 1 foot in thickness. From the central portion of the county where the bed is of workable thickness, the Norton thins, in every direction, to a non-workable or questionably workable coal bed. In the Pound River drainage basin the bed is poorly exposed but nowhere shows a minable thickness. On upper Powell River the Norton

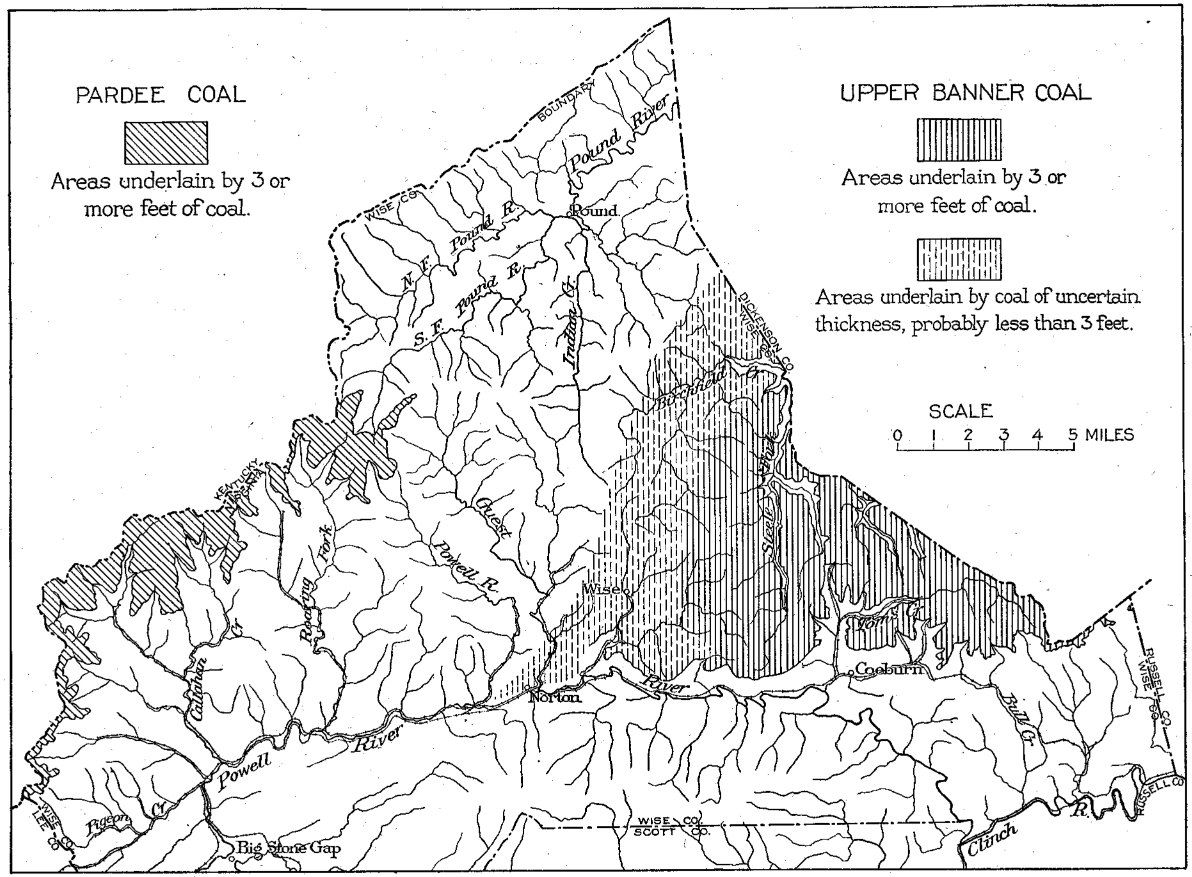


Fig. 16.—Sketch map of Wise County showing areas in which the Upper Banner and Pardee coal beds contain 3 feet or more of minable coal.

bed is also little exposed but drilling shows it to range from 2 feet to 3 feet, 8 inches, in thickness. East of upper Guest River the Norton coal bed is workable to Tacoma, but from that place eastward the bed thins and is not of minable thickness.

The Norton coal is mined by the Norton Coal Co., the Hawthorne Coal Co., the Yellow Creek Co., the Gladeville Co., and many other smaller operators. It is among the large producing coal beds of Wise County. The Norton is a good coking coal, and a large percentage of the production from this bed is coked at the mines.

Chemical analyses of the coal from this bed are given on page 513.

Coal beds in the Wise formation.

DORCHESTER COAL BED.

A coal bed of considerable commercial importance lies immediately above the Gladeville sandstone (see fig. 18.) It was first described by Butts[1] and named by him the "Glamorgan" coal bed because Glamorgan was the largest mine operating in this bed in the territory he was describing. The present work has shown that the coal bed immediately above the Gladeville sandstone was first dveloped many years ago by the Wise Coal and Coke Co. at Dorchester, a mile west of Norton, and for that reason the name "Glamorgan" is here abandoned and the bed given the name of Dorchester from the place at which it was first worked. The bed has in the past received many local names, such as "Norton No. 2," "Haskell No. 3," "Esserville Big Dirt Seam," and "Gladeville." The Dorchester bed is called the Cedar Grove by the West Virginia Geological Survey.

The best section of the Dorchester coal bed is in central Wise County just north of the upturned rocks of Powell Mountain. On Guest River in the vicinity of Norton the bed averages 60 to 70 inches of coal and on Powell River, 56 inches. The detailed section of the Dorchester bed varies greatly, even in small areas, and often changes rapidly within a single mine. The partings range from 1 inch to many feet and at many places split off benches of the bed that are too thin to work or too close to the main bed to be recoverable if the larger bed is mined. Such is the case at Glamorgan, where a notable split in the bed occurs. At Esserville the bed is parted near the middle by clay varying from 2 to 8 feet thick, hence the local name, "Esserville Big Dirt Seam." The Dorchester bed is 3 to 3½

[1] Butts, Chas., The coal resources and general geology of the Pound quadrangle of Virginia and Kentucky, U. S. Geol. Survey Bull. 541, 1914, p. 174.

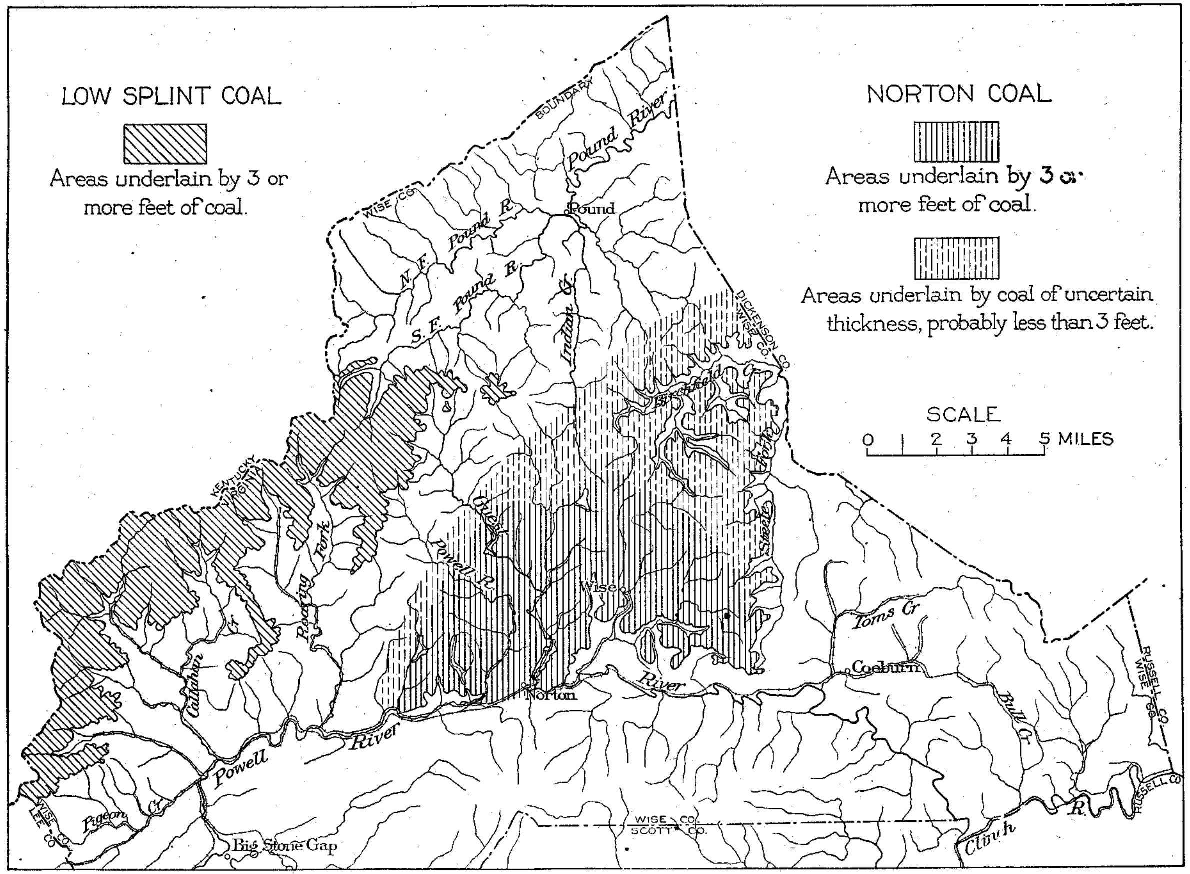


Fig. 17.—Sketch map of Wise County showing areas in which the Norton and Low Splint coal beds contain 3 feet or more of minable coal.

feet thick with parting from 1 inch to 1 foot in the Bear Creek basin, and 1 foot, 6 inches to 2 feet, 6 inches thick, including partings, on Indian, Dotson, and Birchfield creeks, and on the forks of Bowlecamp Creek.

The Dorchester coal bed is mined by several large companies in central Wise County and as a coal producer ranks creditably with the Imboden and Upper Banner beds. The Wise Coal and Coke Co. at Dorchester, the Norton Coal Co., at Norton, the J. A. Esser Coke Co., at Esserville, and the Stonegap Colliery Co. at Glamorgan, are among the larger producers of the Dorchester coal. Mining on the Dorchester bed is confined almost entirely to the basins of Upper Powell and Guest rivers and Bear Creek.

The coal is an excellent coking coal, but locally runs too high in sulphur to be used for metallurgical coke. In general it is a coal of good heating value, running as high as 14,000 B. t. u. Analyses of coal samples collected is Wise County mines from the Dorchester bed are given on pp. 513-516.

LYONS COAL BED.

A 2½ to 3-foot bed of coal, 40 feet above the Gladeville sandstone, outcrops in the Upper Powell River and Bear Creek basins that is called the Lyons bed, being the extension of the Lyons bed in Dickenson County. The bed is probably an upper bench or split of the Dorchester bed. In Dickenson County the coal is of local importance only and in Wise County the bed is little better, being able when coal is in great demand to support a few wagon mines. The bed is usually separated from the Dorchester by clay shale and is overlain in places by a thin, white sandstone. The thinness of this bed makes it of slight importance in Wise County.

BLAIR COAL BED.

The Blair coal bed lies 90 to 120 feet above the Gladeville sandstone and is of widespread occurrence in central and northern Wise County. The areas in which the bed is of workable thickness lie largely in the central part of the county, in the Upper Guest River basin, Upper Powell River basin, and in the Bear Creek basin. The Blair was so named by Butts,[1] because it was opened at the mouth of Lick Branch of Indian Creek by a man of that name. The bed is probably the Bens Creek bed of the West Virginia Geological Survey. Locally the Blair is called the "Norton No. 7 bed" and the "Haskell No. 1" or No. 3-a bed. The Blair bed is separated from the Lyons coal bed in large part by soft sandstone.

[1] The coal resources and general geology of the Pound Quadrangle in Virginia, Virginia Geol. Survey Bull. IX, p. 29, 1914.

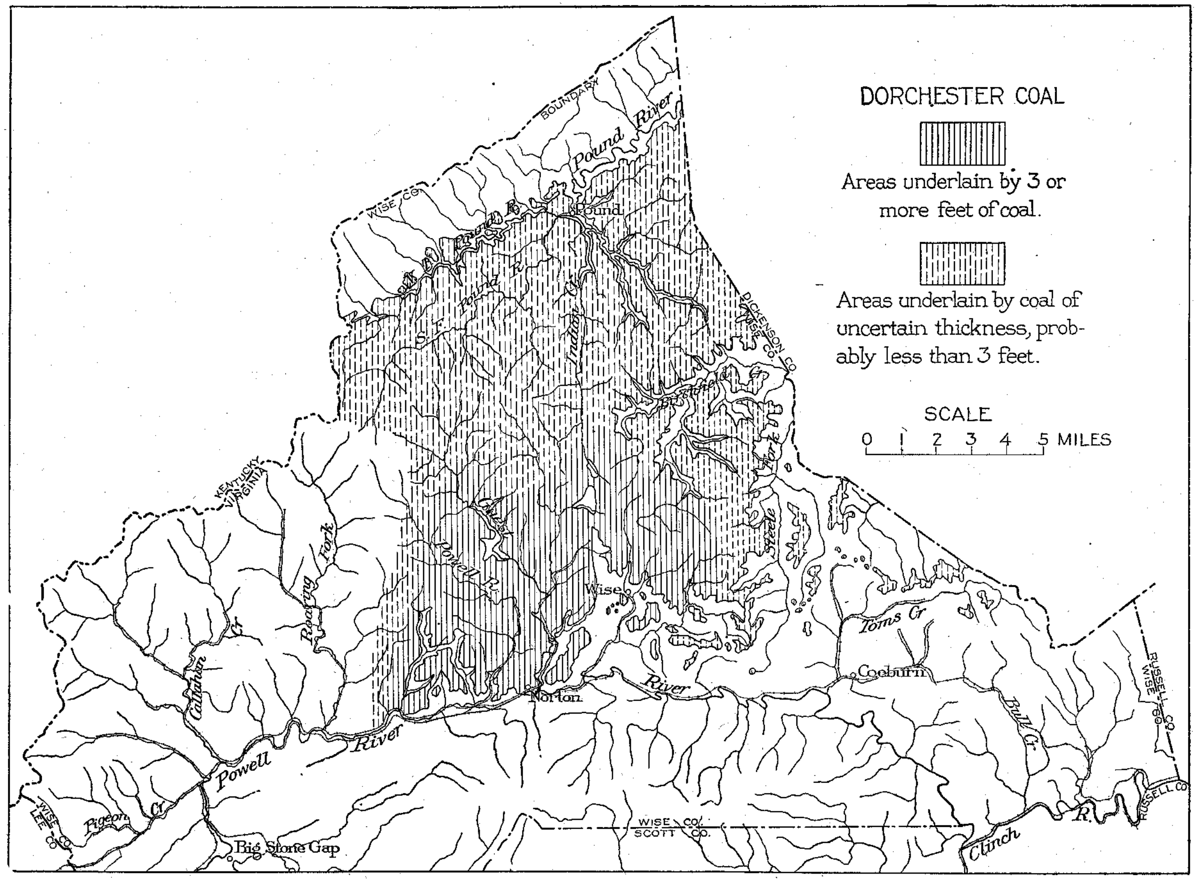


Fig. 18.—Sketch map of Wise County showing areas in which the Dorchester coal bed contains 3 feet or more of minable coal.

The Blair coal bed is at its best in the vicinity of Esserville, where it approaches 4 feet in thickness, without a parting. The coal here is hard but clear and one of the best coking coals in the county. On Powell River the Bair is 2½ to 3 feet thick, usually unparted. In the north-central section of the county the bed is parted by 10 feet of shale into an upper 2-foot and a lower 3 to 5-foot bench. The Blair is minable in the Bear Creek basin and to a small extent on McFall Fork, and Indian Creek, but is too thin or too much parted to be workable in the remaining part of the Pound River drainage basin.

The chief mining operation in the Blair bed is the J. A. Esser Coke Co.'s mines at Esserville. The bed is also opened at Dorchester by the Jordon mine of the Wise Coal and Coke Co.

Analyses of the Blair coal are given on page 516.

CLINTWOOD COAL BED.

The next commercially important coal bed is the Clintwood, 70 feet above the Blair and 160 to 200 feet above the Gladeville sandstone (see fig. 14). The bed is everywhere overlain by a massive sandstone, herein named Addington sandstone, which is 20 to 40 feet thick and which either rests upon the coal bed or is separated from it by only a few feet of shale. The bed is named for Clintwood, the county seat of Dickenson County, where the bed ranges in thickness from 4 to 11 feet. The Clintwood is the same as the Matewan coal of the West Virginia Geological Survey and the Teds Creek bed on Rocklick Creek and vicinity in Kentucky. The bed is locally known as the "Norton No. 8 bed" and the "Big Dorchester" bed.

The great thickness of the Clintwood coal bed extends west from Clintwood into Wise County as far as Indian Creek. From Indian Creek to the south and west the bed is widely split, and in the vicinity of Lipps it is separated into two benches 20 feet apart. Farther south the parting decreases and from Sutherland to Dorchester and Glamorgan to Norton the bed is 4 to 5 feet of coal with a middle parting of shale or clay 1 to 5 feet thick. The large parting in the Clintwood bed is persistently present throughout the south-central part of the county. The bed has been extensively prospected in northern Wise County by the Clinchfield Coal Corporation and in southern Wise County by the Wise Coal and Coke Co., and the character of the bed and its partings is thus well known.

The bed is mined at Dorchester by the Wise Coal and Coke Co. It was also formerly mined at Norton. The Clintwood is now opened at many localities by small wagon mines or pits to supply fuel for local needs.

ADDINGTON COAL BED.

A coal bed in central and northern Wise County is commonly found overlying the massive Addington sandstone and is called the Addington coal bed. It is of local importance only, seldom exceeding 2 feet in thickness and has not been seen to exceed 3 feet in thickness.

ROCKY FORK COAL BED.

The Rocky Fork coal bed lies 40 feet above the Addington bed and occurs only on Rocky Fork of Guest River. The bed has a thickness ranging from 2 to 2½ feet, and is unimportant so far as commercial production is concerned.

IMBODEN COAL BED.

The Imboden coal bed in the lower part of the Wise formation is one of the notable coal beds of Wise County, both in thickness and quality of coal and the many mines now working it. The identification and correlation of the Imboden coal bed in Wise County is explained in detail in another section of this report (pp. 75-85), and only the main features of the bed will be described here. The bed is now known to be the same as the Lower Bolling coal bed of Butts in northern Wise County and hence is the equivalent of the Lower Campbell Creek coal bed of Dickenson and Buchanan counties. The areal extent of the bed in Wise County is shown in figure 12.

The Imboden has its maximum development throughout the western basins of the county, reaching nearly 10 feet in thickness at Inman, on Looney Creek. The average thickness of the bed on Pigeon, Looney, and Callahan creeks is between 5 and 6 feet of coal, with 6 to 8 inches of parting. The bed has much the same section on Lower Roaring Fork that it has on the creek just mentioned, but below Potcamp Fork at Pardee, where it has been prospected by the drill is greatly parted. On Black Creek, upper Powell River and upper Guest River the Imboden bed lies high in the hills, and little of it now remains in those drainage basins. Where the bed is preserved, however, it is thick and has few partings. In the Pound River basin the Imboden bed ranges from 18 inches to 4 feet in thickness and is subordinate in importance to the overlying Kelly bed.

The stratigraphic position of the Imboden places it near the top of the lower third of the Wise formation. In western Wise County the bed is calculated to lie 650 feet above the Gladeville sandstone, an interval that decreases to 550 feet at Black Creek and 500 feet in north-central Wise County, and is probably as small as 450 feet in the northeast section of the county. The thinning of the strata intervening between the Gladeville sandstone and the Imboden coal bed is in almost the same proportion as observed in the northeastward thinning of the Lee formation in Wise County. The Imboden lies above a thick micaceous sandstone that makes prominent ledges in the southwestern section of the field. This sandstone in places, as on Black Creek, is hard and massive, resembling the Gladeville. A sandstone usually overlies the Imboden coal and separates it from the Kelly coal. The bed has been largely prospected on Buck Knob and Bowlecamp Knob by the Clinchfield Coal Corporation.

The Imboden coal bed at its type locality in the western basins carries few partings and consists of a high quality coking coal. The bed is featured by zones of crushed coal, called by the miners "curly coal," from the polished curved surfaces formed in the crushing and slipping of the coal within the weaker zones of the bed. The coal within these zones breaks out in shapeless blocks showing lustrous, rounded faces, when the bed is mined. The quality of the coal is not affected in the process. The normal coal is hard and well jointed.

The Imboden coal bed is being worked chiefly by the Stonega Coke and Coal Co., Virginia Iron, Coal and Coke Co., and the Blackwood Coal and Coke Co. The mines are located on Pigeon, Looney, and Callahan creeks, and Roaring Fork. The coal bed was formely mined west of the mouth of Black Creek and in small outliers on upper Powell River drainage.

The Imboden coal bed has been sampled in many of the mines and the analyses are given on pp. 517-520.

KELLY COAL BED.

The Kelly coal bed is workable throughout much of its extent in the county. It ranges in thickness from 18 inches to 5 feet and has been prospected in Bowlecamp and Buck knobs by the Clinchfield Coal Corporation under the name of "5-foot bed." The Kelly is the Upper Bolling coal of previous reports of this region.

The interval between the Kelly and the Imboden coal beds is extremely variable in south-central and western Wise County, ranging from a few inches to 70 feet. In northern Wise County the beds are more uniformly separated, the interval between them ranging from 20 to 40 feet. Above the Kelly bed is 50 to 80 feet of coarse micaceous sandstone, which, on Pound River especially, crops out for long distances as a low cliff or escarpment. The escarpment is conspicuous on the ridges along Indian Creek. The sandstone persists throughout the area underlain by the Kelly coal in northern Wise County. On South Fork of Pound River the coarse sandstone is overlain by 140 feet of shale and sandstone, capped by a 40-foot bed of sandstone.

The Kelly bed is mined for shipment only at Roaring Fork, where it is entered by one of the mines of the Blackwood Coal and Coke Co. The bed is opened locally by many country mines, particularly in the Pound River region. The analyses of samples of the coal taken in the Roaring Fork mine are given on page 520.

LOWER STANDIFORD COAL BED.

In northern Wise County two coal beds of workable thickness outcrop 260 feet above the Imboden bed, or on an average of 810 feet above the Gladeville sandstone. The beds are 20 feet apart at their type locality on the South Fork of Pound River. They were named Upper and Lower Standiford by Butts for the man opening the beds at their type locality.

The Lower Standiford bed contains from 2 to 2½ feet of coal. It is nowhere thick enough to sustain a shipping mine under the present coal market conditions and is therefore of small commercial importance today.

The outcrop of the Lower Standiford coal bed is indicated on the geologic map for that portion of Black Mountain and Buck Knob, where the bed is fairly well known.

UPPER STANDIFORD COAL BED.

The upper of the two Standiford beds averages 3 feet of coal, with 1 to 5 inches of parting, and is a workable bed. The outcrop of the Upper Standiford has not been traced into the Callahan Creek basin or into other basins to the west, but comparative intervals suggest the correlation of the bed with the Wilson bed as it appears on the boundary line separating Wise County from Lee County. A bed of coal that is supposed to be the Upper Standiford and workable under favorable market conditions, has been opened at the head of Callahan Creek.

The Upper Standiford bed shows its best section on Critical Fork of Guest River, where it measures 3 feet, 10 inches of coal with only a small parting. The Wilson bed on Pigeon and Looney creeks ranges from 3 feet, 3 inches on the former to 2 feet, 4 inches in thickness on the latter creek. The Wilson bed is 300 to 330 feet above the Imboden in the basins of these streams.

TAGGART MARKER COAL BED.

A coal bed lying 30 to 50 feet below the Taggart bed and approximately 410 feet above the Imboden bed has been called the Taggart Marker as it indicates the proximity of that valuable bed. A thick fine-grained sandstone usually overlies the Taggart Marker bed and not uncommonly constitutes all the rocks between it and the Taggart.

The Taggart Marker bed is known in the Roaring Fork basin and in all the basins to the west, but it was not seen in the Pound River country. The most promising occurrence of the bed is in Ninemile Spur, where it has a thickness of 3½ feet of clear coal.

The bed is mined at Dunbar by the Stonega Coke and Coal Co., this being the only shipping mine in the bed. The coal was sampled in this mine and the analyses are given on page 521.

The outcrop of the Marker bed is not given on the geologic map but can readily be inferred from the Taggart outcrop, as the two could not be differentiated on a map of this scale.

TAGGART COAL BED.

The Taggart coal bed ranks as one of the most valuable coal beds in Wise County (see fig. 13). Its average heating value is greater than any other bed in the county and it extends under many square miles with a thickness of coal ranging from 5 to 6 feet, with less than 1 foot of parting. The outcrop of the bed has been traced throughout its entire extent in Wise County and into the adjacent part of Lee County and mines have been driven in it through Black Mountain into Kentucky, where the bed is correlated with the "C" bed of the United States Coal and Coke Co. at Lynch, in Harlan County. Locally, the bed is known as the "Roda Seam" or "Roda coal" for Roda, a mining town in the Callahan Creek basin. In Lee County the bed is called the "Keokee bed" and is correlated by Giles[1] with the "No. 5" bed in the Pocket in that county. White arkosic sandstone crops out above and below the Taggart coal, but thin beds of shale usually separate the coal from the sandstone.

The interval between the Taggart and the Imboden beds varies, with the largest interval in the region of Nine-mile Spur and decreasing to both the east and the west. On Looney Creek and Preacher Creek, boreholes show that the interval is almost exactly 400 feet; on the north of Callahan

[1] Giles, A. W., The geology and coal resources of the coal-bearing portion of Lee County, Virginia: Bulletin Virginia Geological Survey (in press).

Creek and Roaring Fork the interval is 450 feet; and in the Pound River basin it rapidly decreases to approximately 350 feet.

The Taggart coal bed is one of the thickest coal beds in Black Mountain and its spurs in the western basins of Wise County. Roda, on Mudlick Creek of Callahan Creek, might be regarded as the type locality of the bed. At this locality the bed ranges from 5 to 6 feet thick, consisting of a soft, well jointed coal possessing a high luster, and mines out in large blocks. The coal burns with an intensity characteristic of cannel coal. The Stonega Coke and Coal Co. has several mines in the bed at Roda and one at Dunbar. The Virginia Iron, Coal and Coke Co. is mining the bed on Looney Creek.

The Taggart is persistent in Black Mountain at the head of Pound River but is split into two or more benches, none of which is a particularly desirable coal bed.

The coal has been analyzed from samples collected at Roda and Dunbar and the results are given on page 521. A discussion of the quality of the coal is given at length on pp. 533-534.

LOW SPLINT COAL BED.

The first persistent coal bed above the Taggart is the Low Splint, the interval between them ranging from 200 to 240 feet (see fig. 17). The bed crops out continuously throughout the Black Mountain region and lies in an isolated tract near the top of Buck Knob, where it was prospected by the Clinchfield Corporation as the "Buck Knob" bed. It averages 2½ to 3½ feet of coal and 6 to 12 inches of parting.

The bed has been prospected on Roaring Fork by the Virginia Coal and Iron Co. It is, however, not mined for shipment anywhere in the county but is opened by several local mines.

PHILLIPS COAL BED.

The Low Splint bed on the South Fork of Pound River is succeeded by 260 feet of shale and sandstone at the top of which is a coal bed named by Butts the Phillips coal because it has been opened on the Ambrose Phillips farm, at the head of South Fork of Pound River (see fig. 15). The bed at its type locality is reported to be 26 inches thick, without a parting. The Phillips coal bed may be the same as the Dean coal of the Kentucky Geological Survey.

The Phillips bed is 2 feet thick on Looney Creek, consisting of clear, hard, almost splinty coal. It outcrops between massive sandstones and in this region is 250 feet above the Low Splint coal. On Callahan Creek it is thin and scarcely workable. In the Pound River basin of Black Mountain the bed is persistent but averages only 2 feet of coal. The bed is not mined in Wise County.

The Phillips coal bed lies 390 feet below the Pardee bed. A carefully measured section on South Fork of Pound River shows the following thin coal beds between the Phillips and the Pardee:[1]

Eighty feet above the Phillips is an 18-inch bed of coal; 210 feet above the Phillips is a 1-foot bed; 225 feet above is a 2-foot bed; and 340 feet above the Phillips, or 50 feet below the Pardee bed, is a 6-inch bed of coal. Between 210 and 225 feet above the Phillips coal is an 8-inch limestone bed, which is the only limestone that was seen in the entire Pennsylvanian section in Wise County.

PARDEE COAL BED.

The highest bed in the Wise formation, that is now being mined in Wise County is the Pardee coal bed, which lies 850 feet above the Taggart bed and 400 to 450 feet below the Harlan sandstone (see fig. 16). The Pardee bed is named for Pardee on the headwaters of Potcamp Fork of Roaring Fork, where the bed is now mined by the Blackwood Coal and Coke Co. The Pardee is the "Limestone" and "Haddix" coal beds of the Kentucky Geological Survey and has locally been known as the Parsons bed. It lies 2,800 to 3,100 feet above sea level and therefore near the summit of Black Mountain and its highest spurs. Above the Pardee bed is about 100 feet of shale overlain by rather coarse-grained flaggy sandstone 300 feet thick.

The Pardee coal bed reaches its maximum thickness of 9 to 11 feet of coal with small and relatively insignificant partings in the Roaring Fork basin. From the head of Roaring Fork and its branches, the bed splits both to the east and to the west. Thus on Callahan Creek the main bench of the bed ranges from 4 to 4½ feet of coal with 3 to 6 inches of partings. Northeast of Pardee the bed thins to 5 feet of coal with 1 foot of partings, well scattered throughout the section. The partings, however, are extremely variable and at places split the bed into two or more benches many feet apart.

The Pardee bed is mined in Wise County only at Pardee. Samples of the coal were collected in this mine and the analyses are given on pp. 521-524. A discussion of the quality of the coal is given on page 534.

[1] Butts, Charles, Coal resources and general geology of the Pound Quadrangle in Virginia, Bull IX: Virginia Geol. Survey, 1914, p. 12.

MORRIS COAL BED.

A coal, which is called the Morris bed, has been opened on Callahan Creek, about 350 feet above the Pardee. It is best developed in Bluff Spur, where it averages 5 to 5½ feet in thickness and it is 3 to 4 feet thick on Roda Spur of Black Mountain. The Morris bed was not seen in the Roaring Fork basin or in any basin to the east or northeast of Roaring Fork. On Looney and Pigeon creeks west of Callahan Creek the bed is present, but measured sections were not obtained.

HIGH SPLINT COAL BED.

The High Splint coal bed is 350 to 450 feet above the Pardee bed, the maximum interval holding for the extreme western end of the county and the minimum interval prevailing throughout the major part of the Black Mountain area (see fig. 14). At Pardee it is 320 feet above the Pardee coal. The bed lies so high on Black Mountain that it has a comparatively small extent in Wise County. The basal bed of the Harlan sandstone, 20 to 40 feet above the coal, makes a conspicuous escarpment everywhere above the High Splint bed.

The bed is a genuine splint coal 4 to 5 feet thick, usually without a parting. It is well developed and constant in character throughout the Roaring Fork basin, as shown by numerous prospects, and it is seldom broken by partings.

The bed was mined at Pardee by the Blackwood Coal and Coke Co., the only mine in the county in this bed, but the operation is now closed. The general inaccessibility of the bed will prevent it from competing successfully with lower and thinner beds, at the present status of the coal market.

No coal beds of workable thickness were seen above the High Splint bed.

DETAILED DESCRIPTION OF COAL BEDS.

METHOD OF STATEMENT.

The natural channels of approach to the coal beds of the county are the valleys of the larger streams. Railroads and wagon roads built for the purpose of exploiting these coals follow up these valleys. In describing in detail, therefore, the coal beds of the region it is preferable to divide the coal field into its major drainage basins and describe the beds that outcrop in each particular basin. The names and locations of the drainage basins of the coal field are shown in fig. 19. A brief description and geologic summary will be given for each basin, followed by the description of each coal bed, starting with the lowest bed. So far as practical the outcrops of the coal beds have been shown on the geologic map.

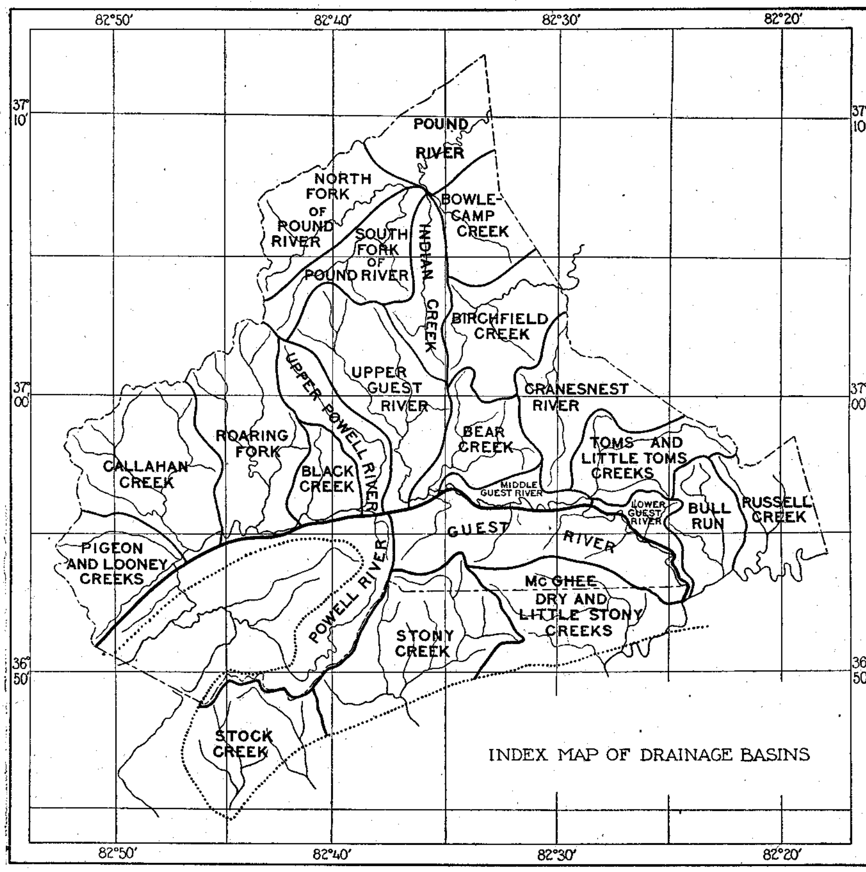


Fig. 19.—Index map of drainage basins in coal field of Wise and Scott counties.

The prospects and mines on the various beds are described in regular order beginning on one side of the basin and following the outcrop around the head of the basin and down the other side. In general, the policy of this report has been to proceed up the west bank and return down the east bank of both north and south-flowing steams. The prospects and mines are numbered in sequence as described in the text. The coal beds of the Norton and Wise formations are described first, and the area of their chief occurrence is divided into 19 basins, 5 of which drain into Powell River, 5 into Guest River, 7 into Russell Fork, and 2 into Clinch River. The coal beds of Powell Mountain are described last. All measurements of coal beds were made by the writer or by other State or Federal geologists, except where credit is assigned to a coal company or a private individual. In the case of sections furnished by companies, the initials of the company are given at the head of the section. The companies furnishing such information and their initials as used in this report are as follows: Clinchfield Coal Corporation, C. C. C.; Virginia Iron, Coal and Coke Co., V. I. C. & C.; Virginia Coal and Iron Co., V. C. & I.; Stonega Coke and Coal Co., S. C. & C.; Wise Coal and Coke Co., W. C. & C.; Norton Coal Co., N. C.; Blackwood Coal and Coke Co., B. C. & C.; Interstate Coal and Iron Co., I. C. & I; and the Interstate Investment Co., I. I.

The elevations given were not all determined in the same manner and three symbols are used to show their relative accuracy. Those marked "B" indicate elevations gotten by aneroid barometer, and those marked "L" by transit or stadia measurements or by hand-leveled elevations from known bench marks. Where an elevation was not determined in the field and was obtained by report or approximation, it is described by the abbreviation, "Approx."

Many sections of coal beds given in the text are also graphically shown on plates, the numbers at the sides of the graphic sections showing thicknesses in inches, those on the right for coal and those on the left for partings.

POWELL RIVER DRAINAGE BASIN.

PIGEON CREEK AND LOONEY CREEK BASINS.

General features.—The region drained by Pigeon Creek and Looney Creek lies in the extreme western part of Wise County bordering Lee County, and the State of Kentucky on the west, and adjoining the Callahan Creek basin on the north and east. On the south except at the extreme head of Pigeon Creek the coal-bearing rocks are cut off sharply by the Pigeon Creek fault. Pigeon Creek and Looney Creek, the chief streams, flow northeastward and southeastward respectively, and join Powell River within a short distance of one another at the entrance of Big Stone Gap. The streams are separated by a long sharp divide called Looney Ridge, which is the extension into Wise County of Little Black Mountain, that to the west carries the Kentucky–Virginia State line. The Wise–Lee county line follows the divide between the waters of Pigeon Creek in Wise County and the waters of North Fork of Powell River in Lee County.

The rocks exposed, including only those north of the fault, or the steep upturn which in places parallels the fault, belong to the Wise formation and the Harlan sandstone. Nearly all of the Wise formation and several hundred feet of the Harlan comprise the stratigraphic section, making a thickness of strata ranging from 2,500 to 2,800 feet. The column is made up of shale and sandstone in about the ratio of 2 to 1. Numerous coal beds are present in the section.

North of the Pigeon Creek fault, which is described on pages 134-137, the rocks dip gently northwestward toward the axis of the Middlesboro syncline. On Lick, Frank, and Bearpen branches of Pigeon Creek the rocks are almost flat, whereas on Looney Creek from Inman to Linden the beds dip as much as 8° to 10° to the northwest.

The lowest coal bed now being mined in either basin is the Imboden. This bed outcrops near stream level on Pigeon Creek as far west as Exeter and on Looney Creek as far northwest as Linden. The Imboden is one of the thickest beds outcropping in western Wise County, averaging 5 to 7 feet, with one measured section at Inman showing a total thickness of more than 9½ feet. The Kelly coal bed closely overlies the Imboden on Looney Creek, the interval between them at places being less than 6 inches. The Kelly is a 5-foot bed of clear coal, lying so close to the Imboden that the two make practically a continuous coal bed 12 to 14 feet thick. Several thin beds of coal outcrop between the Imboden and Taggart. The Taggart is the first commercially important bed above the Imboden, and averages 36 to 40 inches of usually clear coal. The bed outcrops on Pigeon Creek only near its headwaters and crosses Looney Creek 1 mile west of Laurel. The Taggart is 400 feet above the Imboden.

Beds of coal above the Taggart that are of workable thickness, named in ascending order, include the Low Splint, Phillips, Pardee, Morris and High Splint. The beds will be described more in detail in later paragraphs of this chapter. Graphic sections of the coal beds in the Pigeon and Looney creeks basins are shown in figure 20.

Mining in this field dates from the early nineties when the Imboden bed was first opened on Looney Creek (see page 9). Mines are now being operated at Inman and Linden on the Imboden bed and at Laurel on the Taggart bed by the Virginia Iron, Coal & Coke Co. Also extensive mines in the Imboden bed at Exeter and Imboden on Pigeon Creek are being operated by the Stonega Coke & Coal Co.

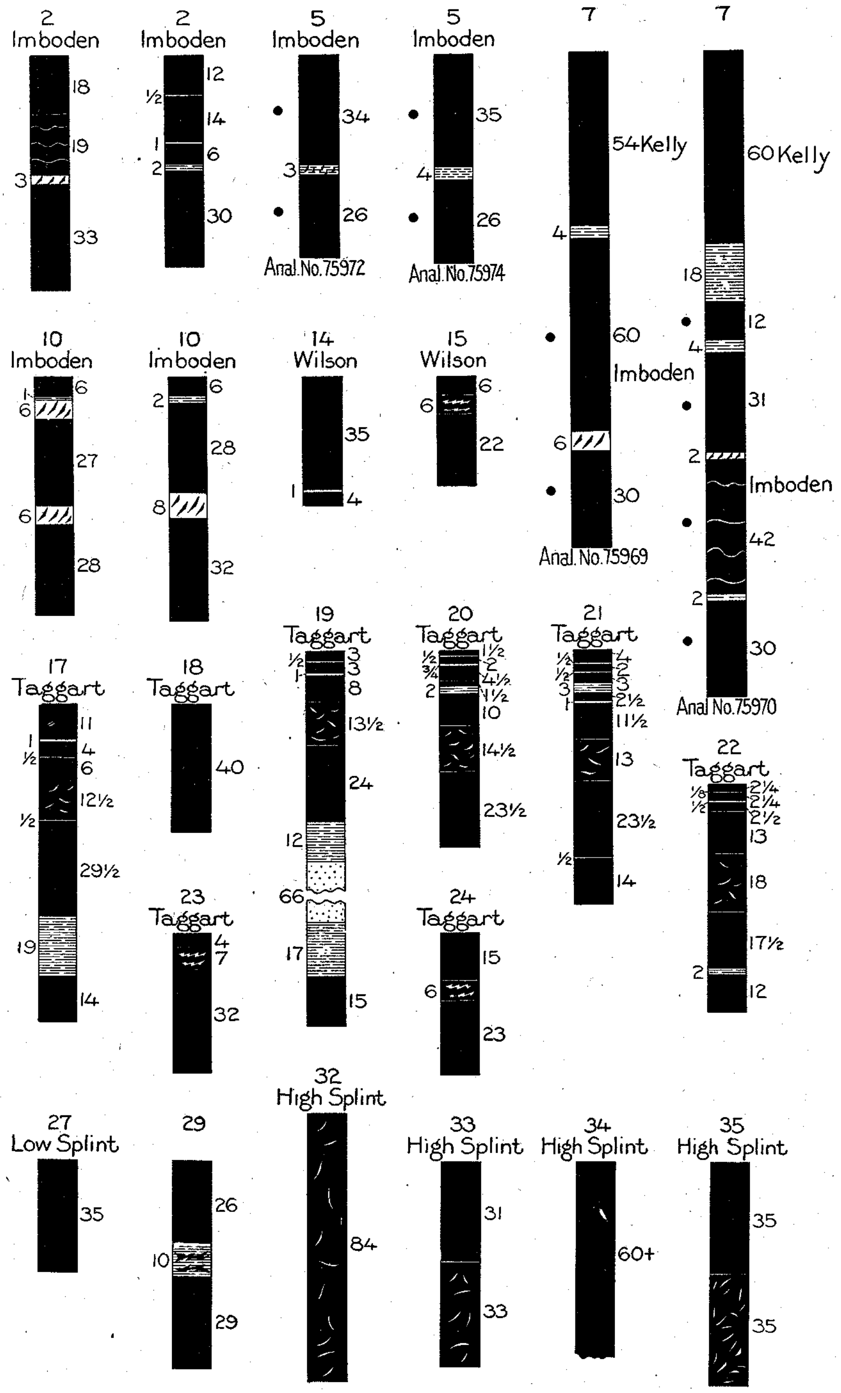


Fig. 20.—Sections of coal beds in the basins of Pigeon and Looney creeks.

The basins of Pigeon and Looney creeks are particularly favored with facilities for the transportation of coal. The Southern Railroad (St. Charles–Bristol line) runs up Pigeon Creek and Laurel Fork, crossing the county line to St. Charles in Lee County. The Interstate Railroad serves the mines at Exeter on upper Pigeon Creek. The railroad yard at Inman at the mouth of Looney Creek is the largest in the county. Besides the Southern and Interstate railroads, the Louisville and Nashville is conveniently near (mouth of Pigeon Creek) to further serve the needs of the two basins.

Imboden, Kelly, and lower coal beds.—Coal beds lower in the formation than the Imboden have been prospected by deep drilling on Looney Creek but only the horizons at which coal has been found have been made public. These are shown in the graphic representation of the well logs on Plate III. The lowest coal beds in the Norton formation are shown in the upturned rocks north of the "Bee Rock" in Big Stone Gap. Here on the west side of Powell River 480 feet of shale and sandstone is exposed, containing 4 thin beds of coal, the largest being 18 inches thick. Above this, 480 feet of shale and sandstone occurs 280 feet of coarse thick-bedded sandstone, overlying which several more thin beds of coal were seen, but all greatly crushed and distorted. The remainder of the Norton formation is cut out by the Pigeon Creek fault.

The Imboden coal is the lowest bed that is mined in the two basins. It has been thoroughly prospected by the Stonega Coke & Coal Co. on Pigeon Creek and its branches and by the Virginia Iron, Coal & Coke Co. on Looney Creek. The borings of these companies, together with their mine workings, which extend for many miles, furnish a large amount of information regarding the thickness and character of the bed. Analyses of the Imboden coal from samples collected at Imboden and Inman are given on page 519. The coal averages 4 to 5 per cent of ash, .8 per cent of sulphur, 34 to 35 per cent of volatile matter, and 55 to 59 per cent of fixed carbon.

A feature often found in the Imboden bed is a zone of crushed coal near the middle of the bed. This crushed coal has been called "curly coal," an apt descriptive expression. It is prominent in the Inman mines, where the zone is in places as much as 42 inches thick.

The Imboden coal bed directly overlies a thick, coarse-grained sandstone that usually is so resistant to erosion that it makes ledges on the hill slopes. Another massive sandstone in many places closely overlies the coal bed.

The Imboden coal is now being mined by the Stonega Coke & Coal Co. at Exeter. Mine No. 1 and Mine No. 2 enters the bed on the east and west side, respectively, of a small ravine east of Exeter (loc. 1, el. 1,887 feet, L). No. 1 south entry is another opening into Mine No. 1, about ½ mile to the northeast on the outcrop (loc. 2, el. 1,875 feet, L). The following sections measured in Mine No. 1 are typical of the bed in the vicinity of Exeter:

Sections of the Imboden coal bed at Exeter (loc. 1).

	Ft.	In.
Shale.		
Coal	1	6
Coal, curly	1	7
"Rash"		3
Coal	2	9
Shale		
Coal	5	10
Parting		3

	Ft.	In.
Shale.		
Bone		4
Coal	1	
Shale		½
Coal	1	2
Shale		1
Coal		6
Shale		2
Coal	2	6
Coal	5	2
Partings		3½

The Stonega Coke & Coal Co. has three mines in the Imboden bed at Imboden. One is on Franks Branch and is called the Franks Branch mine (loc. 3, el. 1,888 feet, L)), two are on Bear Pen Run and are called Old Imboden No. 1 mine (loc. 4, el. 1,902 feet, L), and Imboden No. 2 or Hale mine (loc. 5, el. 1,899 feet, L). All these mines are connected in scores of places underground and constitute practically a single large mine. Of the 3 mines, the Imboden No. 2 or Hale mine is the largest producer, yielding two-fifths of the entire output of the Imboden plant. Imboden No. 2 mine is said to have produced 290,400 tons of coal in 1919, at a rate of 1,200 tons per day.

The thickness of the coal bed in the Imboden mines is 5 feet of coal with generally a few inches of clay and "rash" near the middle of the bed, but in some places there are thin clay partings near the top. The following sections were measured in sampling the coal bed in the Imboden No. 2 mine:

Sections of Imboden coal bed in Imboden No. 2 or Hale mine (loc. 5).

Section where sample was cut half-way between 7 and 8 left entries, off main line, from newly cut manhole, 2,000 feet from drift mouth.

(Analysis No. 75972.)

	Ft.	In.
Sandstone.		
*Coal	2	10
Clay and "rash"		3
*Coal	2	2
Clay		
Coal	5	0
Parting		3

Section where sample was cut at 8 left main entry, 3,500 feet from drift mouth.

(Analysis No. 75973.)

	Ft.	In.
Shale, sandy.		
*Coal	1	11
*Coal, with clay streaks		6
*Coal	3	3
Shale		
Coal	5	8
Parting, clay streaks.		

Section where sample was cut from pillar between rooms 18 and 19 on 6 right entry, off main entry.

(Analysis No. 75974.)

	Ft.	In.
Shale.		
*Coal	2	11
Clay and "rash"		4
*Coal	2	2
Clay		
Coal	5	1
Parting		4

The coal in this mine is largely undercut by machines, although much coal is shot from the solid. The life of the mine is estimated by the owners at 40 years.

The Imboden coal bed makes an excellent showing on Looney Creek, especially in the vicinity of Inman, where it reaches an unusual thickness. The Virginia Iron, Coal & Coke Co. has several mines at this place, the chief ones being Mine No. 1 at loc. 6, el. 1,925 feet (B); Mine No. 2 at loc. 7, el. 1,920 feet (B); Mine No. 5 at loc. 8, el. 1,920 feet (B), and Mine No. 4 at loc. 9, el. 1,900 feet (B).

The largest single mine is No. 2, which produces 500 tons of coal per day. This mine, together with old Mine No. 2, the entry to which lies 30 feet southwest of the present Mine No. 2, but which is now closed, is one of the oldest mines in Wise County, having been in operation continuously for 36 years. The roof of the mine is hard sandstone, requiring little timbering, and the floor is a hard clay. There are a number of water holes, or local sags or depressions, in the floor of the mine that collect water.

*Sampled.

The Kelly coal bed lies in this mine very close to the Imboden, but is not mined on account of the great thickness of the Imboden and the very bad roof of the Kelly bed. Two sections measured in the Inman mine are given below to show the thickness and character of the Imboden bed.

Sections of the Imboden coal bed in Mine No. 2 at Inman (loc. 7).

Section where sample was cut at entry of old No. 2 mine, off main-line air course; 3,600 feet southwest of drift mouth.

(Analysis No. 75969.)

	Ft.	In.
Shale.		
Coal, Kelly	4	6
Shale		4
*Coal	5	0
Rash		6
*Coal	2	6
Shale		
Coal, Imboden	7	6
Partings, Imboden		6

Section where sample was cut at 3d right entry in new mine No. 2; 2,300 feet from drift mouth.

(Analysis No. 75970.)

	Ft.	In.
Coal, Kelly	5	0
Shale	1	6
*Coal	1	0
Shale		4
*Coal	2	7
Rash		2
*Coal, curly	3	6
Shale		2
*Coal	2	6
Shale		
Coal, Imboden	9	7
Partings, Imboden		8

The coal in this mine is partly shot from the solid and partly undercut by hand. More than 90 per cent of the mined coal is coked in the 164 Beehive ovens located at Inman. The life of Mine No. 2 is estimated by the owners at scarcely more than 4 years.

Mine No. 5 at Inman is located about 1/8 of a mile southwest of Mine No. 2. The average thickness of the Imboden coal bed in this mine is 6 feet 7 inches. Inman Mine No 4 lies 1/2 miles northwest of Mine No. 2, and in it the Imboden bed averages 5 feet 3 inches of coal.

At Linden, 1 mile west of Inman, the Virginia Iron, Coal & Coke Co. has three mines, No. 1, No. 2, and No. 3 in the Imboden bed. The Linden mines have been in operation about 13 years. During 1918 the normal output of the three mines collectively was 1,200 tons per day, and for the year, 331,805 tons of coal. The Imboden bed is said to average in these mines 6 feet 11 inches of coal with 10 inches of "rash" in the middle of the bed. Two measured sections in Linden Mine No. 1 are given below:

*Sampled.

Sections of the Imboden coal bed in Linden Mine No. 1.

(Loc., 10; el., 1,852 feet, L.)

	Ft.	In.
Shale.		
Coal		6
Shale		1
"Rash"		6
Coal	2	3
"Rash"		6
Coal	2	4
Clay		
Coal	5	1
Partings	1	1

	Ft.	In.
Shale.		
Coal		6
Shale		2
Coal	2	4
"Rash"		8
Coal	2	8
Clay		
Coal	5	6
Partings		10

Linden Mine No. 2 faces Mine No. 1 from the opposite side of a narrow ravine.

A massive but thin-bedded sandstone overlies the coal at these two mines and a thick-bedded sandstone makes a distinct ledge of nearly 30 feet in height just below the coal. A 16-inch bed of coal carrying 1 inch of shale near the bottom outcrops beneath this sandstone.

Linden Mine No. 3, of the Virginia Iron, Coal & Coke Co., lies on the north side of Looney Creek (loc. 11, el. 1,857 feet, L). One-half mile east of this mine is Inman Mine No. 3 of the same company (loc. 12, el. 1,870 feet, B). The Imboden coal bed in the Inman Mine No. 3 has an average section of 6 feet 5 inches of coal.

The Kelly coal bed, which on Pigeon and Looney creeks lies from a few inches to 30 feet above the Imboden bed, is 4 to 5 feet thick. The Imboden is now being mined on a large scale and will unquestionably be mined to its fullest extent and once the workings in this bed are abandoned and the roof allowed to settle, the consequent disruption of the overlying rocks will seriously impair if not ruin the possibilty of working the Kelly bed. Even where the beds are practically together, as at Inman, it is not considered feasible to take out the Kelly coal as the overlying shale is not firm enough to serve as a mine roof. Hence the Kelly coal bed can scarcely be considered an asset to the economic resources of the Pigeon Creek or Looney Creek basins.

Coal beds between Kelly and Taggart beds.—Several beds of coal lie between the Imboden–Kelly horizon and the Taggart bed. Near the Exeter mines a coal bloom was seen near loc. 13 (el. 2,000 feet, B), showing 40 inches of coal with 2 inches of clay near the bottom. The bed outcrops about 85 feet above the Imboden and lies just over a 60-foot bed of sandstone. The coal is the Pinhook as shown on Plate III. The name Pinhook for this bed is carried over from Lee County.

A more important bed, 300 to 330 feet above the Imboden, is called in Lee County the Wilson bed. This coal is probably the same as the Upper Standiford of northern Wise County. The Wilson bed is well known to split into thin benches north of Looney Ridge, and as it has nowhere been definitely traced to the Upper Standiford coal bed, it will, on Looney and Pigeon creeks, be called by its Lee County name, the Wilson bed.

The Wilson bed has been opened north of Exeter and the following section was measured there:

Section of the Wilson coal bed north of Exeter.

(Loc., 14; el., 2,280 feet, B.)

	Ft.	In.
Shale.		
Coal	2	11
Clay		1
Coal		4
Coal	3	3
Parting		1

The Wilson bed also has been prospected between Inman and Laura, and shows a decidedly poorer section, as follows:

Section of the Wilson bed on Looney Creek, between Inman and Laura.

(Loc., 15; el., 2,050 feet, B.)

	Ft.	In.
Shale, sandy.		
Coal		6
Coal, bony		6
Coal	1	10
Clay		
Coal	2	4
Parting		6

The coal bed here overlies a thick bed of sandstone.

A coal bed about 75 feet below the Wilson is revealed in borings, No. 3, 4, 5, 6, 7, 9, 10, 16 and 19, Plate III, which is correlated with the Lower Standiford coal bed. The uppermost of the coal beds between the Kelly and the Taggart is the Taggart Marker which, as shown in bore-holes No. 4, 9, and 16, Plate III, lies from 30 to 50 feet below the Taggart. The Taggart

Marker bed was not measured at its outcrop anywhere on Pigeon or Looney creeks and as the bore-hole sections of the bed are confidential information the thickness of the bed in this basin is not known.

Taggart coal bed.—The Taggart coal bed outcrops around Looney Ridge at the foot of the steep slope. The bed is mined only at one locality on Looney Creek,—at the Laura mine of the Virginia Iron, Coal & Coke Co. The distance between the Taggart and the Imboden, as shown by a boring of the company noted above west of the Laura mine (loc. 9, el. 2,267 feet, L) is 399.1 feet, the Taggart being at an elevation of 2,171.5 feet and the Imboden at 1,772.4 feet. This interval is about 50 feet less than the interval between the same beds on Callahan Creek and Roaring Fork.

A prospect pit on the Taggart bed was seen on the Lee–Wise county line (loc. 16, el. 2,385 feet, B) but the coal is not exposed.

The Taggart bed contains nearly 6½ feet of coal in a prospect pit of the Stonega Coke & Coal Co., just east of the county line. The section is as follows:

Section of Taggart coal bed northwest of Exeter.

(Loc., 17; el., 2,380 feet, approx.)

	Ft.	In.
Shale.		
Coal		11
Shale		1
Coal, soft		4½
Shale		½
Coal, soft		6
Coal, splinty	1	½
Shale		½
Coal	2	5½
Shale	1	7
Coal	1	2
Shale		
Coal	6	5½
Partings	1	9

The bed is also exposed in a ravine about ½ mile farther east at loc. 18, el. 2,400 feet (B) and 40 inches of clear coal was seen. A nearby pit partly caved, exposes 48 inches of coal, with the bottom of the bed concealed.

Measurements made in 4 pits at the head of Pigeon Creek and Lick Branch of Pigeon Creek show the Taggart to contain, on an average, nearly 6 feet of coal, with usually few and thin partings. A lense of shale and sandstone splits off the lower 15 inches of the Taggart bed at one place on upper Pigeon Creek. The sections in detail are as follows:

Sections of the Taggart coal bed at head of Pigeon Creek and Lick Branch.

(S. C. and C. Co. prospects.)

(Loc., 19; el., 2,375 feet, approx.)

	Ft.	In.
Shale.		
Coal		3
Clay		½
Coal		3
Shale, soft		1
Coal, soft		8
Coal, splinty	1	1½
Coal	2	
Shale	1	
Sandstone	5	6
Shale	1	5
Coal	1	3
Shale		
Coal	5	6½
Partings	8	½

(Loc., 20; el., 2,375 feet, approx.)

	Ft.	In.
Shale.		
Coal		1½
Shale		½
Coal		2
Shale		¾
Coal		4½
Coal, soft		1½
Shale		2
Coal, soft		10
Coal, splint	1	2½
Coal	1	11½
Shale		1½
Coal	1	
Shale		
Coal	5	9½
Partings		4¾

(Loc., 21; el., 2,370 feet, approx.)

	Ft.	In.
Shale.		
Coal		4
Clay		½
Coal		2
Clay		½
Coal		3
Shale		3
Coal		2½
Shale		1
Coal, soft		11½
Coal, splinty	1	1
Coal	1	11½
Shale		½
Coal	1	2
Shale		
Coal	6	1½
Partings		5½

(Loc., 22; el., 2,360 feet, approx.)

	Ft.	In.
Shale.		
Coal		2¼
Shale		⅛
Coal		2¼
Clay		½
Coal		2½
Coal, soft	1	1
Coal, splinty	1	6
Coal	1	5½
Shale		2
Coal	1	
Shale		
Coal	5	7½
Partings		2⅝

Near the head of Looney Creek the bed consists of 3 feet of coal with partings as shown below:

Section of Taggart bed near head of Looney Creek.

(Loc., 23; el., 2,300 feet, B.)

	Ft.	In.
Shale.		
"Rash"		2
Coal		4
Coal, bony		7
Coal	2	8
Clay		
Coal	3	0
Parting		7

The Virginia Iron, Coal & Coke Co.'s mine on the Taggart bed at Laura is located on the north bank of the stream. It produces on an average 7 cars of coal or 350 to 400 tons a day. A section of the coal bed in the mine is as follows:

Section of Taggart coal bed in Laura mine on Looney Creek.

(Loc., 24; el., 2,200 feet, B.)

	Ft.	In.
Shale.		
Coal	1	3
Coal, bony		6
Coal	1	11
Shale		
Coal	3	2
Parting		6

Coal beds between Taggart and Low Splint beds.—Two workable coal beds each 28 inches thick were seen between the Taggart and Low Splint coal beds in a section measured up Looney Creek from Inman to the Double on Black Mountain. The higher bed is 180 feet above the Taggart bed and about 80 feet below the Low Splint bed, and the other bed is 80 feet lower. The distances between the coal beds and the character of the intervening rocks are given in the detailed description of local sections on page 89. The outcrops of the two beds on Looney Creek are at loc. 25, el. 2,300 feet (B) and loc. 26, el. 2,380 feet (B).

Low Splint coal bed.—The Low Splint coal is workable throughout all of its extent in Looney Ridge. The bed lies within 200 feet of the Taggart bed north of Exeter but the interval is apparently considerably greater on Looney Creek, the average being nearly 230 feet.

The Low Splint coal bed is exposed north of Exeter (loc. 27, el. 2,520 feet, B) and shows 35 inches of clear, hard, splinty coal. The coal rests on a 20-foot bed of hard sandstone.

On Looney Creek, the full thickness of the bed was not seen, but 12 inches of splinty coal of the upper part of the bed is exposed (loc. 28, el. 2,450 feet, B).

Coal beds above the Low Splint bed.—A coal bed more than 4 feet thick is exposed north of Exeter (loc. 29, el. 2,640 feet, B), 120 feet above the Low Splint bed. It has the following section:

Section of coal bed 120 feet above the Low Splint bed, north of Exeter.

(Loc., 29; el., 2,640 feet, B.)

	Ft.	In.
Shale.		
Coal	2	2
Shale and bone		10
Coal	2	5
Shale		
Coal	4	7
Parting		10

A smaller bed is exposed between this bed and the Low Splint and is given in the local section on page 92.

The Phillips coal bed is 250 feet above the Low Splint bed and was seen at only one place in the two basins here being considered. This exposure is in the channel of Looney Creek near its head (loc. 30, el. 2,700 feet, B) where there is visible 24 inches of clear hard coal, almost splinty in character. The coal bed is underlain by a 12-inch bed of clay and the two are enclosed both above and below by two massive 40-foot beds of sandstone.

About 300 feet above the Phillips bed is thin coal in sandy shale. The bed contains 21 inches of coal with 3 inches of clay, 4 inches above the bottom of the bed, at a natural exposure in the channel of Looney Creek, high up the side of Black Mountain (loc. 31, el. 3,020 feet, B). An 8-inch bed of hard coal was seen about 30 feet higher in the section. These two coal beds are from 50 to 100 feet below the Pardee bed.

The Pardee bed was not measured on the waters of Looney Creek or Pigon Creek. Judging from a number of sections measured on the north side of Ison Rock Ridge, however, the bed probably averages 40 to 46 inches of coal with a small parting. The bed is unquestionably workable on the south side of Ison Rock Ridge as the ridge is narrow between Looney Creek and Preacher Creek where the sections were measured. Judging from columnar sections measured in Lee County[1] and in the Callahan Creek basin of Wise County giving the approximate altitude of the Pardee bed, it should cross the heads of Pigeon and Looney creeks between elevations of 3,150 and 3,250 feet.

Two coal beds, the Morris and High Splint, occur above the Pardee bed. The Morris lies approximately 400 feet above the Pardee and the High Splint 60 to 70 feet higher in the mountain. Several measurements were made showing the thickness of the High Splint but the Morris bed was not

[1] By Albert W. Giles, Virginia Geological Survey.

measured in either of the two basins here described. The High Splint bed outcrops from 40 to 60 feet below the base of the great ledges of hard, white Harlan sandstone. This coal bed lies so high on Black Mountain that it has only a small acreage in the Pigeon Creek and Looney Creek basins, and it is cut through by low gaps in the mountain west of Looney Ridge. In a survey made by the Interstate Investment Co. in 1905, four sections of the High Splint coal bed were measured in prospect pits about the head of Looney Creek and on the south side of Ison Rock Spur. At loc. 32, el. 3,730 feet (L) the coal is splinty and the bed is 6 feet 2 inches thick; at loc. 33, el. 3,725 (L) the bed consists of an upper bench 2 feet 7 inches thick and a lower bench of splinty coal 2 feet 9 inches thick; at loc. 34, el. 3,675 feet (L) there is only a part of the bed 5 feet thick exposed; and at loc. 35, el. 3,630 feet (L) there are two benches, each 2 feet 11 inches thick, the splinty coal being restricted to the lower bench.

The locations of the prospects noted above may be in error to a small extent, as the pits could not be found by the writer and they were plotted on the accompanying map from a rather small-scale blue print. Also for the same reasons the elevations may not be strictly accurate.

CALLAHAN CREEK BASIN.

General features.—All of the territory drained by Callahan Creek and Halfway Branch of Powell River will be described as the Callahan Creek basin. This basin is one of the largest drainage basins in Wise County, containing from 32 to 35 square miles of territory. It is also one in which coal-mining is carried on to as great an extent as it is in any other basin in the county, producing, in the year 1918, 29.2% of the entire coal output of the county, of which 16.9% came from the Imboden and 12.3% from the Taggart coal bed.

Callahan Creek is eight miles long and flows south from Black Mountain into Powell River at Appalachia. The principal tributaries of Callahan Creek enter that stream from the west, the largest two being Preacher Creek and Mudlick Creek. The basin of Callahan Creek is bounded on the west and north by Harlan and Letcher counties, Kentucky, and on the east by Roaring Fork basin. The surface of the basin is characterized by steep-sided, narrow valleys, and long sharp divides. The relief of the basin varies from less than 700 feet at Appalachia to nearly 4,000 feet on the crest of Black Mountain. The slopes for the most part are thickly wooded.

Throughout the entire Callahan Creek basin the regional dip of the rocks is to the northwest, but there is a slight reverse or southeast dip in a narrow zone adjoining and paralleling the upturned strata along Powell River. Though the dips as a whole are uniformly northwest, the structure contours based on accurate mine data bring out several irregularities that would otherwise have been overlooked. Thus the Imboden bed, considered as a key bed, lies practically flat for nearly 1 square mile northwest of Arno and west of Osaka, but east of Stonega it is domed up nearly 50 feet, the height not being quite sufficient to catch a closed structure contour. Northwest of the 1,750-foot structure contour the dip is regular, at a slope of about 150 feet to the mile. The irregularities of structure described above lies close to Little Stone Mountain and are unquestionably the result of the same horizontal pressure within the earth's crust that produced the folded and crushed rocks along the base of Stone Mountain and the great anticline of which this ridge is the northern limb. The rocks exposed in the Callahan Creek basin comprise the longest stratigraphic section found in Wise County. The beds (not including upturned beds) range from 400 feet below the Imboden coal bed to nearly 700 feet above the top of the Wise formation, making a section of more than 3,400 feet. This great exposure is brought about by the great relief of the surface and by the fact that the regional northwest dip is directly opposed to the stream gradients. Under such conditions the streams have cut rapidly and deeply into the Wise formation, exposing more of the formation and its enclosed coal beds than would have been possible were the dip in the other direction. The deep cutting into the formation by Callahan Creek and its branches is of tremendous value in exposing at the surface and making readily available the Imboden coal bed, but it also is responsible for the erosion of much of the higher beds.

The two coal beds of the Callahan Creek basin from which most of the coal is being mined at present are the Imboden and the Taggart. Other beds of sufficient thickness to be mined are the Kelly, Taggart Marker, Low Splint, Pardee, Morris, and High Splint. As in the Pigeon and Looney creeks basins, several intermediate beds of workable thickness have been found. The quality and character of the Callahan Creek coals are described in another section of this report (page 533), and graphic sections of the coal beds are given in figures 21, 22, and 23. The high heating value of the Taggart coal in its run-of-mine form is excelled by only one other coal in Virginia, the Pocahontas No. 3 bed in Tazewell County. The relation of the heating value of the Taggart to that of the Pocahontas No. 3 bed and the other Wise County beds is shown in figure 54, page 532.

The Stonega Coke & Coal Co. has three large mines operating in the Imboden bed, one at Arno, one at Osaka, and one at Stonega, and one mine in the Taggart bed, at Roda. The mines at these places have modern equipment, and all mining machinery is driven by electricity. Electric motors

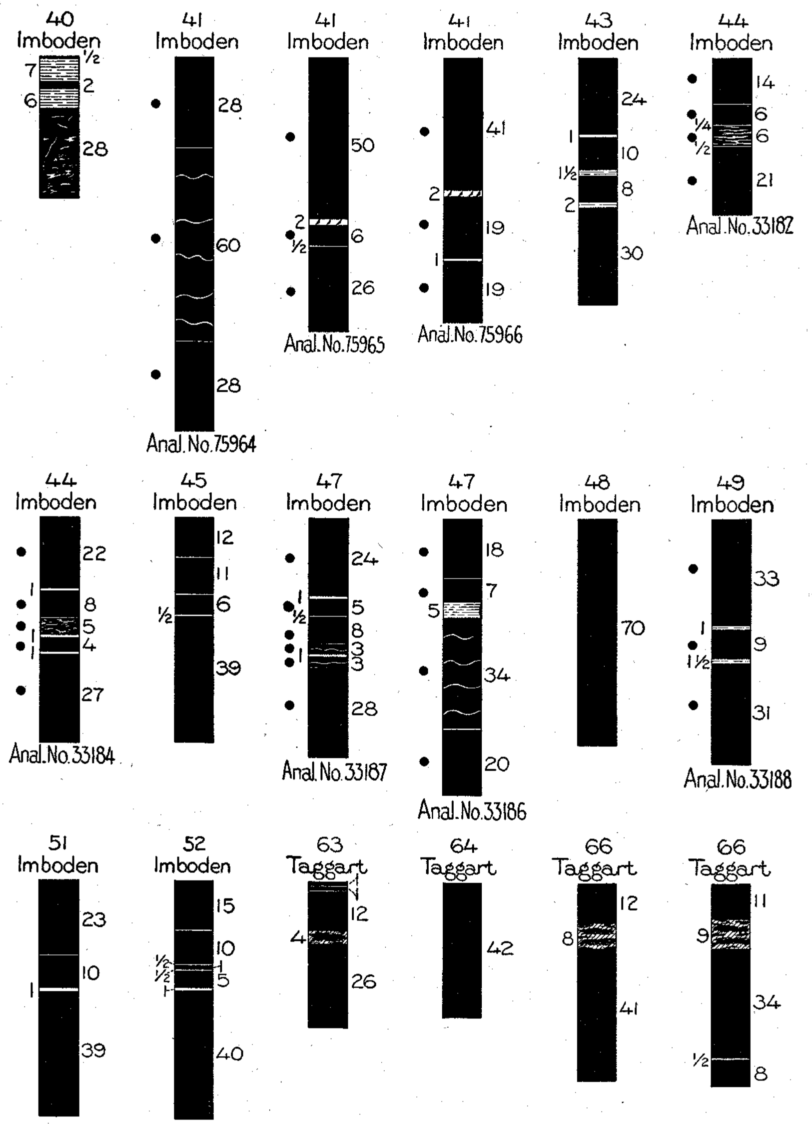


Fig. 21.—Sections of coal beds in the basin of Callahan Creek.

are used to haul the coal to the tipples, which are equipped with screens so as to separate the run-of-mine into 3 sizes of coal, lump, egg and slack. The coal from the Imboden bed is largely coked in the several hundred beehive ovens located at Stonega and Osaka. The Taggart coal is shipped, either as run-of-mine coal or as sized coal.

The Callahan Creek basin is served by the Interstate Railroad that has spurs to all of the mines. The Southern and the Louisville and Nashville railroads both enter Appalachia and give adequate transportation facilities to the basin.

The rough character of the surface of the Callahan Creek basin narrowly restricts the settlement of the region to the valleys. Appalachia, located at the mouth of the basin, has a population of over 2,000, and has practically no room for expansion. North of Appalachia the main valleys are narrow but habitable and fairly large settlements have grown up around the mines of Arno, Osaka, Roda and Stonega. The ridges, however, are steep, rough, covered in large part by sandstone debris, and are particularly uninviting to the homesteader.

The basin has a good wagon road up Callahan Creek to Stonega and up Mudlick Creek to Roda. Trails cross Black Mountain from the heads of Preacher Creek and Mudlick Creek to Lynch, Kentucky, and a passable wagon road crosses the mountain from the head of Callahan Creek to Eolia, Kentucky. No roads cross the ridges between the Callahan Creek basin and the adjoining coal basins in Wise County. A trail crosses Nine-mile Spur from Stonega to Dunbar on Roaring Fork but it is almost too steep for horseback travel. All vehicular traffic between the Callahan Creek basin and the adjacent basins must proceed by way of Appalachia.

Coal beds below the Imboden.—A deep boring at Andover (see Plate III in pocket) discloses representatives of the Clintwood, Blair, Dorchester, and Norton coal beds. As these beds do not outcrop on Callahan Creek, little can be said of their extent and character in this basin. A coal bed exposed in a bank by the roadside at loc. 36, el. 1,830 feet (B) on Halfway Branch, lies about 180 feet below the Imboden. It ranges in thickness from 15 to 20 inches. An opening on the same bed on the east bank of Halfway Branch (loc. 37, el. 1,810 feet, B) shows 18 inches of coal.

Another thin bed of coal 70 feet below the Imboden was seen on the east bank of Callahan Creek, near the mouth of Mudlick Creek where it is overlain by 20 feet of coarse cross-bedded sandstone. It is not workable at present as the following section shows:

Section of coal bed 70 feet below the Imboden bed on Callahan Creek near Mudlick Creek.

(Loc., 38; el., 1,750 feet, B.)

	Ft.	In.
Sandstone	20	
Coal	1	
Shale		2
Coal		2
Bone		1
Coal		5
Shale		2
Coal		1
Shale		
Coal	1	8
Partings		5

A thin coal bed 40 feet below the Imboden was seen on Callahan Creek south of Stonega, of which the following is a section:

Section of coal bed 40 feet below the Imboden near Stonega.

(Loc., 39; el., 1,810 feet, B.)

	Ft.	In.
Shale.		
Coal		9
Shale		2
Coal		2
Shale		2
Coal		4
Shale, carbonaceous		
Sandstone		
Coal	1	3
Partings		4

Imboden and Kelly coal beds.—The Imboden is commercially the most important coal bed in the basin, producing 33⅓ per cent more coal than the Taggart bed, its nearest rival. The Imbdoen coal bed has an average thickness of 6 feet with 3 inches of parting. The extremes of thickness found in measured sections show a minimum of 3 feet 11 inches at Osaka and a maximum of 9 feet 8 inches at Arno. Both are exceptional and rarely found. The bed as a whole shows remarkable uniformity of thickness and quality.

The Imboden bed in many places contains a zone of crushed coal, commonly called "curly coal," which has been produced by slight movements along the bedding planes when the rocks of this region were being folded and crushed. The movement has broken the coal in this zone into irregular blocks, with smooth, curved, and slickensided surfaces. The curly coal is usually in or near the middle of the bed and the adjoining coal is hard, and cut by cleavage planes into columnar blocks or prisms. The quality of the normal coal is not essentially different from that of the curly coal, according to the local mine superintendents, but this statement has not been tested by chemical analysis.

The Imboden coal is being mined at Arno at the mouth of Preacher Creek in five mines belonging to the Stonega Coke & Coal Co. These mines are named the Rock Heading mine, Dip mine, Hog Branch mine, A-face mine, and Old No. 2 mine. Respectively these mines employ 60, 30, 12, 12, and 6 miners, with a total daily output of 1,200 tons. The coal is all shipped as run-of-mine and none of the coal is coked. The roof in many parts of the Arno mines is weak and requires considerable timbering.

The coal bed near the outcrop of Old No 2 mine has the following section:

Section of Imboden coal bed in Old No. 2 mine.

(Loc., 40; el., 1,790 feet, L.)

	Ft.	In.
Shale.		
Coal	2	2
Shale		½
Coal		7
Shale		2
Coal, impure		6
Coal	2	4
Clay		
Coal	5	7
Partings		2½

Three samples of coal collected in the Rock Heading mine were analyzed and the results appear on page 518. One sample (lab. No. 75965) contained only 1.2% ash and gave a heating value of 14,380 B. t. u.,' a remarkable result, in view of the much higher average ash content—5% or more—in all the other Imboden samples collected. The bed in this mine is also a low-sulphur coal, averaging .63%. The sections measured in taking the samples are as follows:

Sections of the Imboden coal bed in the Rock Heading mine, Arno.

(Loc., 41; el., 1,798 feet, L.)

Section where sample was cut in room 7, off 5 face entry, off 1st right butt entry.

(Analysis No. 75964.)

	Ft.	In.
Shale.		
*Coal	2	4
*Coal, curly	5	0
*Coal	2	4
Clay		
Coal	9	8

Section where sample was cut in room 14, off 5 face entry, off 1st right butt entry.

(Analysis No. 75965.)

	Ft.	In.
Shale.		
*Coal	4	2
"Rash"		2
*Coal		6
"Sulphur" streaks		½
*Coal	2	2
Clay		
Coal	6	10
Partings		2½

Section where sample was cut from pillar between rooms 30 and 31, off 1st left face entry, off 2d butt entry.

(Analysis No. 75966.)

	Ft.	In.
Shale.		
*Coal	3	5
"Rash"		2
*Coal	1	7
Shale		1
*Coal	1	7
Clay		
Coal	6	7
Partings		3

The Hog Branch mine lies a short distance to the east of the Rock Heading mine, on the north side of Preacher Creek (loc. 42, el. 1,789 feet L) and is connected underground at several points with the Rock Heading mine.

The Stonega Coke & Coal Co. also is operating a mine at Osaka at the mouth of Mudlick Creek. The mine is a large producer with a normal daily output of 1,150 tons. The bed in this mine is reported to have an average thickness of 5 feet 6 inches of coal and 3 inches of parting.

A section measured in a pit west of the main opening is as follows:

*Sampled.

Section of the Imboden coal bed near Osaka mine.

(Loc., 43; el., 1,810 feet, B.)

	Ft.	In.
Shale.		
Coal	2	0
Shale		1
Coal		10
Shale		1½
Coal		8
Shale		2
Coal	2	6
Shale		
Coal	6	0
Partings		4½

The following sections were measured in the Osaka mine while collecting samples for analysis (see page 517):

Sections of the Imboden coal bed in Osaka mine.

(Loc., 44; el., 1,812 feet, L.)

Section where sample was cut at face of 2d face left entry.
(Analysis No. 33182.)

	Ft.	In.
Shale.		
*Coal	1	2
Knife-edge parting		
*Coal		6
Shale		¼
*Coal with streaks of shale		6
Shale		½
*Coal	1	9
Clay		
Coal	3	11
Partings		¾

Section where sample was cut at face of No. 2 right entry, off 4th right face entry.
(Analysis No. 33183.)

	Ft.	In.
Shale.		
*Coal	1	8
Clay		1
*Coal		4
*Coal, curly		7
*Coal, laminated		8
Shale		2
*Coal		6
Clay		
Coal	3	9
Partings		3

Section where sample was cut at face of left entry, off 3d face entry.
(Analysis No. 33184.)

	Ft.	In.
Shale.		
*Coal	1	10
Shale		1
*Coal		8
*Coal, impure		5
Shale		1
*Coal		4
Shale		1
*Coal	2	3
Clay		
Coal	5	6
Partings		3

Average section reported for mine.

	Ft.	In.
Coal	2	0
Shale		1
Coal	1	3
Shale		2
Coal	2	3
Coal	5	6
Partings		3

*Sampled.

On Callahan Creek north of the mouth of Preacher Creek the Imboden coal bed outcrops on both sides of the stream over a thin but hard ledge-making sandstone and under a 60-foot bed of coarse micaceous sandstone. At the southern end of Stonega the coal bed has the following section:

Section of the Imboden coal bed at south end of Stonega.

(Loc., 45; el., 1,874 feet, L.)

	Ft.	In.
Shale.		
Coal	1	0
Knife-edge parting		
Coal		11
Knife-edge parting		
Coal		6
Shale		½
Coal	3	3
Coal	5	8
Parting		½

Opposite the drift mouth of Stonega mine No. 3 (loc. 46, el. 1,932 feet, L) the bed consists of 72 inches of clear coal. The bed is overlain by a thin bed of shale and 55 feet of sandstone.

There are 3 mines in the Imboden bed at Stonega, which are known as Stonega mines Nos. 1, 2, and 3. Together they employ 158 miners and have a daily output of 1,650 tons, which makes them the largest producers of Imboden coal on Callahan Creek. The average section of the Imboden bed in these mines is reported to be 70 inches of coal with a 1-inch shale parting. A section measured near the mouth of Mine No. 3 and two sections measured in the mine in connection with collecting samples for analysis (see page 518) are given below:

Sections of the Imboden coal bed in Stonega Mine No. 3.

(Loc., 47; el., 1,947 feet, L.)

Section where sample was cut in room 7, off 13th right butt entry, off 2d left face entry.
(Analysis No. 33187.)

	Ft.	In.
Shale, bony		4
*Coal	2	0
Shale		1
*Coal		5
Shale		½
*Coal		8
*Coal, curly		3
Shale		1
*Coal, curly		3
*Coal	2	4
Clay		
Coal	5	11
Partings		2½

Section for sample cut at face of main butt entry toward Dunbar.
(Analysis No. 33186.)

	Ft.	In.
Sandstone.		
*Coal	1	6
Knife-edge parting		
*Coal		7
Clay		5
*Coal, curly	2	10
*Coal	1	8
Clay		
Coal	6	7
Parting		5

*Sampled.

Section measured near mine mouth.

	Ft.	In.
Shale.		
Coal	1	3
Knife-edge parting		
Coal		7
Shale		½
Coal		2
Shale		½
Coal		6
Shale		1
Coal	2	4+
Coal	4	10+
Partings		2

In Possum Trot Hollow (loc. 48, el. 1,950 feet, B) the Imboden coal bed is clear coal 5 feet 10 inches thick underlain by clay and overlain by 6 feet 2 inches of shale and an indefinite thickness of sandstone.

The following section of the Imboden bed was measured in Stonega Mine No. 2 at the point where a sample was cut for analysis:

Section of the Imboden coal bed in Stonega Mine No. 2.

(Loc., 49; el., 1,913 feet, L.)

Section where sample was cut in room 6, off 16th left butt entry, off 5th face entry.
(Analysis No. 33188.)

	Ft.	In.
Shale.		
*Coal	2	9
Shale		1
*Coal		9
Shale		1½
*Coal	2	7
Clay		
Coal	6	1
Partings		2½

Stonega Mine No. 1 (loc. 50, el. 1,898 feet, L) lies 1,500 feet west of Mine No. 2. Southeast of Mine No. 1, ½ mile on the outcrop, the following section was measured at a surface pit:

Section of the Imboden coal bed near Stonega Mine No. 1.

(Loc., 51; el., 1,880 feet, B.)

	Ft.	In.
Coal	1	11
Knife-edge parting		
Coal		10
Shale		1
Coal	3	3
Clay		
Coal	6	0
Parting		1

*Sampled.

The Imboden coal bed maintains to the south a uniform thickness of about 6 feet. Opposite the mouth of Mudlick Creek it shows the following section:

Section of the Imboden coal bed on Callahan Creek at Mudlick Creek.

(Loc., 52; el., 1,840 feet, B.)

	Ft.	In.
Shale.		
Coal	1	3
Knife-edge parting		
Coal		10
Shale		½
Coal		1
Shale		½
Coal		5
Shale		1
Coal	3	4
Clay		
Coal	5	11
Partings		2

One mile east of Andover, a branch of Callahan Creek cuts through the Imboden bed, exposing it in a freshly cut channel. In a pit by the stream (loc. 53, el. 2,000 feet, B) 60 inches of clear coal was seen with the bottom of the bed not exposed. The coal bed overlies the hard sandstone, before described, and the latter holds up the stream, making the valley floor a swampy flat.

The Imboden coal bed has been prospected near the heads of the two ravines branching north from the Interstate railroad station at Appalachia. At loc. 54, el. 2,000 feet (B) 4 feet of coal was seen with the bottom of the bed concealed. Near the head of the next ravine to the east, called Boggs Hollow, there is a slumped pit with a large amount of curly coal scattered about, (loc. 55, el. 2,000 feet, B). The coal was not exposed in place. Across the ridge in a northeasterly direction from this pit the bed is exposed at a local mine on Halfway Branch (loc. 56, el. 2,020 feet, B) with a thickness of 60 inches of clear coal.

The Kelly coal bed is of questionable value in the Callahan Creek basin. Where it is of known workable thickness the bed is so close to the Imboden that if the latter is mined first, as it undoubtedly will be, the Kelly bed can not be recovered. Across the south end of the basin the bed is 4 to 5 feet thick and lies within a few feet of the Imboden; in the northern end of the basin the bed is either absent or separated from the Imboden by 60 to 70 feet of sandstone.

On Callahan Creek opposite Stonega Mine No. 3 only one coal bed was seen in a clean exposure above the Imboden bed up to 150 feet. The bed that was seen is 70 feet above the Imboden and has the following section:

Section of the coal bed 70 feet above the Imboden bed near Stonega Mine No. 3.

(Loc., 57; el., 2,005 feet, B.)

	Ft.	In.
Shale.		
Coal	1	0
Shale, carbonaceous		6
Coal		2
Shale		10
Coal		8
Shale	2	6
Shale, carbonaceous	1	
Shale		
Coal	1	10
Partings	1	4

A bed of the character shown in this section is not workable under present conditions.

The Kelly bed was seen outcropping about 10 feet above the Imboden in a ravine 1 mile east of Andover, and a large pit at loc. 58, el. 2,020 feet, (B) has been opened on it, but a slide covered the coal so that its thickness could not be measured. The Kelly is also prospected in the ravine north of Appalachia where coal at least 3 feet 6 inches thick is exposed (loc. 59, el. 2,030 feet, B).

Standiford and Taggart Marker coal beds.—The Standiford beds have not been prospected on Callahan Creek, and several carefully measured sections between the Imboden and Taggart coals have not revealed any persistent beds. Borings on Preacher Creek and Meadow Fork (see plate III in pocket) indicate the presence of two beds, separated by 70 feet of sandstone, at the approximate positions of the Upper and Lower Standiford beds.

Near the mouth of Meadow Fork, a mile and a half north of Stonega (loc. 60, el. 2,070 feet, B), there is a bed consisting of at least 26 inches of coal, the bottom not being exposed. The bed lies under 50 feet of sandstone and directly over a 20-foot bed of the same kind of rock. The coal is 250 feet above the Imboden bed and 170 feet below the Taggart bed which would place it at about the Upper Standiford horizon. As this bed was not seen in other localities where it would be expected to outcrop, if present in workable thickness, it is assumed that it is wanting in much of this basin and consequently its outcrop has not been drawn on the map in the Callahan Creek basin.

The Taggart Marker bed is present throughout much of the basin. It lies from 30 to 35 feet above the Taggart bed. It is of workable thickness on Preacher Creek where it has been prospected by the Stonega Coke & Coal Co., showing 42 inches of clear coal. The company plans to mine the coal from this bed at the head of Preacher Creek jointly with the Taggart bed, the new operation to be known as Derby. The drift that will be the entrance to the new mine in the Taggart Marker bed is on the south side of the creek, three-fifths of a mile south of loc. 63 on the Taggart bed, and is at an elevation of 2,133 feet (L).

On Mudlick Creek, midway between Roda and Osaka, loc. 61, el. 2,140 feet, B) the Taggart Marker bed is partially exposed showing 16 inches of clear coal. It is here 40 feet below the Taggart, with sandstone in the interval between them. The Marker bed was seen near the mouth of Meadow Fork 1½ miles north of Stonega (loc. 62, el. 2,205 feet, B) where it consists of 18 inches of clear coal. It is separated from the Taggart bed by 30 feet of sandstone.

The Taggart Marker coal bed is undoubtedly of workable thickness in much, if not all, of Nine-mile Spur. It is being mined at Dunbar on the Roaring Fork side of the ridge and there has a thickness of 43 to 45 inches. No sections of it, however, were obtained on the Callahan Creek side of the ridge.

Taggart coal bed.—The Taggart coal bed has an extensive outcrop throughout the entire Callahan Creek basin and averages 5 to 6 feet in thickness. The coal is remarkably low in ash and sulphur, the average for each, in four samples,[1] being 2.1% and .52%, respectively. The heating value of the coal averages slightly less than 14,700 B. t. u.'s. (See fig. 54, page 532.) The coal ignites with great ease and burns freely. The excellent quality of this coal makes it especially useful for railroad fuel, steam-raising, illuminating and producer gas, bunker, domestic, beehive coke and by-products. On Preacher Creek the bed is 415 feet above the Imboden bed, on Meadow Fork, 450 feet, and on Nine-mile Spur, 450 feet. White, arkosic sandstone outcrops above and below the Taggart coal bed, and forms more than 80% of the rocks between the Taggart and Imboden

[1] See table of coal analyses, page 520.

beds. It is not uncommon to find thin beds of clay shale separating the coal bed from the underlying and overlying sandstone.

The Taggart bed is mined at Roda by the Stonega Coke & Coal Co., and this is the only operation at present in the bed on Callahan Creek. The company plans to mine the Taggart coal at the head of Preacher Creek, the new operation to be called the Derby plant. The mines at Roda are as follows: Roda mines No. 1 and 2, using the same mine mouth, Roda Mine No. 3 and Roda Mine No. 4. For the various mines the company employs 265 miners for a daily production of 2,500 tons of coal.

The coal bed is exposed in a prospect pit on Preacher Creek and a section, thinner than the average, was measured as follows:

Section of the Taggart coal bed on Preacher Creek.

(Loc., 63; el., 2,110 feet, B.)

	Ft.	In.
Sandstone.		
Coal		1
Sandstone		¼
Coal		1
Sandstone		¼
Coal	1	
Bone		4
Coal	2	2
Coal	3	4
Partings		4½

The prospect pit that marks the location of the new mine in the Taggart bed at the head of Preacher Creek lies one-half a mile east of loc. 63 and is at an elevation of 2,171 feet (L). The coal in this pit is 68 inches thick without a parting.

The Taggart bed shows on the north side of Roda Spur, west of Osaka (loc. 64, el. 2,180 feet, B) where 42 inches of coal was seen, but this is not the full thickness as the base of the bed was not fully exposed. The coal lies between beds of sandstone.

Roda Mine No. 4 enters the Taggart coal bed under Roda Spur, at the mouth of McHenry Fork (loc. 65, el. 2,053 feet, L). The main drift runs due south, thus taking advantage of the northwest dip in hauling out loaded cars. The actual rise of the coal from the entrance south is 100 feet in a mile or about 35 feet less per mile than if it mounted the rise at right angles to the strike. The average thickness of the bed in Mine No. 4 is 6 feet of coal with 2 inches of shale divided into thin partings.

The following sections of the bed were measured in McHenry Fork Hollow due west of Roda:

Sections of the Taggart coal bed in McHenry Fork Hollow.

(Loc., 66; el., 2,050 feet, B.)

(West Pit.)

	Ft.	In.
Sandstone.		
Coal	1	
Bone		8
Coal	3	5
Clay		
Coal	4	5
Parting		8

(East Pit.)

	Ft.	In.
Sandstone.		
Shale	4	
Coal		11
Bone		9
Coal	2	10
Shale		½
Coal		8
Coal	4	5
Partings		9½

The Taggart coal has been sampled in Roda Mine No. 3, which enters the bed north of McHenry Fork. The sections measured in collecting samples are as follows:

Sections of the Taggart coal bed in Roda Mine No. 3.

(Loc., 67; el., 2,047 feet, L.)

Section where sample was cut in room 5, off 4th butt entry, off 3d left face entry.

(Analysis No. 33203.)

	Ft.	In.
Shale.		
*Coal		2
*Bone		½
*Coal		4
Shale		¼
*Coal		10
*Bone		5
*Coal, laminated with shale	2	4
Shale		1
*Coal	2	4
Clay		
Coal	6	0
Partings		6¾

Section where sample was cut in room 5, off 3d butt entry, off 2d left face entry.

(Analysis No. 33204.)

	Ft.	In.
*Coal		2
*Bone		½
*Coal		4
Shale		¼
*Coal	1	0
*Bone		4
*Coal, with shale laminae	2	1
Shale		¼
*Coal	2	2
Clay		
Coal	5	9
Partings		5

*Sampled.

Section where sample was cut in room 3, off 2d butt, off 2d left face entry. (Analysis No. 33205.)

	Ft.	In.
Shale.		
*Coal		2
*Bone		½
*Coal		4
Shale		¼
*Coal		9
*Bone		4
*Coal, with shale laminae	2	10
Shale		½
*Coal	1	
Clay		
Coal	5	1
Partings		5¼

Section where sample was cut in room 9, off 2d butt entry, off 2d left face entry. (Analysis No. 33206.)

	Ft.	In.
Shale.		
*Coal		2
*Bone		½
*Coal		6
Shale		½
*Coal		7
*Bone		5
*Coal, with shale laminae	2	
Shale		½
*Coal	1	8
Shale		½
*Coal	1	
Clay		
Coal	5	11
Partings		7

The entrance to mines No. 1 and No. 2 lies east of Mine No. 3 and is at loc. 68, el. 2,055 feet (L). The section of the Taggart bed in these mines does not vary appreciably from the average of those given above.

Southeast of mines No. 1 and No. 2 nearly 1 mile two surface pits give the following sections of the Taggart bed:

Sections of the Taggart coal bed 1 mile southeast of Roda.

(Loc., 69; el., 2,105 feet, L.)

(West Pit.)

	Ft.	In.
Sandstone.		
Shale	5	
Coal		10
Bone	1	
Coal	4	7
Clay		
Coal	5	5
Parting	1	

(East Pit.)

	Ft.	In.
Sandstone.		
Shale	6	
Coal		8
Bone		9
Coal	3	11+
Coal	4	7+
Parting		9

The coal bed has been opened near the head of Halls Branch and shows an excellent section, with the characteristic parting of bone near the top of the bed.

*Sampled.

Section of the Taggart coal bed on Halls Branch.

(Loc., 70, el. 2,172 feet, L.)

(West Pit.)

	Ft.	In.
Shale.		
Coal		10
Bone		9
Coal	4	8
Clay		
Coal	5	6
Parting		9

(East Pit.)

	Ft.	In.
Shale.		
Coal		11
Bone		6
Coal	4	3
Clay		
Coal	5	2
Parting		6

An incomplete section of the Taggart bed is exposed on the southeastern end of Bluff Spur (loc. 71, el. 2,245 feet, L). The base of the bed was under cover, but 3 feet 2 inches of coal containing 4 inches of bone was seen.

The Taggart bed is thin on Meadow Fork of Callahan Creek, 1 mile north of Stonega. It was measured in pits, on the two sides of the stream, giving the following sections:

Sections of the Taggart coal bed on Meadow Fork.

(Loc., 72; el., 2,236 feet, B.)

	Ft.	In.
Coal		10
Bone		4
Coal	1	8
Coal	2	6
Parting		4

(Loc., 73; el., 2,350 feet, B.)

	Ft.	In.
Shale.		
Coal	1	
Shale		½
Coal		10
Shale		1
Coal		3
Shale		½
Coal		4
Shale		½
Coal	1	8
Clay		
Coal	4	1
Partings		2½

No measurements were made on the Taggart coal bed on Nine Mile Spur as few of the pits on this bed were found, and those few were closed. Natural exposures are not so common as on the slopes west of Callahan Creek, as Nine Mile Spur contains few ledge-making sandstones, and the shale slopes are heavily wooded. Sections measured on the Roaring Fork side indicate a thickness of from 3 to 4 feet throughout much of the ridge.

Low Splint and lower coal beds.—The first persistent bed above the Taggart is the Low Splint coal bed, which lies at a distance above the Taggart of about 230 feet. Beds were found, however, at intermediate positions between these main beds at several localities. The only one of these seen lies 50 feet above the Taggart bed. It is exposed on Preacher Creek (loc. 74, el. 2,160 feet, B) and shows 43 inches of coal, the top 3

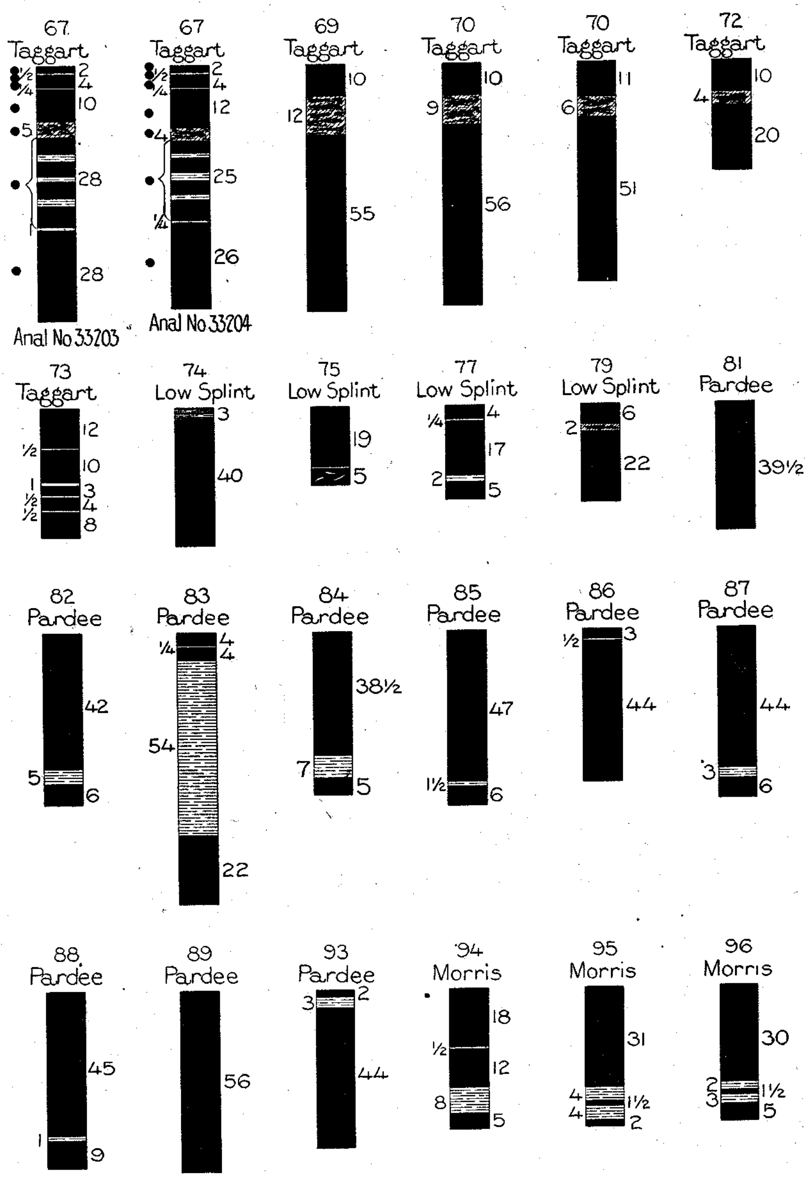


Fig. 22.—Sections of coal beds in the basin of Callahan Creek.

inches being laminated with shale. The bed is overlain by 80 feet of sandstone, over which lies $7\frac{1}{2}$ inches of coal. Several closed pits were seen on Roda Spur that evidently had been opened on this bed, but no traces of the coal were found on the east side of Callahan Creek or at any other place in the basin.

The Low Splint coal bed lies 220 to 240 feet above the Taggart and outcrops continuously around the Callahan Creek basin. It averages 26 inches of coal with a parting of bone or shale that is 3 inches or less in thickness. The coal is hard and usually splinty near the base of bed, but it has not been mined anywhere in the basin.

The Low Splint bed is exposed on Preacher Creek between massive sandstone beds that dip 4° northwest. The section of the coal bed is as follows:

Section of the Low Splint coal bed on Preacher Creek.

(Loc., 75; el. 2,380 feet, B.)

	Ft.	In.
Sandstone.		
Clay	2	3
Coal	1	7
Coal, splinty		5
Sandstone		
Coal	2	0

On Mudlick Creek, 1 mile northwest of Osaka (loc. 76, el. 2,370 feet, B) the Low Splint bed is partially exposed, showing a thickness of a little more than 2 feet. The overlying sandstone is here only 40 feet thick and the coal above the sandstone, 2 inches thick.

Three sections of the bed were measured near Roda, of which 2 were measured on McHenry Fork and one near head of Mudlick Creek. On McHenry Fork the Low Splint coal bed is prospected in 2 pits, where the following sections were measured:

Sections of the Low Splint coal bed on McHenry Fork.

(Loc., 77; el. 2,210 feet, B.)

	Ft.	In.		Ft.	In.
Sandstone.			Sandy shale		
Coal		4	Coal	1	6
Shale		¼	Shale		4
Coal	1	5	Coal		6+
Shale		2	Coal	2+	
Coal		5	Parting		4
Clay					
Coal	2	2			
Partings		2¼			

The bed at the location noted above is under 40 feet of sandstone. Six inches of coal was seen above this sandstone with the top of the bed not exposed. North of Roda on Mudlick Creek (loc. 78, el. 2,230 feet, B) the Low Splint shows 2+ feet of coal with 3 inches of clay 6 inches from the top of the bed. The bottom of the bed is not exposed.

The Low Splint bed is exposed on Halls Branch (loc. 79, el. 2,360 feet, B), where it consists of 2 feet, 4 inches of coal with 2 inches of clay 6 inches from the top of the bed.

The Low Splint coal bed was not found on the Callahan Creek side of Nine Mile Spur. A few closed pits were visited but sections of the bed were unavailable.

Coal beds between Low Splint and Pardee coal beds.—Several local coal beds or lenses of coal occur in the interval of 600 to 630 feet between the Low Splint and the Pardee coal beds. One of these, the Phillips, is a persistent bed but it is thin and scarcely workable. The intervals, thickness, and character of the intermediate beds can readily be obtained from the local sections given on pp. 89-96 and will not be further described here. As will be seen in the sections the beds are thin and for the most part unworkable. At one exposure near the head of Preacher Creek (loc. 80, el. 2,580 feet, B) a bed that is thought to be the Phillips has the following section:

Section of the Phillips coal bed near head of Preacher Creek.

	Ft.	In.
Sandstone.		
Coal		3
Bone		1
Coal		7
Bone		1
Coal		10
Sandstone		
Coal	1	8
Partings		2

Pardee coal bed.—The Pardee coal bed outcrops high on the slope of Black Mountain, lying 850 feet above the Taggart bed and from 400 to 450 feet below the Harlan sandstone. The bed here does not possess the great thickness that characterizes it at Pardee, its type locality. Throughout much of the Callahan Creek basin it averages 4 to 4½ feet of coal with 3 to 6 inches of shale partings. The bed is not mined on Callahan Creek.

The Pardee coal bed was quite thoroughly prospected in this basin about 20 years ago, but the prospect pits are now closed by slumping of roof and the coal could not be seen. Many of the sections, as reported by this old survey, are given below to illustrate the character of the bed in this basin. Thus on the north flank of Ison Rock Ridge the sections are as follows:

Sections of the Pardee coal bed on Ison Rock Ridge.

(S. C. & C. Co. prospects.)

(Loc., 81; el., 3,210 feet, L.)

	Ft.	In.
Coal	3	3½

(Loc., 82; el., 3,171 feet, L.)

	Ft.	In.
Coal	3	6
Shale		5
Coal		6
Coal	4	0
Parting		5

(Loc., 83; el., 3,113 feet, L.)

	Ft.	In.
Coal		4
Shale		½
Coal	4	4
Shale	1	6
Coal		10
Coal	5	6
Partings	1	6½

(Loc., 84; el., 3,074 feet, L.)

	Ft.	In.
Coal	3	2½
Shale		7
Coal		5
Coal	3	7½
Parting		7

(Loc., 85; el., 3,045 feet, L.)

	Ft.	In.
Coal	3	11
Shale		1½
Coal		6
Coal	4	5
Parting		1½

(Loc., 86; el., 3,001 feet, L.)

	Ft.	In.
Coal		3
Shale		½
Coal	3	8
Coal	3	11
Parting		½

The coal bed shows a similar section on Roda spur where the following sections were measured:

Sections of the Pardee coal bed on Roda spur.

(S. C. & C. Co. prospects.)

(Loc., 87; el., 2,980 feet, L.)

	Ft.	In.
Coal	3	8
Shale		3
Coal		6
Coal	4	2
Parting		3

(Loc., 88; el., 3,107 feet, L.)

	Ft.	In.
Coal	3	9
Shale		1
Coal		9
Coal	4	6
Parting		1

The Pardee bed was measured on McHenry Fork by the Stonega Co. (loc. 89, el. 2,780 feet, L), and the bed found to contain 56 inches of coal without a parting. In the valley northwest of Roda (loc. 90, el. 2,798 feet, L) the bed contains, according to the same authority, 4 feet 7 inches of coal with 1 inch of shale near the base of the bed. The Pardee coal contains many small partings of shale at its outcrop near the head of Mudlick Creek, as shown by the following sections measured in drifts that had been driven into the bed 10 to 15 feet:

Sections of the Pardee coal bed at the head of Mudlick Creek.

(Loc., 91; el., 2,750 feet, B.)

	Ft.	In.
Shale.		
Coal		2
Shale		3
Coal		1½
Shale		½
Coal		½
Shale		½
Coal		1
Shale		3
Coal		3
Shale		½
Coal	1	3
Coal, bony		8
Coal	1	0
Shale		1
Coal		7
Coal	4	2
Partings		8½

(Loc., 92; el., 2,760 feet, B.)

	Ft.	In.
Shale.		
Coal		½
Shale		6
Coal		1½
Clay		½
Coal		3
Shale	1	3
Coal		3
Shale		1
Coal		1
Shale		5
Coal		2
Shale		1
Coal		1
Shale		4
Coal	3+	
Coal	4+	
Partings	2	8½

The bed has been prospected on the end of the spur due east of Roda, where it has the following section:

Section of the Pardee coal bed east of Roda.

(S. C. & C. Co. prospect.)

(Loc., 93; el., 3,059 feet, L.)

	Ft.	In.
Coal		2
Shale		3
Coal	3	8
Coal	3	10
Parting		3

The Pardee coal bed has only a small acreage on Nine Mile Spur, near the head of Callahan Creek and no prospects on it were seen that could be measured.

Morris coal bed.—A coal bed, called the Morris, lies from 300 to 350 feet feet above the Pardee bed and has been extensively prospected in the Callahan Creek basin. The best development of this bed is in Bluff Spur where the coal bed averages 5 to 5½ feet thick. Southwest along Black Mountain from Bluff Spur the bed thins to less than 3 feet, at the head of Preacher Creek. The bed contains very few partings, the total impurities in it rarely exceeding 6 inches. The coal is of good quality but is not mined anywhere in the Callahan Creek basin. It outcrops near the top of Black Mountain and Bluff Spur, and, if worked, the coal could be let down to railroad level only by long chutes or inclined tramroads.

The thickness of the bed was measured at a number of prospect pits that were opened by the Stonega Coke & Coal Co. Thus on Roda Spur the following sections were taken:

Morris coal bed on Roda Spur.

(S. C. & C. Co. prospect.)

(Loc., 94; el., 3,357 feet, L.)

	Ft.	In.
Coal	1	6
Shale		½
Coal	1	
Shale		8
Coal		5
Coal	2	11
Partings		8½

(Loc., 95; el., 3,363 feet, L.)

	Ft.	In.
Coal	2	7
Shale		4
Coal		1½
Shale		4
Coal		2
Coal	2	10½
Partings		8

(Loc., 96; el., 3,378 feet, L.)

	Ft.	In.
Coal	2	6
Shale		2
Coal		1½
Shale		3
Coal		5
Coal	3	½
Partings		5

(Loc., 97; el., 3,326 feet, L.)

	Ft.	In.
Coal	3	4
Shale		1
Coal		8
Coal	4	0
Parting		1

West and northwest of Roda the bed averages from 3 to 4 feet of nearly clear coal. The following sections measured at the head of McHenry Fork and northwest of Roda are representative of the bed.

Morris coal bed west and northwest of Roda.

(S. C. & C. Co. prospect.)

(Loc., 98; el., 3,240 feet, L.)

	Ft.	In.
Coal	2	11
Shale		1
Coal		6
Coal	3	5
Parting		1

(Loc., 99; el., 3,192 feet, L.)

	Ft.	In.
Coal	3	1

(Loc., 100; el., 3,096 feet, L.)

	Ft.	In.
Coal	3	6
Shale, coal streaks	1	1
Coal	3	6

(Loc., 101; el., 3,038 feet, L.)

	Ft.	In.
Coal	4	2

The Morris bed is an excellent coal on the head of Mudlick Creek, where numerous sections indicate an average thickness of more than 5 feet. The character of the bed is better illustrated by giving the detailed sections, as follows:

Morris coal bed on head of Mudlick Creek.

(S. C. & C. Co. prospects.)

(Loc., 102; el., 3,138 feet, L.)

	Ft.	In.
Coal	4	1

(Loc., 103; el., 3,042 feet, L.)

	Ft.	In.
Coal	5	2
Bone		3½
Coal		3
Coal	5	5
Parting		3½

(Loc., 104; el., 3,023 feet, L.)

	Ft.	In.
Coal	4	5
Bone		½
Coal		8
Coal	5	1
Parting		½

(Loc., 105; el., 3,021 feet, L.)

	Ft.	In.
Coal	4	7
Bone		½
Coal	1	1
Shale	1	
Coal		9
Coal	6	5
Partings	1	½

(Loc., 106; el., 3,059 feet, L.)

	Ft.	In.
Coal	5	5

(Loc., 107; el., 3,063 feet, L.)

	Ft.	In.
Coal	5	1½
Shale		½
Coal		6
Bone		1
Coal		2
Shale		2
Coal		2
Coal	5	11½
Partings		3½

(Loc., 108; el., 3,126 feet, L.)

	Ft.	In.
Coal	4	6
Shale		½
Coal	1	2½
Coal	5	8½
Parting		½

(Loc., 109; el., 3,199 feet, L.)

	Ft.	In.
Coal	4	8
Shale		½
Coal		7
Shale		1
Coal		2
Coal	5	5
Partings		1½

(Loc., 110; el., 3,281 feet, L.)

	Ft.	In.
Coal	3	8
Shale		½
Coal		7
Coal	4	3
Parting		½

On the southern end of Bluff Spur the Morris bed shows excellent sections as follows:

Sections of Morris coal bed on south end of Bluff Spur.

(S. C. & C. Co. prospects.)

(Loc., 111; el., 3,281 feet, L.)

	Ft.	In.
Coal	3	8
Shale		½
Coal	1	1
Coal	4	9
Parting		½

(Loc., 112; el., 3,309 feet, L.)

	Ft.	In.
Coal	4	8
Shale		½
Coal		7
Shale		1½
Coal		5½
Shale		2
Coal		4
Coal	6	½
Partings		4

(Loc., 113; el., 3,232 feet, L.)

	Ft.	In.
Coal	4	2½
Shale		½
Coal		2
Coal	4	4½
Parting		½

(Loc., 114; el., 3,177 feet, L.)

	Ft.	In.
Coal	5	8
Shale		1
Coal		2
Coal	5	10
Parting		1

The bed has an excellent thickness on the east side of Bluff Spur, on Meadow Fork of Callahan Creek.

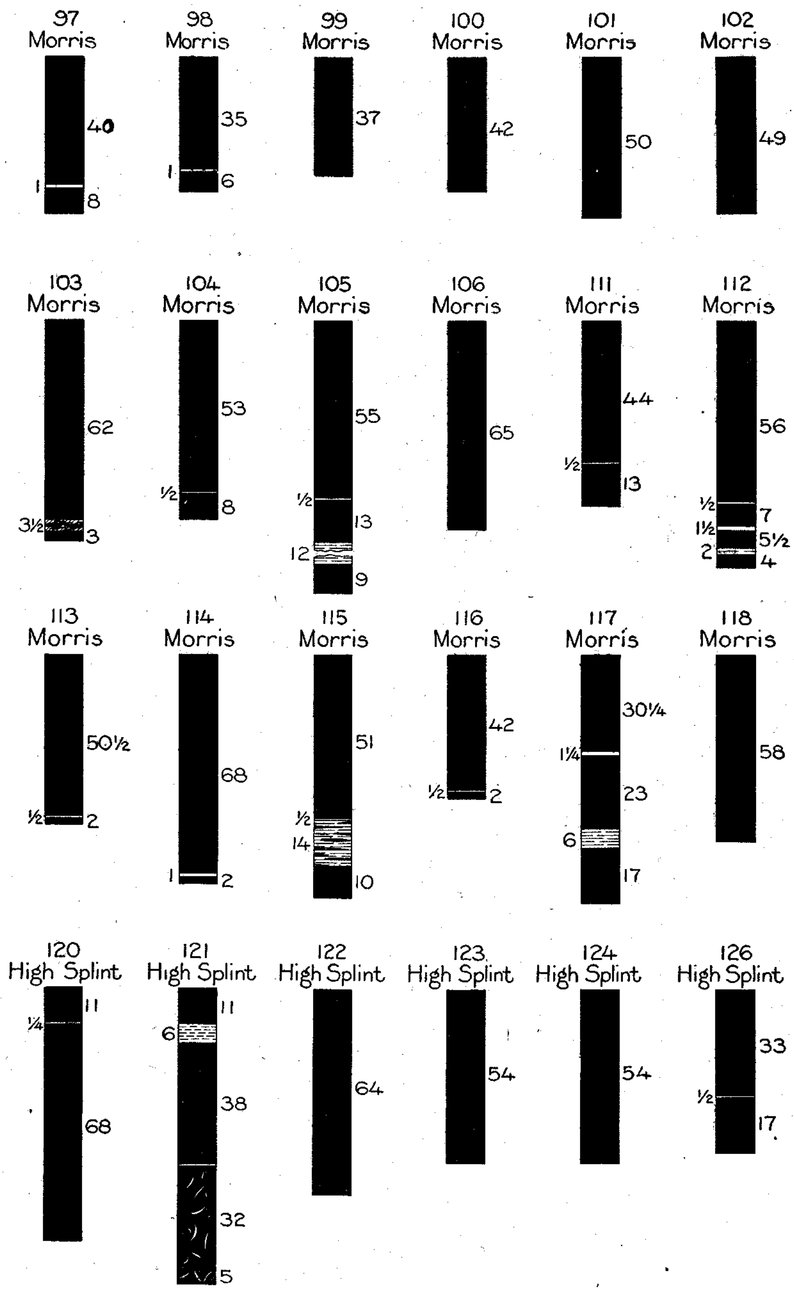


Fig. 23.—Sections of coal beds in the basin of Callahan Creek.

Sections of Morris coal bed on east side of Bluff Spur.

(S. C. & C. Co. prospects.)

(Loc., 115; el., 3,204 feet, L.)

	Ft.	In.
Coal	4	3
Shale		½
Shale, coal streaks	1	2
Coal		10
Coal	5	1
Parting	1	2½

(Loc., 116; el., 3,137 feet, L.)

	Ft.	In.
Coal	5	6
Shale		½
Coal		2
Coal	5	8
Parting		½

(Loc., 117; el., 3,168 feet, L.)

	Ft.	In.
Coal	2	6¼
Shale		1¼
Coal	1	11
Shale		6
Coal	1	5
Coal	5	10¼
Partings		7¼

(Loc., 118, el., 3,114 feet, L.)

	Ft.	In.
Coal	4	10

(Loc., 119; el., 3,156 feet, L.)

	Ft.	In.
Coal	3	6
Bone		½
Coal	1	2
Coal	4	8
Parting		½

High Splint coal bed.—The highest coal bed in the Callahan Creek basin that has been prospected to any extent is the High Splint, lying from 40 to 70 feet above the Morris. It lies below the Harlan sandstone at a distance ranging up to 80 feet, and its outcrop can be traced by the continuous cliff of the overlying basal sandstone of the Harlan formation. The coal bed is generally thick, but its remaining acreage is small as it outcrops near the top of Black Mountain and Bluff Spur. Sections measured on Black Mountain show thicknesses of coal exceeding 7 feet, with insignificant partings. The bed is usually divided into normal hard coal in the top half and splint coal in the bottom half.

At the head of Preacher Creek the bed ranges in thickness from 4½ to over 7 feet, as shown by the following sections:

Section of High Splint coal bed at the head of Preacher Creek.

(S. C. & C. Co. prospects.)

(Loc., 120; el., 3,706 feet, L.)

	Ft.	In.
Clay.		
Coal		11
Clay		¼
Coal	5	8
Coal	6	7
Parting		¼

(Loc., 121; el., 3,660 feet, L.)

	Ft.	In.
Shale.		
Coal		11
Clay		6
Coal	3	2
Coal, splint	2	8
Coal		⅛
Coal, splint		5
Coal	7	2⅛
Parting		6

The following additional sections were measured at the head of Preacher Creek by the Stonega Co.; at loc. 122, el. 3,520 feet (L), coal 5 feet 4 inches; at loc. 123, el. 3,393 feet (L), coal 4 feet, 6 inches; and at loc. 124, el. 3,362 feet (L), coal 4 feet, 6 inches.

On the crest of Roda Spur the High Splint bed contains a parting of sandstone that splits the bed into 2 benches. The record of the exact interval between these two benches could not be found but is reported to be less than 20 feet. The section as reported is given below:

Section of the High Splint coal bed on Roda Spur.

(Loc., 125; el., 3,437 feet, L.)

	Ft.	In.
Coal	4	5
Sandstone		
Coal		3
Shale		4
Coal	2	8
Shale		
Coal	7	4
Partings		4+

No sections of the bed were obtained on Bluff Spur, the coal being concealed in most places by the large amount of debris from the sandstone ledges above it. A prospect has been opened near the roadside at the head of Callahan Creek, just south of the gap in Black Mountain. The bed here has the following section:

Section of the High Splint coal bed at head of Callahan Creek.

(Loc., 126; el. 3,200 feet, B.)

	Ft.	In.
Shale.		
Coal	2	9
Bone		½
Coal	1	5
Clay		
Coal	4	2
Parting		½

The High Splint bed at this locality is 80 feet below the Harlan sandstone.

ROARING FORK BASIN.

General features.—The territory drained by Roaring Fork and Mill Branch of Powell River lies in a west-central Wise County, and is one of the largest basins to be described north of Powell Mountain. Roaring Fork is 9½ miles long, having its source on the south slope of Black Mountain and it flows into Powell River at Kent Junction. Roaring Fork, Dunbar, and Pardee, are the centers of mining in this basin and the coal beds mined are the Imboden, Kelly, Taggart, Taggart Marker, and Pardee. The basin is composed of a network of deep valleys cut in an upland ranging in altitude from 2,500 to 3,500 feet, and there is little flat land in it. The ridges dividing the Roaring Fork basin from that of the adjoining basins, such as Nine Mile Spur, Fork Ridge, and Rogers Ridge, are sharp and have deep V-shaped valleys cut into their sides. The main branches of Roaring Fork are Potcamp Fork and Canepatch Creek.

The main geologic structures which control the attitude of the rocks of the Roaring Fork basin are the Middlesboro syncline and the Buck Knob anticline. The axis of the former runs slightly south of west, crossing the head of the basin, and toward it all of the rocks between Pine and Stone mountains tend to dip; the axis of the latter runs in a general north-south direction about two miles east of the basin and affects the rocks for only a few miles on either side. Under the influence of these two structures the rocks in the southern half of Roaring Fork basin dip nearly due west; whereas in the northern half of the basin the rocks, in general, dip to the northwest. The dips in both sections of the basin are gentle, ranging usually from 2 to 4 degrees.

The rocks exposed in the Roaring Fork basin comprise several hundred feet of the lower part of the Harlan sandstone and all of the Wise formation except the lower 250 feet.

The Wise formation consists largely of shale and soft micaceous sandstone, but contains a few beds of hard sandstone. A massive but thin bed of sandstone outcrops across the lower end of the basin, about 200 feet below the Imboden coal bed. A second thick-bedded sandstone lies below the Imboden coal bed and is persistent throughout this and adjoining basins. The base of the Harlan sandstone is marked by a cliff-making bed of hard coarse-grained sandstone that is sparingly conglomeratic. This bed is 40 to 60 feet thick and is overlain by thin beds of shale and sandstone.

The chief producing coal beds of the basin are the Imboden, Kelly, Taggart Marker and Taggart, and the Pardee, named in ascending order. The Imboden and Kelly beds are thickest at the town of Roaring Fork, where they are separated by only 18 inches of shale. Each bed ranges from 3½ to 7 feet in thickness, but 5 feet is about the average of each. The thin shale between the beds at Roaring Fork, however, thickens rapidly in all directions and near the head of Canepatch Creek reaches the maximum measured thickness of 60 feet. Graphic sections of the coal beds are shown in figures 24, 25, 26, 27, 28, and 29.

At the Stonega Coke & Coal Co.'s mine at Dunbar the Taggart coal bed by direct measurement is 448 feet above the Imboden coal bed, an interval that is fairly constant throughout the entire basin. The Taggart Marker bed outcrops 30 to 40 feet below the Taggart. Both beds range from 3 to 5 feet in thickness of clear hard coal, and both beds are mined by the Stonega Coke & Coal Co. at Dunbar. The interval of 800 to 850 feet from the Taggart to the Pardee contains only one bed of importance, the Low Splint, and that bed is less than 3 feet in thickness throughout much of its extent. The Pardee is the thickest coal bed outcropping in the Roaring Fork basin, averaging 9 feet at the head of Potcamp Branch, where it is mined by the Blackwood Coal & Coke Co.

The Roaring Fork basin has large resources of coal that have not as yet been touched except by the prospector's pick, and consequently it has ample opportunity for additional development of mines. The three main operations now located in the Roaring Fork basin are relatively new; the Roaring Fork mine is 13 years old, the Pardee mine, 7 years old, and the Dunbar mine, only 3 years old (1920). The mines are served by the Interstate Railroad, that has a branch from its main line in Powell valley, up Roaring Fork to Pardee. A graded cinder road, with concrete culverts and bridges, recently has been completed up the Roaring Fork valley to Pardee. There is no wagon road over Black Mountain into Kentucky from the Roaring Fork basin, but two trails cross the mountain, one north from Pardee, and one at the head of Straight Fork of Roaring Fork. Both trails are so steep that they are of little use.

The basin abounds in second-growth timber. The forest land has been cut over and log trams formerly ran up Roaring Fork and Canepatch Creek, to carry logs to the Interstate Railroad for shipment. Some of the original stand of timber is left, however, which together with the second-growth is able to furnish an abundant supply of timber for mine supports, ties, and other needs in mining operations. Water is generally plentiful in the basin throughout the year. These natural resources, together with the excellent shipping facilities at hand, and the unusual flatness, or lack of disturbance, of the coal beds, favor economic development of the coal beds of the Roaring Fork basin.

Imboden, Kelly, and lower coal beds.—Only one coal bed, showing a maximum measured section of 2 feet of coal, without a parting, is opened on Roaring Fork below the Imboden. This bed is exposed in the cuts of the graded road near the mouth of Roaring Fork, and lies stratigraphically 150 feet below the Imboden bed. A thin bed of coal lies 45 feet below this workable bed and is exposed in two road cuts on the main Norton–Appalachian highway west of Roaring Fork. At these localities (loc. 127, el. 1,810 feet, B, and loc. 128, el. 1,760 feet, B) the bed measures 10 and 12 inches thick, respectively, and overlies a hard fine-grained sandstone 10 to 20 feet thick. On Roaring Fork these two coal beds are separated by 10 to 20 feet of massive hard sandstone. The lower of the two beds is here correlated with the bed opened on Halfway Branch, as described in the Callahan Creek basin (page 182). The lower bed, 160 feet below the Imboden bed, is exposed on Roaring Fork in two road cuts, showing 2 feet of coal with sandstone above and clay below at loc. 129, el. 1,860 feet (B); and 2 feet of coal with clay above and below the coal bed but sandstone outcropping 2 to 3 feet above the top clay at loc. 130, el. 1,870 feet (B). The bed has been opened at the mouth of Gabe Branch but the pit is now caved.

Two sections of the coal bed overlying the sandstone were measured as follows:

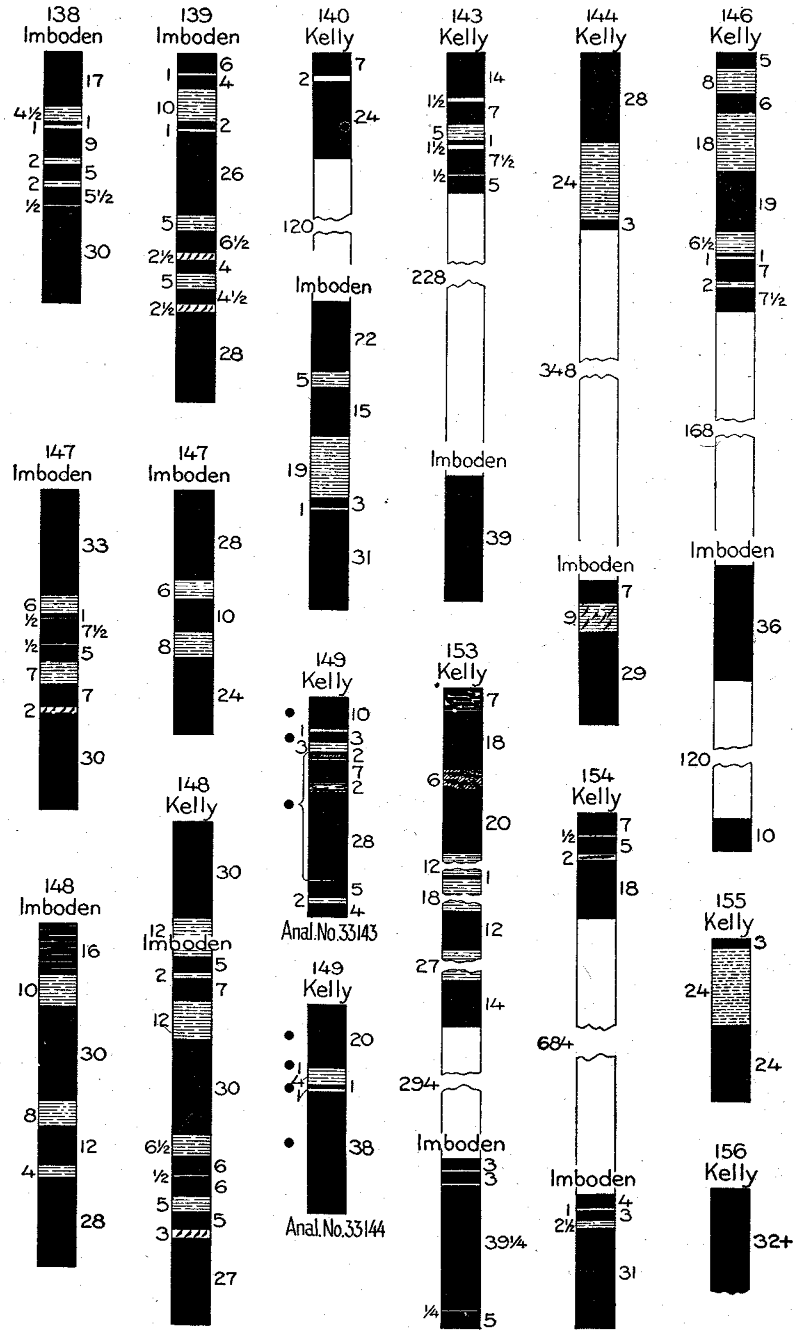


Fig. 24.—Sections of coal beds in the basin of Roaring Fork.

Section of the coal bed, 145 feet below the Imboden coal on Roaring Fork.

(Loc., 131; el., 1,880 feet, B.)

	Ft.	In.
Clay.		
Coal	1	4
Shale		

(Loc., 132; el., 1,880 feet, B.)

	Ft.	In.
Clay.		
Coal	1	7
Shale	2	
Coal		10+
Coal	2	5+
Parting	2	

An excellent section of the rocks from the base of the Imboden coal bed to stream level was measured in a trench on Canepatch Creek, ¾ of a mile north of its mouth. The section here given is taken from a previous report.[1] The prospect trench ran from the Imboden pit at loc. 161, el. 2,195 feet (B) southwest, to stream level.

Sections of coal beds on Canepatch Creek.

	Ft.	In.
Coal, Imboden (see pp. 225-226)		
Not seen, probably sandstone	70	0
Sandstone, thick-bedded	20	
Coal (loc., 134)	1	0
Clay	3	0
Coal		8
Shale	10	
Sandstone	105	0
Shale, sandy, clayey at base	110	0
Coal (loc., 133)		8
Sandstone, to Canepatch Creek	10	
	330	4

The section given above, together with rocks exposed along lower Roaring Fork, indicate clearly that there are no coals below the Imboden bed on Roaring Fork drainage that are workable in the present market conditions.

The Imboden and Kelly coal beds are so closely associated in the Roaring Fork basin that they will be described together here as benches of the same bed, rather than two distinct coal beds. The two coals have been extensively prospected by the Virginia Coal & Iron Co. Many of these prospects appear on the geologic map and some of the sections measured are given in the following text to show the thickness and character of the beds. The Imboden bed is thickest near the south-central part of the basin, thinning, however, more rapidly to the north, northeast, and northwest than to the south. The bed ranges in thickness from 5 to 7 feet in a circular area of two miles radius whose center is at the mouth of Cane-

[1] Campbell, M. R., Geology of the Big Stone Gap Coal Field of Virginia and Kentucky, U. S. Geol. Survey Bull. 111, 1893, p. 69.

patch Creek. North of this area the bed averages from 3 to 5 feet in thickness, with 1 foot or more of partings. The same rate of thinning holds for the Kelly bed, although the bed as a whole is thinner than the Imboden.

Neither the Imboden nor Kelly coal bed shows the bands of crushed or "curly" coal that characterize these beds in the lower parts of the Looney and Pigeon creeks basins, and the Callahan Creek basin. The beds dip slighty to the northwest and are readily accessible in all the stream valleys in the basin. A sandstone that grades, at places, into a sandy shale underlies the Imboden bed; and a hard micaceous sandstone is found nearly everywhere over the Kelly, with similar rock often separating the two beds.

One mile northwest of Kelly View School (loc. 135, el. 2,000 feet, B) the Imboden coal was opened to supply a sawmill that formerly operated in that vicinity. The pit is now closed, but the bed is reported to be 5 feet thick. The bed is also reported to have been opened on Mill Branch, but the pit was not found. Near the mouth of Roaring Fork it is opened to supply local needs but when visited the pit was partly caved. The following is a section of part of the bed:

Incomplete section of the Imboden coal bed near mouth of Roaring Fork.

(Loc., 136; el., 2,120 feet, B.)

	Ft.	In.
Shale, sandy.		
Clay	1	2
Coal		2
Clay		2
Shale		2
Coal	1	8+
Coal	1	10+
Partings		4

Several pits on the Imboden coal bed were seen on the west side of Roaring Fork between the town of Roaring Fork and the mouth of the basin, but no sections of the bed are available. Southeast of Dunbar, however, according to report, the Imboden and Kelly are exposed and they have the following sections:

Section of the Imboden and Kelly coal beds at Dunbar.

(V. C. & I. Co. prospect.)

(Loc., 137; el., (Imboden) 1,960 feet, L.)

		Ft.	In.
Coal, Kelly		2	½
Shale and sandstone		58	
Coal	Imboden	5	10
Shale	Imboden	8	
Bone	Imboden		11
Coal	Imboden		11
Clay			
Coal, Imboden		6	9
Partings		8	11

The Imboden and Kelly are split into worthless coal beds at the head of Potcamp Fork according to a boring put down at Pardee. The following section is taken from the log of this well drilled for C. Pardee, in 1905, near the church at Pardee on Potcamp Fork.

The approximate location of the well is indicated under Borehole Loc. N. 17. The drill encountered 3 thick beds of sandstone as shown in Plate III (quode vide), and the Imboden is supposed to be represented by the numerous thin layers of coal between the middle and lower sandstone beds.

Section through Imboden coal horizon from boring on Potcamp Fork.

(Loc., No. 17; Surface el., 2,050 feet, approx.)

		Thickness. Ft.	Thickness. In.	Depth. Ft.	Depth. In.
Surface				0	0
Interval (details omitted)		142	6	142	6
Sandstone		56	4	198	10
Clay			8	199	6
Coal	Imboden coal bed.		4	199	10
Shale	Imboden coal bed.		1	199	11
Coal	Imboden coal bed.		1	200	0
Shale	Imboden coal bed.		2	200	2
Coal	Imboden coal bed.		1	200	3
Clay	Imboden coal bed.	1	3	201	6
Shale	Imboden coal bed.	1	4	202	10
Shale, cannel	Imboden coal bed.		6	203	4
Coal, cannel, impure	Imboden coal bed.		6	203	10
Clay	Imboden coal bed.		7	204	5
Coal	Imboden coal bed.	1	2	205	7
Coal, cannel, impure	Imboden coal bed.		9	206	4
Coal	Imboden coal bed.		2	206	6
Shale	Imboden coal bed.	1	8	208	2
Coal	Imboden coal bed.		9	208	11
Clay	Imboden coal bed.	8	1	217	0
Coal	Imboden coal bed.	1	2	218	2
Shale	Imboden coal bed.	3	6	221	8
Coal	Imboden coal bed.	1	3	222	11
Clay	Imboden coal bed.	5	1	228	0
Sandstone	Imboden coal bed.	4	10	232	10
Coal	Imboden coal bed.		9	233	7
Shale	Imboden coal bed.		5	234	0
Coal	Imboden coal bed.		1	234	1
Clay			11	235	0
Shale		3	0	238	0
Sandstone		4	0	242	0
Shale		13	0	235	0
Sandstone		55	7	290	7
Interval (details omitted)		107	11	398	6
Bottom of hole				398	6

The section given above shows 7 feet, 1 inch of coal separated into thin beds by 27 feet 6 inches of partings. .Of this coal, however, 3 feet 10 inches lie above the thick bed of clay near the top of the section, and contains only 5 feet, 7 inches of partings. In these considerations the beds called "cannel coal, impure" are taken to be mineable coal, an assumption which probably on actual trial would not prove to be the case.

On the east bank of Potcamp Fork, almost at stream level, the Imboden bed has been opened by the Virginia Coal & Iron Co., showing the following section:

Section of the Imboden coal bed at Dunbar.

(V. C. & I. Co. prospect.)

(Loc., 138; el., 1,960 feet, L.)	Ft.	In.
Coal	1	5
Shale		4½
Coal		1
Shale		1
Coal		9
Shale		2
Coal		5
Shale		2
Coal		5½
"Rash"		½
Coal	2	6
Coal	5	7½
Partings		10

The Imboden coal bed is opened one-fourth of a mile northwest of the town of Roaring Fork. The coal at this place is highly lustrous, and breaks into long splintery pieces. The overlying shale contains abundant plant fossil, (see Plate XX A). Sections measured at this opening are as follows:

Sections of the Imboden coal bed northwest of the town of Roaring Fork.

(Loc., 139; el., 1,948 feet, L.)

(V. C. & I. Co. prospect.)	Ft.	In.
Coal		6
Shale		1
Coal		4
Shale		10
Coal		2
Shale		1
Coal	2	2
Shale		5
Coal		6½
"Rash"		2½
Coal		4
Shale		5
Coal		4½
"Rash"		2½
Coal	2	4
Coal	6	9
Partings	2	3

	Ft.	In.
Shale and clay	20	
Shale, carbonaceous, and coal	1	4
Coal	2	4
Clay		9
Coal	1	4
Shale and clay		8
Coal	3	4+
Coal	7+	
Partings	1	5

Sections were measured of both the Imboden and Kelly coal beds on the west bank of Roaring Fork, one-fourth of a mile north of the town of Roaring Fork. The Imboden averages 6 feet of coal and the Kelly 2½ feet of coal, and the beds are 6 to 10 feet apart. Two sections are given below as follows:

Sections of the Imboden and Kelly coal beds one-fourth mile north of Roaring Fork.

(V. C. & I. Co. prospect.)

(Loc., 140; el., (Imboden), 1,942 feet, L.)

	Ft.	In.
Sandstone.		
Coal		7
Bone		2
Coal	2	0
Coal, Kelly	2	7
Parting		2
Interval	10	
Coal	1	10
Shale		5
Coal	1	3
Shale	1	7
Coal		3
Shale		1
Coal	2	7
Coal, Imboden	5	11
Partings	2	1

(Loc., 141; el., (Imboden), 1,948 feet, L.)

	Ft.	In.
Sandstone.		
Coal		5
Bone		1
Coal	2	2
Coal, Kelly	2	7
Parting		1
Interval, Shale	7	
Coal	2	
Shale		4
Coal		1
Shale		½
Coal	1	6
Shale	4	
Coal		6
Shale		4
Coal	2	½
Coal, Imboden	6	1½
Partings	4	8½

The Imboden coal bed outcrops for almost 2 miles north of Roaring Fork. At the point of the outcrop farthest up the creek the coal is imperfectly exposed in the stream channel. The character of the bed is shown in the following partial section:

Section of the Imboden bed 2 miles north of Roaring Fork.

(Loc., 142; el., 1,970 feet, B.)

	Ft.	In.
Sandstone.		
Shale, carbonaceous, and coal	1	8
Shale		8
Coal, bony	1	6
Shale		8
Coal, bony		3
Coal	1+	
Coal	2	9+
Parting		8

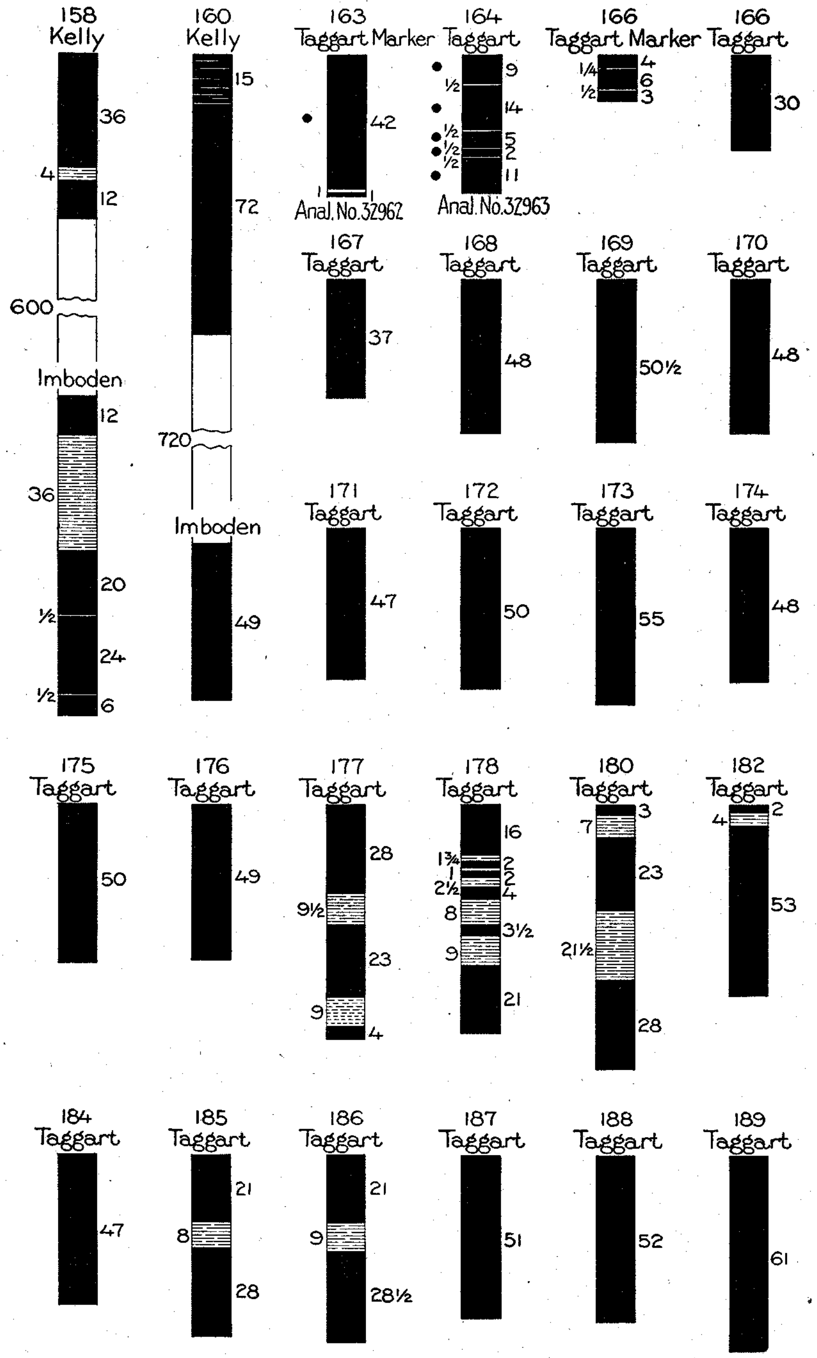


Fig. 25.—Sections of coal beds in the basin of Roaring Fork.

The Imboden is prospected by a boring about ½ mile due north (loc. 18) by one of the coal companies, but the section of the bed is not made public.

The Imboden is much thinner along the east bank of Roaring Fork, north of the town, than it is generally in this basin. Near the head of the outcrop the following section was measured:

Section of the Imboden and Kelly coal beds 1 1-2 miles north of Roaring Fork.

(V. C. & I. Co. prospect.)

(Loc., 143; el., (Imboden) 1,968 feet, L.)

	Ft.	In.
Coal	1	2
Shale		1½
Coal		7
Shale		5
Coal		1
Shale		1½
Coal		7½
Shale		½
Coal		5
Coal, Kelly	2	10½
Parting		8½
Interval	19	
Coal, Imboden	3	3

Three-quarters of a mile north of the main Roaring Fork mine, two sections of the Imboden and Kelly coal beds were measured at the mouth, and on opposite sides of a large branch entering Roaring Fork from off Amos Ridge. The sections disclose a greatly enlarged interval between the beds and a minimum thickness for the Imboden.

Sections of the Imboden and Kelly coal bed three-quarters of a mile north of Roaring Fork.

(V. C. & I. Co. prospect.)

(Loc., 144; el., of Imboden, 1,947 feet, L.)	Ft.	In.	(Loc., 145 el.;, of Imboden, 1,941 feet, L.)	Ft.	In.
Coal	2	4	Coal		6
Shale	2		Shale		5
Coal		3	Shale with coal partings		11
Coal, Kelly	2	7	Shale	2	
Parting	2		Coal	1	8
Interval	29		Shale		¼
Coal		7	Coal		11
Shale and "rash"		9	Coal, Kelly	3	1
Coal	2	5	Parting	3	4¼
Coal, Imboden	3	0	Interval	26	
Parting		9	Coal, Imboden	3	

A short distance to the southwest the beds have the following section:

Sections of the Imboden and Kelly coal beds one-half mile north of Roaring Fork.

(V. C. & I. Co. prospect.)

(Loc., 146; el., of Imboden, 1,942 feet, L.)

	Ft.	In.
Coal		5
Shale		8
Coal		6
Shale	1	6
Coal	1	7
Shale		6½
Coal		1
Shale		1
Coal		7
Shale		2
Coal		7½
Coal, Kelly	3	9½
Parting	2	11½
Interval	14	
Coal, Imboden	3	
Interval	10	
Coal		10

The Imboden and Kelly coal beds are mined at Roaring Fork by the Blackwood Coal & Coke Co. The mines of the company are grouped at the mouth of the branch entering Roaring Fork from the east and named in order from north to south, mines No. 2, No. 2½, No. 3, and No. 1. Mine No. 1 is the oldest and by far the most extensive mine of the four. All the mines enter on the outcrop of the Imboden bed, but the main line entry of mine No. 1 enters the Kelly coal bed 2,000 feet southeast of the mine mouth and for the next 3,600 feet of its extent remains in the Kelly bed. Practically all of the coal now being taken from Mine No. 1 comes from the Kelly bed. The other mines of the Blackwood Co. are entirely in the Imboden bed and none has been extended more than 1,200 feet from the outcrop.

The Kelly coal bed is cleaner than the Imboden and almost as thick. The superior character of the higher bed can more readily be shown by detailed sections, as given below. The average section of the Kelly coal bed consists of a top bench of coal 13 inches thick, underlain by 2 inches of clay, and a bottom bench of coal 3 feet 9 inches thick.

The normal daily output of coal of the Roaring Fork mines is 400 tons. The operation produced 115,534 tons in 1917, and 47,765 tons in

1918. The plant employs 36 miners at normal working capacity. The output of the mines is brought to a large tipple at Roaring Fork, where the coal is screened and loaded for shipment.

The following sections of the Imboden coal bed were measured in Mine No. 2.

Sections of the Imboden coal bed in Roaring Fork Mine No. 2.

(Loc., 147; el., 1,952 feet, L.[1])

(V. C. & I. Co. section.)

	Ft.	In.
Coal	2	9
Shale		6
Coal		1
Shale		½
Coal		7½
Shale		½
Coal		.5
Shale		7
Coal		.7
"Rash"		2
Coal	2	6
Coal	6	11½
Partings	1	4

	Ft.	In.
Coal, splinty, roof.		
Clay	1	
Coal	2	4
Shale		6
Coal		10
Shale		8
Coal	2	0
Clay		
Coal	5	2
Partings	1	2

The Imboden bed shows its best development in Mine No. 3, where it contains over 7 feet of coal. The bed, however, is somewhat broken up by many small partings as shown in the following sections:

Sections of the Imboden and Kelly coal beds in Roaring Fork Mine No. 3.

(Loc., 148; el., 1,952 feet, L.)

(V. C. &. I. Co. section.)

	Ft.	In.
Coal, Kelly	2	6
Shale	1	
Coal		5
Shale		2
Coal		.7
Shale	1	
Coal	2	6
Shale		6½
Coal		6
Shale		½
Coal		6
Shale		5
Coal		5
"Rash"		3
Coal	2	3
Coal, Imboden	7	2
Partings	2	5

	Ft.	In.
Coal with shale streaks	1	4
Shale		10
Coal	2	6
Shale		8
Coal	1	
Shale		4
Coal	2	4
Coal, Imboden	7	2
Partings	1	10

[1] The elevations given in this report for the coal beds in the vicinity of Roaring Fork are taken from levels run by the Virginia Coal and Iron Company (April 9, 1918, File No. 338) and are 23 feet higher than the elevations appearing on mine maps of the Blackwood Coal and Coke Company.

The Kelly coal bed was sampled in Mine No. 1 at Roaring Fork and the analyses are given on page 520. The sections of the bed measured where the samples were taken are as follows:

Sections of the Kelly coal bed in Roaring Fork Mine No. 1.

(Loc., 149; el., 1,946 feet, L.)

Section where sample was cut in room 10, off No. 6 left entry, off No. 2 butt entry.

(Analysis No. 33143.)

	Ft.	In.
Shale.		
*Coal		10
Bone		1
*Coal		3
Shale		3
*Coal, bony		2
*Coal		7
*Coal, bony		2
*Coal	2	4
Coal		5
Shale		2
Coal		4
Clay		
Coal	5	1
Partings		6

Section where sample was cut in room 6, off No. 8 left entry, off No. 2 butt entry.

(Analysis No. 33144.)

	Ft.	In.
Shale.		
*Coal	1	8
*Bone		1
Shale		4
*Coal		1
*Bone		1
*Coal	3	2
Shale		2
"Rash"		4
Clay		
Coal	4	11
Partings		6

The Imboden bed is partially exposed in an old prospect one-half mile south of Mine No. 1, and the following section was measured there:

Section of the Imboden coal bed one-half mile south of Roaring Fork.

(Loc., 150 el., 2,017 feet, L.)

	Ft.	In.
Shale, fossiliferous (see Pl. XXA).		
Shale, carbonaceous.		
Coal		9
Coal, "rash" streaks		4
Bone		3
Coal, bony	1	2
Coal	1+	
Coal	3	3+
Parting		3

On Amos Ridge, 2 miles north of the mouth of Canepatch Creek, the Imboden is opened, showing the following section:

*Sampled.

Section of the Imboden coal bed 2 miles north of mouth of Canepatch Creek.

(Loc., 151; el., 2,100 feet, B.)

	Ft.	In.
Shale.		
Coal	1	0
Shale	3	
Coal	3	
Coal	4	0
Parting	3	0

A thin bed of coal outcrops at this place 80 feet below the Imboden, and shows 15 inches of coal, with 2 inches of bone near the bottom of the bed. A hard fine-grained sandstone directly overlies the bed.

In the stream hollow, one-half mile northeast of the location given above, the Imboden is greatly parted in the upper half of the bed. The following section illustrates the character of the bed in this vicinty:

Section of the Imboden coal bed two and one-half miles north of mouth of Canepatch Creek.

(V. C. & I. Co. prospect.)

(Loc., 152; el., 2,100 feet, approx.)

	Ft.	In.
Coal		4
Shale		2
Coal		2
Shale		1½
Coal, impure		8½
Bone		2½
Coal	1	
Shale		½
Coal		5
Shale		½
Coal	1	4
Shale		2½
Coal		2
Shale		10½
Coal		7
Shale		3
Coal	1	2
Shale	1	2
Coal		4
Shale		7
Coal	1	2½
Shale	1	1½
Coal	3	0
Coal	10	5
Partings	4	9½

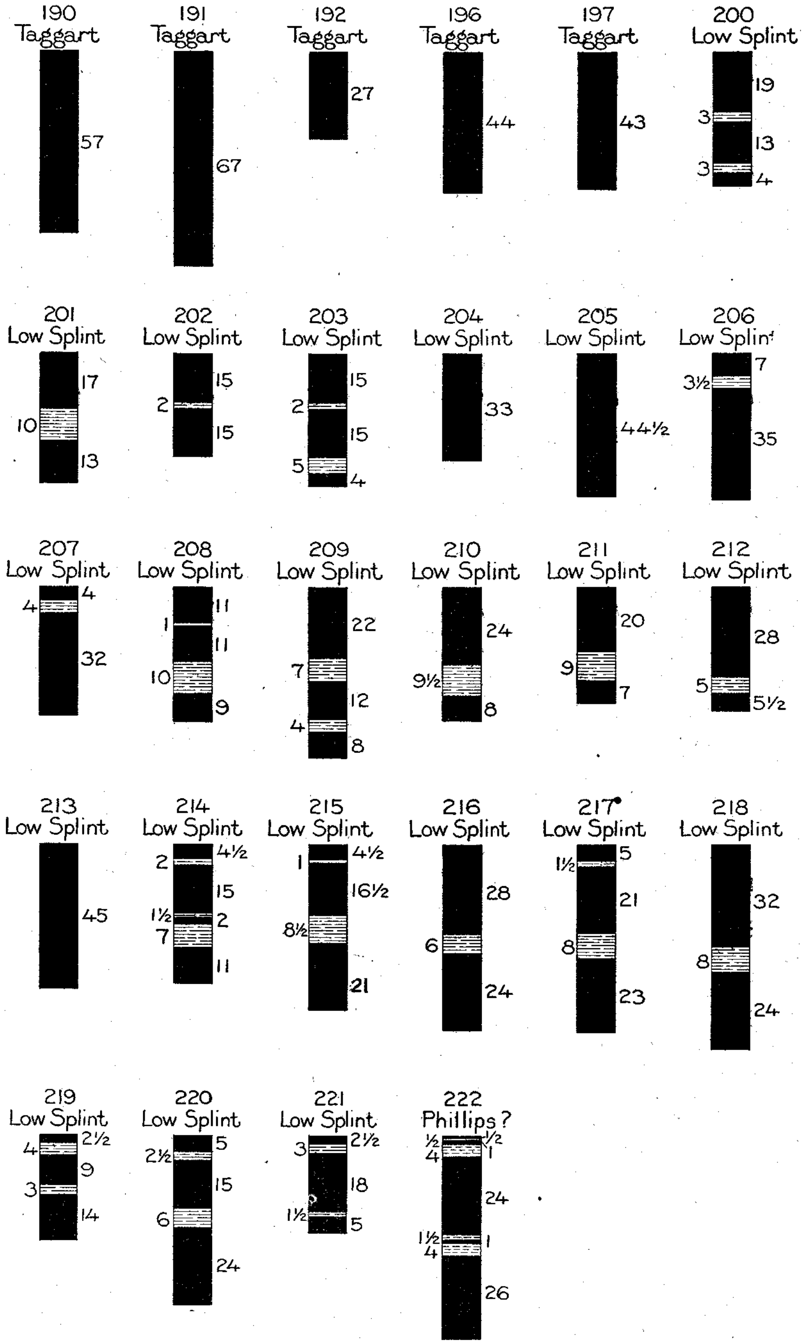


Fig. 26.—Sections of coal beds in the basin of Roaring Fork.

In Rogers Ridge at the head of Canepatch Creek the Imboden and Kelly beds have the following sections:

Sections of the Imboden and Kelly coal beds on Rogers Ridge.

(V. C. & I. Co. prospect.)

(Loc., 153; el., (Imboden), 2,284 feet, L.)

	Ft.	In.
Sandstone.		
Coal, impure		7
Coal	1	6
Bone		6
Coal	1	8
Shale	1	
Coal		1
Shale	1	6
Coal	1	
Shale	2	3
Coal	1	2
Coal, Kelly	6	0
Partings	5	3
Interval	24	6
Coal		3
Shale		1
Coal		3
Shale		1
Coal	3	3½
Shale		¼
Coal		5
Coal, Imboden	4	2½
Partings		2¼

(Loc., 154; el., (Imboden), 2,414 feet, L.)

	Ft.	In.
Coal		7
Shale		½
Coal		5
Bone		2
Coal	1	6
Coal, Kelly	2	6
Partings		2½
Interval	57	
Coal		4
Shale		1
Coal		3
Shale		2½
Coal	2	7
Coal, Imboden	3	2
Partings		3½

The high ridge dividing the headwaters of Canepatch and Black creeks is held up by the massive sandstone overlying the Imboden bed and beneath the Kelly bed. The Kelly coal is exposed at several places in the southeastern section of Rogers Ridge where shale knobs rise above the sandstone platform. The following sections of the Kelly were measured in the high knob, 2 miles east of Roaring Fork.

Sections of the Kelly coal bed in knob 2 miles east of Roaring Fork.

(Loc., 155, el., 2,500 feet, B.)

	Ft.	In.
Clay.		
Coal		3
Clay	2	0
Coal	2	0
Clay		
Coal	2	3
Parting	2	

(Loc., 156; el., 2,375 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous		8
Coal	2	8+
Coal	2	8+

(Loc., 157; el., 2,490 feet, B.)

	Ft.	In.
Shale.		
Coal		1
Shale		5
Coal	3	8+
Coal	3	9+
Parting		5

The Imboden and Kelly coal beds, as exposed in two prospect pits on the east bank of Canepatch Creek, 1 mile east of Roaring Fork, have the following sections:

Sections of the Imboden and Kelly coal beds 1 mile east of Roaring Fork.

(Loc., 158; el., (Imboden), 2,085 feet, L.)

	Ft.	In.
Sandstone.		
Coal	3	
Sale and bone		4
Coal	1	
Coal, Kelly	4	
Parting		4
Interval	50	
Shale		
Coal	1	
Shale	3	
Coal	1	8
Shale		½
Coal	2	
Shale		½
Coal		6
Clay		
Coal, Imboden	5	2
Partings	3	1

Two openings 30 feet apart on the right fork of Canepatch Creek are thought to be on the Imboden, but as the northern pit is 10 feet (barometrically) higher than the southern pit, it can not be said with certainty that the two are on the same bed. The north pit may be on the Kelly and the south pit on the Imboden, but dense underbrush so effectually conceals the outcrop that it is impossible to determine their exact relations. In the south pit 4 feet of coal, overlain by clay, is exposed, but the base of the bed is concealed; the section in the north pit is as follows:

Section of the Imboden (?) coal bed on right fork of Canepatch Creek.

(Loc., 159; el., 2,293 feet, L.)

(North pit.)

	Ft.	In.
Shale.		
Coal	1	10
Shale	2	
Shale, carbonaceous	2	
Coal, bony	1	3
Coal		6
Bone		½
Coal	1	0
Shale		½
Coal		7
Shale		½
Coal		7
Shale and clay		½
Coal	2	1
Clay		
Coal	7	10
Partings	4	2

The Imboden and Kelly coal beds were opened years ago on the south side of the right fork of Canepatch Creek and the following sections are taken from a previous report:[1]

Sections of the Imboden and Kelly coal beds on right fork of Canepatch Creek.

(Loc., 160; el., (Imboden), 2,275 feet, B.)

	Ft.	In.
Coal, shaley	1	3
Coal	6	
Coal, Kelly	6	
Interval	60	
Shale		
Coal, Imboden	4	1

The Imboden bed thickens rapidy to the west and at a pit, opened in the hillside southeast of the juncture of the two principal forks of Canepatch Creek, the following section was measured:[2]

[1] Campbell, M. R., Geology of the Big Stone Gap Coal Field of Virginia and Kentucky; U. S. Geol. Survey Bull. No. 111, 1893, p. 69.

[2] Op. cit., p. 69.

Section of the Imboden coal bed 2 miles southeast of Roaring Fork.

(Loc., 161; el., 2,195 feet, B.)	Ft.	In.
Coal	2	0
Clay	3	0
Coal	1	0
Shale and clay	3	0
Coal, splint	1	0
Coal	3	1¾
Coal	7	1¾
Partings	6	0

The Imboden and Kelly coal beds outcrop high on the ridge on the east side of lower Roaring Fork. This section of Fork Ridge has largely been mined ou by the Blackwood Coal & Coke Co., which formerly operated a mine from the southeast side of the ridge. The bed in this locality will be described in the Black Creek drainage basin (page 259).

Coal beds between the Kelly and Taggart Marker beds.—No coal bed that shows a workable thickness of coal is opened on Roaring Fork between the Kelly and the Taggart Marker bed. The coal bed, shown in borehole No. 17, on Potcamp Fork, overlying the Imboden bed 110 feet (see Plate III) measures only 4 inches in thickness. A thin and worthless bed of coal is exposed just north of borehole No. 17 showing 8 inches of coal split by 6 inches of shale (loc. 162, el. 2,080 feet, B). The bed is stratigraphically about 200 feet above the Imboden and 250 feet below the Taggart. The Standiford coal beds are not opened on Roaring Fork and in several measured sections from the Imboden to the Taggart bed no trace of them was found. They are, if present, undoubtedly too thin to attract the prospector and it is probable that they are absent.

Taggart Marker and Taggart coal beds.—The Taggart Marker and Taggart coal beds are well developed throughout much of the Roaring Fork basin, and both beds are now being mined southwest of Dunbar. The beds lie from 20 to 40 feet apart and usually from 420 to 480 feet above the Imboden coal. A single outcrop line is shown on the geologic map for the two beds, as the scale of the map will not permit two lines to be drawn, for beds that lie within 50 feet of one another. The Taggart bed has been extensively prospected by the Virginia Coal & Iron Co. on the ridge between Potcamp Fork and Roaring Fork and on Amos Ridge.[1]

[1] The writer is informed by E. J. Prescott, Vice-president of the Virginia Coal and Iron Co., that additional prospecting on the Taggart and Taggart Marker beds on Roaring Fork will shortly be undertaken for the purpose of sharply differentiating the two beds. The sections of the Taggart bed credited to the Virginia Coal and Iron Co., that will be given on the following pages, were measured in pits opened years ago when a survey of the basin was made, and the identity of the Taggart bed was in some cases confused with the Taggart Marker bed.

The average thickness of the Taggart Marker bed west of Dunbar is 3½ feet, and of the Taggart bed for the entire basin 4½ feet. The thickness of the Marker bed on Amos Ridge was not determined.

The Taggart Marker and Taggart beds are now being mined by the Stonega Coke & Coal Co., southwest of Dunbar. The Marker bed at this locality is 40 feet below the Taggart bed, and the Taggart is 448 feet above the Imboden.

The beds were sampled at the Dunbar mines and the analyses are given on page 521. The sections measured are as follows:

Sections of the Taggart Marker and Taggart coal beds at Dunbar.

Taggart Marker Bed.
(Loc., 163; el., 2,327 feet, L.)
Section where sample was cut in room 5, off main entry, mine No. 2.
(Analysis No. 32962.)

	Ft.	In.
Shale.		
*Coal	3	6
Bone		1
Coal		1
Shale, carbonaceous		
Coal	3	7
Parting		1

Taggart bed.
(Loc., 164; el., 2,376 feet, L.)
Section where sample was cut in room 2, off main entry, mine No. 1.
(Analysis No. 32963.)

	Ft.	In.
Shale.		
*Coal		9
Shale		½
*Coal	1	2
Shale		½
*Coal		5
Shale		½
*Coal		2
Shale, carbonaceous.		½
*Coal		11
Coal	3	5
Partings		2

On Whitley Fork of Potcamp Fork the Taggart Marker bed, 30 feet below the Taggart bed, is exposed in a local mine showing 35 inches of coal (loc. 165, el. 2,290 feet, B). The bed contains a few streaks of "rash" and is overlain and underlain by yellow, clay shale.

At Pardee the following sections of the Taggart Marker and Taggart coal beds were measured:

Section of the Taggart Marker bed.
(Loc., 166; el., 2,160 feet, B.)

	Ft.	In.
Sandstone	3+	
Shale		½
Coal		4
Shale		¼
Coal		6
Sandstone		½
Coal		3
Clay		
Coal	1	1
Partings		¾

Section of the Taggart bed.
(Loc., 166; el., 2,220 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous		8
Coal	2	6
Shale		
Coal	2	6

*Sampled.

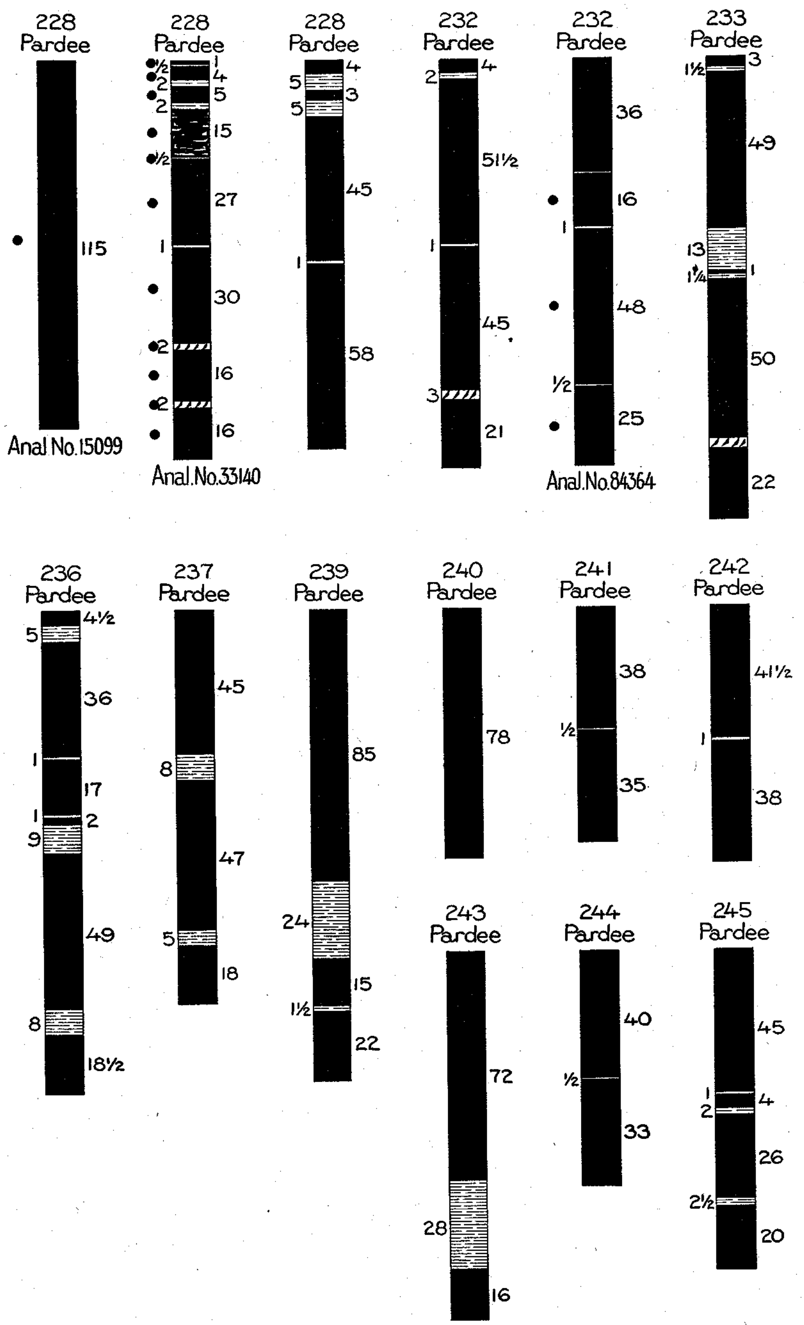


Fig. 27.—Sections of coal beds in the basin of Roaring Fork.

The Taggart bed outcrops 600 feet north of the railroad station at Pardee, displaying 37 inches of clear coal (loc. 167, el. 2,225 feet, B). It is underlain at a short distance by a sandstone more than 50 feet thick, which is undoubtedly the massive sandstone not uncommonly found between the Taggart and the Taggart Marker coal beds.

The Taggart bed has been prospected by the Virginia Coal & Iron Co. at many places about the head of Roaring Fork. Its character and thickness here are indicated by the following sections: Loc. 168, el. 2,157 feet (L), coal 4 feet; loc. 169, el. 2,137 feet (L), coal 4 feet, 2½ inches; loc. 170, el. 2,134 feet (L), coal 4 feet; loc. 171, el. 2,126 feet (L), coal 3 feet, 11 inches; loc. 172, el. 2,122 feet (L), coal 4 feet, 2 inches; loc. 173, el. 2,161 feet (L), coal 4 feet, 7 inches; loc. 174, el. 2,155 feet (L), coal 4 feet; and loc. 175, el. 2,161 feet (L), coal 4 feet, 2 inches. The bed is overlain by shale and underlain by hard gray clay. The following additional sections were measured in the same vicinity:

Sections of the Taggart coal bed at head of Roaring Fork.

(V. C. & I. Co. prospect.)

(Loc., 176; el., 2,197 feet, L.)

	Ft.	In.
Shale.		
Coal	4	1
Clay		

(Loc., 177; el., 2,208 feet, L.)

	Ft.	In.
Shale.		
Clay		10
Coal	2	4
Shale		9½
Coal	1	11
Clay		9
Coal		4
Clay		
Coal	4	7
Partings	1	6½

(Loc., 178; el., 2,209 feet, L.)

	Ft.	In.
Shale.		
Coal	1	4
Shale		1¾
Coal		2
Shale		1
Coal		2
Shale		2½
Coal		4
Shale		8
Coal		3½
Shale		9
Coal	1	9
Clay		
Coal	4	½
Partings	1	10¼

(Loc., 179; el., 2,223 feet, L.)

	Ft.	In.
Shale.		
Coal	2	9
Shale	3	10
Coal	2	
Shale		8
Coal		4
Clay		
Coal	5	1
Partings	4	6

(Loc., 180; el. 2,226 feet, L.)

	Ft.	In.
Shale.		
Coal		3
Shale		7
Coal	1	11
Shale	1	9½
Coal	2	4
Clay		
Coal	4	6
Partings	2	4½

(Loc., 181; el., 2,227 feet, L.)

	Ft.	In.
Shale.		
Coal	1	5
Shale		2
Coal	1	10½
Shale		1
Coal	2	9
Shale		½
Coal		4
Clay		
Coal	6	4½
Partings		3½

(Loc., 182; el., 2,246 feet, L.)

	Ft.	In.
Shale.		
Coal		2
Shale		4
Coal	4	5
Clay		
Coal	4	7
Parting		4

(Loc., 183; el., 2,263 feet, L.)

	Ft.	In.
Shale.		
Coal	2	3
Shale		½
Coal		3½
Shale		11
Coal	2	
Clay		
Coal	4	6½
Partings		11½

All of the sections given above were measured on the Taggart bed in Roaring Fork basin north of Pine Branch. South of Pine Branch on the west and south slope of Amos Ridge the following sections of the Taggart were measured:

Section of the Taggart coal bed on Amos Ridge south of Pine Branch.

(V. C. & I. Co. prospect.)

(Loc., 184; el., 2,226 feet, L.)

	Ft.	In.
Shale.		
Coal	3	11
Clay		

(Loc., 185; el., 2,282 feet, L.)

	Ft.	In.
Shale.		
Coal	1	9
Shale		8
Coal	2	4
Clay		
Coal	4	1
Parting		8

(Loc., 186; el., 2,277 feet, L.)

	Ft.	In.
Shale.		
Coal	1	9
Shale		9
Coal	2	4½
Clay		
Coal	4	1½
Parting		9

(Loc., 187; el., 2,308 feet, L.)

	Ft.	In.
Shale.		
Coal	4	3
Clay		

At loc. 188, el. 2,317 feet (L), the coal bed is 4 feet, 4 inches thick; loc. 189, el. 2,341 feet (L), 5 feet, 1 inch thick; loc. 190, el. 2,343 feet (L), 4 feet, 9 inches thick; loc. 191, el. 2,297 feet (L), 5 feet, 7 inches thick; loc. 192, el. 2,339 feet (L), 2 feet, 3 inches thick; and loc. 193, el. 2,325 feet (L), only 1 foot, 5 inches thick.

The Taggart bed is thinner on Canepatch Creek than on Roaring Fork as indicated by the following four sections measured by the Virginia Coal & Iron Co.: Loc. 194, el. 2,372 feet (L), the coal is 3 feet, 1 inch thick; loc. 195, el. 2,381 feet (L), 3 feet, 11 inches thick; loc. 196, el. 2,436 feet (L), 3 feet, 8 inches thick; and loc. 197, el. 2,467 feet (L), 3 feet, 7 inches thick.

The foregoing sections of the Taggart coal bed in the Roaring Fork basin reveal a markedly persistent coal bed of excellent thickness and character. The large number of prospects show that the Taggart is uniformly a clear bed of coal, containing but few sporadic partings or lenses of clay and shale.

Low Splint coal bed.—The next persistent coal bed is the Low Splint which lies 200 feet above the Taggart bed, but two thin coal beds were seen at Pardee in this interval. One of these, 8 inches in thickness, is exposed at Pardee, 100 feet below the Low Splint. The other, 40 feet higher, is exposed on the east bank of Potcamp Fork at Pardee. The Low Splint is opened above each of the two exposures of the lower beds and the sections of the beds are as follows:

Sections of Low Splint and a lower coal bed at Pardee.

(Loc., 198; el., (Low Splint), 2,310 feet, B.)

	Ft.	In.
Sandstone.		
Shale.		
Coal	1	3
Clay		4
Coal	1	3
Clay		5
Coal	1	2
Clay		
Coal, Low Splint	3	8
Partings		9
Interval	60	
Shale		
Coal	2	1
Shale		1
Coal		8
Shale		
Coal	2	9
Parting		1

(Loc., 199; el., (Low Splint), 2,420 feet, B.)

	Ft.	In.
Shale.		
Shale, soft		3
Coal	1	3
Clay		2
Coal	1	4
Clay		2
Coal	1	2
Shale		5
Clay		7
Coal		2
Shale		
Coal, Low Splint	3	11
Partings	1	4
Interval	60	
Shale		
Coal	2+	

Bottom not exposed.

North and west of Osborne Fork of Roaring Fork the Low Splint bed contains on an average a little more than 2½ feet of coal, with a parting ranging up to 10 inches in thickness. The following sections indicate in detail the character of the bed:

Sections of the Low Splint coal bed on head of Roaring Fork.

(V. C. & I. Co. prospect.)

(Loc., 200; el., 2,389 feet, L.)

	Ft.	In.
Shale.		
Coal	1	7
Shale		3
Coal	1	1
Shale		3
Coal		4
Shale		
Coal	3	0
Partings		6

(Loc., 201; el., 2,361 feet, L.)

	Ft.	In.
Shale.		
Coal	1	5
Shale		10
Coal	1	1
Shale		
Coal	2	6
Parting		10

(Loc., 202; el., 2,345 feet, L.)

	Ft.	In.
Shale.		
Coal	1	3
Shale		2
Coal	1	3
Shale		
Coal	2	6
Parting		2

(Loc., 203; el., 2,272 feet, L.)

	Ft.	In.
Shale.		
Coal	1	3
Shale		2
Coal	1	3
Shale		5
Coal		4
Shale		
Coal	2	10
Partings		7

At loc. 204, el. 2,222 feet (L) the bed is 2 feet, 9 inches thick and at loc. 205, el. 2,240, 3 feet, 8½ inches thick.

On the east side of Roaring Fork from Osborne Fork to Pine Branch the Low Splint bed contains on an average 3 feet of coal as shown by the following sections:

Section of the Low Splint coal bed on east side of upper Roaring Fork.

(V. C. & I. Co. prospect.)

(Loc., 206; el., 2,259 feet, L.)

	Ft.	In.
Shale.		
Coal		7
Shale		3½
Coal	2	11
Shale		
Coal	3	6
Parting		3½

(Loc. 207; el., 2,285 feet, L.)

	Ft.	In.
Shale.		
Coal		4
Shale		4
Coal	2	8
Shale		
Coal	3	0
Parting		4

(Loc., 208; el., 2,296 feet, L.)

	Ft.	In.
Shale.		
Coal		11
Shale		1
Coal		11
Shale		10
Coal		9
Shale		
Coal	2	7
Partings		11

(Loc., 209; el., 2,311 feet, L.)

	Ft.	In.
Shale.		
Coal	1	10
Shale		7
Coal	1	0
Shale		4
Coal		8
Shale		
Coal	3	6
Partings		11

(Loc., 210; el., 2,319 feet, L.)

	Ft.	In.
Shale.		
Coal	2	0
Shale		9½
Coal		8
Shale		
Coal	2	8
Parting		9½

(Loc., 211; el., 2,347 feet, L.)

	Ft.	In.
Shale.		
Coal	1	8
Shale		9
Coal		7
Shale		
Coal	2	3
Parting		9

Loc., 212; el., 2,410 feet, L.)

	Ft.	In.
Shale.		
Coal	2	4
Shale		5
Coal		5½
Shale		
Coal	2	9½
Parting		5

(Loc., 213; el., 2,458 feet, L.)

	Ft.	In.
Shale.		
Coal	3	9
Shale		

South of Pine Branch the Low Splint bed rises gently eastward on Amos Ridge and the outcrop crosses the point of the spur 1 mile northeast of the town of Roaring Fork. The bed, in this vicinity, varies in thickness from 2 to 4 feet, with 6 to 10 inches of shale partings. The following sections of the bed were measured on Amos Ridge northeast of Roaring Fork:

Sections of the Low Splint coal bed on Amos Ridge.

(V. C. & I. Co. prospect.)

(Loc., 214; el., 2,485 feet, L.)

	Ft.	In.
Shale.		
Coal		4½
Shale		2
Coal	1	3
Shale		1½
Coal		2
Shale		7
Coal		11
Shale		
Coal	2	8½
Partings		10½

(Loc., 215; el., 2,488 feet, L.)

	Ft.	In.
Shale.		
Coal		4½
Shale		1
Coal	1	4½
Shale		8½
Coal	1	9
Shale		
Coal	3	6
Partings		9½

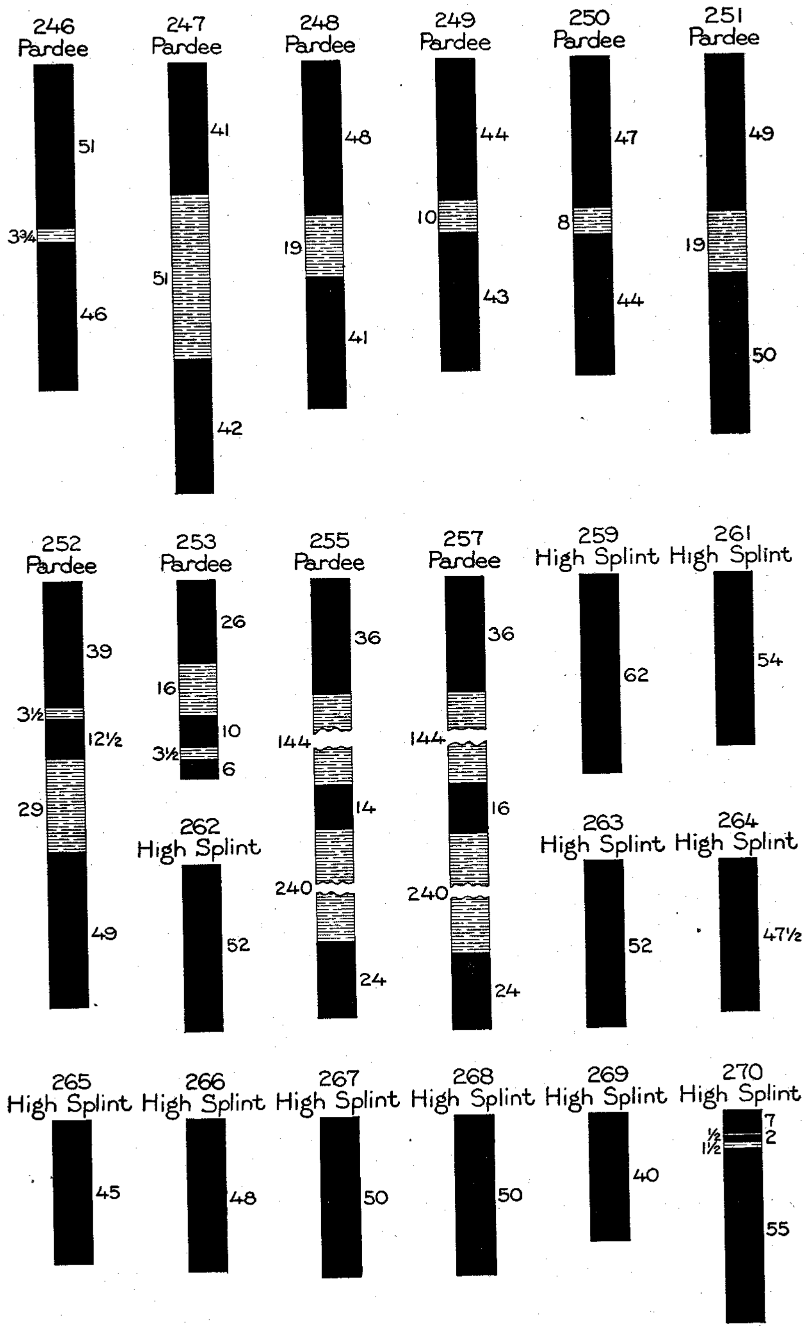


Fig. 28.—Sections of coal beds in the basin of Roaring Fork.

(Loc., 216; el., 2,502 feet, L.)

	Ft.	In.
Shale.		
Coal	2	4
Shale		6
Coal	2	
Shale		
Coal	4	4
Parting		6

(Loc., 217; el., 2,544 feet, L.)

	Ft.	In.
Shale.		
Coal		5
Shale		1½
Coal	1	9
Shale		8
Coal	1	11
Shale		
Coal	4	1
Partings		9½

(Loc., 218; el., 2,535 feet, L.)

	Ft.	In.
Shale.		
Coal	2	8
Shale		8
Coal	2	0
Shale		
Coal	4	8
Parting		8

(Loc., 219; el., 2,584 feet, L.)

	Ft.	In.
Shale.		
Coal		2½
Shale		4
Coal		9
Shale		3
Coal	1	2
Shale		
Coal	2	1½
Partings		7

(Loc., 220; el., 2,587 feet, L.)

	Ft.	In.
Shale.		
Coal		5
Shale		2½
Coal	1	3
Shale		6
Coal	2	0
Shale		
Coal	3	8
Partings		8½

(Loc., 221, el., 2,647 feet, L.)

	Ft.	In.
Shale.		
Coal		2½
Shale		3
Coal	1	6
Shale		1½
Coal		5
Shale		
Coal	2	1½
Partings		4½

Coal beds between the Low Splint and Pardee beds.—Several coal beds are exposed in the Roaring Fork basin between the Low Splint and Pardee coal beds, but only one containing a workable thickness of coal was found. This workable bed lies 200 feet above the Low Splint and is just below the horizon of the Phillips coal bed as described in the South Fork of Pound River basin. The bed on Roaring Fork is most probably the Phillips or its equivalent. The best section of the coal beds between the Low Splint and the Pardee was measured at Pardee from Low Splint, loc. 198 north up the valley one-half mile and then up the east ridge to Pardee mine No. 4, loc. 232.

Local section at Pardee.

	Ft.	In.
Coal, Pardee; loc., 232; el., 2,867 feet (L).		
Unexposed	60	
Sandstone	20	
Unexposed, probably shale	110	
Sandstone	20	
Shale	5	
Coal		3
Shale, sandy	35	
Coal		10+
Shale, sandy	15	
Coal	1	2
Shale, sandy	30	
Coal } Phillips (?)		1½
Clay } Phillips (?)		1
Coal } Phillips (?)	1	5
Shale	15	
Coal		3
Shale	20	
Sandstone	10	
Shale	10	
Sandstone, thin-bedded, arkosic	30	
Shale	5	
Coal		3
Shale	5	
Coal		10
Sandstone, thin-bedded	50	
Unexposed	75	
Sandstone	50	
Coal, Low Splint, loc., 198; el., 2,310 feet (B)		
Total	570	2½+

This section corrected for the northwestward dip of the rocks, represents a stratigraphic interval of 610 to 620 feet. An excellent section of the Phillips (?) bed was also obtained in a pit about one-quarter of a mile north of the railroad station at Pardee. It is as follows:

Section of the Phillips (?) coal bed at Pardee.

(Loc., 222; el., 2,580 feet, B.)

	Ft.	In.
Shale.		
Coal		½
Shale		½
Coal		1
Clay		4
Coal	2	
Clay		1½
Coal		1
Clay		4
Coal	2	2
Shale		
Coal	4	4½
Partings		10

The coal bed has been prospected in several pits adjoining the location noted above, but all are caved except the one in which the measurement was made. The rocks here dip gently to the northwest.

Pardee coal bed.—The Pardee bed, named for Pardee, Va., where it is being extensively mined, outcrops high on the slopes of Black Mountain and its radiating spurs. The bed is called the "Limestone" coal in reports of the Kentucky Geological Survey [1] because of the presence of a thin bed of fossiliferous limestone 40 to 80 feet above the coal bed, and has locally been known as the "Parsons" bed.

The Pardee bed on the headwaters of Potcamp Fork, where the bed is now being mined, ranges from 9 to 11 feet in thickness with several thin partings of shale, bone, and "rash." East and northeast of the headwaters of Roaring Fork it splits into 2 or 3 benches separated by 10 to 20 feet of shale. In some localities the individual benches are thick and pure enough to constitute workable coal beds. Southwest of Pardee the coal bed splits also into several benches. A description of the quality of the Pardee coal is given in a later section of this report (page 534), where also the analyses of the coal, given in the table of analyses (pp. 521-524), are reviewed.

The bed has been prospected in several openings in the small spur of the ridge west of Pardee and south of Pardee No. 1 mine. In 5 or 6 prospects opened by the Virginia Coal & Iron Co., the Pardee bed was measured and found to contain 10 feet of clear coal (loc. 223, el. 2,849 feet, L; loc. 224, el. 2,870 feet, L; loc. 225, el. 2,819 feet, L; loc. 226, el. 2,881 feet, L; and loc. 227, el. 2,847 feet, L).

The mines of the Blackwood Coak & Coke Co. are in the Pardee bed at the head of Potcamp Fork. The two chief producers are Mine No. 1 (loc. 228, el. 2,807 feet, L), and Mine No. 4 on the east side of the valley (loc. 232, el. 2,867 feet, L).

The following sections of the Pardee bed in Mine No. 1 were measured in collecting samples of the coal for analysis (see pp. 521-523).

[1] Crider, A. F., The coals of Letcher County, Ky. Geol. Survey, Fourth Series, Volume Four, Part One, page 22.

Section of the Pardee coal bed in Mine No. 1 (loc. 228).

Section where sample was cut at face of main entry, 2,000 feet from mine mouth.

(Analysis No. 15099.)

	Ft.	In.
Sandstone.		
Shale		3
*Coal	9	7
Clay	4	
Shale		
Coal	9	7

Section where sample was cut in room 15, off 6 right cross entry.

(Analysis No. 33140.)

	Ft.	In.
Shale.		
*Coal		1
*Shale		½
*Coal		4
Shale		2
*Coal		5
Shale		2
*Coal, impure	1	3
*Bone		½
*Coal	2	3
Shale		1
*Coal	2	6
*"Rash"		2
*Coal	1	4
*"Rash"		2
*Coal	1	4
Clay		
Coal	9	6
Partings		10

Section where sample was cut opposite room 15 in 2d right entry, off 3 face entry.

(Analysis No. 84357.)

	Ft.	In.
Shale.		
*Coal, soft		6
Clay		2
*Coal, soft	1	5
*"Rash"		1
*Coal	1	9
*Coal, soft		8
Shale		1
*Coal	5	8
Shale		
Coal	10	0
Partings		4

*Sampled.

Section where sample was cut at face of 2d right entry, off main 3d face entry, 2,500 feet north, 15° west of mine mouth.

(Analysis No. 22277.)

	Ft.	In.
Coal		4
Clay		2
*Coal		11
Parting		½
*Coal	7	10
Coal	9	1
Partings		2½

Section where sample was cut in room 14, off 6 right cross entry.

(Analysis No. 33141.)

	Ft.	In.
Shale.		
*Coal		2
Shale		1
*Coal		4
Shale		2
*Coal		8
Shale		½
*Coal		10
Shale		½
*Coal, bony	1	0
*Coal	1	2
Shale		½
*Coal	2	6
*Bone		1
*Coal	1	4
*"Rash"		2
*Coal	1	10
Clay		
Coal	9	10
Partings		7½

Section where sample was cut in room 6, off Goda Heading entry, 30 feet from face of entry.

(Analysis No. 84358.)

	Ft.	In.
Shale.		
Coal		4
Shale		6
Coal		4
Shale		2
Coal	1	10
*Coal	1	8
Clay		5
*Coal	3	4
"Rash"		1
*Coal	1	7
Shale		
Coal	9	1
Partings	1	2

Section where sample was cut in room 11, off 6 right face entry, off 3 face entry.

(Analysis No. 84359.)

	Ft.	In.
Shale.		
*Coal		4
Shale		3
*Coal	3	8
"Rash"		1
*Coal	5	3
Shale		
Coal	9	3
Partings		4

Section where sample was cut in room 8, off 9 right entry, off 3 face entry.

(Analysis No. 84360.)

	Ft.	In.
Shale.		
*Coal	1	2
Shale		1½
*Coal	1	11
Shale and "sulphur"		½
*Coal	2	5
Shale		4
*Coal	2	9
Shale		
Coal	8	3
Partings		6

Section where sample was cut in 4 face entry, off of First radius (main-line), 250 feet from (main-line).

(Analysis No. 84361.)

	Ft.	In.
Shale.		
Coal	1	2
Shale		¼
*Coal	1	9
Shale and "rash"		4
*Coal	2	2
Shale		½
*Coal	1	2
*Coal, bony		1½
*Coal	1	8
Shale		
Coal	8	½
Partings		4¾

Section where sample was cut in haulway to 1 right, off Angle-heading entry.

(Analysis No. 84362.)

	Ft.	In.
Coal	1+	
Shale		¼
*Coal	1	6
Shale, "sulphur", "rash"		1½
*Coal	3	8
"Rash"		1
*Coal	1	9
Shale		
Coal	7	11+
Partings		2¾

The following section measured near the mine mouth is representative of the Pardee bed in Mine No. 2.

	Ft.	In.
Sandstone.		
Shale	1	4
Coal		4
Shale		5
Coal		3
Shale		5
Coal	2	9
Shale		1
Coal	4	10
Shale		
Coal	9	2
Partings		11

*Sampled.

The Pardee bed is singularly uniform in character around the head of Potcamp Fork. At three pits at the head of the valley the Virginia Coal & Iron Co. reports 10 feet of clear coal for each opening: loc. 229, el. 2,814 feet, L; loc. 230, el. 2,826 feet, L; and loc. 231, el. 2,868 feet, L.

The bed is 10 feet thick in Mine No. 4 as shown in the following sections, measured in collecting coal samples for analysis (see page 523).

Sections of the Pardee coal bed in Mine No. 4.

(Loc., 232; el., 2,867 feet, L.)

Section where sample was cut in room 11, off 3d left butt entry, off 1st right entry.

(Analysis No. 84364.)

	Ft.	In.
Shale.		
Coal	3	0
*Coal	1	4
Shale		1
*Coal	4	0
Shale		½
*Coal	2	1
Shale		
Coal	10	5
Partings		1½

Section where sample was cut in room 10, off main entry, 150 feet from main entry.

(Analysis No. 84365.)

	Ft.	In.
Shale.		
*Coal		8
Shale, carbonaceous		2
*Coal	4	2
Shale		1
*Coal	3	9½
"Rash"		1
*Coal	1	3
Shale		
Coal	9	10½
Partings		4

The following section of the Pardee bed in Mine No. 4 is reported by the Virginia Iron, Coal & Coke Co.

Section of Pardee coal bed in Pardee Mine No. 4.

(Loc., 232; el., 2,867 feet, L.)

	Ft.	In.
Coal		4
Shale		2
Coal	4	3½
Shale		1
Coal	3	9
"Rash"		3
Coal	1	9
Coal	10	1½
Partings		6

A considerable acreage of the Pardee coal bed lies on the spur southeast of Mine No. 4. The bed is opened at several places around the point of the spur, revealing the same large and constant thickness. The following sections serve to indicate the character of the bed on this spur:

*Sampled.

Section of the Pardee coal bed on spur southeast of Mine No. 4.

(V. C. & I. Co. prospect.)

(Loc., 233; el., 2,890 feet, L.)

	Ft.	In.
Coal		3
Shale		1½
Coal	4	1
Shale	1	1
Coal		1
Shale		1¼
Coal	4	2
"Rash"		3
Coal	1	10
Coal	10	5
Partings	1	6¾

(Loc., 234; el., 2,928 feet, L.)

	Ft.	In.
Coal		5
Shale		1½
Coal	1	2
Shale	1	1½
Coal	1	6
Shale	1	3
Coal		1½
Shale		½
Coal	3	10
"Rash"		4
Coal	1	8
Coal	8	8½
Partings	1	10½

(Loc., 235; el., 2,949 feet, L.)

	Ft.	In.
Shale.		
Coal		6
Shale		5½
Coal	3	11½
Shale		2
Coal	1	6
Shale	3	7
Coal	3	6
Shale		1
Coal		2
Shale		5
Coal		1½
Shale		1
Coal	1	7
Shale		
Coal	11	4
Partings	4	9½

(Loc., 236; el., 2,816 feet, L.)

	Ft.	In.
Shale.		
Coal		4½
Shale		5
Coal	3	0
Shale		1
Coal	1	5
Shale		1
Coal		2
Shale		9
Coal	4	1
Shale		8
Coal	1	6½
Shale		
Coal	10	7
Partings	2	0

(Loc., 237; el., 2,898 feet, L.)

	Ft.	In.
Shale.		
Coal	3	9
Shale		8
Coal	3	11
Shale		5
Coal	1	6
Shale		
Coal	9	2
Partings	1	1

(Loc., 238; el., 2,895 feet, L.)

	Ft.	In.
Shale.		
Coal	4	2
Shale		5
Coal	4	
Shale		4
Coal	1	10
Shale		
Coal	10	
Partings		9

The Pardee coal bed is of excellent thickness and character around the head of Straight Fork of Roaring Fork, but northeast of the juncture of

Straight and Osborn forks, a 4-foot parting of shale appears, that gradually increases in thickness to the southeast. The following section illustrates the character of the Pardee bed at the head of Straight Fork:

Sections of the Pardee coal bed at head of Straight Fork.

(V. C. & I. Co. prospects.)

(Loc., 239; el., 2,871 feet, L.)

	Ft.	In.
Shale.		
Coal	7	1
Shale	2	
Coal	1	3
Shale		1½
Coal	1	10
Shale		
Coal	10	2
Partings	2	1½

(Loc., 240; el., 2,858 feet, L.)

	Ft.	In.
Shale.		
Coal	6	6
Shale		
Coal	6	6

(Loc., 241; el., 2,853 feet, L.)

	Ft.	In.
Shale.		
Coal	3	2
Shale		½
Coal	2	11
Shale		
Coal	6	1
Parting		½

(Loc., 242; el., 2,859 feet, L.)

	Ft.	In.
Shale.		
Coal	3	5½
Shale		1
Coal	3	2
Shale		
Coal	6	7½
Parting		1

(Loc., 243; el., 2,860 feet, L.)

	Ft.	In.
Shale.		
Coal	6	0
Shale	2	4
Coal	1	4
Shale		
Coal	7	4
Parting	2	4

(Loc., 244; el., 2,861 feet, L.)

	Ft.	In.
Shale.		
Coal	3	4
Shale		½
Coal	2	9
Shale		
Coal	6	1
Parting		½

(Loc., 245; el., 2,875 feet, L.)

	Ft.	In.
Shale.		
Coal	3	9
Shale		1
Coal		4
Shale		2
Coal	2	2
Shale		2½
Coal	1	8
Shale		
Coal	7	11
Partings		5½

(Loc., 246; el., 2,888 feet, L.)

	Ft.	In.
Shale.		
Coal	4	3
Shale		3¾
Coal	3	10
Shale		
Coal	8	1
Parting		3¾

(Loc., 247; el., 2,924 feet, L.)

	Ft.	In.
Shale.		
Coal	3	5
Shale	4	3
Coal	3	6
Shale		
Coal	6	11
Parting	4	3

(Loc., 248; el., 2,920 feet, L.)

	Ft.	In.
Shale.		
Coal	4	0
Shale	1	7
Coal	3	5
Shale		
Coal	7	5
Parting	1	7

(Loc., 249; el., 2,914 feet, L.)

	Ft.	In.
Shale.		
Coal	3	8
Shale		10
Coal	3	7
Shale		
Coal	7	3
Parting		10

(Loc., 250; el., 2,887 feet, L.)

	Ft.	In.
Shale.		
Coal	3	11
Shale		8
Coal	3	8
Shale		
Coal	7	7
Parting		8

On Rogers Ridge south of Osborn Fork the Pardee bed is abruptly parted into benches containing 2 and 3 feet of coal. At the southern outcrop of the bed on Rogers Ridge the Pardee is split into three benches, the thickest of which is 2 feet. The degeneration of the thick Pardee bed from Osborn Fork, south along Rogers Ridge can best be described by giving the details of several sections measured at short distance on the outcrop. The sections are as follows:

Sections of the Pardee coal bed on Rogers Ridge.

(V. C. & I. Co. prospect.)

(Loc., 251; el. 2,888 feet, L.)

	Ft.	In.
Shale.		
Coal	4	1
Shale	1	7
Coal	4	2
Shale		
Coal	8	3
Parting	1	7

(Loc., 252; el., 2,900 feet, L.)

	Ft.	In.
Shale.		
Coal	3	3
Shale		3½
Coal	1	½
Shale	2	5
Coal	4	1
Shale		
Coal	8	4½
Partings	2	8½

(Loc., 253; el., 2,943 feet, L.)

	Ft.	In.
Shale.		
Coal	2	2
Shale	1	4
Coal		10
Shale		3½
Coal		6
Shale		
Coal	3	6
Partings	1	7½

(Loc., 254; el., 2,954 feet, L.)

	Ft.	In.
Shale.		
Coal	3	0
Shale	12	0
Coal	1	2
Shale	20	
Coal	2	
Shale		
Coal	6	2
Partings	32	

(Loc., 255; el., 2,960 feet, L.)

	Ft.	In.
Shale.		
Coal	3	
Shale	12	
Coal	1	2
Shale	20	
Coal	2	
Shale		
Coal	6	2
Partings	32	

(Loc., 256; el., 2,966 feet, L.)

	Ft.	In.
Shale.		
Coal	3	
Shale	12	
Coal	1	2
Shale	20	
Coal	2	
Shale		
Coal	6	2
Parting	32	

(Loc., 257; el., 2,971 feet, L.)

	Ft.	In.
Shale.		
Coal	3	
Shale	12	
Coal	1	4
Shale	20	
Coal	2	
Shale		
Coal	6	4
Partings	32	

(Loc., 258; el., 3,080 feet, L.)

	Ft.	In.
Shale.		
Coal	2	
Shale	12	
Coal	1	2
Shale	20	
Coal	1	2
Shale		
Coal	4	4
Partings	32	

If that part of the Pardee coal bed which is unbroken by partings is considered as lying in a basin, the limits of the basin would roughly be described by a circle of 2 miles radius with its center one-quarter of a mile west of the mouth of Creger Fork. This holds only for the Virginia side of Black Mountain and its spurs. Of that portion of the circular area in Virginia, less than 20 per cent of the surface now lies above the horizon of the Pardee bed, and hence more than four-fifths of the thick Pardee coal bed is irretrievably lost by the erosion of the land. That which remains, however, constitutes a bed that rivals in thickness the best beds in southwest Virginia.

High Splint coal bed.—The next coal bed of proven workable thickness, overlying the Pardee by 320 feet at the Pardee mine and by nearly 400 feet at the northeast end of the basin, is the High Splint bed. Prospectors report 24 inches of coal without parting, 90 to 100 feet above the Pardee bed. This intermediate bed, however, is but little more than a marker for the thicker adjoining beds.

The High Splint coal bed, consisting of 4 to 5 feet of hard splinty coal free from partings, lies 20 to 40 feet below the massive sandstone bed at the base of the Harlan formation, and the outcrop of the coal may be readily traced by the prominent cliff made by this sandstone. It, however, lies so high in Black Mountain that only a small acreage of the bed remains in the Roaring Fork basin.

The High Splint bed was once opened over the Pardee No. 1 mine (loc. 259, el. 3,130 feet, B) and coal was mined for several years. The mine was not operated during 1919 or 1920, having been closed down for lack of miners. The coal bed in the mine averages 5 feet, 2 inches of coal, without a parting.

Sections measured in nearby openings to the south show thicknesses ranging from 4 feet, 1 inch to 5 feet in a distance of 1 mile. On the east side of the valley only a very small isolated area of coal underlies the ridge. Several pits were opened on the bed near the State line (loc. 260, el. 3,220 feet, L) but all were caved when visited and only 2 feet of the top of the bed was exposed. The ridge here is capped by conglomerate of the Harlan formation.

Numerous sections of the bed were measured at the head of Roaring Fork by the Virginia Coal & Iron Co., showing a notably clear bed of coal. At the head of Straight Fork the following sections of the bed were taken: at loc. 261, el. 3,245 feet (L), coal 4 feet, 6 inches; loc. 262, el. 3,234 feet (L), coal 4 feet, 4 inches; loc. 263, el. 3,200 feet (L), coal 4 feet, 4 inches; loc. 264, el. 3,191 feet (L), coal 3 feet, 11½ inches; loc. 265, el. 3,197 feet (L), coal 3 feet, 9 inches; loc. 266, el. 3,200 feet (L), coal 4 feet; loc. 267, el. 3,199 feet (L), coal 4 feet 2 inches; loc. 268, el. 3,206 feet (L), coal 4 feet, 2 inches; and loc. 269, el. 3,209 feet (L), coal 3 feet, 4 inches. The bed is parted at loc. 270 as shown below:

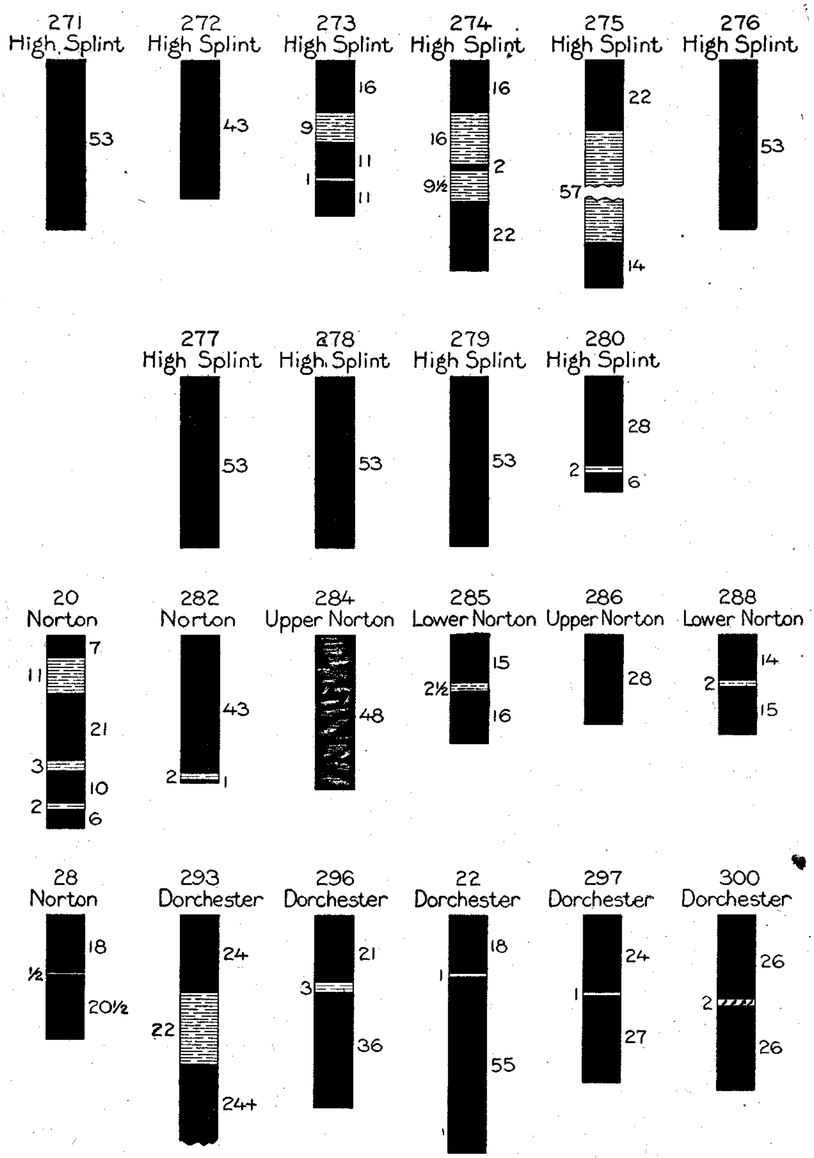


Fig. 29.—Sections of coal beds in the basins of Roaring Fork and Black Creek.

Section of the High Splint coal bed at head of Straight Fork.

(V. C. & I. Co. prospect.)

(Loc., 270; el., 3,206 feet, L.)

	Ft.	In.
Shale.		
Coal		7
Shale		½
Coal		2
Shale		1½
Coal	4	
Shale		
Coal	4	9
Partings		2

The bed consists of 4 feet, 5 inches of unparted coal at loc. 271, el. 3,230 feet (L), and 3 feet, 7 inches of unparted coal at loc. 272, el. 2,241 feet (L).

The High Splint coal bed has an abnormal section at the head of Osborn Fork, where four prospects reveal the bed as follows:

Sections of the High Splint coal bed at head of Osborn Fork.

(Loc., 273; el., 3,237 feet, L.)

	Ft.	In.
Shale.		
Coal	1	4
Shale		9
Coal		11
Shale		1
Coal		11
Shale		
Coal	3	2
Partings		10

(Loc., 274; el., 3,232 feet, L.)

	Ft.	In.
Shale.		
Coal	1	4
Shale	1	4
Coal		2
Shale		9½
Coal	1	10
Shale		
Coal	3	4
Partings	2	1½

(Loc., 275; el., 3,236 feet, L.)

	Ft.	In.
Shale.		
Coal	1	10
Shale	4	9
Coal	1	2
Shale		
Coal	3	0
Parting	4	9

(Loc., 276; el., 3,240 feet, L.)

	Ft.	In.
Shale.		
Coal	4	5
Shale		

The High Splint has its normal unparted section east and southeast of Osborn Fork. The bed in that vicinity consists of nearly 4½ feet of coal. At loc. 277, el. 3,375 feet (L) the bed contains 4 feet, 5 inches of coal; loc.

278, el. 3,388 feet (L), 4 feet, 5 inches of coal; and loc. 279, el. 3,465, 4 feet, 5 inches of coal. The bed is thinner and is parted at loc. 280, el. 3,356 feet (L), where it consists of only 2 feet, 10 inches of coal, with 2 inches of shale occurring 6 inches from the bottom of the bed.

Coal beds above the High Splint bed.—A caved pit was seen on the outcrop of a coal bed 100 feet above the High Splint west of the Pardee No. 1 mine, but no section is available (loc. 281, el. 3,230 feet, B). The bed is reported 4½ feet thick.

BLACK CREEK BASIN, INCLUDING BASINS OF LICK BRANCH AND THACKER BRANCH.

General features.—The territory here described will be called the Black Creek basin although three other smaller basins are included under the same head, namely those of Thacker Branch, Lick Branch, and Bearpen Branch. All of these streams, including Black Creek, flow south into Powell River. The main stream in this basin is Black Creek, which is 4½ to 5 miles long.

Black Creek, since the opening of the Wise County coal fields, has been the barrier or boundary across which, heretofore, the correlation of the coal beds have not been definitely established. The detailed description of the structure of this basin is given elsewhere[1] in this report and the history of the correlation of the coal beds is also given in another section.[2] Therefore, only brief mention of the salient geologic features of the Black Creek basin will be made here.

The geologic structure of the Black Creek basin is dominated wholly by the Buck Knob anticline (see fig. 30). The axis of this fold enters the basin from the north, passes through White Oak Gap,[3] bends slightly to the west, and then swnigs southeast over Mine No. 10 of the Intermont Coal & Iron Corporation (loc. 303), until cut off sharply by the upturned rocks of the great anticline of Powell valley. The dip on the west limb of the Buck Knob anticline is rather steep for one of these minor folds. Along a line from Black Creek school to the town of Roaring Fork the average dip is at the rate of 285 feet to the mile. The sharp upturn of the rocks along the north side of Little Stone Mountain at Blackwood is graphically shown in the photographs in Plate XXI and in Plate XXII.

[1] See page 133.

[2] See page 79, et seq.

[3] The gap, 1 mile east of Black Creek school, in the ridge between Black Creek and Thacker Branch.

(A) Shale overlying Imboden coal bed showing fossil plant stems and leaf debris. Photograph made of roof shale in coal mine at Dunbar.

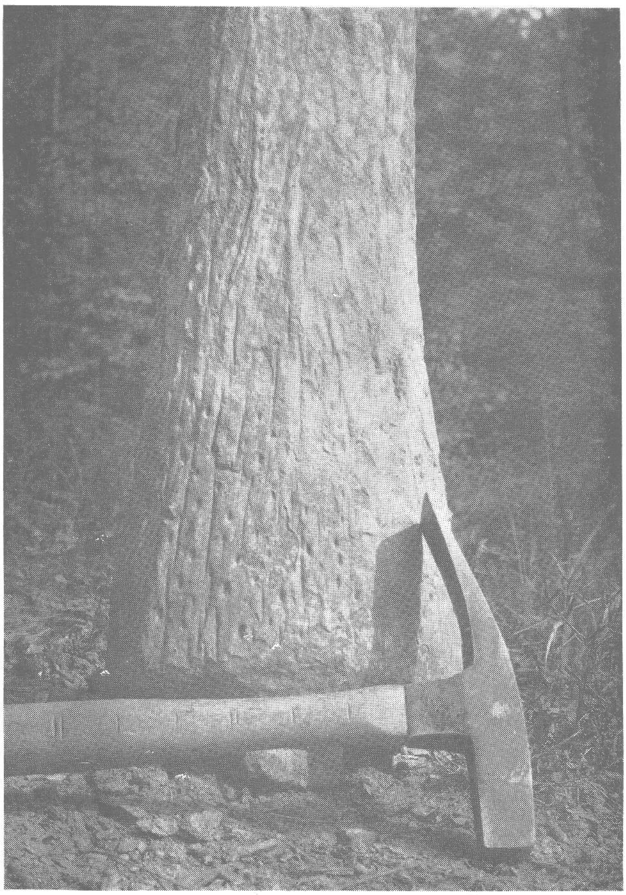
Photo by C. K. Wentworth.

(B) Sandstone cast of large fossil, extinct club-moss (Sigillaria), removed from sandstone in Roaring Fork coal mine. The scars mark points of leaf attachment, and the spreading of the trunk towards its base indicates growth in swamp environment.

Photo by C. K. Wentworth.

(A) Shale overlying Imboden coal bed showing fossil plant stems and leaf debris. Photograph made of roof shale in coal mine at Dunbar.

Photo by C. K. Wentworth.

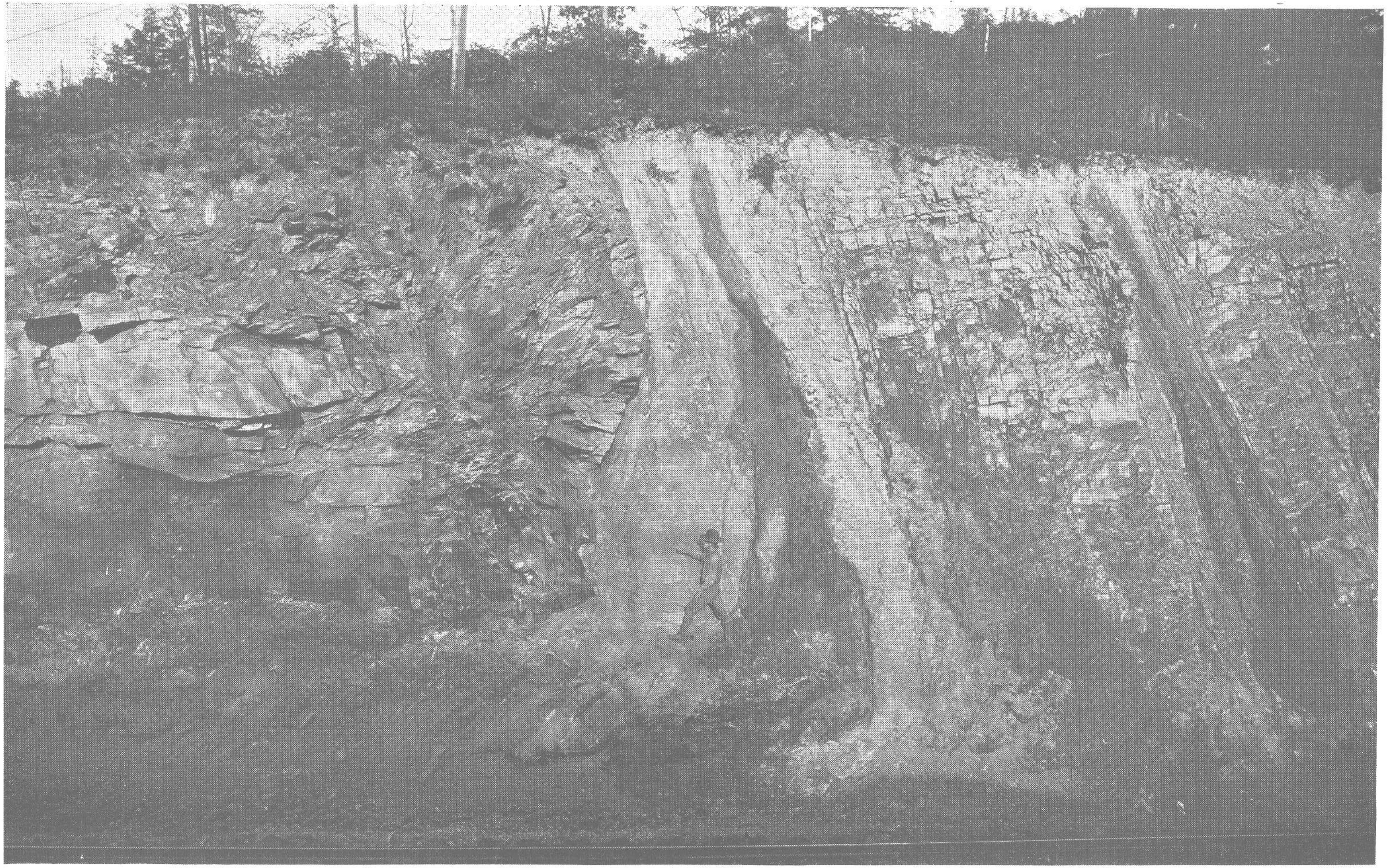


(B) Sandstone cast of large fossil, extinct club-moss (Sigillaria), removed from sandstone in Roaring Fork coal mine. The scars mark points of leaf attachment, and the spreading of the trunk towards its base indicates growth in swamp environment.

Photo by C. K. Wentworth.

CONTACT OF HORIZONTAL AND UPTURNED ROCKS AT BLACKWOOD.
ILLUSTRATING PROBABLE MANNER OF ORIGIN OF THE PIGEON CREEK FAULT.

The horizontal sandstone at the left is broken at the sharp bend in the rocks and the overturned portion of the sandstone has been thrust back several feet over the flat-lying bed. A detailed view of the fault is shown in Plate XXII (A). A coal bed occurs directly below the sandstone. It appears white in the upturn due to reflected light.



CONTACT OF HORIZONTAL AND UPTURNED ROCKS AT BLACKWOOD.
ILLUSTRATING PROBABLE MANNER OF ORIGIN OF THE PIGEON CREEK FAULT.

The horizontal sandstone at the left is broken at the sharp bend in the rocks and the overturned portion of the sandstone has been thrust back several feet over the flat-lying bed. A detailed view of the fault is shown in Plate XXII (A). A coal bed occurs directly below the

The rocks exposed in the Black Creek basin belong to the upper part of the Norton formation, the Gladeville sandstone, and the lower part of the Wise formation. The highest rocks of the basin lie just above the Imboden

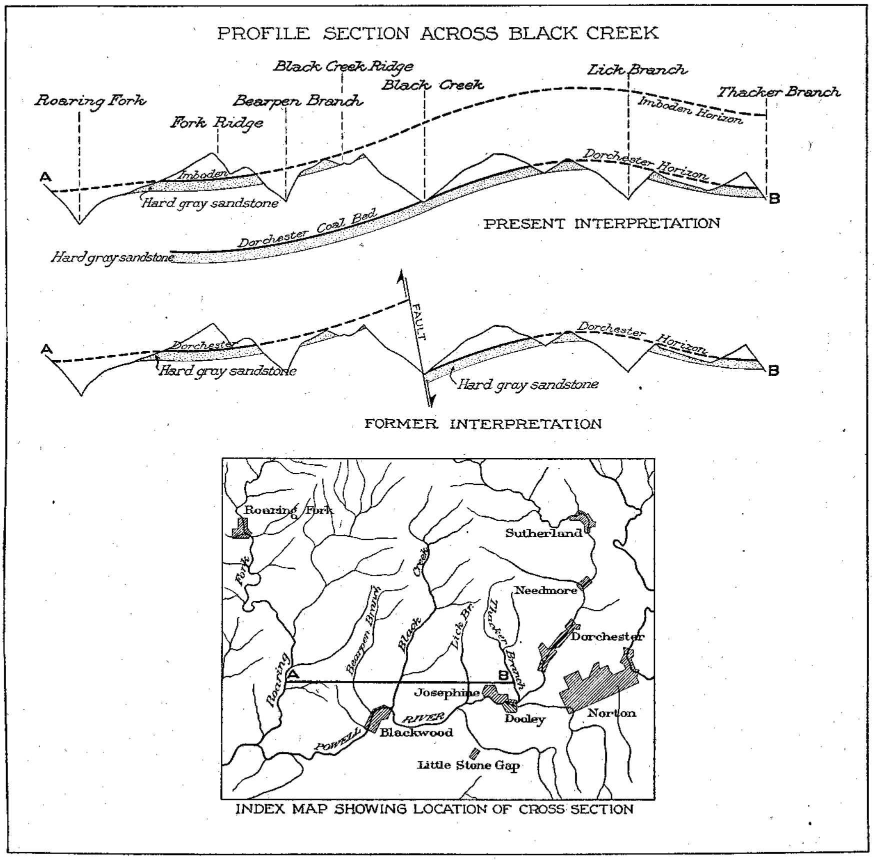


Fig. 30.—Structure section across Black Creek, half a mile north of Blackwood.

coal bed, and the lowest are from 300 to 350 feet below the Gladeville sandstone, thus giving a stratigraphic section on Black Creek of approximately 1,000 feet.

The Gladeville is a hard gray quartzose sandstone. It outcrops in the bed of Black Creek from near the mouth of the stream northward for 3½ miles, and has been cut through by the stream for a short distance north and south of Black Creek school. The eastward rise of the rocks on the west limb of the Buck Knob anticline carries the Gladeville east from Black Creek school, through White Oak Gap, into the drainage basin of Thacker Branch. This stream likewise has cut through the Gladeville for the larger part of its course. In the vicinity of Lick Branch the Gladeville sandstone is high up on the ridges and makes prominent cliffs on its outcrop. West of Black Creek this bed dips rapidly westward and outcrops nowhere in Wise County except in the upturned rocks at the foot of Little Stone Mountain and Stone Mountain.

Within the Wise formation the Addington sandstone member is the most conspicuous lithologic unit outcropping on Black Creek or the other branches. It resembles the Gladeville in being a massive hard sandstone from 20 to 40 feet thick and lying at a distance above the Gladeville that ranges, at different places, from 180 to 210 feet. The top of the Addington sandstone is about 350 feet below the Imboden coal bed.

Another prominent sandstone from 40 to 60 feet thick lies just below the Imboden coal bed. It is massive at the top but the lower two-thirds is thin-bedded, soft, and coarse-grained, with much mica present. The massiveness of the top stratum makes it difficult for those not realizing the respective positions of this sandstone and the Gladeville sandstone in the geologic column to distinguish one from the other. At the head of Black Creek a thin-bedded but fairly resistant sandstone, seldom more than 20 feet thick, separates the Imboden coal bed from the Kelly coal bed.

The important coal beds in the Black Creek basin are the Norton, Dorchester, Clintwood, and to a lesser extent the Imboden and Kelly. The latter two beds have been removed by erosion from so much of the region that they are relatively unimportant. They outcrop along the western edge but have very little acreage in the other part of the basin. Coals below the Norton bed have not been opened or prospected by the drill in this region. Graphic sections of the coal beds are shown in figures 29 and 31.

The mines of the Intermont Coal & Iron Corporation are the largest in the Black Creek basin. The Wise Coal and Coke Co. has numerous openings on Thacker Branch but the coal is shipped out from mines on upper Powell River. The Blackwood Coal & Coke Co. has, in the past, operated mines on Black Creek and Bearpen Branch, but these are now abandoned. Several wagon mines are working the Norton and Dorchester beds on Black Creek.

The basin is served by the Interstate, and Louisville and Nashville railroads, and thence easy connection is made with the other roads at

Appalachia and Norton. A route for a branch from the Interstate Railroad up Black Creek was being surveyed in the spring of 1921. The building of this spur would open for development the valuable Dorchester, Clintwood and higher coal beds along and at the head of Black Creek.

Norton coal bed.—The Norton coal bed has a small closed outcrop on both Black Creek and Thacker Branch, and an outcrop from 2 to 3 miles long between Josephine and Blackwood in the ridge bordering Powell River on the north. The bed occurs in two benches. The upper bench is the thicker, averaging 3 to 3½ feet with a maximum measured section of 4 feet. The lower bench is 2 feet thick and lies about 30 feet below the upper bench.

The Norton coal bed is now being mined for shipment at Josephine but is nowhere else mined in the Black Creek basin. Prospects on it and drill-hole records of the Wise Coal & Coke Co., however, furnish material for a good description of the bed.

Near the head of Black Creek a drill-hole was sunk to the Norton coal bed, revealing the following section:

Section of the Norton coal bed under head of Black Creek.

(W. C. & C. Co. DH–19.)

(Loc., 20[1]; surface el., 2,350 feet, approx.; coal el., 2,100 feet, L.)

	Ft.	In.
Shale.		
Coal		7
Shale		11
Coal	1	9
Shale		3
Coal		10
Shale		2
Coal		6
Clay		
Coal	3	8
Partings	1	4

In the next ravine southeast of that in which this bore hole was put down is another boring which shows the Norton bed in two benches separated by 31 feet of sandstone. Calling the two beds here benches of the same bed is an arbitrary inference, based largely on the fact that throughout the greater part of the entire outcrop of the Norton bed in Wise County

[1] The location numbers of all bore-hole sections given in the text are the map bore-hole location numbers given on the plate of bore-hole sections (Plate III) and on the geologic map (Plate II).

outside this basin no persistent coal bed is found within the 150 to 200 feet of strata below the Norton horizon. The two sections are given as follows:

Sections of the Norton coal bed under head of Black Creek.

(W. C. & C. Co. DH–29.)

(Loc., 21; surface el., 2,275 feet, L.)

Upper bench (coal el., 2,172 feet, L).

	Ft.	In.
Shale.		
Coal		7
Shale		6
Coal	2	7
Shale		1
Coal		3
Shale, carbonaceous		3
Sandy shale		
Coal	3	5
Partings		7

Lower bench (coal el., 2,241 feet, L.)

	Ft.	In.
Sandstone.		
Coal		4
Shale		4
Coal		8
Shale	1	3
Coal	1	2
Shale		
Coal	2	2
Partings	1	7

High up on the point of the spur northeast of Black Creek school a boring went down to the Norton coal bed, which shows a section of 26 inches of coal, parted by 2 inches of shale, 11 inches below the top of the bed (W. C. & C. Co., DH-22, loc. 22, surface el. 2,516 feet, L, coal el. 2,252 feet, L).

The Norton coal bed shows its best development in the basins under consideration at its exposure on Black Creek, south of Black Creek school. At a new prospect driven into the bed in that vicinity the following sections were measured:

Sections of the Norton coal bed on Black Creek.

(Loc., 282; el., 2,124 feet, L.)

	Ft.	In.
Sandstone, Gladeville.		
Shale		10
Coal	3	7
Shale		2
Coal		1
Clay		
Coal	3	8
Parting	2	

(W. C. & C. Co.)

	Ft.	In.
Coal	3	10

At the mouth of the ravine, 1 mile east of Blackwood, a coal bed is opened 20 feet below the Gladeville sandstone and is referred to the lower bench of the Norton. A section measured in the pit is as follows:

Section of the Norton coal bed (lower bench) 1 mile east of Blackwood.

(Loc., 283; el., 2,050 feet, B.)

	Ft.	In.
Shale.		
Coal	1	0
Shale		2
Coal	1	3
Clay		
Coal	2	3
Parting		2

On Lick Branch below Mine No. 10 of the Intermont Coal & Iron Corporation, the two benches of the Norton coal bed are opened, 30 feet stratigraphically apart. The sections[1] are as follows:

Sections of the Norton coal bed on Lick Branch.

Upper bench.

(Loc., 284; el., 2,180 feet, B.)

	Ft.	In.
Coal, impure	4	0

Lower bench.

(Loc., 285; el., 2,150 feet, B.)

	Ft.	In.
Coal	1	3
Clay		2½
Coal	1	4
Coal	2	7
Parting		2½

At Josephine, mines Nos. 1, 2, and 3 are in the Dorchester coal bed and the upper and lower benches of the Norton coal bed respectively. During the summer of 1920, however, only Mine No. 2 was in operation, Mine No. 3 being closed for lack of men, and Mine No. 1 abandoned and caved shut. The bed in Mine No. 2 (loc. 286, el. 2,100 feet, B), contains 28 inches of clear coal. Thirty feet below this opening is the entrance to Mine No. 3. A reported section of the lower bench of the Norton in this mine is given below:

Section of the Norton coal bed (lower bench) at Josephine.

(Loc., 287; el., 2,070 feet, B.)

	Ft.	In.
Sandstone.		
Coal	1	2
Shale		1
Coal	1	4
Clay		
Coal	2	6
Parting		1

[1] Measured by E. L. Gobble, Blackwood, Va.

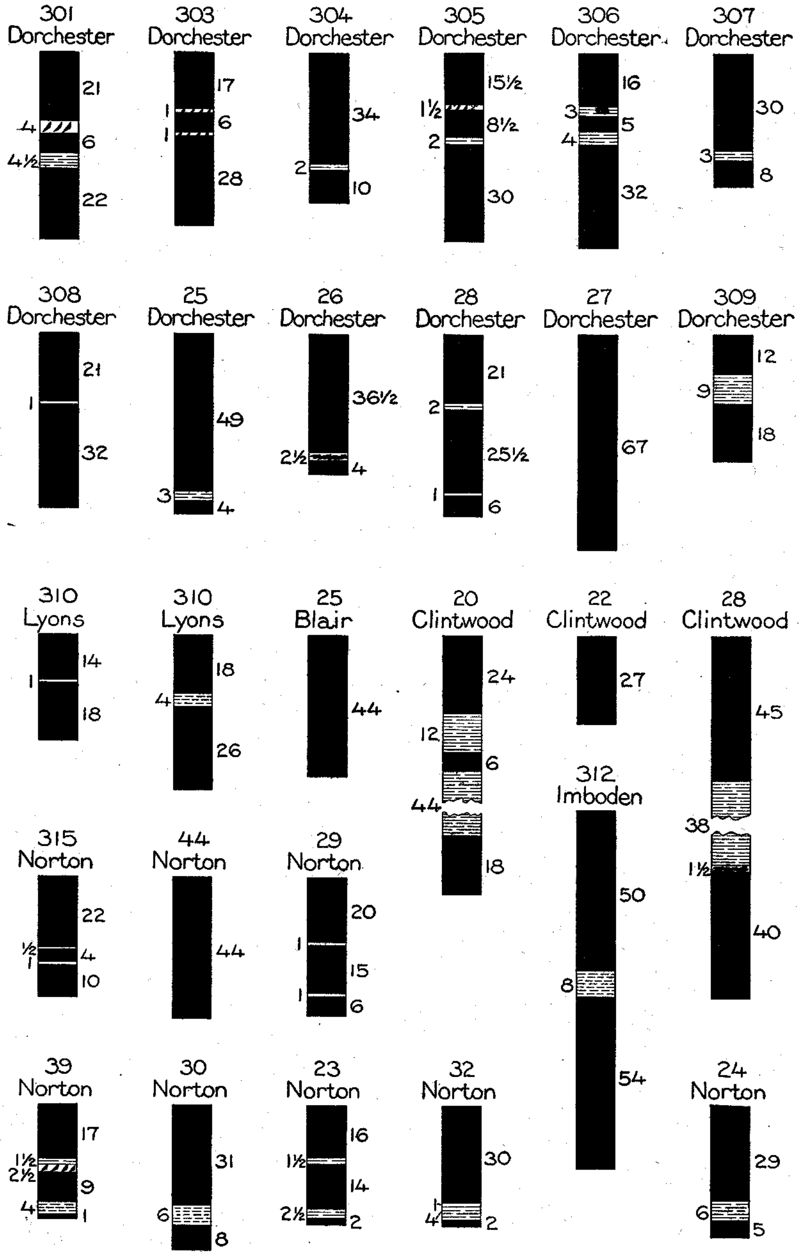


Fig. 31.—Sections of coal beds in the basins of Black Creek, Lick Branch, Thacker Branch, and Upper Powell River.

The coal mined at Josephine has long been made into coke for use in the blast furnace at Big Stone Gap. The furnace has been recently closed, however, and the coal is now mined for shipment. On the south side of Powell River at Josephine a mine being worked by Collier & Collier, of Norton, is operating in what is thought to be the lower bench of the Norton bed. The coal occurs in a low hill from which the Gladeville sandstone has been entirely removed. Only a small acreage of the bed is present, as the belt of upturned strata lies only a very short distance to the south. The Collier mine produces about 50 tons per day. The coal bed at this mine dips 5° east. In Mine No. 1 the bed has the following section:

Section of the Norton coal bed (lower bench) in Collier & Collier Mine No. 1.

(Loc., 288; el., 2,095 feet, B.)

	Ft.	In.
Sandstone.		
Coal	1	2
Clay		2
Coal	1	3
Clay		
Coal	2	5
Parting		2

The Norton bed is partially exposed on Thacker Branch, one mile above its mouth (loc. 289, el. 2,070 feet, B), showing only 8 inches of coal, 15 to 18 feet below the Gladeville sandstone. The bed is workable, however, in this vicinity, as shown by a borehole put down near the head of the hollow that branches off Thacker Branch valley northeastward from the location mentioned above. In this boring the bed has the following section:

Section of the Norton coal bed near head of Thacker Branch.

(W. C. & C. Co. DH-6.)

(Loc., 28; surface el., 2,359 feet, L; coal el., 2,055 feet, L.)

	Ft.	In.
Shale.		
Coal	1	6
Shale, soft		½
Coal	1	8½
Clay		
Coal	3	2½
Parting		½

Dorchester coal bed.—The coal bed overlying the Gladeville sandstone, here called the Dorchester coal bed, is the thickest bed outcropping in the Black Creek basin. The bed averages 4 to 5 feet of coal with only a few inches of parting at the most. The Dorchester bed is now being mined more than any of the other beds in the basin and will undoubtedly continue to be so for many years to come. The Intermont Coal & Iron Corporation and the Wise Coal & Coke Co., both have large mines in the bed. On account of the rapid westward dip of the rocks from the Buck Knob anticline, the Dorchester bed is nowhere exposed in Wise County west of the Black Creek valley and north of the upturned rocks.

The Dorchester bed has been opened on the west side of Black Creek about 1 mile north of Blackwood (loc. 290, el. 2,038 feet, L) exposing 22 inches of clear coal with the bottom of the bed not exposed. Due north of this location a few hundred feet is the entrance to the Blackwood Coal & Coke Co.'s old slope mine, (loc. 291, el. 2,073 feet, L). The mine is said to have struck unusual "rolls" or disturbances in the bed, 400 feet in from the mouth, and was abandoned. It promptly filled with water and has not been pumped out since abandonment, nearly 20 years ago. The mining of the Dorchester bed on the west side of Black Creek will always present two disadvantages, first the adverse grade (from 3 to 5 degrees) up which the coal would have to be hauled, and second, the pumping that would be required to keep the mine free from water, as the mine would have no natural drainage.

A local prospect was seen in the Dorchester bed at loc. 292, el. 2,100 feet (B). The coal bed is not exposed and no measure is available.

In a pit one mile north of Black Creek school and on the west bank of the stream the following section of a part of the bed was measured:

Section of the Dorchester bed on upper Black Creek.

(Loc., 293; el., 2,200 feet, B.)

	Ft.	In.
Clay.		
Coal	2	0
Shale	1	10
Coal	2+	
Base concealed by water in pit.		
Coal	4+	
Parting	1	10

The bed in the section given above is 8 feet above the Gladeville sandstone. A short distance farther north, at the fork of the stream (loc. 294, el. 2,200 feet, B), the bed has been opened but when visited the pit was full of water.

A section of the bed obtained in a boring put down near the head of Black Creek by the Wise Coal & Coke Co., is as follows:

Section of the Dorchester coal bed under head of Black Creek.

(W. C. & C. Co. DH-19.)

(Loc., 20; surface el., 2,350 feet, approx.; coal el., 2,191 feet, L.)

	Ft.	In.
Shale, sandy.		
Coal	1	6
Shale	8	
Coal	2	9
Clay		
Coal	4	3
Parting	8	

The parting noted above is quite uncommon, and it is not improbable that the upper bench is an isolated lense of coal of no consequence and bearing no relation to the main Dorchester bed.

A partially caved pit on the east side of Black Creek, 1 mile north of the school (loc. 295, el. 2,250 feet, B), showed 24 inches of coal, the bottom of the bed being concealed. South of this location several hundred feet the following section of the bed is given:

Section of the Dorchester coal bed on Black Creek.

(W. C. &. C. Co. prospect.)

(Loc., 296; el., 2,223 feet, L.)

	Ft.	In.
Coal	1	9
Shale		3
Coal	3	
Coal	4	9
Parting		3

The bed is more than 6 feet thick in the spur northeast of Black Creek school as shown in a boring put down in that locality.

Section of the Dorchester bed beneath ridge northeast of Black Creek school.

(W. C. & C. Co. DH-22.)

(Loc., 22; surface el., 2,516 feet, L; coal el., 2,226 feet, L.)

	Ft.	In.
Shale.		
Coal	1	6
Shale		1
Coal	4	7
Shale		
Coal	6	1
Parting		1

Where measured in an outcrop pit due west of the bore hole the bed shows the following section:

Section of the Dorchester bed near Black Creek school.

(W. C. & C. Co. prospect.)

(Loc., 297; el., 2,304 feet, L.)

	Ft.	In.
Coal	2	0
Shale		1
Coal	2	3
Coal	4	3
Parting		1

Throughout the upper part of the Black Creek basin the bed lies very close above or rests on the massive Gladeville sandstone. As the Gladeville makes a steep cliff wherever exposed in a ridge, it greatly aids in following the outcrop of the Dorchester coal bed.

The coal bed is cut through at White Oak Gap east of Black Creek school and a 10-inch bloom of the bed was seen by the roadside near the summit of the gap (loc. 298, el. 2,350 feet, B).

A large acreage of the Dorchester coal bed lies in the ridges south of White Oak Gap. The coal here has been mined only along its southern extremity by the Intermont Coal & Iron Corporation. The bed has been largely prospected, however, and shows an excellent thickness. The area may be divided roughly into three segments, a northwest segment, a southwest segment, and an eastern segment. The first two lie on the westward slope and the third lies on the eastward slope of the Buck Knob anticline. On account of the dip of the rocks away from the axis of this anticline, the northwest and southwest segments should be developed from Black Creek, a development which only awaits the building of the Interstate spur up that stream. The coal from the eastern segment can best be taken out by way of Thacker Branch or south, under the ridge, to Josephine, where mines already enter the bed.

A measured section taken in a prospect south of Black Creek school (loc. 299, el. 2,203 feet, L) shows the bed to contain 5 feet of clear coal.

A group of mines of the Intermont Coal & Iron Corporation are working the Dorchester bed near the mouth of Lick Branch and the next small stream to the east. The bed shows a uniform section of 50 to 52 inches of coal. As measured in mines No. 6 and No. 8 it has the following sections:

Sections of the Dorchester coal bed in Intermont Coal & Iron Corporation mines Nos. 6 and 8.

Mine No. 6.

(Loc., 300; el., 2,230 feet, B.)

	Ft.	In.
Shale		
Coal	2	2
"Rash"		2
Coal	2	2
Clay		
Coal	4	4
Parting		2

Mine No. 8.[1]

(Loc., 301; el., 2,235 feet, B.)

	Ft.	In.
Coal	1	9
"Rash"		4
Coal		6
Shale		4½
Coal	1	10
Coal	4	1
Partings		8½

Mine No. 11 enters the bed at the head of the ravine (loc. 302, el. 2,300 feet, B), and Mine No. 10 is working a small isolated acreage of the Dorchester bed on a knob lying between Lick Branch and the small ravine to the west. The tract is nearly worked out and the mine will probably soon be abandoned. The bed shows the following section in Mine No. 10:

Section of the Dorchester coal bed in Intermont Coal & Iron Corporation mine No. 10.

(Loc., 303; el., 2,310 feet, L.)

	Ft.	In.
Shale.		
Coal	1	5
"Rash"		1
Coal		6
"Rash"		1
Coal	2	4
Clay		
Coal	4	3
Partings		2

Mine No. 10, when visited in the summer of 1920, was producing 50 tons of coal daily, and employing 7 miners. Mine No. 11 was producing 40 tons with 6 miners and Mine No. 6, from 80 to 100 tons per day with 9 miners. Mine No. 8 usually worked 8 men and produced from 70 to 80 tons a day. Some parts of this mine are unworkable due to the rapid accumulation of water. The coal bed in all four mines lies directly on the Gladeville sandstone.

The coal from mines Nos. 8 and 11 is hauled by tram to Mine No. 6 and here lowered on an inclined tram to a tipple by a railroad spur. The coal from Mine No. 10 is lowered directly from the portal of the mine.

[1] Section measured by E. L. Gobble, Blackwood, Va.

Near the head of Lick Branch a prospect on the Dorchester coal bed reveals the following section:

Section of the Dorchester coal bed at head of Lick Branch.

(W. C. &. C. Co. prospect.)

(Loc., 304; el., 2,228 feet, L.)

	Ft.	In.
Coal	2	10
Shale		2
Coal		10
Coal	3	8
Parting		2

At Josephine, the Dorchester bed was worked for some time in Mine No. 1, by the Intermont Coal & Iron Corporation. The mine is now abandoned and caved, but the following measured section is reported by E. L. Gobble, Blackwood, Va.

Section of the Dorchester coal bed in Intermont Coal & Iron Corporation Mine No. 1.

(Loc., 305; el., 2,225 feet, B.)

	Ft.	In.
Coal	1	3½
"Rash"		1½
Coal		8½
Shale		2
Coal	2	6
Coal	4	6
Partings		3½

On the opposite side of the ravine the bed shows a similar section:

Section of the Dorchester coal bed at Josephine.

(W. C. &. C. Co. prospect.)

(Loc., 306; el., 2,223 feet, L.)

	Ft.	In.
Coal	1	4
Shale		3
Coal		5
Shale		4
Coal	2	8
Coal	4	5
Partings		7

The Dorchester coal bed has been opened midway up Thacker Branch on the west side of the stream, where the following section was measured:

Section of the Dorchester coal bed on Thacker Branch.

(W. C. & C. Co. prospect.)

(Loc., 307; el., 2,190 feet, L.)

	Ft.	In.
Coal	2	6
Shale		3
Coal		8
Coal	3	2
Parting		3

An entry in one of the larger mines on upper Powell River, that has been driven to the outcrop, exposes the Dorchester bed at the head of Thacker Branch, just below the sharp bend in the road. The section at this opening is as follows:

Section of the Dorchester bed at head of Thacker Branch.

(W. C. & C. Co. prospect.)

(Loc., 308; el., 2,324 feet, L.)

	Ft.	In.
Coal	1	9
Shale		1
Coal	2	8
Coal	4	5
Parting		1

The thickness of the Dorchester bed southeast of White Oak Gap is well determined by a group of boreholes put down in that vicinity by the Wise Coal & Coke Co. The logs of the holes reveal excellent sections, none containing more than 3 inches of parting. The sections are as follows:

Sections of the Dorchester coal bed in boreholes southeast of White Oak Gap.

(W. C. & C. Co. DH-9.)

(Loc., 25, surface el., 2,443 feet, L; Coal el., 2,185 feet, L.)

	Ft.	In.
Shale.		
Coal	4	1
Shale		3
Coal		4
Clay		
Coal	4	5
Parting		3

(W. C. & C. Co. DH-8.)

(Loc., 26; surface el., 2,322 feet, L; coal el., 2,134 feet, L.)

	Ft.	In.
Shale.		
Coal	3	½
Bone		2½
Coal		4
Shale		½
Clay		
Coal	3	4½
Parting		2½

(W. C. &. C. Co. DH-6.)

(Loc., 28; surface el., 2,359 feet, L; coal el., 2,163 feet, L.)

	Ft.	In.
Shale.		
Coal	1	9
Shale		2
Coal	2	1½
Bone		1
Coal		6
Clay		
Coal	4	4½
Partings		3

(W. C. & C. Co. DH-10.)

(Loc., 27; surface el., 2,235 feet, approx.; coal el., 2,080 feet, L.)

	Ft.	In.
Coal	5	7

South of the group of borings mentioned above, an airvent on Thacker Branch into Mine No. 3 of the Wise Coal & Coke Co., shows the following section of the Dorchester bed:

Section of the Dorchester coal bed in airvent of Mine No. 3 on Thacker Branch.

(W. C. & C. Co. measurement.)

(Loc., 309; el., 2,072 feet, L.)

	Ft.	In.
Coal	1	0
Shale		9
Coal	1	6
Coal	2	6
Parting		9

Lyons coal bed.—A coal bed lying 30 feet above the Dorchester bed is present throughout much of the Black Creek basin. The bed is called the Lyons coal as it occurs at the horizon of a bed by that name in eastern Wise County and parts of Dickenson County. The coal bed on the average is less than 2 feet thick, although it is thicker near the mouth of Black Creek. Throughout most of the basin the bed has been revealed only incidentally by drilling for the larger and lower coal beds. The Lyons has not been prospected to any extent and it is doubtful whether the bed can ever be successfully mined, if the Dorchester bed, 30 feet below, is first mined out.

Two boreholes on upper Black Creek show sections of clear coal as follows: 20 inches of coal in bore hole loc. 20 (W. C. & C. Co., DH-19, surface el. 2,350 feet, approx., coal el. 2,215 feet, approx.); and 24 inches of coal in bore hole loc. 22 (W. C. & C. Co., DH-22, surface el. 2,516 feet, L; coal el. 2,377 feet, L).

On the east bank and near the mouth of Black Creek several entries have been driven into a bed that is referred to the Lyons. Near the entrance of a newly opened mine the coal bed dips 13° in a direction south 75° west. A thin bed of hard sandstone overlies the coal bed. Section "A" in this opening was measured about 20 feet back from the outcrop. Section "B" is reported by E. L. Góbble, of Blackwood, but no exact location in the entry was given.

Sections of the Lyons coal bed near mouth of Black Creek.

(Loc., 310; el., 2,030 feet, B.)

A

	Ft.	In.
Clay.		
Coal	1	2
Clay, soft	1	
Coal	1	6
Clay		
Coal	2	8
Parting	1	0

B

	Ft.	In.
Coal	1	6
Clay		4
Coal	2	2
Coal	3	8
Parting		4

Another prospect to the south, as measured by E. L. Gobble, Blackwood, Va., shows the variable character of this coal bed:

Section of the Lyons coal bed near mouth of Black Creek.

(Loc., 311; el., 2,000 feet, B.)

	Ft.	In.
Coal		6
Clay, soft		3
Coal		2
Clay, soft		5
Coal	1	3
Coal	1	11
Partings		8

The Lyons bed shows a fairly uniform workable section on Thacker Branch, as disclosed by several borings in that region.

Sections of the Lyons coal bed in boreholes on Thacker Branch.

(W. C. & C. Co. DH–9.)

(Loc., 25; surface el., 2,443 feet, L; coal el., 2,243 feet, L.)

	Ft.	In.
Shale.		
Coal	1	10
Clay	1	6
Shale, carbonaceous		11
Coal		6
Shale		
Coal	2	4
Parting	2	5

(W. C. & C. Co. DH–8.)

(Loc., 26; surface el., 2,322 feet, L; coal el., 2,188 feet, L.)

	Ft	In.
Coal	2	0

Blair coal bed.—The Blair coal bed is not being mined at present in the Black Creek basin. An old opening in this coal bed was seen at Josephine but the coal was not exposed. This bed lies from 80 to 110 feet above the Dorchester coal. From a number of boreholes put down in this region it appears that the Blair is exceedingly variable and ranges in thickness from zero up to 3 feet, 8 inches.

The Blair bed shows its poorest sections on Black Creek. In borehole loc. 20 (W. C. & C. Co. DH-19), the bed was not found at all in drilling from the Clintwood to the Norton coal bed. About 1 mile southeast of this hole another boring (W. C. & C. Co. DH-22, loc. 22, surface el. 2,516 feet, L, coal el. 2,410 feet, L) shows only 2 inches of coal at this horizon.

At Josephine the Blair coal bed was worked for some time in Mine No. 4 by the Intermont Coal & Iron Corporation. The mine was abandoned and caved in 1920. A reported section of the Blair bed in this mine gives it a thickness of 5 feet of coal, with a 2-foot parting.

That the Blair bed is of workable thickness in the east half of the basin is further borne out by several test holes put down on Thacker Branch by the Wise Coal & Coke Co. The sections as shown by these boreholes are as follows:

Sections of the Blair coal bed under Thacker Branch.

(W. C. & C. Co. DH-9.)

(Loc., 25; surface el., 2,443 feet, L; coal el., 2,307 feet, L.)

	Ft.	In.
Shale.		
Coal	3	8
Clay		

(W. C. & C. Co. DH-8.)

(Loc., 26; surface el., 2,322 feet, L; coal el., 2,250 feet, L.)

	Ft.	In.
Shale.		
Coal	1	0
Clay		8
Coal	2	6
Clay		
Coal	3	6
Parting		8

At borehole, loc. 28 (W. C. & C. Co. DH-6), 15 inches of coal was encountered at the Blair horizon (surface el. 2,359 feet, L; coal el. 2,256 feet, L) and at borehole loc. 27 (W. C. & C. Co. DH-10) 18 inches of coal (surface el. 2,235 feet, L; coal el. 2,212 feet, L).

A glance at the plate of boreholes (Plate No. III) will show the occurrence of a small local bed of coal about 15 feet below the Blair, in the vicinity of the boreholes mentioned above. In borehole No. 25 a bed of 15 inches of clear coal was drilled through, 14 feet below the Blair. A

23-inch thickness of coal was met 13 feet below the Blair in borehole No. 26, and 22 inches of coal was met 19 feet below the Blair in borehole No. 27. This bed, however, due to its small area and thinness, will scarcely ever be worked, and deserves no more than passing mention in this report.

Clintwood and higher coal beds.—Nothing is known of the Clintwood coal bed on the west side of Black Creek and only bore hole information is available regarding the bed in the basin east of Black Creek. The Addington sandstone overlying the Clintwood coal outcrops throughout much of the region and furnishes an excellent key for tracing the Clintwood horizon. The country is densely covered with second-growth timber and underbrush and natural outcrops of coal beds are rarely seen. The Clintwood coal bed has not been mined at any place in the Black Creek basin, although from bore hole evidence it is a bed of workable thickness. All of the bore hole sections show an upper or main bench and a smaller lower bench of coal. As will be seen later, the Clintwood bed is split throughout practically all of the upper Powell River and upper Guest River basins.

The following sections were obtained from borings on upper Black Creek:

Sections of the Clintwood coal bed from boreholes on upper Black Creek.

(W. C. & C. Co. DH–19.)

(Loc., 20; surface el., 2,350 feet, approx.; coal el., 2,319 feet, L.)

	Ft.	In.
Sandstone, Addington.		
Coal	2	0
Shale	1	0
Coal		6
Shale, soft	3	8
Coal	1	6
Clay		
Coal	4	0
Partings	4	8

(W. C. & C. Co. DH–22.)

(Loc., 22; surface el., 2,516 feet, L; coal el., 2,495 feet, L.)

	Ft.	In.
Shale.		
Coal	2	3
Clay		

A 20-inch bed of coal occurs 25 feet below the coal given as Clintwood in borehole No. 22. It is probably the lower bench of the Clintwood at a considerably greater distance below the upper bench than is commonly the case in this region.

On Thacker Branch this distance is extremely variable as shown by bore hole sections, as follows:

Sections of the Clintwood coal bed in boreholes on Thacker Branch.

(W. C. & C. Co. DH-9.)

(Loc., 25; surface el., 2,443 feet, L; coal el., 2,345 feet, L.)

	Ft.	In.
Coal	4	0
Clay	1	0
Shale, sandy	4	0
Shale	2	7
Coal	2	11
Clay		
Coal	6	11
Partings	7	7

(W. C. & C. Co. DH-8.)

(Loc., 26; surface el., 2,322 feet, L; coal el., 2,474 feet, L.)

	Ft.	In.
Shale.		
Coal	5	0
Shale	7	
Sandstone	6	
Shale	1	6
Coal	1	4
Clay		
Coal	6	4
Parting	14	6

(W. C. & C. Co. DH-6.)

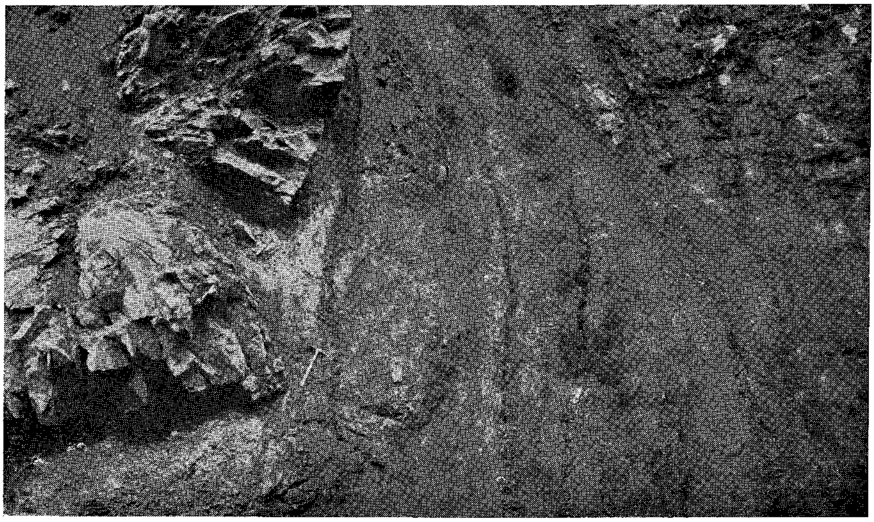
(Loc., 28; surface el., 2,359 feet, L; coal el., 2,300 feet, L.)

	Ft.	In.
Shale.		
Coal	3	9
Shale	3	2
Bone		1½
Coal	3	4
Clay		
Coal	7	1
Partings	3	3½

No workable coal beds have been found in the Black Creek basin between the Clintwood and the Imboden beds, a distance of about 390 feet. The only occurrence of the Imboden and Kelly in this basin is at the head of Bearpen Branch and on Rogers Ridge at the head of Black Creek. A very small isolated acreage is reported to lie under a knob of Black Creek ridge west of the schoolhouse.

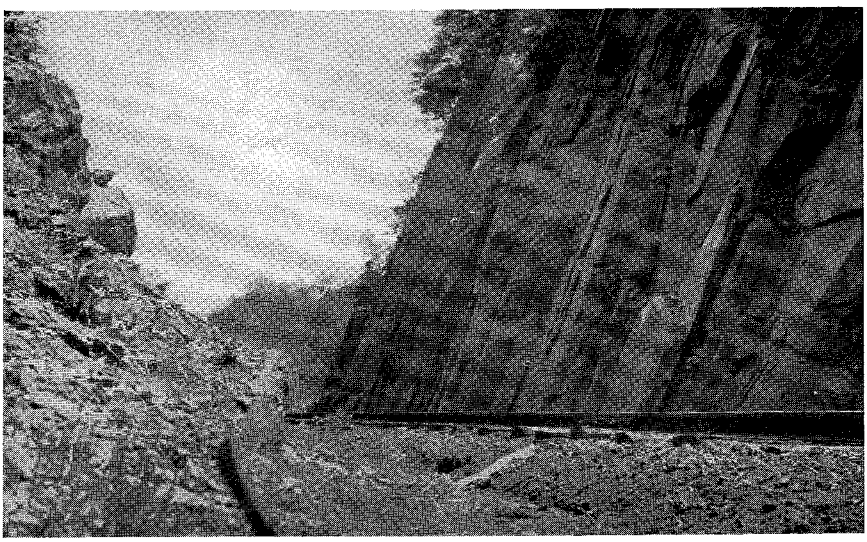
The Imboden coal bed was once mined at the head of the ravine west of Bearpen Branch by the Blackwood Coal & Coke Co. The mine is now abandoned by that company, although when visited in 1920, the chain pillars were being removed by lessees. During the larger operation the coal was hauled by tram to an incline at Blackwood where it was lowered and coked.

A section measured near the entrance of the old mine is given below:



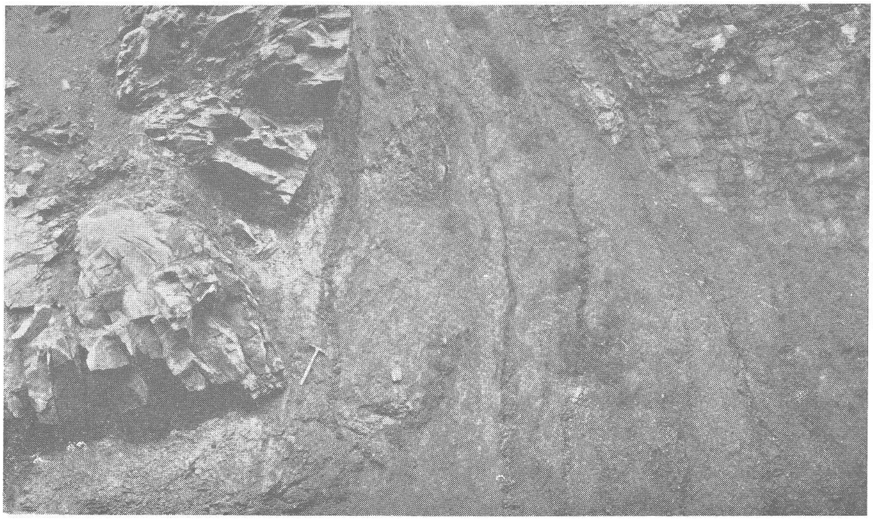
(A) Detailed view showing the break and dislocation of the sandstone overlying the coal bed in the upturned rocks against which the coal bed has been crushed in the upturn, shown in Pl. XXI. The hammer is on the coal bed and lies just to the right of the broken end of the horizontal sandstone.

Photo by J. B. Eby.



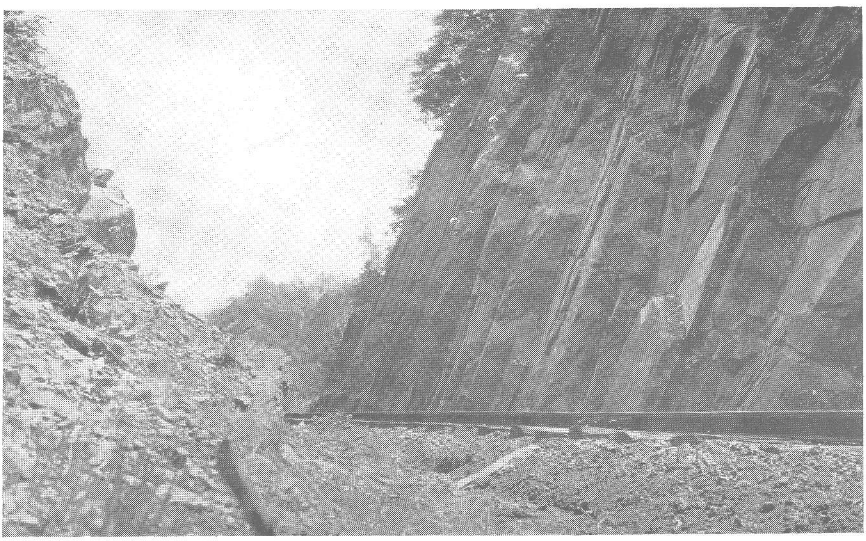
(B) Upturned sandstone of the Norton formation exposed in railway cut near Blackwood.

Photo by C. K. Wentworth.



(A) Detailed view showing the break and dislocation of the sandstone overlying the coal bed in the upturned rocks against which the coal bed has been crushed in the upturn, shown in Pl. XXI. The hammer is on the coal bed and lies just to the right of the broken end of the horizontal sandstone.

Photo by J. B. Eby.

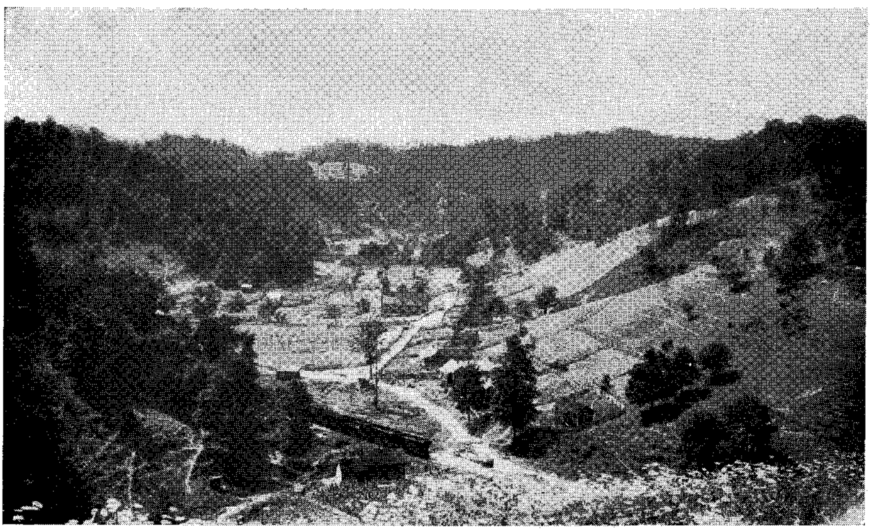


(B) Upturned sandstone of the Norton formation exposed in railway cut near Blackwood.

Photo by C. K. Wentworth.

(A) Barren slopes caused by the killing of vegetation by gases from coke ovens ¼-mile distant. Miners' houses shown in foreground.

Photo by J. B. Eby.

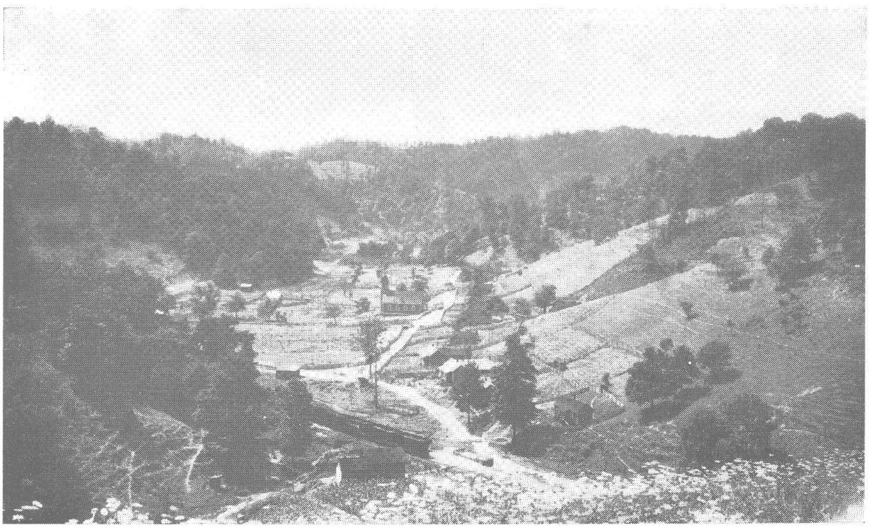


(B) Bull Run Valley, near head, with typical valley settlement. Looking up stream.

Photo by C. K. Wentworth.

(A) Barren slopes caused by the killing of vegetation by gases from coke ovens ¼-mile distant. Miners' houses shown in foreground.

Photo by J. B. Eby.



(B) Bull Run Valley, near head, with typical valley settlement. Looking up stream.

Photo by C. K. Wentworth.

Section of the Imboden coal bed west of Bearpen Branch.

(Loc., 312; el., 2,232 feet, L.)

	Ft.	In.
Shale.		
Coal	4	2
Clay		8
Coal	4	6
Clay		
Coal	8	8
Parting		8

The coal is hard and owing to the development of cleavage shows prismatic structure. The bed overlies closely a thick sandstône that holds up the ridges to the south, giving them unusually flat tops. It is reported to range in thickness up to and sometimes over 13 feet in the different parts of the old mine described above.

The Kelly coal bed is reported to have been opened 50 feet above the Imboden in this vicinity and to have a section of 4 feet of unparted coal. This shows a great increase in the interval between the beds from Roaring Fork where its average is only 18 inches.

UPPER POWELL RIVER BASIN.

General features.—That portion of central Wise County drained by Powell River and its branches, north of the mouth of Thacker Branch, is here described as the Upper Powell River basin. The basin is long and narrow and contains 12 to 15 square miles of territory. The tributary streams are all short, the longest two being Bear and Buckeye branches, both of which are less than 2 miles in length.

The rocks exposed in the Upper Powell River basin include the top beds of the Norton formation, the Gladeville sandstone, and the entire Wise formation. Norton rocks are exposed only in a very narrow belt south of Dorchester and north of the upturned rocks along the north face of Powell Mountain. The Gladeville sandstone outcrops on the southern end of the ridge between Dorchester and Norton and it is exposed in the cuts of the main line of the Interstate Railroad. From the railroad the Gladeville sandstone dips nearly due north and is beneath the valley floor at the Dorchester coke ovens. It is brought to the surface for a short distance near the head of Bear Branch and also on Powell River in the vicinity of Graden, where these streams cross the axis of the Buck Knob anticline. At these exposures the Gladeville exhibits the hard massive quartzose character

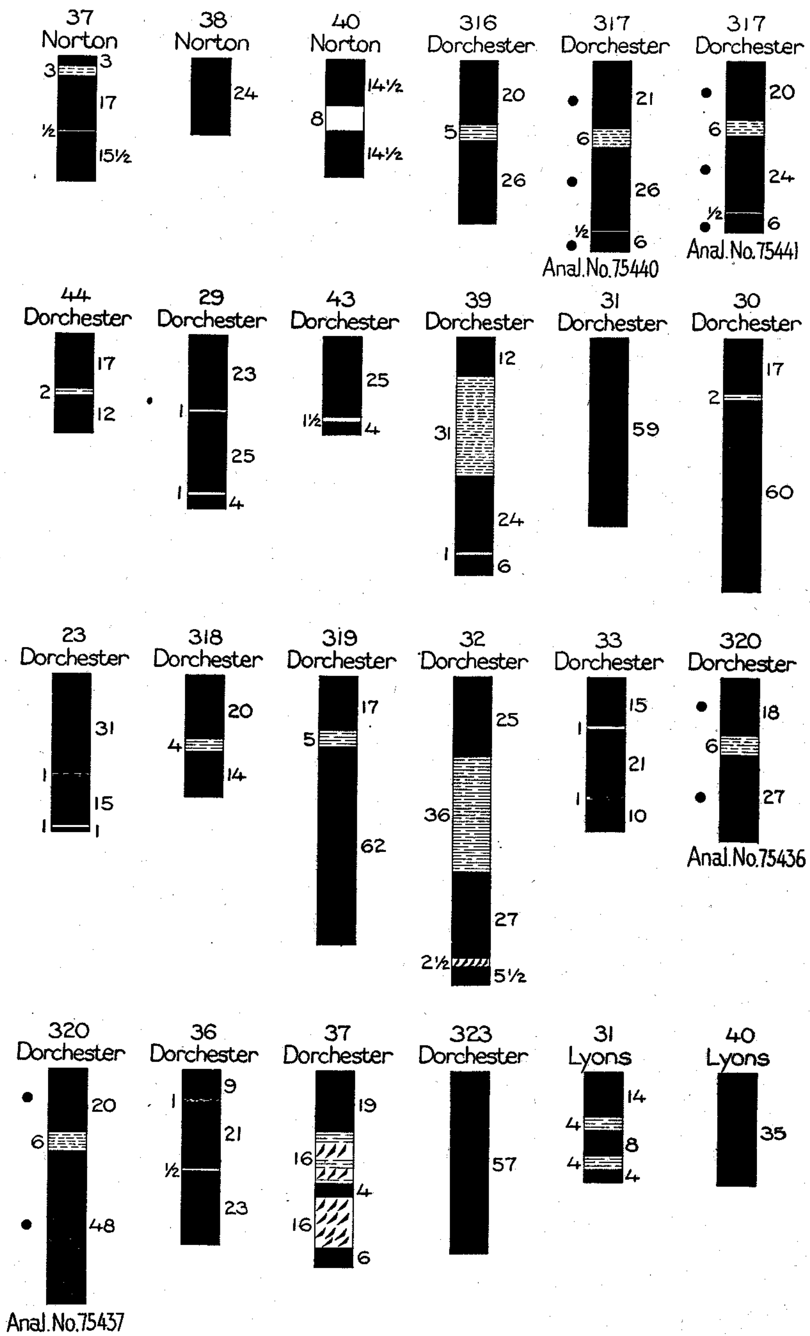


Fig. 32.—Sections of coal beds in the basin of Upper Powell River.

that is typical of the bed. The Addington is a hard gray sandstone lying about 180 feet above the Gladeville. Above the Addington and outcropping in general just beneath the Imboden coal, a thick-bedded micaceous sandstone is commonly found in the Upper Powell River basin. Other beds of sandstone, higher in the Wise formation, are less persistent than those just described.

North of the upturned rocks at Powell Mountain the axis of two important cross folds, the Dorchester syncline and the Buck Knob anticline, cross the lower and the middle portion respectively of the Upper Powell River basin. On the western limb of the Buck Knob fold the rocks dip toward the Middlesboro syncline, the axis of which lies just beyond the Upper Powell River basin. The structural relief, or difference in elevation, from the bottom of the Dorchester syncline to the top of the Buck Knob anticline, is 450 to 500 feet, and from the top of the anticline to the axis of the Middlesboro syncline one-half mile northwest of the head of Powell River, the difference is approximately 1,200 feet. The folds in the rocks on upper Powell River, exposing coal beds that otherwise would be deeply buried, has exerted a notable influence on the commercial development of the coal beds of this basin.

The coal beds outcropping here belong to the Wise formation, with the single exception of the Norton bed, which shows in outcrop for less than a mile at the southern end of the basin. The beds are 10 to 12 in number, but of these only three, the Dorchester, Blair, and Clintwood, are being mined for coking coal or coal for shipment. Several of the higher beds are opened by local users and all of the remaining beds have been more or less well prospected. Graphic sections of the coal beds in this basin are shown in figures 31, 32, 33 and 34.

The coal beds on Powell River have been opened and mined for over 30 years and the basin is one of the oldest mining centers in Wise County. At present, practically all of the Upper Powell River basin production comes from one company, the Wise Coal & Coke Co., at Dorchester. This company operates extensive mines in the Dorchester and Clintwood coal beds and has at times worked a few small mines in the Blair bed. The company has worked the Kelly and Imboden beds but the mines in these beds are now closed, the coal having been practically worked out.

In developing mines on upper Powell River and Black Creek the Wise Coal & Coke Co. prospected their property thoroughly by surface pits and core-drilling. The information obtained from these pits and bore holes has been invaluable in determining the thickness, quality and persistence of the coal beds and the geologic structure. All references to bore holes in this basin will be made by the serial number of the hole as indicated on Plate III. None of the drill holes was extended below the Norton coal bed.

The character and thickness of the coal beds are different in different parts of the basin. The Norton bed, however, is 2½ to 3½ feet thick, usually with a small parting, and shows a fairly constant section in the drill holes. The Dorchester bed varies from 3 to 6 feet throughout the larger part of the basin but thins to a worthless bed in the ridge north of Graden. This coal carries 2 to 2½ per cent of sulphur throughout much of the extent of the bed, a feature it holds in common with the same bed on upper Guest River. The Dorchester bed is 80 to 110 feet above the Norton coal and an equal distance below the Blair coal bed. The Blair bed has a 40 to 50-inch section. The Clintwood coal is the thickest bed of the three coals now being mined, having more than 6 feet of coal throughout much of its extent. A parting, however, averaging 1 foot in thickness in the south end of the basin and 4 feet and more in the north central part of the basin splits the bed. The Imboden and Kelly beds underlie only a limited area at the head of Powell River and they have not been worked except in a few small outliers on Divide Ridge and the hills west of Powell River and north of Graden. The beds show an abnormal thickness of about 10 feet in one of the outliers in the ridge west of Dorchester. Above the Imboden coal the Standiford, Taggart, Low Splint, Pardee, and High Splint beds are all workable but only a small acreage of these beds lies in the upper Powell River basin.

All of the coal now produced by the Wise Coal & Coke Co. comes from two beds, the Dorchester and Clintwood. The lower bed is worked in Mine No. 3 in the southern part of the basin and in Clarke Mine No. 2 near Graden. The upper bed is worked in Mine No. 2 and Mine No. 9 near Dorchester. The mines on the Dorchester bed, Mine No. 3 and Clarke No. 2, each produces an average of 500 tons of coal a day, or a monthly output of 10,000 tons each. Mine No. 2 is the only large mine in the Clintwood bed, having an average daily output of 400 tons or 8,000 tons monthly.

Nearly all of the coal from Mine No. 2 in the Clintwood bed is coked at Dorchester. Ovens were formerly operated also at Sutherland, but all the coking is now done in 167 ovens at Dorchester. The coal makes a hard, good quality coke (see Pl. XXXI A).

The upper Powell River basin as far north as Sutherland is served by the Interstate Railroad. The Louisville and Nashville, Norfolk and Western, and the Southern roads are all nearby and, with the Interstate, give the basin ample and divergent outlets for its coal and coke. A narrow gauge road runs from Sutherland to the Clarke Mine No. 2 near Graden. It will be a relatively simple matter to extend the Interstate Railroad from Sutherland up Powell River for several miles, when development of the higher coal beds is attempted.

South of Graden the basin is closely settled and the inhabitants are for the most part miners; north of Graden the basin is thinly settled and farming is the chief occupation. Timber is not plentiful on upper Powell River and most lumber requirements of the mining companies must be filled from outside sources.

Norton coal bed.—The lowest coal bed on Powell River north of Dooley about which there is any definite information is the Norton coal bed. Lower beds have not been drilled into and the upturned beds along Powell Mountain are so completely covered by the river, roads, railroads, closely grown vegetation, and débris from the mountain, that it was impossible to determine their number or thickness. A caved entry was seen at road level 200 feet west of the entrance of the Interstate Coal Co.'s mine (loc. 315), but the coal is not visible and no report of the thicknes or character of the bed could be obtained. Judging from its location, this bed probably lies from 70 to 80 feet below the Norton bed.

The Norton coal bed, as shown by 10 drill holes of the Wise Coal & Coke Co., varies from 2 feet to 3 feet, 8 inches in thickness, the parting varying from zero to 8 inches. The bed is not available in most of the basin, however, as it is under from 100 to 250 feet of cover in the valleys and it is scarcely thick enough to warrant the sinking of a slope or shaft while thicker coal beds are still available. In time the bed will undoubtedly be worked.

The Norton coal bed is exposed in a cut of the Interstate Railroad east of Dooley and shows 28 inches of clear coal. Although the general trend of the structure in this vicinity is a gentle dip to the north and northwest, the rocks exposed in the Interstate cut dip 5° W. Variation in direction and amount of dip as well as the crushed and tilted condition of the coal beds indicate their nearness to the upturned rocks of Powell Mountain.

The stratigraphic section below the Norton coal bed exposed in the cut is given below:

Section of the Norton and other coal beds at Dooley.

(Loc., 313; el., 2,060 feet, B.)

	Ft.	In.
Shale.		
Coal	2	4
Coal, laminated		5
Clay		6
Sandstone	1	0
Shale	1	3
Sandstone		6
Shale	1	3
Shale, sandy	2	0
Coal		6
"Rash"		3
Clay	2	
Sandstone		
Total	12	0

A caved pit was seen in the Norton bed about one-quarter of a mile east of loc. 313 and north of the railroad (loc. 314, el. 2,050 feet, B). At this location an 8-inch "marker" is exposed 10 feet above the bed.

The Norton coal bed is now being mined by the Interstate Coal Co., in a slope mine alongside the main line of the Interstate Railroad, near Norton (see Pl. XXIV A). About 15 miners are employed and the mine has an output of 150 tons per day. An 18-inch coal bed or "marker" outcrops 7 feet above the main bed in the vicinity of this mine. The Norton bed has the following section in the Interstate mine:

Section of the Norton coal bed in mine of the Interstate Coal Co. near Norton.

(Loc., 315; el., 2,110 feet, B.)

	Ft.	In.
Shale.		
Coal	1	10
Shale		½
Coal		4
Clay		1
Coal		10
Clay		
Coal	3	0
Partings		1½

The Norton coal bed has been penetrated by many of the test borings of the Wise Coal and Coke Co. At Dorchester, 1,000 feet southwest of Mine No. 2 (W. C. & C. Co. DH-1,[1] No. 44;[2] surface el. 2,027 feet, L; coal el. 1,805 feet, L) the bed has a thickness of 3 feet, 8 inches of coal

[1] DH-1, drill hole, with company serial number.
[2] No. 44, map location number.

without a parting. Near the head of Baker Branch, the stream entering Powell River at Dorchester from the northwest, the bed shows small partings as indicated in the following section:

Section of the Norton coal bed under Baker Branch at Dorchester.

(W. C. & C. Co. DH-4.)

(Loc., 29; surface el., 2,377 feet, L; coal el., 2,006 feet, L.)

	Ft.	In.
Shale, sandy.		
Coal	1	8
Parting		1
Coal	1	3
Parting		1
Coal		6
Clay		
Coal	3	5
Partings		2

Four test borings have been put down on Bear Branch, three of which penetrated the Norton coal bed. The borings show that the bed is thinner and has thicker partings than it has to the south. The sections given below are from the logs of these wells:

Sections of the Norton coal bed in boreholes under Bear Branch.

(W. C. & C. Co. DH-7.)

(Loc., 39; surface el., 2,097 feet, L; coal el., 1,827 feet, L.)

	Ft.	In.
Shale.		
Coal	1	5
Shale		1½
"Rash"		2½
Coal		9
Clay		4
Coal		1
Clay		
Coal	2	3
Partings		8

(W. C. & C. Co. DH-15.)

(Loc., 30; surface el., 2,309 feet, L; coal el., 2,192 feet, L.)

	Ft.	In.
Shale.		
Coal	2	7
Clay		6
Coal		8
Clay		
Coal	3	3
Parting		6

(W. C. & C. Co. DH-14.)

(Loc., 23; surface el., 2,466; coal el., 2,230.)

	Ft.	In.
Shale.		
Coal	1	4
Shale		1½
Coal	1	2
Shale		2½
Coal		2
Clay		
Coal	2	8
Partings		4

A boring on one of the small streams entering Bear Branch from the north reveals the following section of the coal bed:

Section of the Norton coal bed in borehole north of Bear Branch.

(W. C. & C. Co. DH-13.)

(Loc., 32; surface el., 2,264 feet, L; coal el., 1,930 feet, L.)

	Ft.	In.
Shale.		
Coal	2	6
Clay		1
Shale		4
Coal		2
Clay		
Coal	2	8
Partings		5

A core drill hole, put down 350 feet east of the gap over which the road from Graden to Guest River passes, shows the following section of the Norton bed:

Section of the Norton coal bed at summit north of Graden.

(W. C. & C. Co. DH-21.)

(Loc., 24; surface el., 2,431 feet, L; coal el., 2,234 feet, L.)

	Ft.	In.
Shale.		
Coal	2	5
Shale		6
Coal		5
Shale		
Coal	2	10
Parting		6

At Sutherland and about 1 mile south of this place on Powell River, two holes have been drilled to the Norton coal bed, which show the sections given below:

Sections of Norton coal bed on Powell River near Sutherland.

(W. C. & C. Co. DH-2.)

(Loc., 37; surface el., 2,109 feet, L; coal el., 1,848 feet, L.)

	Ft.	In.
Shale.		
Coal		3
Clay		3
Coal	1	5
Clay		½
Coal	1	3½
Clay		
Coal	2	11½
Partings		3½

(W. C. & C. Co. DH-27.)

(Loc., 38; surface el. 2,050 feet, B; coal el., 1,774 feet, L.)

	Ft.	In.
Shale, sandy.		
Shale with coal streaks		3
Coal	2	0
Shale, sandy		
Coal	2	0

The following section is taken from the log of a borehole at Needmore:

Section of the Norton coal bed at Needmore.

(W. C. & C. Co. DH-3.)

(Loc., 40; el., 2,120 feet, L; coal el., 1,766 feet, L.)

	Ft.	In.
Coal	1	2½
Parting		8
Coal	1	2½
Coal	2	5
Parting		8

Dorchester coal bed.—More than two-thirds of the coal shipped from the upper Powell River basin comes from the Dorchester bed. This bed outcrops at a convenient level for mining, without requiring the use of long chutes or inclines or long tram roads into otherwise inaccessible valleys. The mine workings have been extended through the ridge east of Powell River and along the ridge from Dorchester to Graden.

The Dorchester coal bed has an average thickness of 4½ feet throughout much of the basin, but the thickness is not constant as the bed thins rapidly in places. The extremes of thickness measured on this bed ranges from 6 inches in the ridge north of Graden to over 6 feet on Bear Branch.

Just north of the mouth of Thacker Branch the bed shows the following section:

Section of the Dorchester coal bed on Powell River at Thacker Branch.

(W. C. & C. Co. prospect.)

(Loc., 316; el., 2,102 feet, L.)

	Ft.	In.
Coal	1	8
Shale		5
Coal	2	2
Coal	3	10
Parting		5

Mine No. 3, of the Wise Coal & Coke Co., enters the Dorchester bed at the town of Dorchester. It has an excellent sandstone roof and little timbering is required, though the main haulway for some distance from the mine mouth carries three parallel tracks with ample room to spare. The coal in this mine rises with a 9 to 10 per cent grade from the end of the first 1,000 feet to the end of the second 1,000 feet in from the drift mouth. It then rises very gently toward the west and northwest. In general, the coal bed in this mine appears to lie in "flats" or plateaus, with short steep grades on all sides.

The coal in Mine No. 3 of the Wise Coal & Coke Co., was sampled at two points and the results of the analyses appear on page 516. The sections measured at the points of sampling show about 4 feet, 4 inches of coal with partings as follows:

Sections of the Dorchester coal bed in Mine No. 3, Dorchester.

(Loc., 317; el., 2,021 feet, L.)

Section where sample was cut at face of C-entry, off No. 1 main entry.

(Analysis No. 75440.)

	Ft.	In.
Sandstone.		
*Coal	1	9
Clay		6
*Coal	2	2
Bone		½
*Coal		6
Clay		
Coal	4	5
Partings		6½

Section where sample was cut at face of C-entry, off No. 2 main entry.

(Analysis No. 75441.)

	Ft.	In.
Sandstone.		
*Coal	1	8
Clay		6
*Coal	2	
Bone		½
*Coal		6
Clay		
Coal	4	2
Parting		6½

The Dorchester coal bed dips below stream level at Dorchester and is 100 feet below the surface near Mine No. 2 on the Clintwood bed where a boring has been put down. The Dorchester bed shows a mediocre section in the log of the boring as is indicated in the following section:

Section of the Dorchester coal bed in borehole under Mine No. 2.

(W. C. & C. Co. DH-1.)

(Loc., 44; surface el., 2,027 feet, L; coal el., 1,917 feet, L.)

	Ft.	In.
Clay.		
Coal	1	5
Shale		2
Coal	1	0
Clay		
Coal	2	5
Parting		2

*Sampled.

Northwest of this hole another boring reveals a greatly improved section, as follows:

Section of the Dorchester coal bed in borehole northwest of Mine No. 2.

(W. C. & C. Co. DH–4.)

(Loc., 29; surface el., 2,377 feet, L; coal el., 2,104 feet, L.)

	Ft.	In.
Shale.		
Coal	1	11
Parting		1
Coal	2	1
Parting		1
Coal		4
Shale		
Coal	4	4
Partings		2

The Dorchester bed has been drilled into at the north end of the town of Dorchester showing the following section:

Section of the Dorchester bed in borehole at the north end of Dorchester.

(W. C. & C. Co. DH–5.)

(Loc., 43; surface el., 2,075 feet, L; coal el., 1,869 feet, L.)

	Ft.	In.
Shale.		
Coal	2	1
Bone		1½
Coal		4
Clay		
Coal	2	5
Parting		1½

On Bear Branch the dip is about 13° due east and the Addington sandstone makes a conspicuous showing just above creek level throughout most of the basin. As the coal bed underlies the Addington sandstone it is generally under cover, the stream cutting through it and into the underlying Gladeville sandstone for only a short distance near the crest of the Buck Knob anticline. Where the Dorchester coal is exposed it has been thoroughly prospected by surface pits and where it is under cover it has been tested by the drill.

The thickness of the bed on and under Bear Branch varies from 2½ to 6½ feet. The following sections are from the logs of boreholes put down in the valley of Bear Branch:

(W. C. & C. Co. DH-7.)

(Loc., 39; surface el., 2,097 feet, L; coal el., 1,906 feet, L.)

	Ft.	In.
Shale.		
Coal	1	0
Clay	2	7
Coal	2	0
"Rash"		1
Coal		6
Clay		
Coal	3	6
Partings	2	8

(W. C. & C. Co. DH-16.)

(Loc., 31; surface el., 2,236 feet, L; coal el., 2,075 feet, L.)

	Ft.	In.
Shale.		
Coal	4	11
Shale		1
Clay		
Coal	4	11

(W. C. & C. Co. DH-15.)

(Loc., 30; surface el., 2,309 feet, L; coal el., 2,270 feet, L.)

	Ft.	In.
Shale.		
Coal	1	5
Shale		2
Coal	5	0
Clay		
Coal	6	5
Parting		2

(W. C. & C. Co. DH-14.)

(Loc., 23; surface el., 2,466 feet, L; coal el., 2,305 feet, L.)

	Ft.	In.
Shale, sandy.		
Coal	2	7
Bone		1
Coal	1	3
Shale		1
Coal		1
Clay		
Coal	3	11
Partings		2

An unusual difference in thickness is noted in two surface pits within one-eighth of a mile of one another, as shown by the following sections:

Sections of the Dorchester coal bed on Bear Branch.

(W. C. &. C. Co. prospect.)

(Loc., 318; el., 2,347 feet, L.)

	Ft.	In.
Coal	1	8
Shale		4
Coal	1	2
Coal	2	10
Parting		4

(Loc., 319; el., 2,318 feet, L.)

	Ft.	In.
Coal	1	5
Shale		5
Coal	5	2
Coal	6	7
Parting		5

About three-fourths of a mile due east of the pits mentioned above, a test bore shows a 3-foot parting in the Dorchester bed. A parting of such thickness is rare in this bed on Powell River and undoubtedly represents a local body or lense of shale. The section is as follows:

Section of the Dorchester coal bed north of Bear Branch.

(W. C. & C. Co. DH-13.)

(Loc., 32; surface el., 2,264 feet, L; coal el., 2,021 feet, L.)

	Ft.	In.
Shale.		
Coal	2	1
Shale	3	0
Coal	2	3
"Rash"		2½
Coal		5½
Clay		
Coal	4	9½
Partings	3	2½

The Dorchester bed contains a workable thickness of coal southwest of Sutherland, as shown in the record of a borehole put down near the electric substation on the south bank of Powell River. The section is as follows:

Section of the Dorchester coal bed in borehole near Sutherland.

(W. C. & C. Co. DH-18.)

(Loc., 33; surface el., 2,249 feet, L; coal el., 2,023 feet, L.)

	Ft.	In.
Shale.		
Coal	1	3
Shale		1
Coal	1	9
Coal, bony		1
Coal		10
Clay		
Coal	3	10
Partings		2

The Clarke No. 2 mine enters the Dorchester bed 1 mile southeast of Graden. The mine is one of the largest producers of the Wise Coal & Coke Co., which uses electric haulage in the mine and steam haulage from the mine to the Southerland tipple. The coal in this mine contains some streaks of pyrite and a middle parting of 3 to 12 inches of shale, but is of excellent quality and heating value. Chemical analyses of three samples of coal from this mine are given on page 515. The sections measured at the points where these samples were taken are as follows:

Sections of the Dorchester coal bed in Clarke No. 2 mine.

(Loc., 320; el., 2,231 feet, L.)

Section where sample was cut at face of 2nd left air-course, off 3d right entry.

(Analysis No. 75436.)

	Ft.	In.
Shale.		
Shale, soft		2
*Coal	1	6
Shale and coal		6
*Coal	2	3
Clay		
Coal	3	9
Parting		6

Section where sample was cut from face of monkey heading, 5,100 feet from mine mouth.

(Analysis No. 75437.)

	Ft.	In.
Shale.		
*Coal	1	8
Clay		6
*Coal	4	0
Shale		
Coal	5	8
Parting		6

Section where sample was cut at face of 4th left air-course, off 3d right entry.

(Analysis No. 75438.)

	Ft.	In.
Shale.		
*Coal	1	9
Shale and clay	1	0
*Coal	2	5
Clay		
Coal	4	2
Parting	1	0

Reported average section for Clarke Mine No. 2.

	Ft.	In.
Shale.		
Coal	2	0
Parting		3
Coal	3	0
Shale		
Coal	5	0
Parting		3

From Clarke No. 2 mine to Graden the Gladeville sandstone outcrops in the river bottom in massive ledges, or it strews the bottom with large blocks of gray sandstone. The Dorchester coal bed, which lies immediately above the sandstone, shows in a number of places as small blooms which seem to indicate that the coal bed is too thin to be of economic value. A borehole of the Wise Coal & Coke Co. (DH. 21, loc. 24; surface el. 2,431; and coal el. 2,328) reveals only 6 inches of coal in the Dorchester bed. The coal bed lies directly on the Gladeville sandstone, which, as shown in the well record, is practically 100 feet thick.

Much doubt has been expressed in the field about the identification of the 6-inch bed referred to above as the Dorchester, and the thinness of the bed was pointed out as an argument favoring another correlation. Many instances of rapid changes in the thickness of beds and splitting of beds are met with in the coals of Wise County, as elsewhere in the coal fields

*Sampled.

of the United States, and little weight can be given to such an argument. Moreover, the Dorchester bed shows but 12 inches of coal in a road bloom just east of the church at Graden (loc. 321, el. 2,310 feet, B), where it outcrops over undoubted Gladeville sandstone.

A mine was formerly operated in the Dorchester bed, opposite the Clarke No. 2 mine, but has been closed and the entry since caved (loc. 322, el. 2,210 feet, B). The coal in this mine is reported to be 6 feet thick.

Two drillholes have been put down, one at Sutherland, and one just north of that town, which show the following dissimilar sections for the same bed.

Sections of the Dorchester coal bed in boreholes at Sutherland.

(W. C. & C. Co. DH-17.)

(Loc., 36; surface el., 2,216 feet, L; coal el., 2,017 feet, L.)

	Ft.	In.
Shale, sandy.		
Coal		9
Coal, bony		1
Coal	1	9
Shale		½
Coal	1	11
Sandstone		
Coal	4	5
Partings		1½

(W. C. & C. Co. DH-2.)

(Loc., 37; surface el., 2,109 feet, L; coal el., 1,946 feet, L.)

	Ft.	In.
Sandstone, shaly.		
Coal	1	7
"Rash" and shale	1	4
Coal		4
"Rash"	1	4
Coal		6
Clay		
Coal	2	5
Partings	2	8

South of Sutherland two drillholes on Powell River show a fairly constant thickness of 2½ feet. At loc. 38 (W. C. & C. C. DH-27; surface el. 2,050 feet, B; and coal el. 1,860 feet, L) the bed contains 28 inches of coal with 2 inches of bony coal 10 inches from the bottom of the bed. At loc. 40 (W. C. & C. Co. DH-3; surface el. 2,120 feet; and coal el. 1,858 feet) the bed has 2 feet 7 inches of coal, with a 2-inch parting 6 inches from the bottom.

The Dorchester bed shows more coal and also more parting than usual in the log of a drillhole put down in a small ravine southeast of Needmore, the section being as follows:

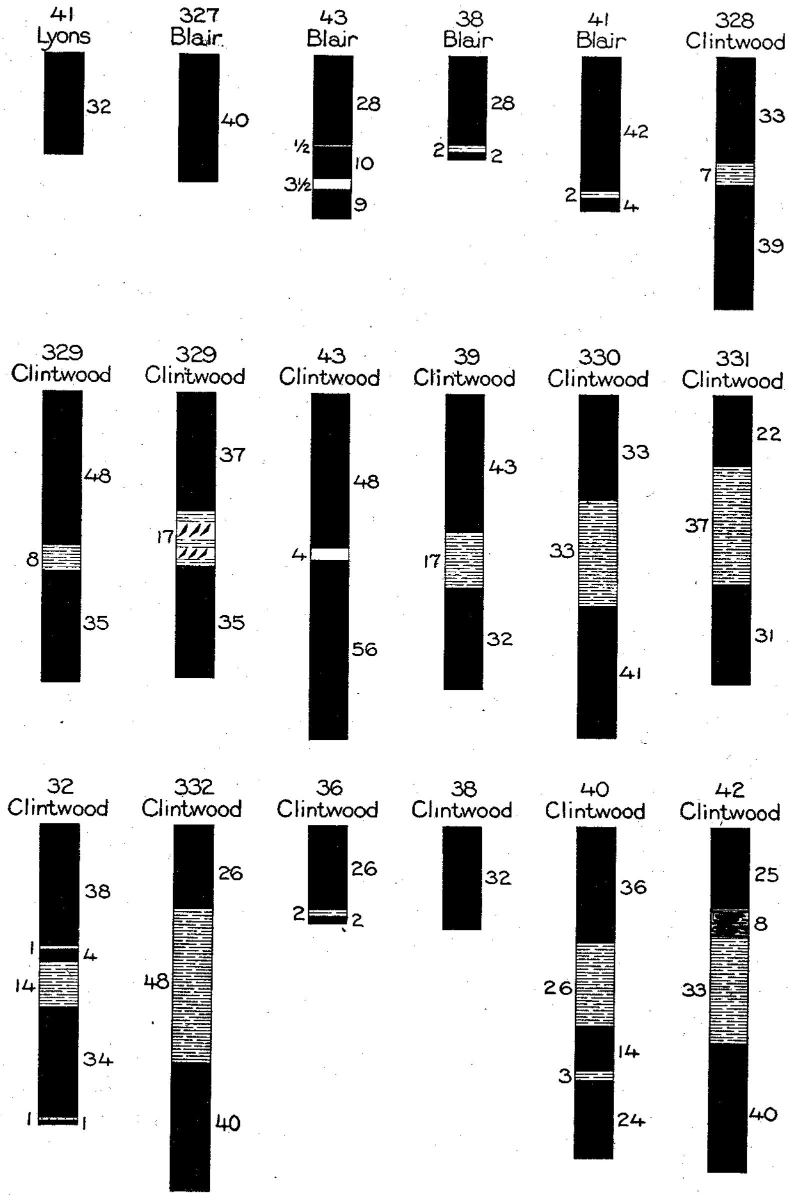


Fig. 33.—Sections of coal beds in the basin of Upper Powell River.

Section of the Dorchester coal bed in borehole southeast of Needmore. (Loc. 41).

(W. C. & C. Co. DH–11.)

	Ft.	In.
Shale.		
Coal		1
Shale with coal streaks		3
Coal	2	0
Shale	3	5
Coal	2	0
Shale		1
Coal		5
Clay		
Coal	4	6
Partings	3	9

The parting 3 feet, 5 inches thick noted above is the largest that is known in the Upper Powell River basin and is probably of local occurrence only.

On the slope of the hill back of West Norton, which is considered in this report a part of the Upper Powell River basin, the bed is prospected at several places. Only one pit was found open (loc. 323, el. 2,270 feet, B), that being a small wagon mine from which coal was being hauled to Norton for shipment. The Dorchester bed shows a thickness of 4 feet, 9 inches of clear coal in this mine. In studying the sections given above it will be seen that the Dorchester bed is thinner in two areas than elsewhere in the basin. One of these areas is a narrow belt extending from Dorchester due north through Sutherland; the other area lies along the ridge north of Graden.

Lyons coal bed.—A coal bed occurring 45 feet above the Dorchester bed is reported in nearly all of the drillhole records of the Wise Coal & Coke Co. The bed has been referred to by that organization as the No. 3 Haskell (Dorchester) Marker. The coal bed will here be called the Lyons, from the Lyons bed outcropping in Dickenson County[1] and eastern Wise County at about this horizon.

The Lyons coal bed has an average thickness of 2 feet, 6 inches and rarely contains partings. The bed has not been prospected, and was seen in natural exposures or in road cuts at only a few localities. A knowledge of the bed can be gotten only from the records of borings put down in the Upper Powell River basin.

The bed shows its maximum development under Powell River from Dorchester to Sutherland. It is 3 feet, 7 inches thick in borehole No. 44

[1] Giles, Albert W., The Geology and Coal Resources of Dickenson County, Virginia: Va. Geol. Survey Bull. XXI, p. 75, 1921.

(W. C. & C. Co. DH-1; surface el. 2,027 feet, L; and coal el. 1,950 feet L). Another bed or upper bench of the Dorchester showing 2½ feet of coal is disclosed in this boring as lying 20 feet below the Lyons. The Lyons bed is 2 feet 10 inches thick in a borehole (W. C. & C. Co. DH-5; loc. 43; surface el. 2,175 feet, L; and coal el. 1,915 feet, L) midway between Dorchester and Needmore. The bed is only 2 feet 1 inch thick in borehole 39 on Bear Branch (W. C. & C. Co. DH-7; surface el. 2,097 feet, L; and coal el. 1,966 feet, L). West beneath Bear Branch the bed shows its first signs of splitting as the section below indicates:

Section of the Lyons coal bed beneath Bear Branch.

(W. C. & C. Co. DH-16.)

(Loc., 31; surface el., 2,236 feet, approx.; coal el., 2,121 feet, L.)

	Ft.	In.
Shale, sandy.		
Coal	1	2
Shale		4
Coal		8
Shale		4
Coal		4
Shale		
Coal	2	2
Partings		8

The Lyons bed contains 1 foot, 11 inches of clear coal at the head of Bear Branch as shown in borehole No. 23 (W. C. & C. Co. DH-14; surface el. 2,466 feet, L; and coal el. 2,363 feet, L). North of Bear Branch in borehole No. 32 (W. C. & C. Co. DH-13; surface el. 2,264 feet, L); and coal el. 2,066 feet, L) the bed consists of 2 feet, 7 inches of coal without a parting. In borehole No. 33 (W. C. & C. Co. DH-18; surface el. 2,249 feet, L; and coal el. 2,078 feet, L) the bed shows a section of 2 feet, 5 inches.

The Lyons bed is exposed in a cut of the tram-road from Clarke No. 2 mine to Sutherland (loc. 324, el. 2,220 feet, B) and shows 2 feet of coal without a parting. The bed here is 50 feet above the Dorchester bed and it dips 8° east.

The bed shows a thickness of 2 feet, 2 inches in the two boreholes near Sutherland (W. C. & C. Co. DH-17; loc. 36; surface el. 2,216 feet, L; and coal el. 2,060 feet, L) and (W. C. & C. Co. DH-2; loc. 37; surface el. 2,109 feet L; and coal el. 2,000 feet, L). The maximum thickness of the Lyons bed is recorded in borehole No. 38 (W. C. & C. Co.; surface el. 2,050 feet, B; and coal el. 1,900 feet, L) where the bed contains 3 feet, 10 inches of clear coal.

At Needmore and southeast of that place the bed shows sections of 2 feet, 11 inches and 2 feet, 8 inches respectively in boreholes No. 40 (W. C. & C. Co. DH-3; surface el. 2,120 feet, L; and coal el. 1,900 feet, L) and 41 (W. C. & C. Co. DH-11; surface el. 2,170 feet, L; and coal el. 1,956 feet, L).

The Lyons coal bed cannot be worked with a profit under the present condition of the coal market, as the bed is thin, and thicker coals are still available. If the demand for coal becomes great enough, however, it is quite certain that some of the Lyons coal will be mined.

Blair coal bed.—The Blair coal bed lies about 100 feet above the Dorchester and from 40 to 80 feet below the Clintwood. It averages in thickness a little more than the Lyons bed, reaching in places 2½ to 3 feet.

The bed is being mined to some extent at Dorchester by the Wise Coal & Coke Co., the operation being called the Gordon mine (loc. 325, el. 2,079 feet, L). The bed in this mine is more than 3 feet thick. A partial section gotten near the entrance is as follows:

Section of the Blair coal bed in Gordon mine.

	Ft.	In.
Shale.		
Coal (not mined)		1
Clay	2	6
Coal	2	7+
Coal	2	7+

A few hundred feet northwest of the entrance of the Gordon mine, two entries have been driven into the Blair bed; one on the southwest side of the ravine, which is known as Mine No. 1, and the other on the northeast side of the ravine (loc. 326, el. 2,078 feet, L), known as Mine No. 7. At a caved entry several hundred feet east of Mine No. 7 (loc. 327, el. 2,150 feet, B), the Blair bed is exposed, showing 40 inches of clear coal.

The character and thickness of the Blair bed can better be understood by presenting some sections of the bed recorded in boreholes put down on upper Powell River. The bed contains 2 feet of clear coal under Powell River near Haskell Mine No. 2 at Dorchester, where borehole No. 44 (W.

C. & C. Co. DH-1; surface el. 2,027 feet, L; and coal el. 2,010 feet, L) was put down. A half-mile up the river the following section is recorded:

Section of the Blair coal bed in borehole under Powell River.

(W. C. & C. Co. DH-5.)

(Loc., 43; surface el., 2,075 feet, L; coal el., 1,963 feet, L.)

	Ft.	In.
Shale.		
Coal	2	4
Parting		½
Coal		10
Parting		3½
Coal		9
Shale		
Coal	3	11
Partings		4

The Blair coal bed has a thickness of 2 feet, 1 inch in a borehole (W. C. & C. Co. DH-16; loc. 31; surface el. 2,236 feet, approx.; coal, el. 2,187 feet, L), one mile up Bear Branch from Powell River. At the head of the branch, however, the bed apparently thins to 2 inches, as only that amount of coal is shown at what is supposed to be the Blair horizon in borehole No. 23 (W. C. & C. Co. DH-14; surface el. 2,466 feet, L; coal el. 2,403 feet, L). A thinning of this character, within such a short distance is no uncommon feature in coal beds, a similar thinning having been described in the Dorchester bed at Graden.

North of Bear Branch midway between Dorchester and Graden, however, the bed is well developed and apparently carries two benches.

Section of the Blair coal bed in borehole north of Bear Branch.

(W. C. & C. Co. DH-13.)

(Loc., 32; surface el., 2,264 feet; coal el., 2,120 feet, L.)

	Ft.	In.
Shale.		
Bone		2
Coal	2	6
Shale	5	8
Coal	1	4
Clay		
Coal	3	10
Parting	5	8

A similar division of the bed is noted in borehole No. 33 (W. C. & C. Co. DH-18; surface el. 2,249 feet, L; and coal el. 2,132 feet, L), where the following section was measured:

Section of the Blair coal bed in borehole near Sutherland.

	Ft.	In.
Sandstone.		
Coal	1	8
Shale	1	4
Shale, sandy	7	
Coal	1	10
Sandstone		
Coal	3	6
Partings	8	4

The Blair bed shows poor sections in the boreholes put down in and north of Sutherland. In one north of the town (W. C. & C. Co. DH-17; loc. 36; surface el. 2,216 feet, L; and coal el. 2,110 feet, L), the Blair is 2 feet, 4 inches thick with 2 inches of shale, 8 inches above the base of the bed. In the Sutherland boring, however, (W. C. & C. Co. DH-2; loc. 37; surface el. 2,109 feet, L; and coal el. 2,037 feet, L), the bed consists of only 10 inches of coal.

South on Powell River the bed regains its normal thickness as indicated by the logs of borings between Sutherland and Dorchester. Thus in borehole No. 38 (W. C. & C. Co. DH-27; surface el. 2,050 feet, B; and coal el. 1,946 feet, L), it has the following section:

Section of the Blair coal bed in borehole south of Sutherland.

	Ft.	In.
Shale, sandy.		
Coal	2	4
Shale		2
Coal		2
Shale		
Coal	2	6
Parting		2

The Blair bed shows an improved section farther south, although a parting of variable thickness enters it, and, as indicated in one of two sections given below, at places makes the bed unworkable.

Sections of the Blair coal bed in boreholes at and near Needmore.

(W. C. & C. Co. DH-3.)

(Loc., 40; surface el., 2,120 feet, L; coal el., 1,963 feet, L.)

	Ft.	In.
Shale.		
Coal	2	1
Shale	4	
Coal	1	2
Clay		5
Coal		3
Sandstone		
Coal	3	6
Partings	4	5

(W. C. & C. Co. DH-11.)

(Loc., 41; surface el., 2,170 feet, L; coal el., 2,011 feet.)

	Ft.	In.
Shale.		
Coal	3	6
Shale		2
Coal		4
Clay		
Coal	3	10
Parting		2

From the sections given above it is obvious that the bed is workable throughout most of its acreage, but it is split by sporadic lenses of clay and shale and the thickness of the bed is far from constant. Both of these facts will hinder its extensive commercial development.

Clintwood coal bed.—The next workable coal above the Blair in the Upper Powell River basin is the Clintwood coal bed, though several small beds lie in the interval between these beds, as revealed by the logs of bore-holes given on Plate III, but none of the intermediate beds is of commercial importance. The Clintwood on the other hand reaches a thickness of almost 9 feet in parts of the basin and is one of the most valuable beds outcropping on upper Powell River.

The Clintwood coal, known locally as the "Big Dorchester" bed, is being mined extensively at Dorchester, and in this vicinity it shows an average thickness of 6 feet. A middle parting of shale or clay is almost everywhere present, being 8 inches at Dorchester but showing a considerably greater thickness to the north of that town.

The coal bed outcrops in the vicinity of Dorchester and a number of old entries were seen near the mouth of the ravine to the west of the center of the town, but the coal bed is not exposed. A mine was visited but the drift was closed. However, two sections were obtained to the north and south of the mine mouth that give an excellent thickness for the Clintwood bed:

Sections of the Clintwood coal bed near mine at Dorchester.

(Loc., 328; el., 2,129 feet, L.)

Section in pit south of mine mouth.

	Ft.	In.
Shale.		
Coal		9
Clay		9
Shale, carbonaceous		6
Coal	3	5+
Bottom concealed by water.		
Coal	4	2+
Partings	1	3

Section in pit north of mine mouth (W. C. & C. Co. prospect; el., 2,131 feet, L.)

	Ft.	In.
Coal	2	9
Shale		7
Coal	3	3
Coal	6	0
Parting		7

The largest single mine on the Clintwood coal bed in Wise County is Mine No. 2 of the Wise Coal & Coke Co. at Dorchester, near the northern end of the town and west of Powell River. The mine is equipped with electric trolley haulage and can produce from 300 to 400 tons of coal daily. The mine had been temporarily closed but is now reopened and coal is being taken out.

The Clintwood coal in Mine No. 2 is hard and is cut by distinct cleavage planes. The bed has no impurities except the ever-present middle parting, which varies from 1 to 20 inches, and divides the bed generally into a top 3½-foot bench and a lower 3-foot bench. The maximum thickness of the upper bench, measured in Mine No. 2, is 52 inches. Two sections of the bed in this mine are given below, with the locations in the mine where the sections were measured:

Sections of the Clintwood bed in Mine No. 2 of the Wise Coal & Coke Co.

(Loc., 329; el., 2,037 feet, L.)

Section at No. 7 right entry, off 3d face entry.

	Ft.	In.
Shale.		
Coal	4	0
Shale or "rash"		8
Coal	2	11
Clay		
Coal	6	11
Parting		8

Section at No. 6 left entry, off 3d face entry.

	Ft.	In.
Shale.		
Coal	3	1
Shale and "rash"	1	5
Coal	2	11
Coal	6	0
Parting	1	5

The Clintwood bed is under cover beneath Powell River from Dorchester to Sutherland, lying as it does in that vicinity, in the trough of the Dorchester syncline. The bed, however, has been prospected by the drill and its thickness fairly well determined.

The coal bed shows its greatest development beneath Powell River just north of Dorchester, as determined by a borehole put down there which gives the following section of the bed:

Section of the Clintwood coal bed in borehole north of Dorchester.

(W. C. & C. Co. DH–5.)

(Loc., 43; surface el., 2,075 feet, L; coal el., 2,018 feet, L.)

	Ft.	In.
Sandstone (Addington member)	42	6
Coal	4	0
Parting		4
Coal	4	8
Coal	8	8
Parting		4

The Clintwood coal bed has an excellent section on and beneath Bear Branch. The middle parting, however, increases steadily to the north, as can readily be seen by comparing the sections given above with the next three sections given below:

Sections of the Clintwood coal bed in borehole on Bear Branch.

(W. C. & C. Co. DH–7.)

(Loc., 39; surface el., 2,097 feet, L; coal el., 2,064 feet, L.)

	Ft.	In.
Sandstone.		
Shale	5	
Coal	3	7
Shale	1	5
Coal	2	8
Clay		
Coal	6	3
Parting	1	5

A short distance west of borehole No. 39 the Clintwood, owing to the rapid rise of the rocks to the west, comes to the surface on Bear Branch. It underlies the massive Addington sandstone, which makes a prominent cliff on both sides of the ravine and shows the following sections in surface pits a little over 1 mile west of the mouth of the branch.

Sections of the Clintwood coal bed on Bear Branch.

(W. C. & C. Co. prospects.)

Loc., 330; el., 2,399 feet, L.)

	Ft.	In.
Shale.		
Coal	2	9
Shale	2	9
Coal	3	5
Shale		
Coal	6	2
Parting	2	9

(Loc., 331; el., 2,430 feet, L.)

	Ft.	In.
Shale.		
Coal	1	10
Shale	3	1
Coal	2	7
Shale		
Coal	4	5
Parting	3	1

The Clintwood shows two additional partings in the log of a boring put down in the ravine which joins Bear Branch north and west. The section in this log is given below:

Section of the Clintwood coal bed in borehole north of Bear Branch.

(W. C. & C. Co. DH–13.)

(Loc., 32; surface el., 2,264 feet, L; coal el., 2,172 feet, L.)

	Ft.	In.
Shale.		
Coal	3	2
Shale		1
Coal		4
Shale	1	2
Coal	2	10
Sandstone		1
Coal		1
Clay		
Coal	6	5
Partings	1	4

The middle parting of the Clintwood reaches such a thickness in the vicinity of Sutherland and farther north that it practically results in the separation of the Clintwood into two beds. The parting is 4 feet in one prospect pit of the Wise Coal & Coke Co., opened west of Sutherland, as shown by the following section:

Section of the Clintwood coal bed west of Sutherland.

(W. C. & C. Co. prospect.)

(Loc., 332; el., 2,199 feet, L.)

	Ft.	In.
Shale.		
Coal	2	2
Shale	4	
Coal	3	4
Shale		
Coal	5	6
Parting	4	0

The Clintwood coal bed was being opened in the summer of 1920 by the Wise Coal & Coke Co., at the locality noted above, by stripping off the top soil with a steam shovel preparatory to driving an entry to meet the underground workings of Haskell Mine No. 2 extended from Dorchester. The work was temporarily suspended, however, shortly after the field was visited.

The top bench only was opened in a pit several hundred yards southeast of the Clarke No 2 mine (loc. 333, el. 2,319 feet, L) by the Wise Coal & Coke Co., this bench showing 42 inches of coal.

On the north bank of Powell River at the west end of Sutherland the following section, indicating a decided deterioration of the bed, was measured:

Section of the Clintwood coal bed west of Sutherland.

(Loc., 334; el., 2,230 feet, B.)

	Ft.	In.
Shale.		
Coal	1	2
Shale		6
Coal	1	0
Shale, sandy		11
Coal		6
Clay		3
Shale	1	0
Sandstone		
Coal	2	8
Partings	1	5

The bed shows a similar division into two benches in the log of the boring put down north of Sutherland, but the lower bench is abnormally thin, as shown by the following section:

Section of the Clintwood coal bed in borehole north of Sutherland.

(W. C. & C. Co. DH–17.)

(Loc., 36; el., surface el., 2,216 feet, L; coal el., 2,192 feet, L.)

	Ft.	In.
Sandstone, hard.		
Coal	2	2
Shale		2
Coal		2
Shale		
Coal	2	4
Parting		2

South of Sutherland on Powell River two borehole sections will suffice to show the progressive thickening of the Clintwood coal bed in that direction. The borings also show the close relationship of the Addington sandstone and the Clintwood coal:

Section of the Clintwood coal bed and Addington sandstone in boreholes south of Sutherland.

(W. C. & C. Co. DH–27.)

(Loc., 38; surface el., 2,050 feet, B; coal el., 2,003 feet, L.)

	Ft.	In.
Sandstone, hard	35	
Shale, sandy	3	11
Coal	2	8
Shale, sandy		
Coal	2	8

(W. C. & C. Co. DH–3.)

(Loc., 40; surface el., 2,120 feet, L; coal el., 2,019 feet, L.)

	Ft.	In.
Sandstone, hard	50	0
Coal	3	0
Shale	2	2
Coal	1	2
Shale		3
Coal	2	0
Shale		
Coal	6	2
Partings	2	5

Two boreholes have penetrated the Clintwood coal bed in the ravine south of Needmore and east of Powell River. The borings indicate a considerable thickening of the parting from Powell River toward the east. The sections are as follows:

Section of the Clintwood coal bed in boreholes east of Powell River.

(W. C. & C. Co. DH–12.)

(Loc., 42; surface el., 2,116 feet, L; coal el., 2,032 feet, L.)

	Ft.	In.
Sandstone, hard	69	1
Shale		5
Coal	2	1
Coal, impure		8
Shale	2	9
Coal	3	4
Clay		
Coal	6	1
Parting	2	9

(W. C. & C. Co. DH–11.)

(Loc., 41; surface el., 2,170 feet, L.; coal el., 2,063 feet, L.)

	Ft.	In.
Shale, sandy.		
Bone		2½
Coal	3	1
Shale with coal streaks		2
Shale	5	
Coal	3	3
Clay		
Coal	6	4
Partings	5	2

The Clintwood is mined in the ridge between Dorchester and Norton by the Wise Coal & Coke Co. Mine No. 9 of this company is operating on a small scale in this bed on the east side of the ravine southeast of Dorchester. A section of the coal bed measured 100 feet from the drift mouth is as follows:

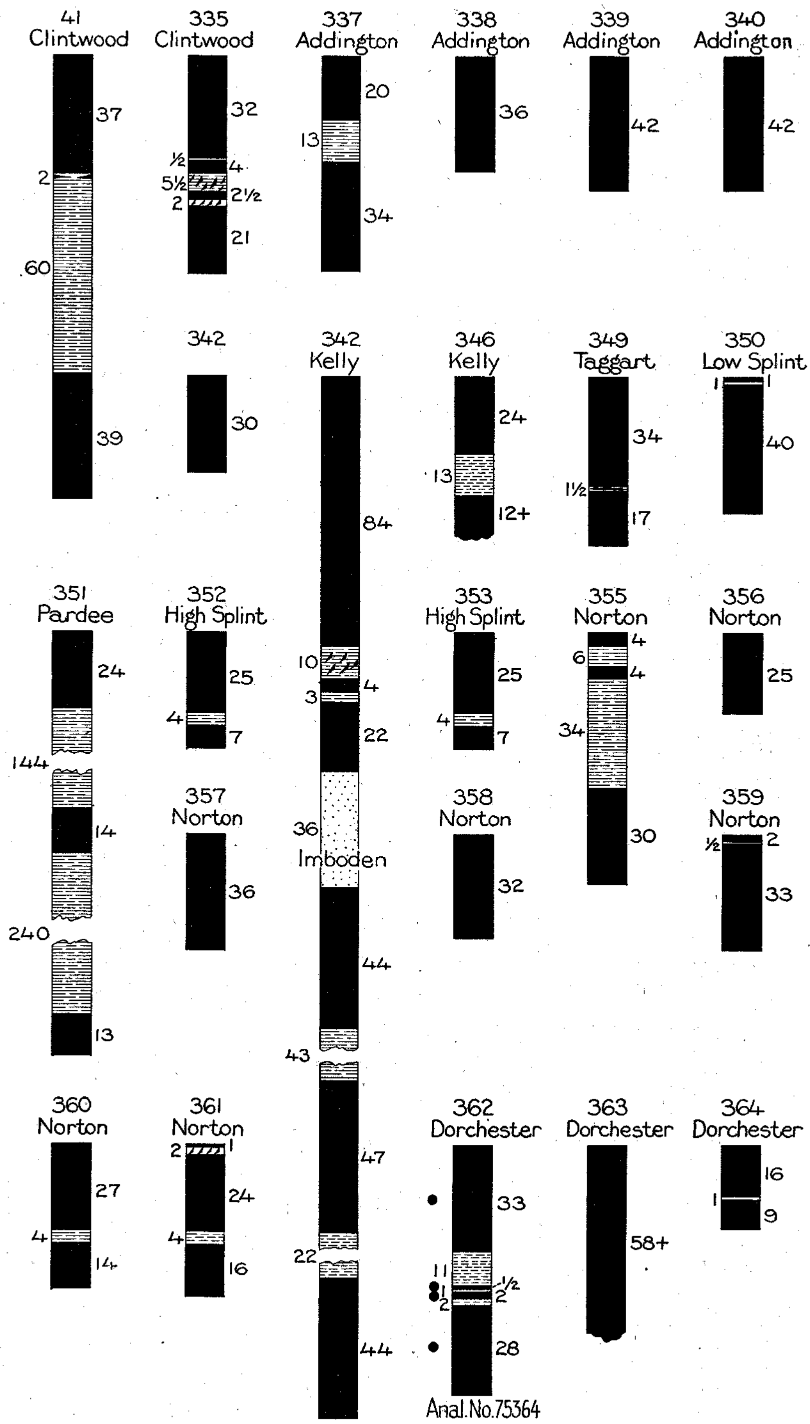


Fig. 34.—Sections of coal beds in the basins of Upper Powell River and Upper Guest River.

Section of the Clintwood coal bed in Mine No. 9 of Wise Coal & Coke Co., near Dorchester.

(Loc., 335; el., 2,310 feet, B.)

	Ft.	In.
Shale.		
Coal	2	8
"Rash"		½
Coal		4
Shale and "rash"		5½
Coal		2½
"Rash"		2
Coal	1	9
Clay		
Coal	4	11½
Partings		8

The Clintwood shows a better section in an abandoned mine on the spur (loc. 336, el. 2,345 feet, B), a short distance south of Mine No. 9. The bed is not fully exposed but 54 inches of clear coal was seen, separated by 6 inches of clay from 12 inches and more of bottom coal.

Addington coal bed.—In the major portion of the basin no traces of a coal bed can be found directly over the Addington sandstone, but on Dog branch (a stream entering Powell River from the north half a mile above Graden), the bed is well developed, with a thickness ranging from 3 to 4½ feet. The bed lies immediately above the hard quartzose Addington sandstone.

Four prospects have been opened by the Wise Coal & Coke Co. on the east side of Dog Branch, showing the following sections: 4 feet, 6 inches of coal with 13 inches of shale near the top of the bed at loc. 337, el. 2,500 feet (B); 3 feet of clear coal at loc. 338, el. 2,475 feet (B); 3 feet, 6 inches of coal at loc. 339, el. 2,490 feet (B); and 3 feet, 6 inches of coal at loc. 340, el. 2,510 feet (B).

In view of the great amount of prospecting that has been done on upper Powell River, it is reasonably safe to assume that the Addington coal bed is of little importance in this basin. The sandstone over the Clintwood coal carries an overlying coal bed in only a few parts of the county, as has already been noted under the general description of coal beds.

Imboden, Kelly, and two lower coal beds.—The Imboden coal bed lies 340 to 390 feet above the Clintwood coal bed on upper Powell River. The interval between these beds, on the whole, is almost barren of coal, there being a few exceptions to the general statement. The occurrence of the Addington bed just described is one of these exceptions. Coal beds have been found at two other horizons between the Addington and Imboden, although neither shows more than an ordinary thickness.

Northeast of the Sutherland tipple an entry has been driven 100 feet into a bed outcropping 90 feet below the Imboden coal bed. The mine is no longer used, although the mine tracks are still in place. The bed at this place has the following section:

Section of the coal bed 90 feet below the Imboden bed near Sutherland.

(Loc., 341; el., 2,385 feet, B.)

	Ft.	In.
Sandstone.		
Coal	1	7
Clay		1
Coal	1	7
Clay		
Coal	3	2
Parting		1

A coal bed 30 inches thick without partings was found 26 feet below the Imboden in a prospect trench dug from Powell River to the old Dorchester Mine No. 6 (loc. 342), which is in the Imboden bed in the high hill north of Dorchester. Neither this bed nor the bed described above, however, have sufficient thickness or extent to attract more than passing notice from mining men.

The Imboden and Kelly beds have very little acreage in the lower half of the Upper Powell River basin, and much of that has been mined out. The two beds lie under a coarse sandstone and are separated by sandstone. The beds show exceptional thicknesses in outliers in the hills west of Powell River, a section at the old Mine No. 6 being as follows:

Sections of the Imboden and Kelly coal beds at old Mine No. 6.

(Loc., 342; el., 2,410 feet, B.)

		Ft.	In.
Coal	Kelly	7	0
"Rash" and shale	Kelly		10
Coal	Kelly		4
Shale	Kelly		3
Coal	Kelly	1	10
Coal		9	2
Partings		1	1
Sandstone	Imboden	3	0
Coal	Imboden	3	8
Shale	Imboden	3	7
Coal	Imboden	3	11
Clay	Imboden	1	10
Coal	Imboden	3	8
Coal		11	3
Partings		5	5

When visited during the summer of 1920, the mines were closed and the incline dismantled. The sections given above were obtained from Malcolm Smith, mining engineer, who was with the Wise Coal & Coke Co. when Mine No. 6 was in operation.

The Imboden and Kelly coal beds have been worked southwest of Sutherland (loc. 343, el. 2,465 feet, B), but these openings are abandoned and caved shut.

The Imboden and Kelly coal beds outcrop near the crest of Rogers Ridge, due west of Graden. A resistant coarse-grained sandstone reaching 50 feet in thickness lies beneath the coals in this region. One of the beds is partially exposed in a caved pit in a ravine that heads southwest of Powell River and enters the valley 1 mile northwest of Graden (loc. 344, el. 2,520 feet, B). A large quantity of coal is on the dump and a considerable flow of water comes from the old pit. These indicate that the prospecting entry was driven in a considerable distance in the bed and also that the bed is of considerable thickness. A section of the bed here is not available.

The rocks from the location noted above dip rapidly to the westward on the flank of the Buck Knob anticline, and the Imboden and Kelly beds are carried to water level on Powell River about 2¼ miles northwest of Graden. In this vicinity a coal bed is opened on the north side of the river which is believed to represent one of the two beds. The section of the coal bed here is as follows:

Section of coal bed on Powell River two and one-quarter miles northwest of Graden.

(Loc., 345; el., 2,360 feet, B.)

	Ft.	In.
Shale.		
Coal		8
Clay		1
Coal	1	6
Coal	2	2
Parting		1

Two outliers of the Imboden and Kelly beds occur on Divide Ridge southeast of the outcrop of the main body of coal on that ridge. Both of the outliers have been prospected and the one at Sutherland has been mined to a small extent. The outlier north of Norton has not been mined.

The beds northeast of Sutherland were mined from two openings, the upper of which was known as the Kelly No. 2 mine of the Wise Coal &

Coke Co. The roof of this mine has caved badly and, when visited, only a partial section of the coal bed could be measured. A section, reported by reliable persons, and the partial section measured by the writer, are given below:

Sections of the Kelly coal bed northeast of Sutherland.

(Loc., 346; el., 2,475 feet, B.)

(Measured section.)

	Ft.	In.
Shale.		
Coal	2	0
Clay	1	1
Coal	1+	
Coal	3+	
Parting	1	1

(Reported section.)

	Ft.	In.
Shale.		
Coal	2	6
Shale	1	0
Coal	3	0
Shale		
Coal	5	6
Parting	1	0

The Imboden coal bed was opened 10 feet below the Kelly where, according to report, the bed contains 6 feet of coal, split in the middle by 17 inches of clay and "rash."

Measured sections of the Imboden or Kelly beds were not obtained from the pits in the outlier, lying east of Needmore. In this locality the interval between the two beds is greater than it is at Sutherland, as two stadia measurements give 54 and 55 feet as the distance separating the Imboden and Kelly. As the beds in this outlier lie so far apart, they have been represented on the geologic map, Plate II, by separate outcrop lines.

Standiford and Taggart coal beds.—The Standiford coal beds are little known on upper Powell River. Near the fork of the river, close to the head of the basin, a pit was seen in what is regarded as one of these beds. The coal bed here exposed has the following section:

Section of one of the Standiford coal beds near head of Powell River.

(Loc., 347; el., 2,390 feet, B.)

	Ft.	In.
Shale.		
Coal		1
Clay		½
Coal	1	9½
Shale		
Coal	1	10½
Parting		½

The Taggart bed lies 80 to 100 feet above the Standiford coal beds in this basin. The bed is in two benches, both in excellent condition, as shown by the following section measured on the west side of Powell River:

Section of the Taggart and Taggart Marker coal beds on upper Powell River.

(Loc., 348; el., top bed, 2,475 feet, B.)

		Ft.	In.
Coal	Taggart	3	7
Shale	Taggart	10	
Sandstone	Taggart	10	
Coal	Taggart	3	
Sandstone		40	
Coal (Taggart Marker)		3	6
Shale and unexposed		10	
Coal		1	
Total		81	1

A few feet away the Taggart bed shows 4 feet, 5 inches of clear coal.

A short distance to the north (loc. 349, el. 2,470 feet, B), the Taggart bed consists of an upper bench 2 feet, 10 inches and a lower bench 1 foot, 5 inches thick, separated by a parting of bone 1½ inches thick.

Low Splint and higher coal beds in Wise formation.—The Low Splint coal and higher beds have only a small extent of outcrop in the Upper Powell River basin. The extreme upper part of the basin consists of a single narrow valley cut deeply into the south side of Black Mountain, and hence the coal beds above the Taggart have very little acreage that can actually be said to lie in the Upper Powell River basin.

The Low Splint is a good, workable bed, consisting of 40 to 50 inches of clear splinty coal. The following section, measured at the head of Powell River, is typical of the bed and resembles closely sections measured in the Roaring Fork basin:

Section of the Low Splint coal bed on upper Powell River.

(V. C. & I. Co. prospect.)

(Loc., 350; el., 2,560 feet, B.)

	Ft.	In.
Shale.		
Coal		1
Bone		1
Coal	3	4
Coal	3	5
Parting		1

No coal bed was seen between the Low Splint and the Pardee bed, nor has any been prospected by the large companies on either Roaring Fork or Powell River and it is doubtful whether the beds are of workable thickness, or even are present at all. No natural blooms or exposures of the beds were seen.

The Pardee coal bed has a greatly divided section on the ridge between Roaring Fork and Powell River as shown by the following section measured in that place:

Section of the Pardee coal bed on upper Powell River.

(V. C. & I. Co. prospect.)

(Loc., 351; el., 2,991 feet, L.)

	Ft.	In.
Shale.		
Coal	2	0
Shale	12	
Coal	1	2
Shale	20	
Coal	1	1
Coal	4	3
Partings	32	0

This broken-up condition is only local, however, as numerous sections on Roaring Fork show a much better thickness and fewer partings than those given in the above section, and the same is true of the Pardee bed in the basin of South Fork of Pound River.

The outcrop of the High Splint coal bed practically marks the extreme limit of the Upper Powell River basin and hence can hardly be considered as an economic asset to the basin now under consideration. The very small portion of Black Mountain that is underlain by the High Splint coal at the head of the basin, is however, of some importance as it is underlain by a thick workable bed of nearly clear coal, as numerous sections in the adjoining basins show.

Two sections of the High Splint measured at the extreme head of Powell River give the thickness and character of the bed as follows:

Sections of the High Splint coal bed on upper Powell River.

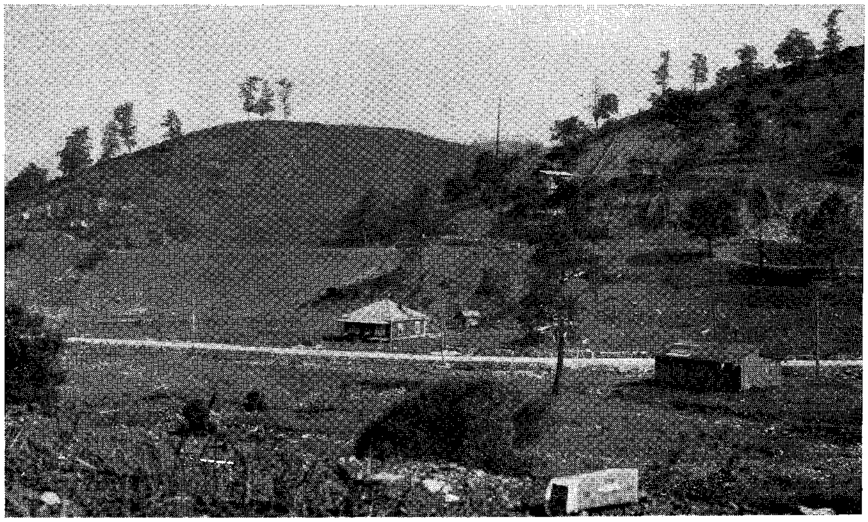
(V. C. & I. Co. prospects.)

(Loc., 352; el., 3,406 feet, L.)

	Ft.	In.
Shale.		
Coal	2	1
Shale		4
Coal		7
Shale		
Coal	2	8
Parting		4

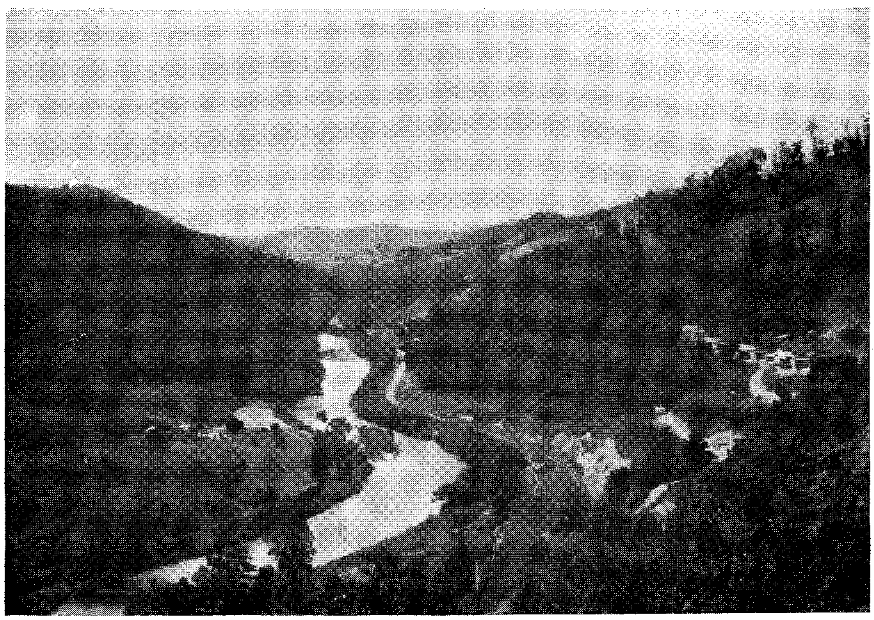
(Loc., 353; el., 3,331 feet, L.)

	Ft.	In.
Shale.		
Coal	2	1
Shale		4
Coal		7
Shale		
Coal	2	8
Parting		4



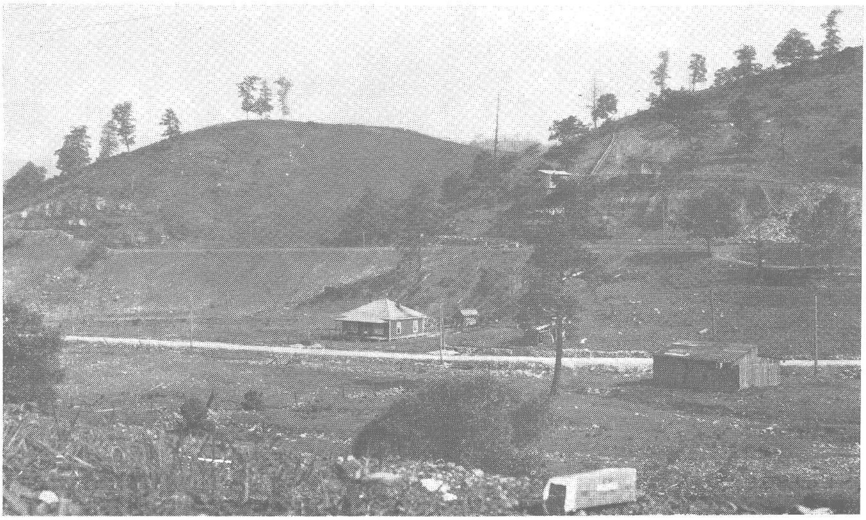
(A) Interstate Mine tipple and the Interstate Railroad at west end of Norton. The Gladeville sandstone exposed in the cut to the left does not make the outstanding cliffs typical of that bed.

Photo by C. K. Wentworth.



(B) General view down Clinch River from Virginia Iron, Coal and Coke Co.'s tipple at Carfax. Carolina, Clinchfield and Ohio Railroad on north bank of river.

Photo by C. K. Wentworth.



(A) Interstate Mine tipple and the Interstate Railroad at west end of Norton. The Gladeville sandstone exposed in the cut to the left does not make the outstanding cliffs typical of that bed.

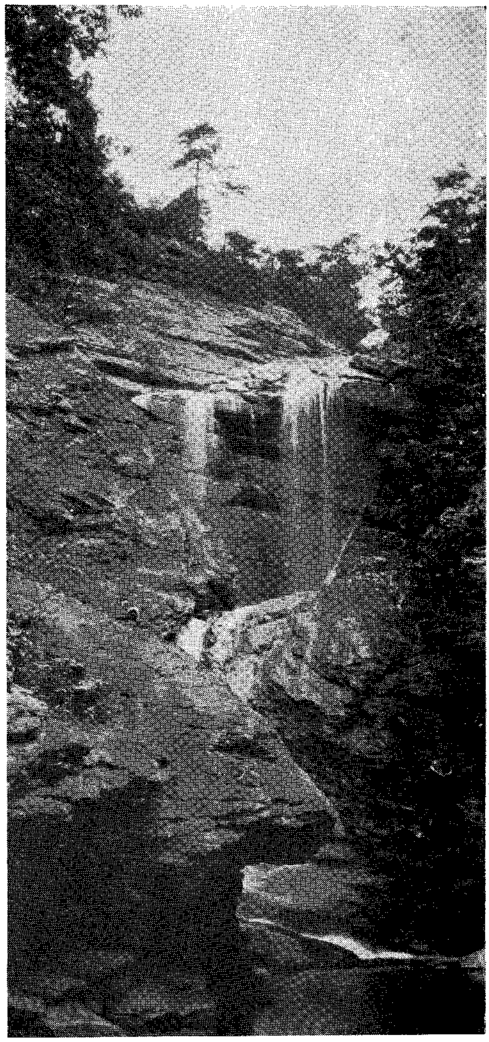
Photo by C. K. Wentworth.

(B) General view down Clinch River from Virginia Iron, Coal and Coke Co.'s tipple at Carfax. Carolina, Clinchfield and Ohio Railroad on north bank of river.

Photo by C. K. Wentworth.

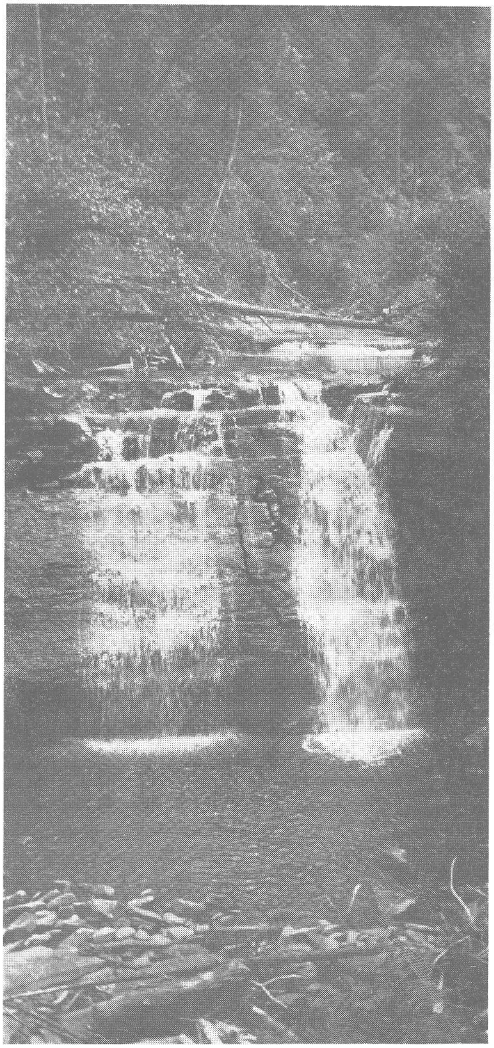
(A) Waterfall on Powell Mountain over hard ledge of sandstone under-lain by shale. The sandstone is undermined by the more rapid cutting away of the shale and breaks off at the edge of the waterfall.

Photo by J. B. Eby.



(B) Waterfall in conglomerate. The cutting is done by the constant wear of stream-borne sand on the conglomerate surface, a much slower process than shown in photograph (A).

Photo by C. K. Wentworth.



(A) Waterfall on Powell Mountain over hard ledge of sandstone under-lain by shale. The sandstone is undermined by the more rapid cutting away of the shale and breaks off at the edge of the waterfall.

Photo by J. B. Eby.

(B) Waterfall in conglomerate. The cutting is done by the constant wear of stream-borne sand on the conglomerate surface, a much slower process than shown in photograph (A).

Photo by C. K. Wentworth.

Notwithstanding the many years that mining has been carried on in Wise County, the coal beds of the Upper Powell River basin from the Norton bed up, are still only slightly touched. The Wise Coal & Coke Co.[1] estimates that at their normal rate of output the supply will last for 200 years. Thus the Upper Powell River basin promises to be one of the chief producers in Wise County for many years to come.

GUEST RIVER DRAINAGE BASIN.

UPPER GUEST RIVER BASIN.

General features.—The territory north of Norton, drained by Guest River and its branches, makes up what here is described as the Upper Guest River basin. The basin is roughly triangular in shape, with Norton at the southern apex and Black Mountain and Buck Knob making the west and east apices respectively. The area inclined is about 25 square miles.

Many valuable beds of coal outcrop in this basin but development has been carried very little beyond the mining centers at Norton, Esserville, and Glamorgan, all of which lie on the southeastern edge of the basin. The production from these operations is large, however, and gives the upper Guest River country a high rank among the coal-producing basins of the county.

Two pronounced anticlines, separated by a syncline, cross the basin in a north-south direction. The sharply plunging Gladeville anticline, upon which are developed two unusual domes, one west of Wise and the other at Indian Gap, borders the eastern side of the basin. The rocks dip steeply westward away from the axis of this fold west of Wise but at Parsons Spring on the Norton–Wise pike, midway between Wise and Esserville, they dip only 7° west, and at Esserville they pass with a dip of about 4° into the Dorchester syncline on the west. The result of this westward dip has been to carry the massive Gladeville sandstone from the plateau about Wise to the valley floor at Esserville and below river level at Needmore on Powell River. The pike between Wise and Esserville runs almost continuously on the surface of this sandstone, which offers an almost indestructible road foundation (see Pl. XV B).

South of Esserville, Guest River has cut through the Gladeville for a distance of somewhat more than a mile. This is fortunate for the mining industry as it makes readily accessible the very valuable Norton coal bed, which closely underlies the sandstone. East of Norton the top of the

[1] Crawfords Weekly, Industrial Supplement, Norton, Va. October, 1920, p. 8.

Gladeville is just above water level, but from here south, it drops gently under the influence of a minor structural depression, until upturned sharply southeast of Norton in the narrow belt of disturbed rocks, which parallel the north face of Powell Mountain.

West of Esserville, the Gladeville sandstone dips gently into the Dorchester syncline which crosses Guest River one-half miles west of Addington, trending in a direction approximately 15 degrees east of north. The broad flat flood-plain of Guest River in this vicinity results in large part from the resistance to stream cutting of the Gladeville sandstone at Esserville which is here brought to the surface on the eastern limb of the syncline.

The Addington sandstone, so conspicuous a feature at Addington, sinks to water level at the synclinal axis and then rises rapidly west of the axis and makes cliffs in the ridges on both sides of the river.

Among the structural features dominating the rocks of the Upper Guest River basin is the Buck Knob anticline. Its axis parallels and lies 2 miles west of the Dorchester syncline. The highest point of this fold lies directly southeast of Lipps and represents a rise in the rocks of over 400 feet. From Lipps, the axis of the anticline plunges uniformly to the north at the rate of about 140 feet to the mile. The rocks from Lipps to the headwaters of Guest River dip rapidly on the western flank of the anticline, bringing coals high in the Wise formation to stream level.

In the vicinity of Lipps, the Gladeville is extremely massive, making resistant benches on the hill slopes and covering the surface with massive blocks. The Norton formation is exposed for more than a mile along the river south of Lipps, where the stream has cut through the Gladeville sandstone. This narrow band of Norton and the small strip along the same river south of Esserville, are the only exposures of this formation in the flat-lying rocks of the Upper Guest River basin.

Fifteen to twenty beds of coal outcrop in the ridges of this basin. At least twelve of these beds are thick enough to be considered workable, and of these, six are now being mined. However, about 98 per cent of the coal produced in the basin comes from three beds, the Norton, Dorchester, and Blair, the three lowest coals exposed in Upper Guest River basin. The rocks outcropping in this basin range from below the base of the Gladeville sandstone to above the High Splint coal bed, a section of more than 2,300 feet. Graphic sections of the coal beds are shown in figures 34, 35, and 36.

The Norton is the lowest coal bed exposed in the basin. It lies beneath the Gladeville sandstone, in many places in contact with it, but often separated by 5 to 10 feet of shale or clay. In the neighborhood of Norton and Esserville this coal bed ranges in thickness from 44 to 57 inches, and carries one or more thin shale partings. Little can be said of coal beds below the Norton, as no core drillholes have been put down. Boreholes on Indian Creek, 8 to 10 miles north of Norton, disclose several beds below the Gladeville sandstone, and similar beds outcrop on Bear Creek to the east. The presence of these beds under the Upper Guest River basin may be inferred, but absolute proof of their presence or absence can be obtained only by deep drilling throughout the basin.

The largest producing coal bed in the basin at present is the Dorchester bed overlying the Gladeville sandstone. This coal, ranging in thickness up to 6 feet, is one of the most valuable beds outcropping in the Upper Guest River basin. The interval between the Norton and Dorchester coal beds ranges from 100 to 130 feet.

The Blair coal bed ranges from 90 to 110 feet above the Dorchester and contains from 30 to 40 inches of coal, usually clear. The Clintwood bed outcrops 60 to 80 feet above the Blair and almost directly beneath the Addington sandstone. This bed is split into two benches by a bed of clay and shale 2 or more feet in thickness.

The regularity and persistence of the Addington sandstone as a lithologic unit assists greatly in tracing the outcrop of the Clintwood bed and also of coals overlying the sandstone. A bed outcropping just above the sandstone has been opened in several places and the name Addington is here applied to it. It is on the average about 2 feet thick and contains high grade coal. Forty feet above this bed lies another coal bed, to which the name Dean is given, being named for an operator who has opened the bed on Rocky Fork, a mile north of Addington station. The Dean coal bed is from 2 to 3 feet thick. These two beds on the whole are only locally of workable thickness, there being many places in the basin where they are thin and practically worthless or are absent from the formation.

Except for local operations, no coals above the Dean bed are being mined in this basin. The Imboden coal bed, about 550 feet above the Gladeville sandstone, crosses Guest River at the mouth of Critical Fork, where, as shown by several prospects, it is 42 to 48 inches thick. The Kelly, a much parted bed containing 3 to 4½ feet of coal, lies from 20 to 40 feet above the Imboden.

The Standiford coal beds and the Taggart bed outcrop near the base of Black Mountain. The former appear to be of workable thickness throughout much of the Black Mountain area drained by Guest River. The

Standiford coal beds are 20 to 30 feet apart and about 80 feet below the Taggart. The latter bed is thin, showing a much poorer section on Guest River than it does on Powell River and Roaring Fork. The Low Splint bed outcrops 200 feet above the Taggart. It contains 4 to 5 feet of nearly clear coal. The bed has been thoroughly prospected by the Clinchfield Coal Corporation, on Buck Knob.

The only coals in Upper Guest River basin above the Low Splint bed lie in Black Mountain. They are the Phillips, 260 feet above the Low Splint, a bed 215 feet above the Phillips, the Pardee, and the High Splint. Only a very small acreage of the High Splint is in the Upper Guest River basin.

The Upper Guest River basin is admirably located for the development of its coal resources. Norton, the largest town in the county, is situated at the mouth of the basin and three railroads offer ample transportation facilities. The Interstate Railroad furnishes an outlet for the coal mined at Glamorgan and Esserville. Coal is now hauled by wagon from Lipps and its vicinity to Addington for shipment, but it would be a relatively simple matter to construct a branch railroad up Guest River from Addington to Critical Fork when the demand for coal is such as to make it expedient to develop the higher beds. A very large territory would be opened for mining operations by the building of such a spur.

Timber for mining purposes is plentiful in the Upper Guest River basin. It is nearly all second-growth, however, for the original stand of trees was cut and sawed into lumber by a large saw mill at Glamorgan. This mill was in operation for many years but is now abandoned.

The chief coal producers of this basin are the Norton Coal Co., at Norton, the J. A. Esser Coke Co., at Esserville, and the Stonegap Colliery Co., at Glamorgan. The amounts of coal produced by these companies for the year 1918 were respectively as follows:[1] 136,639, 63,065, and 106,303 tons, which, in total, represent over 8 per cent of the entire tonnage accredited to Wise County for the same year. The Gladeville Coal Co. and the Hawthorne Coal Co. have mines on Upper Guest River drainage but their major operations lie in Yellow and Bear Creek valleys.

Norton coal bed.—The Norton coal bed lies immediately below the Gladeville sandstone and usually has a thickness of 2½ to 5 feet of clear coal. In the Upper Guest River basin this bed outcrops on both sides of the river for a distance of a mile south of Lipps, and for nearly a mile south of

[1] Figures furnished by the Virginia Coal Operators Association.

Esserville. Sections measured on the outcrop indicate an average thickness of 3 feet. In the vicinity of Norton the bed lies from 120 to 130 feet below the Dorchester bed, an interval which decreases to 100 feet in the vicinity of Esserville and Wise.

The Norton coal bed is mined south of Esserville by the Norton Coal Co. and the Hawthorne Coal Co., and south of Lipps by a wagon mine.

The Norton Coal Co. plans further development of this coal bed, east of Norton, and during the summer of 1920 began excavating to uncover the bed. The company proposed to sink a rock slope to the coal bed and calculated on reaching it in a vertical distance of 85 feet. The proposed mine lies 200 feet southwest of the drift mouth of Mine No. 2, at loc. 362.

South of Lipps the Norton coal bed outcrops along the Fox Gap road at several points. At loc. 354, el. 2,160 feet (B), 30 inches of coal was seen, with the bottom of the bed still under cover. Here the bed is nearly 30 feet below the lowest exposure of the Gladeville sandstone.

The Norton coal was mined one mile south of Lipps for a short time at the close of the war and the coal was hauled to Addington for shipment. The entry is about 10 feet below and under the wagon road. The coal bed has the following section in this mine:

Section of the Norton coal bed 1 mile south of Lipps.

(Loc., 355; el., 2,200 feet, B.)

	Ft.	In.
Shale.		
Coal		4
Shale		6
Coal		4
Shale	2	10
Coal	2	6
Coal	3	2
Partings	3	4

The Norton coal shows 25 inches of clear hard coal in a small prospect by the roadside north of the mine (loc. 356, el. 2,240 feet, B).

Two openings in the Norton bed have been made on the Wise pike one-half mile southeast of Wise by the Gladeville Coal Co. The one on the north side (loc. 357, el. 2,550 feet, B) is a newly made opening and shows 3 feet of coal. The one on the south side (loc. 358, el. 2,520 feet, B) connects with the main mines of the Gladeville Coal Co., that open on Yellow Creek. The coal is 2 feet, 8 inches thick in this entry. The company has built a small tipple at the Guest River opening of their mines (loc. 358) to serve the local trade, but the bulk of the coal goes out on the Yellow Creek side of the hill.

The Norton coal bed has been opened by the Ida Coal Co., midway between Wise and Esserville. The entry was driven about 100 feet into the ridge southeast of the road fork, but a strong westward dip, averaging 7°, caused the abandonment of the mine. The section of the coal bed which is almost identical with one measured in Mine No. 5 of the Gladeville Coal Co., one-eighth mile east, is as follows:

Section of the Norton coal bed at Parsons Springs.

(Loc., 359; el., 2,460 feet, B.)

	Ft.	In.
Shale.		
Coal		2
Shale and clay		½
Coal	2	9
Shale		
Coal	2	11
Parting		½

The Hawthorne Coal Co. has several mines on the east side of Guest River, but the major portion of their coal is hauled out through openings on the Yellow Creek side of the divide. At the drift mouth on the Guest River side of Hawthorne Mine No. 2 the coal bed has the following section:

Section of the Norton coal bed in Hawthorne Mine No. 2.

(Loc., 360; el., 2,172 feet, L.)

	Ft.	In.
Shale.		
"Draw slate"		4
Coal	2	3
Shale		4
Coal	1	2
Clay		
Coal	3	5
Parting		4

The Norton Coal Co. is driving in a new mine on the Norton coal bed about one-half mile south of Hawthorne Mine No. 2. The mine is Norton No. 15 and the main entry was in 125 feet when visited in 1920. The section of the coal bed at the face of the entry is as follows:

Section of the Norton coal bed in Mine No. 15 of the Norton Coal Co.

(Loc., 361; el., 2,140 feet, B.)

	Ft.	In.
Clay.		
Coal		1
"Rash"		2
Coal	2	0
Clay		4
Coal	1	4
Clay		
Coal	3	5
Partings		6

Dorchester coal bed.—Among the most valuable beds in the basin is the Dorchester bed, locally known as "Norton No. 2," "Haskell No. 3," "Glamorgan," and "Gladeville." The Dorchester coal bed, at its best development, ranges in thickness from 60 to 70 inches. The bed lies 120 to 130 feet above the Norton coal bed and 90 to 110 feet below the Blair bed. The coal in the Dorchester bed runs high in sulphur, as a glance at the table of analyses (pp. 513-516) will show, but this does not materially affect the coal for many purposes and it ranks close to that of the best beds in Wise County.

The Dorchester bed is opened east of Norton in Mine No. 2 of the Norton Coal Co., which is one of the largest producing mines of the company. The mine is equipped with electric haulage and has a capacity of 250 tons daily. For the year 1919 its output was 50,000 tons of coal and the number of miners employed was 30. The main entry of the mine is nearly 3,000 feet long.

The water in this mine is highly charged with sulphuric acid[1] and has strong corrosive power, being especially destructive to steel, iron, and wearing apparel. The acid water collects in large amber-colored drops upon the roof in various parts of the mine.

Three coal samples were taken in this mine for analysis. The locations and the sections of the coal bed measured at these locations are given below:

[1] An analysis of the mine-water drippings collected from large drops suspended from the roof in the main haulway, one-half mile from the drift mouth, shows .83% of free sulphuric acid.

Sections of the Dorchester coal bed in Norton Mine No. 2.

(Loc., 362; el., 2,120 feet, L.)

Section where sample was cut from face of 3d left entry.
(Analysis No. 75364.)

	Ft.	In.
Shale.		
*Coal	2	9
Clay		11
*Coal		½
Clay		1
*Coal		2
Clay		2
Coal	2	4
Coal	5	3½
Partings	1	2

Section where sample was cut at face of room 1, off 4th left entry.
(Analysis No. 75365.)

	Ft.	In.
Shale.		
*Coal	2	2
Pyrite streaks		
*Coal	1	1
Clay		11
*Coal		2
Clay		3
*Coal	1	5
*Coal, with "rash"		8
Coal	5	6
Partings	1	2

Section where sample was cut at face of room 2, off 5th right entry.

(Analysis No. 75363.)

	Ft.	In.
*Coal, with "sulphur" balls	2	9
Shale		4
*Coal		½
Shale		7
*Coal		1
Shale		2
*Coal	2	5
Shale		
Coal	5	3½
Partings	1	1

At the present rate of production the life of this mine is estimated at twenty years.

Numerous openings have been made on the Dorchester bed west of the road leading from Norton to Esserville, but when visited the majority of the openings had been abandoned. A few new openings in the bed in this locality have been reported since the field was visited. At loc. 363, el. 2,140 feet (B), an old mine opening, partly flooded, showed 58 inches of coal above water level, the bottom of the bed being concealed.

The Gladeville sandstone beneath the Dorchester coal is massive at Esserville, being hard, quartzose, and cross-bedded. It is quarried for foundation stone and fences. It dips under Guest River at Esserville, carrying with it the Dorchester coal bed and overlying rocks.

*Sampled.

On the west side of the Dorchester syncline the Dorchester coal bed rises above river level about four miles to the north of Esserville and about one mile south of Lipps. Here a number of local mines have been opened in the coal bed. The coal occurs from five to ten feet above the Gladeville sandstone, which in this vicinity is 30 feet thick. The sandstone makes a bench, the cut edge of which is a prominent cliff facing the wagon road. The slope below the cliff is littered with tremendous blocks and smaller sandstone float. The Dorchester coal does not have the thickness that characterizes it around Norton and Esserville. The following sections of the coal bed were measured in prospect pits on the west bank just beyond the northward bend of Guest River.

Sections of the Dorchester coal bed on Guest River south of Lipps.

(Loc., 364; el., 2,320 feet, B.)

	Ft.	In.
Shale.		
Coal	1	4
Bone		1
Coal		9
Clay		
Coal	2	1
Parting		1

(Loc., 365; el., 2,330 feet, B.)

	Ft.	In.
Shale.		
Coal	1	6
Shale		1
Coal	1	0
Clay		
Coal	2	6
Parting		1

(Loc., 366; el., 2,320 feet, B.)

	Ft.	In.
Shale.		
Coal	1	9
Bone		1
Coal		6
Shale		1
Coal		5
Clay		
Coal	2	8
Partings		2

(Loc., 367; el., 2,300 feet, B.)

	Ft.	In.
Shale.		
Coal	2	6
Shale		1
Coal		5
Clay		
Coal	2	11
Parting		1

The shale overlying the coal in the sections given above contains large and well preserved fossil leaves.

A coal bed has been opened at Lipps, which is thought to represent an upper bench or split of the Dorchester bed. The coal lies 30 to 40 feet above the Gladeville sandstone at loc. 368, el. 2,260 feet (B). Two feet of coal was seen and the bed is reported to be 3½ feet thick. On the east bank of the river at Lipps, but south of the Pinnacle Gap road (loc. 369, el. 2,260 feet, B), the Dorchester bed is exposed in a pit, showing a clear

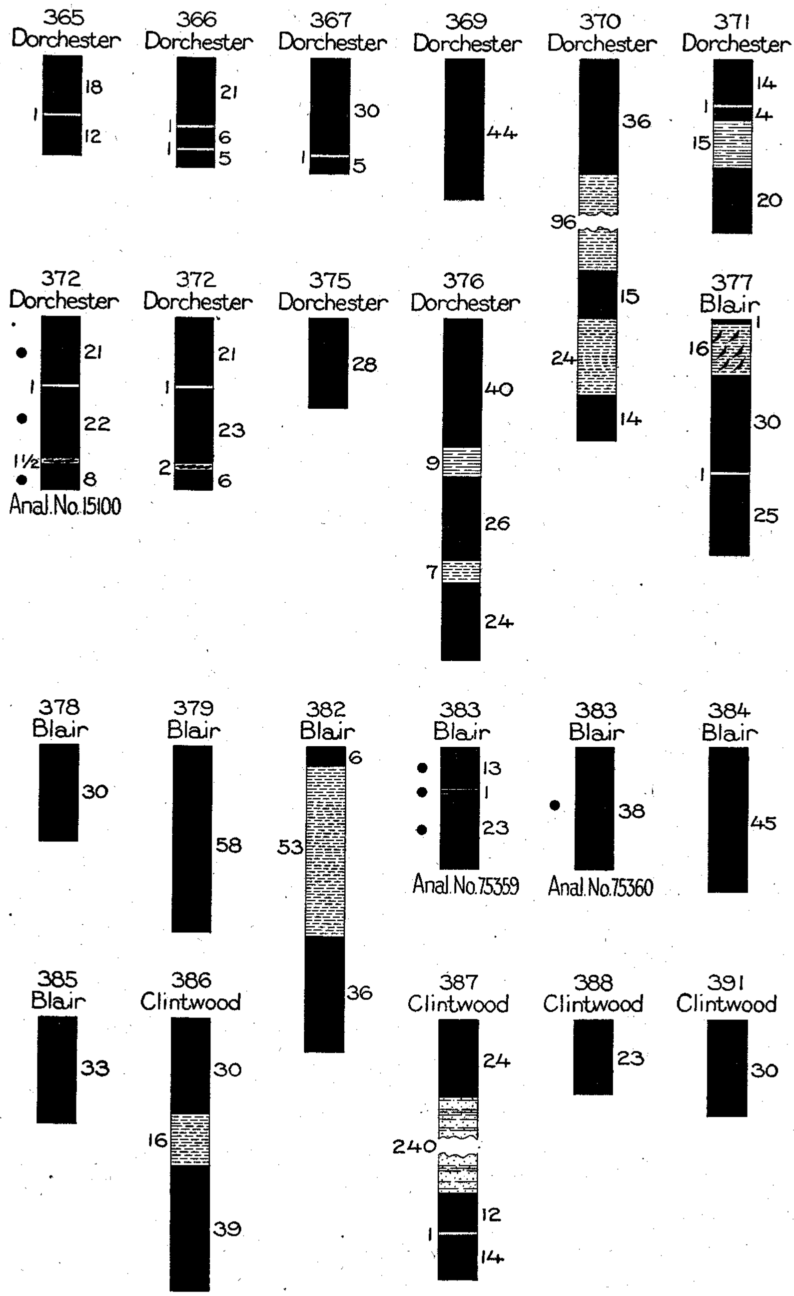


Fig. 35.—Sections of coal beds in the basin of Upper Guest River.

section of 44 inches of coal. Several other old openings were located in the vicinity of Lipps and their positions indicated on the geologic map, but sections could not be measured.

At Esserville the Dorchester coal bed has been called the Esserville "Big Dirt Seam." As the name indicates, the bed here is split by shale and clay partings ranging in thickness up to 8 feet. The J. A. Esser Coke Co. operates this bed from Mine "A," at the town of Esserville. This mine is one of the smaller producers of the company, averaging 15 tons daily. A section of the coal bed in this mine is as follows:

Section of the Dorchester coal bed at Esserville.

(Loc., 370; el., 2,150 feet, B.)

	Ft.	In.
Shale.		
Coal	3	0
Clay	8	0
Coal	1	3
Clay	2	0
Coal	1	2
Shale		
Coal	5	5
Partings	10	0

Mines "B," "C," "D," and "E" are on the same bed, but were temporarily closed in 1920. The very large parting in the Dorchester bed in this district renders it very difficult to mine the coal profitably and this no doubt accounts, in part at least, for the closing of the mines.

The Dorchester bed is brought to the surface north of Glamorgan by sharp doming up of the rocks in the vicinity of Indian Gap. A slope, known as the Roberts mine, has been driven into the bed on the east flank of the dome by the Corder Coal Co. The slope is driven in the coal bed down a 15 to 18-degree dip, which lessens gradually the farther east the entry is driven. At a distance of 1,200 feet the dip is 12° S. 45° E. The mine produces 80 tons daily, which is carried by tramcar to Glamorgan for shipment. The bed has the following section at the face 1,200 feet from the mine mouth:

Section of the Dorchester coal bed in the Roberts mine.

(Loc., 371; el., 2,220 feet, B.)

	Ft.	In.
Sandstone.		
Coal	1	2
Shale		1
Coal		4
Shale	1	3
Coal	1	8
Shale		
Coal	3	2
Partings	1	4

The Dorchester bed is under cover in the low gap on the anticline at the north end of the town of Glamorgan. It shows south of the gap, 26 inches of coal with 3 inches of clay near the base. The dip of the bed here is 5° N. 35° W.

The Stonegap Colliery Co. is mining the Dorchester coal bed extensively at Glamorgan. Its largest producer is Mine No. 3, at loc. 372, el. 2,296 feet (L). Mine No. 2 at loc. 373, el. 2,320 feet (L) has been worked out and abandoned after connecting up inside with the main Mine No. 3. Mine No. 3 employs 72 miners and has a daily capacity of 500 tons of coal. The major portion of the coal from this mine is coked at Glamorgan, where there is a bank of 350 coke ovens.

The Dorchester coal bed at Glamorgan lies on the Gladeville sandstone (see Pl. XV A) and an almost equally massive sandstone outcrops 50 to 80 feet above the coal bed in the ridges northeast of the town. The presence of this massive sandstone above the coal has led to the correlation of the coal bed with the coal underlying the Gladeville sandstone south of Wise and known locally as the Edwards or Yellow Creek bed but here called the Norton coal bed. In Mine No. 3, which extends seven thousand feet northeastward toward Birchfield and Dotson creeks, the bed is divided into two benches by a parting which is nearly 30 feet thick at the mine mouth; 10 feet at a distance of 1,000 feet from the mine mouth; 1 inch at 6,000 feet; and a quarter of an inch at the face of the entry. From the mine mouth to a point 1,500 feet distant the parting is everywhere 2 feet or more in thickness and the lower bench only is mined, but beyond the point mentioned the two benches come within two feet of one another and from this point to the face the entire bed is mined. The coal bed lies nearly flat, a dip of 2° slightly north of west being recorded midway in the mine. The operators report a low anticline with a north-south axis in the bed about one mile from the mine mouth.

A number of samples were collected in this mine for analysis. In heating value the coal ranks among the better class of coals in this county. The sections measured at the points where these samples were taken fairly well represent the average thickness of the Dorchester coal bed at Glamorgan. (For analyses see pp. 513-514.)

Section of the Dorchester coal bed in Mine No. 3 at Glamorgan, loc. 372.

Section where sample was cut 7,000 feet from mine mouth.

(Analysis No. 15101.)

	Ft.	In.
Shale.		
***Coal, with ¼-inch shale parting near middle**	3	8
Bone		1
***Coal**		7
Shale		
Coal	4	3
Parting		1

Section where sample was cut 6,000 feet from mine mouth.

(Analysis No. 15100.)

	Ft.	In.
Shale.		
*Coal	1	9
Bone		1
*Coal	1	10
Bone		1½
*Coal		8
Coal	4	3
Partings		2½

Section where sample was cut in room 19, off 1st right entry.

(Analysis No. 32842.)

	Ft.	In.
Sandstone.		
Shale.		
*Coal		3½
*Shale		¼
*Coal	1	3
*Shale		¼
*Coal		4
Shale		½
Coal		1
Shale		1
*Coal		6
*Shale		¼
*Coal	1	4
Bone		1
*Coal, hard		7
Shale		
Coal	4	4½
Partings		3¼

Section where sample was cut in room 2, off 3d right entry.

(Analysis No. 32843.)

	Ft.	In.
Sandstone.		
Shale		10
*Coal		8
*Shale		¼
*Coal		3
*Shale		¼
*Coal		6
*Shale		½
*Coal		4
Shale		½
Coal		1
Shale		1
*Coal	1	9
*Bone		1½
*Coal		9
Shale		
Coal	4	4
Partings		4

*Sampled.

Section of coal bed measured in main haulway 1 mile from mine mouth.

	Ft.	In.
Shale.		
Coal	1	9
Clay		1
Coal	1	11
Bone		2
Coal		6
Shale		
Coal	4	2
Partings		3

The Dorchester coal bed outcrops on the Wise–Glamorgan pike at a number of places. At loc. 374, el. 2,480 feet (B), a bloom of the bed shows 25 inches of coal with streaks of "rash," over a 6-inch bed of clear coal.

The Dorchester coal bed outcrops in the ridge between Guest River and Bear Creek, southeast of Esserville, and a new mine was opened here in 1920, but very little coal was gotten out. The section in this mine (loc. 375, el. 2,230 feet, B) shows 28 inches of coal, with a cap of 6 inches of carbonaceous shale.

Several closed pits with coal debris plainly visible were seen on the outcrop of the bed farther south. The next mine operating in this bed is Mine No. 10 of the Norton Coal Co., which is situated on the east bank of the river due east of Norton. The mine gives employment to eight miners and its output averages 125 tons a day.

The coal bed in this mine is parted into three benches, the lowermost of which is not mined. The coal bed has the following section 900 feet in from the mine mouth:

Section of the Dorchester coal in Norton Mine No. 10.

(Loc., 376; surface el., 2,108 feet, L; coal el., 2,051 feet, L.)

	Ft.	In.
Shale.		
Coal	3	4
Shale		9
Coal	2	2
Clay		7
Coal	2	0
Clay		
Coal	7	6
Partings	1	4

Blair coal bed.—The Blair coal bed outcrops from 60 to 80 feet below the Clintwood coal. It is a high-grade coking coal, and in the Upper Guest

River basin has an average thickness of 3 to 3½ feet. At its best development in the vicinity of Esserville, its thickness approaches 4 feet. The bed is unusually free from partings and is persistent throughout a large part of central Wise County.

The coal from the Blair bed is mined by the J. A. Esser Coke Co., at Esserville, the Norton Coal Co., at Norton, and by the Wise Coal & Coke Co., on Powell River.

At a small mine that has been opened in the city limits of Norton the bed has the following section:

Section of the Blair coal bed at Norton.

(Loc., 377; el., 2,190 feet, B.)

	Ft.	In.
Shale.		
Coal		1
Clay and "rash"	1	4
Coal	2	6
"Rash"		1
Coal	2	1
Clay		
Coal	4	8
Partings	1	5

In the cut-bank of the road, several hundred feet to the northeast of the mine, loc. 378, el. 2,140 feet (B), a bloom of the bed shows 30 inches of unparted coal. The bed here dips strongly to the east.

The Norton Coal Co. has mined the Blair coal on the west bank of Guest River, at Norton, calling the openings Mine No. 4 and Mine No. 7. Both were temporarily closed when visited. In Mine No. 4 (loc. 379, el. 2,190 feet, L), the bed has a thickness of four feet, ten inches without parting, with clay roof and floor. Water in the mine prevented the measurement of a complete section of the bed in Mine No. 7 (loc. 380, el. 2,200 feet L) being made. Three feet of coal shows above water level.

The Blair coal bed takes cover on Guest River just north of Esserville and is not exposed on the river again until brought up by the Buck Knob anticline three miles to the north. Even on this anticline the bed has been little prospected south of Lipps, but on the Guest River road north of Lipps, coal exceeding two feet in thickness and taken to be the Blair is exposed (loc. 381, el. 2,245 feet B). Between Lipps and a point on Guest River one mile to the northwest, there are five coal beds exposed from the upper Dorchester bench through the Clintwood horizon, all dipping northward and passing in succession below water level. By projecting the beds into a plane as nearly as may be according to the dip, the following section is obtained, the measurements being made by Butts.

Section of coal beds on Guest River road for 1 mile north of Lipps.

	Ft.	In.
Coal, Addington (?) (Reported thickness)	2	
Sandstone, hard, siliceous Addington member	20	
Interval, not exposed	20	
Coal, Clintwood (?)	2	
Sandstone	10	
Shale	10	
Coal, Clintwood split (?)	2	3
Sandstone	15	
Interval, not exposed	10	
Sandstone	5	
Interval, not exposed	20	
Coal, Blair (?)	2+	
Sandstone, partly hard, siliceous	40	
Coal, Upper Dorchester bench, (reported thickness 3½ feet)	2	
Total	160	3

The Blair coal bed is being extensively mined at Esserville, the largest operations being Mine No. 4 and Mine No. 5 of the J. A. Esser Coke Co. The two mines are 1 mile northeast of Esserville, with Mine No. 5 at loc. 382, el. 2,240 feet (B) and Mine No. 4 at loc. 383, el. 2,240 feet (B). The coal bed here dips 4° due west, and Mine No. 5 is driven down the dip whereas Mine No. 4 heads north on the strike. The coal from these mines is hauled by steam tram to Esserville, where a large percentage is coked, making a high-grade coke. The bed lies 60 feet above the Dorchester bed and 40 feet beneath a bed, which probably represents the lower split of the Clintwood, as seen in the Guest River section at Lipps. The following section was measured in Mine No. 5, 550 feet from the mouth:

Section of the Blair coal bed in Mine No. 5 of the J. A. Esser Coke Co., loc. 382.

	Ft.	In.
Sandstone.		
Shale		6
Coal		6
Clay	4	5
Coal	3	0
Clay		
Coal	3	6
Parting	4	5

The big clay and shale parting noted in the section given above is reported to vary greatly throughout the mine, in general thinning as the upper bench of coal thins.

Mine No. 4 was sampled at three points, and the analyses of these samples are given on page 516. The thickness of the bed is shown by the three measured sections taken at the points of sampling:

Sections of the Blair coal bed in Mine No. 4 of the J. A. Esser Coke Co., loc. 383.

Section where sample was cut in room 2, off 2d left entry, 3,000 feet from mine mouth.

(Analysis No. 75359.)

	Ft.	In.
Shale.		
Shale, "draw slate".		2½
Bone		1
*Coal	1	1
*Coal, "mother coal"		1
*Coal	1	11
Clay, hard		
Coal	3	1

Section where sample was cut at face of 5th right entry, 2,500 feet from mine mouth.

(Analysis No. 75360.)

	Ft.	In.
Shale.		
Shale, "draw slate"		3
Bone		2
*Coal	3	2
Clay		
Coal	3	2

Section where sample was cut in room 5, off 4th right entry, 3,000 feet from mine mouth.

(Analysis No. 75361.)

	Ft.	In.
Shale, "draw slate"		2½
*Coal	3	4
Clay, hard		
Coal	3	4

A local mine has been opened on the Blair coal bed east of Esserville and on the ridge to the south of the main highway (loc. 384, el. 2,370 feet, B). The bed here shows an excellent section of 45 inches of clear hard coal. The coal is overlain by 12 inches of carbonaceous shale, and it is 100 feet above the top of the Gladeville sandstone.

The coal bed was measured in another entry, partly caved, several hundred feet south (loc. 385, el. 2,350 feet, B) of the mine just described. The coal bed here is only 33 inches thick, with a cap of 16 inches of car-

*Sampled.

bonaceous shale. As compared with the section of the coal bed at loc. 384, this shows rather rapid thinning toward the south.

Clintwood coal bed.—The Clintwood bed ranks with the most persistent coal beds of the county, underlying the ridges of central and northern Wise County and a large area in Dickenson County. The bed is split in central Wise County into two benches, the interval between them ranging from a few inches up to, but seldom exceeding, 25 feet. In the Powell River basin the bed has long been called the Big Dorchester, and the thick parting is one of its characteristic features.

Near the south end of the Upper Guest River basin the parting ranges from 1 to 3 feet and the bed contains from 4 to 5 feet of coal. To the northward the parting increases, splitting the bed into two nearly equal benches. Thus in the vicinity of Lipps the Clintwood is represented by two beds 20 feet apart, and both beds are so thin that their exploitation is doubtful.

The Liberty Coal Co. operates a mine in the Clintwood coal at Norton, where the coal has a thickness of 5½ feet separated into two benches by 16 inches of shale. Eight miners are employed here and the output averages 40 tons a day. The coal is hauled by wagons to the railroad yards at Norton.

The coal bed shows low arches and hollows which doubtless were produced by the same force in the earth's crust that formed the great anticline of Powell Mountain. The beds dip 4° north for 200 feet, then rise at a rate of 2° for the next 300 feet beyond which it runs nearly level. The section measured in this mine is given below:

Section of the Clintwood coal bed in Liberty Coal Co.'s mine.

(Loc., 386; el., 2,250 feet, B.)

	Ft.	In.
Shale.		
Clay		10
Coal	2	6
Clay	1	4
Coal	3	3
"Rash"		1
Clay		
Coal	5	9
Parting	1	4

The Clintwood bed was opened by Mine No. 8 of the Norton Coal Co. near the top of the hill, and directly over Mine No. 4 and Mine No. 7 of the same company. The mine was caved at the time of this examination, having been abandoned several years before, and the coal bed was not accessible.

The Clintwood coal is represented on Guest River three-quarters of a mile north of Lipps (loc. 387, el. on upper bench, 2,287 feet, L) by two beds 20 feet apart and under massive hard gray sandstone. The section of the two benches is given below:

Section of the Clintwood coal bed north of Lipps.

		Ft.	In.
Sandstone		30	
Coal, upper bench		2	
Shale and sandstone		20	
Coal	lower bench	1	
Clay	lower bench		1
Coal	lower bench	1	2
Clay		3	
Total		57	3

The Clintwood coal bed outcrops for two and one-half miles along the upper half of Rocky Fork, where it has been prospected by the Clinchfield Coal Corporation. The sections measured by this company were made available for use in this report, but in the majority of instances it appears that the top bench only was opened. Near the head of Rocky Fork the coal bed is thin, practically to the point of not being workable. At loc. 388, el. 2,346 feet, L (C. C. C. prospect) it measures 23 inches. One-half mile to the north it has the following section:

Section of the Clintwood coal bed at head of Rocky Fork (C. C. C. prospect).

(Loc., 389; el., 2,310 feet, L.)

	Ft.	In.
Coal		5
Shale		¼
Coal		10¾
Coal	1	3¾
Parting		¼

The bed holds this thickness south along the east side of the Rocky Fork at least as far as a Clinchfield pit (loc. 390, el. 2,214 feet, L) two miles below the location last given, where it measures 15 inches of clear coal.

At Addington, the massive Addington sandstone, overlying the Clintwood coal, has been cut through by the small streams flowing into Rocky

Fork from the east, thus exposing the coal bed which lies immediately under the sandstone. The bed has been opened here by the Guest Mountain Fuel Co. (loc. 391, el. 2,156 feet L), and shows a thickness of 2½ feet at the face of the main entry 450 feet east of the mine mouth. In the mine the

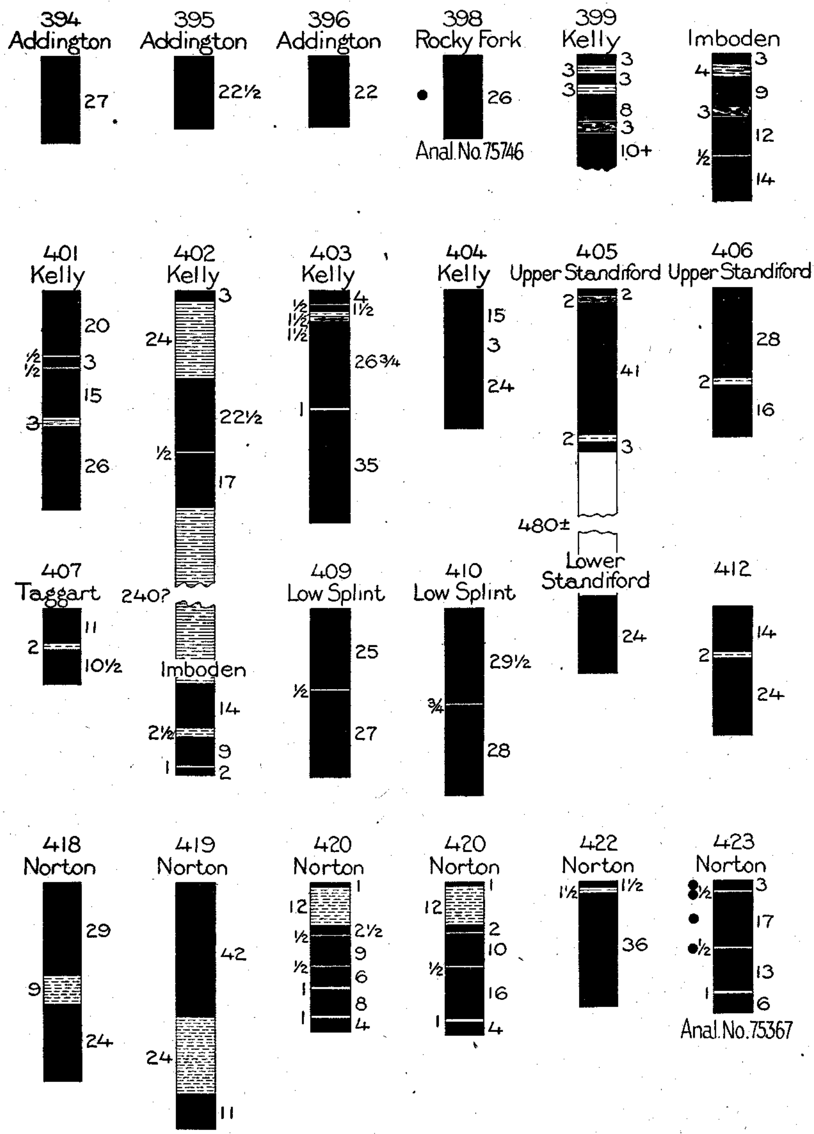


Fig. 36.—Sections of coal beds in the basins of Upper Guest River and Bear Creek.

bed rises to the east at the rate of 4 feet in 500, but this rate of rise increases eastward toward the axis of the Gladeville anticline.

Addington coal bed.—Throughout a large part of central and northern Wise County there is a coal bed closely overlying the Addington sandstone which is here called the Addington coal bed. At very few places is the bed thick enough to be considered workable, as it seldom exceeds 2 feet, and in many places is absent from the formation.

A 10-inch blom of a coal bed, overlying clay shale, thought to be of the Addington, is exposed on the Guest River road north of Esserville (loc. 392, el. 2,120 feet, B). The Addington sandstone is not exposed here and the relation of the coal bed to it can not be determined exactly.

In the high cut-bank by the road fork 1½ miles north of Esserville an 8-inch bed outcrops 15 to 20 feet above the sandstone (loc. 393, el. 2,130 feet, B). Thus the Addington bed appears to be worthless west of Guest River.

The Addington coal is mined in a small way on Rocky Fork near Addington (loc. 394, el. 2,150 feet, B), where the bed measures 27 inches in thickness. The coal bed at this mine has a sandstone roof.

The coal bed was opened at Stephens (loc. 395, el. 2,190 feet, B by an entry 1,500 feet long, but it is so thin that the operators were forced to abandon the mine. The bed has generally a thickness of less than 2 feet, one section, 100 feet from the mine mouth, showing 22½ inches of clear coal.

For several years the Addington coal has been mined north of Esserville (loc. 396, el. 2,150 feet, B) by H. Dabb, of Norton. The bed here is 15 feet above the Addington sandstone and has a thickness of 22 inches of clear coal. Ten miners are employed here, and the production on the average is about 50 tons of coal a day.

Rocky Fork coal bed.—The Rocky Fork coal bed lies 40 feet above the Addington coal bed, but is relatively unimportant. It is opened at a very few places in the county and is mined at only one locality in the Upper Guest River basin. Where best developed it rarely is thicker than 2 feet. A small showing of coal that is thought to be at about the horizon of the Rocky Fork bed was seen in a cut of the Guest River wagon road 1 mile north of Esserville, loc. 397, el. 2,145 feet (B). Four inches of coal is all that could be seen.

The type locality of the Rocky Fork coal is on Rocky Fork about 1 mile north of Addington (loc. 398, el. 2,150 feet, B), where the coal is being mined by W. S. Dean & Bro., of Wise. The bed in this mine is about 2 feet thick, without parting. At the face of the entry 95 feet from the mine mouth in the summer of 1920 the bed measures 2 feet, 2 inches thick. A sample of coal was collected at this point for chemical analysis (see analysis No. 75746, page 517). The coal in this mine is overlain by shale and underlain by clay.

The Rocky Fork coal bed in this vicinity is overlain by 22 feet of shale, above which is a 10 to 14-inch bed of coal. The bed is not workable but is locally called a "marker" for the thicker Rocky Fork coal bed beneath it.

The outcrop of the Rocky Fork coal bed has been drawn on the geologic map only in the Rocky Fork basin where a few closed pits indicate that the bed is present. In other parts of the field, where carefully measured sections were made in this part of the Wise formation, the bed was not noted. It is of local importance only.

The Imboden and Kelly coal beds.—The outcrops of the Imboden and Kelly coal beds cross Upper Guest River basin north and west of Lipps. The Imboden bed shows at river level at the mouth of Critical Fork, where several prospect pits have been dug, exposing it on both banks of the river. The Kelly bed overlies the Imboden at an average distance of 20 feet. The Imboden and Kelly beds have largely been removed by erosion from the Upper Guest River basin. Two small isolated areas underlain by these beds still remain in the highest portion of Divide Ridge between Powell and Guest rivers.

The beds have been prospected by the Clinchfield Coal Corporation in much of the northern section of Wise County. The Kelly, in the Upper Guest River basin, is the better of the two beds, displaying a thickness ranging from 3½ to 5½ feet, whereas the Imboden averages only 3½ feet. Both beds contain partings of clay and shale, which, although generally thin, average for the Kelly bed between 4 and 5 inches thick. Both beds are workable, but neither has been mined to any appreciable extent. The two beds are separated by sandstone which in many places is soft and friable. A more conspicuous sandstone lies beneath the Imboden, but on Guest River it does not generally make such prominent cliffs as it does on Black Creek and Indian Creek.

The Kelly coal bed has also been opened on the west bank of Guest River at the mouth of Critical Fork. The pit, when examined, was partly caved and the entire thickness of the bed could not be seen. That part of the coal bed that was exposed has the following section:

Section of the Kelly coal bed on Guest River at Critical Fork.

(Loc., 399; el., 2,230 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous		3
Coal		3
Shale		3
Coal		3
Shale		3
Coal		8
Coal, impure		3
Coal		10+
Coal	2	3+
Partings		6

The Imboden is opened in this locality in several pits, the coal lying beneath a thick bed of sandstone. The coal bed has the following section:

Section of the Imboden coal bed on Guest River at Critical Fork.

(Loc., 400; el., 2,223 feet. L.)

	Ft.	In.		Ft.	In.
Sandstone.			Sandstone.		
Bone, "rash," and pyrite		8	Coal		3
Coal with many thin partings and lenses of pyrite	3	6	Shale, carbonaceous, and coal		4
Clay			Coal		9
			Coal, impure		3
			Coal	1	0
			Shale		½
			Coal	1	2
			Clay		
			Coal	3	5
			Partings		4½

The Kelly coal also has been prospected several hundred yards south on the east bank of the river. In two pits the following sections were measured:

Sections of the Kelly coal bed on Guest River at Critical Fork.

(Loc., 401.)

Section in north pit.

(El., 2,260 feet, B.)

	Ft.	In.
Sandstone.		
Shale	1	
Shale, carbonaceous.		8
Coal		4
Shale, carbonaceous		4
Coal		3
Shale		¼
Coal		8
Coal, impure		2
Coal		11
Shale		1
Coal		10+
Coal	3	2+
Partings		5¼

Section in south pit.

(El., 2,300 feet, B.)

	Ft.	In.
Coal	1	8
Shale		½
Coal		3
Shale		½
Coal	1	3
Shale		3
Coal	2	2
Shale		
Coal	5	4
Partings		4

On Steve Horn Branch at the west base of Buck Knob the beds have the following section:

Sections of the Imboden and Kelly coal beds on Steve Horn Branch.

(Loc., 402; el., (Imboden), 2,323 feet, L.)

	Ft.	In.
Shale.		
Coal		3
Shale	2	
Coal	1	10½
Bone		½
Coal	1	5
Shale		
Coal, Kelly	3	6½
Partings	2	½
Interval, Shale (?)	20	
Coal	1	2
Clay		2½
Coal		9
Clay		1
Coal		2
Coal, Imboden	2	1
Partings		3½

The Kelly bed was measured in a pit on the east side of Guest River south of Critical Fork and 2 miles north of Lipps. The section obtained here is given below:

Section of the Kelly coal bed on Guest River 2 miles north of Lipps.

(Loc., 403; el., 2,384 feet, L.)

	Ft.	In.
Shale, coal, and bone	2	
Coal		4
Clay		½
Coal		1½
Clay		1½
Bone		1½
Coal	2	2¾
Bone		1
Coal	2	11
Clay		
Coal	5	7¼
Partings		4½

On the southernmost exposure of the bed in the ridge, dividing Steve Horn Branch and Rocky Fork, the Kelly coal bed shows the following section:

Section of the Kelly coal bed 2 miles southeast of Buck Knob.

(Loc., 404; el., 2,665 feet, L.)

	Ft.	In.
Shale.		
Coal, laminated	1	3
Coal, soft, shaly		3
Coal, bright, hard	2	0
Clay		
Coal	3	6

At this place the Kelly bed, lying on the axis of the Buck Knob anticline, is nearly 450 feet higher than it is on Guest River at Critical Fork.

A number of prospects of the Clinchfield Coal Corporation are indicated on the geologic map for which no sections are available.

Standiford coal beds.—The two Standiford coal beds are present in the upper portion of the Upper Guest River basin, outcropping on Black Mountain and on Buck Knob. The beds have been very little prospected and are not well known.

On Critical Fork of Guest River two beds are exposed that are regarded as the Standiford coals, although on account of a rather strong westward dip, the distance between them appears to be greater than it is elsewhere.

Sections of the Standiford coal beds on Critical Fork.

(Loc., 405; el., (upper bed), 2,340 feet, B.)

	Ft.	In.
Shale.		
Bone		3
Coal		2
Clay, bone, and impure coal		2
Coal, clear	3	5
Clay		2
Coal		3
Clay		
Coal, upper bed	3	10
Partings		4
Interval	40+	
Shale		
Coal, lower bed	2	

On the new road south of Fox Gap, at the foot of the hill, the upper Standiford bed has a workable thickness as shown by the following section:

Section of the upper Standiford coal bed south of Fox Gap.

(Loc., 406; el., 2,263 feet, L.)

	Ft.	In.
Shale.		
Coal	2	4
Clay		2
Coal	1	4
Shale		
Coal	3	8
Parting		2

This bed is also opened on the old road less than a quarter of a mile northeast of location 406.

Taggart coal bed.—The Taggart bed lies about 80 feet above the upper Standiford coal bed, but it does not approach the thickness that characterizes it on Callahan Creek or Roaring Fork. The Taggart outcrops well up the slope of Black Mountain and underlies but a small area at the top of Buck Knob. Very few prospects have been opened on this bed and not much can be said of its general character in the Upper Guest River basin. It was measured in a prospect on the hill south of Critical Fork, where the following section was obtained:

Section of the Taggart coal bed south of Critical Fork.

(Loc., 407; el., 2,450± feet, B.)

	Ft.	In.
Shale.		
Bone		3
Coal		11
Clay		2
Coal		10½
Clay		
Clay	1	9½
Parting		2

Low Splint coal bed.—The Low Splint coal bed lies about 200 feet above the Taggart bed. It outcrops about midway up the slope of Black Mountain. At Steve Horn Gap the bed is cut through by erosion, leaving a small isolated acreage of coal capping Buck Knob. The Low Splint bed on Buck Knob has been thoroughly prospected by the Clinchfield Coal Corporation, which reports the following sections:

Section of the Low Splint coal bed on Buck Knob.

(C. C. C. prospects.)

(Loc., 409; el., 2,819 feet, L.)

	Ft.	In.
Coal	2	1
Shale		½
Coal	2	3
Coal	4	4
Parting		½

(Loc., 410; el., 2,830 feet, L.)

	Ft.	In.
Sandstone.		
Shale	?	
Coal	2	5½
Shale		¾
Coal	2	4
Coal	4	9½
Parting		¾

The Low Splint bed is not mined in the Upper Guest River basin, although it shows a fair workable thickness. On the head of Critical Fork (loc. 408, el. 2,435 feet, B) a bed showing a top bench of 23 inches of coal, with a reported thin parting, and a lower bench, seems likely to be the Low Splint.

Phillips and higher coal beds.—The Phillips coal bed was seen at only one place in the Upper Guest River basin and little can be said of its character. It outcrops about 260 feet above the Low Splint.

In a closed pit on the head of Critical Fork of Guest River this bed has a reported thickness of more than 4 feet (loc. 411, el. 2,640 feet, B). In a pit nearby the bed is partially exposed, showing more than 2 feet of good coal. The Phillips coal was not seen elsewhere in the Upper Guest River basin.

A coal bed having the following section and regarded as the bed 215 feet above the Phillips, was seen under fairly massive sandstone near the head of Critical Fork of Guest River:

Section of coal bed on Critical Fork.

(Loc., 412; el., 2,700 feet, B.)

	Ft.	In.
Sandstone.		
Coal	1	2
Clay		2
Coal	2	0
Shale		
Coal	3	2
Parting		2

This bed is the highest coal bed measured in the Upper Guest River basin. The Pardee bed of remarkable thickness on Callahan Creek and Roaring Fork outcrops near the top of Black Mountain, but the acreage of coal on Guest River drainage is very small. No pits on that bed were seen in this basin.

BEAR CREEK BASIN.

General features.—The basin of Bear Creek has an area of about 25 square miles in central Wise County. The principal streams are Bear Creek, its chief branch, Yellow Creek, and the main branch of the latter, Glade Creek. Wise, the county seat, is situated in the west central part of the basin, at the juncture of Yellow and Glade creeks.

Bear Creek drains most of the plateau (see Pl. VI) east and north of Wise and consequently the surface features that occur in that part of its basin on the plateau are very different from those which characterize the valley of the lower part of the stream where it has cut a deep gorge in its descent to Guest River. As previously stated, the plateau from Wise eastward is held up by the Gladeville sandstone, an extremely resistant stratum, from 80 to 120 feet thick. Low, well rounded shale hills of the Wise formation are scattered about the plateau (see Pl. VII); the streams are sluggish and, in many places in the upper part of the basin, have been held back by the massive sandstone, making swamps. In the southern end of the basin the streams have steep grades, swift currents, narrow valleys and are separated from one another by sharp divides. The southern outcrop of the Gladeville sandstone makes a rugged country, characterized largely by cliffs which make the line of demarcation between the two types of topography in the Bear Creek basin.

The plateau is terminated on the south by the erosion of the Gladeville sandstone where it has been upturned on the flank of Powell Mountain and on the west by erosion of the rocks on the Gladeville anticline, the axis of which passes through Ramsey and Glamorgan. A few miles back from the margins of the plateau on the south and west the rocks lie nearly flat and they continue in this attitude throughout the remaining portion of the basin. The general dip of the rocks in this region is north to northeast.

The uppermost conglomerate of the Lee formation, folded by the Gladeville anticline, is brought to the surface just east of Ramsey and makes a prominent projecting point of hard massive rock extending northward into the softer rocks of the Norton formation. The conglomerate is deeply notched by Guest River, notwithstanding the sinuous bend of the stream to the north to avoid the hard rock. This is the only instance in Wise County in which the minor folds in the basin of the Middlesboro syncline appear to have affected the rocks of Powell Mountain.

The Norton formation consists largely of shale, sandy shale, and a very few beds of sandstone. The Gladeville is hard, light to buff, coarse-grained sandstone. It is largely used in building fences, foundations, and road repairing. In the Wise formation the Addington sandstone is the only traceable bed in the Bear Creek basin.

The coal beds exposed in Bear Creek basin range from coal beds in the lower part of the Norton formation to the Addington coal bed in the Wise formation. The coals of the lower part of the Norton formation, however, are thin and of poor quality and are not mined at the present time. A bed that is thought to be the Kennedy was once opened but soon abandoned, it being reported too thin to work.

The Upper Banner is apparently split into thin and probably worthless benches, as at several places a number of very thin beds were found at what is thought to be the Upper Banner horizon. In tracing the Upper Banner bed west from Beaver Dam Creek, north of Tacoma, early prospectors reported the thinning and splitting of this bed. Drilling west of Bear Creek may reveal the bed again of workable thickness, but the indications are strongly against this supposition.

In the Bear Creek basin the important coal beds are the Norton, Dorchester, Lyons, and Addington. The Norton bed outcrops immediately beneath the Gladeville sandstone and the Dorchester just above the sandstone, usually with a small thickness of clay or shale betwen them. The Lyons coal bed lies 30 to 35 feet above the Dorchester bed, and about 70 feet below the Blair bed. The Blair has been opened at a few places only, and the Clintwood appears scarcely to have been prospected. The Addington coal bed has been opened at several places and is a good workable bed. Its acreage, however, is relatively small in the Bear Creek basin. Sections of the coal beds in this basin are shown in graphic form in figures 36 and 37.

The Hawthorne Coal Co., Gladeville Coal Co., and Yellow Creek Coal Co. are among the larger organizations mining in the Norton coal bed. At least 75 per cent of the coal shipped from the Bear Creek basin comes from the Norton bed. The Dorchester, Lyons, and Addington coal beds are worked in numerous small mines, the coal from which is hauled by tram or wagon to the railroad. Although coal mining is one of the chief industries of this region, the output of the Bear Creek basin does not rank with the larger producing basins of Wise County.

The lower part of Bear Creek basin has ample shipping facilities in the Norfolk and Western, and Norton and Northern railroads. The latter is a small road running up Bear Creek and Yellow Creek valleys from Norton to Wise. A spur which leaves the main line 2 miles up Bear Creek was in process of construction in the spring of 1921. This spur was being built to serve a new mine in the Norton bed east of Bear Creek. The upper portion of the Bear Creek basin is not reached by any railroad and coal mined in this territory must be hauled to Wise for consumption or shipment. The region is thoroughly covered by roads, three of which—the roads from Wise to Glamorgan, from Wise to Norton, and from Wise to Coeburn—are excellent pikes.

There is no virgin timber of consequence in the Bear Creek basin. The plateau has largely been cleared for farming and the southern portion, which consists largely of steep slopes, was completely cut over about 20 years ago. Considerable stand of second-growth trees and brush has sprung up along the southeastern forks of Bear Creek and mine timbers can be obtained in small quantity from this part of the basin.

Coal beds below the Norton coal bed.—On a small knob east of the juncture of Bear Creek and Guest River (loc. 413, el. (lower pit) 2,100 feet, B), two entries have been driven into the upper and lower benches of a coal bed. This is probably at the horizon of the Kennedy coal bed. One drift is 15 feet below and 50 feet southwest of the other, but both had so slumped that at the time they were visited, the fall of 1920, no coal could be seen in place though coal fragments in abundance were scattered over the dump.

Nothing was seen of the Lower Banner bed on Bear Creek, but several pits have been opened at the approximate horizon of the Upper Banner. This bed has not been traced west of the Middle Guest River basin, in the western portion of which prospecting shows that the bed splits and is of small economic value. A newly opened pit showing 2 to 3 feet of coal was seen on the west bank of Bear Creek near its mouth (loc. 414, el. 2,125 feet, B). Another pit, apparently on the same bed, one-half mile farther north, was visited but the coal was not seen in place. These pits are thought to be on the Upper Banner coal or one of the benches resulting from the splitting of that bed. An entry driven west under the railroad at the juncture of Bear Creek and Yellow Creek is reported to be in a 28-inch bed of clear coal, overlain by soft shaly soil. Another opening in the same bed, on the left bank of Bear Creek (loc. 415, el. 2,210 feet, B), shows 20 inches of coal without a parting, with a shale roof and sandstone floor. A coal bed showing at the spring where the wagon road crosses the railroad (loc. 416, el. 2,130 fet, B) is probably the lower of the two benches referred to above. The lower bench is from 20 to 40 feet below the upper bench.

An unidentified coal bed has been prospected on the first south fork of Bear Creek (loc. 417, el. 2,380 feet, B) beneath a heavy sandstone. The pit was closed and no section of the coal could be measured. It is referred to the Hagy horizon, however, for two reasons; first, because it outcrops beneath the only massive sandstone found between the Upper Banner and the Gladeville sandstone, and secondly, because its relation to the general structure indicates an interval of 270 feet between it and the base of the Gladeville.

Norton coal bed.—The Norton coal bed throughout the larger part of the basin underlain by it displays a strikingly uniform section of coal, the thickness ranging from 2 feet 9 inches to 3 feet 6 inches. Occasionally a lower and thinner bed or bench separated by 2 to 4 feet of shale is found in the section. The parting in the main bed usually consists of one-half inch layers of shale, having an aggregate thickness of 1 to 2 inches, although it is not uncommon in the southwestern end of the basin for the middle parting to thicken up to 8 or 9 inches.

The Hawthorne Coal Co. is operating two mines in the Norton coal bed in the ridge south and southeast of Esserville. Much of the coal from these mines is coked by the company, which has a bank of ovens on Guest River south of the mines. The coal bed in Hawthorne No. 10 Mine (old No. 1 mine) (loc. 418, el. 2,136 feet, L) is split by 9 inches of clay with 2 feet, 5 inches of coal above and 2 feet of coal below.

The main entry of the Mine No. 10 has been driven straight through the ridge and opens on Guest River at loc. 360. The company employs seven miners in Mine No. 10 and produces about 40 tons of coal daily.

The coal bed rises rapidly to the north from Mine No. 10 and is more than 50 feet higher at Mine No. 2 of the Hawthorne Coal Co., which is 900 feet north of Mine No. 10. Mine No. 2 and Mine No. 10 have been connected at several places underground. The Norton bed shows a thicker parting and thinner lower bench in Mine No. 2 than it does in Mine No. 10.

Section of the Norton coal bed in Hawthorne Coal Co.'s Mine No. 2.

(Loc., 419; el., 2,190 feet.)

	Ft.	In.
Shale.		
Coal	3	6
Clay	2	0
Coal		11
Shale		
Coal	4	5
Parting	2	0

A mine was opened in the Norton bed east of Esserville and near the summit of the ridge on the Bear Creek side. This mine, operated by the West Coal Co., used a long metal-lined open chute to transport the coal from the mine to a tipple on a railroad spur at the foot of the hill. When visited in 1921 the mine was abandoned and the spur torn up.

The coal bed in this mine is much broken by partings and has a thin section. It dips 10 to 12 degrees to the northwest, as measured at two places in the mine. The Norton coal is directly under the Gladeville sandstone, which towers above the mine in a high cliff and caps the ridge. The mine when in operation, produced 40 tons daily, requiring the services of 9 miners.

In the mine the following sections were measured:

Sections of the Norton coal bed in West Coal Co.'s mine.

(Loc., 420; el., 2,520 feet, B.)

Section at face of main entry 500 feet from mine mouth.

	Ft.	In.
Sandstone.		
Clay	2	
Coal		1
Clay	1	
Coal		2½
"Rash"		½
Coal		9
"Rash"		½
Coal		6
"Rash"		1
Coal		8
Clay		1
Coal		4
Clay		
Coal	2	6½
Partings	1	3

Section in room 2, off 1st left entry 300 feet from mine mouth.

	Ft.	In.
Sandstone.		
Clay	2	
Coal		1
Clay	1	
Coal		2
Clay		½
Coal		10
"Rash"		½
Coal	1	4
Clay		1
Coal		4
Clay		
Coal	2	9
Partings	1	2

South of Wise the Gladeville Coal Co. is mining the Norton coal bed at several places. The bed averages 33 to 42 inches throughout the entire area being mined by this company. It has an average thickness of 36 inches in Gladeville Coal Co.'s mine No. 5 (loc. 421, el. 2,500 feet, B). This mine had been temporarily closed, but when visited, was being reopened.

The mouth of Mine No. 2 in the Norton bed is on the southeast end of the ridge, where the bed is 2 feet below the massive Gladeville sandstone. Mine No. 2 is the second largest producer of the Gladville Coal Co., engaging 15 miners and having an output of 75 tons per day. The section of the coal bed in this mine is given below:

Section of the Norton coal bed in Gladeville Coal Co.'s Mine No. 2.

(Loc., 422; el., 2,380 feet, B.)

	Ft.	In.
Sandstone.		
Shale	2	0
Coal		1½
Shale		1½
Coal	3	
Clay		
Coal	3	1½
Parting		1½

Old Mine No. 2, now abandoned, lies several hundred feet north of the present Mine No. 2.

The largest mine of the Gladeville Coal Co. is its Mine No. 1, three-quarters of a mile south of Wise railroad station. The mine produces 100 tons of coal daily, using 20 miners. The mine mouth is several feet above and 20 feet west of the railroad. The coal of this mine has been sampled and the results of the analyses appear on page 513. The sections of the bed measured in connection with the sampling are given below:

Section of the Norton coal bed in Gladeville Coal Co.'s mine No. 1.

(Loc., 423; el., 2,350 feet, B.)

Section where sample was cut at face of entry, off 4th right air drift; 2,000 feet from mine mouth.

(Analysis No. 75368.)

	Ft.	In.
Shale.		
*Coal		3
Bone and clay		½
*Coal	1	7
*Bone		¼
*Coal		10
*Bone		½
*Coal		4½
Shale		
Coal	3	0½
Partings		1¼

Section where sample was cut in 3d left entry, on chain pillar; 700 feet from main line and 2,500 feet from mine mouth.

(Analysis No. 75367.)

	Ft.	In.
Shale and sandstone.		
*Coal		3
*Bone and "rash"		½
*Coal	1	5
*Bone		½
*Coal	1	1
Bone		1
*Coal		6
Clay		
Coal	3	3
Partings		2

*Sampled.

Section where sample was cut in 1st right entry, off entry No. 20, from south wall of "break-through" to main line, 2,000 feet from mine mouth.

(Analysis No. 75369.)

	Ft.	In.
Sandstone and shale.		
*Coal		3
Bone and "rash"		½
*Coal	1	7
*Clay streaks in coal		½
*Coal	1	1
*Bone		½
*Coal		5
Clay		
Coal	3	4
Partings		1½

The Yellow Creek Coal Co. is mining the Norton coal bed on the east side of Yellow Creek, opposite the Gladeville Coal Co.'s mines. The bed is not so thick here as it is on the west side, as the following two sections measured in the Yellow Creek mine show but 2 feet, 9 inches of coal, whereas the sections in the Gladeville Company mines show nearly 3 feet 6 inches of coal.

Sections of the Norton coal bed in Yellow Creek Coal Co.'s mine.

(Loc., 424; el., 2,346 feet, L.)

	Ft.	In.		Ft.	In.
Sandstone.			Coal		1⅞
Coal	1	6	Shale		2½
Clay		½	Coal	2	2
Coal		11	Clay		1
Clay		1	Coal		5¼
Coal		4			
Clay			Coal	2	9⅛
			Partings		3½
Coal	2	9			
Partings		1½			

The Norton coal bed has been prospected on Bear Creek by Scarborough and Dotson. On the west bank of the stream, one-half mile south of the Coeburn pike, they report the following section:

Section of the Norton coal bed on Bear Creek.

(S. and D. prospect.)

(Loc., 425; el., 2,393 feet, L.)

	Ft.	In.
Shale.		
Coal, hard		4
Shale		7
Coal	1	8
Clay		
Coal	2	0
Parting		7

*Sampled.

Two slumped pits were seen on the bed east of Bear Creek. The first pit (loc. 426, el. 2,420 feet, B), to the east of location 425, had been dug to supply coal for the logging road that formerly ran up the valley. The second pit (loc. 427, el. 2,510 feet, B) is a local mine. The coal here is reported to be 36 inches thick.

On the south bank of Bear Creek, west of location 427, the Norton coal bed has been opened, showing, according to Scarborough and Dotson, a section, as follows:

Section of the Norton coal bed on Bear Creek.

(S. and D. prospect.)

(Loc., 428; el., 2,381 feet, L.)

	Ft.	In.
Shale.		
Coal	1	7
Clay and shale		1
Coal	1	0
Clay and shale		1
Coal		6
Shale	3	11
Coal	1	
Shale		
Coal	4	1
Partings	4	1

In the section given above, the bottom bench 1 foot thick is separated from the remainder of the bed by so thick a parting that it could not be mined at a profit. Hence 3 feet, 1 inch of coal is all that should be regarded as workable under present conditions.

The Norton coal bed is opened by the Huettel mine in the ridge southeast of Bear Creek, where it is separated from the Gladeville sandstone overlying it, by 20 to 30 feet of shale. The coal bed in this mine, measured near the outcrop, has the following section:

Section of the Norton coal bed in the Huettel mine.

(Loc., 429; el., 2,450 feet, B.)

	Ft.	In.
Clay.		
Coal	1	9
"Rash"		1
Coal	1	9
Shale		
Coal	3	6
Parting		1

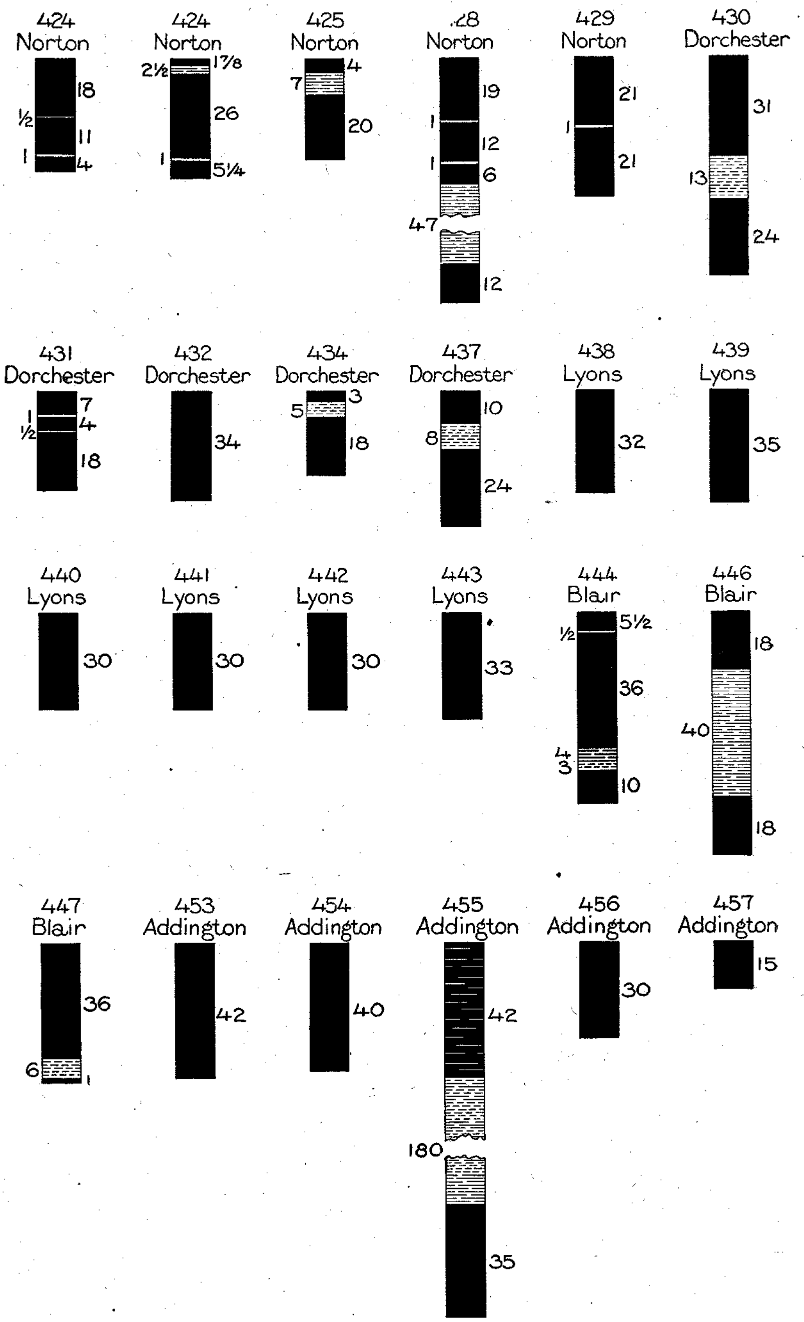


Fig. 37.—Sections of coal beds in the basin of Bear Creek.

A bed of coal 15 inches thick is reported to have been opened about 30 feet above the Huettel mine.

Dorchester coal bed.—The Dorchester coal bed, wherever exposed in the Bear Creek basin, lies directly over the Gladeville sandstone. It is thickest (more than 4 feet) on Guest River near the southwestern edge of the basin and in the remainder of the basin it ranges from 3 to 3½ feet of coal.

The Dorchester coal bed southeast of Wise has been removed by erosion from much of the Gladeville plateau. The bed still remains, however, in small areas under the scattered knobs of shale that rise here and there above the sandstone.

The Dorchester coal is mined for shipping by the Hawthorne Coal Co. in Mine No. 3 or "Old" Mine No. 1, 1 mile east of Norton. This mine produces an average of 20 tons of coal daily.

The coal bed in this mine, as shown by the irregularity of the dips in various parts, has been warped by the forces which produced the uplift of Powell Mountain. Thus the coal bed dips 13° N. 10° W. at a point 100 feet in from the mine mouth. From here the dip decreases to a point 300 feet from the mine mouth where the rocks are flat. Four hundred feet from the mine mouth the rocks begin to rise gently. The coal is crushed at places and ranges considerably in thickness, due to the bunching up of the coal under intense pressure. The following section was measured 100 feet from the mine mouth, and is fairly typical of the bed:

Section of the Dorchester coal bed in Hawthorne Coal Co.'s Mine No. 3.

(Loc., 430; el., 2,215 feet, L.)

	Ft.	In.
Shale.		
Coal	2	7
Clay	1	1
Coal	2	0
Clay		
Coal	4	7
Parting	1	1

The Bradley Coal Co. has a shipping mine in the Dorchester bed, south of the railroad station at Wise. The coal bed here lies 2 feet above the Gladeville sandstone and, as reported by the owner, has the following section:

Section of the Dorchester coal bed in Bradley Coal Co.'s mine.

(Loc., 431; el., 2,470 feet, L.)

	Ft.	In.
Shale.		
Coal	2	10
Bone		1½
Coal		5
Shale	2	
Coal	3	3
Parting		1½

The section of the bed as measured by Scarborough and Dotson in this mine is as follows:

Section of the Dorchester coal bed in Bradley Coal Co.'s mine.

	Ft.	In.
Coal		7
Shale		1
Coal		4
Shale		½
Coal	1	6
Coal	2	5
Partings		1½

The bed has been opened in Wise on the north side of the Coeburn pike northeast of the railroad station in an old mine (loc. 432, el. 2,450 feet, B) that, when visited in 1920, was being reopened. The bed measures 34 inches of soft, prismatic coal, and the mine has a clay floor and shale roof.

The Dorchester bed, containing only 20 inches of coal between layers of clay, is being worked in a small mine opposite the Wise fair grounds (loc. 433, el. 2,425 feet, B).

On the Coeburn pike just east of the town limits of Wise the coal is exposed in an abandoned local mine. The mine is caved about 30 feet from the entrance, but the section measured near the outcrop is as follows:

Section of the Dorchester coal bed east of Wise.

(Loc., 434; el., 2,450 feet, B.)

	Ft.	In.
Shale.		
Coal		3
Clay		5
Coal	1	6
Clay		
Coal	1	9
Parting		5

On the Coeburn pike 1½ miles east of Wise the Dorchester coal is exposed in a road cut where it lies within a few feet of the Gladeville sandstone.

Section of the Dorchester coal bed one and one-half miles east of Wise.

(Loc., 435; el., 2,490 feet, B.)

	Ft.	In.
Soil, shaly.		
Coal, impure	1	
Shale, carbonaceous		6
Clay		2
Shale, carbonaceous		10
Coal		6
Clay		
Coal	1	6
Partings	1	6

The bed is partly exposed in an old pit on Bear Creek one-half mile north of the Coeburn pike (loc. 436, el. 2,480 feet, B), showing 16 inches of coal. The overlying material is a 2-foot bed of shale with clay overlying it.

A local mine in the Dorchester bed has been opened on the south end of the ridge east of Yellow Creek. The bed shows a workable thickness, as the following section indicates:

Section of the Dorchester coal bed 1 mile south of Wise.

(Loc., 437; el., 2,550 feet, B.)

	Ft.	In.
Clay.		
Coal		10
Clay		8
Coal	2	0
Shale		
Coal	2	10
Parting		8

From the foregoing sections it appears evident that the Dorchester coal bed in this basin is inferior on the whole to the Norton coal bed. It is workable throughout its entire extent on Bear Creek drainage, however, as is well shown by the scattered local mines on its outcrop, but it is too thin and too limited in extent to sustain any operation on a large scale.

Lyons coal bed.—Thirty to 40 feet above the Dorchester lies a coal bed varying from 30 to 36 inches in thickness. The bed is here designated the Lyons, as it is correlated with the Lyons bed in Dickenson County, which lies at this stratigraphic horizon. The bed is of local importance only, the Bear Creek basin representing about the only territory in Wise County in which the bed is of workable thickness. It is not improbable that the Lyons coal of this basin is the upper split or bench of the Dorchester, as this bed splits within the Glamorgan mine from 1 inch to nearly 30 feet. This supposition would account for the mediocre showing of the Dorchester coal bed in the territory east of Glamorgan.

The Lyons bed has been mined in a small way near the fair grounds at Wise (loc. 438, el. 2,450 feet, B). It has a thickness of 2 feet, 8 inches of clear coal and is 32 feet above the Dorchester bed. The mine employs 4 miners and produces 10 tons of coal daily.

A wagon mine is working the Lyons coal bed on the east side of the small stream valley, one-half mile east of the fair grounds (loc. 439, el. 2,560 feet, B). The bed here is locally termed the "Fraley" bed. It has an excellent section of 35 inches of clear coal overlain by 1 foot of carbonaceous shale.

The Dorchester bed is reported to have been opened below this mine and to contain only 8 inches of coal. The pit was not seen, however, and the interval between the two beds could not be determined.

The Lyons coal, with a thickness of 3 feet, has been opened several hundred yards southeast of the mine just described, though the pit, when visited, was slumped, and the report could not be verified.

The bed has been opened at several places on the divide between Yellow Creek and Bear Creek, south of the Coeburn road. One wagon mine and 2 caved pits face the Coeburn road. In the wagon mine (loc. 440, el. 2,575 feet, B) the bed is 30 inches thick and is overlain by 2 feet of carbonaceous shale.

Two pits, temporarily abandoned, at locs. 441 and 442. el. 2,550 feet, B. were visited and both showed a uniform section of 30 inches of coal.

Northwest of Bear Creek and the Coeburn pike (loc. 443, el. 2,500 feet, B) a small mine was being opened in the Lyons bed by the Bear Creek Coal Corporation, when visited in 1920. A thickness of 33 inches of clear coal was measured.

Blair coal bed.—The Blair coal bed in the Bear Creek basin, ranging from 3 to 3½ feet thick, is from 100 to 120 feet above the Gladeville sandstone. It is mined at several small mines in the country northeast of Wise.

The bed has a very small acreage south of Wise, outcropping only on the ridge between upper Guest River and Bear Creek. It contains more than 4 feet of hard coal, according to a measurement made in the northernmost of two pits that had been opened in the hollow just west of the mouth of Bear Creek.

Section of the Blair coal bed west of the mouth of Bear Creek.

(Loc., 444; el., 2,250 feet, B.)

	Ft.	In.
Clay.		
Coal		5½
Shale		½
Coal	3	0
Shale, carbonaceous		4
Clay		3
Coal		10
Clay		
Coal	4	3½
Partings		7½

Correlation of coal beds in this hollow is difficult and the results are questionable in view of the steep dips close to the belt of upturned rocks. A dip of 33° N. 20° W was measured at the mouth of the pit. The direction of dip is local, the general direction being to the southwest.

One mile and a half northeast of Wise a coal bed, here referred to as the Blair, was seen as a bloom on the west side of the road (loc. 445, el. 2,500 feet, B). The bed measures 25 inches of coal with 2 inches of clay, 1 inch from the bottom. A caved entry was seen just east of the stream and about 20 feet lower than the coal just noted, but it is probably the same bed.

The Blair coal bed outcrops in the low knobs 1 mile east of the fair grounds at Wise. At loc. 446, el. 2,575 feet (B) a bloom exposes 3 feet of coal split in the middle by 40 inches of shale, and south of the road and just north of the house a 26-inch bloom was seen. An entry driven into the bed 200 feet west of the house exposed 3 feet of coal. The large parting noted in the coal bloom represents a local lense of shale which was seen at no other place in the basin.

A local mine, newly opened by a man named Beverly, near the head of Bear Creek, gives the following section of the Blair bed:

Section of the Blair coal bed in Beverly mine.

(Loc., 447; el., 2,530 feet, B.)

	Ft.	In.
Clay.		
Shale, carbonaceous.		
Coal	3	0
Clay		6
Coal		1
Sandstone		
Coal	3	1
Parting		6

The parting at the base of the bed is characteristic of this coal in the Bear Creek basin.

An abandoned and caved opening in the same bed lies on the east side of the stream (loc. 448, el. 2,530 feet, B) due south of the present mine. The coal is inaccessible and its thickness could not be determined. The coal bed is exposed at two places on one of the eastern branches of Bear Creek, one mile north of the Coeburn road, but here only a small part of the bed is exposed and its full thickness and character could not be determined.

A prospect pit in the hollow at the road crossing (loc. 449, el. 2,580 feet, B) was visited, but the base of the bed is under water and a full section could not be measured. The coal exposed is 1 foot, 10½ inches thick, with a parting of clay 2½ inches thick one-half inch from the top of the bed.

On the outcrop a short distance south of this prospect pit a second pit was seen (loc. 450, el. 2,580 feet, B). This is a timbered prospect, but it was flooded and only 1 foot of coal shows above water. The coal bed here is underlain at a short distance by a thick sandstone. The Addington sandstone caps the ridges on both sides of the stream at this locality and sheds many large blocks down the slope.

The Blair coal bed was not seen elsewhere in the basin. Its lack of development here indicates that as a whole it is not of great commercial importance. As the better coals become scarce or mined out, however, there is a considerable tonnage of the Blair bed economically available in the Bear Creek basin.

Clintwood and Addington coal beds.—The outcrop of the Clintwood and Addington coal beds is clearly marked in this basin by the ledges of the Addington sandstone, which show near the hill tops throughout the area west and south of Hurricane. The Clintwood coal beneath it is thin and in most places worthless, but the Addington coal bed above the sandstone is nearly everywhere of workable thickness. This hard gray, quartzose sandstone is 15 to 30 feet thick and weathers out in large blocks.

The Clintwood coal bed is not mined at present in the Bear Creek basin, but a caved drift was found in it on the south end of the ridge between Bear Creek and Upper Guest River (loc. 451, el. 2,460 feet, B). The coal here outcrops close to the Addington sandstone which caps the spur at this place.

A 12-inch coal bloom, which is regarded as the Clintwood, was seen on the road running north from the fair grounds at Wise, on the south side of the low gap between Dotson Fork of Birchfield Creek and Yellow

Creek (loc. 452, el. 2,520 feet, B). The Addington sandstone is cut through in the gap, but a bed of shale still protects the coal bed.

The Addington coal bed is 3 to 3½ feet thick and one of the best beds in the Bear Creek basin. Unfortunately, however, it has a very small acreage as it occurs only in the high knobs in the northeast part of the basin. A number of small mines have been opened in the bed in this locality. One of these, a local mine 1½ miles northeast of Wise (loc. 453, el. 2,560 feet, B), shows the bed contains 42 inches of clear coal. The coal bed lies from 8 to 10 feet above the Addington sandstone. The mine has a clay roof and clay floor, with a thin carbonaceous bed 10 feet above the general level of the roof. The bed shows a 40-inch bloom near the house in the low gap on the road one-half mile north of the local mine just described (loc. 454, el. 2,565 feet, B). It also shows the following section in a road cut southeast of the last mentioned location:

Section of the Addington coal bed, 1 mile south of Hurricane.

(Loc., 455; el., bottom bed, 2,590 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous	4	
Coal, with shale streaks	3	6
Shale and clay	15	
Coal	2	11
Clay	12	
Sandstone	12	
Shale		
Coal, upper bench	3	6
Coal, lower bench	2	11

The upper bench is not persistent and was not seen at any other place with a thickness approaching that which it has at loc. 455. Two road blooms farther east show the following thicknesses for the Addington coal bed: 30 inches of coal at loc. 456, el. 2,590 feet (B), and 15 inches of coal at loc. 457, el. 2,590 feet (B).

Very little of the Addington coal bed occurs on the divide between Bear Creek and Steele Fork of Cranesnest River. The Addington sandstone, forming the backbone of the divide, is the highest bed exposed over much of the length of the ridge, and the Addington coal occurs only where erosion has failed to remove the beds overlying the sandstone. The coal is 1 foot thick at loc. 458, el. 2,690 feet (B), where it lies 2 feet above the Addington sandstone member, which here is massive, gray to white in color and greatly resembles the Gladeville sandstone.

MIDDLE GUEST RIVER BASIN.

General features.—The territory drained by Guest River from Bear Creek to Toms Creek lying north of the outcrop of the Lee formation will here be described as the Middle Guest River basin. The basin is about 5 square miles in extent and contains only one stream, tributary to Guest River, namely, Beaver Creek, that enters Guest River at Tacoma.

The Norton formation, the Gladeville sandstone, and a few isolated remnants of the Wise formation, comprise the rocks outcropping in the basin. The attitude or lay of the rocks is dominated by the Powell Valley anticline which lies south of Tacoma and makes the prominent feature of Powell Mountain. From Ramsey east, the north limb of the Powell Valley anticline flattens rapidly and south of Tacoma the "Bee Rock," or uppermost massive sandstone involved in the fold, dips to the north from 16° to 20°. In harmony with this structure the rocks of the overlying Norton formation dip at about the same rate to the north in a narrow zone paralleling and adjacent to the outcrop of the Lee formation. This dip decreases rapidly away from and to the north of the mountain.

The Norton formation in the Middle Guest River basin is largely shale but contains several prominent beds of sandstone. Thus, a thin bed of sandstone outcrops over the Raven coal bed and a fairly massive sandstone underlies the Kennedy coal bed. At places the Kennedy is capped by sandstone. A massive arkosic sandstone outcrops 65 feet above the Upper Banner coal bed. This stratum is nearly 140 feet thick, with thin-bedded sandstone at the top which weathers out in dark rusty-colored blocks. A second sandstone overlies the Upper Banner coal approximately 300 feet. It is hard, gray and quartzose, from 40 to 50 feet thick, and makes bold, outstanding cliffs. This is the sandstone which overlies the Hagy coal bed in the Toms Creek basin, and which makes the plateau of Sandy Ridge east of Fairview School. The bed is below the Gladeville sandstone and separated from it by 80 to 100 feet of shale.

The Gladeville in the Middle Guest River basin is a hard massive white sandstone that weathers into great tables as it does at Wise. It ranges from 110 to 120 feet in thickness and is exposed only in the ridge tops north and northeast of Tacoma.

Five coal beds of commercial importance outcrop in the Middle Guest River basin, namely, the Raven, the Kennedy, the Lower Banner, the Upper Banner, and the Norton. Other beds have been prospected but have not been mined to any extent. The beds named above contain from 2 to 4½ feet of coal each and all are being mined to a greater or lesser extent. Graphic sections of these coal beds are shown in figures 38 and 39.

Mining operations on lower Guest River date from the opening of the field in 1889 and 1890. At that time the Raven bed was opened east of Tacoma (loc. 465). Other mines were opened in the Raven, Kennedy, and the two Banner beds. The early development of the region was coincident with the building into it of the Clinch Valley division of the Norfolk and Western railroad.

The chief mines in the Middle Guest River basin are located about Tacoma, but several shipping mines are operating north of the railroad between Tacoma and Coeburn. None of the mines, however, has extensive workings and the output of coal for the basin is relatively small compared with that of the adjoining basins.

Raven and lower coal beds.—The Jawbone and Tiller beds were not seen, although the former bed is reported in the bed of Guest River at several places west of Tacoma. This coal bed normally lies about 200 feet below the Raven. The interval between them, combined with the geologic structure of the region, would bring the Jawbone bed to water level at a point about 1 mile west of Tacoma.

The Raven is the lowest coal bed worked in the Middle Guest River basin. It was called by early workers in the field the Imboden, and then later, the "so-called Imboden" bed. Its average thickness for the basin is about 3½ feet, but in a few places it is as much as 5 feet. The Raven is usually parted by 6 to 10 inches of shale near the middle of the bed.

The Indian Fuel Co. was pumping out and restoring an abandoned mine in the Raven bed, three-quarters of a mile west of Tacoma, when that locality was visited in the summer of 1920. The bed at this mine dips 13° N. 20° W., necessitating a slope mine. The bed has the following section:

Section of the Raven coal bed in Indian Fuel Co. mine west of Tacoma.

(Loc., 460; el., 2,050 feet, B.)

	Ft.	In.
Clay.		
Coal	2	1
Shale		8
Coal	1	4
Clay		
Coal	3	5
Parting		8

The bed is also exposed by the side of a caved pit about one-half mile west of Tacoma, dipping 10° north, showing the section given below:

Section of the Raven coal bed one-half mile west of Tacoma.

(Loc., 461; el., 2,050 feet, B.)

	Ft.	In.
Soil.		
Coal	1	8
Clay		6
Coal	1	2
Clay		1
Coal		1
Clay		
Coal	2	11
Partings		7

The Davis Bend Coal Co. is working the Raven coal in its mine at Tacoma. The bed dips 14° north and the coal is hauled out by a steam-operated cable and drum. The mine produces 40 tons of coal per day.

Section of the Raven coal bed in Davis Bend mine at Tacoma.

(Loc., 462; el., 2,020 feet, B.)

	Ft.	In.
Shale.		
Coal	2	7
Clay and shale		8
Coal	1	2
Clay		
Coal	3	9
Parting		8

The Raven bed is worked at Tacoma by the Bolling Coal Co., in a slope mine a short distance southwest of the railroad station. The coal bed dips 12° north and cable haulage is employed in drawing up the coal.

The Raven coal bed was sampled for analysis (see page 509) in the Bolling mine and the sections measured at the points where the samples were cut are given below:

Sections of the Raven coal bed in Bolling mine at Tacoma.

(Loc., 463; el., 2,020 feet, B.)

Section where sample was cut in room 5, off left side of main entry; 550 feet from mine mouth.

(Analysis No. 75444.)

	Ft.	In.
Sandstone.		
Shale	2	
*Coal		½
Clay		1
*Coal, soft		2
*Coal, hard	1	9
Clay and "rash"	1	2
*Coal, hard	1	4
Clay		
Coal	3	3½
Partings	1	3

Section where sample was cut in room 3, off main entry; 350 feet from mine mouth.

(Analysis No. 75443.)

	Ft.	In.
Sandstone.		
Shale	2	
*Coal	1	8
"Rash" and thin layers of coal	1	
*Coal	1	4
Clay		
Coal	3	0
Parting	1	0

*Sampled.

The Raven bed outcrops in the bend of the river southeast of the railroad station at Tacoma and the Guest River Coal Co. is here operating a slope mine. The bed dips 10° to the northwest and is overlain by 75 feet of compact hard shale, above which is a thick-bedded micaceous sandstone, coarse-grained and highly jointed.

A section of the bed measured at the outcrop by Campbell[1] in 1893 and a mine section taken recently show an excellent thickness of coal, the sections being as follows:

Sections of the Raven coal bed at the Guest River Coal Co. mine.

(Loc., 464; el., 2,000 feet, B.)

(Campbell's section on the outcrop.)	Ft.	In.	(Mine section.)	Ft.	In.
Shale.			Shale.		
Coal		2	Coal	2	7
Shale		3	Shale		6
Coal		7	Coal	2	6
Knife-edge parting			Shale		
Coal	1	8	Coal	5	1
Coal, impure		8	Parting		6
Coal	1	6			
Coal	4	7			
Parting		3			

The Guest River Coal Co. produces an average of 50 tons daily and employs eight miners. The coal is hauled by wagon to the railroad at Tacoma. This mine is said to be the only one producing coal on the south side of Guest River between Norton and Coeburn and north of the slope of Powell Mountain.

An old slope mine on the north side of the railroad 1 mile east of Tacoma, was temporarily closed at the time it was visited, being in the hands of a receiver. It is reported to be in 1,500 to 1,600 feet, and when operating, to produce 25 to 30 tons of coal, using five miners. A section measured here by McCreath and d'Invilliers[2] is given as follows:

[1] Campbell, M. R., Big Stone Gap coal field, U. S. Geol. Survey Bull, 111, 1893, p. 83.

[2] Report on a portion of the Virginia and Tennessee Coal and Iron Company's property, Wise County, Virginia, 1892, p. 35.

Section of the Raven coal bed 1 mile east of Tacoma.

(Loc., 465; el., 2,035 feet, B.)

	Ft.	In.
Shale.		
Coal		2
Shale		2
Coal	2	8
Shale with seam of mineral charcoal	1	0
Coal	1	4
Coal	4	2
Partings	1	2

A coal bloom, taken to be the Raven bed, is exposed in the railroad cut 2 miles east of Tacoma. The bed is overlain by 15 feet of shale, above which is from 20 to 30 feet of massive sandstone. The exposure shows a much-parted bed:

Section of the Raven coal bed 2 miles east of Tacoma.

(Loc., 466; el., 2,030 feet, B.)

	Ft.	In.
Shale.		
Coal		1
Shale		10
Bone		2
Shale		10
Coal	1	2
Clay		6
Shale, carbonaceous	1	
Clay		6
Coal	1	4
Clay		
Coal	2	7
Partings	3	10

The bed shows considerable improvement one-fourth mile farther east where it is again exposed on the north side of the road.

Section of the Raven coal bed two and one-fourth miles east of Tacoma.

(Loc., 467; el., 2,000 feet, B.)

	Ft.	In.
Shale.		
Coal	3	8
Shale		10
Coal	1	2
Clay		
Coal	4	10
Parting		10

A nearby slope which enters the bed on a dip of 17° north shows the Raven to contain 34 inches of coal and a 9-inch parting.

The sandstone overlying the Raven bed, but separated from it in the vicinity of Tacoma by 10 to 20 feet of shale, approaches the bed toward the east, and 1 mile west of Coeburn (loc. 468, el. 2,000 feet, B) the sandstone rests directly on the coal bed which here consists of 30 inches of clear coal.

The Raven bed shows evidence of splitting just west of Coeburn, for several layers of coal are exposed in the side of a railroad cut, which are supposed to be benches of this bed. The following section, measured at this place, shows the broken character of the coal bed:

Section of the Raven coal bed 1 mile west of Coeburn.

(Loc., 469; el., (bottom bench), 2,050 feet, B.)

	Ft.	In.
Sandstone	5+	
Shale		6
Coal	1	10
Shale, carbonaceous		3
Shale	6	
Coal	1	8
Shale	6	
Coal	1	1
Shale		
Coal	4	7
Partings	12	3

Kennedy coal bed.—The Kennedy coal bed crops out about 150 feet above the Raven in the ridge on the north side of Guest River. The bed does not directly overlie a sandstone in this basin as it does to the north, but a massive sandstone is usually present 100 to 120 feet below the coal bed. This sandstone in all probability represents the McClure sandstone to the north and northeast. The Kennedy coal bed is not mined as extensively as the Raven bed in the middle Guest River basin. It is, in many parts of the basin, badly crushed and shows polished surfaces, where slipping or slickensiding has taken place.

North of the sharp bend of the river, 1 mile east of Ramsay, a coal bed that is thought to be the Kennedy, although there is little evidence to support this conclusion except its relation to the structure contours on the Gladeville sandstone, was opened high up on the hillside. The rocks in this vicinity dip from 7° to 10° north and an accurate section from the top of the Lee to the coal bed which would have assisted in the correlation of the bed could not be made with hand instruments. The coal here is of mediocre quality and the mine has been abandoned. The following sections, measured in the entry within 100 feet of one another, will serve to show the character of the bed:

Section of the Kennedy (?) coal bed east of Ramsey.

(Loc., 474; el., 2,260 feet, B.)

	Ft.	In.
Shale	15	
Clay	2	
Coal	1	8
Shale		7
Coal		8
Clay		
Coal	2	4
Parting		7

	Ft.	In.
Shale.		
Coal	1	6
Clay		11
Coal		5
Clay		½
Shale, carbonaceous		2
Sandstone		
Coal	1	11
Parting		11

The Kennedy coal bed was being reopened by the Indian Fuel Co. at an old pit 1 mile west of Tacoma, when that locality was visited in the summer of 1920. The bed here lies about 120 feet above the Raven coal and shale occupies the major part of the interval. The section of the bed in this pit is as follows:

Section of the Kennedy coal bed 1 mile west of Tacoma.

(Loc., 475; el., 2,130 feet, B.)

	Ft.	In.
Clay.		
Coal		7
Clay	1	6
Coal	2	0
Clay		
Coal	2	7
Parting	1	6

A mine was once developed in the Kennedy coal bed north of Tacoma (loc. 476, el. 2,070 feet, B), but it has been abandoned and a cave-in has obscured the coal bed so that its thickness could not be determined.

Three pits opened in the coal bed a little over 1 mile east of Tacoma show a 13-inch section at loc. 477, el. 2,160 feet (B), and a 45-inch section in each of the next two pits (loc. 478, el. 2,155 feet, B, and loc. 479, el. 2,170 feet, B). The coal in the pit at loc. 478 shows a 1-inch parting of shale near the middle of the bed.

The Kennedy is exposed in several openings 1¼ miles west of Coeburn (loc. 480, el. 2,150 feet, B), with a thickness of 2 feet, 7 inches of coal. The bed is reported to be 13 feet thick in parts of one of these openings (loc. 480) but such a thickness is of local occurrence only and not persistent throughout the district.

On the small spur east of the location noted above, the coal bed is exposed in a shipping mine (loc. 481, el. 2,140 feet, B) with a thickness of 25 inches of coal without a parting. At the ravine east of the spur mentioned above, the coal is being mined by the Stonega Coal Co. (loc. 482, el. 2,120 feet, B). The coal in this mine is said to average as much as 44 inches of coal without a parting. A coal bed which, according to Giles is the Kennedy, was prospected in the spur southeast of Coeburn (loc. 483, el. 2,020 feet, B). The pit was closed and the thickness of the bed could not be determined. The bed here is overlain by 15 feet of sandstone.

Lower Banner coal bed.—The Lower Banner lies from 180 to 200 feet above the Kenndy bed and 140 feet below the Upper Banner bed. No coal bed in the Middle Guest River basin presents such a uniform section throughout a wide area as the Lower Banner. It is practically free from partings and averages 40 to 45 inches of coal. The coal, however, is not of uniform character from top to bottom of the bed but shows striking differences in physical characteristics. This is well illustrated at the Beaver mine, where there is a 20-inch bench near the base of the bed of exceptionally hard dull coal, whereas the adjacent strata are soft and usually quite bright. The quality of the hard coal is not perceptibly different from that of the soft coal.

The Lower Banner bed has been prospected 1 mile west of Tacoma at loc. 487, el. 2,255 feet (B), but the pit has slumped and only a few inches of coal at the top of the bed were seen. The Indian Fuel Co., which, at the time the locality was visited, was preparing to mine the Raven and Kennedy coal beds just below this Lower Banner prospect, also had in view the development of the Lower Banner bed at this locality.

The Lower Banner is extensively mined 1 mile north of Tacoma by the Beaver Coal Corporation. A stream tram brings the coal from this mine down to a tipple at the railroad at Tacoma. The mine produces 150 tons of coal per day, employing 20 miners. The bed in the Beaver mine dips 3° N. 20° W. The coal in the Beaver mine was sampled for analysis (see page 510) and the following sections were measured:

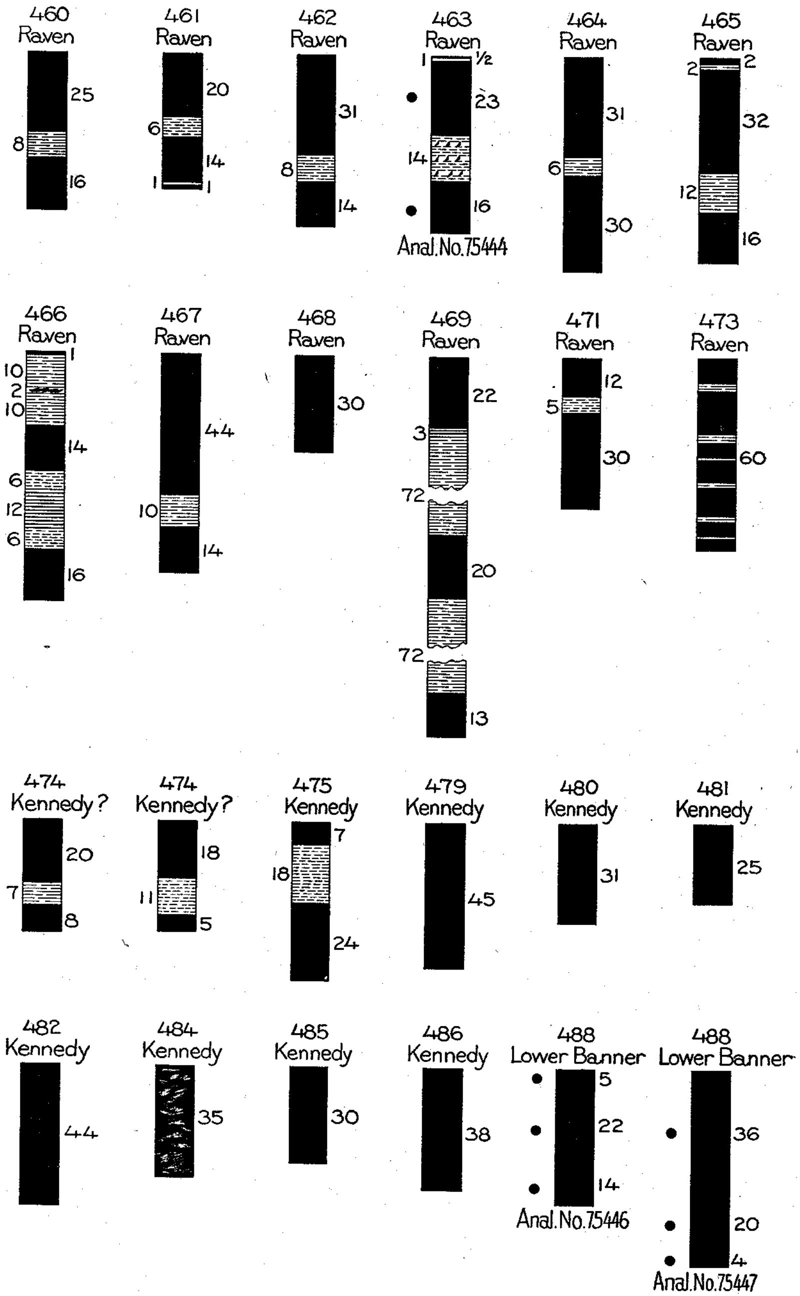


Fig. 38.—Sections of coal beds in the basins of Middle and Lower Guest River.

Sections of the Lower Banner coal bed in Beaver Coal Corporation's mine.

(Loc., 488; el., 2,083 feet, L.)

Section where sample was cut at face of main right entry, 1,300 feet from mine mouth.

(Analysis No. 75446.)

	Ft.	In.
Shale.		
*Coal, soft		5
*Coal, hard	1	10
*Coal, soft	1	2
Shale		
Coal	3	5

Section where sample was cut 20 feet from face of main left entry, 1,000 feet from mine mouth.

(Analysis No. 75447.)

	Ft.	In.
Shale.		
*Coal, soft	3	0
*Coal, hard	1	8
*Coal, soft		4
Shale		
Coal	5	0

The thickness of the coal given in these sections is probably exceptional, as the coal bed in other parts of the mine is somewhat thinner. Two openings in the Lower Banner bed near the head of a small ravine 1 mile east of Tacoma give the following sections:

Section of the Lower Banner coal bed 1 mile east of Tacoma.

(Loc., 489; el., 2,280 feet, B.)

	Ft.	In.
Clay.		
Coal	1	0
Coal, laminated		2
Coal	2	11
Clay	1	
Sandstone		
Coal	4	1

(Loc., 490; el., 2,280 feet, B.)

	Ft.	In.
Shale.		
Coal	3	6
Shale		

These openings were timbered but long ago abandoned. They probably are the old drifts of the Greeno-Bodine works that began operations about 1890.

Approximately 2 miles east of Tacoma the Lower Banner bed has been prospected by a 50-foot timbered drift (loc. 491, el. 2,330 feet, B), which apparently was opened several years ago. The bed contains 45 inches of coal, without a parting, and dips 6° slightly west of north.

The Lower Banner bed is opened above the mine of the Standard Coal Co., a little more than a mile west of Coeburn (loc. 492, el. 2,320 feet, B), and shows 3 feet, 4 inches of clear coal. From this location east the outcrop of the Lower Banner coal bed swings across the low spur and runs north on the Toms Creek drainage.

*Sampled.

Upper Banner coal bed.—The Upper Banner, in the Middle Guest River basin, lies 425 to 450 feet beneath the Gladeville sandstone and 100 to 140 feet above the Lower Banner coal bed. Two beds of sandstone, noted in the general description of the Middle Guest River basin, lie between the Upper Banner coal bed and Gladeville sandstone. East of Tacoma the coal bed is workable and in some localities reaches a thickness of nearly 7 feet. Westward from Tacoma, however, it splits rapidly into thin benches and is not mined anywhere in the basin west of the town. In that part of the basin where the bed is best developed the characteristic sandstone parting is commonly present, though at several pits the bed contains shale, "rash," and even bone as partings in lieu of sandstone.

Between Tacoma and Coeburn the Upper Banner coal bed has been well prospected and at places mined for shipment. Several pits were opened in the bed west and north of Tacoma, but the sections exposed are so poor that any attempt to mine the bed was promptly given up. A caved pit on the outcrop of the Upper Banner bed was seen above the Indian Fuel Co.'s mine west of Tacoma (loc. 493, el. 2,370 feet, B). The bed is 100 to 120 feet above the Lower Banner bed at this point. On the west side of the road leading north from Tacoma a caved pit was seen at the Upper Banner horizon (loc. 494, el. 2,270 feet, B). Four inches of coal is exposed in a bloom by the side of the pit. A section of the Upper Banner bed, measured by F. T. Dotson north of the Beaver Coal Co.'s mine (loc. 495, el. 2,186 feet, L), shows 1 foot, 7 inches of coal with one-half inch of bone near the top of the bed. The bed containing two distinct benches of coal was also measured north of the sharp bend in Guest River at Tacoma:

Section of the Upper Banner coal bed northeast of Tacoma.

(S. & D. prospect.)

(Loc., 496; el., 2,327 feet, L.)

	Ft.	In.
Shale.		
Coal	4	4
Clay	1	4
Coal		11
Sandstone		1
Coal	1	5
Clay		
Coal	6	8
Partings	1	5

Two miles east of Tacoma a shipping mine had been operating in the Upper Banner bed, but it was not in operation when the field was visited in 1920. The coal is lowered from the mine to railroad level by an inclined trough or chute. Two entries had been driven into the bed within 50 feet of one another. Sections measured in these entries are given below:

Sections of the Upper Banner coal bed 2 miles east of Tacoma.

(Loc., 497; el., 2,440 feet, B.)

(West entry.)

	Ft.	In.
Sandstone.		
Shale	2	
Coal	4	2
Clay		2
Coal		1½
Clay		½
Coal		1
Clay		½
Coal		2
Clay		
Coal	4	6½
Partings		3

(East entry.)

	Ft.	In.
Sandstone.		
Shale, clayey	1	6
Coal	2	4
Shale		2
Coal		10
Clay		
Coal	3	2
Parting		2

The Upper Banner bed was seen in two prospect pits about one-half mile farther east. The bed here appears to lie in two benches separated by 20 feet of shale, though 20 feet is an unusually large split for this part of the basin. The upper bench was only partly exposed, as the upper prospect pit was flooded and the bottom of the coal bed could not be reached. The sections are as follows:

Sections of the Upper Banner coal bed west of Coeburn.

(Loc., 498; el., (lower bench), 2,410 feet, B.)

	Ft.	In.
Shale.		
Coal, base concealed by water	2	2+
Interval, probably shale	20	
Shale, carbonaceous		5
Coal	1	8
Sandstone		1
Coal	1	1
Shale		6
Clay		
Coal (lower bench)	2	9
Parting (lower bench)		1

The presence of the characteristic sandstone parting in the lower one of the two benches here exposed makes it seem likely that the coal bed containing it is the Upper Banner and the bed 2 feet 2 inches +, lying 20 feet higher in the formation, is another bed or a local lense distinctly above the Upper Banner horizon. The only objection to this supposition is the extreme thinness of the main bed, but this thickness is not very different from that of the bed exposed in the east entry at loc. 497.

Coal beds between the Upper Banner and Norton beds.—At only one place in the basin was a coal bed measured between the Upper Banner and the Norton coal beds and at that place the bed in question is worthless. Northeast of Tacoma a bed was noted by Dotson at loc. 499, el. 2,486 feet (L), showing 11 inches of coal. The bed is 160 feet above the Upper Banner. It was not seen elsewhere in the basin.

Norton coal bed.—The extent of the Norton coal bed in the middle Guest River basin is comparatively small. The Gladeville sandstone caps the plateau north of the railroad for about 2 miles east of Tacoma and only a short distance west of the town. The Norton coal bed lies in places in contact with the Gladeville sandstone, but in other places at a distance of as much as 40 feet below the sandstone, a soft clayey shale occupying the interval between them. The coal is mined at one locality north of the Beaver Coal Co.'s mine, where it averages about 3 feet in thickness.

The bed is exposed in an old mine 80 to 100 feet above the road running north from Tacoma with the following section:

Section of the Norton coal bed north of Tacoma.

(Loc., 500; el., 2,575 feet, B.)

	Ft.	In.
Clay.		
Coal		2½
Shale		½
Coal	2	11
Clay		
Coal	3	1½
Parting		½

A new entry was being driven into the bed practically at road level, in the summer of 1920, north of the old mine described above. The bed at this new entry is 118 feet below the top of the Gladeville sandstone and as the Gladeville is practically 100 feet thick in this region the coal bed is about 20 feet below the sandstone.

The Norton coal bed has the following section in the new entry:

Section of the Norton coal bed north of Tacoma.

(Loc., 501; el., 2,575 feet, L.)

	Ft.	In.
Shale, clayey.		
Coal		3
Shale	1	
Coal	2	11
Clay		
Coal	3	2
Parting	1	

The Norton coal is mined for local use and to some extent for shipment in the Johnson mine, located due north of Tacoma. The bed here lies close to the massive Gladeville sandstone, which makes a conspicuous cliff over the entrance of the mine. At the drift mouth 2 feet of shale separates the coal bed from the sandstone, but in the mine the coal is reported to come in contact with the sandstone itself. The section measured here is as follows:

Section of the Norton coal bed in the Johnson mine.

(Loc., 502; el., 2,593 feet, L.)

	Ft.	In.
Sandstone.		
Clay	2	
Coal		2
"Rash"		½
Coal	3	2
Clay		
Coal	3	4
Parting		½

The Norton coal bed is reported to be opened on the two sides of the low gap in the ridge northeast of Tacoma. The sections measured in these openings by Dotson show unusual variations in the bed, as can be readily seen by noting the sections given below:

Sections of the Norton coal bed northeast of Tacoma.

(Loc., 503; el., 2,729 feet, L.)

	Ft.	In.
Shale.		
Coal		6
Shale	1	8
Coal	1	10
Clay		1
Coal		3
Coal	2	7
Partings	1	9

(Loc., 504; el., (lower bench), 2,759 feet, L.)

	Ft.	In.
Soil.		
Coal		4
Shale		½
Coal		2
Coal, upper bench		6
Parting		½
Interval	24	
Coal		3
Shale		8
Coal	2	6
Shale		1
Coal		3
Shale		
Coal, lower bench	3	0
Partings		9

The top of the Gladeville sandstone is in this vicinity 114 feet above the Norton coal bed.

Dorchester coal bed.—The Dorchester coal bed is present in the Middle Guest River basin only in the few small outliers of the Wise formation that

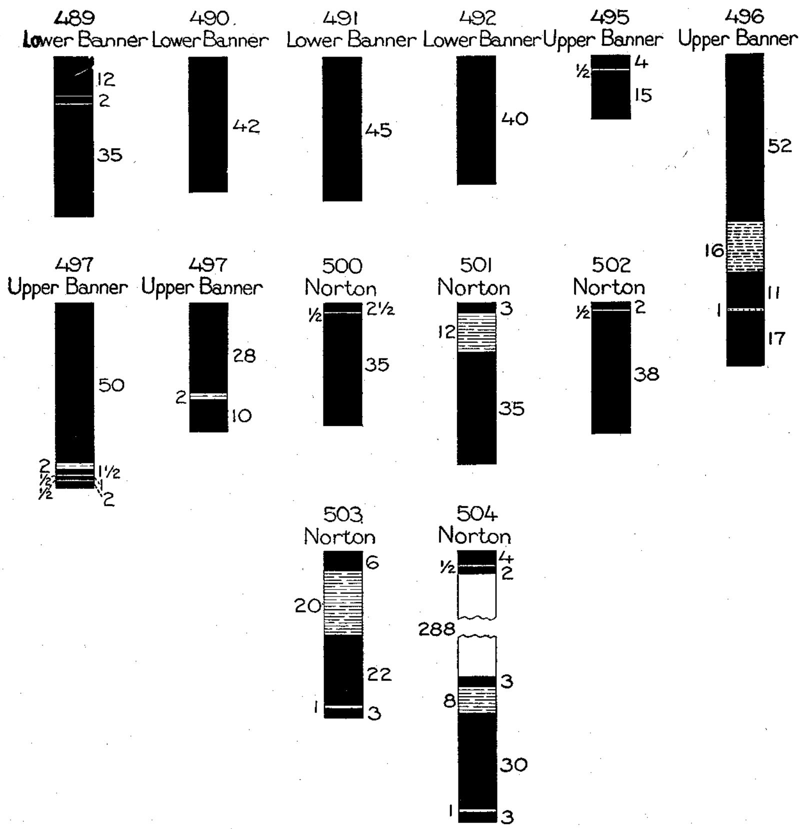


Fig. 39.—Sections of coal beds in the basin of Middle Guest River.

have not been removed from the top of the Gladeville sandstone on the plateau north of Tacoma. The bed is worthless both in view of its negligible extent and its exceptional thinness. The bed is exposed in a bloom by the Coeburn pike north of Tacoma at loc. 505, el. 2,810 feet (B). Twelve inches of coal was seen, without the bottom being exposed, and the bed is 5 to 8 feet above the Gladeville sandstone. A twelve-inch bloom was seen in a bank by the south side of the road, a little less than 1 mile southeast of the location just mentioned (loc. 506, el. 2,760 feet, B).

LOWER GUEST RIVER BASIN.

General features.—The Lower Guest River basin, as here described, embraces a territory about 10 square miles in extent, which lies north and east of the outcrop of the Lee formation and is drained by that part of Guest River lying between the mouth of Toms Creek and Clinch River. The southeast border of the basin, namely, the outcrop of the Lee, closely follows the course of Guest River, but as this stream has cut its bed in the hard sandstone of the top member ("Bee Rock") of the Lee (see Plates V and XIV A), the river itself does not lie within the limits of the basin, as described above. The drainage entering Guest River from the north and east consists of small streams, the largest and only important tributary being Craborchard Branch, a two-mile stream flowing into Guest River 2½ miles southeast of Coeburn.

The rocks exposed in this basin include the lower portion of the Norton formation, representing a stratigraphic section of about 500 feet. The dominant structural feature of the basin is the Powell Valley anticline, the axis of which passes across the basin about midway between Laurel Grove School and the mouth of Craborchard Branch. The anticline here is a very low fold which plunges slightly toward the northeast. As the fold plunges toward the northeast, the top of the Lee west of the river is higher than it is on the east side, and erosion has therefore removed nearly all of the less resistant rocks overlying this bed on the west side of Guest River.

The coal beds occurring within the Norton formation in the Lower Guest River basin that are of known commercial thickness are the Jawbone, Raven, and Kennedy. Each bed is 3½ feet or more in thickness with no prohibitive partings. Graphic sections of these beds are shown in figure 38.

The Lower Guest River basin has no shipping mines of consequence. During the summer of 1920, when high prices were paid for coal, several mines operated in beds opened on the Coeburn–Carfax pike in the valley of Craborchard Branch, but the coal had to be hauled 2 or 3 miles to Coeburn for shipment. Prior to that year (1920) practically no coal was mined in the Lower Guest River basin, owing to the inaccessibility of the region (see Pl. V).

The Interstate Railroad, at the time of writing, is extending its system by building a line from Norton down Guest River to Clinch River, to effect a junction with the Carolina, Clinchfield, and Ohio Railroad. With the completion of this railroad through the Guest River gorge, the basin will have an outlet for its coal and it is likely that other mining operations will be undertaken. The best coal beds on Lower Guest River lie in the Craborchard basin, and a spur up Craborchard Branch would be imperative for extensive mining in that vicinity. Notwithstanding a new railroad down Guest River, the limited extent of the workable coal beds on Lower Guest River will prevent the basin from ever rising to the ranks of the major coal producing basins of the county.

Jawbone coal bed.—The lowest coal bed of commercial importance in this basin is the Jawbone bed, which lies about 340 feet above the "Bee Rock." The bed is persistent and outcrops extensively in the ridges east of Guest River, where its average thicknesses is from 3½ to 6 feet. The coal is in places parted by layers of clay and shale and is generally much jointed, if not actually crushed, but not in a way to greatly impair its value or to prevent its mining.

The Jawbone bed has been prospected on the Coeburn-Carfax pike at Craborchard Branch, but the pit (loc. 459, el. 2,030 feet, B) was closed and the coal could not be seen. No openings in this bed were found near the mouth of Guest River. As described under loc. 703 in the Bull Run basin (page 444), however, the bed has been mined nearly 1 mile west of Carfax where it has a thickness of 40 inches of coal with 1 foot of shale 10 inches below the top of the bed. This opening, with the one noted on Craborchard Branch, indicate the presence of the Jawbone bed in the ridge between Guest River and Dry Fork. It is very doubtful if the bed anywhere exceeds 40 inches in thickness as practically all of the coal beds of the Norton formation thin with unusual regularity in a westward direction.

Raven coal bed.—The Raven coal bed lies about 200 feet above the Jawbone bed and is confined largely to the basin of Craborchard Branch, having been almost entirely removed from the low knobs overlying the Jawbone in the ridge between Guest River and Dry Fork of Bull Run.

In the lower half of the Lower Guest River basin the Raven bed has only recently been prospected in several pits on the main road from Coeburn to Carfax. At the head of the west fork of Craborchard Branch (loc. 470, el. 2,010 feet, B) the bed although newly prospected is not exposed. The wagon mine of Banner and Hartsock north of the pike and midway down the west fork of Craborchard Branch is in the Raven bed. The bed here dips 6° N. 20° W. and its thickness and composition is as follows:

Section of the Raven bed in Banner and Hartsock's mine on Craborchard Branch.

(Loc., 471; el., 2,060 feet, B.)

	Ft.	In.
Sandstone.		
Coal	1	0
Clay		5
Coal	2	6
Shale		
Coal	3	6
Parting		5

A new wagon mine in the Raven bed has been opened in the small drain northeast of the church and school that stand by the Coeburn–Carfax pike, one-fourth mile west of Craborchard Branch (loc. 472, el. 2,055 feet, B), but when visited the mine was closed. The bed is also opened 35 feet below the summit of the gap between Craborchard Branch and Dry Fork (loc. 473, el. 2,115 feet, B). Here the bed contains 5 feet of coal but the output is rendered impure by the presence of numerous layers of shale. A soft irony sandstone outcrops below the bed but no sandstone was seen above it.

Kennedy coal bed.—The highest and probably most valuable coal bed in the Lower Guest River basin is the Kennedy which lies from 100 to 200 feet above the Raven bed. It occurs only in the high ridge at the head of Craborchard basin, but only a portion, probably 50 per cent of the acreage in this ridge can be considered as belonging to the Lower Guest River basin. The average section of the bed shows 3 to 4 feet of clear coal.

The coal has been prospected in several pits northwest of the sharp bend in the highway where it crosses the divide between Craborchard Branch and Little Toms Creek. These pits show the coal bed to have a general thickness of 3 feet without a parting. At loc. 484, el. 2,210 feet (B), the Kennedy coal bed consists of 35 inches of impure, crushed coal. Here a fairly massive sandstone outcrops immediately above and a similar bed, the McClure sandstone, outcrops immediately below the coal bed.

The bed is opened at loc. 485, el. 2,180 feet (B) and shows a section of 30 inches of clear coal, overlain by brown sandy clay and underlain by clay. Ten feet below the bed lies the McClure sandstone, a 30-foot bed of hard gray sandstone.

In the hillside north of the sharp bend in the road, a prospect pit shows the Kennedy bed to consist of 38 inches of crushed and badly contorted coal (loc. 486, el. 2,110 feet, B).

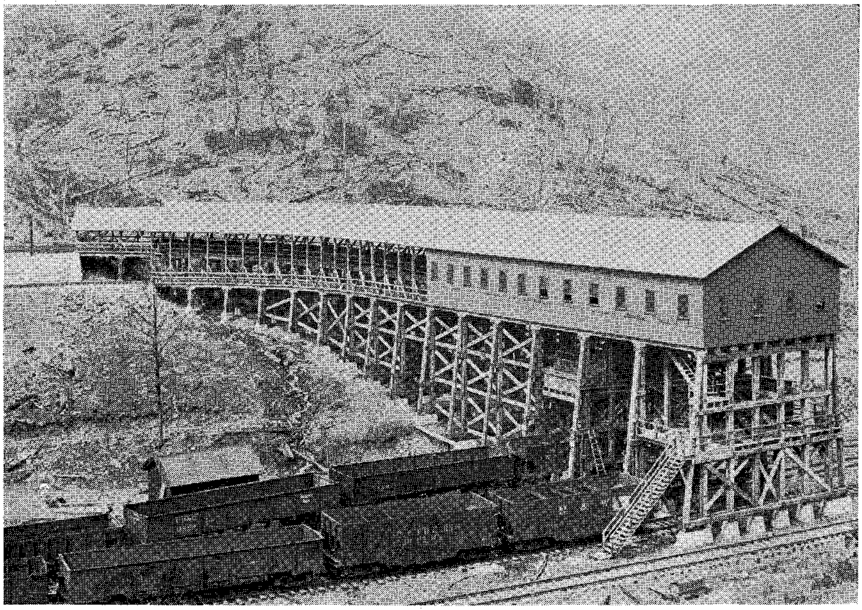
TOMS AND LITTLE TOMS CREEKS BASIN.

General features.—The Bee Rock of the Lee formation, which is such a prominent feature on the long slopes of Powell Mountain on the west side of Guest River opposite the mouth of Toms Creek, dips to the northward and passes under cover along a line roughly corresponding with the course of Guest River. This hard bed is well exposed at the bridge of the Coeburn–Dungannon pike southeast of Coeburn where it is distinctly notched by the channel of Guest River. The northward dips carry this bed beneath the surface at a fairly rapid rate so that, according to well data, it is 500 feet below the surface in the vicinity of Coeburn and 800 feet at Fullers Gap. As the Bee Rock dips continuously, though at a somewhat diminishing rate northward throughout the entire length of this basin, higher and higher rocks are brought to the surface as one passes northward, until the whole of the Norton formation passes below drainage level and the Gladeville sandstone caps the plateau of Sandy Ridge.

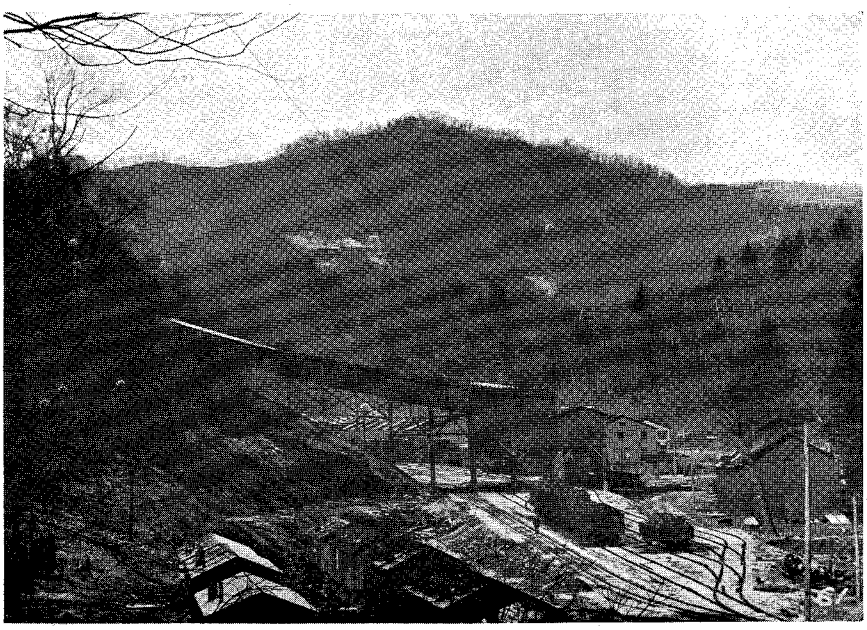
All of the coal beds of the Norton formation are exposed and readily accessible in this basin. The most important bed commercially is the Upper Banner coal which is the thickest one in the formation and ranks in quality with the best beds in the County. In heating value it compares favorably with the Pocahontas coal of Tazewell County and the Sewell coal of Fayette County, West Virginia. (See fig. 54, page 532). The bed averages from 5 to 7 feet in thickness, the maximum measure being 9 feet, 3 inches, including 10 inches of partings—a section taken in Mine No. 4 of the Virginia Iron, Coal & Coke Co. This basin is the type locality of the Upper Banner bed and here was first noted the sandstone parting which gives to the coal its distinctive value as a key bed. Graphic sections of the coal beds in these basins are shown in figures 40 and 41.

The Lower Banner coal bed lies 100 feet below the Upper Banner bed and averages 3 feet in thickness. It is distinctly inferior in quality to the Upper Banner, averaging about 2% higher in ash, 0.2% higher in sulphur, and considerably lower in B. t. u's, or heating units. The Lower Banner as well as the Upper Banner bed received its name from the village of Banner east of Coeburn, where it was first mined. It is now mined at several places in the basin and has been thoroughly prospected on the ridges and spurs of Sandy Ridge.

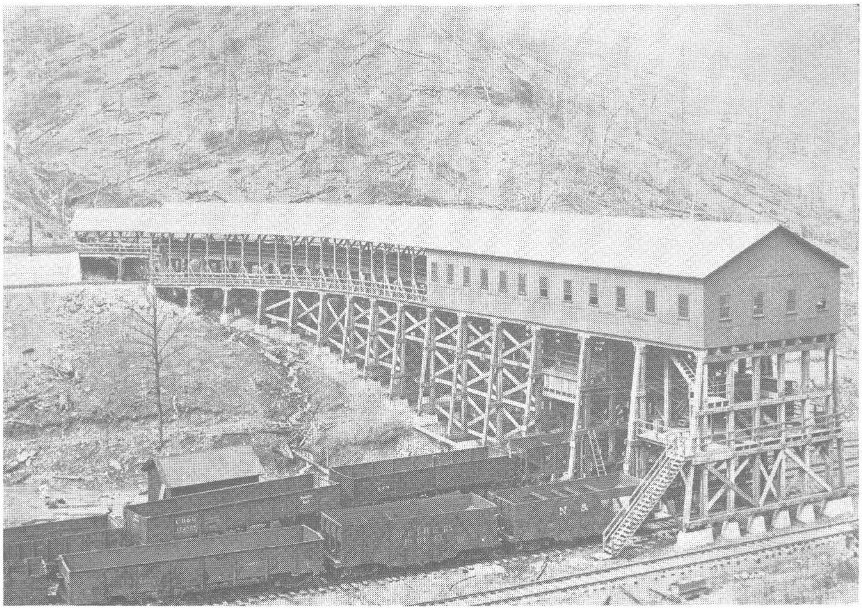
The Kennedy coal bed outcrops for several miles on Little Toms Creek, but takes cover on Toms Creek at Bondtown, about a mile up from the mouth of the stream. It is little worked in this basin at present, many of



(A) A large tipple of recent construction capable of screening the coal and loading two cars simultaneously. The bare slopes are typical in the mining centers.



(B) Coal mine tipple and incline. The loaded mine cars are lowered by cable down the incline and dumped. The coal is caught in a vibrating tilted screen by means of which the lump coal is separated from the slack coal.



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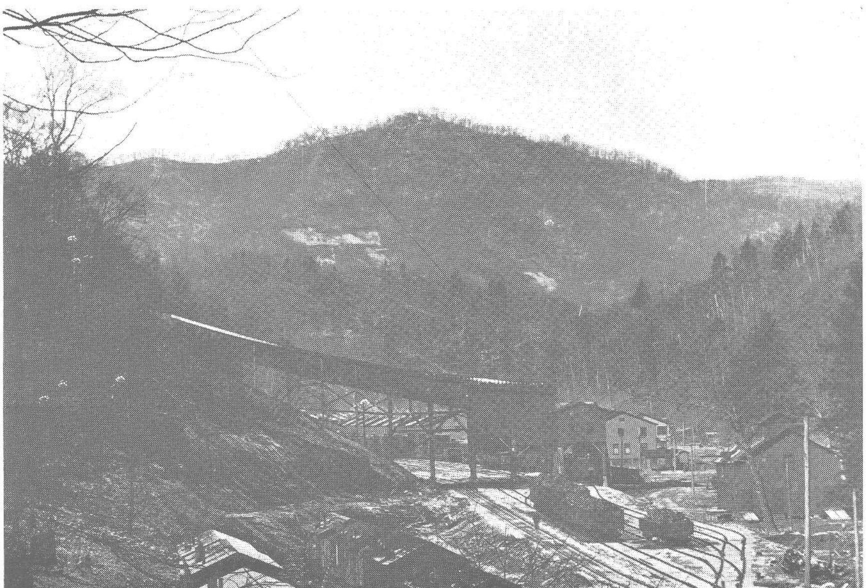

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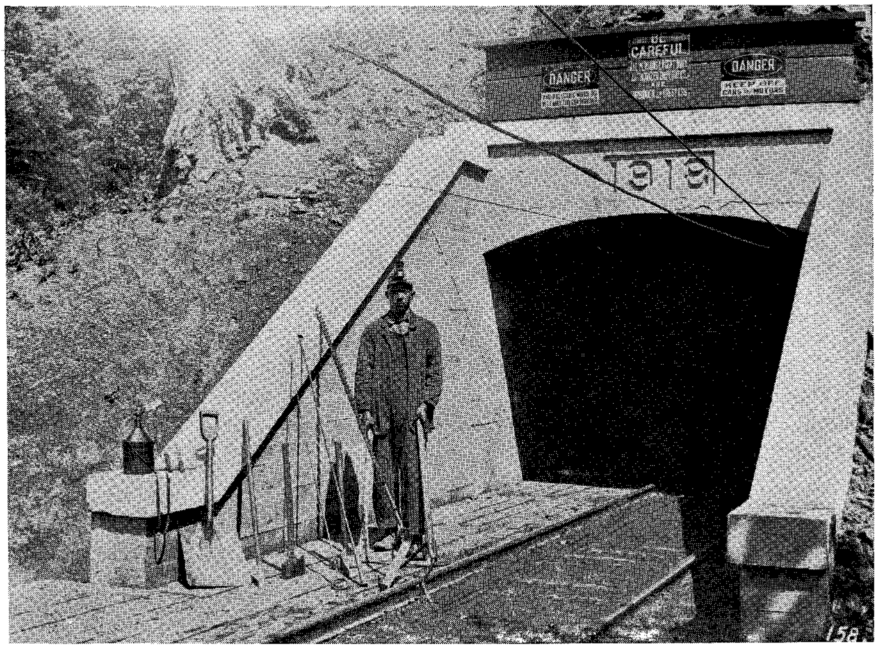
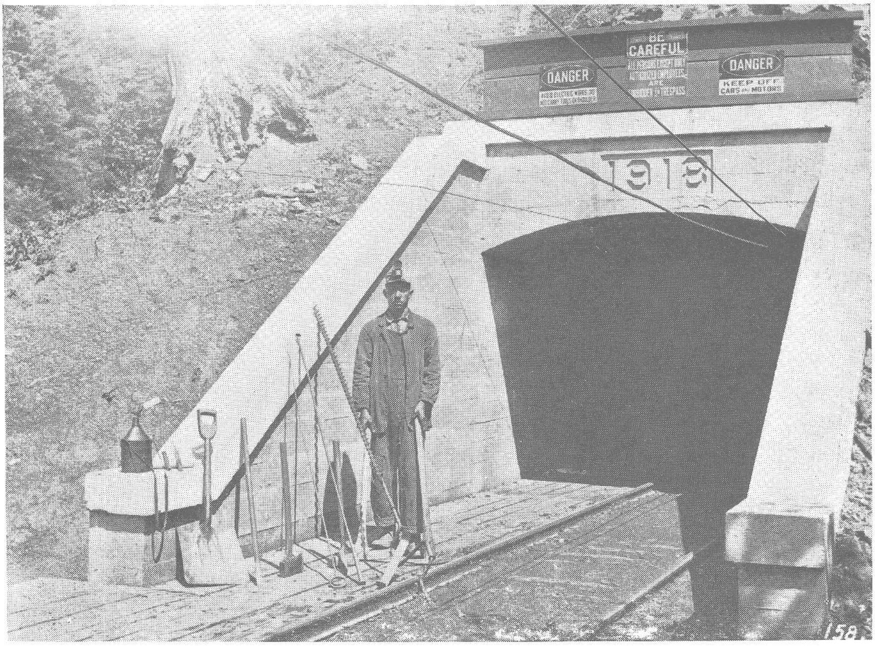
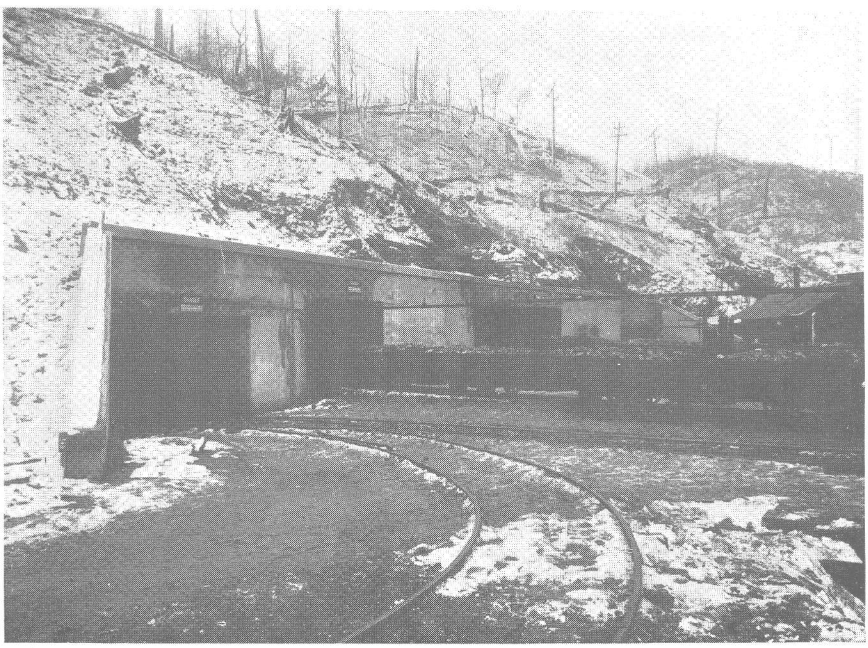


(A) A new concrete mine portal showing miner and kit of tools used in mining coal. Caution signs are conspicuously posted at all the larger mines.

(B) A four-track mine portal of one of the larger mines in the county. Concrete makes the safest type of portal for a drift mine and is in common use by the larger companies in the field.



(A) A new concrete mine portal showing miner and kit of tools used in mining coal. Caution signs are conspicuously posted at all the larger mines.



(B) A four-track mine portal of one of the larger mines in the county. Concrete makes the safest type of portal for a drift mine and is in common use by the larger companies in the field.

the former mines having been abandoned. The Raven and lower beds have a very small outcrop in the valleys of Toms Creek and Little Toms Creek and are not now mined for shipping. Several small mines have been opened in the Raven bed, but when visited they were slumped so that the thickness of the coal bed could not be determined.

Coals above the Upper Banner are thin and of little value. Future development of coal beds in the Toms Creek basin will be confined principally to the Lower Banner, Kennedy and Raven beds, as next to the Upper Banner, these beds rank in the order named in worth and accessibility.

The largest single producer in this basin is the Virginia Iron, Coal and Coke Co., with a normal daily output of about 5,000 tons. All undercutting is done by machine and mule haulage is used in all the mines except the Thelma mine, where storage battery motors are used. Much of the output is coked at Toms Creek, the company having 800 ovens in the district.

The Clinchfield Coal Corporation ships much of its coal mined in Dickenson County out through the Cranesnest mine mouth south of Fullers Gap. Other producers in the field are Robert Fleming & Co., Bondtown Coal Corporation, Culbertson Coal Co., Shop Ridge Coal Co., and others.

The basin is served by the Clinch Valley division of the Norfolk & Western Railroad. It is thickly settled, and represents one of the earliest coal-mining centers in southwest Virginia.

Raven coal bed.—The lowest coal bed that has been prospected in this basin is the Raven. It outcrops only in the southern edge of the basin, crossing Toms Creek about one-half mile southwest of Coeburn. No mines have been opened on the Raven in this basin and the few prospects are caved; for this reason it was impossible to obtain complete sections of the coal bed. Judging by several exposures where partial sections were measured, the bed is probably more than 2 feet thick. In the basins to the east it shows many impure layers which doubtless are present in the coal on Toms Creek. These depreciate its value and are responsible in large part for its lack of development.

Three caved pits northeast of Coeburn (loc. 507, el. 2,020 feet, B) are located on a coal bed lying about 35 feet above the Raven and 60 feet below the Kennedy coal bed. The coal itself was not seen here or elsewhere and probably it is an insignificant local bed.

The same bed was prospected at loc. 508, el. 2,020 feet (B), where 20 inches of coal were seen with the bottom not exposed. The bed is also partly exposed south of Coeburn in an old opening on the road to Norton (loc. 509, el. 2,000 feet, B). Twelve inches of coal were visible, the bottom of the bed not being reached.

Kennedy coal bed.—This coal bed, approximately 150 feet above the Raven, is present in the Toms Creek basin with an average thickness of at least 5 feet. Unfortunately the bed at many localities contains partings that greatly lessen its value. The bed has been mined at several places in past years but now the entries are either caved or used occasionally to bring out coal for local use. The bed lies above the McClure sandstone and is capped by a thin sandstone but neither sandstone is here so conspicuous and consistent a horizon marker as the lower bed is in Dickenson and Buchanan counties. The McClure sandstone is about 30 feet thick in this basin.

Two abandoned entries on the Kennedy coal bed were examined west of Coeburn. The northern entry was flooded and the coal could not be seen but the following incomplete section was obtained in the southern entry:

Section of the Kennedy coal bed west of Coeburn.

(Loc., 510; el., 2,010 feet, B.)

	Ft.	In.
Shale	10+	
Coal	1	1
Shale		2
Coal	1	0
Shale		3
Coal	1	9
Coal	3	10
Partings		5

The Kennedy coal bed is partly exposed on the east side of Toms Creek, at loc. 511, el. 2,000 feet (B), where 2½ feet of coal were seen, with the bottom of the bed concealed. Five feet of clay shale separate the overlying sandstone from the coal bed.

In a ravine northeast of Coeburn (loc. 512, el. 2,070 feet, B) the Kennedy coal is 2 feet, 1 inch thick and is overlain by 3 inches of black shale.

Immediately west of Banner, loc. 513, el. 1,940 feet (B), the Kennedy coal is opened by two mines both of which have long been abandoned and caved. The cause for the abandonment of the mines, which were opened in 1892 by the Virginia Gas Coal Company, was the great irregularity of the bed, which is a characteristic feature of the bed in this portion of the field.

The coal in these mines is described in detail by McCreath and d' Invilliers[1] as follows:

"The variations of bed section are perhaps more noticeable at this point than anywhere else in the field, inasmuch as the coal has a thickness of from nothing to 9 feet in different parts of these openings. The condition manifested on March 20, 1892, suggested the thought that the absence of coal in certain parts of the mines was not in any way due to dislocations or rock faults, but was occasioned by the original denudation of the coal bed during the time of its formation, and not in any sense to subsequent dislocations.

"The West Mine entry on March 20th has been extended about 1,000 feet. The coal at the outcrop was about 5 feet thick. The bed, however, soon squeezed to about 2 feet thick, with intrusions of slaty sandstone into the bed itself. But beyond this point the thickness rose to 5 feet and 8 feet again, only to gradually feather out towards the present face where, after driving several hundred feet through rock, the work was abandoned.

"In the East Mine the slope at the same date was down 500 feet starting S. 57° E., with about 5 feet of coal. The bed soon thinned to 2 feet, rose again to 4½ feet thick, and finally was cut out by rock. Entries turned south from this slope have shown as much as 9 feet or 10 feet of coal, with the same irregularities as in the West Mine. The bed has no cleavage and shows a ragged appearance, breaking out in irregular blocks, but always yielding a good commercial coal.

"The excellent character of the coal marketed is well shown by the following analysis of a sample taken from a room in the East Mine where the coal was about its normal thickness, 5½ feet:

Water	.798
Volatile matter	34.022
Fixed carbon	61.411
Sulphur	.619
Ash	3.150

"The purity of this coal is at once manifest, and it is said to yield excellent results, both for gas and steam purposes; but pending further exploitation upon it in other parts of the field, its resources for commercial tonnage can not be estimated."

A group of prospects have been opened north of Banner. The bed shows a thickness of 5 feet of clear coal at loc. 514, el. 2,030 feet (B). At this

[1] McCreath, A. S., and d'Invilliers, E. V. Geological and Chemical Report on a Portion of the Virginia and Tennessee Coal and Iron Companies property in Wise County, Va., 1892, pp. 36-37.

locality the underlying McClure sandstone is hard, medium-grained, and approximately 20 feet thick. About 5 feet of sandstone grading into sandy shale overlie the coal bed.

A number of entries have been driven into the Kennedy coal bed in the neighborhood of Banner, on Little Toms Creek. As in the vicinity of Coeburn, however, the bed was not being actively mined when visited in 1919. East of the town (loc. 515, el. 2,115 feet, B) the bed is reported to be from 7 to 12 feet thick. Near the west portal of Little Tom tunnel about one-quarter mile southeast of loc. 515, an entry was driven in 163 feet on the coal, the bed averaging about 3½ feet in thickness.

The Kennedy has been mined in the ridge southeast of Coeburn and several of the old mines are indicated on the geologic map under loc. 516. Mining on this coal southeast of Coeburn was abandoned several years ago when the coal in one of the mines caught fire and efforts to extinguish it were unsuccessful. The coal was still burning when visited in 1920. No measurements of the bed could be made at these entries, as all were caved.

Lower Banner coal bed.—The persistent thickness and extensive outcrop of the Lower Banner coal bed ranks it with the most important beds on Toms and Little Toms creeks. The bed ranges in thickness from 20 to 42 inches and as a rule seldom contains partings. At Banner, the type locality, the bed is about 100 feet above the Kennedy and 200 below the Upper Banner bed. These intervals vary considerably, however, both to the east and west, the upper interval decreasing, and the lower interval increasing, in the two directions specified. The Lower Banner is identified in the Toms Creek basin mainly by its relation to the Upper Banner, as the higher bed is readily recognized by its sandstone parting.

Mining operations on the Lower Banner began during the last decade of the nineteenth century in the vicinity of Banner, but since that time few shipping mines have been opened on the bed. The proximity of the more profitable upper bed has prevented any extensive development of the Lower Banner.

The bed outcrops without a break along the west side of the lower Toms Creek valley and Cranesnest Hollow, but has not been mined to an appreciable extent. Several slumped entries were seen but no details of the coal bed were obtainable. On the Wise road just west of Coeburn the two following sections of Lower Banner coal indicate the thickness and character of the bed in that vicinity.

Sections of the Lower Banner coal bed on the Wise road west of Coeburn.

(Loc., 517; el., 2,330 feet, B.)

	Ft.	In.
Shale	5+	
Coal		2
Shale		3
Coal	1	8
Clay		
Coal	1	10
Parting		3

(¼-mile west of loc. 517.)

	Ft.	In.
Shale.		
Coal	1	8
Shale		1
Coal	1	8
Shale, carbonaceous		9
Clay		
Coal	3	4
Parting		1

In the ravine east of Cranesnest Hollow the Lower Banner is partly exposed, 18 inches of coal being seen (loc. 518, el. 2,120 feet, B).

On Toms Creek south of the town of Toms Creek, the Lower Banner bed displays an excellent section of clear coal. The bed as measured in a pit at loc. 519, el. 2,090 feet (B), is 42 inches thick. Three caved entries on the Lower Banner bed adjoin this prospect on the east.

Recently the Bondtown Coal Corporation began mining the Lower Banner coal north of Coeburn at loc. 520, and J. J. Body, the superintendent, reported to the writer the following section as representative of the bed in this mine:

Section of the Lower Banner coal bed in Bondtown Coal Corporation's mine (loc. 520).

	Ft.	In.
Coal		6
Shale		1
Coal		4
Shale		1
Coal	3	6
Coal	4	4
Partings		2

The Lower Banner bed is exposed on the hillside north of Coeburn near the Bondtown mine, showing the following outcrop sections:

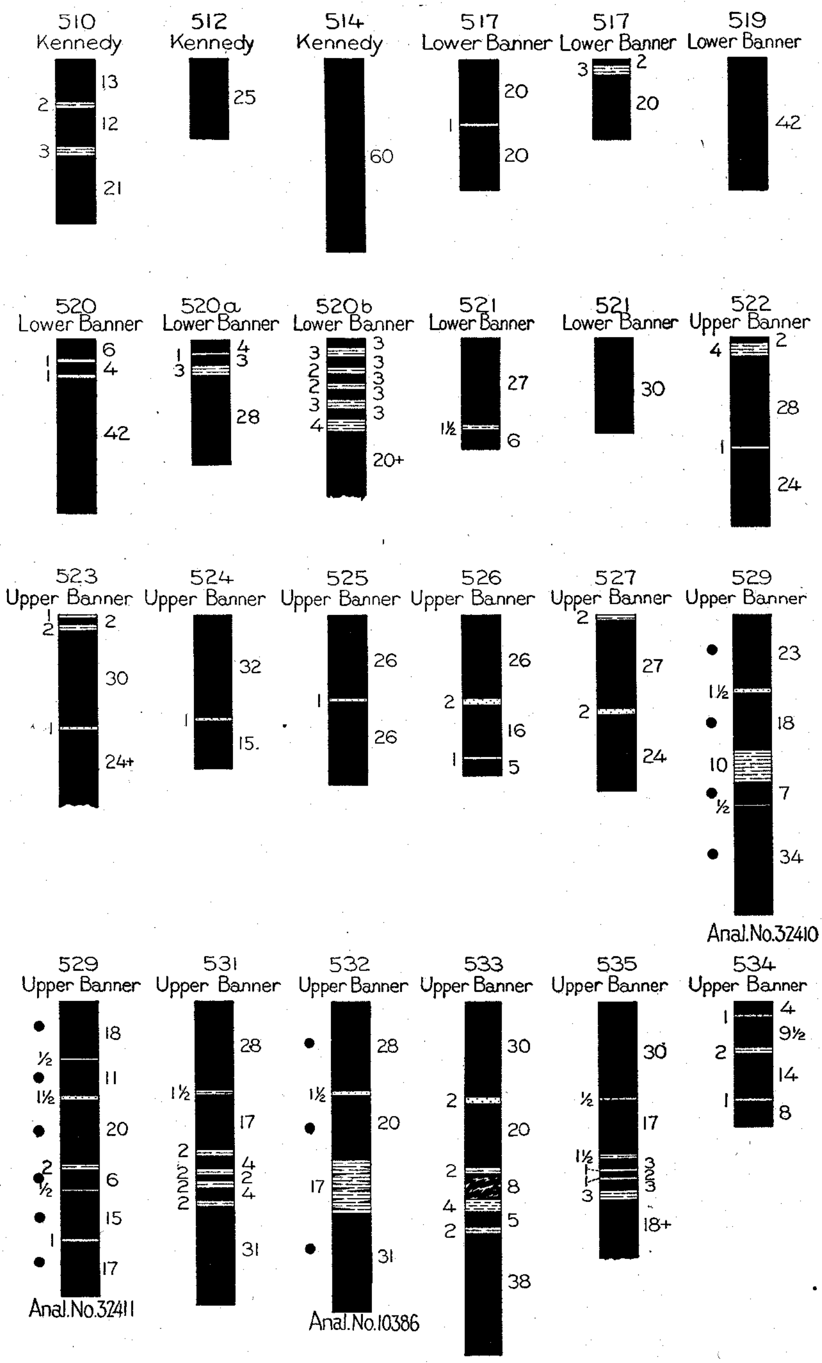


Fig. 40.—Sections of coal beds in the basins of Toms and Little Toms creeks.

Sections of the Lower Banner coal bed on Little Toms Creek near the Bondtown mine north of Coeburn.

A

	Ft.	In.
Shale	3+	
Shale, carbonaceous		3
Coal		4
Shale, carbonaceous		1
Coal		3
Shale, carbonaceous		3
Coal	2	4
Coal	2	11
Partings		4

B

	Ft.	In.
Shale	6+	
Shale, roof	3	
Shale, carbonaceous		3
Coal		3
Shale, carbonaceous		3
Coal		3
Shale, carbonaceous		2
Coal		3
Shale, carbonaceous		2
Coal		3
Shale, carbonaceous		3
Coal		3
Shale, carbonaceous		4
Coal (floor not seen)	1	8+
Coal	2	11+
Partings	1	2

In Mine No. 1 of the Robert Fleming & Co. at Banner, the Lower Banner bed ranges in thickness from 2½ to 3 feet. The following sections were measured at points where samples of coal were cut for analysis. The analyses are given on page 510, under Nos. 32509 and 32510.

Sections of the Lower Banner coal bed in Mine No. 1 of Robert Fleming & Co., Banner.

(Loc., 521; el., 2,100 feet, B.)

Section where sample was cut at face of main air course, 600 feet west of mine mouth.

(Analysis No. 32510.)

	Ft.	In.
Shale.		
*Coal	2	3
Clay		1½
*Coal		6
Shale		
Coal	2	9
Parting		1½

Section where sample was cut 700 feet west of mine mouth.

(Analysis No. 32509.)

	Ft.	In.
Shale.		
Coal	2	6
Shale		
Coal	2	6

The mine was opened originally by the Virginia Gas Coal Co., about 1891 and McCreath and d' Invilliers,[1] who visited it the following year, reported an average thickness of 3 feet, 8 inches to 3 feet, 10 inches of coal in this opening. The bed dips northwest about 20 feet in 700 feet horizontal distance.

*Sampled.

[1] Op. cit., p. 38.

Comparing the thickness of the Lower Banner bed, as averaged from all the sections given above, with the general section of the Upper Banner bed, the former is less than the latter by approximately 2 feet. Thus with the present market price of coal it is not possible for the Lower Banner coal to be systematically mined as long as the thicker Upper Banner coal bed is available.

Upper Banner coal bed.—Fully 95 per cent of the coal mined in the valleys of Toms Creek and Little Toms Creek comes from the Upper Banner bed. The mines in this bed are some of the oldest in Wise County. The bed is without doubt the one referred to by Lesley (see page 7), as having been seen by him in the vicinity of Coeburn. Since 1891, coal has been mined from this bed uninterruptedly and the bed ranks with the noted Imboden bed in the west as one of the greatest coal-producing beds in Wise County. The history of mining operations in this bed on Toms Creek is given elsewhere in this report (see page 7) and only the sections and character of the bed are considered here.

An unusual feature of the Upper Banner bed that has greatly aided in its identification throughout wide areas, is the presence of a hard sandstone parting near the middle of the bed. The parting is usually an inch or more in thickness and the grains consist of quartz, small amounts of mica, some pyrite, and much carbonaceous material. In a few localities it approaches a hard black shale and in others it has been found to be clay, but the quartz grains can usually be made out wherever the parting is carefully examined. The parting persists in uniform thickness and character throughout many square miles. A block of the coal itself without the parting is shown in Plate XXXI B.

The Upper Banner coal has been exposed in two prospects 1½ miles west of Coeburn on the road from Coeburn to Wise. The sections are nearly uniform and show only slight changes from the sections revealed in the mines farther north. The measured sections are as follows:

Section of the Upper Banner coal bed near Wise road one and one-half miles west of Coeburn.

(Loc., 522; el., 2,390 feet, B.)

	Ft.	In.
Shale.		
Coal		2
Shale		4
Coal	2	4
Sandstone		1
Coal	2	0
Clay		
Coal	4	6
Partings		5

(Loc., 523; el., 2,390 feet, B.)

	Ft.	In.
Shale	5+	
Shale, carbonaceous.		1
Coal		2
Shale, carbonaceous.		2
Coal	2	6
Sandstone		1
Coal	2+	
Coal	4	8+
Partings		3

Numerous entries have been driven into the Upper Banner bed on the hillside west of Toms Creek from the Coeburn–Tacoma road to Fuller Gap. The majority of them have been abandoned and are caved but several are shipping mines and sections of the bed are available.

Three of these mines, which are the property of the Virginia Iron, Coal & Coke Co., show a nearly uniform section of the local bed. In the Dale Ridge mine the section is as follows:

Section of the Upper Banner coal bed in Dale Ridge mine of the Virginia Iron, Coal & Coke Co.

(Loc., 524; el., 2,276 feet, L.)

	Ft.	In.
Sandstone.		
Shale	4+	
Coal	2	8
Sandstone		1
Coal	1	3
Shale		
Coal	3	11
Parting		1

The Whitehead mine of the same company enters the coal bed on the south side of the large ravine southwest of Toms Creek post office. The following section, measured several hundred feet from the drift mouth is typical.

Section of the Upper Banner coal bed in Whitehead mine of the Virginia Iron, Coal & Coke Co.

(Loc., 525; el., 2,175 feet, B.)

	Ft.	In.
Shale.		
Coal	2	2
Sandstone		1
Coal	2	2
Shale		
Coal	4	4
Parting		1

Twenty to 30 feet below the entrance of the Whitehead mine a coal bed outcrops that probably represents a lower bench of the Upper Banner. This is quite possible in view of the much greater thickness the bed possesses about 1½ miles to the north. The bench is imperfectly exposed, but shows a 2-inch sandstone parting with more than 11 inches of coal above and more than 20 inches of coal below it. This abrupt parting of coal beds into widely separated benches is common to many of the coal beds in Wise County. It is particularly so of the Dorchester bed at Glamorgan, the Kelly–Imboden beds at Roaring Fork, and the Clintwood bed on Pound River.

The Virginia Iron, Coal & Coke Co. has opened a mine on the north side of the same ravine, calling it the Kentucky mine. The following section is typical of the coal bed in this mine:

Section of the Upper Banner coal bed in Kentucky mine of the Virginia Iron, Coal & Coke Co.

(Loc. 526; el., 2,189 feet, L.)

	Ft.	In.
Shale.		
Coal	2	2
Sandstone		2
Coal	1	4
Shale		1
Coal		5
Shale		
Coal	3	11
Partings		3

A section of the bed is exposed directly west of the forks of the stream in an old pit, which is as follows:

Section of the Upper Banner coal bed west of Toms Creek.

(Loc., 527; el., 2,250 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous		2
Coal	2	3
Sandstone		2
Coal	2	0
Clay		
Coal	4	3
Parting		2

Several openings adjoining the pit in which the measurement given above was made, are caved as the result of robbing the pillars that ordinarily sustain the mine roof.

The Culbertson Coal Co., of Coeburn, is mining the Upper Banner coal west of Cranesnest (loc. 528, el. 2,130 feet, B). The bed has an average thickness of 44 inches split into nearly equal benches by a sandstone parting from 1 to 2 inches thick. Within the mine the coal varies in thickness from 36 to 50 inches. The normal daily output is 75 tons of coal.

Two companies, the Clinchfield Coal Corporation and the Virginia Iron, Coal & Coke Co., have mines in the Upper Banner bed at the head of the Cranesnest Valley. The Virginia Iron, Coal & Coke Co.'s mine, called Mine No. 6 or Lee mine, is but a stone's throw northwest of the Cranesnest mine of the Clinchfield Coal Corporation. The main mouth of the Cranesnest mine, Caney entry, is on Hurricane Fork of Caney Creek (loc. 683). Sections measured in this mine will be given under the detailed description of coal beds in the basins of Cranesnest River and Caney Creek (see pages 436-437). The Toms Creek opening is all-important in giving the Clinchfield Coal Corporation access to the Norfolk and Western railroad for the shipment of its coal. Loc. 530, el. 2,130 feet (B), marks the position of the Clinchfield mine mouth. The portal is about 20 feet below the outcrop of the coal bed, the tunnel rising gradually under the ridge to meet the bed.

The Lee mine of the Virginia Iron, Coal & Coke Co. (loc. 529, el. 2,145 feet, L) has a capacity of 200 tons daily and was producing nearly that amount in 1919. The coal bed in places is split by a layer of shale 10 inches or less in thickness and by the sandstone parting as shown in the following sections. Samples of the Upper Banner coal were taken in this mine and the results of the analyses given on page 512. The sections measured at the place when the samples were cut are given below:

Sections of the Upper Banner coal bed in Lee mine of the Virginia Iron, Coal & Coke Co., loc. 529.

Section where sample was cut 50 to 60 feet from outcrop, 500 feet east of mine mouth.

(Analysis No. 32410.)

	Ft.	In.
Shale.		
Shale, carbonaceous	1	
*Coal	1	11
Sandstone		1½
*Coal	1	6
Shale, carbonaceous		10
*Coal		7
Shale		½
*Coal	2	10
Shale		
Coal	6	10
Partings	1	0

Section where sample was cut in second cross entry, ½ mile northeast of mine mouth.

(Analysis No. 32411.)

	Ft.	In.
Shale.		
*Coal	1	6
Shale		½
*Coal		11
Sandstone		1½
*Coal	1	8
Shale		2
*Coal		6
Shale		½
*Coal	1	3
Shale		1
*Coal	1	5
Shale		
Coal	7	3
Partings		5½

*Sampled.

Section measured in main entry near mine mouth.

	Ft.	In.
Shale.		
Coal	2	2
Sandstone		2
Coal	1	7
Shale		3
Coal		2
Clay		7
Coal		5
Shale		½
Coal	2	8
Shale		
Coal	7	0
Partings	1	½

A number of abandoned mines in which the pillars have been "robbed" are located on the outcrop of the Upper Banner from the forks of the stream to the large mines located immediately southeast of Fuller Gap. The locations of many of the abandoned mines are shown on the map.

The Upper Banner bed outcrops about 200 feet above stream level on Shop Ridge, the spur north of the fork of Toms Creek and its Cranesnest Branch. The bed in the one opening near the Sandy Ridge road, known as the Shop Ridge mine, has the following section:

Section of the Upper Banner coal bed in the Shop Ridge mine of the Shop Ridge Coal Co.

(Loc., 531; el., 2,200 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous		3
Coal	2	4
Shale		1½
Coal	1	5
Shale		2
Coal		4
Shale		2
Coal		2
Shale		2
Coal		4
Shale		2
Coal	2	7
Clay		
Coal	7	2
Partings		9½

The coal bed outcrops near the head of the second valley east of the town of Cranesnest on the north side of Toms Creek where two mines of the Virginia Iron, Coal & Coke Co. are operating in it. The portal of the

Swansea mine is on the west side of the hollow slightly north of Pine Run Mine or Mine No. 4, and goes in practically at the water level of the small stream. This mine has a capacity of 300 tons of coal a day. The coal bed was sampled here (see page 511) and the following section was measured at the point where the sample was cut:

Section of the Upper Banner coal bed in Swansea mine of the Virginia Iron, Coal & Coke Co., north of Toms Creek.

(Loc., 532; el., 2,181 feet, L.)

Section where sample was cut in room 21, off 17 west entry, ½-mile from mine mouth.

(Analysis No. 10386.)

	Ft.	In.
*Coal	2	4
Sandstone		1½
*Coal	1	8
Shale with coal streaks	1	5
*Coal	2	7
Coal	6	7
Partings	1	6½

The average thickness of the bed in the Pine Run mine is 8 feet including partings, but the limits of thickness vary between 6 and 12 feet. When visited in 1919 the pillars were being "robbed," that is, they were being removed for the coal in them and the roof of the mine was allowed to settle. The following section was measured where the coal bed has about its average thickness:

Section of the Upper Banner coal bed in Pine Run mine of the Virginia Iron, Coal & Coke Co., north of Toms Creek town.

(Loc., 533; el., 2,190 feet, B.)

	Ft.	In.
Shale.		
Coal	2	6
Sandstone		2
Coal	1	8
Shale		2
Coal, impure		8
Clay		4
Coal		5
Shale		2
Coal	3	2
Shale		
Coal	8	5
Partings		10

*Sampled.

East of location 533 and on the north side of Toms Creek several entries and prospects are located on the outcrop of the Upper Banner and measured sections reveal many partings in the bed. The following two sections represent the character of the bed near the outcrop west of the Coeburn mine:

Sections of the Upper Banner coal bed west of Coeburn mine on Toms Creek.

(Loc., 535; el., 2,190 feet, B.)

	Ft.	In.
Sandstone	10+	
Shale	6	
Shale, carbonaceous		2
Coal	2	6
Sandstone		½
Coal	1	5
Shale		1½
Coal		3
Shale		1
Coal		2
Shale		1
Coal		3
Shale		3
Coal (bottom not seen)	1	6+
Coal	6	1+
Partings		7

(Loc., 534; el., 2,200 feet, B.)

	Ft.	In.
Shale.		
Coal		4
Sandstone		1
Coal		9½
Shale		2
Coal	1	2
Shale		1
Coal		8
Clay		
Coal	2	11½
Partings		4

Several prospect pits adjoin those in which the two sections given above were measured, but they are so closely grouped that they are not given a separate location number on the map.

The Coeburn mine of the Virginia Iron, Coal & Coke Co., (loc. 536, el. 2,133 feet, L), lies about one-half mile west of the Sexton mine. It is one of the smaller producers of the company, having a normal daily output of about 300 tons.

The Sexton mine, or Mine No. 2 of the Virginia Iron, Coal & Coke Co., has its main entrance on the north side of Toms Creek. This mine has a larger productive capacity than any other mine in the Toms Creek district, being estimated at 1,100 tons daily. Mule-haulage is used to bring the loaded cars to the mine mouth.

The bed was sampled in the Sexton mine and the analysis is given on page 513. The badly parted condition of the bed, as indicated by the section given for loc. 535 and the following section measured where the sample was cut accounts for the unusually high ash content shown in the analysis, notwithstanding the fact that the partings as far as possible were excluded from the sample.

Section of the Upper Banner coal in Sexton mine of the Virginia Iron, Coal & Coke Co., on Toms Creek.

(Loc., 537; el., 2,129 feet, L.)

Section where sample was cut at face of No. 15 west entry, off main entry; 2½ miles northeast of mine mouth.

(Analysis No. 32413.)

	Ft.	In.
Shale.		
*Coal		6
Shale		10
*Coal	1	10
Sandstone		1½
*Coal	1	5
Shale		½
*Coal		4
Shale		4
*Coal		4
Shale		1
*Coal		11
Shale		2
*Coal		5
Shale		
Coal	5	9
Partings	1	7

The Upper Banner coal bed on the north side of the stream, just east of the Sexton mine, has a much parted section, as shown by the following section which was measured in an entry near the outcrop:

Section of the Upper Banner bed on Toms Creek east of the Sexton mine.

(Loc., 538; el., 2,160 feet, B.)

	Ft.	In.
Shale.		
Coal		1
Shale		½
Coal		5
Shale		10
Coal		10
Shale		1
Coal	1	2
Shale		½
Coal		1
Sandstone		1
Coal	1	5
Shale		1
Coal		4
Shale		3
Coal		4
Shale		6
Coal		5
Shale		1
Coal		10
Shale		4
Coal	1	6
Clay		
Coal	7	5
Partings	2	4

*Sampled.

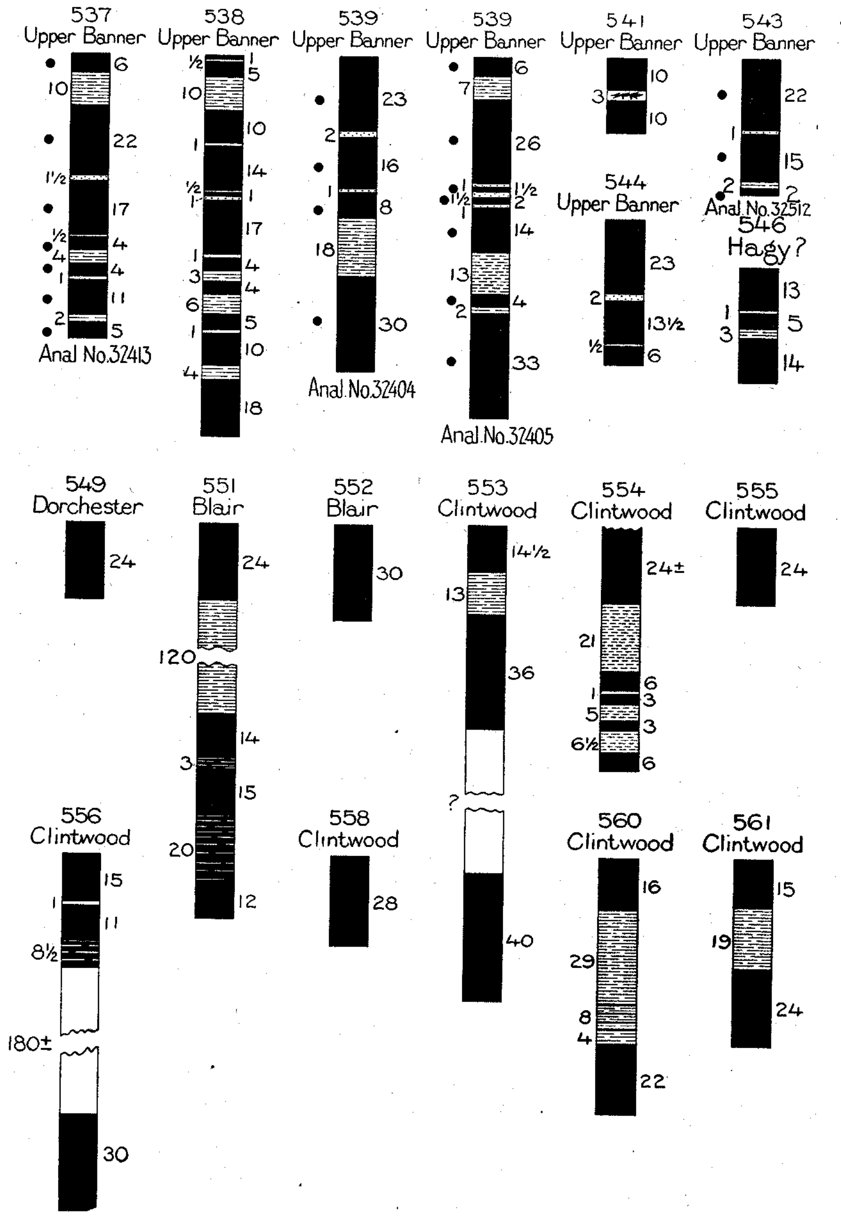


Fig. 41.—Sections of coal beds in the basins of Toms Creek, Little Toms Creek, and Indian Creek.

The Thelma, or Mine No. 1, of the Virginia Iron, Coal & Coke Co., is situated on the south side of the stream a short distance east of Toms Creek town. The mine is one of the large producers of the Toms Creek district, having a daily capacity of 750 tons. Electric storage battery locomotives are used to haul out the coal. The mine is old and the entries have been driven several thousand feet into the ridge. The coal bed ranges in thickness in this mine from 6 to 9 feet. The coal was sampled (page 511) and the sections of the bed at the places the samples were cut are given below:

Sections of the Upper Banner coal bed in Thelma mine of the Virginia Iron, Coal & Coke Co., on Toms Creek.

(Loc., 539; el., 2,131 feet, L.)

Section where sample was cut in east main manway, ½ mile southeast of mine mouth.

(Analysis No. 32404.)

	Ft.	In.
Shale.		
*Coal	1	11
Sandstone		2
*Coal	1	4
Sandstone		1
*Coal		8
Shale	1	6
*Coal	2	6
Coal	6	5
Partings	1	9

Section where sample was cut near 10 cross-entry, off old West Main entry, 1 mile southeast of mine mouth.

(Analysis No. 32405.)

	Ft.	In.
Shale.		
Shale, carbonaceous		2
*Coal		6
Shale, carbonaceous		7
*Coal	2	2
Sandstone		1
*Coal		1½
Sandstone		1½
*Coal		2
Sandstone		1
*Coal	1	2
Clay	1	1
*Coal		4
Shale		2
*Coal	2	9
Coal	7	2½
Partings	2	1½

Several closed prospects were found on the south side of Toms Creek in the vicinity of the town by that name (loc. 540, el. 2,200 feet, B). Here a five-foot sandstone overlies the coal bed.

The Upper Banner coal bed in the ridge north of Coeburn includes many partings and is thinner than usual. In two prospects on the hillside overlooking the town the following sections of the coal bed were measured:

*Sampled.

Sections of the Upper Banner coal bed on Little Toms Creek north of Coeburn.

(Loc., 542; el., 2,370 feet, B.)

	Ft.	In.
Shale	10+	
Shale, carbonaceous		7½
Coal		4
Sandstone		1½
Coal		4
Shale		½
Coal		2½
Shale		6
Coal		7
Clay		
Coal	1	5½
Partings		8

(Loc., 541; el., 2,370 feet, B.)

	Ft.	In.
Sandstone	20+	
Shale	3	
Coal		10
Bone		3
Coal		10
Shale, carbonaceous		2
Clay		
Coal	1	8
Parting		3

Near the bottom of the ravine northwest of Banner, Robert Fleming & Co. have an extensive mine (Upper Banner Mine No. 1) in the Upper Banner bed. The mine has a normal daily output of 150 tons of coal, and employs about 25 miners. The average thickness of the bed is 4 feet, but it is split by a 2-inch sandstone parting.

The coal bed, in the mine workings, shows evident signs of having been disturbed, and a northwest–southeast fault is reported to have been encountered in the entries that were driven off to the right of the main entry. When the fault was reached, work stopped, and mining now is being carried on south of the disturbance. The fault is local, the bed on the north side being depressed about 60 feet. It was not noticed elsewhere in the region. Coal beds near the upturned rocks of the Powell Valley anticline not uncommonly show signs of this great disturbance. The coal was sampled in this mine (page 511) and the following section was measured at the place where the sample was cut:

Section of the Upper Banner coal bed in Upper Banner Mine No. 1 of Robert Fleming & Co.

(Loc., 543; el., 2,310 feet, B.)

Section where sample was cut 4,300 feet west of mine mouth.

(Analysis No. 32512.)

	Ft.	In.
Sandstone.		
Shale, carbonaceous		1
Bone		7
Shale		2
*Coal	1	10
Sandstone		1
*Coal	1	3
Shale, carbonaceous		2
Coal		2
Coal	3	3
Partings		3

*Sampled.

The Upper Banner bed is mined north of Vicco by the Virginia Iron, Coal & Coke Co., in Mine No. 3. The coal is shipped out over a spur of the Norfolk and Western Railroad at Banner. The mine produces about 200 tons of coal daily. The average section of the bed is reported to be 4 feet, 8 inches. The following section was measured in the mine about 300 feet from the mine mouth:

Section of the Upper Banner coal bed in Virginia Iron, Coal & Coke Co.'s Mine No. 3 north of Vicco.

(Loc., 544; el., 2,200 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous		1
Coal	1	11
Sandstone		2
Coal	1	1½
Shale		½
Coal		6
Shale, carbonaceous		1½
Clay		
Coal	3	6½
Partings		2½

The Upper Banner bed is being mined by the Virginia Iron, Coal & Coke Co. at Marion Mine No. 1 on the east fork at the head of Little Toms Creek. In this mine the bed averages slightly less than 4 feet in thickness. The following section is representative:

Section of the Upper Banner coal bed in Marion Mine No. 1 of the Virginia Iron, Coal & Coke Co. at Vicco.

(Loc., 545; el., 2,286 feet, L.)

	Ft.	In.
Coal	1	9½
Sandstone		1½
Coal	1	2½
Shale		½
Coal		11½
Coal	3	11½
Partings		2

Coal beds above the Upper Banner.—Practically no coal beds of a thickness sufficient to support active mines exist in the Toms Creek basin above the Upper Banner. The Hagy and Dorchester coal beds were found at several places but they are so thin as to be worthless. The Norton coal bed was not seen. The Splash Dam coal bed appears to be represented here by black carbonaceous shale which occurs about 50 feet directly up the slope from Mine No. 3 of the Virginia Iron, Coal & Coke Co. (loc. 544).

A coal bed, workable on a small scale, was mined about one mile north of Banner. The mine was operated for some time, but later the pillars were robbed and the mine abandoned. As the bed is 150 feet above the Upper Banner coal bed it is probably the Hagy coal bed. A section measured near the old mine is as follows:

Section of the coal bed 150 feet above Upper Banner bed, 1 mile north of Banner.

(Loc., 546; el., 2,460 feet, B.)

	Ft.	In.
Shale.		
Coal	1	1
Shale		1
Coal		5
Shale		3
Coal	1	2
Coal	2	8
Partings		4

This bed is reported to have an average thickness in the mine of 3 feet.

A prospect was opened on a coal bed at about the Hagy horizon south of the Sandy Ridge road, near the Dickenson County line (loc. 547, el. 2,550 feet, B). The coal could not be seen as the pit was caved, but it lies 60 feet below a massive sandstone.

The Dorchester coal bed was seen as a bloom 16 inches thick on the summit of the divide north of Vicco (loc. 548, el. 2,600 feet, B).

POUND RIVER DRAINAGE BASIN.

INDIAN CREEK BASIN.

General features.—Indian Creek flows northward in a remarkably straight valley. It is singular that the stream should have cut its channel so nearly in a straight line, for over 7 miles, in a country of sharp relief, with no flat land. In explanation it may be stated that the valley is located on a straight and comparatively sharp monoclinal fold or westward dipping rocks which in general separate an anticline on the east from a syncline on the west. This structure apparently has had much to do with shaping the course of the creek. The basin of Indian Creek reaches its maximum width of 2½ miles at Riley School but tapers to an average of 1½ miles north and south of this place.

The rocks exposed in the Indian Creek basin range from the top of the Gladeville sandstone to the middle of the Wise formation. The attitude or lay of the rocks is governed largely by two structural features, the Dorchester syncline, and the Gladeville anticline. Of these two folds, the Dorchester syncline is of major importance and affects nearly all the rocks in the Indian Creek basin except a small area at the head of the stream, or south of Tank Hollow. The axis of the syncline lies from one-half to 1 mile west of Indian Creek and is roughly parallel to the course of the stream, in consequence of which the prevailing dip of the rocks of the basin is to the west, sloping into the trough of the fold.

The term Gladeville anticline is somewhat of a misnomer as the fold in general is scarcely an anticline at all, but here and there, as at Wise (formerly Gladeville) and Indian Gap pronounced domes have been developed on it, which, in a general way is more nearly a monocline than an anticline. In the upper part of the Indian Creek basin the structure contours parallel Indian Creek very closely, but to the north they curve to the east and by their curves indicate only a broad, low anticlinal fold some distance east of the creek.

The extension of the Gladeville anticline northward from near Ramsey, past Wise and Glamorgan, into the southern end of the Indian Creek basin is marked by the development of pronounced folds north of Glamorgan and at the head of Indian Creek. Locally the folding has been so severe that the rocks were arched up considerably above the general elevation of the axis of the Gladeville anticline, resulting in the formation of elongated domes. The summit of the northernmost dome approximately coincides with Indian Gap and from this dome the rocks on Indian Creek drainage plunge rapidly to the north, carrying the Gladeville sandstone from an elevation of 2,500 feet at the gap to 1,850 feet, or stream level, in less than a mile. The Gladeville here, as at Glamorgan, carries its massive "rider" sandstone, a bed overlying the principal sandstone about 50 feet. This upper sandstone is equally as massive as the Gladeville and just northeast of Indian Gap makes a most conspicuous outcrop. The influence of the Indian Gap dome on the surface rocks dies out going north about the vicinity of Tank Hollow and from that place north the regional dip is toward the axis of the Dorchester syncline. The Gladeville sandstone from south of Tank Hollow to Lick Branch is not exposed on Indian Creek, but lies under very little cover.

The coals exposed on Indian Creek belong to the lower part of the Wise formation. Three drillholes, put down in the bottom of the valley by the

Clinchfield Coal Corporation, show the presence of a few coal beds in the upper half of the Norton formation. The sections of these coal beds are not available, however, but the intervals between the beds are indicated in Plate III. The Dorchester coal is of little value as it is split by partings of shale into benches too thin to be worked. The Blair and Clintwood coal beds both outcrop low in the ridges bordering Indian Creek and show thicknesses that can be mined. The Imboden and Kelly coal beds are so high that the only large body of these coal beds in the Indian Creek basin lies under the eastern portion of Buck Knob. Sections of the coal beds in the basin are shown graphically in figures 41 and 42.

The Addington sandstone overlying the Clintwood coal outcrops throughout a large part of the basin as a hard gray sandstone. A hand-leveled section on the west slope of Indian Creek Valley 1 mile south of Pound shows the interval between the top of the Gladeville sandstone and the base of the Addington sandstone to be 263 feet. The Clintwood coal was not seen in this section. Near the head of Indian Creek the Addington sandstone is thin but a massive bed. The Addington coal outcrops above the sandstone in this vicinity and apparently has been confused with the Clintwood by early prospectors on the Clintwood bed. This probably resulted from mistaking the Gladeville "rider" for Gladeville sandstone, as the two are so similar that the writer was puzzled at first regarding the true position of the uppermost bed.

The correlation of coal beds is still further confused by the presence of the Indian Gap dome, upon the sides of which the beds are turned up at sharp angles. The outcrops of the Clintwood, Imboden and Kelly coal beds do not extend around the head of Indian Creek as heretofore thought, but are carried so high that they have been eroded in the gap. A number of coal prospects have been opened at the head of Indian Creek and their locations are indicated on the geologic map. As very few were seen in the field, there will be no attempt made to correlate them, except in a general way, in interpreting their relation to the general structure.

Development of mining in the basin depends on means of transportation. A road, suitable for automobiles, has recently been built from Glamorgan over Indian Gap and down Indian Creek and is the main artery of travel from the Pound River region to Norton and Wise.

Dorchester coal bed.—The Dorchester bed at the mouth of Indian Creek is split into two or three thin beds of little or no value. Farther south one or two of the benches unite to form a bed 2 feet or more in thickness. At no place where it was seen in the Indian Creek basin is the Dorchester more than 2 feet, 6 inches in thickness. In Peake Hollow, one-half mile north of Riley School (loc. 549, el. 1,675 feet, B) an upper bench of the Dorchester, showing 2 feet of coal overlain by 4 inches of clay with coal streaks, is exposed in the bed of the stream. The clay with coal streaks overlying the coal bed is characteristic of the bed northeast of Pound. The coal bed ranges from 5 to 10 feet above the Gladeville sandstone. The Dorchester coal has been prospected for local use at the head of Indian Creek. An entry was seen at loc. 550, el. 2,000 feet (approximately) which probably had been driven into the upper bench of this bed, but the thickness was not determined.

Blair coal bed.—The Blair coal on Lick Branch of Indian Creek, 2 miles south of Pound, has been mined on a small scale for local use. This is the type locality of the bed, the name of the owner, James Blair, being given to the bed because the mine is on his property. The following section was measured at the mouth of the mine:

Section of the Blair coal bed at the Blair mine on Indian Creek.

(Loc., 551; el., 1,685 feet, B.)

(Elevation on base of highest bench.)

	Ft.	In.
Shale.		
Coal	2	0
Shale	10	
Coal	1	2
Coal, shaly		3
Coal	1	3
Coal, shaly	1	8
Coal	1	
Coal, lower bench	5	4

The upper bed lies more nearly at the position of the Blair coal, as found in other basins, whereas the lower bench is probably represented in the lower bench of the coals opened on the South Fork of Pound River at loc. 567 (p. 394). The upper bed lies about 100 feet above the Gladeville sandstone.

On the east side of Indian Creek about half a mile due east of the Blair mine at loc. 552, el. 1,665 feet (B), the Blair coal is 30 inches thick without a parting.

Clintwood and Addington coal beds.—The Clintwood coal bed outcrops on both sides of Indian Creek, maintaining an average distance of 100 feet above the Blair coal bed and an average distance of 200 feet above the Gladeville sandstone. The Clintwood has been prospected by the engineers of the Clinchfield Coal Corporation throughout the entire basin and several of the sections measured by them are presented in this report. The bed appears to be workable in the entire basin but is inferior to the same bed where it is mined to the east in Dickenson County. The Clintwood, on Indian Creek, consists essentially of two benches separated by 5 or more feet of shale. The upper bench has the greater thickness of coal but is badly parted, whereas the lower bench usually consists of 2 to 2½ feet of clear coal.

The Clintwood coal bed is easily traced in this basin by the cliffs and ledges of the Addington sandstone. The sandstone possesses its usual hard, coarse-grained quartzose character, and is from 15 to 40 feet thick, and strews the slopes below the coal outcrop with massive blocks. Near[1] the mouth of Indian Creek the Clintwood bed shows a section of workable coal in both benches as follows:

Section of the Clintwood coal bed near mouth of Indian Creek.

(C. C. C. prospect.)

(Loc., 553; el., 1,755 feet, L.)

	Ft.	In.
Coal	1	2½
Shale	1	1
Coal	3	0
Interval		?
Shale		
Coal, Clintwood split	3	4
Shale		
Coal, in both benches	7	6½
Partings, exclusive of interval	1	1

Three miles above the mouth of Indian Creek the Clintwood coal lies close beneath the Addington sandstone, and is much parted. The section is as follows:

Section of the Clintwood coal bed on Indian Creek 3 miles above its mouth.

(Loc., 554; el., 1,864 feet, L.)

	Ft.	In.
Sandstone.		
Coal	2	
Clay	1	9
Coal		6
Clay		1
Coal		3
Clay		5
Coal		3
Clay		6½
Coal		6
Clay (?)		
Coal	3	6
Partings	2	9½

[1] Locations on the Clintwood, Imboden, and Kelly coal beds are referred to as seen, starting from the ridge on the west bank at the mouth of Indian Creek, and following the outcrops to the head of the stream and down the east bank.

The Clintwood coal is thinner in the south half of the Indian Creek basin than it is in the north half. The bed shows only 2 feet of coal, without parting at the mouth of Potcamp Branch (loc. 555, el. 1,996 feet, L., C. C. C. prospect).

A bed was opened by the Clinchfield prospectors near the old tram road one-half mile northeast of Indian Gap, and was called by them the Clintwood bed. The location of this pit, which was plotted on the map from a blueprint record of a Clinchfield survey, was not found in the field. In view of the discrepancy in correlations in this part of the basin by early prospectors, as noted in the general description of this basin (page 384), the correctness of the Clintwood correlation is questioned. The coal bed has the following section:

Section of the coal bed near head of Indian Creek.

(Loc., 556; el., 2,276 feet, L.)

	Ft.	In.
Coal, shaly		6½
Coal	1	3
Shale, sandy		1
Coal		11
Coal, shaly		8½
Shale		
Coal	2	2
Parting		1
Interval, 10 to 20 feet (?).		
Coal	2	6

The bed is opened at the Roberts mine (loc. 557, el. 2,100 feet, approx.). The mine was closed when visited and no measurement of the bed could be obtained. The Clintwood coal bed outcrops high up on the divide between Indian and Birchfield creeks east of Riley School. The Clintwood is cut out by Bean Gap, the low point of which is about 50 feet lower than the general level of the coal bed. The section of the coal bed measured south of Bean Gap is as follows:

Section of the Clintwood coal bed south of Bean Gap.

(C. C. C. prospect.)

(Loc., 558; el., 2,028 feet, L.)

	Ft.	In.
Shale.		
Coal, shaly		4
Shale		5
Coal, clear	2	4
Coal	2	4

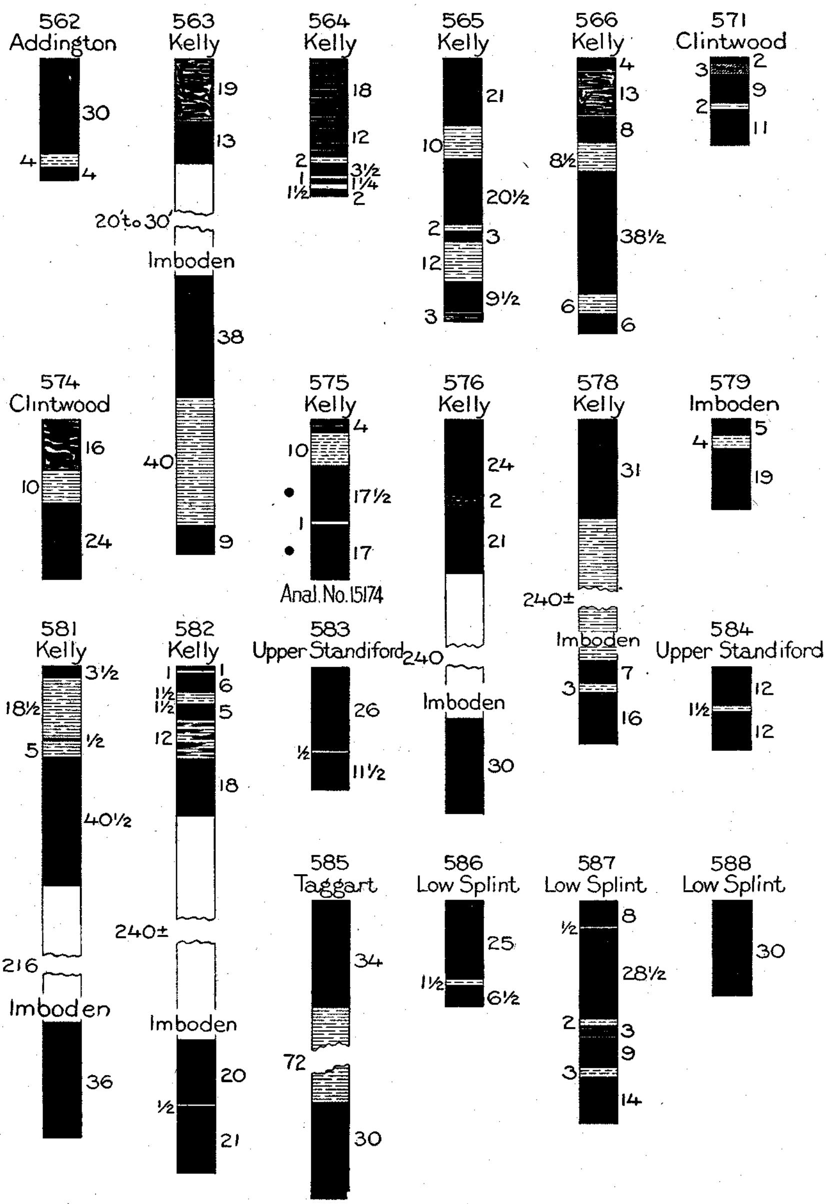


Fig. 42.—Section of coal beds in the basins of Indian Creek and South Fork of Pound River.

The coal is 33 inches thick in a Clinchfield prospect at the head of the large ravine two miles south of Pound River. (Loc. 559, el. 1,912 feet, L). The Clintwood bed has been opened on both sides of a small tributary of Indian Creek, 1 mile south of Pound River, and the following sections measured:

Section of the Clintwood coal bed 1 mile south of Pound River.

(C. C. C. prospects.)

(Loc., 560; el., 1,837 feet, L.)

	Ft.	In.
Coal	1	4
Shale	2	5
Shale, with coal partings		8
Shale		4
Coal	1	10
Coal	3	2
Partings	3	5

(Loc., 561; el., 1,887 feet, L.)

	Ft.	In.
Coal	1	3
Shale	1	7
Coal	2	0
Coal	3	3
Parting	1	7

The Addington coal bed outcrops around the head of Indian Creek 5 to 10 feet above the Addington sandstone. It has been mined locally but no mines are working it at present. On the old tram road about one-eighth of a mile southeast of the Roberts Mine, a cut in the road exposed the following section:

Section of the Addington coal bed on head of Indian Creek.

(One-eighth mile southeast of loc., 562; el., 2,175 feet, approx.)

	Ft.	In.
Shale.		
Coal	2	6
Clay		4
Coal		4
Shale		
Coal	2	10
Parting		4

The bed does not show at many places to the north and is a relatively unimportant bed in the Indian Creek basin.

Imboden and Kelly coal beds.—The Imboden and Kelly coal beds outcrop uniformly at a distance of 250 feet above the Clintwood bed. Like the Clintwood, they have been extensively prospected by the Clinchfield Coal Corporation. The beds in this basin do not reach the great thicknesses that characterize them in the basins to the southwest. The largest areas of these coals in the Indian Creek basin underlie the eastern part of Buck Knob and the western part of Bowlecamp Mountain. These beds are the highest ones in the dividing ridge between Indian Creek and the South Fork of Pound River. On this divide southwest of Pound the coal beds have the sections given below. Here the upper bed is scarcely 150 feet from the summit of the ridge.

Sections of the Imboden and Kelly coal beds southwest of Pound (C. C. C. prospects).

(Loc., 563; el., 2,050 feet, L.[1])

	Ft.	In.
Sandstone.		
Coal, impure	1	7
Coal	1	1
Shale	25	
Coal	3	2
Shale	3	4
Coal		9
Shale		
Coal, in both beds	5	0
Parting, excluding interval, between beds	3	4

Southeast of Buck Knob the upper bed takes on a somewhat crushed and laminated character in its upper part as shown by the following section:

Section of the Kelly coal bed on Buck Knob.

(Loc., 564; el., 2,307 feet, L.)

	Ft.	In.
Coal, laminated thin partings of "rash" or "mother coal"	1	6
Coal, laminated	1	
Clay		2
Coal		3½
Clay and bone		1
Coal		1¼
Clay and bone		1½
Coal		2
Clay	2	
Coal	1	6¾
Coal and "rash"	1	6
Partings		4½

At the head of Indian Creek the Imboden and Kelly coal beds, especially the Kelly, are badly broken by shale partings from 1 to 10 inches thick. The Kelly bed is reported to be 19 inches thick at the Clinchfield prospect, loc. 565, but this section probably represents only the thickness of a clear

[1]Elevation on the bottom coal of upper bed.

bench in the upper bed, as one-eighth mile due north the bed displays a distinctly larger section. The latter section is given as follows:

Section of the Kelly coal bed near head of Indian Creek.

(C. C. C. prospects.)

(⅛-mile north of loc., 565; el., 2,454 feet, L.)

	Ft.	In.
Coal	1	9
Shale		10
Coal	1	8½
Shale		2
Coal		3
Shale	1	0
Coal		9½
Coal, shaly		3
Shale		
Coal	5	6
Partings	2	0

The coal beds show a badly broken section in Tank Hollow where the following sections were measured:

Sections of the Imboden and Kelly coal beds, in Tank Hollow.

(C. C. C. prospect.)

(Loc., 566; el., 2,457 feet, L.)

	Ft.	In.
Shale.		
Coal		4
Coal, impure	1	1
Coal		8
Shale		8½
Coal	3	2½
Shale		6
Coal		6
Shale		
Interval, 20 feet or more		
Shale		
Coal		7½
Shale		4½
Coal		5
Coal	5	9
Parting, excluding interval between beds	2	8

SOUTH FORK OF POUND RIVER BASIN.

General features.—The South Fork of Pound River drains all of the territory in Wise County north of the crest of Black Mountain and Buck Knob and south of the ridge dividing the two forks of Pound River. It is more than 9 miles long and heads on the north slope of Black Mountain. The valley from the head of South Fork to Donald school is narrow and steep, the ridges on either side rising 1,000 feet above the stream which drains them. Northeast of the school South Fork flows in a valley which has a low gradient, with here and there stretches of flood plain that vary from several hundred feet to one-fourth of a mile in width. The greater portion of the drainage of South Fork is received from the slopes of Black Mountain and Buck Knob, and includes such tributaries as Glady Fork, Burnthouse Branch, Short Branch, and Donald Branch.

The region is characterized by sharp relief, no flat land occurring in the basin except the small flood plains along the main stream and a few of its chief branches. Outside the influence of Black Mountain, South Fork flows in a valley cut in an upland plateau whose elevation above sea level ranges from 2,000 to 2,200 feet, but the slopes are not so steep as those of Black Mountain nor even the slopes in other basins to the east.

The rocks exposed in the South Fork of Pound River basin belong almost entirely to the Wise formation, as the top of the Gladeville sandstone which marks the base of the formation is just beneath water level at the mouth of South Fork and the Harlan sandstone overlying the formation caps Black Mountain at the southwestern end of the basin. Thus the stratigraphic section in this basin comprises about 2,500 feet of sandstone, shale, and coal beds.

The structural features of the basin are the Middlesboro syncline, the Buck Knob anticline, and the Dorchester syncline. The Middlesboro syncline is the major fold affecting the rocks of this region. The axis of the syncline enters the basin from the southwestern corner, swings northeast to about 1 mile north of Dewey and from that place extends due east beyond the limits of the basin. At the point of turning north of Dewey, a minor synclinal flexure of the rocks appears to extend from 1 to 2 miles toward the north. The axis of the Buck Knob anticline enters the basin from the south, passes almost directly under the high point of Buck Knob and trends northward until the fold is flattened and merges into the major fold of the Middlesboro syncline. The axis of the Dorchester syncline as previously described, lies just west of and parallel to Indian Creek, and although closely approaching, does not enter the South Fork basin. A well marked structural depression crosses the axes of the Middlesboro and the Dorchester synclines, about 1½ miles southwest of Pound.

The coal beds outcropping in the South Fork basin are 8 to 12 in number and occur entirely within the Wise formation. The beds average from

2 to 4 feet, with the Pardee bed ranging as high as 7 feet in thickness. The most persistent beds are the Clintwood, Imboden, Kelly, Low Splint, the Standiford beds, and the Pardee. The coal beds have been prospected throughout much of the basin but no coal is mined for shipment. Several mines are operated each autumn for a supply of fuel for local use in the winter. Graphic sections of the coal beds in this basin are shown in figures 42 and 43.

The coals of the basin will not be mined for shipment until railroad connections are made with places in the basin. This could be accomplished by the building of a line from the Carolina, Clinchfield, and Ohio Railroad up Pound River, or by building a spur of the Interstate Railroad up Guest River and a tunnel through Fox Gap. It is unlikely that either undertaking will be considered until the more available coal in Wise and Dickenson counties has been used up and the demand for coal on Pound River drainage is sufficient to justify the expense of building railroads into that basin.

The South Fork basin is heavily timbered and quantities of lumber will be available when means are provided to ship it to market. The population of the basin is very small and scattered along the main streams. There are no towns and the inhabitants are engaged in farming. Around every cabin or homestead a portion of the valley bottom and usually small tracts of cleared lands on the slopes are cultivated.

Clintwood and lower coal beds in the Wise formation.—As the Dorchester coal bed, overlying the Gladeville sandstone, does not outcrop in this basin, its character is unknown, but there are strong indications that the bed is split in the South Fork basin and almost certain to be of little value. Above and within 70 feet of the Gladeville sandstone at least four coal beds are known, but none exceeds 2 feet in thickness. It is not improbable that the lowest of these beds is a split from the Dorchester. The Dorchester on Indian Creek and the North Fork of Pound River, moreover, shows poor sections and it is quite unlikely that the bed improves towards the west. No core drillholes have been put down in the South Fork basin.

Along the South Fork of Pound River between Donkey at the mouth of South Fork and Glady School, four coal beds outcrop at 50 to 70 feet above the Gladeville sandstone. The two higher beds are opened on the Widow Short farm where the following section was obtained:

Section of coal beds between Donkey and Glady School.

(Loc., 567; el., (top bed), 1,635 feet, B.)

	Ft.	In.
Sandstone.		
Coal	2	4
Shale	11	
Coal, impure		4
Shale		3
Coal	1	6
Shale		
Coal, lower bed	1	10
Parting, lower bed		3

The interpretation of the section given above is somewhat in doubt but it is possible that the upper bed is the Blair and the lower a coal bed that has been found at several places in the Pound River basin outcropping about 70 feet above the Gladeville sandstone.

Southwest of loc. 567, about half-a-mile along the stream, four coal beds or benches are exposed, as shown by the following section:

Section of coal beds between Donkey and Glady School.

(Loc., 568; el., (top bed), 1,620 feet, B.)

	Ft.	In.
Coal	2	
Interval	10	
Coal		6
Interval	10	
Coal		6
Interval	8	
Coal	1	1+
Coal, all beds	4	1+
Intervals	28	

The uppermost coal in this section is probably the Blair coal bed; the two 6-inch beds may be splits from either the Blair or the bed between the Blair and Dorchester; and the bottom bed represents the main bench of the bed 70 feet above the Gladeville sandstone.

Three-fourths of a mile north of Dewey (loc. 569, el. 1,670 feet, B) the bed above the Dorchester contains 2 feet, 2 inches of impure coal.

The same bed measured at Glady Fork School at the mouth of Glady Fork has the following section:

Section of a coal bed at Glady Fork School.

(Loc., 570; el., 1,620 feet, B.)

	Ft.	In.
Coal		10
Shale		2
Coal	1	8
Coal, bony		6
Coal	3	0
Parting		2

The Clintwood has a variable section on South Fork of Pound River, ranging up to nearly 3½ feet in thickness. The bed throughout the larger part of its outcrop, however, averages about 2 feet in thickness and lies from 10 to 40 feet beneath the massive Addington sandstone.

The Clintwood coal bed is opened at Dewey in the mine of J. F. Stidham, and shows the following section:

Section of the Clintwood coal bed in mine of J. F. Stidham at Dewey.

(Loc., 571; el., 1,750 feet, B.)

	Ft.	In.
Sandstone.		
Coal		2
Bone		3
Coal		9
Shale		2
Coal		11
Shale		
Coal	1	10
Partings		5

The Clintwood bed at the Stidham mine is 40 feet below the Addington sandstone, which makes a conspicuous showing in the outcrop everywhere in this vicinity. A thin worthless bench or split of the Clintwood bed occurs between the main bed and the sandstone. Such a bench is shown in the Clinchfield opening on Short Branch just south of Dewey as illustrated by the following section:

Section of Clintwood coal bed on Short Branch (C. C. C. prospect).

(Loc., 572; el., (upper bench), 1,806 feet, L.)

	Ft.	In.
Coal		8
Interval, 15 to 30 feet.		
Coal		3
Shale		1
Coal		9
Shale		3
Coal		9
Shale		
Coal, lower bench	1	9
Partings, lower bench		4

The Clintwood coal bed outcrops for about 2 miles up Glady Fork and has been prospected by the Clinchfield Coal Corporation on both sides the stream. The lower or main bed appears not to have been opened at the prospect near the head of Glady Fork (loc. 573, el. 1,815 feet, L), where 12 inches of coal is the entire thickness of the bed as exposed.

Near the mouth of South Fork the bed shows its best development in the basin, reaching a thickness of more than 3 feet, with a middle 10-inch parting. The bed near the mouth of the stream has the following section:

Section of the Clintwood coal bed near mouth of South Fork.

(C. C. C. prospect.)

(Loc., 574; el., 1,617 feet, L.)

	Ft.	In.
Shale.		
Coal, impure	1	4
Shale		10
Coal	2	0
Coal	3	4
Parting		10

Imboden, Kelly, and higher coal beds.—The Imboden and Kelly are probably the best and most easily available coals beds in the basin of South Fork. They range from 2½ to 3½ feet in thickness and show few partings. They are separated by shale ranging in thickness from 20 to 40 feet. The Imboden and Kelly beds underlie an unbroken area of 25 square miles west of Guest River and south of North Fork of Pound River and they have an extensive acreage under Buck Knob. The Kelly has been widely prospected by the Clinchfield Coal Corporation and the location of many of their pits is indicated on the geologic map. The coals are found north of South Fork only in the high ridge west of Dewey.

The upper bed, or Kelly, is mined to supply local needs near Donald School, by Reuben Bolling. The section of the coal bed in this mine was measured by Charles Butts at the same time that a sample was taken for chemical analysis (see page 517). The section of the bed is as follows:

Section of the Kelly coal bed 2 miles southwest of Dewey.

(Loc., 575; el., 1,860 feet, B.)

(Analysis No. 15174.)

	Ft.	In.
Shale.		
Coal, with thin shale partings		4
Clay		10
*Coal	1	5½
Clay		1
*Coal	1	5
Coal	3	2½
Partings		11

*Sampled.

Both the Kelly and Imboden coal beds[1] are opened on the property of J. E. Bolling, 1½ miles southwest of Dewey, on the south bank of the stream. The Kelly bed at this opening has a considerably thicker section than that of the Imboden bed, as shown by the following section:

Section of the Imboden and Kelly coal beds one and one-half miles southwest of Dewey.

(Loc., 576; el., (Kelly bed), 1,875 feet, B.)

		Ft.	In.
Shale.			
Coal	Kelly	2	
Coal, bony	Kelly		2
Coal	Kelly	1	9
Coal		3	11
Interval		20	
Coal, Imboden		2	6
Shale			

In the sharp bend of the Fox Gap road 1 mile southwest of Dewey a coal bed of variable thickness and character is exposed as a bloom, 80 feet above the Kelly horizon. The following section shows that the bed is thin and worthless:

Section of the coal bed 1 mile southwest of Dewey.

(Loc., 577; el., 2,020 feet, L.)

	Ft.	In.
Shale.		
Coal		5
Clay		½
Coal		2
Clay		1
Coal		½
Clay		1
Coal		½
Clay		¾
Coal		1½
Clay, carbonaceous		½
Clay		
Coal		9½
Parting		3¼

The Imboden and Kelly coal beds have been opened by the Clinchfield Coal Corporation in the ridge west of the juncture of Burnthouse Branch and Short Branch, where they show the following sections:

[1] Charles Butt's (The coal resources and general geology of the Pound quadrangle in Virginia, Virginia Geol. Survey Bull. IX, p. 36, 1914) gave the name "Bolling coal" to the two beds opened on the Bolling farm, but recent work has shown clearly that these beds correspond to the Kelly and Imboden beds of the Big Stone Gap region and hence the named "Bolling" is dropped in favor of the older name.

Sections of the Imboden and Kelly coal beds on Burnthouse Branch.

(Loc., 578; el., Kelly bed, 1,983 feet, L.)

		Ft.	In.
Coal, Kelly		2	7
Shale, interval, about 20 feet.			
Coal	Imboden		7
Clay	Imboden		3
Coal	Imboden	1	4
Coal, Imboden		1	11
Parting, Imboden bed			3

These beds have been opened on the spur dividing Short Branch from Burnthouse Branch, where they show sections similar to those measured farther west.

Sections of the Imboden and Kely coal beds 1 mile southeast of Dewey.

(Loc., 579; el., Kelly bed, 2,179 feet, L.)

		Ft.	In.
Coal, Kelly		1	9
Interval		23	
Coal	Imboden		5
Clay	Imboden		4
Coal	Imboden	1	7
Coal, Imboden		2	0
Parting, Imboden bed			4

These two coal beds have been largely prospected on the spur north of Buck Knob where the Kelly bed is partly exposed, showing only 1 foot of coal, and 18 feet below the Imboden bed has a thickness of only 1 foot, 5 inches.

The two beds are thicker in the ridge between Indian Creek and Glady Fork, than anywhere else in the South Fork basin. A section measured southeast of Glady Fork school is given below:

Sections of the Imboden and Kelly coal beds southeast of Glady Fork School.

(Loc., 581; el., Kelly bed, 1,964 feet, L.)

		Ft.	In.
Coal	Kelly		3½
Shale	Kelly		6½
Coal	Kelly		½
Shale	Kelly		5
Coal	Kelly	3	4½
Coal		3	8½
Partings			11½
Interval		18	
Shale			
Coal, Imboden		3	0
Clay			

East of Glady Fork school the two coal beds have sections very similar to those given above. They have been opened by the Clinchfield Coal Corporation and the following measurements of the beds obtained:

Sections of the Imboden and Kelly beds east of the Glady Fork School.

(Loc., 582; el., Kelly bed, 1,939 feet, L.)

		Ft.	In.
Coal	Kelly		1
Clay	Kelly		1
Coal	Kelly		6
Shale	Kelly		1½
Clay	Kelly		1½
Coal	Kelly		5
Shale, with coal	Kelly	1	0
Coal	Kelly	1	6
Shale			
Coal, Kelly bed		2	6
Partings, Kelly bed		1	4
Interval, about 20 feet.			
Coal	Imboden	1	8
Shale	Imboden		½
Coal	Imboden	1	9
Shale			
Coal, Imboden bed		3	5
Parting, Imboden bed			½

Standiford and Taggart coal beds.—The Imboden and Kelly coal beds are overlain by 260 feet of shale and sandstone that are practically barren of coal beds. As described in the foregoing paragraphs, a thin bed was seen at one place about 80 feet above the Kelly but this appears to be of local development only. At the top of this barren group of sandstone and shale are two coal beds 20 feet apart that have been opened by a man named Standiford and after whom the beds are named. The Standiford coal beds are present only in the Buck Knob and Black Mountain region west of Guest River, and their areal extent is therefor much less than that of the Imboden and Kelly beds.

At the Standiford farm near the head of the South Fork of Pound River the upper bed is opened on the east side of the valley and the lower bed on the west side. The Lower Standiford bed contains 31 inches of clear coal, but the upper bed is broken by a parting shown in the following section:

Section of the Upper Standiford coal bed near head of South Fork.

(Loc., 583; el., 2,095 feet, L.)

	Ft.	In.
Shale.		
Coal	2	2
Parting		½
Coal		11½
Clay		
Coal	3	1½
Parting		½

A coal bed which is exposed on the new road north of Fox Gap and is regarded as the Upper Standiford bed, has the following section:

Section of the Upper Standiford coal bed north of Fox Gap.

(Loc., 584; el., 2,235 feet, L.)

	Ft.	In.
Shale.		
Coal	1	0
Clay		1½
Coal	1	0
Clay		3
Shale		
Coal	2	0
Parting		1½

The Taggart bed on South Fork of Pound River outcrops 80 to 100 feet above the Standiford beds. The interval between them is for the most part sandstone. The Taggart bed in the South Fork basin appears to be represented by two coal beds each of workable thickness, separated by 6 feet of shale. The Taggart also shows a double section at places on Roaring Fork where its equivalence has been ascertained by extensive and careful prospecting.

Near the head of South Fork, the bed has the following section:

Section of the Taggart coal bed on South Fork of Pound River.

(Loc., 585; el., 2,160 feet, L.)

	Ft.	In.
Shale.		
Coal	2	10
Shale	6	
Coal	2	6
Clay		
Coal	5	4
Parting	6	0

Low Splint coal bed.—The Low Splint coal bed lies 200 to 220 feet above the Taggart coal bed in the South Fork of Pound River basin. It crops out high up on Black Mountain and in the Buck Knob ridge, and is cut through at Steve Horn Gap thus isolating a small acreage in Buck Knob. The average thickness of the bed is 2½ feet although at one opening it contains over 5 feet of coal. The bed consists of relatively clear coal and is minable throughout its entire extent in the South Fork basin. It was prospected on Buck Knob by the Clinchfield Coal Corporation under the name of Buck Knob coal bed.

The Low Splint coal bed is opened near the head of South Fork, by George Phillips, and shows the following section of the coal and overlying beds.

Section of the Low Splint coal bed near head of South Fork.

(Loc., 586; el., 2,303 feet, L.)

	Ft.	In.
Sandstone, thin-bedded, flaggy	50+	
Shale	15	
Coal	2	1
Clay		1½
Coal		6½
Clay	2	
Shale		
Coal	2	7½
Parting		1½

The coal is hard and shows well-developed cleavage. The parting thins out and disappears as another section, measured near the one given above shows 34 inches of coal without a parting.

In a ravine a short distance east of the new road north of Fox Gap a bed supposed to be the Low Splint is opened and shows a greater thickness but contains more impurities.

Section of the Low Splint coal bed north of Fox Gap.

(Loc., 587; el., 2,495 feet, L.)

	Ft.	In.
Shale.		
Coal		8
Bone		½
Coal	2	4½
Clay		2
Coal, shaly		3
Coal		9
Clay		3
Coal	1	2
Clay		
Coal	5	2½
Partings		5½

On Buck Knob, at the head of Burnthouse Branch, (loc. 588, el. 2,736 feet, L) the bed is exposed in a prospect of the Clinchfield Coal Corporation, showing 2 feet, 6 inches of coal.

Phillips and other coal beds up to the Pardee bed.—At the head of South Fork, near the house of Ambrose Phillips, (loc. 589, el. 2,560 feet, L a coal bed, called the Phillips, 260 feet above the Low Splint bed, has been opened. This bed is a splint coal of good quality. The Phillips opening was partly slumped when visited and the full thickness could not be measured but 1 foot, 9 inches of coal was seen overlying 1 foot of shale and coal was seen below the shale but only the top of this bench was exposed. At this opening 26 inches of coal was seen in all, but a total of 45 inches is reported at the face of the entry.

A coal bed, of local importance, was prospected 70 feet above the Phillips opening, showing 18 inches of coal with partings as indicated in the section below:

Section of coal bed 70 feet above Phillips bed at Phillips opening.

(Loc., 590; el., 2,630 feet, L.)

	Ft.	In.
Sandstone.		
Coal		6
Clay		1
Coal		6
Shale		½
Coal		6
Shale		
Coal	1	6
Partings		1½

A coal bed 215 feet above the Phillips bed is exposed at the head of South Fork, showing the following section:

Section of a coal bed 215 feet above Phillips bed at head of South Fork.

(Loc., 591; el., 2,785 feet, L.)

	Ft.	In.
Shale.		
Coal		4
Shale	1	6
Coal		6
Clay		2
Coal	1	7
Clay		
Coal	2	5
Partings	1	8

Eight inches of limestone, overlain and underlain by shale, is exposed 18 feet below the coal bed just described and 10 feet lower is a bed of coal

1 foot thick. The limestone though impure is one of the few marine beds in the Pennsylvanian series and is a valuable key bed in tracing and correlating the higher coal beds.

Pardee coal bed.—The thickest coal bed on the South Fork of Pound River is the Pardee, which lies from 380 to 390 feet above the Phillips coal bed. The bed has a thickness ranging from 6 to 7 feet of coal, with variable partings of clay and shale. The partings thicken in short distances from mere laminae to beds 2 or more feet thick. The Pardee underlies only a small area of Black Mountain and its outcrop in this basin is limited to the region about the extreme headwaters of South Fork. In this vicinity the bed has been opened in three pits, showing the following sections:

Sections of the Pardee coal bed at head of South Fork.

(Loc., 592; el., 2,993 feet, L.)

	Ft.	In.
Coal	1	6
Clay		3½
Coal	1	7
Clay		½
Coal		7
Clay		3
Coal		½
Clay		½
Coal		4
Clay		1
Coal	1	1½
Clay		2
Coal		11
Coal	6	1
Partings		10½

(Loc., 593; el., 2,978 feet, L.)

	Ft.	In.
Sandstone.		
Coal	3	0
Clay		6
Coal	4	0
Shale		
Coal	7	0
Parting		6

(Loc., 594; el., 3,000 feet, L.)

	Ft.	In.
Shale.		
Coal	2	10
Shale	12±	
Coal	1	
Clay and bone		3
Coal		10
Clay		2
Coal	2	0
Coal	6	8
Partings	12	5±

When measured, the base of the bed was not exposed and the thickness of the two lower coal benches and the clay parting are given from what is considered a reliable report.

High Splint coal bed.—The High Splint coal bed underlies only a very small area at the top of Black Mountain. It outcrops almost 400 feet above the Pardee bed and was seen on South Fork at one place only, where it shows a bed of clear hard splint coal from 4 to 5 feet thick. The following section of this bed was measured north of and 60 feet below the gap in Black Mountain between the basins of South Fork and Osborn Fork of Roaring Fork:

Section of the High Splint coal bed at head of South Fork.

(Loc., 595; el., 3,370 feet, L.)

	Ft.	In.
Sandstone.		
Coal	3	4
Bone		1
Coal	1	0
Sandstone		
Coal	4	4
Parting		1

The coal bed is underlain by a bed of sandstone 100 feet thick and nearly 50 feet of sandstone was seen between the coal bed and the gap. The upper sandstone is massive, cliff-making, and in places conglomeratic in character and is taken to be the basal stratum of the Harlan sandstone.

NORTH FORK OF POUND RIVER BASIN.

General features.—The basin of the North Fork of Pound River includes all of the territory drained by that stream from Flat Gap at its head on the west line of Wise County to Donkey, 1 mile west of Pound where the North and South forks unite to form Pound River. The basin, roughly rectangular in shape, is 7 miles long by 3½ miles wide, with the south margin on the ridge just south of the river and the north margin on the summit of Pine Mountain. The river receives its water almost exclusively from the north and northwest, through the many and long branches coming off the Pine Mountain slope. The drainage from the south consists of a few inconsequential streams, all entering the river in its upper half.

The surface of the basin is very hilly and densely covered with forest. The streams, such as Laural Fork, Phillips Creek, and Rumley Branch, have cut deeply into the mountain side and head in valleys that are wild and almost impenetrable but which become unusually flat, though narrow, on approaching the North Fork. The average height of Pine Mountain in this basin is about 3,000 feet, with Indian Grave Gap, the lowest point, a little over 2,500 feet. The crest of the mountain is on an average from one to two hundred feet higher west of Pound Gap than it is east of that place. No roads cross the mountain in this region, but a rough trail crosses at Indian Grave Gap. The only low outlets of this basin are that down Pound River at its lower end and a low gap connecting with South Fork, 1 mile below Dewey. This gap so closely resembles an old stream valley that it seems highly probable that originally the upper part of North Fork flowed through it uniting with South Fork 1 mile below Dewey. The diversion to its present course seems to have been accomplished by a small stream from Donkey eating back along the present course of North Fork and eventually tapping the larger streams. As soon as the diversion occurred the cross valley was left high and dry and today its highest point is scarcely more than 500 feet above the streams on either side. The evidence of such a diversion is to be found in the flatter grade of North Fork compared with that of South Fork; the narrow valley of North Fork compared with other valleys of the region; and the peculiar angle which North Fork makes at the point of division.

North Fork basin is thinly settled, Flat Gap being the only village within its limits. The entire population, almost without exception, live on North Fork, or short distances up its side valleys.

From Pine Mountain the rocks dip southeastward to the axis of the Middlesboro syncline which runs in a general northeast direction, conforming closely to the course of Pound River. On the crest of the mountain the dips are 20° to 40°; at the southeast base, 10°, and thence diminishes gradually to zero at the axis of the syncline. Rocks from the base of the Lee to the lower part of the Wise formation are exposed in this basin, with the basal conglomerate of the Lee near the Summit of Pine Mountain and the Wise formation on the ridges and knobs along the North Fork of Pound River. The massive sandstones of the Norton and Lee formations outcropping on the east slope of the mountain make in many places distinct ledges and low escarpments.

The coal beds in this basin, as in the Pound basin to the east, appear to be more constant and thicker in the higher measures than in the lower ones. The coal beds of the Lee formation are generally so thin that they have not been noted in this basin and the Norton coals were seen in only a few places, where mediocre beds are exposed. In the Wise formation the Clintwood and Imboden are the main coal beds, although some prospects have been opened on beds at intermediate horizons. Graphic sections of some of the coal beds are shown in figure 43. The coal resources of the basin are wholly untouched with the possible exception of small mines which are operated to supply local needs. The fact that but one wagon road crosses the basin, the one along the North Fork to Pound River and over Flat Gap, and that no railroads enter the basin explain in large part this lack of development. It is likewise apparent from the sections measured that even the more persistent coal beds in the Wise formation are thinner here than on Guest River and Indian Creek.

Coal beds below the Dorchester bed.—The lowest coal bed worked in this basin is opened on Rumley Branch 2 miles north of Flat Gap, (loc. 596, el. 1,880 feet, B). The bed shows a thickness of 2 feet of clear coal which has been mined on a small scale for local use. The bed lies at about the horizon of the Kennedy coal although the sandstone bed that underlies that coal elsewhere to the east is here not conspicuous. Its presence is indicated by sandstone float and a shaly sandstone dipping 12° southeast, about 60 feet below the coal bed.

On the North Fork of Pound River about 2 miles west of Pound a coal bed has been opened about 175 feet below the Gladeville sandstone. It shows the following section:

Section of a coal bed 2 miles west of Pound.

(Loc., 597; el., 1,560 feet, B.)

	Ft.	In.
Shale.		
Coal		10
Bone		3
Coal	1	9
Sandstone		
Coal	2	7
Parting		3

Two thin coal beds are exposed in the bottom of a ravine at loc. 598, el. 1,575 feet (B), one-half mile west of 597. They measured 18 inches and 6 inches in thickness and appeared to be 150 to 200 feet below the Gladeville sandstone.

The Norton coal bed, immediately below the Gladeville sandstone, is exposed just west of Laurel Fork in a cut of the logging railroad that formerly ran up the North Fork of Pound River. The coal is overlain by 120 feet of cross-bedded sandstone, massive near its top, and streaked with coal near its base. The section of the coal bed is as follows:

Section of the Norton coal bed 3 miles west of Pound.

(Loc., 599; el., 1,575 feet, B.)

	Ft.	In.
Sandstone.		
Shale	2±	
Coal	1	1
Clay		1½
Coal		6
Coal	1	7
Parting		1½

Coal beds above the Dorchester bed.—The coal beds of workable thickness in the Wise formation lie above the Dorchester. Several exposures and openings on this coal bed on the North Fork of Pound River indicate its presence in this basin but none shows a bed sufficiently thick to work. A coal bed 2 feet thick has been prospected 2 miles north of Dewey (loc. 600, el. 1,700 feet, B). The bed, which lies about 60 feet above the Gladeville sandstone, is fairly persistent and has been opened on the South Fork of Pound River and on the forks of Bowlecamp Creek.

The Clintwood coal has been opened by a mine 750 feet west of the store at Donkey, where the section given below was measured:

Section of the Clintwood coal bed west of Donkey.

(Loc., 601; el., 1,630 feet, B.)

	Ft.	In.
Sandstone.		
Coal	1	11
Clay		10
Coal		10
Coal	2	9
Parting		10

The hard, quartzose sandstone overlying the coal is the same as that commonly found above the Clintwood in other parts of the county.

Two prospects on the Clintwood coal bed three-fourths of a mile northeast of Flat Gap post office had been opened at loc. 602, el. 1,825 feet (B). Both were caved when visited but are reported to have been in a bed varying from 18 inches to 2 feet thick.

Locally a workable coal bed occurs at the top of the Addington sandstone above the Clintwood coal. It is 2 feet thick in a mine by the Flat Gap road near the state line, loc. 603, el. 2,040 feet (B), where it has been mined for local use. A coal bed lying about 70 feet above the Clintwood

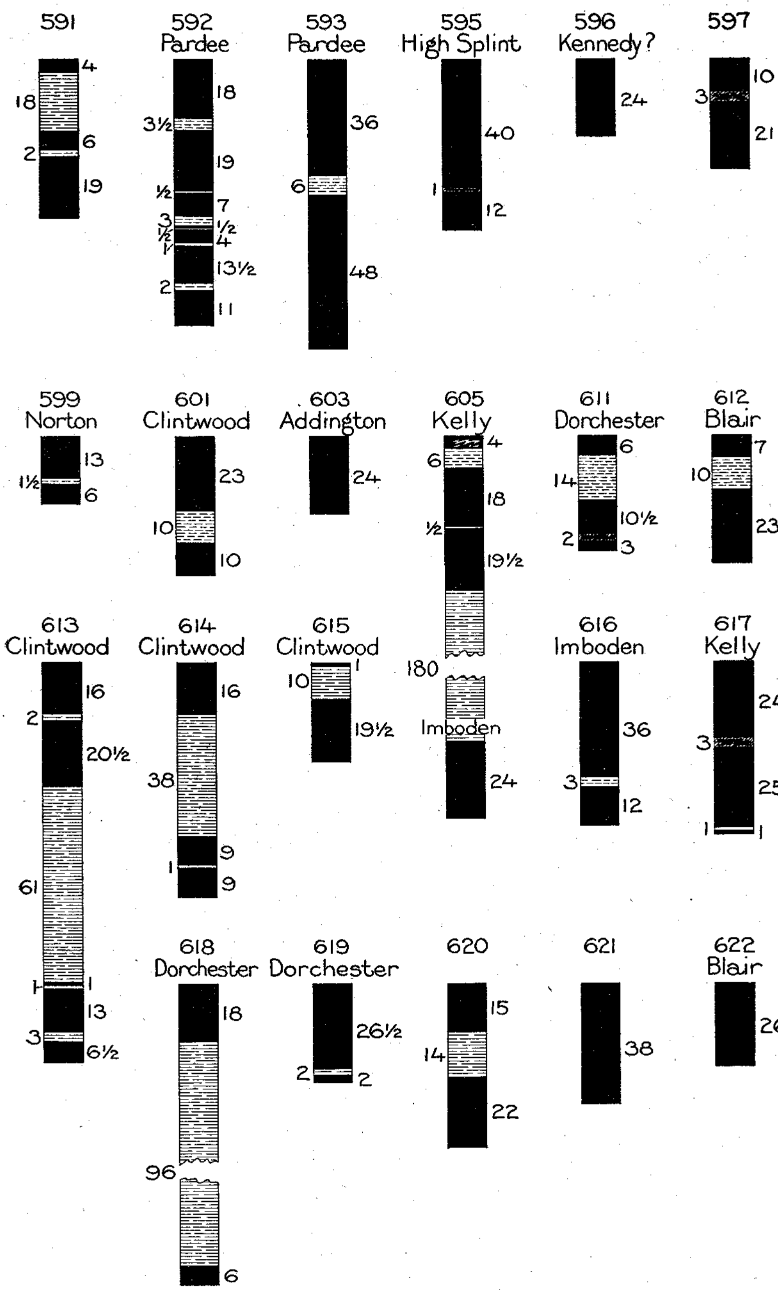


Fig. 43.—Sections of coal beds in the basins of South Fork and North Fork of Pound River, Pound River and Bowlecamp Creek.

coal is reported to be 2 feet thick in an old pit directly above the Clintwood prospect at loc. 602. Another thin coal bed has been prospected about 1 mile southwest of Flat Gap post office, loc. 604, el. 2,000 feet (B). The bed is 1 foot thick and about 150 feet above the Clintwood coal bed.

The Imboden and Kelly coal beds are the best coals in the North Fork basin but they lie only in the ridge south of Flat Gap and west of Dewey. Erosion has removed the beds almost entirely from the divide between the North and South forks of Pound River from Dewey to Donkey. The beds have been opened on the property of W. A. Bolling about 1 mile southwest of Flat Gap post office. It was from these openings that the two beds were previously given the names "Lower" and "Upper Bolling." Their sections at this place are as follows:

Sections of the Imboden and Kelly coal beds 1 mile southwest of Flat Gap post office.

(Loc., 605; el., 2,078 feet, L.)

	Ft.	In.
Upper bed.		
Shale.		
Coal and bone		4
Clay		6
Coal	1	6
Clay		½
Coal	1	7½
Coal	3	5½
Partings		6½
Shale (15 feet).		
Lower bed.		
Coal, reported 3 feet, exposed	2	0

The areal extent of the coal beds above the Imboden and Kelly outcropping in the North Fork basin is very small. The Standiford coals, 260 feet above the Kelly bed, occur in the high ridge immediately south of Flat Gap post office. As shown in two mines in Kentucky about one-half a mile west of the State line, on drainage of the Poor Fork of Cumberland River, the coal beds are without partings, the Lower Standiford being 3 feet, 2 inches and the upper bed 2 feet, 6 inches thick. The coal beds are about 20 feet apart. The Taggart and Low Splint coals occur higher up in the ridge, the outcrop of the latter being scarcely 100 feet below the summit. Their extent in the North Fork basin is insignificant.

POUND RIVER, WHITEOAK, AND MILL CREEK BASIN.

General features.—This basin is bounded by the State and the county line on the north and east, the divide between Mill Creek and Meade Fork on the south, and the divide between Stacy Branch and Bad Creek on the west. Pound River parallels Pine Mountain flowing to the northeast in deeply intrenched meanders. From the river whose average elevation is 1,500 feet, the slopes rise rapidly to flat or gently rounded hill summits at an elevation of about 2,000 feet. These rounded summits are remnants of what was once a general plateau but now is represented only by the hill and ridge tops southeast of Pine Mountain. From this plateau level the surface rises rapidly to the crest of Pine Mountain at an average elevation of 2,800 feet. Pound Gap, the lowest point in the mountain crest in Wise County, lies at the western margin of this drainage basin. The country is rough, sparsely settled, and its coal beds are practically untouched. Pound and Almira are the two largest settlements in the basin. A small settlement called Donkey is located at the juncture of the North and South forks of Pound River, 1 mile west of Pound.

The rocks in this basin rise uniformly to the northwest into Pine Mountain which forms the northwestern rim of the Middlesboro syncline, but the dips are somewhat in excess of that of the slope of the surface. The geologic structure of the basin is dominated wholly by the Middlesboro syncline, the axis of which lies just south of the Mill Creek and Meade Fork divide. The effect of this syncline is to expose rocks of successively lower stratigraphic position from Mill Creek to the crest of Pine Mountain. The section thus exposed ranges from the basal conglomerate of the Lee formation near the crest of Pine Mountain to the Imboden and Kelly coal beds of the Wise formation, south of Mill Creek.

The coming to the surface of the massive sandstones of the Norton and Lee formations makes exceedingly rough, broken topography on the slope of Pine Mountain, and strongly influences the drainage pattern. All of the mountain streams flow off the higher slopes in straight structurally-determined channels. The jutting massive sandstone beds farther down the slopes, however, have in many cases diverted the stream for long distances to courses along the outcrops of the weaker rocks at right angles to the regional dips. Examples of this right-angled or trellised arrangement of the streams are to be found in Bad Creek, Whitcoak Creek and their tributaries flowing down the slope of Pine Mountain. The most conspicuous ledge-making sandstone lying just beneath the Kennedy coal is widely exposed near Almira and is called the McClure sandstone. The outcrop of this sandstone has been traced across Dickenson [1] and Buchanan [2] counties. The Kennedy coal, however, has nowhere been seen by the writer or associated geologists in this basin. The Gladeville sandstone is a coarse-grained white sandstone which outcrops in the ridge along the south side of Pound River. It is a resistant bed and usually makes a distinct bench on the side of the ridge.

The lowest coal beds exposed in this basin are in the Lee formation. Four coals, exposed on the Pound Gap road, are closely grouped near the middle of the formation. The best of the beds shows a thickness of about 2½ feet. The coal beds of the Norton formation are thin and for the most part supposed to be valueless, as no exposure of a minable thickness of coal was seen.

The most valuable coal beds of the basin are in the Wise formation, but from the few sections measured it appears that the larger beds do not exceed 50 inches of coal exclusive of partings. The Dorchester, Clintwood, Imboden and Kelly coal beds are the principal ones outcropping in this basin. Graphic sections of some of the coal beds are shown in figure 43.

Coal beds below the Dorchester coal bed.—The lowest coal bed in the geologic section seen in this basin is exposed by the side of the Pound Gap road 500 feet southeast of the summit (loc. 606, el. 2,350 feet, B). The bed is about 200 feet above the base of the Lee and though it is imperfectly exposed, it appears to be at least 2½ feet thick.

One mile southeast of Pound Gap, in the vicinity of the abandoned narrow-guage railroad station, a group of coal beds in the Lee are exposed. At loc. 607, el. 2,000 feet (B), the coal is 1 foot, 2 inches thick with a 1-inch clay parting near the middle of the bed. The coal is impure and clearly not minable. At loc. 608, el. 1,940 feet (B), a bloom of 5 inches of coal split by 2 inches of clay is exposed. A coal bed is exposed at loc. 609, el. 1,860 feet (B), showing 1 foot, 6 inches of clear coal. Another thin coal bed was seen at loc. 610, el. 1,850 feet (B), several hundred feet east of loc. 609. The bed is 3 inches thick and lies 20 feet above the bed exposed at loc. 609.

As a whole, the coal beds of the Norton are practically untouched even by the prospector, and very little is known of their character. A prospect

[1] Giles, Albert W., The Geology and Coal Resources of Dickenson County, Bulletin No. XXI, Virginia Geological Survey, 1921, p. 13.

[2] Hinds, Henry, The Geology and Coal Resources of Buchanan Country, Virginia, Bulletin XVIII, Virginia Geological Survey, 1918, p. 68.

is reported to have been opened recently on the west side of the Pound Gap road three-fourths of a mile south of Almira in a coal bed of this formation. The coal bed is said to contain more than 2 feet of clear coal.

Dorchester coal bed.—Overlying the coarse-grained white Gladeville sandstone is the Dorchester coal bed. In this basin it is represented by a thin bed characetrized by partings, and comparing very poorly with the bed at Dorchester, the type locality. The Dorchester coal bed was measured in a prospect on Mill Creek 1 mile northeast of Pound and shows the following sections:

Section of the Dorchester coal bed on Mill Creek.

(Loc., 611; el., 1,605 feet, B.)

	Ft.	In.
Shale.		
Coal		6
Clay	1	2
Coal		10½
Bone		2
Coal		3
Coal	1	7½
Partings	1	4

In judging its value in this basin it is well to point out that the bed shows a wide range in thickness in several sections measured on Georges Fork and Camp Creek in Dickenson County just east of this basin, the average approximating 1½ to 2½ feet of coal exclusive of partings. The bed is doubtless of sufficient thickness in much of the area it underlies in the Pound River and Mill Creek basins to permit its being mined at a future date.

Blair and Clintwood coal beds.—The area underlain by Blair coal in this basin is very small. The dissected knob northwest of Pound contains the bed in workable thickness as indicated by a section measured in a small mine between Pound and Donkey, in which the coal is 2 feet, 6 inches thick but parted by 10 inches of clay 7 inches from the top of the bed.

The Clintwood coal bed outcrops on the ridges south of Pound River. It has been thoroughly prospected by the Clinchfield Coal Corporation, a number of the prospects being represented on the geologic map. The bed, however, is much thinner here than it is farther south and east. The coal bed is split into two benches by a thick parting as shown by a section of the bed measured 1½ miles northeast of Pound. The detailed section is as follows:

Section of the Clintwood coal bed on Mill Creek one and one-half miles northeast of Pound.

(C. C. C. prospect.)

(Loc., 613; el., 1,876 feet, L.)

	Ft.	In.
Coal	1	4
Shale		2
Coal	1	8½
Shale	5	1
Coal		1
Shale		1
Coal	1	1
Shale		3
Coal		6½
Shale		
Coal	4	9
Partings	5	7

On Pound River 1¼ miles south of Phipps the bed shows the following section:

Section of the Clintwood coal one and one-fourth miles south of Phipps.

(Loc., 614; el., 1,876 feet, L.)

	Ft.	In.
Shale.		
Coal	1	4
Clay	3	2
Coal		9
Clay		1
Coal		9
Clay		
Coal	2	10
Partings	3	3

The upper bench only of the Clintwood is represented in the section given for a prospect on Pound River near the Dickenson County line. The section is given below:

Section of the Clintwood coal bed on Pound River near Dickenson County line.

(C. C. C. prospect.)

(Loc., 615; el., 1,716 feet, L.)

	Ft.	In.
Shale.		
Coal		1
Shale		10
Coal	1	7½
Clay		
Coal	1	8½
Parting		10

Imboden and Kelly coal beds.—The Imboden and Kelly beds in this basin are separated by 20 to 40 feet of shale. They outcrop high on the divide between Mill Creek and Meade Fork and the area underlain by them in the Pound River and Mill Creek basin is very limited. From measured sections of these coal beds, they appear beyond question to be the most valuable coal beds in the basin. The following sections show the character of the beds:

Section of Imboden coal bed on summit at head of Mill Creek.

(Loc., 616; el., 2,050 feet, B.)

	Ft.	In.
Shale.		
Coal	3	0
Clay		3
Coal	1	0
Coal	4	0
Parting		3

Section of the Kelly coal bed 3 miles northeast of Pound.

(Loc., 617; el., 2,042 feet, L.)

	Ft.	In.
Sandstone.		
Shale	4	0
Coal	2	0
Bone		3
Coal	2	1
Clay		1
Coal		1
Coal	4	2
Partings		4

Imboden and Kelly coal beds are stratigraphically the highest beds outcropping in the Pound River and Mill Creek basin.

BOWLECAMP CREEK AND FORKS BASIN.

General features.—Four large streams join two miles southeast of Pound to form Bowlecamp Creek. Named successively from west to east they are Mullins, Dotson, Meade, and McFall forks. The streams flow in narrow V-shaped valleys which they have cut deeply into the plateau. The valleys are separated by high, sharp divides, dissected by numerous small lateral valleys. The valleys constitute a basin only in the sense that they are drained by a single stream, Bowlecamp Creek. Bowlecamp Mountain, 2,760 feet above sea level, is the highest point in the basin, rising about 1,150 feet above the mouth of the major stream.

The predominant structural feature in the Bowlecamp basin is the Middlesboro syncline which is unusually shallow and as a consequence the dips are slight. The axis of the syncline trends in a northeasterly direction, practically coincident with Meade Fork, in the northern part of the basin and southward from Meade Fork the strata rise gently on the southern limb of the syncline.

The Gladeville sandstone is the lowest formation outcropping in the basin. It is exposed continuously along Bowlecamp Creek from its mouth for a distance of 5 miles up the two southern forks, Mullins and Dotson. The Dorchester coal bed overlying the sandstone is exposed at several places. The Blair, Clintwood, Imboden, and Kelly coal beds outcrop throughout the basin, but no beds of workable thickness have yet been found on Bowlecamp Mountain above the Imboden and Kelly. Nothing is known of the coals below the Gladeville sandstone, as no boreholes have been put down on Bowlecamp Creek or any of its tributaries. That coal beds do underlie the basin might well be inferred from their presence in neighboring basins, where their presence has been proved by the drill. Graphic sections of coal beds occurring in this basin are shown in figures 43 and 44.

The development of mining in the Bowlecamp Creek basin, as in the basins of other tributaries of Pound River, has been prevented heretofore by the absence of thick beds of coal that are easily accessible and by lack of facilities for transportation. The only openings in the entire basin are a few scattered local mines, for the most part on the Pound–Clintwood road and the Pound–Birchfield Creek roads, the only roads through the basin.

Dorchester, Blair, and Intermediate coal beds.—The variability of the Dorchester bed in short distances lessens greatly its potential value from the point of view of future mining. Shale partings in many places split the bed into benches that are too thin to be worked. This is well shown in the sections given below, both of which were measured on the Dotson Fork, near Dotson school.

Sections of the Dorchester coal bed on Dotson Fork.

Prospect near the head of the creek.

(Loc., 618; el., 1,725 feet, B.)

	Ft.	In.
Shale or sandstone.		
Coal	1	6
Shale	8	0
Coal		6
Shale or clay	2	0
Sandstone, Gladeville.		
Coal	2	0
Parting	8	

Prospect near Dotson school.

(Loc., 619; el., 1,725 feet, B.)

	Ft.	In.
Sandstone.		
Coal	2	2½
Shale		2
Coal		2
Clay		
Coal	2	4½
Parting		2

The Dorchester coal is present on Mullins Fork as indicated by several blooms, but no accurate measurements of the bed could be obtained.

A coal bed 70 feet above the Gladeville sandstone and 25 feet below the Blair coal has been opened on Mullins Fork, 2½ miles above its mouth. This coal bed also has been opened at a few places on the South Fork of Pound River and to the southeast of this basin, but nowhere shows sections to justify hope for a large tonnage of merchantable coal. The section exposed in a local mine on Mullins Fork as given below is better than the average section of the bed.

Section of a coal bed on Mullins Fork.

(Loc., 620; el., 1,740 feet, B.)

	Ft.	In.
Shale.		
Bone		6
Coal	1	3
Clay	1	2
Coal	1	10
Coal	3	1
Parting	1	2

Near the head of Dotson Fork of Bowlecamp Creek (loc. 621, el. 1,920 feet, B) this bed is 38 inches thick and consists of clear coal. The distance between it and the underlying Gladeville sandstone and between it and the overlying Blair coal are almost exactly the same as on Mullins Fork.

On Bowlecamp Creek and its forks the Blair is a persistent and thick bed of coal that outcrops throughout a wide area. The outcrop is low in the ridges, making the bed easily accessible from the bottoms of the valleys.

The Blair coal has been opened on the ridge east of and 2½ miles above the mouth of Mullins Fork. It consists of 2 feet, 2 inches of clear coal, as shown in a prospect pit at loc. 622, el. 1,770 feet (B). On the head of Dotson Fork, at loc. 623, el. 1,950 feet (B), the bed is about 2 feet thick. The exposure is poor and an exact measurement could not be made. The bed on the McFall Fork is much parted as shown by the section given below, which was measured in a prospect pit on that stream.

Section of the Blair coal bed on McFall Fork.

(Loc., 624; el., 1,685 feet, B.)

Shale, black at bottom.	Ft.	In.
Coal		6
Parting		½
Coal		2½
Clay		5½
Coal		11
Bone		2
Coal		3
Clay	2+	
Coal	1	10½
Partings		8

Clintwood coal bed.—The Clintwood is one of the most valuable coal beds in Bowlecamp basin. It has been thoroughly prospected by the Clinchfield Coal Corporation which has opened a great many pits on its outcrop. The location of these pits is indicated on the geologic map, and their elevation, as determined instrumentally, is given in the body of the text. The hard quartzose Addington sandstone, varying from 10 to 50 feet in thickness, overlies the Clintwood coal bed in this basin. So persistent a feature is this sandstone that the outcrop of the Clintwood was traced along many of the ridges with great facility, using the sandstone as a key bed.

Near the head of Mullins Fork (C. C. C. prospect, loc. 625, el. 1,917 feet, L) the Clintwood bed contains but 22½ inches of coal parted by 7 inches of shale 8½ inches from the top of the bed.

The bed varies greatly in character and thickness in short distances. On the west side of Dotson Fork at loc. 626, el. 1,868 feet (L), it consists of 3 feet, 4 inches of clear coal; about 2 miles southeast of this location, however, on the same stream, its thickness is greatly increased, as shown by the following section:

Section of the Clintwood coal bed near head of Dotson Fork.

(C. C. C. prospect.)

(Loc., 627; el., 2,929 feet, L.)

	Ft.	In.
Coal	5	2½
Shale		11
Coal	1	2
Shale		1
Coal	1	0
Shale and clay		7
Coal	1	6
Coal	8	10½
Partings	1	7

This section of the Clintwood bed is exceptionally thick for the Bowlecamp Creek basin, exceeding by several feet the average thickness of the bed.

A Clinchfield prospect at loc. 628 indicates the presence of the Clintwood on Duckcamp Branch of Dotson Fork at an elevation of 1,907 feet

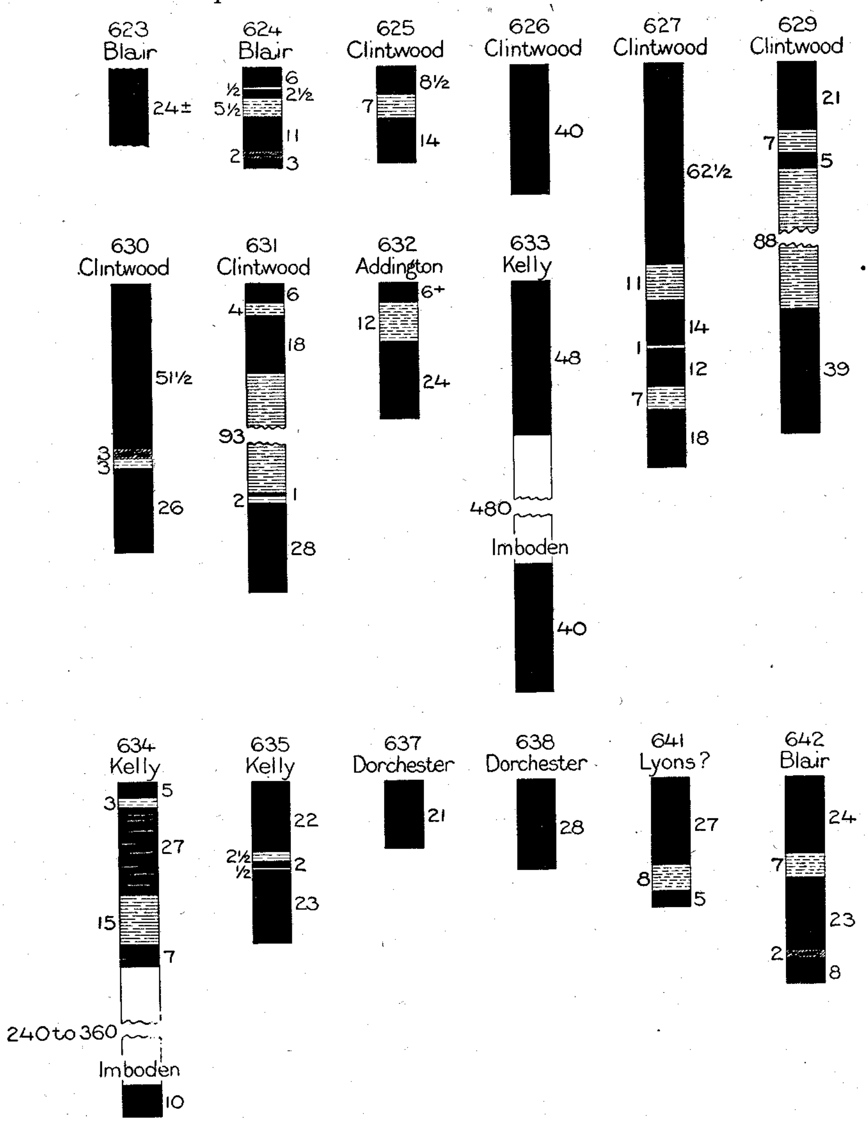


Fig. 44.—Sections of coal beds in the basins of Bowlecamp Creek and Birchfield Creek.

(L), but no section was reported. East of the junction of Meade and Dotson Forks the Clintwood shows the following section:

Section of the Clintwood coal bed at juncture of Meade and Dotson forks.

(C. C. C. prospect.)

(Loc., 629; el., 1,822 feet, L.)

	Ft.	In.
Clay.		
Shale, carbonaceous	1	0
Clay	1	2
Coal, soft	1	9
Shale		7
Coal		5
Shale	7	4
Coal	3	3
Shale		
Coal	5	5
Partings	7	11

An excellent section is exposed on McFall Fork 3 miles east of Pound, which is as follows:

Section of the Clintwood coal bed on McFall Fork.

(Loc., 630; el., 1,786 feet, L.)

	Ft.	In.
Sandstone	50	
Coal	4	3½
Bone		3
Clay		3
Coal	2	2
Coal	6	5½
Parting		6

The bed is scarcely workable on the west side of Meade Fork where shale and clay partings split the bed into a number of thin benches. One measurement shows the bed to have the following section:

Section of the Clintwood coal bed on Meade Fork near mouth.

(C. C. C. prospect.)

(Loc., 631; el., 1,818 feet, L.)

	Ft.	In.
Coal		6
Clay		4
Coal	1	6
Shale	7	9
Coal		1
Shale		2
Coal	2	4
Coal	4	5
Partings	8	3

Addington coal bed.—Locally a coal bed occurs at the top of the Addington sandstone. It is workable at only a few places and is negligibly thin or absent in most of the basin. The greatest observed thickness of this bed is on the ridge west of Mullins Fork. A section here (loc. 632, el. 1,935 feet, B) shows the bed to contain 2½ feet of coal, parted 6 inches from the top by 1 foot of clay.

Imboden and Kelly coal beds.—These coal beds are present only in Bowlecamp Mountain and the ridges between Dotson, McFall and Meade Forks, and Mill Creek, and the area underlain by them is considerably smaller than that underlain by the Clintwood bed. They have been prospected extensively by the Clinchfield Coal Corporation, the upper coal being called the "Five-foot" bed. The Imboden and Kelly coal beds are well developed in the Bowlecamp basin and they are in general free from partings.

The two beds show an excellent section at the head of McFall Fork, in the ravine south of the country line triangulation station. The section is as follows:

Section of the Imboden and Kelly coal beds on McFall Fork.

(Loc., 633; el., 2,110 feet, L.)

(Elevation given on base of Kelly bed.)

	Ft.	In.
Shale	5	
Coal, clear, Kelly	4	0
Clay		
Interval	40	
Coal, Imboden	3	4
Bone		3
Clay		
Coal (Kelly)	4	0
Coal (Imboden)	3	4

The coal beds lie nearly flat on Meade Fork, showing only a very slight dip to the north. On the head of the creek the Kelly bed is laminated with shale and clay and is of questionable value. The following two sections measured near the head of the stream represent the average character of the beds:

Sections of the Imboden and Kelly coal beds on Meade Fork.

(C. C. C. prospects.)

(A) (Loc., 634; el., 2,081 feet, L.)

		Ft.	In.
Coal	Kelly	..	5
Clay or shale	Kelly	..	3
Coal	Kelly	2	3
Shale	Kelly	1	3
Coal	Kelly	..	7
Shale			
Interval 20 to 30 feet.			
Coal, Imboden			10
Coal, Kelly		3	3
Partings, exclusive of interval		1	6

(B) (Loc., 635; el., 2,046 feet, L.)

		Ft.	In.
Coal	Kelly	1	10
Shale	Kelly	..	2½
Coal	Kelly	..	2
Shale	Kelly	..	½
Coal	Kelly	1	11
Shale			
Coal		3	11
Partings			3

The lower bed was searched for at the second prospect (B), but only 1 inch of coal was found at that horizon. Farther west at loc. 636, el. 2,074 feet, L, the upper bed consists of 38 inches of alternating bands of coal and shale. The lower bed is not exposed and is probably absent.

BIRCHFIELD CREEK BASIN.

General features.—A tract of land in northeastern Wise County embracing 15 to 18 square miles is drained by Birchfield Creek, an affluent of Cranesnest River. The stream, about 7½ miles long, takes a northeastward course, and joins Cranesnest River at the Wise–Dickenson County line 2 miles south of Hibbitts Gap. Dotson Fork, the longest branch, enters Birchfield Creek near the center of the drainage basin. Wagon roads follow the main stream valleys, but none of the main highways of the county enters the basin. The nearest important town is Wise, the county seat, two or three miles to the south. There are no railroad lines or connections in this territory, and the basin as a whole is sparsely settled.

The valley of Birchfield Creek is comparatively level and has flood plains that in places are several hundred yards wide. All of the side branches with the exception of Dotson Fork, flow in narrow valleys, so typical of the Pound River section of Wise County. The slopes are well wooded, although most of the large timber has been removed.

There are no dominant structural features in the basin, the rocks having a gentle regional dip to the northwest, toward the axis of the Middlesboro syncline. The rocks exposed belong to the lower part of the Wise formation, the Gladeville sandstone, and the upper part of the Norton formation. The Gladeville sandstone outcrops along Birchfield Creek, nearly to its head, and extends for several miles back towards the head of Dotson Fork and its branches.

The coal beds outcropping in the Birchfield basin and indicating good mining possibilities, are six in number and lie above the Gladeville sandstone. The Norton coal bed below this sandstone was not seen, and the fact that no pits could be found at that horizon is a strong indication that this bed is entirely too thin to encourage even the prospector. The lower coal beds have been prospected with the drill by the Clinchfield Coal Corporation in three holes in the Birchfield basin (see Plate III in pocket) in which they encountered some of the lower coals of the Norton formation. Graphic sections of many of the coal beds are shown in figures 44 and 45.

The Dorchester coal, a bed about 60 feet above the Dorchester, and the Blair bed, is each about 2 feet thick and offers little for mining under present conditions. The Clintwood coal is undoubtedly the best coal outcropping in the basin, with the Addington and Kelly coal beds good seconds. All three have been opened in parts of the basin. The Clintwood bed at places is split by a shale parting up to 10 and 15 feet in thickness but either one bench or the other, or when together both make a coal bed thick enough to mine.

The only shipping mines are located in the southwestern part of the basin, in the Clintwood and Addington coal beds. The coal from these mines is hauled by wagon to Wise. Mining on a larger scale, or in the interior of the basin will not be practical until some way is provided for shipping the coal direct from the mines.

Dorchester and Blair coal beds.—The Dorchester coal bed has been measured at very few places in the Birchfield Creek basin. It was seen, however, at several places, outcropping directly above the Gladeville sandstone, and showing an insignificant bloom. The bed apparently persists throughout the whole basin but its value is questionable. It was measured at two exposures on Birchfield Creek, two miles above the mouth of Dotson Fork. At loc. 637, el. 1,927 feet (L), on the east side of the road the coal shows a thickness of 1 foot, 9 inches. At loc. 638, el. 1,930 feet (B) the bed measures 2 feet, 4 inches.

On the lower part of Birchfield Creek, near the Birchfield School, two closed pits, with a small showing of scattered coal on the dumps, were visited. These pits (loc. 639, el. 1,810 feet B, and loc. 640, el 1,825 feet, approx.), are the only ones that were seen in which attempts have been made to mine the coal.

A coal bed that is higher than the Dorchester and that is referred to the horizon of a coal bed found at other places in the basin outcropping about 60 feet above the Dorchester, has been opened on Dotson Fork, northeast of Gillem School. The coal is probably the Lyons bed. A section was measured at loc. 641, el. 2,160 feet (B), where the coal is 2 feet, 8 inches thick parted 5 inches above the bottom by 8 inches of clay.

A short distance up the stream from loc. 641 the Blair bed is exposed, giving the following excellent section:

Section of the Blair coal bed on Dotson Fork of Birchfield Creek.

(Loc., 642; el., 2,235 feet, L.)

	Ft.	In.
Shale.		
Coal, soft	2	0
Clay		7
Coal, hard	1	11
Bone		2
Coal, hard		8
Shale		
Coal	4	7
Partings		9

The Blair coal is a persistent bed and has been opened in the basins to the west, north, and east. It has, however, scarcely been touched in the Birchfield Creek basin.

Clintwood coal bed.—The Clintwood is unquestionably the best coal bed in the Birchfield basin. Its average thickness is between 4 and 6 feet, but in the northeastern end of the basin the thickness ranges from 9 to 12 feet exclusive of partings. Except for a few scattered wagon mines at the head of Dotson Fork, however, the coal of this bed is not being utilized. The outcrop of the bed has been largely prospected by agents of the Clinchfield Coal Corporation, some of whose measured sections will be given.

The bed, everywhere in the basin, is found immediately beneath the hard, quartzose Addington sandstone, which in this basin is from 20 to 40 feet thick. In the basin of the Left Fork of Lick Fork of Cranesnest River, only a very small portion of which extends into Wise County, the Clintwood coal is split, as the following section shows:

Sections of the Clintwood coal bed at the head of Left Fork of Lick Fork of Cranesnest River.

(C. C. C. prospect.)

(Loc., 643; el., 1,976 feet, L.)

	Ft.	In.
Coal	4	0
Shale		1
Coal		2½
Shale	1	6
Coal	5	0
Shale	1	
Coal	2	
Clay	7	2
Coal	1	9
Clay		
Coal, upper bench	11	2½
Parting, upper bench	2	7

On Duckcamp Branch of Birchfield Creek the Clintwood is much parted but shows a thickness of about 6 feet of coal. The following section was measured near the head of the branch:

Sections of the Clintwood coal bed on Duckcamp Branch.

(Loc., 644; el., 2,006 feet, L.)

	Ft.	In.
Sandstone	40	
Coal		8½
Clay		½
Coal	3	2½
Clay		½
Coal		2
Bone		4
Clay	1	6
Coal	1	
Clay		5
Coal		2
Bone		1½
Coal		1½
Bone		1½
Coal		8
Clay		
Coal	6	½
Partings	2	7

The upper benches, aggregating 4 feet 1 inch in thickness, is workable but the rest is practically worthless.

The Clintwood is cut through in the gap in the ridge three-fourths of a mile west of loc. 644. The bed has been opened on the west side of the gap (loc. 645, el. 2,041 feet, L) showing 3 feet 10 inches of coal with clay above and below.

The Clintwood coal outcrops around the point of the spur west of Ambrose Branch. A pit opened by the Clinchfield Coal Corporation, on the spur (loc. 646, el. 2,005 feet, L) gives the thickness of the bed as 2 feet, 7 inches. It is not improbable that this is the upper bench only as sections measured west of this place show a large shale parting between the two benches. The following section measured south of Bean Gap shows a thick parting:

Section of the Clintwood coal bed south of Bean Gap.

(C. C. C. prospect.)

(Loc., 647; el., 2,083 feet, L.)

	Ft.	In.
Coal		3
Shale		½
Coal		1
Shale		7
Coal	1	3
Shale	7	9
Coal		6
Shale		1
Coal	1	11
Shale		
Coal, upper bench	1	7
Partings, upper bench		7½
Coal, lower bench	2	5
Parting, lower bench		1

The bed has a mediocre section on the head of Birchfield Creek, as shown below:

Section of the Clintwood coal bed at head of Birchfield Creek.

(C. C. C. prospect.)

(Loc., 648:; el., 2,256 feet, L.)

	Ft.	In.
Coal	1	4
Shale	1	5
Coal		1
Shale	2	1
Coal		8½
Coal	2	1½
Partings	3	6

The bed has a much better section on the head of Dotson Fork, where the following was measured:

Section of the Clintwood coal bed near head of Dotson Fork.

(C. C. C. prospect.)

(Loc., 649; el., 2,220 feet, L.)

	Ft.	In.
Sandstone.		
Coal	2	11
Shale		½
Coal		1½
Shale		2
Coal		3
Shale		
Coal	3	3½
Partings		2½

The Clintwood bed is being mined just northeast of Gillem School at the head of Dotson Fork. It lies 5 feet below the Addington sandstone, which here is gray to brown, arkosic, and medium hard. The coal bed has the following section:

Section of the Clintwood coal bed in mine north of Gillem School.

(Loc., 650; el., 2,300 feet, B.)

	Ft.	In.
Sandstone, massive	5	
Shale with sandstone partings	5	
Coal		1
Shale		¼
Coal		1
Shale		¼
Coal		1
Shale		¼
Coal	1	4
Shale		3
Coal		5
Shale, carbonaceous		4
Coal		1
Clay		
Coal	2	1
Partings		7¾

A local mine appearing not to have been recently used, was visited at the southernmost extent of the Clintwood outcrop on Dotson Fork. The coal here (loc. 651, el. 2,460 feet, B) is 33 inches thick. As is commonly the case in this basin the coal bed is overlain by thick sandstone. The coal in this mine is unusually clean and well jointed.

Addington coal bed.—The Addington coal bed has its best and probably only area of development in the Birchfield basin in the low ridge between this basin and Yellow Creek basin to the south. It is primarily a local bed, as it is known to be absent throughout a large part of northern Wise County.

The coal in the ridge southwest of Hurricane has been opened by numerous wagon mines. It averages 3½ feet of coal with very little parting and lies from 40 to 80 feet above the Clintwood bed. Its outcrop has only been sketched on the geologic map (Pl. II) for a small portion of north-central Wise County, as only that area is known to carry the coal.

A slumped mine two miles north of Wise, on the road running north from the Wise fair grounds shows the partial section given below:

Section of the Addington coal bed two miles north of Wise.

(Loc., 652; el., 2,510 feet, B.)

	Ft.	In.
Shale.		
Coal	1	4
Clay		1
Coal		4
Shale	2	4
Coal		6
Clay	4	
(Bottom concealed.)		
Coal, exposed	2	2
Partings, exposed	2	5

A good workable thickness is displayed in a wagon mine a short distance east of the last location. The bed here is 10 to 15 feet above the Addington sandstone.

Sections of the Addington coal bed about 3 miles northeast of Wise.

(Loc., 653; el., 2,540 feet, B.)

	Ft.	In.
Clay	3	
Coal		7½
Clay		1½
Coal	2	11
Clay		
Coal	3	6½
Parting		1½

(Loc., 654; el., 2,540 feet, B.)

	Ft.	In.
Clay.		
Coal		7
Clay		2
Coal	3	0
Clay		
Coal	3	7
Parting		2

A number of closely grouped pits are located on the outcrop of the Addington bed on the north side of the road extending west from B. M. 2565, one-half mile southwest of Hurricane. Three openings are grouped under loc. 655, el. 2,520 feet (B). The coal bed in all three pits is 40 inches thick without a parting, and is overlain and underlain by clay.

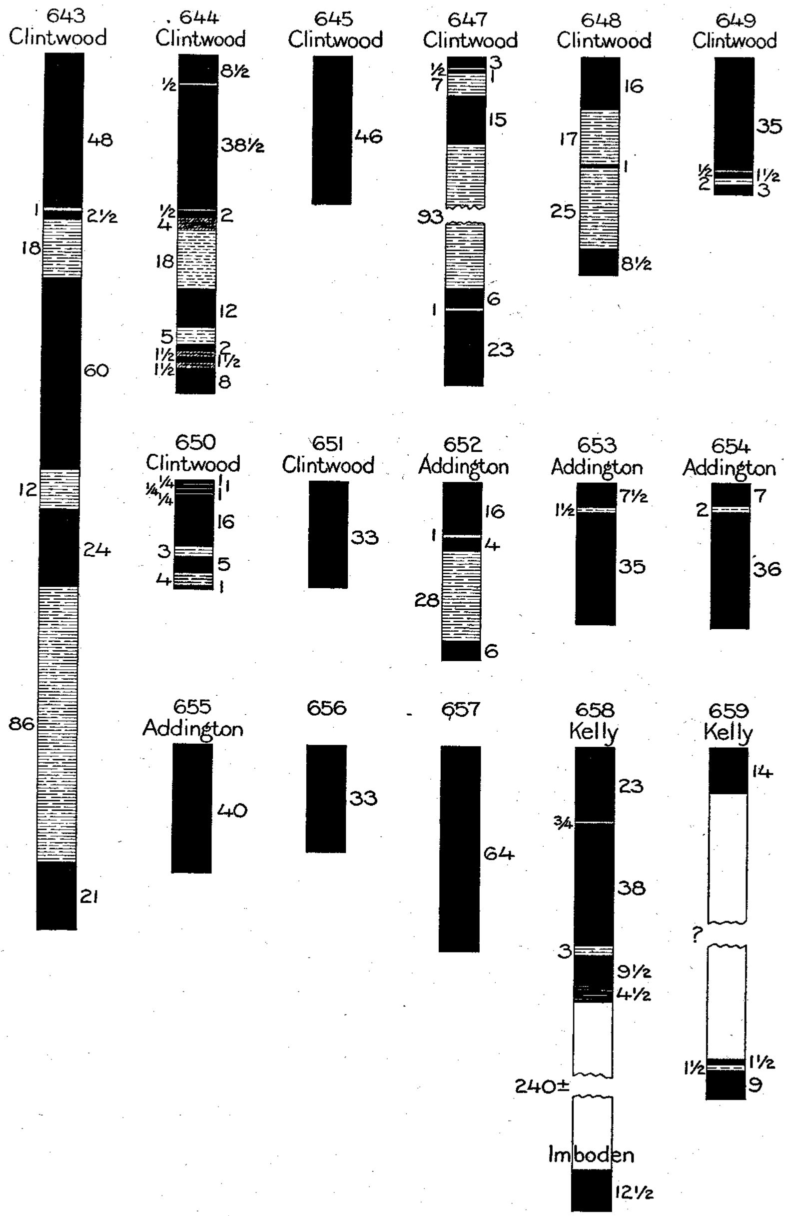


Fig. 45.—Sections of coal beds in the basin of Birchfield Creek.

There is another pit nearly a mile to the west, but the coal is hidden under slide material. The coal was seen at no other place in the Birchfield Creek basin, although a carbonaceous bloom was found at a few localities on Birchfield Creek above the Addington sandstone.

Imboden and Kelly coal beds.—The Imboden and Kelly beds outcrop on Bowlecamp Mountain, on the divide between Birchfield and Indian creeks and near the top of the ridge between Birchfield Creek on the north and Yellow and Glade creeks on the south. The beds probably cap several of the higher hills southeast of Birchfield Creek but their acreage in these hills is so small as to be almost negligible.

The Imboden bed ranges from 18 inches to 5 feet in thickness and the Kelly bed shows a similar variation. These coals are probably at their best in the relatively large Bowlecamp Mountain field, where two entries were driven into one of the beds. The field notes do not designate which of the two beds the sections represent, but at loc. 656, el. 2,300 feet (B), there is 33 inches of coal and at loc. 657, el. 2,269 feet (L), 64 inches of coal.

A small tract of Imboden and Kelly coal on the ridge south of Bean Gap has been prospected by the Clinchfield Coal Corporation, and in a pit south of the gap the coal beds have the following section:

Section of the Imboden and Kelly coal beds south of Bean Gap.

(C. C. C. prospect.)

(Loc., 658; el., 2,367 feet, L.)

	Ft.	In.
Shale.		
Coal	1	11
Shale		¾
Coal	3	2
Shale		3
Coal		9½
Coal, shaly		4½
Coal, Kelly	5	10½
Partings		3¾
Interval about 20 feet.		
Sandstone		
Coal, Imboden	1	0½

At the southern end of the outcrop on this knob, the beds show a very much smaller section, as indicated by the following:

Sections of the Imboden and Kelly coal beds south of Bean Gap.

(C. C. C. prospect.)

(Loc., 659; el., 2,525 feet, L.)

	Ft.	In.
Coal, Kelly	1	2
Interval, not recorded.		
Coal		1½
Shale		1½
Coal		9
Coal, Imboden		10½
Parting		1½

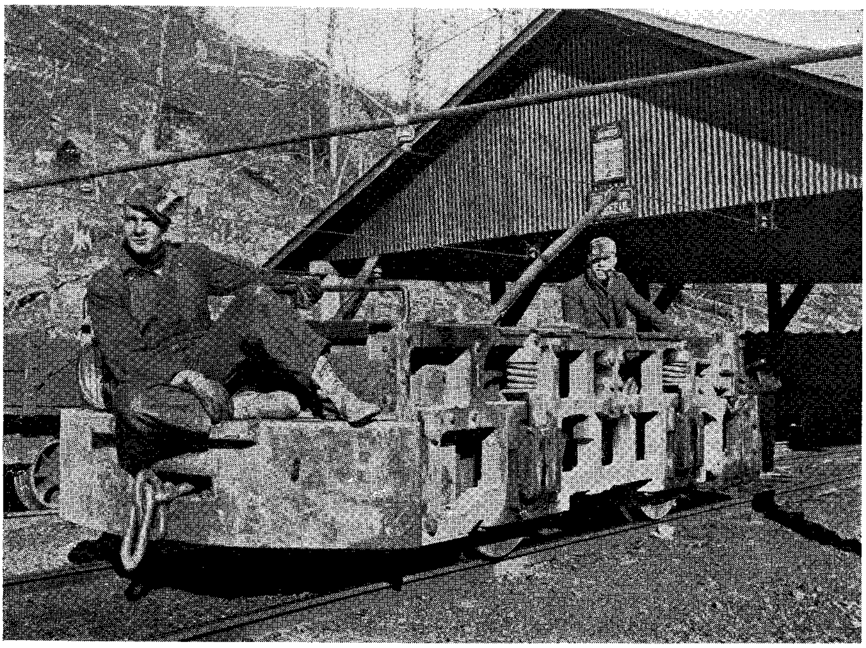
The Imboden and Kelly beds have not been prospected south and east of this place, but many of the knobs are sufficiently high to catch them and their outcrop is indicated on the geologic map by a broken line.

CRANESNEST RIVER AND CANEY CREEK BASIN.

General features.—The drainage of Cranesnest River and Caney Creek, in Wise County, is limited to a few of the headwater tributaries of the two streams. The major portion of the two basins, separated by Big Ridge, lies in Dickenson County, where Cranesnest River empties into Pound River and Caney Creek empties into McClure River, all tributary to the Russell Fork of Big Sandy River. The ridge between the waters of Cranesnest and Guest rivers is narrow and irregular. Three miles west of Coeburn, Steele Fork of Cranesnest River heads far south on the plateau, its head being within three-fourths of a mile of Guest River, whereas at Coeburn, Guest River drainage has pushed the divide back to Fullers Gap, a distance of 4 miles from the main stream.

The rocks in this basin dip gently to the north and northwest. The downstream component of the dip is nearly the same as the gradient of the stream, and this arrangement results in practically the same bed being exposed near water level throughout that part of the valley in Wise County. This likewise accounts for the limited stratigraphic section exposed in the basin, as the only outcropping rocks lie within the interval from 100 feet beneath the Lower Banner coal bed to 100 feet above the Gladeville sandstone.

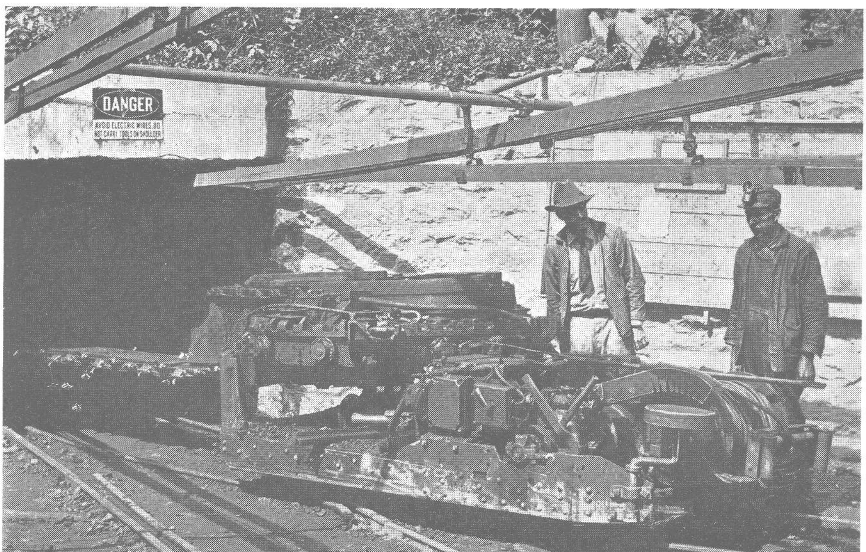
The only coal bed in this basin of commercial importance at present is the Upper Banner, which averages from 3 to 5 feet in thickness. The Lower Banner bed is at many places thin and worthless. The Dorchester bed outcropping near the top of the plateau occurs at only a few places



(A) Electric locomotive used in many of the larger mines in Wise County. The motorman operates the motor from the rear and the switchman rides in front.

(B) A Jeffrey arc wall-cutting machine, used to undermine a bed of coal prior to shooting the coal down. An endless chain with projecting steel knives rotates around the long arm extending to the left from the machine. This arm, with the chain in rapid motion is forced against the coal bed at or near its base and a cut is quickly made up to the length of the arm, which ranges up to 8 feet. The machine is run by electricity.

(A) Electric locomotive used in many of the larger mines in Wise County. The motorman operates the motor from the rear and the switchman rides in front.

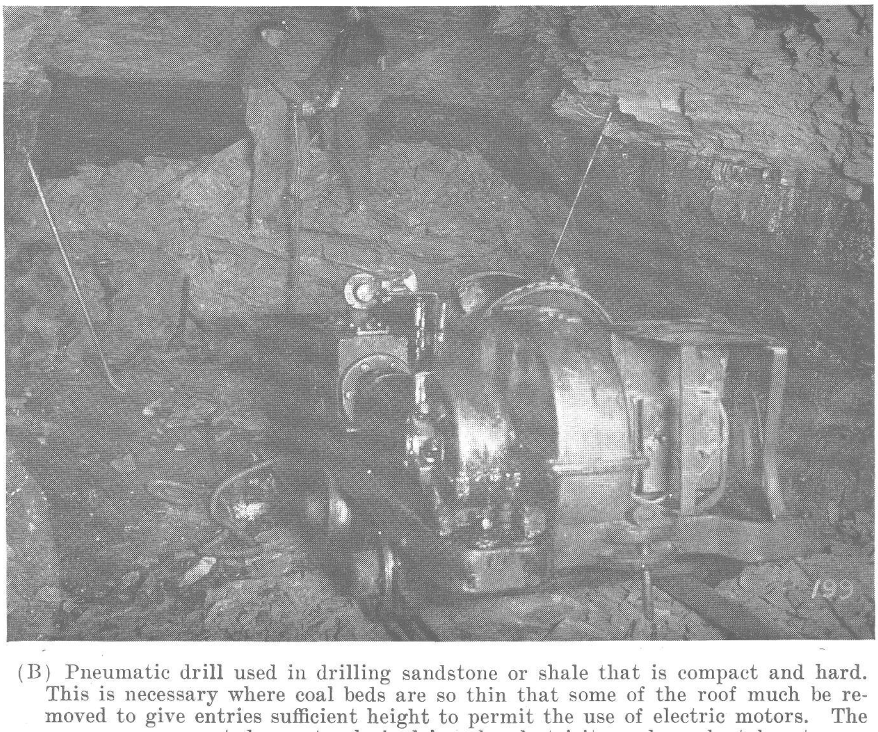


(B) A Jeffrey arc wall-cutting machine, used to undermine a bed of coal prior to shooting the coal down. An endless chain with projecting steel knives rotates around the long arm extending to the left from the machine. This arm, with the chain in rapid motion is forced against the coal bed at or near its base and a cut is quickly made up to the length of the arm, which ranges up to 8 feet. The machine is run by electricity.

(A) Slate fall following the removal of a coal pillar. The miner is testing roof by striking with iron bar and he infers from the sound the strength or weakness of roof.

(B) Pneumatic drill used in drilling sandstone or shale that is compact and hard. This is necessary where coal beds are so thin that some of the roof much be removed to give entries sufficient height to permit the use of electric motors. The compressor, mounted on a truck, is driven by electricity and can be taken to any part of the mine.

(A) Slate fall following the removal of a coal pillar. The miner is testing roof by striking with iron bar and he infers from the sound the strength or weakness of roof.



(B) Pneumatic drill used in drilling sandstone or shale that is compact and hard. This is necessary where coal beds are so thin that some of the roof much be removed to give entries sufficient height to permit the use of electric motors. The compressor, mounted on a truck, is driven by electricity and can be taken to any part of the mine.

and was nowhere found to be more than 2½ feet thick. Sections of the coal beds exposed in this basin are shown graphically in figs. 46 and 47.

Coal beds underlying but not exposed in this basin are shown by drillhole records 70 and 71 (Pl. III) and the rocks between the surface of the plateau and the Upper Banner coal bed are shown by drillhole records 59, 60, 61, 62, and 63 (Pl. III).

The only development of the coal resources of this basin has taken place on Caney Creek where the Clinchfield Coal Corporation has large mines in the Upper Banner coal bed. There are no mines on Cranesnest River, except in so far as those on the Toms Creek side have extended their entries thruogh the divide. The coal mined on Chaney Creek is carried through the mine under Sandy Ridge to Fuller Branch of Toms Creek, whence it is shipped over the Clinch Valley division of the Norfolk and Western Railway.

Lower Banner coal bed.—The lowest coal bed outcropping in the Cranesnest River and Caney Creek basin is the Lower Banner. It is found usually about 100 feet below the Upper Banner bed. Few prospects have been opened on it and where seen it is too thin to encourage mining enterprises. The bed was measured on Trace Fork 1¼ miles above the mouth (loc. 660), where it is 14 inches thick, and is overlain by 1 foot of shale which in turn is overlain by 2 inches of coal.

An identical section was measured on the point of a small spur about 500 yards north of location 660. The exact elevation of the Lower Banner bed was not determined but the bed lies approximately 100 feet below the Upper Banner which here is at an elevation of 2,050 feet. On Hurrican Fork and Caney Creek, in Wise County, the Lower Banner bed takes cover within a mile of the county line.

Upper Banner coal bed.—The Upper Banner is by far the most important coal bed in this basin. It has an extensive outcrop on the various streams and contains, on the average, 5 feet of coal. The bed shows its characteristic parting of sandstone at almost all the locations where sections were measured.

A bloom of the Upper Banner bed was seen at loc. 661, el. 1,800 feet (B) on the west bank of Cranesnest River opposite Lyon Fork, and several prospects were opened on the bed from 4 to 5 miles south of this place on both sides of Steele Fork. The coal bed here is very close to stream level. In old pits near the southernmost extent of the outcrop, on the east side of the stream, the following sections were measured:

Sections of the Upper Banner coal bed near head of Steel Fork.

(Loc., 662; el., 2,190 feet, B.)

	Ft.	In.
Sandstone	4+	
Shale	7	
"Rash"	1	4
Shale		4
Coal	1	8+
Shale		2
Sandstone		4
Coal	1	8+

(Loc., 663; el., 2,120 feet, B.)

	Ft.	In.
Shale	8+	
Sandstone	2	6
Coal		11
Sandstone		1
Coal	2	1
Coal	3	0
Parting		1

The Upper Banner bed has been thoroughly prospected by the Clinchfield Coal Corporation on Trace Fork, Hurricane Fork, and Caney Fork. The sections measured in a number of these prospects are given below. The first section to be considered is that measured near the head of Trace Fork on the west side of the stream:

Section of the Upper Banner coal bed on west side of Trace Fork.

(C. C. C. prospect.)

(Loc., 664; el., 2,110 feet, L.)

	Ft.	In.
Coal	1	2½
Sandstone		1½
Coal	1	2
Shale		¼
Coal		8
Shale		5
Coal		6
Coal	3	6½
Partings		6¾

The other sections measured in prospects on the east side of Trace Fork are given below, the locations being numbered from the head toward the mouth of the stream.

Sections of the Upper Banner coal bed on east side of Trace Fork.

(C. C. C. prospects.)

(Loc., 665; el., 2,072 feet, L.)

	Ft.	In.
Coal	1	5
Sandstone		1
Coal	1	9
Coal	3	2
Parting		1

(Loc., 666; el., 1,989 feet, L.)

	Ft.	In.
Coal	1	10
Sandstone		1½
Coal	1	8
Coal	3	6
Parting		1½

(Loc., 667; el., 2,003 feet, L.)

	Ft.	In.
Sandstone.		
Coal		3
Sandstone		1
Coal	1	4
Sandstone		3
Coal		¼
Sandstone		2½
Coal		½
Sandstone		1
Coal		¼
Coal	1	8
Partings		7½

(Loc., 668; el., 2,040 feet, approx.)

	Ft.	In.
Sandstone.		
Coal		8
Shale		1
Coal	1	4
Sandstone		1
Coal	1	4
Shale		
Coal	3	4
Partings		2

(Loc., 669; el., 2,085 feet, L.)

	Ft.	In.
Shale.		
Coal		8
Shale		1
Coal	1	4
Sandstone		1
Coal	1	4
Coal	3	4
Partings		2

(Loc., 670; el., 2,096 feet, L.)

	Ft.	In.
Shale.		
Coal	1	3
Sandstone		1
Coal	1	5½
Coal	2	8½
Parting		1

(Loc., 671; el., 2,070 feet, approx.)

	Ft.	In.
Coal	1	4
Shale		1
Coal	1	6
Coal	2	10
Parting		1

(Loc., 672; el., 2,040 feet, approx.)

	Ft.	In.
Coal	1	3
Sandstone		1
Coal	1	7
Coal	2	10
Parting		1

(Loc., 673: el., 2,020 feet, approx.)

	Ft.	In.
Shale.		
Coal	1	3
Sandstone		1
Coal	1	3
Shale		
Coal	2	6
Parting		1

(Loc., 674; el., 1,985 feet, L.)

	Ft.	In.
Shale.		
Coal	2	1
Shale		

(Loc., 675; el., 1,975 feet, approx.)

	Ft.	In.
Shale.		
Coal	1	3
Sandstone		1
Coal	1	11
Shale		
Coal	3	2
Parting		1

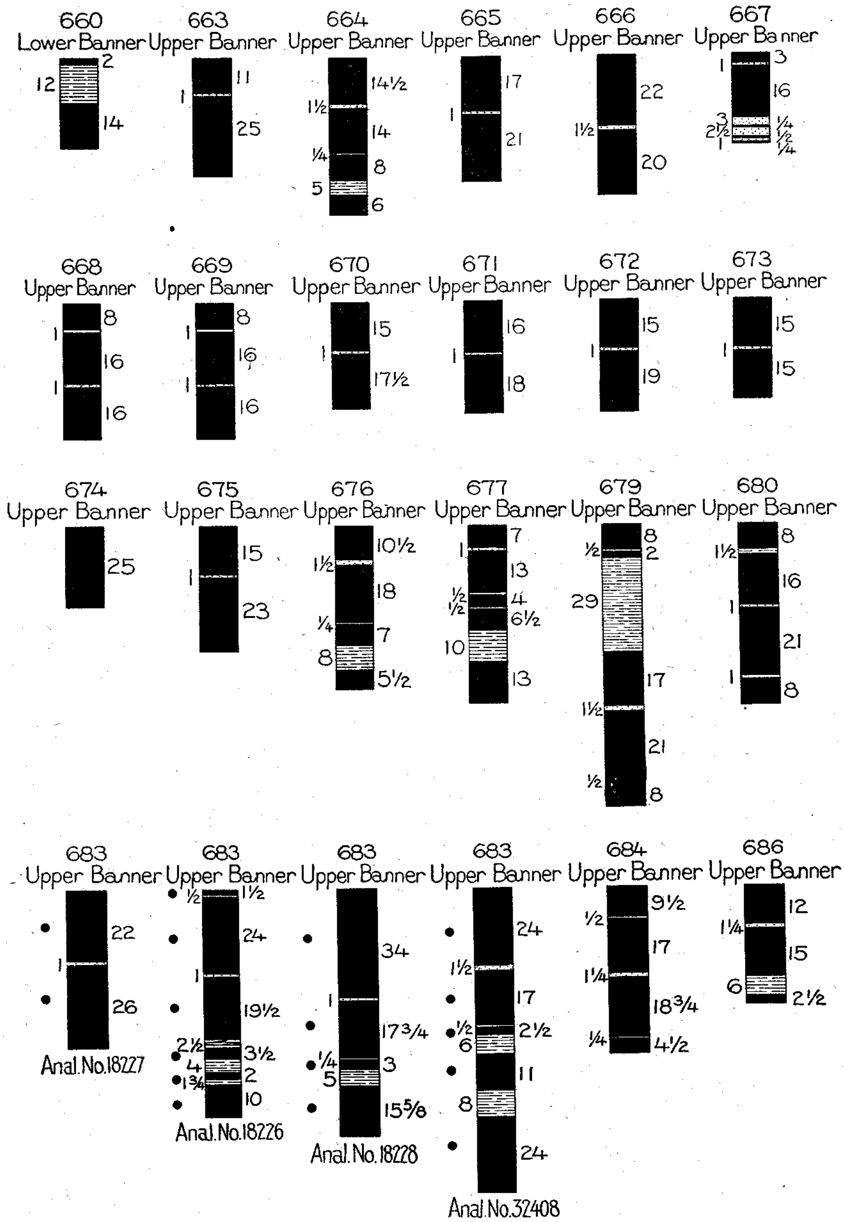


Fig. 46.—Sections of coal beds in the basins of Cranesnest River and Caney **Creek.**

The Upper Banner bed, as shown by several drillholes of the Clinchfield Coal Corporation, is present in the ridge between Trace Fork and Hurricane Fork. The thickness of the bed is withheld from publication but the sections show the characteristic 1-inch sandstone parting. The elevation of the bed at the various holes is as follows: C-127 (see pl. for locations) 2,088 feet, L; C-125, 2,107 feet, L; C-124, 2,063 feet, L; C-123, 2,074 feet, L; and C-126, 2,098 feet, L.

Several sections of the Upper Banner coal bed measured on the west side of Hurricane Fork give variable thicknesses, as shown by the following detailed sections:

Sections of the Upper Banner coal bed on west side of Hurricane Fork.

(C. C. C. prospects.)

(Loc., 676; el., 2,050 feet, L.)

	Ft.	In.
Sandstone.		
Coal		10½
Sandstone		1½
Coal	1	6
Shale		¼
Coal		7
Shale		8
Coal		5½
Shale		
Coal	3	5
Partings		9¾

(Loc., 677; el., 2,060 feet, L.)

	Ft.	In.
Sandstone.		
Coal		7
Sandstone		1
Coal	1	1
Shale		½
Coal		4
Shale		½
Coal		6½
Shale		10
Coal	1	1
Shale		
Coal	3	7½
Partings	1	0

(Loc., 678; el., 2,069 feet, L.)

	Ft.	In.
Sandstone.		
Coal		3
Shale	1	6
Coal	1	4
Sandstone		1
Coal	1	6
Shale		½
Coal		9
Shale	1	4
Coal		6
Sandstone		
Coal	4	4
Partings	2	11½

(Loc., 679; el., 2,064 feet, L.)

	Ft.	In.
Sandstone.		
Coal		8
Shale		½
Coal		2
Shale	2	5
Coal	1	5
Sandstone		1½
Coal	1	9
Shale		½
Coal		8
Shale		
Coal	4	8
Partings	2	7½

(Loc., 680; el., 2,080 feet, L.)

	Ft.	In.
Sandstone.		
Coal		8
Shale		1½
Coal	1	4
Sandstone		1
Coal	1	9
Shale		1
Coal		8
Shale		
Coal	4	5
Partings		3½

(Loc., 681; el., 2,075 feet, approx.)

	Ft.	In.
Coal		8
Shale		½
Coal		5
Coal	1	1
Parting		½

The outcrop of the Upper Banner goes under water at loc. 682, el. 2,071 feet, L, (C. C. C. prospect) in the stream valley forking to the south, off the main Hurricane Creek valley. A coal bed which probably represents an upper bench of the Upper Banner bed was measured in a partly caved prospect pit about 40 feet above the Upper Banner bed, just south of loc. 682. The section exposed shows 1 foot, 8 inches of coal overlying 10 inches of carbonaceous shale which in turn overlies coal that is at least 1 foot thick. The base of the coal bed is not exposed.

At the main Caney entry of the Cranesnest mine of the Clinchfield Coal Corporation (loc. 683, el. 2,117 feet, L) the Upper Banner bed contains 6 feet of coal. The details of the bed are best shown by the following measurements in the mine, where samples of coal were cut for analysis (see pages 512 and 524). The first measurement, 500 feet northeast of the main entrance, apparently does not include the lower part of the bed.

Section of the Upper Banner coal bed in Cranesnest mine of the Clinchfield Coal Corporation.

Section where sample was cut, 500 feet northeast of mine mouth.

(Analysis No. 18227.)

	Ft.	In.
Shale.		
*Coal	1	10
Sandstone		1
*Coal	2	2
Coal	4	0
Parting		1

Section where sample was cut, 1,500 feet southwest of mine mouth.

(Analysis No. 18226.)

	Ft.	In.
Shale.		
*Coal		1½
Shale, sandy		½
*Coal	2	
Sandstone		1
*Coal	1	7½
Shale and coal		2½
*Coal		3½
Shale		4
*Coal		2
Shale		1¾
*Coal		10
Shale		
Coal	5	½
Partings		9¾

*Sampled.

Section where sample was cut, 4,100 feet southeast of mine mouth.

(Analysis No. 18228.)

	Ft.	In.
*Coal	2	10
Shale		1
*Coal	1	5¾
Shale		¼
*Coal		3
Shale		5
*Coal	1	3⅝
Coal	5	10⅜
Partings		6¼

Section where sample was cut in room B, off 3d south entry, 3 miles east-northeast of mine mouth.

(Analysis No. 32407.)

	Ft.	In.
Shale.		
Shale, carbonaceous	1	2
*Coal	2	2
Sandstone		1
*Coal	1	9
Shale		2
*Coal		2
Shale		2
*Coal		4
Shale		6
*Coal	2	0
Shale		
Coal	6	5
Partings		11

Section where sample was cut in 3 south entry near room 20, 3¼ miles northeast of mine mouth.

(Analysis No. 32408.)

	Ft.	In.
Shale.		
Shale, carbonaceous		1
*Coal	2	0
Sandstone		1½
*Coal	1	5
Shale		½
*Coal		2½
Shale		6
*Coal		11
Shale		8
*Coal	2	0
Shale		
Coal	6	6½
Partings	1	4

The mine tracks of the Clinchfield Coal Corporation cross Hurricane Fork and enter a mine in the ridge directly opposite the Cranesnest entry. The coal taken from under this ridge is carried through the Cranesnest mine to the opening on Fuller Branch. North of this opening the company, in prospecting on the outcrop of the bed, has exposed the following sections:

*Sampled.

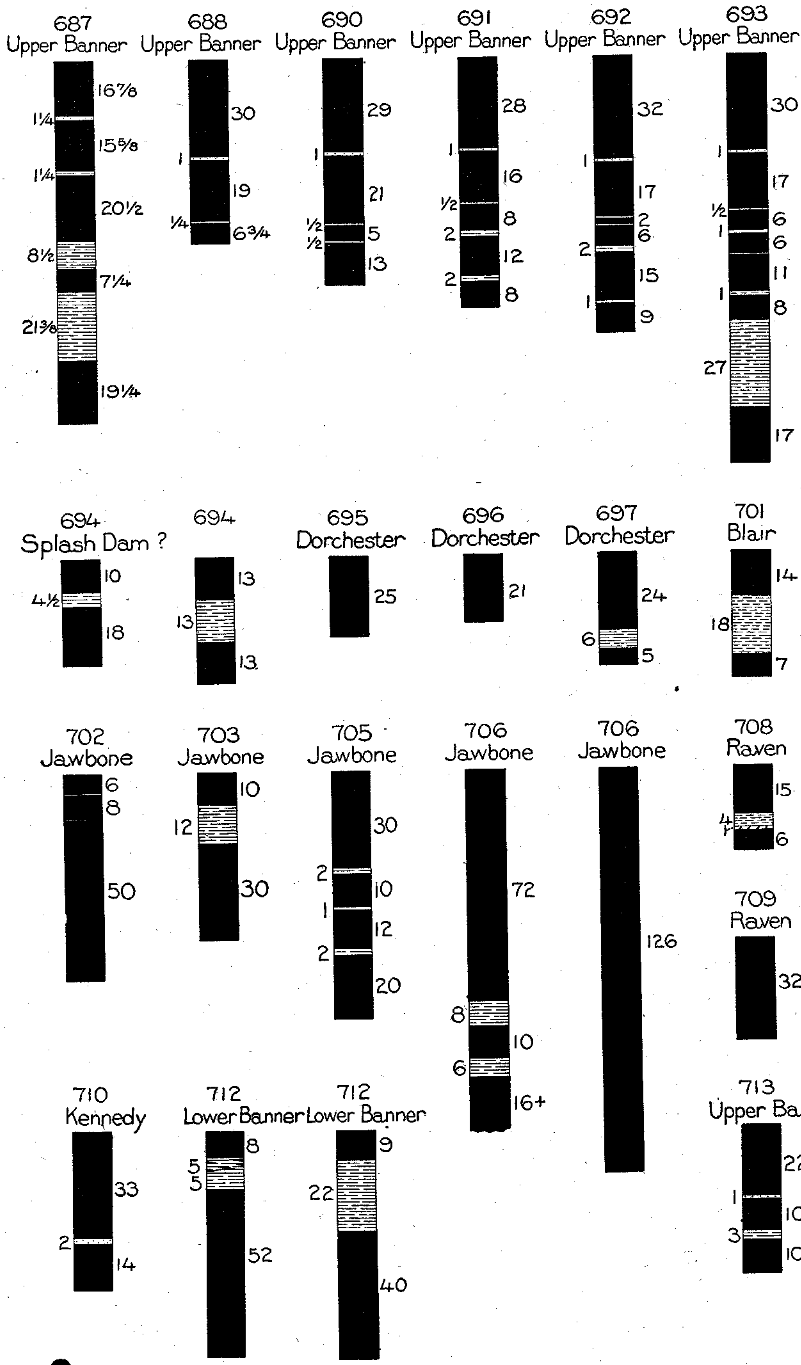


Fig. 47.—Sections of coal beds in the basins of Cranesnest River, Caney Creek, and Bull Run.

Sections of the Upper Banner coal bed on east side of Hurricane Fork.

(C. C. C. prospects.)

(Loc., 684; el., 2,078 feet, L.)

	Ft.	In.
Sandstone.		
Coal		9½
Shale		½
Coal	1	5
Sandstone		1¼
Coal	1	6¾
Shale		¼
Coal		4½
Shale		
Coal	4	1¾
Partings		2

(Loc., 685; el., 2,083 feet, L.)

	Ft.	In.
Sandstone.		
Coal	1	5
Sandstone		1¼
Coal	1	8
Shale		½
Coal		7
Shale		10
Coal		9
Shale		
Coal	4	5
Partings		11¾

(Loc., 686; el., 2,097 feet, L.)

	Ft.	In.
Sandstone.		
Coal	1	0
Sandstone		1¼
Coal	1	3
Shale		6
Coal		2½
Shale		
Coal	2	5½
Partings		7¼

The outcrop of the Upper Banner bed on Caney Creek extends only a little more than a mile into Wise County. In this distance the bed has been thoroughly prospected. The following sections measured in these pits give its character:

Sections of the Upper Banner coal bed on west side of Caney Creek.

(C. C. C prospects.)

(Loc., 687; el., 2,120 feet, L.)

	Ft.	In.
Shale.		
Coal	1	4⅞
Sandstone		1¼
Coal	1	3⅝
Shale		1¼
Coal	1	8½
Shale		8½
Coal		7¼
Shale	1	9⅜
Coal	1	7¼
Shale		
Coal	6	7½
Partings	2	8⅜

(Loc., 688; el., 2,178 feet, L.)

	Ft.	In.
Shale.		
Coal	2	6
Sandstone		1
Coal	1	7
Shale		¼
Coal		6¾
Shale		
Coal	4	7¾
Partings		1¼

(Loc., 689; el., 2,175 feet, approx.)

	Ft.	In.
Shale.		
Coal	2	2½
Sandstone		1¼
Coal	2	0
Shale	1	10⅜
Coal		7¼
Shale		
Coal	4	9¾
Partings	1	11⅝

(Loc., 690; el., 2,197 feet, L.)

	Ft.	In.
Shale.		
Coal	2	5
Sandstone		1
Coal	1	9
Shale		½
Coal		5
Shale		½
Coal	1	1
Shale		
Coal	5	8
Partings		2

There are three closely grouped openings on the Upper Banner where the coal bed crosses the stream at the head of Caney Creek. The southwest opening of the three (loc. 691, el. 2,191 feet, L) is a drift opening of the Clinchfield Coal Corporation near which the following section of the coal bed was measured:

Section of the Upper Banner coal bed at head of Caney Creek.

(Loc., 691; el., 2,191 feet, L.)

	Ft.	In.
Shale, carbonaceous		1
Coal	2	4
Sandstone		1
Coal	1	4
Shale		½
Coal		8
Shale		2
Coal	1	0
Shale		2
Coal		8
Clay		2
Shale, black		3
Clay		
Coal	6	0
Partings		5½

Two sections of the Upper Banner bed were measured in openings on the east side of Caney Creek. The first of the openings north of the stream fork is that of J. A. Odle, where the following section was measured by the Clinchfield Coal Corporation:

Section of the Upper Banner coal bed in J. A. Odle opening.

(Loc., 692; el., 2,175 feet, approx.)

	Ft.	In.
Shale.		
Coal	2	8
Sandstone		1
Coal	1	5
Shale		
Coal		2
Shale		
Coal		6
Shale		2
Coal	1	3
Shale, soft		1
Coal		9
Shale		
Coal	6	9
Partings		4

The bed shows a more parted section but a greater thickness of coal in a prospect entry one-fourth of a mile south of the county line. The detailed section is given below:

Section of the Upper Banner coal bed on east side Caney Creek.

(C. C. C. prospects.)

(Loc., 693; el., 2,206 feet, L.)

	Ft.	In.
Shale.		
Coal	2	6
Sandstone		1
Coal	1	5
Shale		½
Coal		6
Shale		1
Coal		6
Shale		
Coal		11
Clay		1
Coal		8
Shale	2	3
Coal	1	5
Shale		
Coal	7	11
Partings	2	6½

Splash Dam and higher coal beds in Norton formation.—A number of coal beds, between the Upper Banner bed and the Gladeville sandstone, show in outcrop, but none would support mining operations, if the sections exposed are typical of the bed under cover.

One of these coal beds, 50 feet above the Upper Banner, was measured in an opening on the Wise road, opposite Lyon Fork (loc. 694, el. 1,850 feet, B). This bed, which occurs at about the horizon of the Splash Dam coal bed contains 28 inches of coal with a 4½-inch shale parting 10 inches from the top of the bed. Eight other coal beds are indicated by blooms or prospect pits on this road in a vertical interval of 230 feet above the Upper Banner bed. Most of these beds are very thin, but one lying 180 feet above the Upper Banner contains 26 inches of coal split near the middle by 13 inches of shale, and another bed, 40 feet higher has 22 inches of coal, with a parting of 1½ inches of clay.

Dorchester and higher coal beds.—The Dorchester coal bed is present throughout practicaly all of the basin above the Gladeville sandstone. The coal lies very close to the sandstone, and at places the lower benches of the coal are separated from one another by hard beds of sandstone and sandy shale. The bed averages 2 feet in thickness throughout much of the basin. It is not mined but has been dug into for local use in a few places. The bed nowhere shows a thickness comparable to that at its type locality at Dorchester or Glamorgan.

The Dorchester bed is exposed on the new Wise–Clintwood road, about 3 miles northeast of Hurricane, (loc. 695, el. 2,205 feet, B), and has a thickness of 2 feet, 1 inch of coal without a parting.

It is also present in the southern end of Big Ridge, southwest of Hutchinson school, (loc. 696, el. 2,575 feet, B) where it is 21 inches thick without a parting. Several prospect pits have been opened on the bed on Sandy Ridge northeast of Toms Creek. In one of these pits on the north side of a knob the bed has the following section:

Section of Dorchester coal bed on Sandy Ridge.

(Loc., 697; el., 2,680 feet, B.)

	Ft.	In.
Shale.		
Coal	2	0
Shale		6
Coal		5
Clay		
Coal	2	5
Parting		6

Half-a-mile to the east the coal bed is split by 8 feet of sandstone and shale. Thus on Sandy Ridge at loc. 698, el. 2,660 feet (B) the Dorchester bed is parted by 8 feet of sandstone and shale, with 7 inches of coal above and 1 foot, 6 inches of coal below, with the base not exposed.

A coal bed, occurring about 60 feet above the Gladeville sandstone is exposed in cuts of the new Wise–Clintwood road, northeast of Hurricane. At loc. 699, el. 2,330 feet (B), and loc. 700, el. 2,320 feet (B) the bed has an upper bench of coal 1 foot, 6 inches thick and a lower bench 1 to 2 feet thick made up of thin layers of coal. The benches are separated by 4 feet of clay.

The Blair is the highest recognized coal bed outcropping in the Cranesnest basin in Wise County. It outcrops only high on the ridge between Cranesnest River and Birchfield Creek. It is opened on the Wise–Clintwood road (loc. 701, el. 2,410 feet, B), where a section of the bed was measured showing 1 foot, 9 inches of coal with 1 foot, 6 inches of clay 7 inches from the base of the coal bed.

CLINCH RIVER DRAINAGE BASIN.

BULL RUN BASIN.

General features.—Bull Run is a stream six miles long flowing from Pine southeast to Clinch River, at Carfax. It is joined near its mouth by two branches, one from the west and the other from the east. The one from the west is Dry Fork, which heads near Craborchard Branch and joins the main stream one-half mile above Carfax; the other is not named on the map but heads north of Dwina and joins the master stream a little more than one-half mile above the mouth of Dry Fork. The valleys are sharply incised in an upland region with their sides rising from 500 to 800 feet above the stream bed (see Pl. XXIII B). Despite the steep slopes, there are few sandstones exposed and the surface generally is covered with vegetation, in large part trees. The thick vegetal cover and lack of exposures make it difficult to trace coal beds from place to place in the basin.

The rocks of the basin lie north of the disturbed zone marking the southern rim of the coal field, but they are arched up in a low fold by the Powell Valley anticline, the axis of which crosses Bull Run two miles southeast of Pine and trends in a northeast-southwest direction. At the mouth of Bull Run, in the vicinity of Carfax, the strike of the rocks is more nearly north-south and they dip from 4° to 6° slightly south of east.

The rocks exposed in this basin range from the top of the Lee formation to the top of the Gladeville sandstone. The Norton coal beds outcrop on Bull Run, the thickest bed being the Jawbone, and the highest quality coal being in the Upper Banner bed. The Kennedy, Lower Banner and

Upper Banner coal beds, have been mined north of Pine. The Tiller, Jawbone, and Raven have been opened by local operators on Dry Fork and the lower part of Bull Run. Graphic sections of the coal beds in this basin are shown in fig. 47.

Taken as a whole, the coal beds in the Bull Run basin have scarcely more than been touched by past and present mine workings. The bulk of the mining has been concentrated several miles to the west on Little Toms and Toms Creek. The coal beds on Bull Run, however, show very good sections, and as transportation lines are within easy reach, they are certain to receive more attention in the future than they have in the past.

The Tiller and Jawbone coal beds.—These two coal beds are the lowest ones outcropping on Bull Run. A drillhole is reported to have been put down on Dry Fork about two miles above its mouth and struck no coal beds in a depth of 400 or 500 feet. Such a hole would have started about 300 feet below the Jawbone coal bed or near the base of the Norton formation. At no place in the basin were the two beds, the Jawbone and Tiller, seen in the same geologic section. As stated previously, the rocks above the Lee consist largely of shale and sandy shale and the slopes are densely covered with vegetation. The absence of horizon markets, such as sandstone beds, or of continuous exposures, complicates the problem of correctly identifying the lower coal beds.

A thick clear coal bed has been opened by R. L. Osborne, on Dry Fork, at loc. 702, el. 1,760 feet (B), where a massive, fine-grained hard sandstone rests directly upon the coal. The bed is probably the Jawbone, although on first examination it was thought by the writer to represent the Tiller bed. Subsequent search, however, for a higher or Jawbone bed was unavailing, and this, with other evidence, favor the Jawbone correlation for the bed opened here. The dip in the mine is 5° N. 65° E. A section measured in this mine shows 5 feet, 4 inches of coal with 8 inches of "curly" coal 6 inches from the top of the bed.

West of Carfax near the head of a small ravine leading into the Clinch River Valley, the Jawbone has been opened, 300 feet above the top of the Lee. It has the following section.

Section of the Jawbone coal bed west of Carfax.

(Loc., 703; el., 1,855 feet, B.)

	Ft.	In.
Shale.		
Coal		10
Shale	1	0
Coal	2	6
Clay		
Coal	3	4
Parting	1	0

On the east side of the dividing ridge between Craborchard Branch and Dry Fork the Jawbone has been prospected on the main pike. At loc. 704, el. 1,935 feet (B) an entry has been driven in and 5 feet of clear coal is reported. The bed is overlain by shale and underlain by a bed of medium-grained sandstone. The sandstone is resistant and gives rise to considerable float.

A wagon mine has been operated in the Jawbone bed on the west bank of Bull Run north of Dry Fork. The bed here lies 245 feet above the uppermost sandstone of the Lee formation. The coal was hauled to Carfax for shipment. The mine was not in operation when visited in the spring of 1921. The bed shows a thick but parted section as follows:

Section of the Jawbone coal bed on Lower Bull Run.

(Loc., 705; el., 1,765 feet, B.)

	Ft.	In.
Shale.		
Coal	2	6
Shale		2
Coal		10
Shale		1
Coal	1	0
Shale		2
Coal	1	8
Clay		
Coal	6	0
Partings		5

The Jawbone bed shows an extraordinary thickness at its type locality on Bull Run two miles above its mouth. The sections below were measured in two entries 100 feet apart on the east bank of the stream.

Section of the Jawbone coal bed on Bull Run.

(Loc., 706; el., 1,650 feet, B.)

North pit.

	Ft.	In.
Sandstone.		
Shale	3	0
Coal	6	0
Shale		8
Coal		10
Shale		6
Coal	1	4±
Coal	8	2±
Partings	1	2

South pit.

	Ft.	In.
Sandstone.		
Shale.		
Coal	10	6
Clay		
Coal	10	6

About 10 feet below the coal a 20-foot bed of heavy sandstone outcrops. East of Dwina School the bed has been worked by a wagon mine operation. The mine is abandoned and slumped and no section was available when visited. The mine (loc. 707, el. 1,690 feet, B) discharged its coal by means of a chute into a small tipple which stands by the pike. The bed takes cover about one-half mile up the valley from this location.

Raven coal bed.—The Raven coal bed in the Bull Run basin has an average thickness of 2 to 2½ feet. It has been mined profitably by a few local mine operators, but it is not of sufficient thickness to warrant the attempt to mine on a large scale. The opening of wagon mines near the head of Dry Fork resulted from the great demand and high prices of coal during the summer of 1920. Prior to that the bed had practically never been prospected.

The bed was newly opened near the main highway just east of the Craborchard–Dry Fork gap. The mine was abandoned when visited in the summer of 1921.

A bed of thin-bedded sandstone outcrops 15 feet below the coal bed. The dip at this mine is 14° N. 15° E. The coal bed has the following section:

Section of the Raven coal bed at head of Dry Fork.

(Loc., 708; el., 2,110 feet, B.)

	Ft.	In.
Shale.		
Sandstone	2	.
Coal	1	3
Clay		4
"Rash"		1
Coal		6
Coal	1	9
Partings		5

One mile southeast of Pine on the south bank of Bull Run, (loc. 709, el. 1,800 feet, B) the bed contains 32 inches of coal without a parting. The bed here outcrops several feet above a sandstone which is thin-bedded and from 10 to 20 feet thick.

Kennedy coal bed.—The outcrop of the Kennedy coal bed extends up the Bull Run valley as far north as Pine. The bed has been removed by erosion from the hills south of Dry Fork and to the north outcrops high on the dividing ridge between Bull Run and Dry Fork. Except for a few openings near Pine it has been very little prospected in the Bull Run basin.

The bed is underlain by 20 feet of shale which in turn is underlain by a thick hard bed of sandstone, the latter representing the McClure sandstone of Dickenson County. This sandstone in places is nearly 50 feet thick and is 35 to 40 feet thick north of Pine. The McClure and the sandstone beneath the Jawbone coal are the only two beds of the lower part of the Norton formation which make much of a showing in the Bull Creek basin.

Little can be said of the thickness of the Kennedy coal in this basin as it has been measured only in the vicinity of Pine. The section here, measured in one of three openings near its mouth, is given below:

Section of the Kennedy coal bed near Pine.

(Loc., 710; el., 2,020 B.)

	Ft.	In.
Sandstone.		
Shale	2	0
Coal	2	9
Sandstone		2
Coal	1	2
Clay		
Coal	3	11
Parting		2

The mine had been abandoned at the time it was visited and the main haulway was blocked with a cave-in. A 12-foot thickness is reported for the bed at the face of the main entry. The Kennedy bed outcrops at Pine, and is mined there for railroad shipment. It shows a thickness ranging from 18 to 30 inches at loc. 711, el. 2,050 feet (B), and it is but little above the McClure sandstone, which here is thin-bedded and hard.

Lower Banner coal bed.—The outcrop of the Lower Banner bed is confined to the south slope of Sandy Ridge and the northern end of the Bull Hill Ridge. The bed lies 220 feet above the Kennedy coal bed and nearly 120 feet below the Upper Banner bed in this basin. It rivals the Upper Banner in thickness and is an unusually clean coal.

Several mines have been driven into the outcrop of the bed in the ravine northeast of Pine, and a railroad spur has been built up from the Norfolk and Western Railroad, to afford an outlet for the product of these mines. The mines are so closely grouped in the ravine that they are represented by a single location number (loc. 712, el. 2,310 feet, B). Sections measured in two of these mines are as follows:

Sections of the Lower Banner coal bed near Pine.

(Loc., 712; el., 2,310 feet, B.)

North entry.

	Ft.	In.
Shale.		
Coal		8
Shale with coal streaks		5
Shale		5
Coal	4	4
Clay		
Coal	5	
Partings		10

East entry.

	Ft.	In.		Ft.	In.
Shale.			Shale.		
Coal		9	Coal		8
Shale	1	10	Shale	1	8
Coal	3	4	Coal	3	6
Clay			Clay		
Coal	4	1	Coal	4	2
Parting	1	10	Parting	1	8

Upper Banner and higher coal beds.—The Upper Banner coal bed outcrops about 180 feet below the general level of the Sandy Ridge plateau and from 100 to 150 feet below a conspicuous sandstone bed that is holding up the eastern part of the plateau. The bed carries the usually distinctive parting of sandstone.

The acreage of Upper Banner coal on Bull Run drainage is very small. The bed has been opened at the head of both forks of Bull Run, north of Pine. In the pit on the east fork the coal bed has the following section:

Section of the Upper Banner coal bed north of Pine.

(Loc., 713; el., 2,440 feet, B.)

	Ft.	In.
Shale.		
Coal	1	10
Sandstone		1
Coal		10
Shale		3
Coal		10
Coal	3	6
Parting		4

The Upper Banner coal is exposed in the bed of a stream, tributary to Bull Run, northeast of Pine (loc. 714, el. 2,450 feet, B). The entire thickness of the bed could not be seen but it was estimated to be about 4 feet. The coal is 175 feet below the sandstone which here caps Sandy Ridge.

The Hagy coal bed shows as an 18-inch bloom beneath the sandstone over the Upper Banner coal bed just described. It appears not to be of workable thickness.

In the section from the Upper Banner coal at loc. 714 up the stream to the top of the ridge, a carbonaceous shale was seen 90 feet above the Upper Banner. This is the only indication of the possible presence of the Splash Dam coal bed in the Bull Run basin.

RUSSELL CREEK AND LEFT FORK BASIN.

General features.—Russell Creek and its branches, Meade Creek, Middle Fork, and Laney Fork, together with the Left Fork of Lick Creek, drain an area of approximately 16 square miles in the extreme eastern part of Wise County. The surface consists of long V-shaped valleys, and sharp ridges. The slopes are heavily wooded and only sparsely settled. Virginia City on Russell Creek and St. Paul on Clinch River are the only towns in the basin. Both towns are on the Norfolk and Western Railroad and the latter is at the place where this railroad is crossed by the Carolina, Clinchfield and Ohio Railroad. Dirt roads follow the majority of the larger streams and are usually in fair condition for wagon traffic.

The Hunter Valley fault crosses the southeastern end of the basin bringing Middle Cambrian or other limestones in contact with the overturned Lee formation and Pennington shale. The limestone has been thrust over on the younger formations and it is not uncommon to find great masses of pre-Carboniferous limestone over coal beds as it is at the Burtons Ford coal mine in Russell County. In the great overthrust the Pennington and Lee formations have likewise been overturned and dip steeply to the south along the entire belt of the disturbance in Scott and Wise counties. The lower rocks of the Norton formation are involved in the overturn, but erosion has removed all trace of the overturn from the upper two-thirds of the formation. The northern limit of the overturned rocks is indicated on the geologic map.

North of the disturbed belt, low flexures in the rocks with axes parallel to the major structure are common. A syncline of this character crosses the Russell and Left Fork basin in a northeasterly direction from Virginia City. The town itself appears to lie almost in the middle of such a depression or synclinal trough. The Powell Valley anticline arches the rocks to the north in a low uniform fold, the axis of which passes northeastward into Russell County about 4 miles north of St. Paul. The anticline plunges northwestward but at such gentle rate that the arch in Wise County is still high enough to have made it possible for erosion to remove all trace of the Gladeville sandstone and higher formations southeast of Sandy Ridge.

Owing to the resistant barrier which the overturned conglomerate of the Lee formation has interposed near the mouth of Russell Creek, this stream flows in a typical hanging valley and it reaches Clinch River by a series of cascades and falls. Above the barrier it flows through an unusually flat valley more than 100 feet above the level of Clinch River.

The Jawbone and Raven beds are the only coals in this basin now being mined in any quantity. The Jawbone bed is mined by the Virginia Iron, Coal & Coke Co., at Virginia City and by the Twin City Coal Corporation near St. Paul. The Raven bed is mined by the Twin City Coal Corporation near St. Paul and several local operators have small mines in both the Jawbone and the Raven beds. The Virginia Iron, Coal & Coke Co. plans to work the Kennedy bed and has already prospected it with a view to development.

The Jawbone coal is the thickest bed in this section of Wise County, one measurement in the Twin City Coal Corporation's mine showing a thickness of 18 feet, 6 inches. This is an unusual thickness, however, as the average for the bed, compiled from all the measured sections in the basin, gives 6 feet, 6 inches. Everywhere along the edge of the overturned rocks the coal bed shows signs of buckling, due to the tremendous compression exerted during the upturning of the lower strata. The coal, at places, has slipped along the bedding planes, crushing and squeezing it into a very much thicker bed than is normally the case. The bed contains several partings and usually the coal runs high in ash because some or all of these partings have been crushed and so intimately mixed with the coal that their separation is impossible. The quality of the coal is considered later in this report (page 535).

The Raven and Kennedy coal beds have an extensive outcrop in the Russell Creek and Left Fork basin. The two Banner beds, occurring high in the Norton formation, are found only in the extreme north ends of the basin, outcropping on the south slope of Sandy Ridge. The Kennedy and Raven are both workable beds, containing from 2 to 4 feet of fairly good coal. The Banner beds are high in the hills to the north and have little acreage in these basins. Graphic sections of the coal beds in the basin of Russell Creek and Left Fork are shown in fig. 48.

Tiller and Jawbone coal beds.—These beds lie in the lower 300 feet of the Norton formation and are the lowest coals in the Russell Creek and Left Fork basin that offer ready access for mining. The Lee coals, exposed in the overturned part of that formation on the edge of the coal field have not been found workable. The Burtons Ford coal, in the lower part of the Lee formation, has been prospected on the Russell County side of Clinch River, both east and west of St. Paul, but the pits were closed, and no sections obtained, loc. 715, el. 1,500 feet (B).

The thickness and character of the Burtons Ford bed in the mine of the Russell Fork Coal Mining Co., at Burtons Ford in Russell County, may give a clue to the probable thickness of the bed in Wise County. The mine is located on Clinch River just across the line from Wise County. Sections in this mine measured by Wentworth[1] are given below as follows:

Sections of Burtons Ford coal bed in Burtons Ford mine of Russell Fork Coal Mining Co.

Section "A" measured on rib at entry.

	Ft.	In.
Clay.		
Coal	2	7
Clay		
Coal	2	7

Section "B" measured on rib 50 feet from entry.

	Ft.	In.
Clay.		
Coal		7
Shale		½
Coal	1	10
Shale		1
Coal		1
Shale		1
Coal		1
Shale		
Coal	2	7
Partings		2½

Section at face of room near main entry.

	Ft.	In.
Clay.		
Coal	5	6
Sandstone		
Coal	5	6

Section at face, main entry.

	Ft.	In.
Clay.		
Coal	6	6
Sandstone		
Coal	6	6

The Tiller coal bed is separated commonly from the Jawbone bed by a fine-grained hard sandstone, the interval ranging from a few inches to

[1] Wentworth, C. K., The Geology and Coal Resources of Russell County, Virginia. Va. Geol. Survey Bull. No. XXII, 1922, pp. 50-51.

100 feet. As the outcrops of the Tiller and the Jawbone beds lie so close, and in fact often involved in, the overturned rocks, no attempt has been made to sketch the outcrop of the Tiller coal bed. The coals themselves have many characteristics in common and their differentiation in some places has been doubtful, especially in the overturned rocks.

The Tiller coal was opened on the north side of Clinch River, two miles southeast of Virginia City, loc. 716, el. 1,590 feet (B). The pit had caved, but 5 feet of coal was visible with the bottom of the bed still under cover. The Jawbone overlies the Tiller about 75 feet, an exact measurement of the interval not being practicable. The Jawbone bed has been mined in the Shannon mine, about half-a-mile due west of loc. 716, by the Virginia Iron, Coal & Coke Co. The coal bed is thick but the coal is badly crushed. This results in widely divergent thicknesses in the same mine. In the main entry the following section was measured:

Section of the Jawbone coal bed in the Shannon mine of the Virginia Iron, Coal & Coke Co.

(Loc., 717; el., 1,740 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous		10
Coal		10
Shale		5
Coal, crushed	4	0
Coal	4	10
Parting		5

In the first entry to the west, off the main entry, 7 feet, 10 inches of coal without a parting was measured. A soft conglomerate 40 feet in thickness outcrops here 35 feet below the coal bed, which is the representative of the hard finer-grained sandstone farther north, between the Jawbone and Tiller bed.

The Shannon mine, when in full operation, requires the services of 25 miners and has a daily capacity of 200 tons of coal.

The Jawbone coal bed has been opened by two mines of the Virginia Iron, Coal & Coke Co., at Virginia City. The following section was measured near the mouth of Mine No. 1:

Section of the Jawbone coal in Mine No. 1 of the Virginia Iron, Coal & Coke Co.

(Loc., 718; el., 1,600 feet, B.)

	Ft.	In.
Shale, carbonaceous.		
Coal		10
Clay	1	2
Coal	2	10
Shale, carbonaceous		10
Shale, sandy		
Coal	3	8
Parting	1	2

The coal bed in this mine is reported to show a better section and the coal to be of finer quality the farther the entry is driven from the outcrop.

The larger of the two mines of the Virginia Iron, Coal & Coke Co., at Virginia City, is Mine No. 2, entering the bed from the southern end of Nancy Ridge. The coal is high in ash and sulphur (see pp. 508-509), but not sufficiently so as to prevent its use as steam coal, railroad fuel, and domestic fuel. The mine has a daily output of 350 tons and in the year 1918 shipped more than 43,600 tons. Some of the coal is shipped as run-of-mine coal, but most is screened and shipped as lump, nut, and slack. The coal bed ranges from 5 to 6 feet in thickness. The following sections were measured at the places where samples were cut for chemical analysis:

Sections of the Jawbone coal in Mine No. 2 of Virginia Iron, Coal & Coke Co., at Virginia City.

(Loc., 719; el., 1,520 feet, B.)

Section where sample was cut in room 3, off 1st west cross entry from main haulway.

(Analysis No. 32506.)

	Ft.	In.
Sandstone.		
Shale	5	0
*Coal	1	0
Bone		1
*Coal		8
*Coal		10
*Coal	1	10
"Rash"	1	6
*Coal	1	4
Clay		
Coal	5	8
Partings	1	7

Section where sample was cut in room 2, off 2d west cross entry from main haulway.

(Analysis No. 32505.)

	Ft.	In.
*Coal		10
Bone		¼
*Coal		10
Bone, with coal streaks		6
Bone		9
*Coal		6
*Coal, soft	1	2
"Rash"		8
*Coal	1	2
Clay		
Coal	4	6
Partings	1	11¼

*Sampled.

Section where sample was cut in room 1, off 3d west cross entry from main haulway.

(Analysis No. 32504.)

	Ft.	In.
*Coal		9
*"Rash"		¼
*Coal		10
*Bone		3
*Coal		6
*Coal, bony	3	4
"Rash"		8
Clay		
Coal	5	5
Partings		3¼

Section where sample was cut in 1st cross entry, 4th east from main haulway.

(Analysis No. 32503.)

	Ft.	In.
*Coal	3	7
Clay	1	0
*Coal		9
Clay		
Coal	4	4
Parting	1	0

A sample of the bone occurring in the upper part of the bed in this mine was taken for analysis. The analysis is given on page 509 under No. 32508.

The following section measured in the main haulway of the mine shows a slightly greater thickness of the bed than that already given:

Section of the Jawbone coal bed in Mine No. 2 of Virginia Iron, Coal & Coke Co., at Virginia City.

	Ft.	In.
Sandstone.		
Shale	3	0
Shale, carbonaceous		2
Coal	4	0
Shale, carbonaceous		2
Coal	1	0
Shale, carbonaceous		3
Coal	1	0
Shale, with coal streaks		7
Shale		
Coal	6	0
Partings		5

The Jawbone coal bed on Laney Fork shows a very much better section than any that have been given. The bed in a drift recently faced up has a thickness of 70 inches of clear coal. (Loc. 720, el. 1,630 feet, B.) The bed is overlain by 40 inches of shale, which in turn is capped by thick-bedded sandstone.

Several openings have been made in the Jawbone bed on the Virginia City–St. Paul road, a short distance southeast of Virginia City. J. M.

*Sampled.

Hillman and Son have mined and shipped coal from one of the small mines which is in the belt of overturned rocks where the dip is S. 15° E. and ranges from 24° to 55°. The greater dip was measured on the lower of two prospects in the south bend of the road slightly north of the Hillman mine at loc. 721. The bed is partially exposed at the lower prospect and its thickness, as determined by an augur boring, is about 7 feet, all clear coal. Ninety feet above this opening a coal bed was drifted into on the strike for 100 feet. This coal has a dip of 24° and appears to be the Tiller bed. It was thought by some to be the Jawbone turned sharply back on itself, but a short test slope driven down the coal in the upper opening shows the dip to decrease instead of increase as it would be expected to do if the bed is actually the Jawbone folded back on itself.

The Hillman mine has a massive sandstone roof and the coal has the crushed character of the typical Jawbone bed. In view of the character of the coal, suggesting its Jawbone correlation, the sandstone roof adds considerable weight to the theory that the bed here is actually overturned and the higher bed is the Tiller. It will take extensive prospecting to confirm the correlation of these coals as the folding and crumpling of the rocks on the edge of the coal field has been so great that the problem of identifying the overturned coal beds is one of difficulty and uncertainty.

The Jawbone coal ranges from 42 inches to 17 feet in thickness with partings from one-eighth of an inch to 2 feet thick. The following section was measured in the Hillman mine:

Section of the Jawbone coal bed in the Hillman mine.

(Loc., 721; el., 1,840 feet, B.)

	Ft.	In.
Shale.		
Coal	3	6
Shale, carbonaceous		4
Coal		6
Shale, carbonaceous		3
Shale, with coal streaks		4
Coal		10
Shale, carbonaceous		3
Coal		11
Shale, carbonaceous		
Coal	5	9
Partings	1	2

A bed supposed to be the Jawbone has been prospected on the west side of the road (loc. 722, el. 1,810 feet, B). The pit was partly caved, concealing the base of the bed, and exposing only the top 4 feet of the coal.

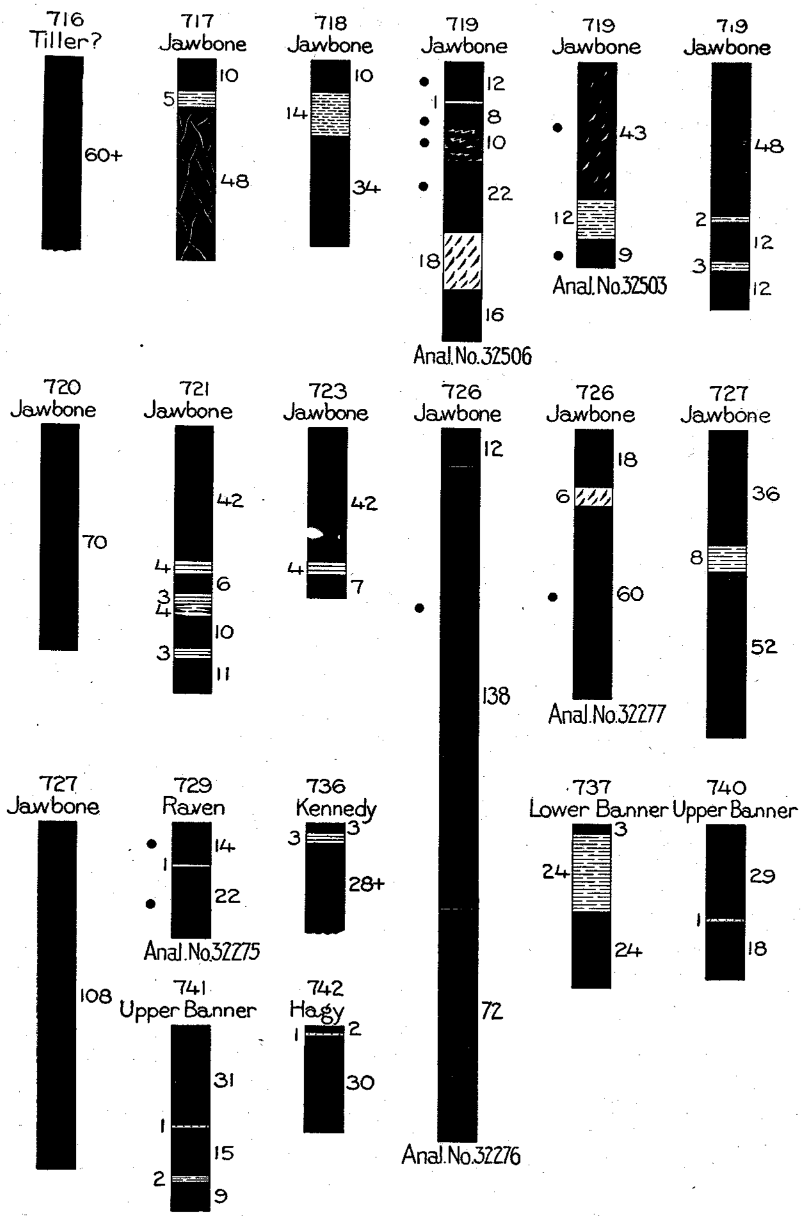


Fig. 48.—Sections of coal beds in the basins of Russell Creek and Left Fork.

A small local mine on the Jawbone at loc. 723, el. 1,820 feet (B) shows a rather inferior section of the bed. The section is given below:

Section of the Jawbone coal bed on Russell Creek south of Laney Fork.

(Loc., 723; el., 1,820 feet, B.)

	Ft.	In.
Shale.		
Shale, carbonaceous		2
Coal	3	6
Shale, carbonaceous		4
Coal		7
Coal	4	1
Parting		4

On the east side of Russell Creek south of Virginia City the Jawbone bed is opened but does not show the same thick section as it does farther north. Only 42 inches of impure shaly coal was measured at loc. 724, el. 1,660 feet (B). A little farther to the south the bed increases in thickness and quality and averages more than 6 feet in thickness in an old mine at loc. 725, el. 1,640 feet (B).

The Jawbone bed is mined by the Twin City Coal Corporation northwest of St. Paul. Mines No. 2 and 3 are located near the head of a small ravine, which opens directly into the Clinch River Valley. The coal bed is overturned and dips 45° S. 70° E. in these mines. It here shows its greatest thickness in the Russell Creek and Left Fork basin, exceeding at one place 18 feet. The coal at this locality is clear and does not suggest the likelihood of the Tiller joining the Jawbone to form this great thickness. The coal seems to lie in lenses or pockets.

The following sections were measured where samples were cut for analysis (page 508):

Sections of the Jawbone coal bed in Twin City Coal Corporation mines.

(Loc., 726; el., 1,640 feet, B.)

Section where sample was cut at face of main entry of mine No. 2.

(Analysis No. 32276.)

	Ft.	In.
Shale.		
Coal	1	0
*Coal	11	6
Coal	6	0
Shale		
Coal	18	6

Section where sample was cut at face of main entry in mine No. 3.

(Analysis No. 32277.)

	Ft.	In.
Shale.		
Coal	1	6
"Rash"		6
*Coal	5	0
Shale		
Coal	6	6
Parting		6

*Sampled.

In mining the 18-foot coal bed, 11½ feet were first mined, leaving 1 foot of coal in the roof and 6 feet of coal on the floor. The floor coal was taken up later, but the roof coal was not recovered. The output of Mine No. 2, when visited, was 25 tons daily and of Mine No. 3, 12 tons daily.

The mine of Ac Gose on the south end of Divide Ridge, in Wise County, is in the Jawbone bed. The main haulageway goes in on the strike, the bed being overturned and dipping from 35° to 40° S. 20° E. When visited in the spring of 1920 the mine was not in operation. Indiscriminate "robbing" during the peak of high coal prices at the time of the Great War has left the mine in a dangerous condition and jeopardized greatly the chances of the mine ever being worked successfully in the future.

The following sections were measured in this mine:

Sections of the Jawbone coal bed in mine of Ac Gose.

(Loc., 727; el., 1,710 feet, B.)

150 feet in from mine mouth.

	Ft.	In.
Shale.		
Coal	3	0
Shale		8
Coal	4	4
Shale		
Coal	7	4
Parting		8

200 feet in from mine mouth.

	Ft.	In.
Shale.		
Coal	9	0
Shale		

Raven coal bed.—In the vicinity of Virginia City the Raven coal bed lies approximately 150 feet above the Jawbone and nearly 300 feet below the Kennedy bed. Except for the mine of the Twin City Coal Corporation near St. Paul, the bed is not worked in the Russell Creek or Left Forks basin. It has been prospected at some few places, but the coal lacks both the thickness and quality to command development and a good market price. The bed averages 3 feet or less in thickness. It is a persistent bed and outcrops continuously throughout the two basins.

On the east side of the valley of Laney Fork, two miles north of Virginia City, the Raven shows as a bloom 32 inches thick, (loc. 728, el. 1,880 feet, B). Shale is exposed for 10 feet above and below the bed. A 20-foot bed of sandstone, massive and shedding blocks down the slope, outcrops beneath the lower shale bed. The coal at this exposure appeared cleaner and of better quality than the coal in the same bed to the east and southeast.

The mine of the Twin City Coal Corporation lies north of the overturned rocks, about 1 mile north of St. Paul. The bed varies from 3 to

5 feet in thickness, with an average section of 3 feet 6 inches, including 3 inches of parting, usually found about 6 inches from the top of the bed. The mine has a sandstone roof and shale floor. A section measured at the face of the main entry 1,500 feet northeast of the mine mouth (see analysis, page 509) is as follows:

Section of the Raven coal bed in Twin City Coal Corporation's mine.

(Loc., 729; el., 1,950 feet, B.)

Section where sample was cut at face of main entry.

(Analysis No. 32275.)

	Ft.	In.
Sandstone.		
*Coal	1	2
Shale, carbonaceous		1
*Coal	1	10
Shale		
Coal	3	0
Parting		1

The output of this mine is 15 tons of coal daily.

An unusual feature of the Raven coal bed in the Russell Creek and Left Fork basin is its extreme shaly character in a wide zone along the outcrop. In the Twin City mine this zone consists of black shale, with coal streaks and "rash." Because of this condition no mining was done for the first 250 feet back from the outcrop. A section, measured near the mine entrance, showed 3 feet of carbonaceous shale and no clear coal.

Near the head of Left Fork of Lick Creek the Raven coal has been prospected but the pits are closed and measurement of the bed was not possible. At loc. 730, el. 1,887 feet (L), the coal seen on the dump indicates that it has a shaly character. The bed is overlain by 10 feet of sandy shale capped by a thin sandstone.

An old opening on Honeycomb Branch of Lick Creek (loc. 731, el. 1,840 feet, B) in the Raven bed was visited but the coal was not visible. The bed here is capped by 10 to 20 feet of shale overlain by sandstone as it is on the head of Left Fork.

Kennedy coal bed.—In the Russell Creek and Left Fork basin the higher coal beds in the Norton formation have scarcely been touched. The Kennedy coal bed has been mined sparingly at a few places. At the time of writing, however, the Virginia Iron, Coal & Coke Co. are planning to develop the Kennedy bed on their property. The plans called for the estab-

*Sampled.

lishment of a mine on Meade Creek of Russell Creek. The outcrop of the Kennedy bed had been traced by this company and numerous pits dug many years before. The location and elevations of many of these pits were available for this report. The pits were slumped, however, and sections could not be measured.

On Russell Creek and Left Fork the Kennedy bed outcrops 200 to 280 feet above the Raven,—a rather large interval. The bed lies approximately at the same distance below the Lower Banner, though it is often closer to the Lower Banner than it is to the Raven.

The Kennedy coal bed crops out along the top of Bull Hill almost as far south as the Norfolk and Western Railroad tunnel. The bed is underlain by the McClure sandstone which ranges in thickness up to 40 feet. The sandstone is soft, however, and does not make such prominent benches as it does in Buchanan and Dickenson counties. A coal bed lying beneath the McClure sandstone has been prospected at loc. 732, el. 2,120 feet (B) and shows a thickness of 42 inches of crushed and laminated coal. A one-inch layer of shale separates it from the sandstone roof. The coal presents all the physical characteristics of the Kennedy.

A little farther south a knoll is high enough to catch the Kennedy bed, and it was seen at loc. 733, el. 2,140 feet (B). The acreage of the Kennedy coal on Bull Hill is so small as not to encourage development. Long and expensive inclines or tramways would be needed to lower the coal to the valley, and the thickness and extent of the bed is not sufficient to justify this expense.

The Kennedy was once mined on Middle Fork, but the mine has been abandoned and is caved shut. The bed here (loc. 734, el. 2,120 feet, B) is overlain by a 15-foot sandstone. A large mine dump and an old tramway down the stream to Virginia City indicate that the mine had been extensively worked.

The Kennedy coal outcrops 90 feet below the gap between the head of Left Fork of Lick Creek and Left Fork of Laurel Fork, in the northeast corner of Wise County. On the south side of the gap (loc. 735, el. 2,000 feet, B), only a bloom shows, the pit having caved. The rocks here have a gentle dip to the east. Sixty feet above the Kennedy a coal bloom of 11 inches in thickness was seen.

On the north side of the gap the following section was measured:

Section of the Kennedy coal bed on Left Fork of Laurel Branch.

(Loc., 736; el., 1,980 feet, B.)

	Ft.	In.
Shale, and sandy shale	15	
Shale	4	
Coal		3
Shale, carbonaceous		3
Coal	2	4+
Clay		
Coal	2	7+
Parting		3

The reported thicknesses of the Kennedy coal bed in the Russell Creek and Left Fork basin range from 2½ to 3½ feet.

Lower and Upper Banner coal beds.—The two Banner coal beds in the Russell Creek and Left Fork basin in Wise County are relatively unimportant. Their small acreage and inaccessibility are the chief features holding up any extended exploitation of them. The beds are of workable thickness throughout most of their extent in the basin, but are little mined for other than local use. The Upper Banner bed carries its sandstone parting throughout the two basins.

The Lower Banner coal bed lies about 130 feet below the Upper Banner bed and 200 to 225 feet above the Kennedy bed. The coal outcrops on Bull Hill, immediately over a soft but fairly massive sandstone and is under 60 feet of shale, which in turn is under a medium-grained buff standstone.

At one bloom in Bull Hill (loc. 737, el. 2,385 feet, B) the Lower Banner is exposed and consists of 2 feet of coal. It is overlain by 2 feet of shale which in turn is overlain by a 3-inch bed of coal.

The bed shows a 2-foot bloom at the gap in Bull Hill (loc. 738, el. 2,435 feet, B), but the gap is not low enough to cut through the bed. The acreage of the two Banner coal beds on Left Fork of Lick Creek, including Left Fork of Laurel Fork, is negligibly small.

The Upper Banner occurs from 400 to 425 feet below the Gladeville sandstone, and in the interval between them there is another massive bench-making sandstone 160 feet above the Upper Banner bed, which displays many of the physical characteristics of the Gladeville sandstone. The detailed section from the Upper Banner bed to the sandstone is given under the table of local sections, page 106. A coal of workable thickness, probably the Hagy, is found at places under this sandstone.

At loc. 739, el. 2,550 feet (B), on the head of Meade Creek the Upper Banner shows 21 inches of coal. This does not, in all probability represent the true thickness of the bed, as the exposure is very poor.

Near the Dickenson County line at the head of Middle Fork, the Virginia Iron, Coal & Coke Co. has several openings in the Upper Banner bed. The drifts are closely grouped as indicated on the geologic map, loc. 740, el. 2,600 feet (B). The bed here has the typical Upper Banner section:

Section of the Upper Banner coal bed at head of Middle Fork.

(Loc., 740; el., 2,600 feet, B.)

	Ft.	In.
Sandstone.		
Shale		6
Coal	2	5
Sandstone		1
Coal	1	6
Shale		2
Clay		
Coal	3	11
Parting		1

An opening in the bed a quarter of a mile southeast shows the Upper Banner with a greater thickness.

Upper Banner coal at head of Middle Fork.

(Loc., 741; el., 2,610 feet, B.)

	Ft.	In.
Shale.		
Coal	2	7
Sandstone		1
Coal	1	3
Shale		2
Coal		9
Clay		
Coal	4	7
Partings		3

Coal beds above the Upper Banner.—The Splash Dam coal bed was not seen in this basin. The Hagy coal bed, which in Dickenson County lies about 160 feet above the Upper Banner, is present and appears at places to be thick enough to mine. It outcrops beneath the thick bed of sandstone 160 feet above the Upper Banner coal. The bed is exposed at loc. 742, near Fairview school, at an elevation of 2,710 feet (B). The section is given below:

Section of the Hagy coal bed near Fairview school.

(Loc., 742; el., 2,710, B.)

	Ft.	In.
Bone		2
Coal		2
Sandstone		1
Coal	2	6
Clay		
Coal	2	8
Parting		1

The bed shows as a bloom in the road, at the head of Middle Fork, near the Dickenson County line. The bloom was seen also 140 feet up the slope from the Upper Banner bed at the head of Middle Fork (loc. 743, el. 2,750 feet B).

No coal beds higher than the Hagy show in outcrop in the basins here described.

COAL BEDS ON POWELL MOUNTAIN.

INTRODUCTION.

General description of the coal beds.

The rocks of Powell Mountain belong largely to the Lee formation and Pennington shale, and contain a number of coal beds that are locally of workable thickness. The general geology and topography of the Powell Mountain field is described in earlier sections of this report, and only the character, thickness, and economic value of the coal beds will be described here.

The Powell Mountain coal field has been described by Campbell[1] and by Campbell and Woodruff.[2] The earlier of these reports by Campbel contain the general statement that few coal beds of workable thickness were found on Powell Mountain and it was the opinion of the writer that that part of the coal field was very unpromising for future development.

Later reports reached the Geological Survey that good coking coal, in beds thick enough to be worked, had been revealed by systematic prospecting on the south side of Powell Mountain and the field was revisited

[1] Campbell, M. R., Geology of the Big Stone Gap coal field of Virginia and Kentucky: U. S. Geol. Survey Bull. 111, 1893; Estillville folio, Va.-Ky.: U. S. Geol. Survey Geol. Atlas, Estillville folio (No. 12), 1894; Bristol folio, Va.: U. S. Geol. Survey Geol. Atlas, Bristol folio (No. 59), 1899.

[2] Campbell, M. R., and Woodruff, E. G., Powell Mountain coal field, Virginia: U. S. Geol. Survey Bull, 431, pp. 147-162, 1909.

by Campbell and Woodruff and a detailed examination made of the prospects on Stony Creek. The conclusions of these authors is stated (page 147) as follows:

"The present paper gives the results of the investigation. It may be mentioned briefly that the previous statements of the senior author have been verified almost to the letter, and that the field has little prospective importance."

Continued prospecting in the Powell Mountain field up to the present day bears out in the main these previous statements that the field is of little prospective value. On Stock and Cove creeks two coal beds 3 to 4 feet thick are opened. Coal beds of workable thickness have also been opened on the north slope of Powell Mountain, south of Coeburn, and, during the high coal prices of 1920, were operated by wagon mines. Considering the coals of the Powell Mountain field as a whole, however, they can not compare with the coal beds in the main coal field of Wise County, to the north and east, either in number or thickness of beds. In the main field there are at least 26 coal beds averaging 4 feet or more in thickness, whereas on Powell Mountain there are but 8 to 10 beds, only 4 of which exceed 2 feet in thickness. Graphic sections of many of these coal beds are shown in fig. 50.

In the following description of the Powell Mountain coal beds, the field is divided into drainage basins that will be described in the following order: Powell River basin, Stock Creek basin, Stony Creek basin, McGhee, Dry, and Little Stony creeks basin, and Guest River basin. Full use has been taken of the sections and other data appearing in Campbell and Woodruff's report in the preparation of the detailed descriptions of the coal beds appearing in these basins. Sections taken from that report are credited to "Bulletin 431."

The coal beds on Powell Mountain, with the exception of the Burtons Ford coal bed, are of local importance only and no lines representing their outcrop have been drawn on the geologic map (Plate II). The outcrop of the Burtons Ford coal is sketched along the south side of Powell Mountain, as this bed is workable throughout a large area and its outcrop has been traced from Burtons Ford to McGhee Creek. A bore-hole reveals its presence as far west as Stock Creek. Above this bed the coals are thin, poorly prospected, and are not often seen in natural exposures, three facts which make the drawing of the outcrop lines of doubtful certainty and little or no practical value. Correlations throughout the different parts of the field are equally hazardous and of little value.

In figure 49, sections of the whole or parts of the Lee formation are arranged in sequence from west to east, showing graphically the position of coal beds.

No coal beds of workable thickness occur below the Lee formation in this field. At a few isolated localities a bed of coal ranging in thickness from nothing to 16 inches is exposed in the upper hundred feet of the Pennington shale. A description of the coal at these outcrops follows in the section of this report devoted to the detailed description of coal beds in the basins of the Powell Mountain field. The Pennington shale is described in the description of the pre-Pennsylvanian rocks (pp. 60-62).

The thickest and most commercially important coal bed in the Lee formation is the Burtons Ford coal bed,[1] which occurs just beneath the massive ridge-making conglomerate member, about 500 feet above the base of the formation.[2] The bed outcrops at many places in the upturned rocks at the southeast edge of the coal field. At Little Stony Creek it is 5 to 7 feet thick, on McGhee Creek it is 4 feet thick, consisting largely of cannel coal, and on Stock Creek it is 2½ feet thick. The bed is 4 feet, 10 inches thick in Big Stone Gap where it occurs below the Bald Rock at the south portal of the main Louisville and Nashville Railroad tunnel. A 10-inch bloom was seen 150 feet below this bed on Little Stony Creek. On the north side of Powell Mountain two coal beds, one 12 inches thick and one 28 inches thick, are exposed below the Bald Rock, at distances of 300 feet and 400 feet, respectively.

The Burtons Ford bed was sampled at two localities, one on McGhee Creek, and one on Little Stony Creek. The sample on McGhee Creek, where the coal is largely cannel, is given in the table of analyses under

[1] The Burtons Ford coal bed, which C. K. Wentworth in the Russell County report placed at the top of the Pennington shale, is here placed in the Lee formation as the result of field work and paleobotanical studies by David White, of the U. S. Geological Survey. Mr. White, accompanied by the writer, in the fall of 1922, visited the type locality of the bed at Burtons Ford, Russell County, and exposures of the same bed in Scott County. A considerable Pennsylvanian (Lee) flora of the Pocahontas Group was obtained, proving the Pennsylvanian (Lee) age of the coal bed.

Structural studies at Burtons Ford indicate that there is a massive conglomerate about 300 feet stratigraphically below the Burtons Ford bed and which represents in all likelihood the base of the Lee. This conglomerate does not outcrop along the railroad in front of the Burtons Ford Mine but is faulted off in the small gully south of the mine. The crest of the main ridge at the Burtons Ford mine is made by the conglomerate stratigraphically above the coal but proceeding southwest along the ridge line about half a mile, the lowermost sandstone rises and becomes the crest-making stratum. Three miles to the southwest where Clinch River swings south out of the coal field and along the southern border of the field in Scott County the basal member of the Lee is non-conglomeratic.

[2] The massive conglomerate is called the Bald Rock member of the Lee formation, —see page 587.

Analysis No. 10359, and the two samples taken from the Little Stony Creek, or J. S. T. Coal Corporation's mine, under Analysis Nos. 75743 and 75744. The cannel coal contains 28.9 per cent ash, from a channel sample of the entire bed, which consists of two benches of impure coal, two benches of good cannel, and one bench of mixed cannel and bituminous

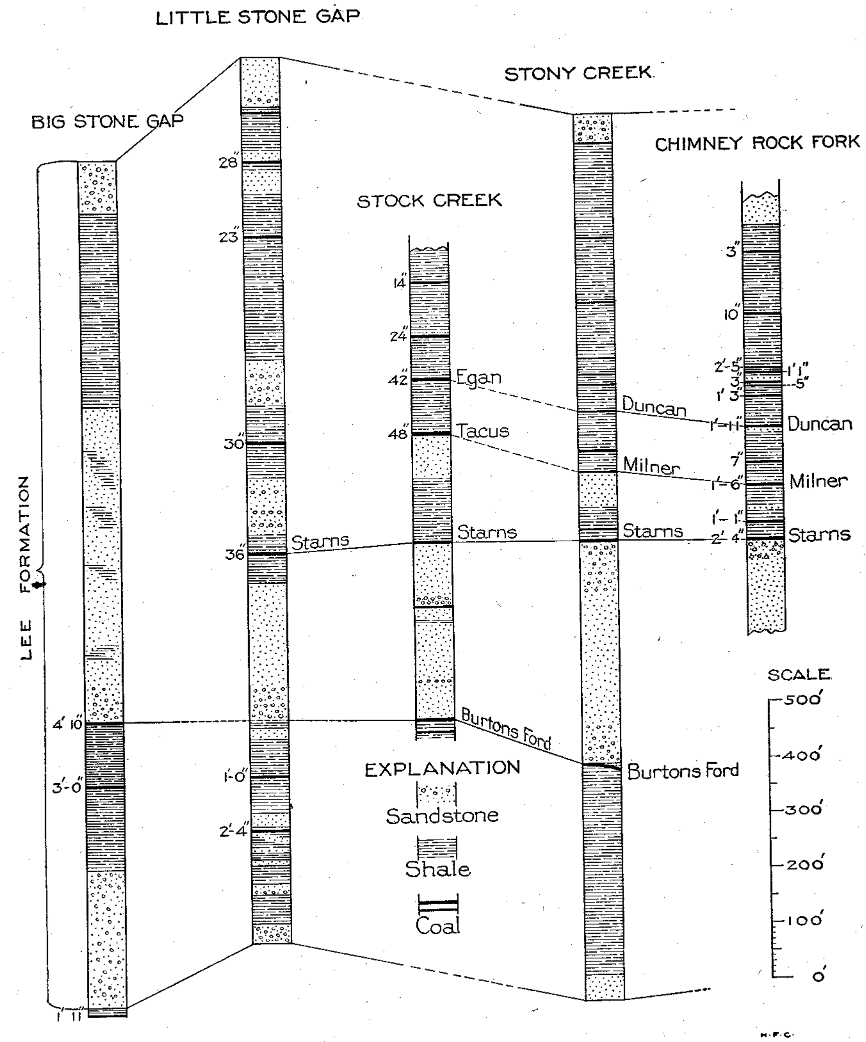


Fig. 49.—Columnar sections of the Lee formation.

coal. The impure benches have an ash content of 38.5 per cent, hence the pure cannel coal probably does not contain more than 20 per cent of ash. The cannel coal makes an excellent grate fuel, but the actual heating value, owing to the high percentage of ash, is low, and therefore it is doubtful if it could be shipped with profit to any great distance. The same bed on Little Stony Creek, however, is entirely bituminous, having about the same fixed carbon, less volatile matter, slightly higher ash, and slightly lower heating value than the coal beds on the Norton and Wise formations.

A coal bed overlying the massive Bald Rock conglomerate has been opened on Stony Creek. It ranges from 2 to 2½ feet thick and is called the Starns bed. The Milner bed on Stony Creek lies 150 feet above the Starns and is on an average less than 2 feet thick. The Milner may be the same bed as the Tacus bed of Stock Creek. The Duncan bed of Stony Creek, 70 feet above the Milner, may likewise be the Egan bed of Stock Creek (see fig. 49). The Tacus bed is 4 feet thick on Stock Creek. Coal beds overlying these beds are thin, and not persistent. Details of them will be given in the description of coal beds by drainage basins, wherever they have been noted.

The coal found in the Lee formation is hard, well jointed, and constant in quality. Samples of the coal were collected on Stony Creek and the results of a chemical analysis are given on page 525, under numbers 10358 and 10361. Commenting on the quality of the Lee coals, Campbell and Woodruff say in part:[1]

> "Analyses 10358 and 10361 represent the coal of the Lee conglomerate, and a comparison will show an almost exact agreement in the two analyses. Comparison of these with analyses of samples from Stonega, Norton, Swansea, and Dante, also shows great similarity—much greater than is usual between coal of different formations and different fields. In general in the Appalachian coal field there is an increase of fixed carbon from west to east and also from the younger to the older rocks, but the Powell Mountain field seems to be an exception to the general rule.
>
> "Although the chemical composition of the coal in the Lee conglomerate seems to be almost identical with that from the Norton formation, there appears to be a great difference in their coking properties. It is reported that the Duncan coal from Coalpit Branch will coke in an open fire, but so far as known, this is the only coal

[1] U. S. Geol. Survey Bull. 431, p. 162.

in Powell Mountain that has this property. When the Pishel test[1] is applied the Duncan coal shows some adhesion to the mortar and so will probably coke, but the Milner coal shows no such tendency, nor does any other coal that was tried. From this it is concluded that the most of the coal of this field will coke with difficulty if at all."

As the owners of the Milner mine were not satisfied with the statement given above, a large sample of coal from this mine was procured by T. K. Harnsberger in 1913, and a practical coking test was made in one of the beehive ovens of the Virginia Iron, Coal & Coke Co., on Toms Creek. The result showed that the Milner is an excellent coking coal and that the Pishel test is not always reliable.[2]

At only a few localities has coal been found in the small outliers of the Norton formation that still exist on the southern or eastern slopes of Powell Mountain. The Jawbone coal bed is opened near the mouth of Guest River, and coal was noted above the Bee Rock on Little Stony Creek. These occurrences are local and will be described later in the rspective drainage basins in which the beds are found.

Detailed description of coal beds.

METHOD OF STATEMENT.

Following the policy used in describing the coal beds of the main coal fields, the major drainage basins of the Powell Mountain coal field will be described individually. A brief sketch of the geology, topography, and commercial development of each basin will be given, followed by a description of the coal beds, beginning with the lowest bed. As far as possible, outcrop locations will be numbered and described in a west-to-east direction. Thus, for north or south-flowing streams, outcrops will be described on the west bank around the head of the stream to the east bank.

Elevations are given where known, and will be designated either (L) for leveled, (B) for barometer, or (approx.) for approximate elevation. All other symbols or notations used will be similar to those already described on page 164, et seq.

[1] Pishel, M. A., A practical test for coking coals; Econ. Geology, vol. 3, 1908, pp. 265-275. This test consists in pulverizing the coal in an agate mortar. If the fine coal adheres to the mortar and pestle, it indicates a coking coal; if it does not adhere the coal will probably not coke.

[2] Campbell, M. R., Coking coal in Powell Mountain, Scott Co., Va.: U. S. Geol. Survey Bull., 541, pp. 163-164, 1914.

POWELL RIVER BASIN.

General features.—All of the territory on Powell Mountain, Stone, and Little Stone mountains, containing coal-bearing rocks and drained by Powell River or any of its branches, will be described as the Powell River basin of the Powell Mountain coal field. The outcrop of the coal-bearing rocks forms, in general, a large horseshoe around the head of the broad Powell Valley. This basin is the leanest in occurrence of coal on Powell Mountain, and consequently the coal is the least developed. The basin contains but one bed of coal that has been measured and found to exceed 4 feet in thickness.

The surface of the basin is extremely rough, made so in the northern and western portions by razor-back ridges of conglomerate and sandstone beds of the Lee formation. On Powell Mountain proper the beds of sandstone dip from 5 to 10 degrees, making low, unsymmetrical ridges. Throughout the basin the vegetation is dense.

Coal beds.—The coal beds occurring in the Lee formation in Stone, Little Stone, and Powell mountains have been prospected at only two localities, in Big Stone Gap and Little Stone Gap. The complete sections measured in these gaps are given under local sections No. 11 and No. 15 and appear in graphic form on figure 49.

A coal was opened by a shallow cut in the roadside in Little Stone Gap, the bed lying 400 feet below the Bald Rock conglomerate member of the Lee formation. The pit (loc. 744, el. 2,350 feet, B) exposes 28 inches of impure coal. The bed dips 80° slightly west of north, and is overlain by sandstone and underlain by a fossiliferous shale. A sample of the coal was analyzed and the results given as No. 75968. As the sample was taken only 3 feet from the actual outcrop, the coal was doubtless weathered and the analysis can not be taken to represent the bed correctly. It shows, however, an extremely low-sulphur coal. The high-ash content is not characteristic of the coal, but represents in large part fine clay particles that had been carried by seeping surface water into the joints of the coal. The presence of considerable water is shown by the high-moisture content.

Coal beds of workable thickness were seen at three other horizons above the bed just described, all in the Lee formation, and exposed in the Little Stone Gap section. As the complete section is given elsewhere in the report, only a summary of the section will be given here, showing the intervals and thickness of the beds:

Section in Little Stone Gap showing coal beds.

	Ft.	In.
Top of Lee formation.		
Interval	110	
Coal, float, not exposed		
Interval	90	
Coal		3
Clay		2
Coal	1	11
Interval	130	
Coal		3
Clay		2
Coal	1	6
Interval	370	
Coal	2	6
Interval	200	
Coal	3	
Interval	300	
Interval	100	
Coal		6
Interval	200	
Coal	1	
Interval	100	
Coal (loc., 744)	2	4
Interval	194	
Base of Lee.		
Thickness of Lee formation	1807	6

One coal bed was found in Big Stone Gap below the base of the Lee formation. The coal bed was measured by Campbell (Bull. 111, page 37) and found to contain 16 inches of coal. The measure was made on the east side of the gap. On the west side of the gap the bed contains but 8 inches of coal.

A 3-foot bed of coal was measured 414 feet above the base of the Lee on the east side of the Gap. The thickest bed found anywhere in the Gap, however, outcrops at the south portal of the Louisville and Nashville Railroad tunnel in the middle of the gap (loc. 745, el. 1,580 feet, B). The coal, the Burtons Ford bed, is 4 feet, 10 inches thick without partings, and is overlain by the Bald Rock member, which here consists of several hundred feet of massive sandstone and conglomerate. The coal is 112 feet above the 3-foot bed. The coal is hard but partly crushed.

From the foregoing description of the coal beds in the Powell River basin, it can readily be seen that the chances of any intended commercial development are remote. The coal is usually crushed and impure and the beds are in many places turned up at high angles, making them more difficult and expensive to work than flat-lying beds. Where the rocks are well exposed, such as in the two gaps, coal beds of mediocre thickness and quality alone appear. In Little Stone Mountain a coal bed nearly 5 feet thick crops out by the side of the road, but it would be hazardous to assume that it maintains this thickness, even in nearby localities. On the contrary, there is every reason to believe that such a thickness is local and due in most instances to the crushing and squeezing of the coal beds into pockets of abnormal thicknesses.

STOCK CREEK BASIN.

General features.—The Stock Creek basin includes all of the coal-bearing rocks on the extreme southwest flank of Powell Mountain, west of Stony Creek. Besides Stock Creek, the basin includes a portion of the Cove Creek drainage basin. The rocks exposed on these creeks consist of the lower half of the Lee formation, the generalized section of which, including coal beds, is shown in figure 49. The rocks dip strongly to the southeast, the total descent from Maple Gap to Mabe amounting to 1,500 feet or an average dip of 4 degrees and 10 minutes.

The Bald Rock and the basal sandstones of the Lee are massive and conglomeratic and make cliffs and steep canyon walls along Stock Creek and its branches. The rocks rise so rapidly to the northwest that the head of Stock Creek has cut through the Lee into the reddish shale of the Pennington formation.

The coal beds on Stock Creek, six to eight in number, were prospected by the Interstate Coal and Iron Co., many years ago. These old pits, several of which are still open and supply local needs, reveal two beds of coal over 40 inches thick and three other beds 24 to 30 inches thick. The coals are usually clean, hard, and well jointed, and graphic sections of some of the beds are shown in figure 50.

Three core drillholes have been put down in the Stock Creek basin by the Interstate Coal & Iron Co. No better conception of the character and thickness of the coal beds in the Lee formation can be obtained than by a careful study of the sections of the beds drilled through in these borings. The total length of stratigraphic section involved ranges from 550 to 575 feet or from the Burtons Ford coal bed to the Tacus bed, inclusive. The graphic sections are given on the plate of boreholes (Plate III) and the detailed sections are as follows:

Log of boring on Stock Creek near Mabe.

(I. C. & I. Co. No. 1.)

(Loc., 75; el., 1,720 feet, B.)

	Thickness. Ft.	In.	Depth. Ft.	In.
Alluvium:				
Gravel and boulders	15		15	
Lee formation:				
Sandstone, broken	3		18	
Shale	5		23	
Coal, Starns		7½	23	7½
Sandstone	97	4½	121	
Conglomerate	3		124	
Sandstone	19	3	143	3
Coal		10	144	1
Sandstone	20	11	165	
Sandstone, soft, with coal streaks	6		171	
Shale, sandy	2		173	
Sandstone	50		223	
Sandstone, very hard	12		235	
Conglomerate	12		247	
Conglomerate, with coal streaks	25		272	
Sandstone, hard, broken	10		282	
Conglomerate, with coal streaks	4		286	
Sandstone, hard	40		326	
Sandstone, hard, slightly conglomeratic	8	6	334	6
Coal		2	334	8
Conglomerate, Bald Rock member	15	4	350	
Coal, with shale bands, Burtons Ford	2	6	352	6
Shale	3	6	356	
Clay	3		359	
Shale	11	8	370	8
Coal	1		371	8
Shale, sandy	28	4	400	

Log of boring on Stock Creek near Walling mine.

(I. C. & I. Co. No. 2.)

(Loc., 74; el., 2,550 feet, approx.)

	Thickness. Ft.	In.	Depth. Ft.	In.
Drift	15		15	
Lee formation:				
Shale, sandy	38		53	
Coal and shale mixed		10	53	10
Shale, sandy	10	2	64	
Coal, Tacus	2		66	
Sandstone	51		117	
Conglomerate	10		127	
Sandstone	27		154	
Conglomerate	11		165	
Sandstone	40	4	205	4

	Thickness. Ft.	In.	Depth. Ft.	In.
Sandstone, with coal partings		5	205	9
Sandstone	13	3	219	
Sandstone, with shale partings	16		235	
Sandstone	40		275	
Sandstone, with coal partings	1	2	276	2
Sandstone	9		285	2
Coal	1	1	286	3
Shale	8	9	295	
Shale, sandy	24		319	
Shale, dark	5		324	
Coal		6	324	6
Shale, dark	10	6	335	
Coal		5	335	5
Shale, dark	7	7	343	
Coal (Starns)		5	343	5
Shale (Starns)	1		344	5
Coal, dirty (Starns)		6	344	11
Clay, sandy	5	1	350	

Log of boring at head of Cove Creek near Tacus flats.

(I. C. & I. Co. No. 3.)

(Loc., 73; el., 3,290 feet, approx.)

	Thickness. Ft.	In.	Depth. Ft.	In.
Drift	3		3	
Lee formation:				
Sandstone	19		22	
Coal, Tacus	1	5	23	5
Clay, sandy	3	7	27	
Sandstone, hard	33		60	
Conglomerate	18		78	
Coal		4	78	4
Conglomerate		8	79	

Coal beds.—The lowest coal that is known on Stock Creek is the Burtons Ford bed revealed in the boring of the Interstate Coal & Iron Co., near Mabe (loc. 75). The bed lies directly beneath the Bald Rock conglomerate member of the Lee and consists of 30 inches of coal with thin shale partings. A 12-inch bed of coal was found 20 feet below the Burtons Ford coal bed, and possibly represents a split from the thick Burtons Ford bed found 10 miles to the east. A 10-inch bed of coal is found midway between the Burtons Ford bed and the Starns coal bed in this borehole.

The Starns bed, or the coal bed overlying the Bald Rock conglomerate, varies from 7½ inches in borehole 75, to a thickness of 27 inches on Stock Creek, 1½ miles north of Mabe. The Starns bed is partly exposed on Stock Creek north of Mabe at loc. 746, el. 2,040 feet (B). The bed is here reported to be 27 inches thick.

A massive bed of conglomerate from 75 to 100 feet thick outcrops about 100 feet above the Starns bed. A coal immediately overlies this sandstone and is here called the Tacus coal bed, for Tacus Flats, near which it has been drilled into by the Interstate Coal & Iron Co. (loc. 73). The bed is 17 inches thick in this boring and 20 feet below the surface. It is about 200 feet above the Starns coal bed.

The Tacus bed has been opened two miles north of Mabe (loc. 747, el. 2,640 feet, B) and reported to be 4 feet thick. One mile southeast of this place (loc. 748, el. 2,120 feet, B) the bed is exposed, showing 3 feet of coal, overlain by gray-brown shale.

A coal bed from 100 to 120 feet above the Tacus bed is named the Egan bed, for a prospector near Mabe, who has opened many of the coal beds. The Egan coal bed is one of the best on Stock Creek, averaging 42 to 50 inches of coal. It is opened two miles due north of Mabe (loc. 749, el. 2,750 feet, B) and shows 4 feet, 10 inches of clear coal. The bed has been prospected a quarter of a mile to the southeast (loc. 750, el. 2,725 feet, B), where 4 feet is reported, but the pit is caved and the report could not be verified.

One mile north of Mabe the Egan bed is opened in an old mine entry that runs east on the strike of the bed for 225 feet. The mine has a hard sandstone floor. The coal bed in this mine has a reverse or north dip which, however, is only local in extent, and it has the following section:

Section of the Egan coal bed 1 mile north of Mabe.

(Loc., 751; el., 2,180 feet, B.)

	Ft.	In.
Shale.		
Coal	1	6
Clay		½
Coal	2	7
Sandstone		
Coal	4	1
Parting		½

A coal bed, measuring 42 inches in thickness, is opened at the head of Dry Branch of Cove Creek (loc. 752, el. 2,815, B). The bed is doubtfully considered the same as the Egan coal bed on Stock Creek.

A persistent coal bed, 90 feet above the Egan coal bed, is reported to be about 24 inches thick. This bed has been prospected one mile north of Mabe (loc. 753, el. 2,270 feet, B). The bed at this pit is said to be 23 to 24 inches thick, but the pit is caved and the report could not be verified.

A still thinner bed, said to average 12 inches, is reported 100 feet above the bed just described. The coal was not seen and the bed is too thin to be of any value.

Considerable prospecting has been done recently by the Mineral Development Co., on two coal beds on Cove Creek. The prospect pits were not visited, and it can not be said with certainty which beds have been opened by this company, but the writer, judging from the thickness and position of these beds, believes that they are probably the Tacus and Egan beds. The two beds range from 3½ to 4 feet thick.

No commercial mining of the coals on Stock Creek or Cove Creek has as yet taken place. Efforts are now being made to develop this basin, but the following factors should be borne in mind: (1) there are only two beds of proven thickness to justify mining under present conditions and the thickness of these two beds is definitely known to be much less to the east, as will be shown in the description of the Stony Creek basin; (2) the coal to be mined commercially would require transportation facilities that are not now available in this section of the field. A railroad line could be built up Hunter Valley from the Southern Railroad at Sunbright, a distance of 3 or 4 miles, or a tram-road could be built from Stock Creek to Sunbright. To reach Cove Creek the line would have to be twice as long. Until coal is in much greater demand than at present it is quite probable that neither the stub nor the tram-road could be constructed and operated at a profit.

STONY CREEK BASIN.

General features.—The south-central portion of the Powell Mountain coal field is drained by Stony Creek and its many long branches. The basin is bounded on the north by the high crest of Powell Mountain and on the south by the upturned rim of the coal-bearing formations. The streams of the basin have rocky bottoms and numerous waterfalls over bold cliffs of sandstone and conglomerate.

The rocks of the basin lie on the south flank of the Powell Valley anticline and dip from 5 to 15 degrees south and southeast into a syncline, the axis of which lies north of the belt of sharply upturned or overturned rocks, 1 mile north of Ka, thus giving a northwest dip to the beds in a narrow belt paralleling the sharply tilted rocks. The rocks exposed in this basin, north of the overturn include the upper two-thirds of the Lee formation and a thin outlier of the Norton formation. The base of the Lee and the top of the Pennington are exposed in the sides of the gap

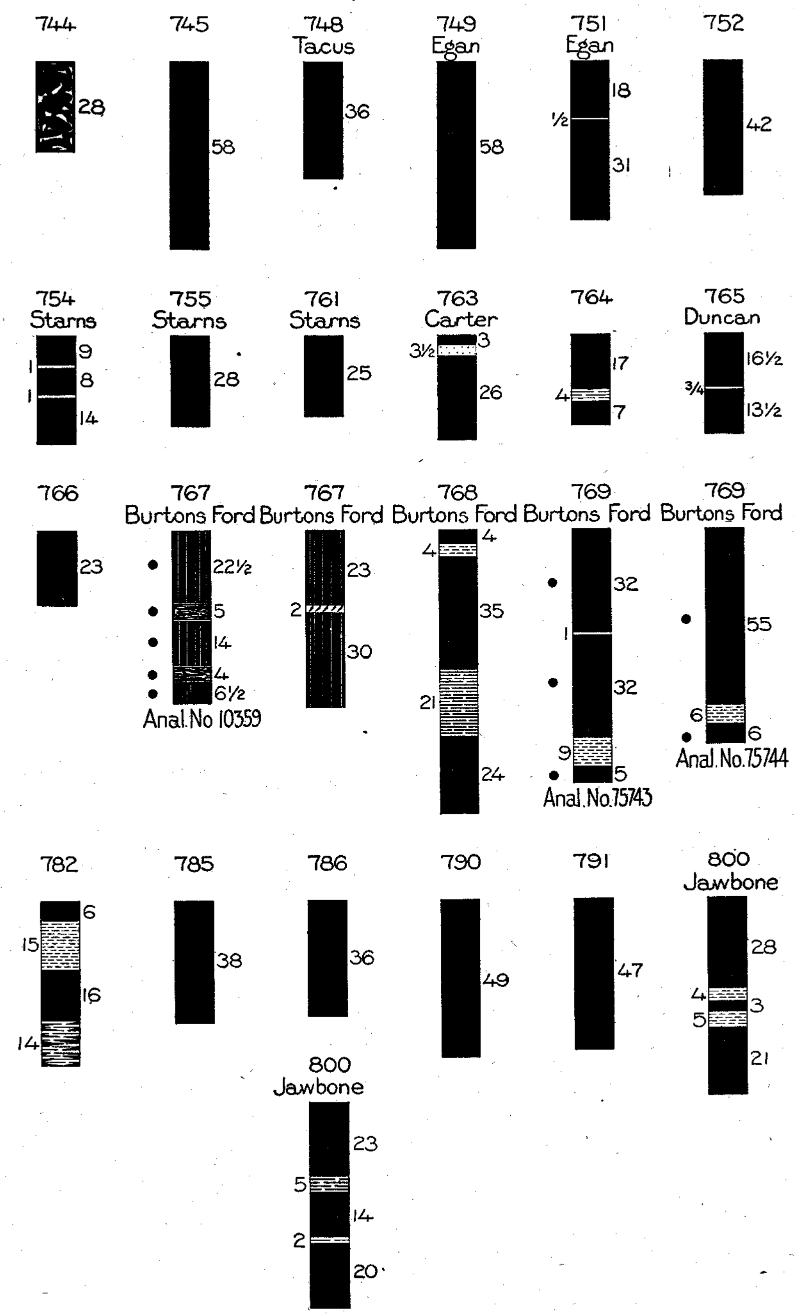


Fig. 50.—Sections of coal beds in the basins of the Powell Mountain coal field.

cut by Stony Creek, through Stone Mountain. The sharp turning up, and in most cases overturning, of the massive sandstones of the Lee and Pennington make "hanging rocks" where streams cross this belt of intense folding.

Coal beds.—The coal beds of the Stony Creek basin average 2 feet or less in thickness. A general description of the beds is given in the introduction to the Powell Mountain coal field section of this report and as the beds will be described in detail later only a brief sketch of their commercial development, past, present, and future, will be given here.

Many attempts were made from 1890 on to capitalize the occurrence of coal on Stony Creek with the view to its commercial development. Prospecting pits have been dug, a few drifts have been driven several hundred feet or more into the beds, and in places trenches have been cut from top to bottom of the hills. The results, however, have helped very little to prove the existence of coal beds of commercial thickness. The latest mine to be opened in the basin is the Stony Creek Lumber Co.'s mine near the mouth of Mountain Fork, which started in a 4-foot bed of coal. About 100 feet in, the bed thins to 2 feet and remains of that thickness for the next 900 feet—the present extent of the mine. The irregularity in the thickness of the coal bed in this mine is but another example of the usually poor condition of the coal beds lying on the south slope of Powell Mountain, especially near the fault line. With regard, therefore, to present and future development of the coal beds on Stony Creek, prospecting and mining operations to date, have only strengthened the observation made by Campbell in 1893 in which he states:[1]

> "There can be but one conclusion in regard to the economic importance of the [Lee] conglomerate coals in this field, [Powell and Stone mountains] and that is that the seams are usually too thin for profitable working, and even if they were of workable thickness they are too much squeezed and contorted to warrant investing much capital in their development."

The Starns bed is the lowest coal bed that is opened on Stony Creek. The bed lies directly above the Bald Rock conglomerate member of the Lee, which here is from 350 to 400 feet thick, and it is opened by the Stony Creek Lumber Co.'s mine near the mouth of Chimney Rock Fork. The coal at the entrance of the drift is 4 feet thick. At a point 1,000 feet in the following section was measured:

[1] Bull. U. S. Geol. Survey No. 111, 1893, p. 40.

Section of the Starns coal bed in Stony Creek Lumber Co.'s mine.

(Loc., 754; el., 1,780 feet, B.)

	Ft.	In.
Sandstone.		
Shale, "draw slate"	2	
Coal		9
Bone		1
Coal		8
Bone		1
Coal	1	2
Shale		
Coal	2	7
Partings		2

The coal is hard and bituminous and used locally for fuel. The mine produces about 7 tons a day.

The bed has been opened by the roadside a quarter of a mile below the mouth of Chimney Rock Fork, where it shows an apparent thickness of 2 feet, 6 inches. The entry had not been driven into fresh coal and the true thickness may not be as great as that just given. That the bed averages more than 2 feet, however, is fairly certain, as it is 2 feet, 4 inches thick in a prospect trench on Chimney Rock Fork (loc. 755).

To expose all of the coal beds in that section of the basin two prospect trenches were dug from stream level to the base of the "Bee Rock" of the Lee, on the ridge between Chimney Rock and Mountain Forks. The coals exposed in these sections are shown graphically in figure 49 and the detailed sections are given below. The section on Chimney Rock Fork was measured from loc. 755, due east, up the ridge, to loc. 756.

Local section on Chimney Rock Fork.

(Bull. 431, p. 154.)

	Thickness.		Interval.	
	Ft.	In.	Ft.	In.
Sandstone, base of "Bee Rock"	50		50	
Unexposed	50		100	
Coal		3	100	3
Unexposed	110		210	3
Coal, not driven under solid cover		10	211	1
Unexposed	96		307	1
Shale	1		308	1
Coal	2	5	310	6
Shale	3	10	314	4
Coal	1	1	315	5
Unexposed	13		328	5
Sandstone	4		332	5
Unexposed	2	2	334	7
Coal, probably contains some cannel		3	334	10

	Thickness. Ft.	In.	Interval. Ft.	In.
Unexposed	8		342	10
Shale	3		345	10
Coal		8	346	6
Unexposed	18		364	6
Coal, not under solid cover	1	3	365	9
Unexposed	45		410	9
Shale	4		414	9
Coal, Duncan (?)	1	11	416	8
Shale	3		419	8
Sandstone, massive	8		427	8
Unexposed	56		483	8
Coal, not under solid cover		7	484	3
Sandstone, massive	10		494	3
Unexposed	24		518	3
Shale	3		521	3
Coal, Milner (?)	1	6	522	9
Unexposed	42		564	9
Sandstone	6		570	9
Unexposed	25		595	9
Coal, not under solid cover	1	1	596	10
Shale, sandy, brown	30		626	10
Coal, Starns	2	4	629	2
Sandstone to creek, Bald Rock member	165		794	2

A similar trench was cut on the east side of the ridge from stream level to the top of the ridge, starting on Mountain Fork opposite the mouth of Glady Fork (loc. 758) and running northwest to loc. 757. This section extends downward to within about 50 feet of the top of the Bald Rock member of the Lee.

Local section on Mountain Fork.

(Bull. 431, p. 153.)

	Thickness. Ft.	In.	Interval. Ft.	In.
Sandstone, massive base of "Bee Rock."				
Unexposed	96		96	
Coal	1		97	
Unexposed, probably shale	130		227	
Coal	1		228	
Unexposed	28		256	
Sandstone	13		269	
Unexposed	73		342	
Coal, may be squeezed	1	11	343	11
Unexposed	40		383	11
Sandstone, gray	4		387	11
Shale	28		415	11
Unexposed	18		433	11
Sandstone	13		446	11
Shale	13		459	11
Shale, sandy	6		465	11
Unexposed, probably shale	40		505	11
Coal	1	8	507	7

	Thickness. Ft.	In.	Interval. Ft.	In.
Shale		10	508	5
Coal		4	508	9
Unexposed, probably shale	51		559	9
Coal, with lens of cannel at base, Milner	1	7	561	4
Shale, drab	3		564	4
Unexposed	11		575	4
Sandstone, shaly	17		592	4
Unexposed	28		620	4
Sandstone	63		683	4
Unexposed to creek	11		694	4

The unexposed interval near creek level probably contains a small coal bed, as shown by a drift on the east side of the creek at loc. 759, el. 1,980 feet (B). The bed at this drift consists of 8 inches of crushed coal overlain by sandstone and underlain by thin beds of clay, carbonaceous shale and impure coal. The drift was driven in only a few feet and showed a reverse or northerly dip at its face.

A section measured on Baker Branch (north of loc. 760) which enters Mountain Fork, one-half mile east of the Stony Creek Lumber Co.'s mine, is given below:

Local section on Baker Branch.

(Bull. 431, p. 155.)

	Thickness. Ft.	In.	Interval. Ft.	In.
Sandstone.				
Coal	1	1	1	1
Interval	300		301	1
Coal, not under solid cover	1	9	302	10
Interval	20		322	10
Coal		7	323	5
Interval	50		373	5
Coal, crushed	1	10	375	3
Interval	140		515	3
Sandstone, Bald Rock member				

The intervals in the section given above were measured by aneroid barometer, without allowance for dip, which here is appreciable. The significant fact to be noted in this section, however, is the thinness of the coal beds, none being more than 1 foot, 10 inches thick.

The Starns coal bed is exposed on Donald Branch, a small stream entering Mountain Fork opposite the mouth of Chimney Rock Fork (loc. 761, el. 1,680 feet, B). The bed shows 2 feet, 1 inch of coal, or only 6 inches less than the section measured in the Stoney Creek Lumber Co.'s mine. The bed here lies about 150 feet below the probable Milner bed, as shown by the following section:

Local section on Donald Branch.

(Bull. 431, p. 156.)

	Thickness. Ft.	Thickness. In.	Interval. Ft.	Interval. In.
Coal, Milner (?)	1	1	1	1
Interval	55		56	1
Coal	1	5	57	6
Interval	60		117	6
Coal	1		118	6
Interval	30		148	6
Coal, Starns	2	1	150	7
Sandstone, Bald Rock member				

The Milner coal bed lies from 100 to 150 feet above the Starns bed. The most important showing of the bed is on Mountain Fork where it was opened about 20 years ago to supply fuel for engines used on a lumber tram. The mine (loc. 762) was known as the Milner mine but is now abandoned and was not seen during recent work in that field. The character of the coal in this mine, however, is described by Campbell and Woodruff,[1] as follows:

"At the mouth of the mine the coal bed is about 28 or 30 inches in thickness. The roof is exceedingly uneven, lying in rolls which give to the coal bed a varying thickness generally ranging from 2 to 3 feet. An entry driven to the left in almost a circle for about 500 feet struck coal, which at its maximum measured 5 feet, 6 inches thick. Such a bed as this would be worth commercial exploitation if the thickness holds throughout a large area. In attempting to cut a sample for analysis it was noted that the laminae of the coal are vertical instead of horizontal, as they should be in a flat-lying bed. It was further noted that at the roof and also at the floor the laminae are curved in opposite directions. The curved laminae extend for a distance of 4 to 6 inches into the coal bed. From this feature it was apparent that the great thickness is not normal, but due to differential movement of the roof and floor. Ordinarily, when coal beds are subject to severe stresses the coal is crushed into small flakes that show slickensides on all faces, but in this locality the coal was too hard to be crushed and it broke up into blocks, and these blocks, through the differential movement of the roof and floor, were turned up on end across the bed."

The Milner bed as exposed in the Chimney Rock and Mountain Fork local sections shows no thickness greater than 1 foot, 7 inches, if the correlation indicated in figure 49 is correct. It was not possible to trace the coal bed from the mine to either section, but the correlation is based on

[1] Bull. 431, p. 155.

relative intervals. Two pits were opened on Mahogany Branch, about one-half mile from Mountain Fork (locations not given on map) exposing a lower 21-inch bed of coal and a higher 18-inch bed of coal. The relation of these beds to the conglomerate was not determined, but the upper bed appears most likely to correspond with the Milner coal bed. From the evidence in the Milner mine and the many sections measured in that part of the basin, it is apparently quite safe to conclude that the thickness of of the Milner coal in the Milner mine is abnormal and does not underlie more than a few acres at most, and that the usual thickness of this bed is probably 18 to 20 inches.

A coal bed of workable thickness has been opened in the massive conglomerate on the west side of the gap just south of the mouth of Straight Fork. The drift is in the overturned rocks and the bed dips 30° southeast. The bed is associated with the first heavy sandstone above the Bald Rock conglomerate, but no satisfactory measure of the interval was made. The coal bed, called the Carter bed, has the following section:

Section of the Carter coal bed in Stony Creek gap of Stone Mountain.

(Bull. 431, p. 158.)

(Loc., 763.)

	Ft.	In.
Coal		3
Sandstone		3½
Coal	2	2
Coal	2	5
Parting		3½

Two coal beds have been opened on Coalpit Branch that lie 145 and 220 feet, respectively, above the Bald Rock conglomerate of the Lee. The upper bed is known as the Duncan bed and is the better of the two coals and one of the most promising beds in the basin. The lower bed was opened near the mouth of Coalpit Branch (loc. 764) and a section measured at this drift shows 2 feet of coal with a 4-inch parting of shale about 7 inches above the base of the bed.

The Duncan bed is exposed in a prospect entry on Coalpit Branch about a quarter of a mile from the mouth of the stream (loc. 765). The entry has been driven in about 125 feet and a section measured at the face shows 2 feet, 6 inches of coal with a three-fourths inch parting of carbonaceous shale in the middle of the bed.

One of the higher coal beds has been prospected on the east bank of Straight Fork, about 3 miles north of its mouth (location not given on map). The bed measures 2 feet 2 inches in thickness. The coal is much crumpled in the upper part of the bed and contains a lense of cannel coal in the lower part. A 23-inch bed outcrops under massive sandstone on the first large branch of Straight Fork coming in from the west (loc. 766, el. 2,400 feet, B). The bed is about 700 feet below the top of the Lee.

MC GHEE, DRY, AND LITTLE STONY CREEKS BASIN.

General features.—A large part of the southeastern flank of Powell Mountain is drained by McGhee Creek, a branch of Staunton Creek, by Dry and Little Stony creeks, branches of Clinch River, and by Clinch River itself. This territory, which will be described as a unit basin, contains coal in beds of workable thickness and is one of the chief coal producing basins on Powell Mountain. The important coal beds lies in the lower part of the Lee formation.

The rocks of the basin dip very gently to the south and southeast throughout much of the field north of the sharply overturned rocks along the Hunter Valley fault. Within the zone of overturning, the dips are variable but on the average range from 40° to 60° north. At places, however, as on Dry Creek, the thrust has been sufficient to overturn the great sandstones of the Lee and Pennington formations so that the beds dip in a south and southeasterly direction. The result of this sharp overturning of the rocks has been to bring to the surface valuable coal beds that otherwise would have been inaccessible in this field. This is particularly true in the case of the Burtons Ford coal bed, which is now being mined within the zone of the upturned rocks, and is the most valuable bed opened in the basin. A more detailed description of the geologic structure of this section of Powell Mountain is given elsewhere (page 119) in this report.

The Burtons Ford coal bed outcrops directly beneath the massive Bald Rock conglomerate member of the Lee formation. It ranges from 4 to 6 feet in thickness with several inches to one foot of parting. The bed contains excellent bituminous coal on Little Stony, but changes in character to a mixed bituminous and cannel coal on McGhee Creek. Coal beds are opened at several horizons in the Lee, but thicknesses of more than 3 feet are rare, whereas the majority of openings disclose beds only 1 to 2 feet thick.

The basin contains only one large shipping mine, the J. S. T. Coal Corporation's mine on Little Stony Creek. Another mine, about a mile east of the J. S. T. mine, was in process of opening in the spring of 1921 on presumably the same or Burtons Ford bed. Though prospect pits have been dug at many places, no other systematic development of the coal beds of the basin was under way when the field was visited.

Burtons Ford coal bed.—The Burtons Ford coal bed, named from its type locality at Burtons Ford, Va., is the bed of greatest economic importance in the basin.

The Burtons Ford bed is opened by a mine, commonly called the Hagan mine, on McGhee Creek, where it measures over 4 feet largely of cannel coal.[1] The mine was visited by Campbell and Woodruff in 1909 and a sample taken of the coal. (See table of analyses, page 525). The section measured when the sample was cut and a section measured later are given as follows:

Sections of Burtons Ford coal bed on McGhee Creek.

(Loc., 767; el., 1,950 feet, B.)

(Analysis No. 10359.)
(Bull. 431, p. 159.)

	Ft.	In.
*Coal, cannel	1	10½
*Coal, hard, impure		5
*Coal, cannel	1	2
*Coal, hard, impure		4
*Coal, mixed cannel and bituminous		6½
Coal	4	4

Section taken at face of drift 100 feet from the mine mouth.

	Ft.	In.
Sandstone.		
Coal, cannel	1	11
"Rash"		2
Coal, cannel	2	6
Coal	4	5
Parting		2

The bed here closely underlies the Bald Rock conglomerate member of the Lee, but the interval could not be satisfactorily measured. The bed

[1] A small block of the cannel coal from the Hagan mine was subjected to a distillation test by the chemistry laboratory of the U. S. Geological Survey and a yield was reported of 56.5 gallons of distillate a ton. This is a high rate of yield and exceeds the average yield of the best cannel coals in the Appalachian trough. The distillate, or "oil," is a greenish, dark, fluid, pungent with the odor of phenol and the residue is a firm, porous, and silver-gray cake. Although the cannel coal is thus well adapted for reduction the extent of the bed is so small that it would not warrant the establishment of a reduction plant.

The methods and apparatus used in the distillation test, which was of 2 hours duration, are described by L. C. Karrick in U. S. Bureau of Mines, Reports of Investigations, serial No. 2229.

*Sampled.

at this mine has a very low dip, 28° N. 10° E., considering the dips of 60° and 70° that are common to the zone of upturned rocks.

An old pit in the Burtons Ford coal bed was seen on the small branch entering Dry Creek from the north, about 1 mile from the mouth of Dry Creek. The pit is caved, and the outcrop of the coal concealed. The following section of the bed in this pit is given in a previous report as follows:

Section of Burtons Ford coal bed 2 miles north of mouth of Dry Creek.

(Loc., 768; el., 1,780 feet, B.)

(Bull. 431, p, 159.)

	Ft.	In.
Coal		4
Clay		4
Coal	2	11
Shale, carbonaceous	1	9
Coal, weathered	2	
Coal	5	3
Partings	2	1

The massive Bald Rock conglomerate at this place is overturned and dips 60° S. 25° E. Comparison of the sections shows that the coal bed here bears little resemblance to the cannel coal on McGhee Creek. The latter is a promising bed if it maintains its thickness and character for any considerable distance, both along the strike and back into the basin. The bed on Dry Creek contains so many partings that it would be expensive to separate the coal from the partings. The number and thickness of these partings, however, are local, for the bed is opened extensively on Little Stony Creek, about 1½ miles to the east, and shows fewer partings, and in places more coal.

The mine of the J. S. T. Coal Corporation in the Burtons Ford bed is on the east bank of Little Stony Creek nearly 1 mile north of Clinch River. The rocks here dip 36° to 40° N. 20° E., and the mine consequently is of the "pitching"[1] coal bed type, in which the main entry is driven in the bed on the strike and the rooms are driven up the rise. The coal bed was sampled at two places in the mine (see table of analyses, page 525) and the thickness of the bed measured at these places is given below:

[1] "Pitching" coal bed,—a steeply-dipping bed.

Section of the Burtons Ford coal bed on Little Stony Creek.

(Loc., 769; el., 1,670 feet, B.)

Section where sample was cut in room 13, 110 feet up from the main entry and 1,000 feet east of the mine mouth.

(Analysis No. 75743.)

	Ft.	In.
Sandstone.		
Shale	2	
*Coal	2	8
Clay		1
*Coal	2	8
Clay		9
*Coal		5
Clay		
Coal	5	9
Partings		10

Section where sample was cut at face of the entry, at beginning of room 17, 1,800 feet east of mine mouth.

(Analysis No. 75744.)

	Ft.	In.
Sandstone.		
Shale	2	
*Coal	4	7
Clay		6
*Coal		6
Clay		
Coal	5	1
Parting		6

This mine, in the summer of 1920, was producing from 60 to 65 tons a day, using 10 miners. The coal was lowered by an inclined tram road, 250 feet in vertical height, to a tipple near creek level. The coal was then hauled by tram to the Carolina, Clinchfield and Ohio Railroad on Clinch River for shipment. In the summer of 1921, a second entry was driven into the bed midway between the first entry and stream level, and coal is now being extracted from this entry. Coal 9 feet thick is reported in the lower entry.

The Burtons Ford bed has recently been opened by T. P. Chilles, of Dungannon, on the west side of Little Stony Creek, directly opposite the J. S. T. coal mine and a wagon mine has been established at this locality. The bed in his mine is 7 feet thick and stands vertical. It crops out on both sides of the stream immediately beneath the great towering wall of the Bald Rock sandstone, which is here 50 to 75 feet thick.

A thin bed of coal was seen south of the J. S. T. Coal Corporation's mine (loc. 770) consisting of 10 inches of coal. The bed is 150 feet below the Burtons Ford bed.

An opening about one-half mile east of the J. S. T. mine (loc. 771, el. 1,760 feet, B) is supposed to be in the Burtons Ford coal bed. The relation of the coal bed to the conglomerate points to this correlation, although the interval between them was not measured. The bed is exposed in several old prospect pits that were being reopened by P. B. Petrie, in

*Sampled.

1920. The coal bed is directly overlain by calcareous red and green shale which strongly suggest the Pennington shale. It is probable that faulting at the time of overturning has taken place, cutting out the base of the Lee. The bed is overturned, dipping 60° S. 30° E. It exhibits considerable evidence of slickensiding, crushing, and buckling, and contains 6 feet, 3 inches of clear coal. In reopening the mine at this locality, the operator constructed a small tipple, by the Carolina, Clinchfield and Ohio Railroad, near the east portal of the railroad tunnel south of the mine.

A coal bed 15 inches thick is exposed in the Pennington shale, in a railroad cut about 1 mile east of the tunnel (loc. 772, el. 1,380 feet, B). The coal bed is vertical with friable shale on the under or south side of the bed and a thick, soft, and greatly fractured sandstone on the upper side of the bed. The bed is probably the same as that which is exposed as a bloom just north of the bend in Clinch River (loc. 773, el. 1,395 feet, B). The coal bed is between 100 and 150 feet below the base of the Lee.

The Burtons Ford coal bed has been opened north of Powers house near the bend of Clinch River (loc. 77 A, el. 1,580 feet, B) and 6 feet of coal is reported. The bed here lies on the face of the overturned Bald Rock conglomerate member of the Lee, which dips 50° S. 45° E. The face of the rock wall is bare for a height of over 400 feet, and it was here that the name Bald Rock was first applied.

The Burtons Ford coal bed, south of Bangor, is 32 feet below the Bald Rock member as exposed in the transection of the upturned rocks by Clinch River (loc. 775, el. 1,400 feet, B). At its weathered outcrop the bed measures 54 inches of clear coal. It was noted in a caved prospect on the east bank of the river (loc. 776, el. 1,425 feet, B), but the coal could not be measured.

Coal beds in the Lee formation.—There are coal beds at various horizons higher in the Lee formation, particularly in the deeply cut valley of Little Stony Creek. At only one locality (loc. 777, el. 2,340 feet, B) on Dry Creek drainage, 10 inches of coal, dipping 53° S. 25° E. was seen nearly 50 feet above the Bald Rock conglomerate.

Entering Little Stony Creek valley from its mouth and going north into the flat-lying rocks, a coal bed is seen just north of the zone of upturned rocks, at loc. 778, el. 1,610 feet (B). The bed is exposed in an abandoned mine and shows 30 inches of good coal. It is approximately 500 feet below the top of the Lee.

Two coal beds were measured by Campbell and Woodruff on the west bank of Little Stony Creek about one-half mile north of Loc. 778. The pits were not located, however, on the base map used for their report and hence the exact locations of the prospects are not given. The lower of the two beds was opened beneath the upper conglomerate of the Lee on Little Stony Creek (half a mile north of loc. 778, Bull. 431, p. 158), where the coal is 3 feet, 1 inch thick, parted at the middle of the bed by 2 feet, 9 inches of shale.

The upper conglomerate of the Lee formation at this prospect is 225 feet thick. South of this pit and on top of the conglomerate a bed in a Norton outlier 2 feet, 6 inches thick crops out.

A coal bed 15 inches thick was seen cropping out between massive sandstone beds on one of the many tributaries at the head of Little Stony Creek (loc. 779, el. 2,150 feet, B). The rocks in this vicinity are nearly flat and the streams have cut deep channels with many falls over the resistant members of the Lee formation (see Pl. XXV). The coal bed noted above is within the upper 400 feet of the Lee.

Three coal beds are opened near the head of Little Stony Creek, each of which is thicker than the minimum allowable thickness for a workable coal bed. The local stratigraphic section involving the coal beds as well as the location and elevation of the lowest one are given below:

Sections of coal beds at head of Little Stony Creek.

(Loc., 780; el., 2,480 feet, B.)

	Ft.	In.
Sandstone, "Bee Rock"	20+	
Coal	2	6
Interval, shale (?)	90	
Sandstone	10	
Coal	2	0
Shale	50	
Coal	1	8
Clay		
Total	176	2+

The upper bed is a good quality bituminous coal ranging from 2 to 3 feet in thickness. The middle bed is without partings and resembles a cannel coal in appearance and character. It is reported to range from 18 to 24 inches in thickness. The middle bed is also opened beneath its cap sandstone on the north side of the stream (loc. 781, el. 2,530 feet, B) and shows 18 inches of clear coal. Coal beds of the thickness of those shown in the section given above and located so far from lines of transportation, are of little economic value at the present time and in all probability will not be mineable for many years to come.

A small prospect near the headwaters of Little Stony Creek reveals a coal bed near the top of the Lee, the worthless character of which is well shown in the following measured section:

Section of a coal bed on headwaters of Little Stony Creek.

(Loc., 782; el., 2,590 feet, B.)

	Ft.	In.
Shale, clayey	3	
Coal		6
Clay	1	3
Coal	1	4
Shale, with coal streaks	1	2
Coal	1	10
Parting	1	3

A second prospect a short distance to the west (loc. 783) was partly caved at the time it was visited and only 12 inches of coal was seen.

East of Little Stony Creek a few coal blooms are exposed in road cuts about 1 mile northeast of the J. S. T. mine. Two of the blooms are indicated on the geologic map, but both are of insignificant beds. One mile southeast of Bangor at loc. 784, el. 1,880 feet (B) an old prospect was visited but it was in such a condition that the section could not be measured. Considerable loose coal indicates that the bed is probably of workable thickness. It is reported that the prospect supplied coal for engines used in the construction of the Carolina, Clinchfield and Ohio Railroad. The bed lies at least 300 feet stratigraphically below the massive conglomerate of the Lee that makes the high ridge to the south.

GUEST RIVER BASIN.

General features.—The Guest River basin of the Powell Mountain coal field includes all the north slope of Powell Mountain from Lost Creek at Norton, east and southeast, to the mouth of Guest River at Bangor. The rocks exposed in this basin occur in the uppermost part of the Lee formation and in a few scattered outliers of the lower part of the Norton formation.

The rocks dip to the north and northeast throughout the greater portion of the basin, the dominating structure being the Powell Valley anticline. In the vicinity of Norton this dip is 72 degrees in the upper conglomerate beds of the Lee, but it decreases rapidly to the east, ranging south of Tacoma from 16° to 20°, and south of Coeburn, from 6° to 8°. On the south side of the anticlinal axis the dips are gentle and directed to the east and southeast.

The basin is one of the poorest in respect to its coal resources on Powell Mountain. Coal beds have been prospected at several localities and show a good quality coal in workable thickness. The prospects, however, with one exception, are located several miles from a railroad and wagon haulage is necessary over roads that are in poor condition for travel. The beds that have produced coal for shipment lie in the upper 500 feet of the Lee formation, and the lower part of the Norton formation. No attempt was made to correlate the coal beds of the Lee or trace their outcrop any distance, and the beds will be described only as seen at the individual prospects or wagon mines.

Coal beds.—The lowest coal bed that is opened in the Guest River basin lies from 450 to 500 feet below the top of the Lee formation. During the World War a mine on Mill Creek, two miles southeast of Tacoma was opened by Jesse Beam, and called the Blue Jem mine, (loc. 785, el. 2,150 feet, B). The coal bed in this mine is 38 inches thick and is a clear, bright, hard coal, with a clay-shale roof and clay floor. When visited, the mine was worked by two miners with a daily output of 12 tons of coal. The dip of the bed at the Blue Jem mine is 12° N. 30° E. A second prospect on the bed was seen on the west side of the stream (loc. 786), showing 36 inches of coal.

Several small beds of coal are exposed on the road that runs south from Tacoma on the divide between Burns Creek and Mill Creek. They are too thin to be commercially workable. A bloom showing 6 inches of coal was seen at loc. 787, el. 2,680 feet (B). The bed dips 10° northeast. Another bed, about 100 feet stratigraphically lower, showing 18 inches of coal, is exposed beneath a bed of soft sandstone at loc. 788, el. 2,750 feet (B). About one-fourth of a mile farther south the bloom of a bed 6 inches thick was seen (loc. 789, el. 2,810 feet, B).

The best development of coal beds of the Lee formation seen in the Guest River basin is that at two prospects on Pine Camp Creek on a bed 4 feet thick and without a parting. The bed was first opened at the Frank Davis mine (loc. 790, el. 2,415 feet, B) where it consists of clear hard coal 48 to 50 inches thick. It outcrops under a ledge of hard sandstone dipping from 6° to 10° due north. The same bed with a thickness of 47 inches of clear coal was being opened several hundred yards to the southwest, (loc. 791, el. 2,435 feet, B) when the mine was visited. The stratigraphic position of this bed was not accurately determined, but it lies within the upper 300 feet of the Lee formation.

Coal beds in the Lee are exposed at many localities southeast of Coeburn, but the beds are so thin that they can not be considered as workable. The thickest bed, reported to be 2 feet, is located half-a-mile south of the Guest River bridge near Coeburn. On Pine Orchard Branch, the first stream east of Jaybird Branch, 18 inches of coal was seen in a cave behind the falls which Jaybird Branch makes over a sandstone cliff 30 to 40 feet high (loc. 792, el. 1,980 feet, B).

Coal was seen at a few localities in the Guest River gorge, but nowhere thick enough to warrant development. At loc. 793, el. 1,520 feet (B) a bed 4 to 6 inches thick is exposed beneath massive sandstone. A prospect pit a short distance up the stream reveals 15 inches of coal stratigraphically about 50 feet higher. Near the mouth of the gorge the following section probably includes these two beds:

Section of coal beds near mouth of Guest River.

(Loc., 794; el., lower bed, 1,470 feet, B.)

	Ft.	In.
Shale.		
Coal	2	
Shale and clay	20	
Shale, hard	10	
Coal		10
Shale	3	
Sandstone		
Total	35	10

At the time of writing the Interstate Railroad is building a line down the gorge from Coeburn to Bangor. The beds described above and others, will undoubtedly be exposed in the cuts that will be made for this road, but from what is known of the upper sandstone of the Lee and the underlying shale the chance of opening any coal beds of economic thickness appears very slight. Renewed prospecting resulting from the opening up of this portion of the basin by a railroad line, however, may reveal beds which are locally of workable thickness, but the rocks of this region are as a whole characteristically barren of productive beds. A coal bed, that is an excellent example of the lenticular character of coal beds, crops out directly below the "Bee Rock." At the mouth of Guest River the bed is 20 inches thick and 3 miles up the river from the mouth it is reported as consisting of a bench of cannel coal 4½ feet thick, overlain by 1 foot of bituminous coal.

Coal is found in the outliers of the Norton formation in the Guest River basin. Two prospects were seen in a small outlier three miles south of Tacoma. The lower of the two prospects (loc. 795, el. 3,180 feet, B) was caved and the coal, which is about 30 feet above the massive "Bee Rock," could not be seen. Sixty feet above the caved prospect another partially exposed bed shows 12 inches of coal, with the base of the bed concealed (loc. 796, el. 3,240 feet, B). The bed has a firm shale cover. The size of the pit indicates that the bed is probably not over 20 inches thick.

These beds have been opened also at the mouth of Mill Creek in the upturned edge of the Norton rocks. The higher bed (loc. 797, el. 2,020 feet, B) appeared to contain from 2 to 2½ feet of coal. The lower bed, lying within 10 feet of the top of the "Bee Rock," was prospected but not exposed (loc. 798, el. 2,000 feet, B). The beds are separated by 50 to 60 feet of sandy, drab shale.

A prospect on the bed immediately above the "Bee Rock" was seen in the large Flatwoods outlier of the Norton formation one mile northwest of Bangor (loc. 799, el. 2,000 feet, B). The coal is reported to be four feet thick, but this statement could not be verified.

The one occurrence of coal in the outliers of the Norton formation in the Guest River basin that is worked commercially lies west of Bangor about a quarter of a mile. At this locality nearly 400 feet of the Norton formation lies above the "Bee Rock" of the Lee, with the result that a considerable acreage of the thick Jawbone bed is still preserved. The bed is opened at loc. 800, el. 1,940 feet (L) by a mine formerly owned by the Clinch River Coal Co., but later by the C. V. O'Donnell Coal Co. The coal from this mine is lowered through a chute to a tipple at railroad level 840 feet west of Bangor. A section measured from the coal bed to the river is as follows:

Local section at mine of the C. V. O'Donnell Coal Co., on Clinch River.

	Thickness. Ft.	Thickness. In.	Interval. Ft.	Interval. In.
Norton formation:				
Shale				
Coal, Jawbone	5		5	
Shale	60			
Coal, thin				
Sandstone, arkosic	35			
Shale	85			
Sandstone, gray	5			
Shale	30			
Shale, sandy	5			
Shale	110			
Shale, clayey	10		340	
Lee formation:				
Sandstone, conglomeratic	200		200	
Total			545	

The coal here is crushed and in places contains shale laminae that show distortion, indicating differential movement on the bedding planes of the coal bed. The bed is extremely variable in thickness as might be expected of a coal bed that has been subjected to such crushing stresses as has the Jawbone at this locality. The thickness of the bed ranges in general from 3½ to 8½ feet, but locally is reported to reach 12 or 14 feet. The bed contains two partings as shown in the following sections measured in the O'Donnell mine:

Sections of the Jawbone coal bed in C. V. O'Donnell Coal Co.'s mine.

(Loc., 800; el., 1,940 feet, L.)

Section in room 3, off 2d left entry, off main entry.

	Ft.	In
Shale.		
Shale, carbonaceous		1
Coal	2	4
Clay		4
Coal		3
Clay		5
Coal	1	9
Shale		
Coal	4	4
Partings		9

Section 150 feet west of room 3 in 2d left entry, off main entry.

	Ft.	In.
Shale.		
Coal	1	11
Shale, carbonaceous		5
Coal	1	2
Shale		2
Coal	1	8
Shale		
Coal	4	9
Partings		7

The Jawbone bed in this mine dips 12° S. 10° W. at the place where the sections given above were measured, but the general dip is not so great, averaging less than 10° in a southerly direction.

COAL MINING.

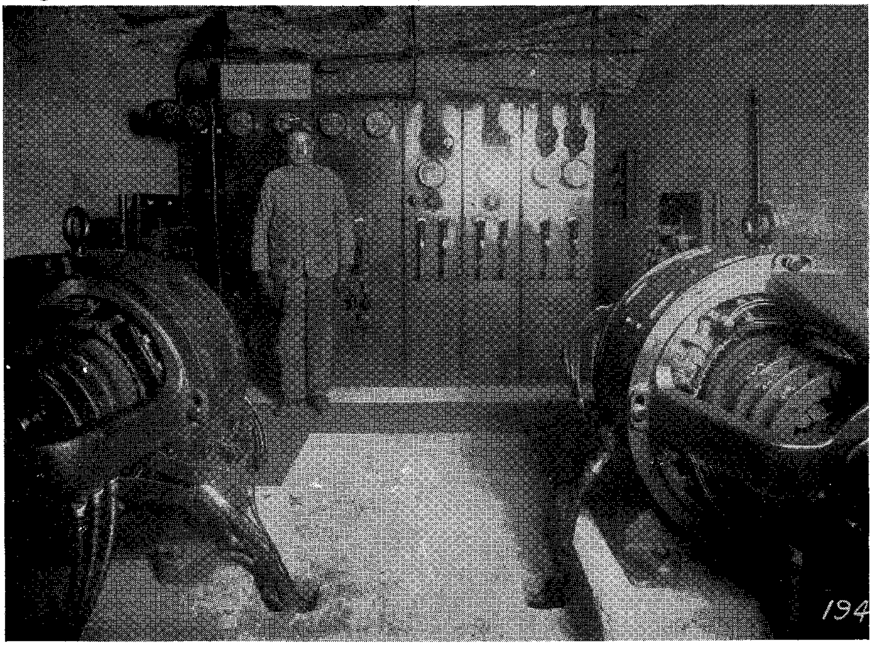
PRESENT OPERATIONS.

Coal mining in Wise County is a well-organized industry and the larger companies keep abreast of the times in their mining equipment. The mines are in large part electrically equipped; cutting machines of the latest design are used to mine the coal (see Pl. XXVIII B), and high-powered electric motors are used to haul it to the tipples (see Pl. XXVIII A). The tipples serving the majority of the mines are of late construction and are provided with shaker screens to make three sizes of coal—lump, egg, and slack (see Pl. XXVI).

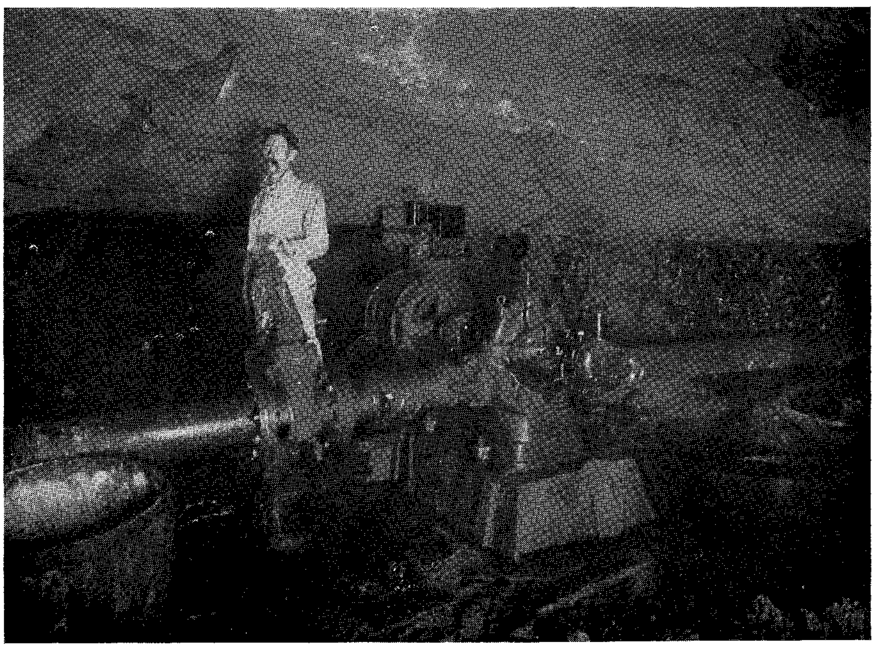
Among the larger coal-mining organizations in the county are the following: the Stonega Coke & Coal Co., Big Stone Gap, and Philadelphia, Pa.; the Virginia Iron, Coal & Coke Co., Toms Creek, and Roanoke, Va.; the Wise Coal & Coke Co., Dorchester; the Blackwood Coal & Coke Co., Blackwood; the Clinchfield Coal Corporation, Dante; The Norton Coal Co., Norton; the Stonegap Colliery Co., Glamorgan; the Hawthorne Coal Co., Norton; the Intermont Coal & Iron Co., Big Stone Gap; the Gladeville Coal Co., Wise; the J. A. Esser Coke Co., Esserville, and the Robert Fleming & Co., Norton. Thirty-seven other organizations and individuals are listed by the Division of Mineral Resources of the United States Geological Survey as producing coal in 1920, but so many of the smaller companies, and particularly individual operators have sold or closed their mines that it would be of little value to publish the list. Many of the smaller mines were abandoned in the fall and winter of 1920, immediately following the great drop in the price of coal.

The types of mines and methods of mining common to southwest Virginia have been described at considerable length by C. K. Wentworth in the consideration of the coals of Russell County, Va.,[1] and the description will not be repeated here in detail. The mines of Wise and Scott counties are predominantly drift mines (see Pl. XXVII), there being only a few slope mines in the field. A drift mine may be described as any mine whose main entry enters a coal bed approximately horizontally. A slope mine is any mine whose main entry slopes into the ground, whether it slopes down the dip of an inclined coal bed or slopes down to meet a flat-lying coal bed that does not outcrop in the vicinity. There are no mines in the field whose main entries are vertical shafts. Probably 99 per cent

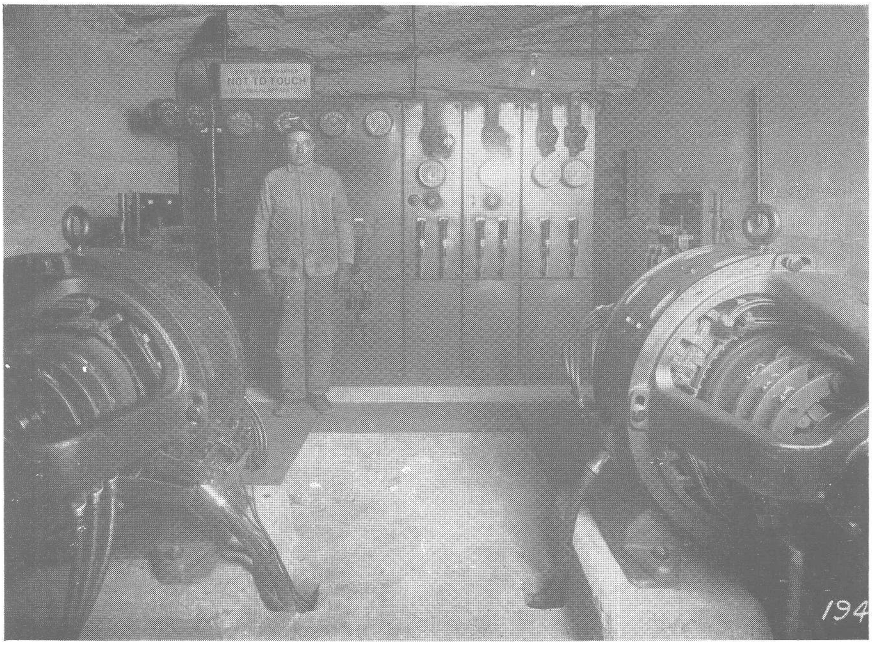
[1] Wentworth, C. K., Geology and Coal Resources of the coal-bearing portion of Russell County, Va. Bull. XXII, Va. Geol. Survey, 1922, pp. 137-150.



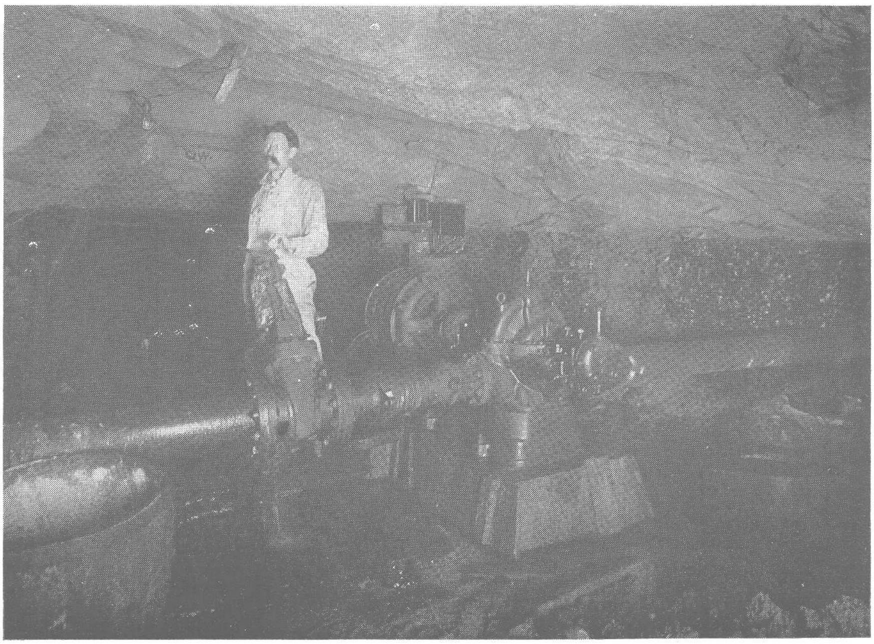
(A) Electric sub-station installed in a Wise County mine, showing concrete walls and floor and natural sandstone roof.



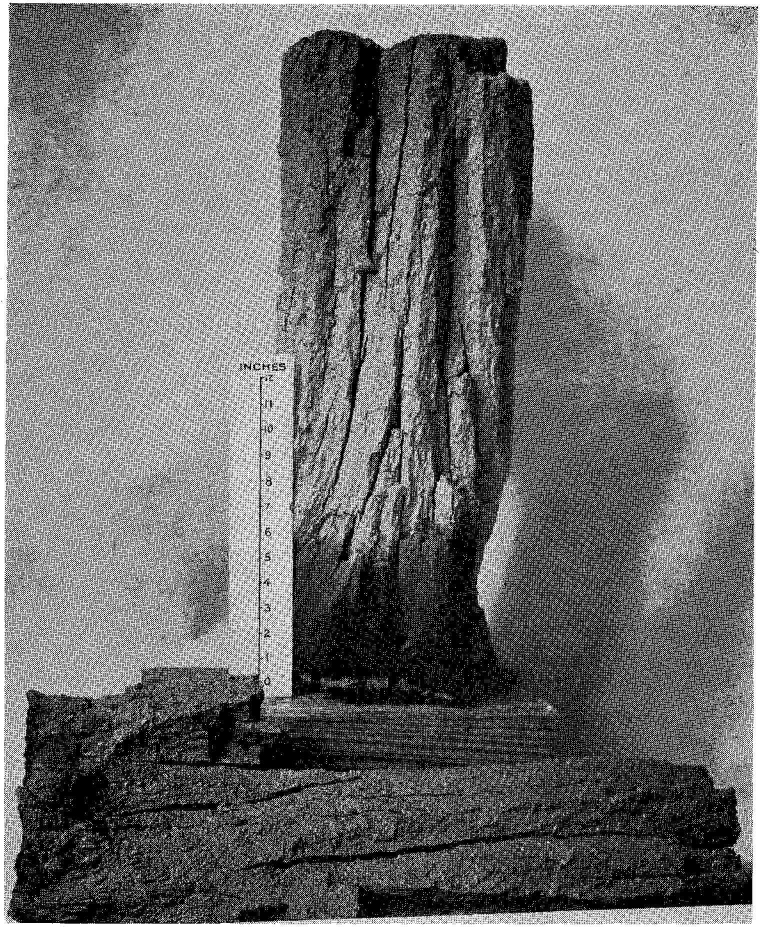
(B) A centrifugal pump, with capacity of 1,000 gallons a minute, located in coal mine. Note the coal bed and solid overlying sandstone.



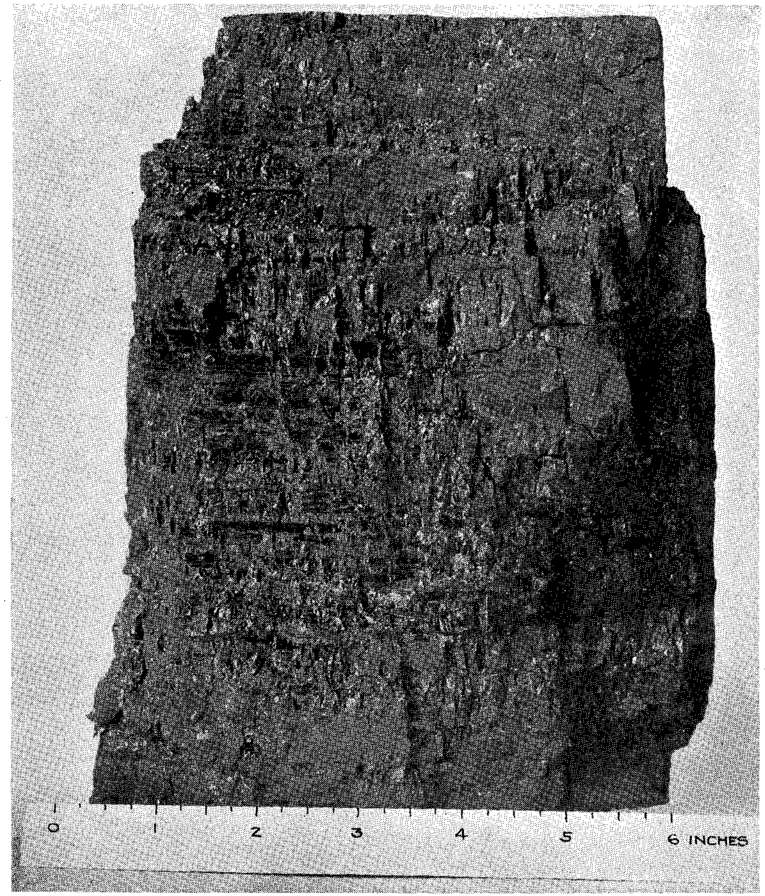
(A) Electric sub-station installed in a Wise County mine, showing concrete walls and floor and natural sandstone roof.



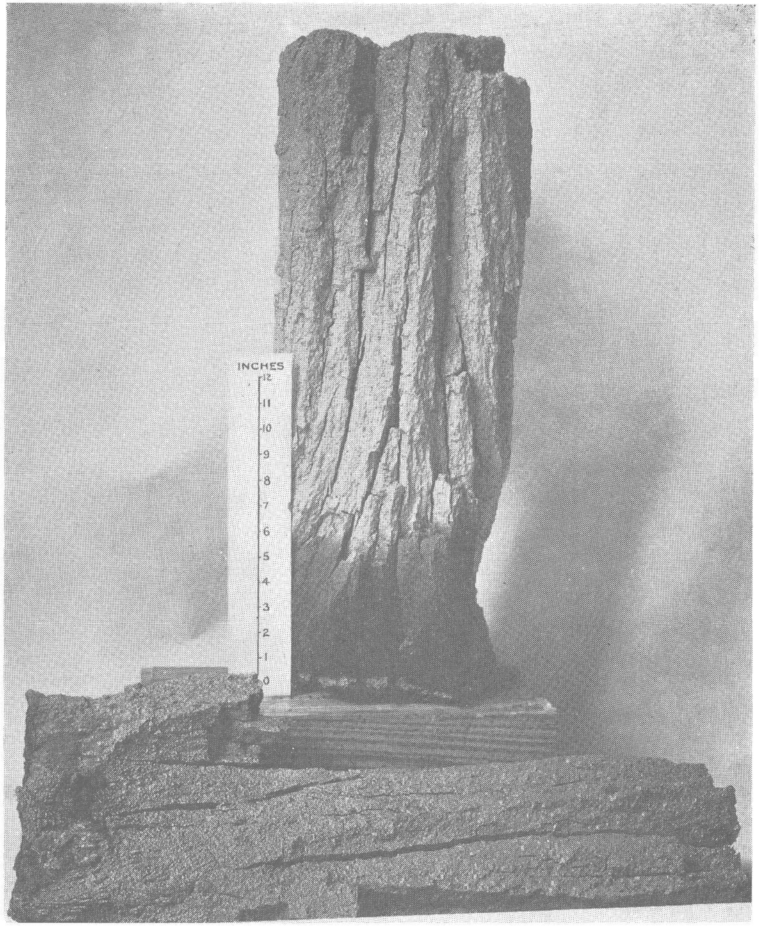
(B) A centrifugal pump, with capacity of 1,000 gallons a minute, located in coal mine. Note the coal bed and solid overlying sandstone.



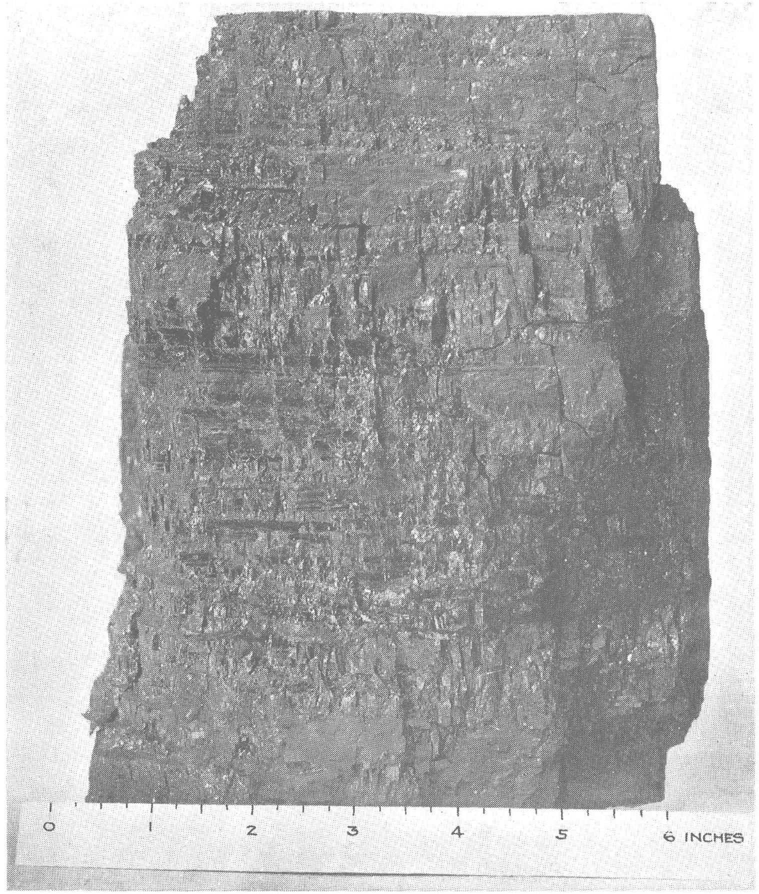
(A) Samples of coke, showing large size and strength of "fingers," as the fragments are called. Redeposited carbon can be plainly seen on the lower specimen as round glodules and as a dendritic moss. The samples are of 72-hour Wicova coke, made by the Wise Coal and Coke Company.



(B) A block of coal from Upper Banner bed. The vertical lines indicate cleavage,—the cleavage parallel to the plane of the page is called "face cleavage" and that at right angles to the page is called "butt cleavage." The irregular fracture is due to the friable character of the coal. The dark bands showing in the block are layers of bright coal.



(A) Samples of coke, showing large size and strength of "fingers," as the fragments are called. Redeposited carbon can be plainly seen on the lower specimen as round glodules and as a dendritic moss. The samples are of 72-hour Wicova coke, made by the Wise Coal and Coke Company.



(B) A block of coal from Upper Banner bed. The vertical lines indicate cleavage,—the cleavage parallel to the plane of the page is called "face cleavage" and that at right angles to the page is called "butt cleavage." The irregular fracture is due to the friable character of the coal. The dark bands showing in the block are layers of bright of the mines in the field are drift mines. An example of a slope mine is the No. 10 mine of the Norton Coal Co. at Norton. The main entry here slopes a vertical distance of 57 feet to meet a nearly flat-lying coal bed that is below stream level.

The "room-and-pillar" method of mining is universally used in the field. By this system, coal is first mined from a number of comparatively small places called rooms, which are usually driven at right angles off the main entry or side entries. Large bodies of coal, called pillars, are left in place between the rooms to sustain the roof. Before abandoning a mine this coal is removed, if possible, allowing the roof of the mine to settle (see Pl. XXIX).

A special application of the "room-and-pillar" system is employed where the main entry of a mine extends along the strike of a dipping coal bed. The J. T. S. Coal Corporation's mine on Little Stony Creek is a mine of this type, the coal bed here dipping 37 to 39 degrees. The main entry is horizontal, going in on the strike of the coal bed, and rooms are driven up the rise at intervals of about 100 feet. The miner in advancing the face of his room loosens the coal either by pick or shooting from the solid and permits the coal to slide by gravity into a bin fastened at the entrance of the room. From this bin the coal can be loaded at will directly into mine cars in the main entry. Such highly inclined coal beds as found at the J. T. S. Coal Corporation's mine, however, are almost entirely confined to the very narrow zone of greatly disturbed rocks along the southeast margin of the coal field, and the coal beds in this zone are little mined.

FUTURE DEVELOPMENT.

The coal reserves of Wise and Scott counties, as shown on a following page (page 504) are large enough to permit of greater development than that which prevails at the present time.[1] Large tracts of coal-bearing lands have not yet been touched. Nevertheless, it requires no careful study of the sections of the coal beds given in the detailed descriptions of the drainage basins, to see that the coal beds of the field as a whole are notably thinner in the virgin areas than in the areas now being worked. Thus, in the Pound River drainage basins and on Powell Mountain, areas of practically no mining at the present time, large numbers of carefully

[1] It should be pointed out here that there is unquestionably an over-production of coal, particularly bituminous, at the present time and new mines are not encouraged. The opening of new mines in times of over-production and in fields that are already well taken care of by existing mines reacts to the great disadvantage of the coal industry in general.

faced prospects and boreholes clearly show beds of a thickness inferior to those on Callahan Creek, Roaring Fork, upper Powell River, upper Guest River, and Toms Creek, all centers of mining. The extensive development of the territory tributary to Powell and Guest rivers is largely if not wholly due to the great thickness and purity of the coal beds.

The future development of the coal field of Wise and Scott counties will naturally divide itself into two periods—the first period including the present and near future, and the second period the more distant future. The first period of the development will witness the progress of mining on Powell and Guest rivers and in eastern Wise County until the important workable beds are largely exhausted in those areas; the second period will then witness the opening up by railroads of the present inaccessible fields and the mining of the inferior coal beds. That these periods in the future mining of the coal beds of Wise and Scott counties will overlap is certain, but it is quite unlikely that the overlap will be great. It is almost inevitable that transportation facilities into the Pound country, or as far as is possible, into the Powell Mountain field, will be delayed until the coal resources in the accessible basins of this and neighboring regions are so impoverished that new supplies of coal will have to be reached notwithstanding the expense.

COAL PRODUCTION.

COAL MINED IN WISE COUNTY.

Coal was first mined and shipped from Wise County in 1892, immediately following the arrival of the railroads. It was December of that year, however, before any coal was actually shipped and as a consequence the amount sent out was only about 2,000 tons. From that year on the production of coal from Wise County grew with great rapidity, reaching its highest annual production for the 30 years from 1892 to 1921, inclusive, in 1920 with a production of 6,062,325 short tons of coal. The total amount of coal mined in Wise County for the 30-year period, including the 188 tons recorded for the year 1889, is 86,098,415 tons. Assuming that an amount of coal equal to one-fourth of all the coal that has been taken out was lost by abandoning pillars in old mines, by mining out thick beds under thin beds and allowing the roof to drop, and by other sources of waste, at least 107,623,000 tons of the coal originally in the ground has been removed or lost. The figures of annual production, taken from Mineral Resources of the United States[1] for those years, are given in the following table, along with the figures showing valuation of the coal.

[1] Mineral resource reports of the United States Geological Survey.

Amount and Value of Coal and Amount of Coke Produced in Wise County, Virginia from 1889 to 1922, inclusive.

Year.	Total quantity of coal produced.	Total value of coal.	Average price per ton.	Amount of coal made into coke within county.
1889	188	$ 188	$1.39	....
1890	....	....	....	....
1891	....	....	....	....
1892	2,000	....	....	....
1893	126,216	113,436	.90	....
1894	330,731	230,637	.70	....
1895	336,593	192,713	.57	11,044
1896	357,607	217,519	.61	95,608
1897	712,011	469,637	.66	314,007
1898	992,723	562,418	.57	512,818
1899	1,232,613	793,174	.64	662,585
1900	1,363,570	1,144,715	.84	739,231
1901	1,918,693	1,537,667	.80	1,064,720
1902	2,422,417	1,782,583	.74	1,522,620
1903	2,563,285	2,322,855	.90	1,538,602
1904	2,514,133	2,024,752	.81	1,404,823
1905	2,990,698	2,525,635	.84	1,933,498
1906	3,041,225	2,915,914	.95	1,977,301
1907	3,145,848	3,066,075	.97	1,962,288
1908	2,558,874	2,204,093	.86	1,487,136
1909	2,841,448	2,463,588	.87	1,468,005
1910	3,730,992	3,274,809	.88	1,805,467
1911	3,754,360	3,301,984	.88	1,154,799
1912	3,500,174	4,094,905	.91	1,335,582
1913	5,103,559	4,899,390	.96	1,738,175
1914	4,620,702	4,345,204	.94	1,182,793
1915	4,186,309	3,874,099	.93	834,660
1916	5,228,945	5,060,442	.97	1,802,218
1917	5,427,455	9,727,637	1.79	1,954,093
1918	5,514,132	13,466,647	2.44	1,527,849
1919	5,049,436	12,643,947	2.50	1,485,313
1920	6,062,325	22,947,215	3.79	1,622,499
1921	3,469,153	10,656,000	3.07	422,521
1922	5,022,866	12,205,000	2.43	584,212
Total	91,121,281			
Estimated loss in mining	21,524,585			
Total exhaustion	112,645,866			

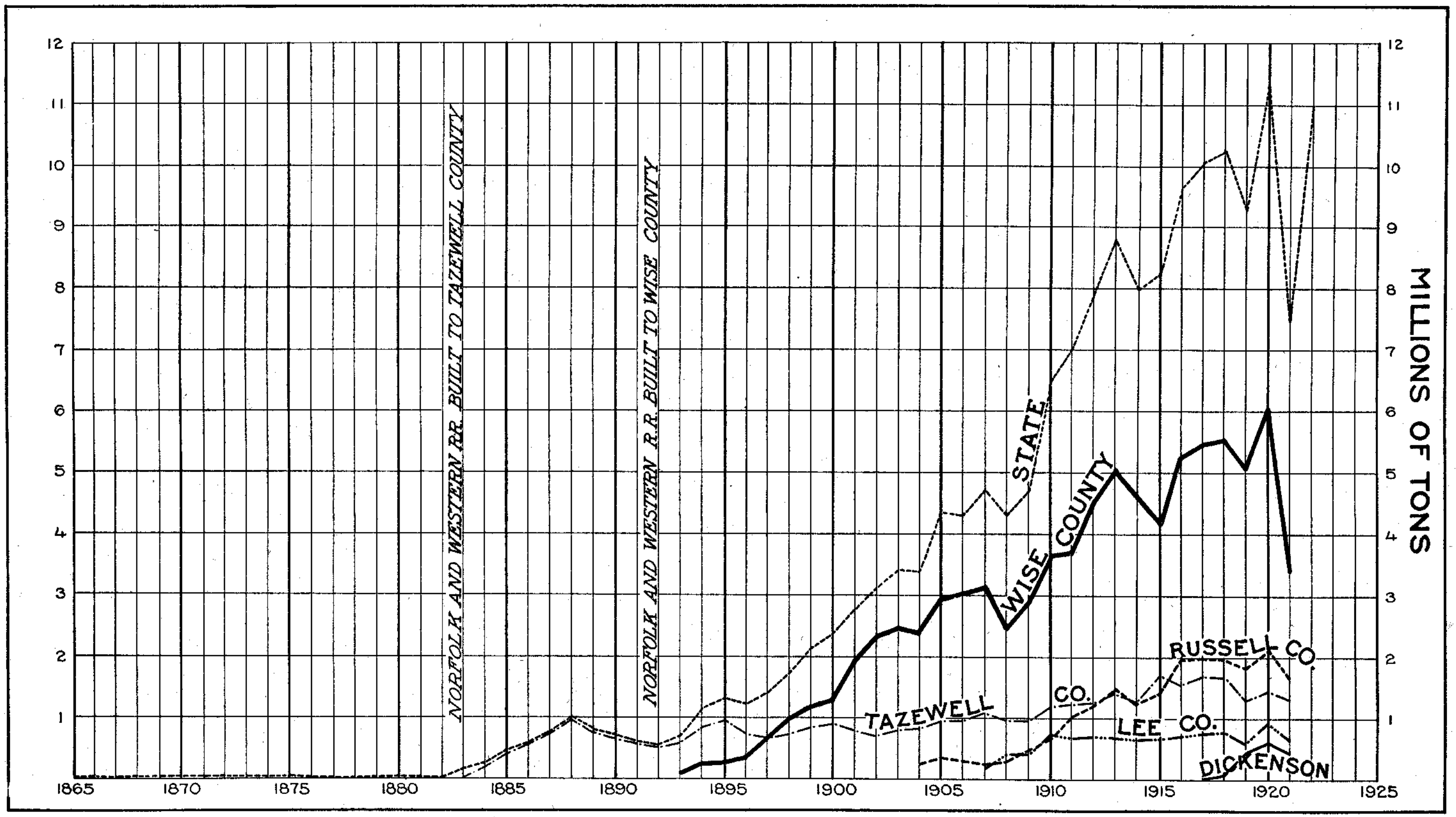


Fig. 51.—Graph showing annual production of coal in southwest Virginia by counties from 1865 to 1922.

The supremacy of Wise County over the other counties of Virginia in the production of coal is graphically shown in figure 51. The table of annual production and the graph showing annual county production clearly point out the "banner" and "lean" years of the mining industry. The years 1913 and 1920 are two of the notable "banner" years, whereas 1915, 1919 and 1921 are notably "lean" years. Lack of cars and labor, and low prices paid for coal were the chief factors in producing the "lean" years. The abnormally high price paid for coal in 1920 made it a year of great production. Notwithstanding the great production for that year it would have been considerably larger had more railroad cars been available to carry away the coal.

The amounts of coal produced from the various coal beds in Wise County are given below in a table and in figure 52 for the three-year period, 1918 to 1920, inclusive. The circle in figure 52 shows the average production for the three-year period, and clearly brings to the front the important producing beds of the county. The diagram shows that the Imboden, Kelly, and Upper Banner beds produce more than 60 per cent of the entire county production, and that the Imboden, Kelly, Upper Banner, Taggart Marker, Taggart, Pardee, Dorchester, Blair, and Clintwood produce more than 90 per cent of the coal. More than 99 per cent of the coal comes from fifteen beds shown in table and figure 52.

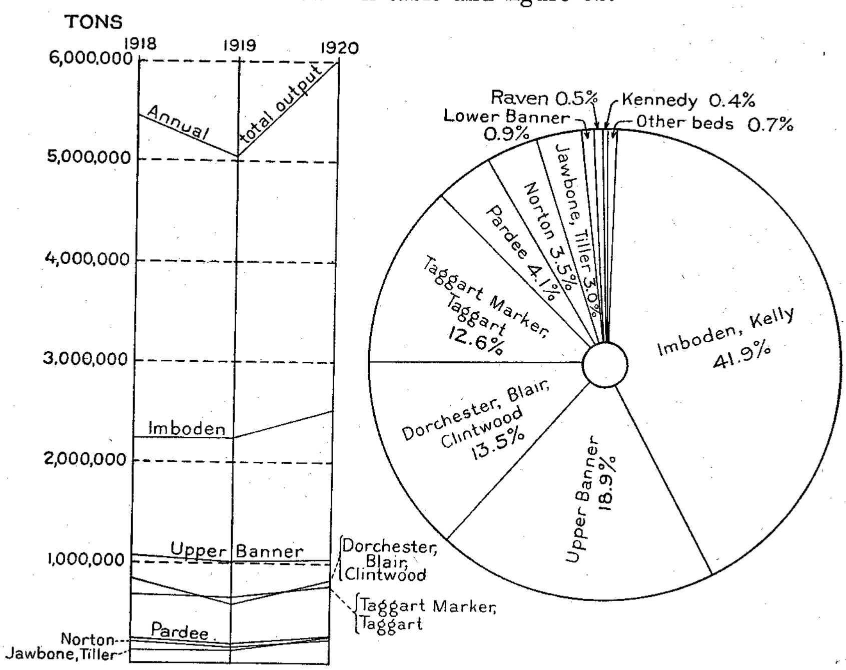


Fig. 52.—Diagram showing amounts of coal produced from various coal beds in Wise County for years 1918, 1919, and 1920.

Production by coal beds for the years 1918, 1919, and 1920.

	Coal Beds	1918	% of total prod.	1919	% of total prod.	1920	% of total prod.	Total	% of total prod.
1	Pardee	218,701	4.0	190,054	3.8	267,978	4.4	676,733	4.1
2	Taggart Taggart Marker	674,941	12.2	641,920	12.7	786,697	13.0	2,103,558	12.6
3	Imboden Kelly	2,214,446	40.3	2,233,429	44.2	2,523,576	41.6	6,971,451	41.9
4	Dorchester Blair Clintwood	833,222	15.1	594, 309	11.8	821,679	13.6	2,249,210	13.5
5	Norton	206,200	3.7	154,061	3.1	215,388	3.6	575,649	3.5
6	Upper Banner	1,056,372	19.2	1,004,770	19.9	1,075,776	17.7	3,136,918	18.9
7	Lower Banner	54,725	1.0	54,434	1.1	39,263	0.6	148,422	0.9
8	Kennedy	39,759	0.7	12,477	0.2	21,578	0.4	73,814	0.4
9	Raven	39,904	0.7	17,435	0.3	17,322	0.3	74,661	0.5
10	Jawbone Tiller	136,576	2.4	137,082	2.7	231,971	3.8	505,629	3.0
		5,474,846	99.3	5,039,971	99.8	6,001,228	99.0	16,516,045	99.3
11	Other beds	39,286	0.7	9,465	0.2	61,097	1.0	109,848	0.7
	Total output	5,514,132	100.0	5,049,436	100.0	6,062,325	100.0	16,625,893	100.0

ESTIMATE OF ORIGINAL TONNAGE OF COAL BEFORE MINING BEGAN.

In attempting to estimate the tonnage of coal in any field, one must first consider the object to be attained by such an estimate. Is it to show the amount of coal that could be mined under present commercial and mining conditions, or is it to show the amount of coal ultimately available? An estimate of the coal in a given field that can be mined under present conditions has great value, but as conditions change rapidly, an estimate that might be considered satisfactory today might not meet the case at all tomorrow.

The people of the State of Virginia as well as those of the Nation are more interested in an estimate of the total amount of coal that will ultimately be available than they are in the amount that can be mined under present conditions, for the latter is of transient value only, while the former is of lasting importance. If the estimate is to include all of the coal that ever will be mined, then it is evident that thinner and more irregular beds must be included than have heretofore been taken into consideration. The only clue to the minimum thickness of coal beds that should be included is that afforded by mining practice in fields in which the thicker coal beds have been mined out and operations are today being carried on in thinner beds and at greater depth than heretofore has been regarded as possible. After an exhaustive search of the literature, the United States Geological Survey has adopted 14 inches as the minimum thickness of high grade coal to be considered in the classification of the public lands and as this thickness has been applied in most estimates of ultimately available coal, it will be used as the basis for all estimates in Wise and Scott counties. The tonnages in the following table, therefore, include all beds or parts of beds in which there are 14 inches or more of minable coal, but do not include thinner beds or parts of beds that could not be mined profitably because of the position and thickness of partings or because of other factors. The calculations of tonnage are based on an estimate of 1,770 tons per acre for each layer of coal 1 foot thick, which is equivalent to a density of 1.3 and to a weight of 81.3 pounds per cubic foot.

The estimates of coal tonnage in Wise and Scott counties were prepared for the main drainage basins of the field. Planimeter[1] measurements were made on the geologic map of the area in acres of each basin underlain by a particular coal bed which shows in outcrop in the basin, and the average thickness of the bed was obtained from sections measured in the basin. Only the tonnages of the more important beds of the largest

[1] An instrument for the determination of areas of irregular outline.

Estimates of Original Tonnage of Coal in Wise and Scott Counties, in Beds 14 Inches or More in Thickness.

Basin.	Area of basin in acres.	Bed.	Acreage of coal.	Average thickness. Ft.	In.	Tonnage of beds.	Total tonnage.
Pigeon and Looney creeks.	9,610	Imboden.	7,460	5	11	77,882,400	
		Taggart.	2,990	5	8	30,636,400	
		Other beds.	....	....		145,381,200	253,900,000
Callahan Creek.	19,640	Imboden.	17,765	6	2	198,257,000	
		Taggart.	11,810	5	6	116,919,000	
		Other beds.	....	....		433,860,000	748,036,000
Roaring Fork.	19,720	Imboden.	15,970	6	0	172,454,500	
		Taggart.	8,385	4	6	67,918,500	
		Other beds.	....	....		285,489,000	525,862,000
Black Creek.	4,785	All beds.	....	....		....	78,743,000
Upper Powell River.	7,535	Dorchester.	7,185	6	0	58,181,400	
		Clintwood.	5,945	4	6	64,184,400	
		Other beds.	....	....		163,375,200	285,741,000
Upper Guest River.	17,740	Norton.	17,520	4	0	126,144,000	
		Dorchester.	16,100	5	5	156,926,700	
		Clintwood.	13,220	4	6	107,082,000	
		Other beds.	....	....		217,941,300	608,094,000
Bear Creek.	9,310	All beds.	....	....		....	151,722,000
Middle Guest River.	3,165	All beds.	....	....		....	34,396,000
Lower Guest River.	4,135	All beds.	....	....		....	23,344,000

Estimates of Original Tonnage of Coal in Wise and Scott Counties, in Beds 14 Inches or More in Thickness.

Basin.	Area of basin in acres.	Bed.	Acreage of coal.	Average thickness. Ft.	In.	Tonnage of beds.	Total tonnage.
Toms and Little Toms creeks.	10,425	Upper Banner. Other beds.	5,970	6 ...	0 ...	64,476,000 154,026,000	218,502,000
Indian Creek.	7,240	All beds.	...	...	...	...	98,574,000
South Fork Pound River.	11,360	All beds.	...	...	...	...	260,529,000
North Fork Pound River.	12,245	All beds.	...	...	...	...	67,390,000
Pound River.	10,385	All beds.	...	...	...	...	58,467,000
Bowlecamp Creek.	8,945	All beds.	...	...	...	...	138,373,000
Birchfield Creek.	13,565	All beds.	...	...	...	...	170,044,000
Cranesnest River.	12,875	Upper Banner. Other beds.	11,260	5	0	101,340,000 64,803,000	166,143,000
Bull Run.	7,250	Jawbone. Other beds.	5,480	6	0	59,205,600 87,212,400	146,418,000
Russell Creek.	8,830	Jawbone. Other beds.	7,780	6	6	91,026,000 117,082,000	208,108,000
Powell Mountain field.	90,000	All beds.	...	...	...	...	1,622,000,000
Total,	288,650		...	...	...	...	5,864,386,000

basins are given in detail; that of the thinner or less regular beds being combined in a single item. Although carefully prepared, these estimated tonnages are at best only approximations. They are based on the assumption that a coal bed maintains throughout an entire basin the average thickness displayed at its outcrop, an agreement which probably seldom, if ever, is attained. Every factor employed in computing the tonnages given below was given the most careful attention and it is felt that the total tonnage figure is more likely to indicate less rather than more coal than is actually present within the field. In preparing the table no allowance has been made for coal already mined and the figures given represent the estimates of coal prior to mining operations.

Since mining operations have begun in Wise County, 86,098,415 short tons of coal have been extracted up to and including the year 1921. This represents 1.5 per cent of all the coal originally present in the county. This is graphically shown in figure 53, in which the larger cube represents approximately the amount of coal now in the ground compared with a smaller cube representing approximately the amount of coal mined.

Assuming 75 per cent recovery, which is a fair estimate for favorable mining conditions throughout a field at large, the amount of minable coal remaining in Wise County at the beginning of 1922 was approximately 4,400,000,000 short tons. At the present rate of consumption of bituminous coal in the United States, Wise County could supply the country for about 9½ years. If the annual production of Wise County averaged 4,000,000 tons, the county could produce coal for 1,100 years, or if, as in the banner year of 1920, it produced 6,000,000 tons a year, the county

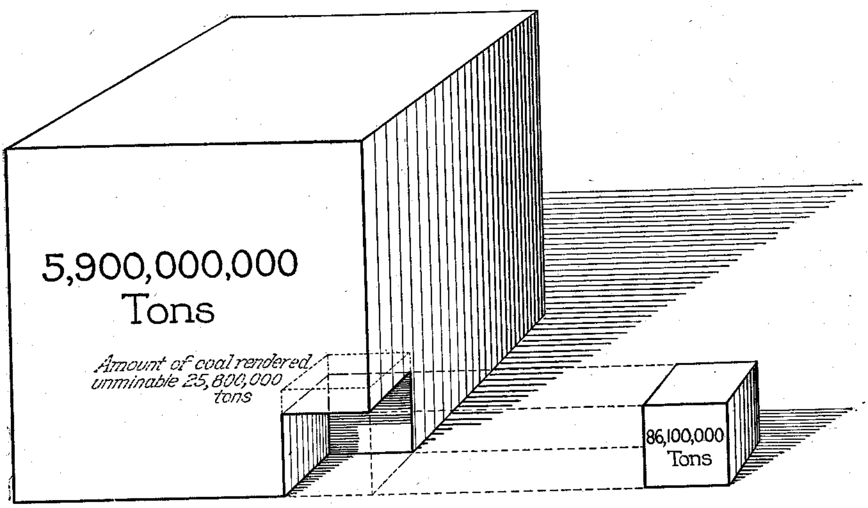


Fig. 53.—Diagram comparing total amount of unmined coal in Wise County to total amount mined up to and including year 1921.

could produce coal for about 730 years. The many factors influencing the rate of production of coal, such as the demand for coal, the availability of labor and cars, and mining conditions, make an estimate as to the life of any field a little better than a guess. Production will undoubtedly increase as long as thick beds of coal are readily accessible. As these beds approach depletion, however, the thinner and more inaccessible beds will become of value and will be mined, but the volume of tonnage of coal produced annually then will unquestionably decrease.

PHYSICAL AND CHEMICAL CHARACTERS OF THE COAL.

GENERAL STATEMENT.

The value of coal depends not only on its chemical, but also on its physical characteristics, and consequently a consumer of coal should take both of these factors into consideration when he makes a selection of the coal he is to purchase and use, and it is equally important for the producer and dealer to know the true value of the coal he handles. A chemical analysis together with a determination of the heat-producing value of a coal in a standard calorimeter will generally give sufficient data for the determination of the comparative values of coals. The analyses of the coals of Wise and Scott counties and also the analyses of a few coals from outside the State of Virginia, but with which the Wise County coals at present come in competition or are liable to come in competition in the future are given in the table, pp. 508-529.

As a large percentage of the coal mined in the United States is used directly or indirectly for the production of heat, it is important, when comparing coals for this use, to know their relative heat-producing values. These are given in the table just referred to under the heading of "Calorific Value" and it is expressed in British Thermal Units (B. t. u.'s), such a unit being the amount of heat required to raise one pound of water (at its maximum density of 68° F.) one degree Fahrenheit. Thus, the heat-producing value of Wise County coals range from 11,410 to 14,690 B. t. u's in the sample as it comes from the mine, which is approximately the same as the coal which reaches the consumer, and hence the true value of these coals, so far as heat-production is concerned will agree with the figures given in the table. Thus it is manifest that a coal with B. t. u.'s of 13,000 is less efficient than a coal with 14,000 B. t. u.'s. Expressed in percentages, the 14,000 B. t. u. coal is 7.7 per cent better than the other, and if the one with 13,000 B. t. u.'s is selling for $5 per ton, the one with the 14,000 B. t. u.'s would be worth $5.38 per ton.

The ordinary chemical analysis reveals a number of facts that are worth noting, because they tend either to enhance or detract from the value of the coal. Thus, the amounts of moisture and ash are important, for though inert, they lessen the heating value of a coal materially; and the sulphur, though it can be burned, is a very bad ingredient in many respects. The volatile matter and the fixed carbon are important in their relative proportions, for to a certain extent they determine the rank of the coal and they are of importance in certain special uses.

The physical properties of coals are almost as important as the chemical, for to a certain extent they control the use of a coal. Thus, nothing but a blocky coal can be successfully used for domestic purposes, and fine coal, if of high calorific value, can be used for steam-raising if it is used in a plant equipped with automatic stokers.

In order, therefore, to determine the true value of a coal and the best use to which it may be put, it is necessary to know its chemical composition and its physical characteristics and balance these against the cost of mining and transportation to the place where the coal is to be used.

PHYSICAL CHARACTERISTICS OF WISE COUNTY COAL.

The coals of Wise County are generally hard and blocky and, when properly mined, reach the railroad cars in fairly large lumps. Lump coal of this character is well adapted to domestic use; to heating and steam-raising, but in modern plants the coal is generally crushed so as to be fired with automatic stokers; and to export trade where lump coal is generally demanded, on the theory that it contains fewer impurities and will stand transportation better than fine coal. If the coal is screened at the mine, as is generally the case, the fine coal may or may not be as clean as the lump coal. If it comes from a bed free from partings, it is generally relatively clean, but if it comes from a bed containing many partings of soft shale or clay, or if the roof is of this kind of material, the "slack" or fine coal is liable to contain a large amount of incombustible matter.

As stated in the description of the coal beds of this field, a number of the beds are characterized, in certain parts of the county, by laminated or crushed and slickensided coal. As this condition is due to a more or less grinding movement in the direction of the bedding, it follows that the whole or a part of the bed has been greatly crushed, and in the forward and backward movements the partings in the bed have become intimately mixed with the coal. This material is so fine that it goes through the screens and produces a very impure slack.

CHEMICAL COMPOSITION.

The real test of a coal is the amount of combustible matter it contains and this, of course, largely depends upon the amount and character of the impurities that are present. The common impurities are moisture, sulphur, and ash. Moisture is very detrimental for it not only takes up space which otherwise would be occupied by combustible matter, but it requires heat to volatilize it and drive it off. Ash is generally an inert impurity, but if it is readily fusible, it may choke the grate bars and become a great detriment to the combustion of the coal. Sulphur is combustible and hence does not materially reduce the heating value, but when not, it corrodes iron very rapidly and this has a bad effect upon grate bars and all metal surfaces with which it comes in contact.

Sampling and analyzing.—The quality of the coal in any field is most clearly shown by analyses and for this purpose many samples were collected from beds in Wise and Scott counties. In order that these analyses may be compared with those of coals in competing fields, it is essential that both the sampling and the analyzing be done according to standard methods and that the samples be collected at fresh exposures. In the following table and discussion therefore, only analyses made by the United States Geological Survey or the United States Bureau of Mines are considered.

In taking a sample of coal for analysis every effort was made to secure fresh unweathered coal that would represent as nearly as possible the product of the mine. The sample was taken by "channeling" the bed from the roof to floor and rejecting all partings three-eights of an inch or more in thickness and all concretions or "sulphur-balls" having a maximum diameter greater than 2 inches and a thickness greater than half an inch. A "channel" sample is obtained by making a uniform cut on a fresh clean face of coal, and weighs on the average 30 pounds. The coal thus obtained was crushed until it passed through a half-inch mesh and was then thoroughly mixed and reduced by successive quartering until 4 pounds remained. The product was placed in a galvanized iron can, sealed in the mine, and mailed at once to the laboratory.

As soon as received at the laboratory, the coal is taken from the can, weighed and allowed to dry at a temperature slightly above normal until its weight becomes practically constant. It is then reweighed, the difference in weight being the air-drying loss. Because the coal is more stable and more easily handled in the air-dried form, it is analyzed in this condition and the results are given under form B (see following tables). Forms A, C, and D are calculated from form B. Form A represents the coal as collected. Form C represents the theoretical condition of the coal if all the moisture were removed and form D if both the moisture and ash were removed. Forms B, C, and D are for special purposes and should not be used in ordinary work.

The sections of coal beds of this field measured at the point where the channel was cut for a sample are given in the detailed description of coal beds by drainage basins. The exact mine locations are also given in the foregoing descriptions. The page references to the sections and mine locations are given in the following tables.

Table of analyses of coal samples from mines in Wise County, Virginia.

A = analysis of sample received, B = air-dried, C = moisture-free, D = moisture-and-ash-free.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Coal bed in Lee formation.	¾-mile southwest of Dooley, Va.	J. Brian Eby....	469	75968	6.5	A	19.0	23.0	22.7	35.3	.50	......	......	......	......	3,520	6,340
					....	B	13.4	24.6	24.3	37.7	.53	......	......	......	......	3,765	6,780
					....	C	......	28.4	28.0	43.6	.62	......	......	......	......	4,350	7,830
					....	D	......	50.3	49.7	......	1.10	......	......	......	......	7,710	13,880
Jawbone	Virginia City Mine No. 1, Virginia Iron, Coal and Coke Co., Virginia City, Va.	K. M. Way......	....	5217	2.2	A	3.4	28.6	53.1	14.9	1.18	......	......	......	......	6,915	12,450
					....	B	1.2	29.2	54.3	15.3	1.21	......	......	......	......	7,070	12,730
					....	C	......	29.6	55.0	15.4	1.22	......	......	......	......	7,155	12,880
					....	D	......	35.0	65.0	......	1.44	......	......	......	......	8,470	15,240
Do...........	.....do..................	.....do...........	....	5235	1.8	A	3.1	27.8	54.2	14.9	1.24	......	......	......	......	6,895	12,410
					....	B	1.3	28.3	55.2	15.2	1.26	......	......	......	......	7,020	12,640
					....	C	......	28.7	55.9	15.4	1.28	......	......	......	......	7,115	12,800
					....	D	......	33.9	66.1	......	1.51	......	......	......	......	8,410	15,140
Do...........	Mine No. 2 of Twin City Coal Corp., St. Paul, Va.	Albert W. Giles..	457	32276	1.9	A	3.0	29.3	54.9	12.83	.71	4.80	72.26	1.41	7.99	7,055	12,700
					....	B	1.1	29.8	56.0	13.08	.72	4.68	73.66	1.44	6.42	7,195	12,950
					....	C	......	30.2	56.6	13.22	.73	4.61	74.48	1.45	5.51	7,275	13,090
					....	D	......	34.8	65.2	......	.84	5.31	85.82	1.67	6.36	8,380	15,090
Do...........	.....do..................	.....do...........	457	32277	.8	A	2.1	29.9	48.6	19.44	1.01	4.41	66.78	1.27	7.09	6,540	11,770
					....	B	1.3	30.2	48.9	19.60	1.02	4.36	67.34	1.28	6.40	6,595	11,870
					....	C	......	30.5	49.6	19.86	1.03	4.27	68.22	1.30	5.32	6,680	12,020
					....	D	......	38.1	61.9	......	1.29	5.33	85.12	1.62	6.64	8,335	15,000
Do...........	Virginia City Mine No. 2, Virginia Iron, Coal and Coke Co., Virginia City, Va.	C. K. Wentworth	454	32503	.7	A	1.8	29.6	49.0	19.6	1.43	......	......	......	......	6,545	11,790
					....	B	1.1	29.9	49.3	19.7	1.44	......	......	......	......	6,590	11,870
					....	C	......	30.2	49.9	19.9	1.46	......	......	......	......	6,665	12,000
					....	D	......	37.7	62.3	......	1.82	......	......	......	......	8,325	14,980
Do...........	.....do..................	.....do...........	454	32504	.4	A	1.6	31.3	50.1	17.0	1.01	......	......	......	......	6,775	12,200
					....	B	1.2	31.4	50.3	17.1	1.01	......	......	......	......	6,805	12,250
					....	C	......	31.8	50.9	17.3	1.03	......	......	......	......	6,880	12,390
					....	D	......	38.5	61.5	......	1.25	......	......	......	......	8,320	14,980

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Jawbone	Virginia City Mine No. 2, Virginia Iron, Coal and Coke Co., Virginia City, Va.	C. K. Wentworth	453	32505	.6	A	1.6	32.3	50.8	15.3	1.76	......	......	......	......	6,955	12,520
					....	B	1.0	32.5	51.1	15.4	1.77	......	......	......	......	7,000	12,600
					....	C	......	32.8	51.6	15.6	1.79	......	......	......	......	7,070	12,730
					....	D		38.9	61.1	......	2.12	......	......	......	......	8,375	15,080
Do..........	.....do..................	.....do...........	453	32506	.4	A	1.5	32.3	49.5	16.7	.81	......	......	......	......	6,785	12,210
					....	B	1.1	32.5	49.7	16.7	.81	......	......	......	......	6,810	12,260
					....	C	......	32.8	50.3	16.9	.82	......	......	......	......	6,885	12,390
					....	D	......	39.5	60.5	......	.99	......	......	......	......	8,285	14,920
Do..........	.....do.................. Composite of Anal. Nos. 32503, to 32506, inclusive.	.....do...........	....	32507	.5	A	1.5	31.4	49.8	17.33	1.25	4.70	68.93	1.32	6.47	6,775	12,190
					....	B	1.0	31.6	50.0	17.42	1.26	4.66	69.28	1.33	6.05	6,810	12,250
					....	C	......	31.9	50.5	17.60	1.27	4.60	69.99	1.34	5.20	6,875	12,380
					....	D	......	38.7	61.3	......	1.54	5.58	84.94	1.63	6.31	8,345	15,020
Bone from Jawbone coal bed.	.....do..................	.....do...........	454	32508	.4 (gain)	A	.6	27.8	48.5	23.1	.43	......	......	......	......	6,340	11,410
						B	1.0	27.7	48.3	23.0	.43	......	......	......	......	6,310	11,360
					....	C	......	27.9	48.9	23.2	.43	......	......	......	......	6,375	11,470
					....	D	......	36.4	63.6	......	.56	......	......	......	......	8,300	14,940
Raven	Mine No. 2, Twin City Coal Corp., St. Paul, Va.	Albert W. Giles..	459	32275	.8	A	1.8	34.7	51.0	12.46	2.18	4.87	72.04	1.37	7.08	7,145	12,860
					....	B	1.1	35.0	51.4	12.55	2.20	4.83	72.58	1.38	6.46	7,200	12,960
					....	C	......	35.4	51.9	12.69	2.22	4.76	73.37	1.40	5.56	7,275	13,100
					....	D	......	40.5	59.5	......	2.54	5.45	84.03	1.60	6.38	8,335	15,000
Do...........	Mine, Bolling Coal Co., Tacoma, Va.	J. Brian Eby....	346	75443	1.2	A	2.6	31.5	58.5	7.4	.99	......	......	......	......	7,630	13,730
					....	B	1.5	31.8	59.2	7.5	1.00	......	......	......	......	7,720	13,900
					....	C	......	32.3	60.1	7.6	1.02	......	......	......	......	7,835	14,100
					....	D	......	35.0	65.0	......	1.10	......	......	......	......	8,480	15,260
Do...........	.....do..................	.....do...........	346	75444	1.1	A	2.5	32.2	59.7	5.6	.83	......	......	......	......	7,835	14,110
					....	B	1.4	32.6	60.3	5.7	.84	......	......	......	......	7,920	14,260
					....	C	......	33.0	61.2	5.8	.85	......	......	......	......	8,035	14,460
					....	D	......	35.0	65.0	......	.90	......	......	......	......	8,525	15,350

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Raven	Mine, Bolling Coal Co., Tacoma, Va.	J. Brian Eby....	....	75445	1.1	A	2.6	32.0	58.9	6.53	.95	5.11	78.59	1.53	7.29	7,745	13,940
	Composite of Anal. Nos. 75443 and 75444.				....	B	1.5	32.3	59.6	6.60	.96	5.04	79.49	1.55	6.36	7,835	14,100
					....	C	......	32.8	60.5	6.70	.97	4.96	80.65	1.57	5.15	7,950	14,310
					....	D	......	35.2	64.8	......	1.04	5.32	86.44	1.68	5.52	8,520	15,340
Lower Banner..	Mine No. 1, Robert Fleming and Co., Banner, Va.	Albert W. Giles..	369	32509	1.2	A	2.2	32.9	56.7	8.2	.65	......	......	......	......	7,635	13,750
					....	B	1.1	33.2	57.4	8.3	.66	......	......	......	......	7,725	13,910
					....	C	......	33.6	58.1	8.3	.66	......	......	......	......	7,815	14,060
					....	D	......	36.7	63.3	......	.72	......	......	......	......	8,525	15,340
Do...........	.....do..................	.....do...........	369	32510	.7	A	1.9	33.8	57.5	6.8	.77	......	......	......	......	7,790	14,020
					....	B	1.1	34.1	57.9	6.9	.78	......	......	......	......	7,845	14,120
					....	C	......	34.4	58.6	7.0	.78	......	......	......	......	7,935	14,280
					....	D	......	37.0	63.0	......	.84	......	......	......	......	8,530	15,350
Do...........	.....do..................	.....do...........	....	32511	.9	A	2.2	33.3	57.1	7.45	.70	5.13	78.05	1.57	7.10	7,710	13,880
	Composite of Anal. Nos. 32509 and 32510.				....	B	1.3	33.6	57.6	7.52	.71	5.08	78.78	1.58	6.33	7,780	14,010
					....	C	......	34.1	58.3	7.62	.72	5.00	79.78	1.60	5.28	7,880	14,180
					....	D	......	36.9	63.1	......	.78	5.41	86.36	1.73	5.72	8,530	15,350
Do...........	Beaver Coal Co. mine, 1 mile north of Tacoma, Va.	J. Brian Eby....	353	75446	1.4	A	2.9	31.3	54.6	11.2	.85	......	......	......	......	7,240	13,030
					....	B	1.5	31.8	55.3	11.4	.86	......	......	......	......	7,345	13,220
					....	C	......	32.3	56.2	11.5	.88	......	......	......	......	7,455	13,420
					....	D	......	36.5	63.5	......	1.00	......	......	......	......	8,430	15,170
Do...........	.....do..................	.....do...........	353	75447	.6	A	1.9	33.2	55.6	9.3	1.06	......	......	......	......	7,585	13,660
					....	B	1.3	33.5	55.9	9.3	1.07	......	......	......	......	7,635	13,740
					....	C	......	33.9	56.7	9.4	1.08	......	......	......	......	7,735	13,920
					....	D	......	37.4	62.6	......	1.19	......	......	......	......	8,540	15,370
Do...........	.....do..................	.....do...........	....	75448	1.0	A	2.4	32.7	54.6	10.29	.97	5.04	74.74	1.56	7.40	7,435	13,390
	Composite of Anal. Nos. 75446 and 75447.				....	B	1.4	33.1	55.1	10.40	.98	4.98	75.50	1.58	6.56	7,515	13,520
					....	C	......	33.5	56.0	10.54	.99	4.89	76.58	1.60	5.40	7,620	13,720
					....	D	......	37.5	62.5	......	1.11	5.47	85.60	1.79	6.03	8,520	15,330

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Heating Value. Calories.	Heating Value. British thermal units.
Upper Banner..	Mine No. 1, Robert Fleming and Co., Banner, Va.	Albert W. Giles..	380	32512	1.1	A	2.3	36.1	57.1	4.55	.89	5.35	79.65	1.50	8.06	7,925	14,260
					......	B	1.2	36.5	57.7	4.60	.90	5.29	80.52	1.52	7.17	8,010	14,420
					......	C	......	36.9	58.4	4.66	.91	5.22	81.51	1.54	6.16	8,110	14,600
					......	D	......	38.8	61.2	......	.95	5.48	85.50	1.62	6.45	8,505	15,310
Do...........	Coeburn mine, Virginia Iron, Coal and Coke Co., Toms Creek, Va.	W. J. Von Borries.	....	2281	1.6	A	2.7	32.4	60.4	4.5	.52	......	......	......	......	8,080	14,540
					......	B	1.1	33.0	61.3	4.6	.53	......	......	......	......	8,210	14,790
					......	C	......	33.4	62.0	4.6	.53	......	......	......	......	8,305	14,950
					......	D	......	35.0	65.0	......	.56	......	......	......	......	8,705	15,670
Do...........	.....do....................	.....do...........	....	2282	1.7	A	2.9	32.0	61.0	4.1	.55	......	......	......	......	....	....
					......	B	1.2	32.5	62.1	4.2	.56	......	......	......	......	....	....
					......	C	......	32.9	62.8	4.3	.57	......	......	......	......	....	....
					......	D	......	34.4	65.6	......	.60	......	......	......	......	....	....
Do...........	Coeburn mine, car sample. Lump coal over 3¾ in. bar screen.	.....do...........	....	2382	2.2	A	3.1	31.6	60.8	4.48	.67	5.17	80.35	1.59	7.74	8,040	14,470
					......	B	.9	32.3	62.2	4.58	.69	5.04	82.15	1.63	5.91	8,220	14,800
					......	C	......	32.7	62.7	4.62	.69	4.98	82.88	1.64	5.19	8,290	14,930
					......	D	......	34.2	65.8	......	.72	5.22	86.89	1.72	5.45	8,695	15,650
Do...........	Swansea mine, Virginia Iron, Coal and Coke Co., Toms Creek, Va.	E. G. Woodruff.	375	10386	1.5	A	2.5	31.7	60.3	5.51	.52	5.59	79.69	1.56	7.13	7,920	14,250
					......	B	1.0	32.2	61.2	5.59	.53	5.50	80.90	1.58	5.90	8,040	14,470
					......	C	......	32.5	61.8	5.65	.53	5.44	81.71	1.60	5.07	8,120	14,610
					......	D	......	34.5	65.5	......	.56	5.76	86.60	1.70	5.38	8,605	15,490
Do...........	Thelma (No. 1) mine, Virginia Iron, Coal and Coke Co., Toms Creek, Va.	Albert W. Giles..	379	32404	1.8	A	2.7	34.4	56.5	6.4	.50	......	......	......	......	7,785	14,020
					......	B	.9	35.0	57.6	6.5	.51	......	......	......	......	7,930	14,280
					......	C	......	35.3	58.1	6.6	.51	......	......	......	......	8,005	14,410
					......	D	......	37.8	62.2	......	.55	......	......	......	......	8,570	15,430
Do...........	.....do....................	.....do...........	379	32405	1.8	A	2.8	32.4	53.9	10.9	.56	......	......	......	......	7,340	13,220
					......	B	1.1	33.0	54.8	11.1	.57	......	......	......	......	7,475	13,460
					......	C	......	33.4	55.4	11.2	.58	......	......	......	......	7,555	13,600
					......	D	......	37.6	62.4	......	.65	......	......	......	......	8,505	15,310

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Heating Value. Calories.	Heating Value. British thermal units.
Upper Banner..	Thelma (No. 1) mine, Virginia Iron, Coal & Coke Co., Toms Creek, Va. Composite of Anal. Nos. 32404 and 32405.	Albert W. Giles..	....	32406	1.8	A	2.8	33.2	55.4	8.57	.52	5.17	76.31	1.59	7.84	7,525	13,540
					....	B	1.1	33.8	56.4	8.73	.53	5.06	77.71	1.62	6.35	7,660	13,790
					....	C	......	34.2	57.0	8.82	.54	4.99	78.54	1.64	5.47	7,745	13,940
					....	D	......	37.5	62.5	......	.59	5.47	86.13	1.80	6.01	8,495	15,290
Do...........	Cranesnest (Caney) mine of Clinchfield Coal Corp., Toms Creek, Va.	.....do...........	437	32407	1.5	A	2.5	32.8	58.3	6.4	.52	......	......	......	......	7,825	14,080
					....	B	1.0	33.3	59.2	6.5	.53	......	......	......	......	7,940	14,290
					....	C	......	33.6	59.8	6.6	.53	......	......	......	......	8,030	14,440
					....	D	......	36.0	64.0	......	.57	......	......	......	......	8,580	15,450
Do...........	.....do..................	.....do...........	437	32408	1.4	A	2.2	32.4	59.5	5.9	.50	......	......	......	......	7,865	14,160
					....	B	.9	32.8	60.3	6.0	.60	......	......	......	......	7,970	14,350
					....	C	......	33.1	60.9	6.0	.60	......	......	......	......	8,045	14,480
					....	D	......	35.2	64.8	......	.64	......	......	......	......	8,560	15,410
Do...........	.....do.................. Composite of Anal. Nos. 32407 and 32408.[1]	.....do...........	....	32409	1.4	A	2.2	32.4	59.2	6.24	.55	5.21	79.72	1.63	6.65	7,850	14,130
					....	B	.8	32.9	60.0	6.33	.56	5.12	80.85	1.65	5.49	7,960	14,330
					....	C	......	33.1	60.5	6.38	.56	5.08	81.51	1.67	4.80	8,025	14,450
					....	D	......	35.4	64.6	......	.60	5.43	87.06	1.78	5.13	8,570	15,430
Do...........	No. 6 (Lee) mine of Virginia Iron, Coal and Coke Co., Toms Creek, Va.	.....do...........	373	32410	2.3	A	3.9	32.4	58.1	5.6	.48	......	......	......	......	7,760	13,970
					....	B	1.6	33.1	59.5	5.8	.49	......	......	......	......	7,945	14,300
					....	C	......	33.7	60.5	5.8	.50	......	......	......	......	8,075	14,540
					....	D	......	35.8	64.2	......	.53	......	......	......	......	8,580	15,440
Do...........	.....do..................	.....do...........	373	32411	.9	A	2.0	33.1	60.4	4.5	.50	......	......	......	......	8,000	14,400
					....	B	1.1	33.4	60.9	4.6	.50	......	......	......	......	8,075	14,530
					....	C	......	33.7	61.6	4.7	.51	......	......	......	......	8,165	14,700
					....	D	......	35.4	64.6	......	.53	......	......	......	......	8,565	15,420
Do...........	.....do.................. Composite of Anal. Nos. 32410 and 32411.	.....do...........	....	32412	1.6	A	2.8	33.0	59.0	5.21	.55	5.31	80.06	1.61	7.26	7,855	14,140
					....	B	1.2	33.6	59.9	5.30	.56	5.21	81.38	1.64	5.91	7,985	14,380
					....	C	......	33.9	60.7	5.36	.57	5.14	82.40	1.66	4.87	8,085	14,560
					....	D	......	35.9	64.1	......	.60	5.43	87.06	1.75	5.16	8,545	15,380

[1] Additional analyses of mine samples collected in this mine (Nos. 18226-27-28) are given on page 524.

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Heating Value. Calories.	Heating Value. British thermal units.
Upper Banner..	Sexton (No. 2) mine, Virginia Iron, Coal and Coke Co., Toms Creek, Va.	Albert W. Giles..	377	32413	2.1	A	3.2	30.4	52.0	14.36	.60	4.88	71.30	1.48	7.38	7,035	12,660
					......	B	1.1	31.1	53.1	14.67	.61	4.75	72.81	1.51	5.65	7,185	12,930
					......	C	......	31.5	53.7	14.84	.62	4.67	73.66	1.53	4.68	7,270	13,080
					......	D	......	36.9	63.1	......	.73	5.48	86.50	1.80	5.49	8,535	15,360
Norton	Mine No. 3, Gladeville Coal Co., Wise, Va.	J. Brian Eby....	333	75367	1.5	A	3.0	32.7	54.8	9.5	1.36	......	......	......	......	7,435	13,390
					......	B	1.5	33.2	55.7	9.6	1.38	......	......	......	......	7,550	13,590
					......	C	......	33.7	56.6	9.7	1.40	......	......	......	......	7,665	13,800
					......	D	......	37.4	62.6	......	1.55	......	......	......	......	8,495	15,290
Do..........	.....do..................	.....do..........	333	75368	2.5	A	4.0	33.1	56.2	6.7	1.42	......	......	......	......	7,575	13,640
					......	B	1.6	33.9	57.7	6.8	1.46	......	......	......	......	7,770	13,990
					......	C	......	34.5	58.6	6.9	1.48	......	......	......	......	7,895	14,220
					......	D	......	37.1	62.9	......	1.59	......	......	......	......	8,490	15,280
Do..........	.....do..................	.....do..........	334	75369	1.58	A	2.9	33.5	57.2	6.4	1.48	......	......	......	......	7,695	13,850
					......	B	1.4	34.0	58.1	6.5	1.50	......	......	......	......	7,815	14,070
					......	C	......	34.5	58.9	6.6	1.52	......	......	......	......	7,925	14,260
					......	D	......	36.9	63.1	......	1.63	......	......	......	......	8,485	15,270
Do..........	.....do.................. Composite of Anal. Nos. 75367 to 75369, inclusive.	.....do..........	....	75370	1.9	A	3.3	32.7	56.5	7.50	1.42	5.36	76.18	1.65	7.89	7,580	13,640
					......	B	1.5	33.3	57.6	7.64	1.45	5.25	77.63	1.68	6.35	7,725	13,900
					......	C	......	33.8	58.4	7.76	1.47	5.16	78.80	1.71	5.10	7,840	14,110
					......	D	......	36.6	63.4	......	1.59	5.59	85.43	1.85	5.54	8,500	15,300
Dorchester	Glamorgan No. 3 mine, Stone Gap Colliery Co., Glamorgan, Va.	Charles Butts...	313	15100	1.6	A	2.6	33.1	59.3	5.0	1.37	......	......	......	......	7,895	14,220
					......	B	1.1	33.6	60.2	5.1	1.39	......	......	......	......	8,025	14,450
					......	C	......	34.0	60.9	5.1	1.41	......	......	......	......	8,115	14,600
					......	D	......	35.8	64.2	......	1.49	......	......	......	......	8,550	15,390
Do..........	.....do..................	.....do..........	313	15101	2.0	A	3.2	31.3	59.1	6.37	.87	5.27	78.02	1.65	7.82	7,730	13,910
					......	B	1.3	31.9	60.3	6.50	.89	5.15	79.61	1.68	6.17	7,885	14,200
					......	C	......	32.3	61.1	6.58	.90	5.08	80.65	1.71	5.08	7,990	14,380
					......	D	......	34.6	65.4	......	.96	5.44	86.33	1.83	5.44	8,550	15,390

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Heating Value. Calories.	Heating Value. British thermal units.
Dorchester	Glamorgan No. 3 mine, Stone Gap Colliery Co., Glamorgan, Va.	C. K. Wentworth	313	32842	1.2	A	2.5	31.8	59.3	6.4	1.29	......	......	......	......	7,785	14,010
					....	B	1.3	32.2	60.0	6.5	1.31	......	......	......	......	7,875	14,170
					....	C	......	32.6	60.8	6.6	1.32	......	......	......	......	7,980	14,370
					....	D	......	34.9	65.1	......	1.41	......	......	......	......	8,545	15,380
Do..........	.....do..................	.....do..........	313	32843	1.5	A	2.8	33.4	59.7	4.1	.99	......	......	......	......	7,985	14,380
					....	B	1.3	33.9	60.6	4.2	1.01	......	......	......	......	8,110	14,590
					....	C	......	34.4	61.4	4.2	1.02	......	......	......	......	8,215	14,790
					....	D	......	35.9	64.1	......	1.06	......	......	......	......	8,575	15,440
Do..........	.....do.................. Composite of Anal. Nos. 32842 and 32843.	.....do..........	....	32844	1.3	A	2.6	32.9	59.3	5.18	1.10	5.28	79.67	1.65	7.12	7,885	14,190
					....	B	1.3	33.4	60.1	5.25	1.11	5.20	80.75	1.67	6.02	7,990	14,390
					....	C	......	33.8	60.9	5.32	1.13	5.12	81.81	1.69	4.93	8,095	14,580
					....	D	......	35.7	64.3	......	1.19	5.41	86.41	1.78	5.21	8,550	15,390
Do..........	Mine No. 6, Intermont Coal and Iron Co. 1½ mile northwest of Dooley, Va.	T. R. Williams..	....	32067	.9	A	2.5	33.7	53.5	10.3	.79	......	......	......	......	7,380	13,280
					....	B	1.7	34.0	54.0	10.3	.80	......	......	......	......	7,440	13,390
					....	C	......	34.6	54.9	10.5	.81	......	......	......	......	7,570	13,620
					....	D	......	38.7	61.3	......	.90	......	......	......	......	8,455	15,220
Do..........	.....do..................	.....do..........	....	32068	1.3	A	2.9	33.5	53.9	9.7	.95	......	......	......	......	7,370	13,270
					....	B	1.6	33.9	54.7	9.8	.96	......	......	......	......	7,465	13,440
					....	C	......	34.5	55.5	10.0	.98	......	......	......	......	7,590	13,660
					....	D	......	38.3	61.7	......	1.09	......	......	......	......	8,435	15,180
Do..........	.....do.................. Composite of Anal. Nos. 32067 and 32068.	.....do..........	....	32069	1.0	A	2.6	33.8	53.6	10.03	.87	5.05	73.73	1.57	8.75	7,370	13,270
					....	B	1.6	34.2	54.1	10.14	.88	4.98	74.50	1.59	7.91	7,450	13,410
					....	C	......	34.7	55.0	10.30	.89	4.89	75.71	1.61	6.60	7,570	13,630
					....	D	......	38.7	61.3	......	.99	5.45	84.40	1.79	7.37	8,440	15,190
Do..........	Mine No. 2, Norton Coal Co., Norton, Va.	C. K. Wentworth	308	75363	2.2	A	3.3	35.1	54.8	6.8	2.08	......	......	......	......	7,605	13,690
					....	B	1.1	35.9	56.1	6.9	2.13	......	......	......	......	7,780	14,000
					....	C	......	36.3	56.7	7.0	2.15	......	......	......	......	7,860	14,150
					....	D	......	39.0	61.0	......	2.31	......	......	......	......	8,455	15,220

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Dorchester	Mine No. 2, Norton Coal Co., Norton, Va.	J. Brian Eby....	308	75364	1.5	A	2.8	35.6	56.6	5.0	2.26	......	......	......	......	7,780	14,000
					......	B	1.4	36.1	57.5	5.0	2.29	......	......	......	......	7,900	14,220
					......	C	......	36.6	58.3	5.1	2.33	......	......	......	......	8,005	14,410
					......	D	......	38.6	61.4	......	2.45	......	......	......	......	8,435	15,180
Do...........	.....do....................	.....do...........	308	75365	1.1	A	2.3	34.1	55.4	8.2	2.33	......	......	......	......	7,605	13,690
					......	B	1.3	34.4	56.0	8.3	2.35	......	......	......	......	7,685	13,830
					......	C	......	34.9	56.7	8.4	2.38	......	......	......	......	7,780	14,010
					......	D	......	38.1	61.9	......	2.60	......	......	......	......	8,495	15,290
Do...........	.....do.................... Composite of Anal. Nos. 75363 to 75365, inclusive.	.....do...........	....	75366	1.6	A	2.9	34.5	56.0	6.64	2.16	5.42	76.83	1.41	7.54	7,670	13,810
					......	B	1.4	35.0	56.9	6.75	2.19	5.32	78.07	1.43	6.24	7,795	14,030
					......	C	......	35.5	57.7	6.84	2.23	5.24	79.16	1.45	5.08	7,905	14,230
					......	D	......	38.1	61.9	......	2.39	5.62	84.97	1.56	5.46	8,485	15,270
Do...........	Clark No. 2 mine, Wise Coal and Coke Co., Sutherland, Va.	.....do...........	280	75436	1.1	A	2.4	36.1	55.0	6.5	2.30	......	......	......	......	7,755	13,960
					......	B	1.4	36.5	55.6	6.5	2.32	......	......	......	......	7,835	14,110
					......	C	......	37.0	56.4	6.6	2.36	......	......	......	......	7,945	14,300
					......	D	......	39.6	60.4	......	2.53	......	......	......	......	8,510	15,320
Do...........	.....do....................	.....do...........	280	75437	3.7	A	5.3	34.7	53.5	6.5	2.59	......	......	......	......	7,505	13,510
					......	B	1.6	36.0	55.6	6.8	2.69	......	......	......	......	7,795	14,030
					......	C	......	36.6	56.5	6.9	2.73	......	......	......	......	7,925	14,260
					......	D	......	39.3	60.7	......	2.93	......	......	......	......	8,510	15,320
Do...........	.....do....................	.....do...........	280	75438	1.5	A	2.8	34.7	56.3	6.2	1.96	......	......	......	......	7,750	13,950
					......	B	1.3	35.2	57.2	6.3	1.99	......	......	......	......	7,870	14,160
					......	C	......	35.7	57.9	6.4	2.02	......	......	......	......	7,975	14,360
					......	D	......	38.1	61.9	......	2.16	......	......	......	......	8,520	15,330
Do...........	.....do.................... Composite of Anal. Nos. 75436 to 75438, inclusive.	.....do...........	....	75439	2.1	A	3.4	34.5	55.7	6.40	2.30	5.33	76.51	1.53	7.93	7,635	13,740
					......	B	1.4	35.2	56.9	6.54	2.35	5.21	78.14	1.56	6.20	7,795	14,030
					......	C	......	35.7	57.7	6.63	2.38	5.13	79.24	1.58	5.04	7,905	14,230
					......	D	......	38.3	61.7	......	2.55	5.49	84.87	1.69	5.40	8,465	15,240

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Heating Value. Calories.	Heating Value. British thermal units.
Dorchester	Haskell No. 3 mine, Wise Coal and Coke Co., Dorchester, Va.	J. Brian Eby....	276	75440	.7	A	2.0	34.4	58.2	5.4	1.53	......	......	......	......	7,895	14,220
					....	B	1.4	34.6	58.6	5.4	1.54	......	......	......	......	7,955	14,320
					....	C	......	35.1	59.4	5.5	1.56	......	......	......	......	8,060	14,510
					....	D	......	37.2	62.8	......	1.65	......	......	......	......	8,525	15,350
Do..........	.....do....................	.....do...........	276	75441	1.7	A	3.0	34.4	58.1	4.5	1.30	......	......	......	......	7,880	14,180
					....	B	1.4	35.0	59.1	4.5	1.32	......	......	......	......	8,015	14,430
					....	C	......	35.5	59.9	4.6	1.34	......	......	......	......	8,130	14,630
					....	D	......	37.2	62.8	......	1.40	......	......	......	......	8,520	15,340
Do..........	.....do.................... Composite of Anal. Nos. 75440 and 75441.	.....do...........	....	75442	1.2	A	2.6	34.3	58.2	4.89	1.41	5.46	78.76	1.60	7.88	7,850	14,130
					....	B	1.4	34.7	59.0	4.95	1.43	5.29	79.72	1.62	6.89	7,945	14,300
					....	C	......	35.2	59.8	5.02	1.45	5.31	80.87	1.64	5.71	8,060	14,510
					....	D	......	37.0	63.0	......	1.53	5.59	85.14	1.73	6.01	8,490	15,280
Blair	Mine No. 4, J. A. Esser Coke Co., Esserville, Va.	.....do...........	317	75359	1.6	A	2.9	32.2	61.2	3.7	.84	......	......	......	......	8,025	14,450
					....	B	1.2	32.7	62.3	3.8	.85	......	......	......	......	8,160	14,690
					....	C	......	33.1	63.1	3.8	.86	......	......	......	......	8,260	14,870
					....	D	......	34.4	65.6	......	.89	......	......	......	......	8,590	15,460
Do..........	.....do....................	.....do...........	317	75360	1.3	A	2.3	32.4	58.8	6.5	1.22	......	......	......	......	7,760	13,970
					....	B	1.0	32.9	59.5	6.6	1.24	......	......	......	......	7,860	14,150
					....	C	......	33.2	60.1	6.7	1.25	......	......	......	......	7,940	14,290
					....	D	......	35.6	64.4	......	1.34	......	......	......	......	8,510	15,310
Do..........	.....do....................	.....do...........	317	75361	1.0	A	2.2	33.8	58.7	5.3	.86	......	......	......	......	7,920	14,250
					....	B	1.2	34.1	59.3	5.4	.87	......	......	......	......	7,995	14,390
					....	C	......	34.5	60.0	5.5	.88	......	......	......	......	8,095	14,570
					....	D	......	36.5	63.5	......	.93	......	......	......	......	8,560	15,410
Do..........	.....do.................... Composite of Anal. Nos. 75359 to 75361, inclusive.	.....do...........	....	75362	1.3	A	2.4	32.8	59.6	5.18	.91	5.26	79.62	1.57	7.46	7,925	14,260
					....	B	1.2	33.2	60.4	5.25	.92	5.19	80.67	1.59	6.38	8,030	14,450
					....	C	......	33.6	61.1	5.31	.93	5.11	81.61	1.61	5.43	8,125	14,620
					....	D	......	35.5	64.5	......	.98	5.40	86.19	1.70	5.73	8,580	15,440

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Blair	Mine No. 4, Norton Coal Co., Norton, Va.	E. G. Woodruff.	....	10390	1.9	A	3.3	32.8	60.1	3.76	.90	5.55	80.01	1.58	8.20	7,895	14,210
					....	B	1.4	33.5	61.3	3.83	.92	5.44	81.56	1.61	6.64	8,045	14,490
					....	C	......	33.9	62.2	3.89	.93	5.36	82.75	1.63	5.44	8,165	14,700
					....	D	......	35.3	64.7	......	.97	5.58	86.10	1.70	5.65	8,495	15,290
Rocky Fork....	Mine of W. E. Dean and Brothers, 2 miles west of Wise, Va.	J. Brian Eby....	322	75746	2.3	A	3.4	31.2	59.2	6.2	.75	......	......	......	......	7,745	13,940
					....	B	1.1	31.9	60.6	6.4	.77	......	......	......	......	7,930	14,270
					....	C	......	32.3	61.3	6.4	.78	......	......	......	......	8,020	14,440
					....	D	......	34.5	65.5	......	.83	......	......	......	......	8,575	15,440
Imboden	Mine (No. 3), Stonega Coke and Coal Co., Stonega, Va.	E. G. Woodruff.	....	10388	.8	A	2.2	33.1	58.2	6.47	.68	5.29	77.85	1.47	8.24	7,775	13,990
					....	B	1.5	33.3	58.7	6.52	.69	5.24	78.48	1.48	7.59	7,835	14,110
					....	C	......	33.8	59.6	6.61	.70	5.16	79.57	1.50	6.46	7,945	14,300
					....	D	......	36.3	63.7	......	.75	5.53	85.20	1.61	6.91	8,510	15,320
Kelly	Local mine of R. Bolling, 2 miles east of Flat Gap, Va.	Charles Butts...	396	15174	5.8	A	6.9	30.4	54.6	8.1	.95	......	......	......	......	7,210	12,980
					....	B	1.2	32.2	57.9	8.7	1.01	......	......	......	......	7,655	13,780
					....	C	......	32.6	58.6	8.8	1.02	......	......	......	......	7,745	13,940
					....	D	......	35.8	64.2	......	1.12	......	......	......	......	8,485	15,280
Imboden	Osaka mine, Stonega Coke and Coal Co., Osaka, Va.	C. K. Wentworth	186	33182	.8	A	1.8	34.9	59.2	4.1	.64	......	......	......	......	8,025	14,450
					....	B	1.1	35.1	59.7	4.1	.65	......	......	......	......	8,090	14,560
					....	C	......	35.5	60.3	4.2	.65	......	......	......	......	8,175	14,720
					....	D	......	37.1	62.9	......	.68	......	......	......	......	8,530	15,350
Do...........	.....do....................	.....do...........	186	33183	1.1	A	2.3	35.0	58.7	4.0	.66	......	......	......	......	7,990	14,380
					....	B	1.2	35.4	59.4	4.0	.67	......	......	......	......	8,080	14,550
					....	C	......	35.8	60.1	4.1	.68	......	......	......	......	8,180	14,720
					....	D	......	37.4	62.6	......	.71	......	......	......	......	8,525	15,350
Do...........	.....do....................	.....do...........	186	33184	1.6	A	2.7	33.9	55.4	8.0	.81	......	......	......	......	7,570	13,630
					....	B	1.1	34.4	56.3	8.2	.82	......	......	......	......	7,690	13,850
					....	C	......	34.8	56.9	8.3	.83	......	......	......	......	7,775	14,000
					....	D	......	37.9	62.1	......	.90	......	......	......	......	8,475	15,260

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Imboden	Osaka mine, Stonega Coke and Coal Co., Osaka, Va. Composite of Anal. Nos. 33182, 33183, and 33184.	C. K. Wentworth	....	33185	1.2	A	2.2	34.0	58.4	5.42	.69	5.19	79.26	1.48	7.96	7,850	14,130
					....	B	1.0	34.4	59.1	5.48	.70	5.12	80.19	1.50	7.01	7,940	14,290
					....	C	......	34.8	59.7	5.54	.71	5.06	81.02	1.51	6.16	8,020	14,440
					....	D	......	36.8	63.2	......	.75	5.36	85.77	1.60	6.52	8,490	15,290
Do...........	Mine No. 3, Stonega Coke and Coal Co., Stonega, Va.	.....do...........	187	33186	1.3	A	2.4	33.6	53.6	10.4	.81	......	......	......	......	7,390	13,310
					....	B	1.2	34.0	54.3	10.5	.82	......	......	......	......	7,485	13,480
					....	C	......	34.4	55.0	10.6	.83	......	......	......	......	7,575	13,640
					....	D	......	38.5	61.5	......	.93	......	......	......	......	8,475	15,260
Do...........	.....do..................	.....do...........	187	33187	.9	A	2.0	35.0	57.7	5.3	.69	......	......	......	......	7,915	14,250
					....	B	1.1	35.3	58.2	5.4	.70	......	......	......	......	7,985	14,370
					....	C	......	35.7	58.9	5.4	.70	......	......	......	......	8,075	14,530
					....	D	......	37.7	62.3	......	.74	......	......	......	......	8,540	15,370
Do...........	Mine No. 2, Stonega Coke and Coal Co., Stonega, Va.	.....do...........	188	33188	.7	A	2.0	34.6	58.5	4.9	.75	......	......	......	......	7,910	14,240
					....	B	1.3	34.9	58.9	4.9	.76	......	......	......	......	7,970	14,350
					....	C	......	35.3	59.7	5.0	.77	......	......	......	......	8,075	14,540
					....	D	......	37.2	62.8	......	.81	......	......	......	......	8,495	15,300
Do...........	Mine No. 3, Stonega Coke and Coal Co., Stonega, Va. Composite of Anal. Nos. 33186 and 33187.	.....do...........	....	33189	1.1	A	2.2	33.7	56.4	7.74	.75	5.07	77.24	1.46	7.74	7,660	13,790
					....	B	1.2	34.1	56.9	7.82	.76	5.00	78.06	1.48	6.88	7,740	13,930
					....	C	......	34.5	57.6	7.91	.77	4.94	78.97	1.49	5.92	7,830	14,100
					....	D	......	37.5	62.5	......	.84	5.36	85.75	1.62	6.43	8,505	15,310
Do...........	No. 2—Rock heading, Stonega Coke and Coal Co., Arno, Va.	J. Brian Eby....	185	75964	.7	A	2.1	33.0	57.8	7.1	.63	......	......	......	......	7,500	13,500
					....	B	1.5	33.2	58.1	7.2	.63	......	......	......	......	7,550	13,590
					....	C	......	33.7	59.0	7.3	.64	......	......	......	......	7,660	13,790
					....	D	......	36.4	63.6	......	.69	......	......	......	......	8,260	14,870
Do...........	.....do..................	.....do...........	185	75965	.9	A	1.9	35.6	61.3	1.2	.65	......	......	......	......	7,990	14,380
					....	B	1.0	35.9	61.9	1.2	.66	......	......	......	......	8,060	14,510
					....	C	......	36.3	62.5	1.2	.66	......	......	......	......	8,140	14,650
					....	D	......	36.7	63.3	......	.67	......	......	......	......	8,240	14,830

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Imboden	No. 2—Rock heading, Stonega Coke and Coal Co., Arno, Va.	J. Brian Eby	185	75966	.5	A	1.9	34.2	59.9	4.0	.63					7,715	13,890
						B	1.5	34.4	60.1	4.0	.63					7,750	13,950
						C		34.9	61.0	4.1	.64					7,865	14,160
						D		36.4	63.6		.67					8,200	14,770
Do	do. Composite of Anal. Nos. 75964 to 75966, inclusive.	do		75967	.7	A	2.0	34.0	57.5	6.47	.65	5.17	78.21	1.50	8.00	7,730	13,910
						B	1.3	34.3	57.9	6.51	.65	5.13	78.74	1.51	7.46	7,780	14,010
						C		34.7	58.7	6.60	.66	5.05	79.80	1.53	6.36	7,885	14,190
						D		37.2	62.8		.71	5.41	85.44	1.64	6.80	8,445	15,200
Do	No. 2, mine, Virginia Iron, Coal and Coke Co., Inman, Va.	do	172	75969	1.2	A	2.5	35.7	56.2	5.6	.74					7,710	13,880
						B	1.3	36.1	56.9	5.7	.75					7,800	14,040
						C		36.6	57.6	5.8	.76					7,905	14,230
						D		38.8	61.2		.81					8,390	15,100
Do	do	do	172	75970	.8	A	2.3	34.7	54.7	8.3	.81					7,470	13,440
						B	1.6	34.9	55.2	8.3	.82					7,525	13,550
						C		35.5	56.0	8.5	.83					7,645	13,760
						D		38.8	61.2		.91					8,350	15,030
Do	do. Composite of Anal. Nos. 75969 and 75970.	do		75971	1.0	A	2.3	35.3	55.4	7.04	.81	5.26	76.38	1.53	8.98	7,590	13,660
						B	1.3	35.6	56.0	7.11	.82	5.20	77.14	1.55	8.18	7,665	13,790
						C		36.1	56.7	7.21	.83	5.12	78.19	1.57	7.08	7,770	13,980
						D		38.9	61.1		.89	5.52	84.27	1.69	7.63	8,370	15,070
Do	Imboden No. 2, (Hale) mine, Stonega Coke and Coal Co., Imboden, Va.	do	171	75972	1.3	A	2.8	34.4	58.2	4.6	.88					7,810	14,060
						B	1.5	34.9	58.9	4.7	.89					7,915	14,250
						C		35.4	59.8	4.8	.91					8,035	14,470
						D		37.1	62.9		.96					8,440	15,190
Do	do	do	171	75973	1.1	A	2.5	34.8	57.4	5.3	.85					7,770	13,990
						B	1.5	35.2	57.9	5.4	.86					7,855	14,140
						C		35.7	58.8	5.5	.87					7,975	14,350
						D		37.8	62.2		.92					8,435	15,180

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Imboden	Imboden No. 2 (Hale) mine, Stonega Coke and Coal Co., Imboden, Va.	J. Brian Eby....	171	75974	.9	A	2.8	33.4	59.2	4.6	.79	......	......	......	......	7,765	13,980
					....	B	1.9	33.7	59.7	4.7	.80	......	......	......	......	7,835	14,110
					....	C	......	34.4	60.9	4.7	.81	......	......	......	......	7,990	14,380
					....	D	......	36.1	63.9	......	.85	......	......	......	......	8,385	15,090
Do............	.....do.................... Composite of Anal. Nos. 75972 to 75974, inclusive.	.....do............	....	75975	1.1	A	2.6	34.1	58.4	4.90	.88	5.31	78.37	1.52	9.02	7,770	13,980
					....	B	1.6	34.5	59.0	4.95	.89	5.25	79.23	1.54	8.14	7,855	14,140
					....	C	......	35.1	59.9	5.03	.90	5.16	80.48	1.56	6.87	7,975	14,360
					....	D	......	36.9	63.1	......	.95	5.43	84.74	1.64	7.24	8,400	15,120
Kelly	Roaring Fork mine, Blackwood Coal and Coke Co., Roaring Fork, Va.	C. K. Wentworth	220	33143	.9	A	2.0	33.6	56.6	7.8	.89	......	......	......	......	7,655	13,780
					....	B	1.1	33.9	57.1	7.9	.90	......	......	......	......	7,725	13,910
					....	C	......	34.3	57.8	7.9	.91	......	......	......	......	7,810	14,060
					....	D	......	37.2	62.8	......	.99	......	......	......	......	8,485	15,270
Do............	.....do....................	.....do............	220	33144	1.6	A	2.7	33.2	59.1	5.0	.94	......	......	......	......	7,870	14,170
					....	B	1.1	33.8	60.1	5.0	.96	......	......	......	......	8,000	14,400
					....	C	......	34.2	60.7	5.1	.97	......	......	......	......	8,085	14,550
					....	D	......	36.0	64.0	......	1.02	......	......	......	......	8,520	15,340
Do............	.....do.................... Composite of Anal. Nos. 33143 and 33144.	.....do............	....	33145	1.3	A	2.2	33.8	57.5	6.50	.93	4.94	78.11	1.54	7.98	7,755	13,960
					....	B	1.0	34.2	58.2	6.58	.94	4.86	79.12	1.56	6.94	7,855	14,140
					....	C	......	34.6	58.8	6.65	.95	4.80	79.91	1.58	6.11	7,935	14,280
					....	D	......	37.0	63.0	......	1.02	5.14	85.60	1.69	6.55	8,500	15,300
Taggart	Roda mine No. 3, Stonega Coke & Coal Co., Roda, Va.	.....do............	193	33203	1.0	A	2.1	34.7	60.8	2.4	.58	......	......	......	......	8,150	14,670
					....	B	1.2	35.0	61.4	2.4	.59	......	......	......	......	8,230	14,810
					....	C	......	35.4	62.2	2.4	.59	......	......	......	......	8,330	14,990
					....	D	......	36.3	63.7	......	.60	......	......	......	......	8,535	15,370
Do............	.....do....................	.....do............	193	33204	.8	A	2.0	35.2	60.4	2.4	.50	......	......	......	......	8,165	14,700
					....	B	1.2	35.5	60.9	2.4	.50	......	......	......	......	8,230	14,810
					....	C	......	35.9	61.7	2.4	.51	......	......	......	......	8,330	15,000
					....	D	......	36.8	63.2	......	.52	......	......	......	......	8,540	15,370

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Heating Value. Calories.	Heating Value. British thermal units.
Taggart	Roda mine No. 3, Stonega Coke & Coal Co., Roda, Va.	C. K. Wentworth	194	33205	.8	A	2.0	34.7	61.4	1.9	.49					8,195	14,750
						B	1.3	34.9	61.9	1.9	.49					8,255	14,860
						C		35.4	62.6	2.0	.50					8,360	15,050
						D		36.1	63.9		.51					8,530	15,350
Do	do	do	194	33206	.7	A	2.0	35.6	60.2	2.2	.51					8,190	14,740
						B	1.3	35.8	60.7	2.2	.51					8,250	14,850
						C		36.2	61.5	2.3	.52					8,360	15,050
						D		37.1	62.9		.53					8,555	15,400
Do	do Composite of Anal. Nos. 33203 to 330206, inclusive.	do		33207	.8	A	2.0	34.9	60.9	2.18	.54	5.32	82.79	1.51	7.66	8,165	14,690
						B	1.3	35.2	61.3	2.20	.54	5.27	83.46	1.52	7.01	8,230	14,810
						C		35.6	62.2	2.23	.55	5.20	84.54	1.54	5.94	8,335	15,000
						D		36.4	63.6		.56	5.32	86.47	1.58	6.07	8,525	15,350
Do	Dunbar mine, Stonega Coke and Coal Co., Dunbar, Va.	do	227	32963	1.4	A	2.6	35.1	59.3	2.98	.61	5.33	81.42	1.34	8.32	8,030	14,460
						B	1.3	35.6	60.1	3.02	.62	5.24	82.59	1.36	7.17	8,145	14,670
						C		36.0	60.9	3.06	.63	5.18	83.63	1.38	6.12	8,250	14,850
						D		37.2	62.8		.65	5.34	86.27	1.42	6.32	8,510	15,320
Taggart Marker	Dunbar mine, Stonega Coke and Coal Co., Dunbar, Va.	do	227	32962	1.0	A	2.0	36.5	58.8	2.72	.75	5.38	81.70	1.49	7.96	8,130	14,630
						B	1.0	36.8	59.4	2.75	.76	5.32	82.50	1.50	7.17	8,210	14,770
						C		37.2	60.0	2.78	.77	5.27	83.27	1.52	6.29	8,295	14,930
						D		38.3	61.7		.79	5.42	85.75	1.56	6.48	8,530	15,360
Pardee	Pardee mine No. 1, Blackwood Coal and Coke Co., Pardee, Va.	Charles Butts	238	15099	1.0	A	2.3	33.8	54.7	9.21	1.56	4.99	74.46	1.57	8.21	7,420	13,360
						B	1.3	34.2	55.2	9.30	1.58	4.93	75.21	1.59	7.39	7,495	13,490
						C		34.6	56.0	9.43	1.60	4.85	76.20	1.61	6.31	7,595	13,670
						D		38.2	61.8		1.77	5.35	84.13	1.78	6.97	8,385	15,100
Do	do	T. K. Harnsberger.	238	22277	1.4	A	3.0	35.9	55.5	5.6	.78					7,760	13,970
						B	1.6	36.4	56.3	5.7	.79					7,875	14,170
						C		37.0	57.2	5.8	.80					8,000	14,400
						D		39.3	60.7		.85					8,490	15,280

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Pardee	Pardee mine No. 1, Blackwood Coal and Coke Co., Pardee, Va.	T. K. Harnsberger.		22278	1.3	A	2.9	36.1	56.2	4.8	.94					7,810	14,060
						B	1.6	36.6	56.9	4.9	.95					7,915	14,250
						C		37.2	57.9	4.9	.97					8,045	14,480
						D		39.1	60.9		1.02					8,460	15,230
Do	do	do		22279	1.1	A	2.7	36.3	54.5	6.5	1.37					7,690	13,850
						B	1.6	36.7	55.1	6.6	1.39					7,780	14,000
						C		37.3	56.0	6.7	1.41					7,905	14,230
						D		40.0	60.0		1.51					8,470	15,250
Do	do Composite of Anal. Nos. 22277 to 22279, inclusive.	do		22280	1.3	A	2.9	36.1	55.4	5.61	1.05	5.49	78.17	1.67	8.01	7,755	13,960
						B	1.6	36.6	56.1	5.68	1.06	5.42	79.19	1.69	6.96	7,855	14,140
						C		37.2	57.0	5.77	1.08	5.32	80.46	1.72	5.65	7,980	14,370
						D		39.5	60.5		1.15	5.65	85.38	1.83	5.99	8,470	15,240
Do	do	C. K. Wentworth	238	33140	2.0	A	3.3	31.8	54.2	10.7	1.12					7,125	12,830
						B	1.4	32.4	55.3	10.9	1.14					7,270	13,080
						C		32.9	56.0	11.1	1.16					7,370	13,260
						D		37.0	63.0		1.30					8,285	14,920
Do	do	do	238	33141	1.3	A	2.5	34.3	55.4	7.8	1.26					7,545	13,580
						B	1.1	34.8	56.2	7.9	1.28					7,650	13,770
						C		35.2	56.9	7.9	1.29					7,740	13,930
						D		38.2	61.8		1.40					8,405	15,130
Do	do Composite of Anal. Nos. 33140 and 33141.	do		33142	1.6	A	3.0	32.9	54.9	9.23	1.20	5.00	74.32	1.59	8.66	7,335	13,200
						B	1.4	33.4	55.8	9.38	1.22	4.90	75.56	1.62	7.32	7,455	13,420
						C		33.9	56.6	9.52	1.24	4.80	76.63	1.64	6.17	7,560	13,610
						D		37.5	62.5		1.37	5.30	84.69	1.81	6.83	8,360	15,040
Do	do	J. Brian Eby	238	84357	3.1	A	3.8	32.4	53.7	10.1	1.4					7,215	12,990
						B	.8	33.4	55.4	10.4	1.4					7,445	13,400
						C		33.7	55.8	10.5	1.4					7,500	13,500
						D		37.6	62.4		1.6					8,380	15,080

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Pardee	Pardee mine No. 1, Blackwood Coal and Coke Co., Pardee, Va.	J. Brian Eby	238	84358	1.8	A	2.6	35.2	57.5	4.7	.8					7,795	14,030
						B	.8	35.9	58.5	4.8	.8					7,940	14,290
						C		36.1	59.1	4.8	.8					8,000	14,400
						D		38.0	62.0		.8					8,405	15,130
Do	do	do	239	84359	1.3	A	2.0	35.4	56.8	5.8	.9					7,745	13,940
						B	.8	35.9	57.4	5.9	.9					7,845	14,120
						C		36.2	57.9	5.9	.9					7,905	14,230
						D		38.4	61.6		.9					8,400	15,120
Do	do	do	239	84360	1.6	A	2.4	35.3	55.5	6.8	.9					7,615	13,710
						B	.8	35.9	56.4	6.9	.9					7,740	13,930
						C		36.1	56.9	7.0	.9					7,800	14,040
						D		38.8	61.2		1.0					8,385	15,090
Do	do	do	239	84361	1.6	A	2.4	35.7	55.8	6.1	.9					7,680	13,830
						B	.8	36.3	56.7	6.2	.9					7,805	14,050
						C		36.7	57.0	6.3	.9					7,870	14,160
						D		39.1	60.9		1.0					8,395	15,110
Do	do	do	239	84362	1.5	A	2.2	37.8	56.1	3.9	1.0					7,915	14,240
						B	.7	38.4	56.9	4.0	1.0					8,035	14,460
						C		38.7	57.3	4.0	1.0					8,090	14,560
						D		40.3	59.7		1.0					8,430	15,170
Do	do Composite of Anal. Nos. 84357 to 84362, inclusive.	do		84363	1.8	A	2.5	35.2	56.1	6.2	.9	5.3	77.1	1.7	8.8	7,640	13,750
						B	.7	35.9	57.0	6.4	1.0	5.2	78.5	1.7	7.2	7,780	14,000
						C		36.1	57.5	6.4	1.0	5.2	79.1	1.7	6.6	7,835	14,110
						D		38.6	61.4		1.0	5.6	84.6	1.9	6.9	8,370	15,170
Do	Pardee mine No. 4, Blackwood Coal and Coke Co., Pardee, Va.	do	240	84364	4.3	A	5.1	32.5	56.4	6.0	.8					7,345	13,210
						B	.8	34.0	58.9	6.3	.8					7,670	13,810
						C		34.2	59.4	6.4	.8					7,735	13,920
						D		36.5	63.5		.9					8,260	14,860

Table of analyses of coal samples from mines in Wise County, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Pardee	Pardee mine No. 4, Blackwood Coal and Coke Co., Pardee, Va.	J. Brian Eby	240	84365	1.4	A	2.0	35.3	55.7	7.0	1.1					7,585	13,650
						B	.7	35.8	56.4	7.1	1.1					7,690	13,840
						C		36.0	56.8	7.2	1.1					7,745	13,930
						D		38.8	61.2		1.2					8,340	15,010
Do	....do Composite of Anal. Nos. 84364 and 84365.	....do		84366	2.8	A	3.6	33.7	56.2	6.5	.9	5.3	75.7	1.6	10.0	7,485	13,470
						B	.8	34.7	57.8	6.7	1.0	5.1	77.9	1.7	7.6	7,700	13,860
						C		35.0	58.2	6.8	1.0	5.0	78.5	1.7	7.0	7,760	13,970
						D		37.5	62.5		1.0	5.4	84.2	1.8	7.6	8,325	14,980
Upper Banner	Cranesnest No. 1 mine of Clinchfield Coal Corp., Toms Creek, Va.	T. K. Harnsberger.	436	18226	1.5	A	2.4	33.4	59.4	4.8	.58					8,035	14,460
						B	.9	33.9	60.3	4.9	.59					8,160	14,680
						C		34.2	60.9	4.9	.59					8,235	14,830
						D		36.0	64.0		.62					8,660	15,590
Do	....do	....do	436	18227	1.5	A	2.3	32.9	59.9	4.9	.53					8,035	14,460
						B	.9	33.4	60.7	5.0	.54					8,150	14,670
						C		33.7	61.3	5.0	.54					8,225	14,810
						D		35.5	64.5		.57					8,665	15,600
Do	....do	....do	437	18228	1.4	A	2.3	32.7	59.2	5.8	.51					7,985	14,370
						B	.9	33.2	60.1	5.8	.52					8,120	14,580
						C		33.5	60.6	5.9	.52					8,170	14,710
						D		35.6	64.4		.55					8,685	15,630
Do	....do Composite of Anal. Nos. 18226-18227 and 18228. (See page 512.)	....do		18229	1.5	A	2.3	32.9	59.6	5.2	.54	5.18	80.78	1.57	6.71	8,010	14,420
						B	.9	33.3	60.5	5.3	.55	5.09	81.97	1.59	5.50	8,130	14,630
						C		33.7	61.0	5.3	.55	5.05	82.67	1.61	4.78	8,200	14,760
						D		35.5	64.5		.58	5.33	87.33	1.70	5.06	8,660	15,590

Table of analyses of coal samples from mines in Scott County, Virginia.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Burtons Ford.	Mine of Patrick Hagan on McGhee Creek. Cannel coal.	M. R. Campbell.	484	10359	1.6	A	2.4	33.8	34.9	28.88	.99	4.87	57.12	1.08	7.06	5,830	10,490
						B	.9	34.3	35.4	29.35	1.01	4.77	58.05	1.10	5.72	5,925	10,660
						C		34.6	35.8	29.61	1.01	4.71	58.55	1.11	5.01	5,975	10,750
						D		49.2	50.8		1.43	6.69	83.18	1.58	7.12	8,485	15,280
Do.	J. S. T. Coal Corp. mine, 3 miles northeast of Dungannon.	J. Brian Eby.	486	75743	.9	A	2.6	31.4	58.8	7.2	.92					7,565	13,610
						B	1.7	31.7	59.3	7.3	.93					7,630	13,740
						C		32.3	60.3	7.4	.94					7,765	13,970
						D		34.8	65.2		1.02					8,385	15,090
Do.	do.	do.	486	75744	1.4	A	2.9	30.8	59.7	6.6	.85					7,605	13,690
						B	1.6	31.2	60.5	6.7	.86					7,715	13,880
						C		31.8	61.4	6.8	.88					7,835	14,100
						D		34.1	65.9		.94					8,410	15,130
Do.	do. Composite of Anal. Nos. 75743 and 75744.	do.		75745	1.1	A	2.9	30.8	59.4	6.92	.95	5.04	77.29	1.23	8.57	7,605	13,690
						B	1.7	31.2	60.1	7.00	.96	4.97	78.18	1.24	7.65	7,695	13,850
						C		31.7	61.2	7.12	.98	4.86	79.56	1.27	6.21	7,830	14,090
						D		34.1	65.9		1.06	5.23	85.66	1.37	6.68	8,430	15,170
Milner	Milner mine on Stony Creek, 5 miles north of Ka.	M. R. Campbell.	481	10358	1.5	A	3.2	33.0	58.1	5.70	1.64	5.32	76.89	1.60	8.85	7,635	13,750
						B	1.7	33.6	58.9	5.80	1.67	5.23	78.06	1.62	7.62	7,750	13,950
						C		34.1	60.0	5.89	1.69	5.12	79.44	1.66	6.20	7,890	14,200
						D		36.3	63.7		1.80	5.44	84.41	1.76	6.59	8,385	15,090
Duncan	Prospect on Coalpit branch of Stony Creek, 1½ miles north of Ka.	do.	482	10361	1.6	A	3.1	33.3	57.2	6.44	.85	5.40	76.24	1.48	9.59	7,580	13,640
						B	1.6	33.8	58.1	6.54	.86	5.30	77.48	1.50	8.32	7,705	13,870
						C		34.4	59.0	6.65	.88	5.21	78.71	1.53	7.02	7,825	14,090
						D		36.8	63.2		.94	5.58	84.31	1.64	7.53	8,390	15,090

Table of analyses of coal samples from mines outside of Wise and Scott counties, Virginia.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Kennedy	3 miles north of Della, Russell Co. Composite of two mine samples.	T. K. Harnsberger.	....	25369	.6	A	2.0	36.1	52.6	9.33	.83	5.21	75.37	1.17	8.09	7,470	13,450
					....	B	1.4	36.3	52.9	9.38	.83	5.18	75.80	1.18	7.63	7,515	13,530
					....	C	......	36.9	53.6	9.52	.85	5.09	76.90	1.19	6.45	7,625	13,720
					....	D	......	40.7	59.3	......	.94	5.63	84.99	1.32	7.12	8,425	15,170
Lower Banner..	Dante, Russell Co. Composite of two mine samples.	C. K. Wentworth	....	32331	.6	A	1.4	36.2	56.2	6.20	.69	5.29	79.59	1.65	6.58	7,900	14,220
					....	B	.8	36.4	56.6	6.24	.68	5.25	80.09	1.66	6.08	7,950	14,310
					....	C	......	36.7	57.0	6.29	.70	5.20	80.72	1.67	5.42	8,010	14,420
					....	D	......	39.2	60.8	......	.75	5.55	86.14	1.78	5.78	8,550	15,390
Upper Banner..	Dante, Russell Co. Composite of two mine samples.	.....do...........	....	32328	1.0	A	2.0	37.0	53.0	8.03	.58	5.22	77.15	1.39	7.63	7,635	13,740
					....	B	1.0	37.4	53.5	8.11	.59	5.16	77.94	1.40	6.80	7,715	13,890
					....	C	......	37.8	54.0	8.20	.59	5.09	78.75	1.42	5.95	7,795	14,030
					....	D	......	41.1	58.9	......	.64	5.54	85.78	1.55	6.49	8,490	15,280
Taggart	St. Charles, Lee Co.	Albert W. Giles..	....	34980	.7	A	2.8	37.0	56.9	3.33	.53	5.43	78.69	1.45	10.57	7.740	13,930
					....	B	2.1	37.3	57.3	3.35	.53	5.39	79.24	1.46	10.03	7,795	14,030
					....	C	......	38.1	58.5	3.43	.55	5.27	80.94	1.49	8.32	7,960	14,330
					....	D	......	39.4	60.6	......	.57	5.46	83.81	1.54	8.62	8,245	14,840
Low Splint.....	St. Charles, Lee Co. Composite of two mine samples.	.....do...........	....	75808	1.2	A	3.5	35.2	53.3	8.05	1.10	5.19	73.24	1.71	10.71	7,260	13,070
					....	B	2.3	35.6	53.9	8.15	1.11	5.11	74.14	1.73	9.76	7,350	13,230
					....	C	......	36.5	55.2	8.34	1.14	4.97	75.87	1.77	7.91	7,520	13,540
					....	D	......	39.8	60.2	......	1.24	5.42	82.77	1.93	8.64	8,205	14,770
Pocahontas No. 3.........	Pocahontas, Tazewell Co.	C. A. Allen	....	67889	....	A	3.2	20.1	72.4	4.3	.63	......	......	......	......	8,125	14,630
					....	B	......	......	......	......							
					....	C	......	20.8	74.8	4.4	.65	......	......	......	......	8,395	15,110
					....	D	......	21.8	78.2	......	.68	......	......	......	......	8,775	15,800
Do...........	.....do..................	.....do...........	....	67886	....	A	3.2	20.5	73.0	3.3	.58	......	......	......	......	8,220	14,790
					....	B	......	......	......	......							
					....	C	......	21.2	75.4	3.4	.60	......	......	......	......	8,375	15,280
					....	D	......	22.0	78.0	......	.62	......	......	......	......	8,790	15,820

Table of analyses of coal samples from mines outside of Wise and Scott counties, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Heating Value. Calories.	Heating Value. British thermal units.
Pocahontas No. 3........	Boissevain, Tazewell Co. Composite of fourteen mine samples.	C. A. Allen and J. J. Bourquin.	....	29907	....	A	2.6	21.6	71.7	4.11	.50	4.74	84.41	1.14	5.10	8,155	14,680
					....	B	......	......	......	......							
					....	C	......	22.2	73.6	4.22	.51	4.57	86.69	1.17	2.84	8,375	15,070
					....	D	......	23.2	76.8	......	.53	4.77	90.51	1.22	2.97	8,740	15,740
Harlan	Harlan, Harlan Co., Ky.	E. B. Sutton....	....	24731	1.7	A	3.3	37.5	56.2	3.0	.61	......	......	......	......	7,880	14,180
					....	B	1.7	38.1	57.2	3.0	.62	......	......	......	......	8,015	14,420
					....	C	......	38.8	58.1	3.1	.63	......	......	......	......	8,150	14,670
					....	D	......	40.0	60.0	......	.65	......	......	......	......	8,410	15,140
Do...........	Composite of three mine samples.	.....do...........	....	24732	1.8	A	3.6	37.1	56.6	2.71	.70	5.54	79.61	1.61	9.83	7,900	14,220
					....	B	1.7	37.9	57.6	2.76	.71	5.44	81.09	1.64	8.36	8,050	14,490
					....	C	......	38.6	58.6	2.81	.73	5.33	82.55	1.67	6.91	8,190	14,750
					....	D	......	39.7	60.3	......	.75	5.48	84.94	1.72	7.11	8,430	15,170
Elkhorn	Fleming, Letcher Co., Ky.	J. J. Bourquin..	....	29845	1.2	A	2.9	36.9	57.2	3.0	.67	......	......	......	......	7,905	14,230
					....	B	1.7	37.4	57.9	3.0	.68	......	......	......	......	8,000	14,400
					....	C	......	38.0	59.0	3.0	.69	......	......	......	......	8,140	14,650
					....	D	......	39.2	60.8	......	.71	......	......	......	......	8,395	15,110
Do...........	.....do.................	.....do...........	....	29846	1.5	A	3.1	36.5	57.2	3.2	.64	......	......	......	......	7,850	14,130
					....	B	1.6	37.0	58.1	3.3	.65	......	......	......	......	7,870	14,340
					....	C	......	37.6	59.1	3.3	.66	......	......	......	......	8,100	14,580
					....	D	......	38.9	61.1	......	.68	......	......	......	......	8,380	15,080
Do...........	.....do.................. Composite of two mine samples.	.....do...........	....	29847	1.3	A	3.0	36.6	57.3	3.13	.65	5.39	79.81	1.53	9.49	7,890	14,200
					....	B	1.7	37.1	58.0	3.17	.66	5.31	80.89	1.55	8.42	7,995	14,390
					....	C	......	37.8	59.0	3.23	.67	5.22	82.28	1.58	7.02	8,135	14,640
					....	D	......	39.0	61.0	......	.69	5.39	85.03	1.63	7.26	8,405	15,130
Harlan	High Splint, Harlan Co., Ky.	W. A. Forrester.	....	31694	1.2	A	2.8	37.5	54.6	5.1	1.17	......	......	......	......	7,720	13,900
					....	B	1.7	37.9	55.2	5.2	1.18	......	......	......	......	7,810	14,060
					....	C	......	38.6	56.1	5.3	1.20	......	......	......	......	7,940	14,290
					....	D	......	40.8	59.2	......	1.27	......	......	......	......	8,385	15,090

Table of analyses of coal samples from mines outside of Wise and Scott counties, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate.				Ultimate.					Heating Value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Harlan	High Splint, Harlan Co., Ky.	W. A. Forrester.	....	81695	1.0	A	2.6	36.7	55.7	5.0	1.17	......	......	......	......	7,610	13,700
					....	B	1.7	37.0	56.2	5.1	1.18	......	......	......	......	7,680	13,830
					....	C	......	37.7	57.1	5.2	1.20	......	......	......	......	7,810	14,060
					....	D	......	39.7	60.3	......	1.27	......	......	......	......	8,255	14,830
Campbell Creek.	War Eagle, Mingo Co., W. Va.	Eugene Stebinger	....	17475	.8	A	2.4	32.8	60.5	4.30	.74	5.06	79.82	1.53	8.55	7,955	14,320
					....	B	1.6	33.1	61.0	4.33	.75	5.01	80.45	1.54	7.92	8,015	14,430
					....	C	......	33.6	62.0	4.41	.76	4.91	81.78	1.57	6.57	8,150	14,670
					....	D	......	35.2	64.8	......	.80	5.14	85.55	1.64	6.87	8,525	15,350
Cedar Grove...	Matewan, Mingo Co., W. Va.	.....do...........	....	17483	1.3	A	3.0	34.7	58.9	3.4	.66	......	......	......	......	7,920	14,250
					....	B	1.7	35.1	59.7	3.5	.67	......	......	......	......	8,025	14,440
					....	C	......	35.7	60.8	3.5	.68	......	......	......	......	8,165	14,700
					....	D	......	37.0	63.0	......	.70	......	......	......	......	8,460	15,230
Pocahontas	West Vivian, McDowell Co., W. Va.	Steidle and Koster.	....	24799	1.5	A	2.0	16.6	76.5	4.9	.58	......	......	......	......	8,090	14,560
					....	B	.5	16.9	77.7	4.9	.59	......	......	......	......	8,215	14,790
					....	C	......	17.0	78.0	5.0	.59	......	......	......	......	8,260	14,860
					....	D	......	17.9	82.1	......	.62	......	......	......	......	8,690	15,640
Do...........	.....do....................	McKee and Koster.	....	24800	1.7	A	2.1	16.9	76.6	4.4	.57	......	......	......	......	8,105	14,590
					....	B	.4	17.2	77.9	4.5	.58	......	......	......	......	8,240	14,830
					....	C	......	17.3	78.2	4.5	.58	......	......	......	......	8,275	14,900
					....	D	......	18.1	81.9	......	.61	......	......	......	......	8,670	15,600
Do...........	.....do.................... Composite of two mine samples.	.....do...........	....	24801	1.6	A	2.0	17.1	76.2	4.66	.58	4.43	84.85	1.15	4.33	8,100	14,580
					....	B	.4	17.5	77.4	4.74	.59	4.32	86.22	1.17	2.96	8,230	14,810
					....	C	......	17.5	77.7	4.75	.59	4.30	86.56	1.17	2.63	8,260	14,870
					....	D	......	18.4	81.6	......	.62	4.51	90.89	1.23	2.75	8,675	15,610
Sewell	Caperton, Fayette Co., W. Va. Composite of three mine samples.	G. D. Deike.....	....	14347	3.0	A	4.0	23.8	70.0	2.22	.56	5.08	83.37	1.62	7.15	8,115	14,610
					....	B	1.0	24.6	72.1	2.29	.58	4.90	85.95	1.67	4.61	8,365	15,060
					....	C	......	24.8	72.9	2.31	.58	4.83	86.81	1.69	3.78	8,450	15,210
					....	D	......	25.4	74.6	......	.59	4.94	88.86	1.73	3.88	8,650	15,570

Table of analyses of coal samples from mines outside of Wise and Scott counties, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Text page where coal sections that yielded the samples are described.	Analysis No.	Air-drying loss.	Form of analysis.	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Heating Value. Calories.	Heating Value. British thermal units.
Sewell	Pax, Fayette Co., W. Va.	L. D. Tracy.....	....	32600	1.4	A	2.3	19.2	72.4	6.09	.91	4.55	82.46	1.65	4.34	7,915	14,240
	Composite of two mine samples.				....	B	.8	19.5	73.5	6.18	.92	4.45	83.66	1.67	3.12	8,030	14,450
					....	C	......	19.7	74.1	6.23	.93	4.40	84.38	1.69	2.37	8,095	14,580
					....	D	......	20.9	79.1	......	.99	4.69	89.98	1.80	2.54	8,635	15,540
Lower Kittanning	Mertens, Allegany Co., Md.	H. I. Smith.....	....	17497	2.1	A	3.1	20.4	63.6	12.9	3.40	......	......	......	......	7,230	13,020
					....	B	1.0	20.8	65.0	13.2	3.47	......	......	......	......	7,390	13,300
					....	C	......	21.1	65.6	13.3	3.51	......	......	......	......	7,460	13,430
					....	D	......	24.3	75.7	......	4.05	......	......	......	......	8,605	15,490
Do...........	Dodson, Garrett Co., Md.	.....do...........	....	17648	1.4	A	2.0	16.9	69.9	11.2	2.45	......	......	......	......	7,405	13,330
					....	B	.7	17.1	70.9	11.3	2.48	......	......	......	......	7,510	13,520
					....	C	......	17.2	71.4	11.4	2.50	......	......	......	......	7,560	13,600
					....	D	......	19.4	80.6	......	2.82	......	......	......	......	8,530	15,360
Do...........	Winber, Cambria Co., Pa.	Eugene Stebinger	....	68191	....	A	3.0	15.5	75.4	6.1	.97	......	......	......	......	7,915	14,250
					....	B	......	......	......	......							
					....	C	......	16.0	77.7	6.3	1.00	......	......	......	......	8,160	14,690
					....	D	......	17.1	82.9	......	1.07	......	......	......	......	8,710	15,680
Do...........	.....do....................	.....do...........	....	68204	....	A	1.8	16.1	73.9	8.2	1.33	......	......	......	......	7,845	14,120
	Tipple sample.				....	B	......	......	......	......							
					....	C	......	16.4	75.3	8.3	1.35	......	......	......	......	7,990	14,380
					....	D	......	17.9	82.1	......	1.49	......	......	......	......	8,710	15,680
Pittsburgh	Elizabeth, Allegheny Co., Pa.	R. H. Seip.......	....	20034	1.5	A	2.5	33.9	57.2	6.36	.78	5.33	78.10	1.60	7.83	7,645	13,760
					....	B	1.0	34.4	58.1	6.46	.79	5.24	79.29	1.62	6.60	7,760	13,970
					....	C	......	34.7	58.8	6.53	.80	5.18	80.13	1.64	5.72	7,845	14,120
					....	D	......	37.1	62.9	......	.86	5.54	85.73	1.75	6.12	8,390	15,110
Do...........	Bruceton, Allegheny Co., Pa.	L. M. Jones.....	....	11986	1.1	A	2.7	36.0	55.0	6.26	1.39	5.26	76.82	1.46	8.81	7,675	13,820
	Composite of two mine samples.				....	B	1.7	36.4	55.6	6.33	1.41	5.20	77.67	1.48	7.91	7,760	13,970
					....	C	......	37.1	56.5	6.44	1.43	5.10	78.98	1.50	6.55	7,890	14,200
					....	D	......	39.6	60.4	......	1.53	5.45	84.41	1.60	7.01	8,435	15,180

In using the figures given in the table of analyses it should be remembered that the sampler is much more careful in excluding impurities than is the miner or even the operator in times of great scarcity of coal, and consequently the coal that reaches the market from these mines is liable to contain much more ash than that shown in the mine samples.

A comparison of results obtained on mine samples and on railroad car samples shows that on the average the ash in the car sample may be from 30 to 50 per cent greater than it is in the mine sample. Thus, coal which shows 6 per cent ash in the mine sample is likely in the car sample to run from 7.8 per cent to 9 per cent, but if it exceeds a 50 per cent increase it indicates gross carelessness in mining or preparing the coal for the market.

The composition of the mine sample may be regarded as the ideal toward which the commercial coal of the mine approaches more and more closely as better methods and more care is exercised in mining and these two will agree whenever the best methods are used and every employe cooperates with the management in excluding impurities from the commercial output of the mine.

COMPARISON OF COALS.

The analyses of the important coals of Wise and Scott counties are averaged and given in the following table to simplify their study and afford a basis for comparison with the important coals of other fields. The first form given for each bed (form A) is the average for the samples "as received" and most nearly represents the condition of the coal as it leaves the mine. The second form (form D) is the average on the "pure coal basis," made theoretically by excluding the moisture and ash from the proximate analysis and recalculating the volatile matter and fixed carbon to total 100 per cent. The second form does not represent the actual condition of the coal at any time and should be used only in a comparative study of the qualities and ranks of the coals.

The figures given in the table show marked uniformity in the coals of Wise County so far as they are represented by the analyses given in the table (pp. 508-529), especially in the D form, which represents the real coal substance without regard to ash or other impurities. In the D form the extreme range in the volatile matter is only 3.4 per cent and the same is the range in the figures representing the fixed carbon. The effect of the variable amount of ash is shown in this table by the range of 5.2

Averages of analyses of each of the important coals.

	Number of analyses averaged.	Form of analysis.	% moisture.	% volatile matter.	% fixed carbon.	% ash.	% sulphur.	B. t. u.'s.
Lee coals	4	A	2.9	32.2	58.6	6.3	1.09	13670
		D	......	35.5	64.5	......	......	15170
Jawbone	8	A	2.3	30.1	51.3	16.3	1.14	12260
		D	......	37.0	63.0	......	......	15050
Raven	3	A	2.3	32.8	56.4	8.5	1.33	13570
		D	......	36.8	63.2	......	......	15200
Lower Banner	4	A	2.2	32.8	56.4	8.6	.83	13620
		D	......	36.9	63.1	......	......	15320
Upper Banner	11	A	2.8	32.7	57.9	6.6	.56	14160
		D	......	36.2	63.8	......	......	15430
Norton	3	A	3.3	33.1	56.1	7.5	1.42	13630
		D	......	37.1	62.9	......	......	15280
Dorchester (at Norton and Dorchester).	10	A	2.9	34.7	55.5	6.9	1.81	13780
		D	......	38.4	61.6	......	......	15280
Dorchester (at Glamorgan)	4	A	2.8	32.4	59.3	5.5	1.13	14130
		D	......	35.3	64.7	......	......	15400
Imboden	15	A	2.4	34.3	57.8	5.5	.75	13960
		D	......	37.3	62.7	......	......	15170
Taggart and Taggart Marker	6	A	2.1	35.3	60.2	2.4	.57	14660
		D	......	37.9	62.1	......	......	15360
Pardee	11	A	2.8	35.3	55.8	6.1	.99	13770
		D	......	38.7	61.3	......	......	15100
All beds	79	A	2.6	33.2	56.8	7.4	1.06	13730
		D	......	36.9	63.1	......	......	15240
Range	......	A	......	5.2	8.9	......	......	2400
		D	......	3.4	3.4	......	......	380

per cent in the volatile matter, the 8.9 per cent in the fixed carbon and 2,400 B. t. u.'s in the A form of analysis. The coals of the Lee, Norton, and Wise formations agree essentially in fixed carbon, sulphur, moisture,

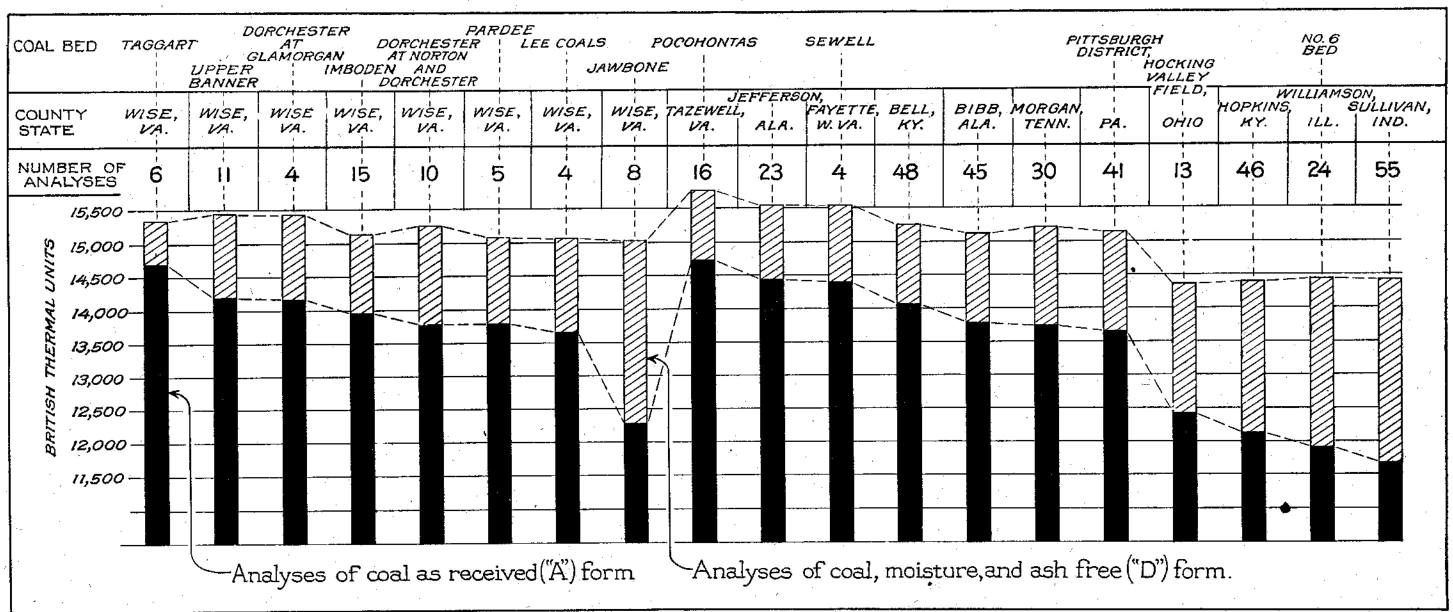


Fig. 54.—Diagram comparing heating value of Wise County coals with coals from other fields.

and B. t. u.'s, but the coals of the Norton and Lee formations run slightly higher in ash and lower in volatile matter than the coals in the Wise formation.

In figure 54 the B. t. u.'s or heating values of the important coals in Wise and Scott counties, and the coals of many fields with which the Wise County coals do now, or may possibly in the near future, come into competition, are compared graphically. This method of comparison is more satisfactory for general purposes for in about 99 cases out of 100 the consumer uses coal to produce heat and it is of the uttermost importance to him to know which coal that is available to his house or factory yields the greatest returns. The broken lines in the diagram indicate the heating value of the coal without moisture and ash, or as commonly called, on a pure coal basis. This part of the diagram represents approximately the heating value of the coal substance or the pure coal, as it may be termed. The solid black lines represent the heating value of the coal as it comes from the mine and is necessarily less than that of pure coal, but it more nearly represents the fuel that goes into the furnace than that which represents pure coal.

The high actual heating values of the Wise County coals is clearly shown in figure 54. The Taggart coal bed, with an average of 14,660 B. t. u.'s ("A" form) is second only to the famous Pocahontas coal of Tazewell County, Va., which is second to none of the coals of the other districts given. The Blair, Upper Banner, and Dorchester coals are above the 14,000 mark and the Norton, Imboden, and Pardee beds are only slightly below. Of all the outside fields given, including Tazewell County, only the Fayette County, West Virginia, Bell County, Kentucky, and Jefferson County, Alabama, coals have a heating value averaging more than 14,000 B. t. u.'s. It is not intended here to convey the impression that no coals east of the Mississippi River other than those listed exceed 14,000 B. t. u.'s. The coals whose heating values are shown in figure 54, are selected from representative eastern and central coal fields of the United States and the averages shown in figure 54 are obtained from a large number of analyses in each case.

The Taggart coal averages higher in fixed carbon and lower in ash than any other coal in Wise and Scott counties. The six samples of the Taggart, and its closely associated bed, the Taggart Marker, taken in western Wise County, give the coal an average fixed carbon content of 60.2 per cent, and an ash content of 2.4 per cent. One sample (Analysis No. 33205) shows an ash content of 1.9 per cent, which is remarkably low.

The Taggart, therefore, as far as present mining operations have shown, is a high rank (*i. e.*, a high fixed carbon) and low ash coal. This coal is said to make a coke having less than 4 per cent of ash. The Taggart bed is mined at Roda and Dunbar and has been sampled at those two places only in Wise County, hence it should not be taken for granted that the bed everywhere throughout the county maintains this unusually high record of quality. The coal is best adapted to the following purposes, railroad fuel, by-product coking, steam-raising, producing illuminating gas and producer gas, domestic use, bunker coal, and making Beehive coke.

An ultimate analysis of a composite of three samples of Blair coal collected at Esserville shows a heating value of 14,260 B. t. u.'s, and a fixed carbon content of 59.6 per cent. The ash is low, ranging about 5 per cent and the coal is well known as one of the best coking coals in the county.

The Upper Banner coal is one of the high quality coals of Wise County, having in eleven samples taken in eastern Wise County an average heating value of 14,160 B. t. u.'s. It is slightly lower in volatile matter, and fixed carbon and higher in ash than the Taggart, and is the lowest sulphur coal in the county. The coal is best suited for railroad fuel, steam-raising, domestic fuel, and making metallurgical coke.

The Dorchester bed at Glamorgan is second in rank to the Taggart bed with a fixed carbon content of 59.3 per cent. The average heating value of this coal is approximately that of the Upper Banner. The Dorchester bed at Glamorgan, Norton, and Dorchester contains excellent domestic fuel and coking coal.

The Imboden coal has a heating value only slightly below that of the Dorchester and Upper Banner coals but is equal in rank and ash content. A sample of Imboden coal (Analysis No. 75965) collected in a mine at Arno, yielded on analysis an ash content of only 1.2 per cent, which is extraordinarily low and is the lowest ash sample that was taken from any bed in Wise or Scott counties. The average ash content as determined by fifteen samples is 5.5 per cent. The Imboden bed is the largest producing bed in the county and the coal is used principally for bunker coal and for making coke. The coal is also valuable as a railroad fuel, by-product coal and steam-raising coal.

The average of eleven analyses of Pardee coal shows that coal to be of high heating value, of low-ash content, and slightly lower in rank than the average of Wise County coals. A study of the individual samples and the sections of the bed included in the samples show that the quality of the coal in the bed is not uniform throughout its entire 10 feet of thickness but that a top layer from 1 to 3 feet thick is relatively high in ash and sulphur. This top layer, in mining, is usually left as a roof but in old parts of the Pardee mines it is in large part removed. Where the entire bed is included in the sample, the analysis shows an ash content up to 10 per cent, but where only the section normally mined is sampled the ash content is about 4 per cent to 6 per cent. The coal is hard, making excellent lump coal, and is largely used as domestic fuel.

The effect of high-ash on the heating value of a coal is graphically shown in figure 54 for the Jawbone coal. The ash content of this bed determined from eight samples is 16.3 per cent and the heating value is 12,260 B. t. u.'s. The Jawbone is the highest ash and lowest rank coal now mined in the county, but the very large production of coal from this bed is sufficient evidence of the minable character of the coal, showing that the term high-ash, as here applied, is relative only to the other coals of Wise County.

The Raven, Lower Banner, and Norton beds are closely akin in character and quality, running about 33 per cent volatile matter, 56 per cent fixed carbon and 13,600 B. t. u.'s. The Norton bed is lower in ash and higher in sulphur than the other two beds. All three, however, are excellent coals and are extensively mined.

The coals of Wise County compare most advantageously in rank, ash content, and calorific value, with the bituminous coals of other States (see figure 54). The local coals average higher in rank and heating values than the coals of Pike and Letcher counties, Kentucky, and considerably higher than those of Hopkins County, in the western Kentucky field. The Wise County coals are equal to and in some cases exceed the highest rank of the Kanawha coals of southern West Virginia, namely those along the easternmost border of the Kanawha field.

The Pocahontas and New River coals are distinctly above the coals of this part of the Virginia region in rank, being 5 to 15 per cent higher in fixed carbon, and are in general their equal in lowness of ash and sulphur content, while, as is to be expected, their more advanced rank gives them somewhat greater B. t. u. values. Also, the New River and Pocahontas coals are coked with less loss of volatile matter. On the other hand, for household use and for export to markets intolerant of great quantities of slack or fine coal, most of the Virginia coals, which have not been so crushed and made friable by the dynamic forces that gave the Pocahontas and New River coals their higher rank, have a distinct advantage on account of the larger proportion of lump coal which may even permit grading by sizes with smaller waste in dust or slack. The Virginia coal especially commends itself as a reasonably high rank, high heat value, low ash, and low sulphur lump coal for export, as well as for domestic use.

Compared with the Tennessee coals these coals, on account of the higher rank resulting from the greater elimination of volatile matter, have a greater calorific value and are lower in ash and sulphur content. In the areas of extraordinarily low ash coals, like Campbell and Claiborne counties in Tennessee, the rank of the coals is so low as to give them a calorific value perceptibly less than that of the Virginia coals, in which, moreover, the sulphur is nearly everywhere smaller in amount. The heating value of the coals of Morgan County, Tennessee, is about that of the Wise County coals taken as a whole (see figure 54).

The coals of Alabama vary greatly in quality. In some localities the fuel is clearly of higher rank and heating power than that of the Virginia area, though nearly everywhere higher sulphur is found in the former than in the latter. In general, the Alabama coals are higher in ash and are inferior in rank and calorific value to the coals of Wise County. The heating value of coals from Jefferson and Bibb counties, Alabama, is graphically shown in figure 54.

As compared with the coals of the other Mississippi Valley states, including Illinois, Indiana, and western Kentucky (see figure 54), the Virginia coals are distinctly superior, being of considerably higher rank, generally lower in ash, almost everywhere lower in sulphur, and much higher in calorific value. The differences in the calorific value, which often exceeds 2,000 B. t. u.'s in favor of the Virginia coal, will possibly be found in some foreign market that is partial to lump coal, to be pitted against the larger percentages of stronger lump in the coals of the upper Mississippi Valley.

Even the best coals of Ohio are so much lower in fixed carbon, i. e., in rank, as hardly to equal the Virginia coals in heat value, and the Ohio coals are higher in sulphur and in ash (see figure 54).

The coals of the upper Potomac and Georges Creek basins in western Maryland are clearly much higher in rank, but their heat value is reduced by their higher ash content. The coal in the southern part of the Potomac basin and neighboring region of West Virginia are locally clearly superior in purity and heat value to the Wise County coals. These high-rank coals yield a larger proportion of fine coal or slack in the run-of-mine product. The average analysis of 41 samples from the Pittsburgh district, Pennsylvania, show the coals of that district to equal in calorific value the average of the Wise County coals (see figure 54).

The Virginia coals concerned in this study seem to compare most closely, in rank, heat value, ash, and moisture content, in the northern Appalachian region, with the low ash coals of the Fairmont district in northern West Virginia and in the Uniontown–Connellsville zone of Pennsylvania. Their low ash, low moisture, and abnormally low sulphur content give the Virginia coals an advantage over those in northwestern West Virginia and in western Pennsylvania, toward the western borders of which the lower fixed carbon is attended in general by lower calorific values.

TESTS.

GENERAL STATEMENT.

Samples of coal from two localities in eastern Wise County were subjected to a series of tests in fuel-testing plants of the United States Geological Survey to determine their value for commercial purposes. A run-of-mine sample from the Jawbone coal bed in the Virginia City No. 1 mine, of the Virginia Iron, Coal & Coke Co., at Virginia City, was used in making steaming and producer-gas tests in the plant at Norfolk, Va. It had been exposed to weathering for 36 days before use at the testing plant. A car sample of lump coal, over a 3½ inch bar screen, from the Upper Banner coal bed in the Coeburn mine of the Virginia Iron, Coal & Coke Co., at Toms Creek, was tested in the St. Louis plant.

The value of these tests is now relatively small in view of the fact that coal testing apparatus and methods have changed greatly in the past 15 years and standards for comparison are difficult to obtain. Furthermore, the two coals tested, the Jawbone and Upper Banner, have been mined continuously for about 30 years and the tests above referred to add little to the well-known properties of the coals in question. Thus, for example, the Upper Banner coal has been coked to great advantage and on a large scale continuously since mining began, and it needs no special tests to prove this quality. For these reasons only the most fundamental results of these tests will be quoted in this report, and for the full description of the tests, the apparatus used, and the results of obtained, the reader is referred to bulletins of the United States Bureau of Mines and the United States Geological Survey [1] and to bulletins of the Virginia Geological Survey.[2]

Four steaming tests were made on Wise County coals, two on Jawbone coal and two on Upper Banner coal. The essential features of the steaming tests are given in the following summary:

SUMMARY OF STEAMING TESTS.

	Test 601. Jawbone.	Test 602. Jawbone.	Test 280. Upper Banner.	Test 283. Upper Banner.
Water apparently evaporated per pound of coal as fired ....pounds..	7.70	7.07	8.14	8.18
Water evaported from and at 212° F.:				
Per pound of coal as fired .....pounds..	8.94	8.32	9.74	9.79
Per pound of dry coal ....pounds..	9.06	8.46	9.91	10.12
Per pound of combustible .....pounds..	10.97	10.36	10.66	10.84

Producer-gas tests were made on one sample of Upper Banner coal and on one sample of Jawbone coal. The coal used in producer (pounds per electrical horsepower per hour) are given below, first, as available for outside purposes, and, secondly, as developed at switch board. The tests are recorded as follows:

[1] Burrows, J. S., Mine sampling and chemical analysis of coals: U. S. Geol. Survey Bull. 362, 1907.

Breckenridge, L. P., Preliminary report on the operations of the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., 1905: U. S. Geol. Survey Bull. 290, 1906.

Breckenridge, L. P., Kreisinger, Henry, and Tay, W. T., Steaming Tests of coals and related investigations: Bureau of Mines Bull. 23, 1912.

Fernald, R. H., and Smith, C. D., Résumé of producer-gas investigations: Bureau of Mines Bull. 13, 1911.

Belden, A. W., Preliminary report on the operations of the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., 1905: U. S. Geol. Survey Bull. 290, 1906.

Belden, A. W., Washing and coking tests of coals and cupola tests of coke: U. S. Geol. Survey Bull. 336, 1908.

[2] Giles, A. W., The Geology and Coal Resources of Dickenson County, Virginia: Va. Geol. Survey Bull. XXI, pp. 206-212, 1921.

Wentworth, C. K., The Geology and Coal Resources of Russell County, Virginia: Va. Geol. Survey Bull. XXII, pp. 124-129, 1922.

SUMMARY OF PRODUCER-GAS TESTS.

	Test 163. Jawbone.			Test 75. Upper Banner.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Per electrical horse-power:						
Available for outside purposes	1.52	1.50	1.26	1.29	1.27	1.21
Developed at switch-board	1.48	1.46	1.23	1.21	1.19	1.13

Coking tests were made on two sample lots of the Upper Banner coal from Toms Creek. The coke obtained was of excellent quality and compared most favorably with 72-hour Connellsville coke.

ANALYSIS OF COAL AS USED AND RESULTING COKE.

	Connellsville.	Test 61. Upper Banner.		Test 88. Upper Banner.	
	Coke.	Coal.	Coke.	Coal.	
Moisture	.18	2.87	0.29	2.49	0.16
Volatile matter	.32	31.58	1.21	31.90	1.26
Fixed carbon	88.75	61.43	92.60	61.16	91.85
Ash	10.75	4.12	5.90	4.45	6.73
Sulphur in coke	.87	.56	.61	.57	.55
Sulphur in ash	.033	....	.085	....	.070
Phosphorus	.018	....	.001	....	.006
Specific gravity	1.92	....	1.93	....	1.87

The coal in test 61 was finely crushed and in test 88 the coal shipped had first been passed over a 3½-inch bar screen. Test 61 was of 45 hours' duration and test 88 was of 50 hours' duration. The coke produced from both tests was light gray and silvery color; had much deposited carbon, metallic ring, small cell structure, good breakage, and was heavy.

FUSIBILITY OF ASH FROM COALS OF WISE AND SCOTT COUNTIES.

The formation of clinker resulting from the melting of the ash of the burning coal has long been a troublesome problem, and it has led the United States Bureau of Mines to make a general survey of the "fusing" or "softening" temperatures of ash from various coals of the United States.

The Bureau has published two reports on the fusibility of coal ash, Bulletin 129 [1] and Bulletin 209,[2] to which the reader is referred for a detailed description of the methods and apparatus used in determining the fusion points of coal ash. In the latter bulletin are given the results of several hundred fusion tests made with ash from coals collected in many of the coal fields of the United States and Alaska. Forty-two tests are given on the ash from coals of Wise and Scott counties and appear in the following table. In order to present a clearer understanding of the table the following discussion on the relationship of ash to fusibility and fusibility to clinker formation is extracted from Bulletin 209.[2]

"SOURCE AND COMPOSITION OF COAL ASH.

"Coal ash is the incombustible residue remaining after the complete combustion of coal; it is derived from the inorganic mineral constituents of the coal. The ash-forming constituents are (1) inherent or intrinsic impurities that are present in an intimate mixture with the coal substance, and are derived either from the original material or from external sources such as sedimentation and precipitation while the coal-forming plant remains accumulated; (2) impurities, formed either during the laying down of the coal bed or subsequently, that occur in the form of partings, veins, and nodules of clay, shale, "slate," pyrite, and calcite; and (3) impurities that become intimately mixed with the coal in the process of mining, such as fragments of roof and floor.

"Coal ash is composed largely of compounds of silica, alumina, lime, and iron, with smaller quantities of magnesia, titanium, and alkali compounds. The chemical composition varies so widely that no typical composition can be given. In general, the analyses of most coal ash will probably come between the following limits:

TYPICAL LIMITS OF ASH ANALYSES.

Constitutent.	Per cent.	Constitutent.	Per cent.
SiO_2	40-60	CaO	1-15
Al_2O_3	20-35	MgO	5-4
Fe_2O_3	5-25	Na_2O+K_2O	1-4

"This list of constituents shows that coal ash contains relatively large proportions of SiO_2 and Al_2O_3, and smaller proportions of the other oxides.

[1] Fieldner, A. C., Hall, A. E., and Field, A. L., The fusibility of coal ash and the determination of the softening temperature: Bureau of Mines, 1918, 146 pp.

[2] Selvig, W. A., and Fieldner, A. C., The fusibility of ash from coals of the United States, Bull. 209, Bureau of Mines, 1922, 119 pp.

"RELATION BETWEEN CHEMICAL COMPOSITION AND FUSIBILITY OF COAL ASH.

"The fusibility of coal ash depends on several factors, such as the ratio of the silica to the bases present, the particular bases, and the percentage of alumina present. Mixtures extremely high in silica or extremely high in bases are not readily fusible. Ash that is low in iron is usually so highly siliceous that it is not readily fusible. Ash from coals high in pyrite is necessarily high in iron, and the ratio between the bases and silica is often such that easily fusible compounds may be formed. As a rule, coals containing considerable sulphur in the form of pyrite are apt to give trouble from clinker formation. Under conditions of the fuel bed the iron of the pyrite is apt to be converted to ferrous oxide, which with the silica present forms ferrous silicates that fuse at comparatively low temperatures. The chemical analyses of a series of five coal ashes ranging from very fusible (softening at 2,060° F.) to highly refractory (softening above 2,900° F.) is as follows:

CHEMICAL ANALYSES OF FIVE COAL ASHES COVERING A WIDE RANGE OF FUSIBILITY.

Sample No.[a]	Softening temperature, ° F.	Analyses of ash, percentage of—								
		SiO_2	Al_2O_3	Fe_2O_3	TiO_2.	CaO.	MgO.	Na_2O.	K_2O.	SO_3
1	2,060	30.7	19.6	18.9	1.1	11.3	3.7	1.9	.5	12.2
2	2,320	46.2	22.9	7.7	1.0	10.1	1.6	.7	.8	8.9
3	2,500	49.7	26.8	11.4	1.2	4.2	.8	1.6	1.3	2.5
4	2,730	51.0	30.9	10.7	1.9	2.1	.9	1.0	.4	.6
5	+2,900	58.5	30.6	4.2	1.8	2.0	.4	.7	.9	.9

[a] Sample 1, subbituminous coal, Montana; 2, bituminous coal, No. 6 bed, Illinois; 3, bituminous coal, Pittsburgh bed, Pennsylvania; 4, semibituminous coal, Pocahontas No. 3 bed, West Virginia; 5, bituminous coal, Dean bed, Kentucky.

"RELATION OF FUSIBILITY TESTS TO CLINKER FORMATION.

"It is well to bear in mind that the conditions of fusibility tests in the laboratory may not be directly comparable to the conditions in the fuel bed of a furnace. In a laboratory test the ash-forming constituents are intimately mixed, whereas there is usually no such uniform distribution of the ash-forming constituents in coal fire.

"Some coal ash is so infusible that little trouble is experienced from the formation of clinker. Ash that is slightly more fusible will often form a porous, spongy clinker which does not seriously obstruct the flow of air through the fuel bed and is easily removed. Coal ash with a low fusing temperature, say 2,100° F., not only melts in the average fire box, but is heated several hundred degrees above its melting temperature, becoming quite fluid and spreading out in a thin sheet over the grate, thereby obstructing the flow of air and localizing the heat in the fuel bed.

"The method adopted for making fusibility tests was the result of considerable experimental work,[1] by the Bureau of Mines on the nature of the fusion of coal ash and the influence of various oxidizing, reducing, and neutral atmospheres on the softening temperature of ash molded in the form of Seger cones. The method takes into consideration the various factors that influence the result obtained, with special reference to the atmosphere surrounding the ash during the test. The atmosphere in which the ash is heated is controlled by burning an excess of gas; a reducing atmosphere is thus obtained by which the iron in the ash is reduced mainly to the ferrous state, giving the lowest temperature at which clinkering may result.

"Analyses of clinkers from boiler furnaces indicate that fuel-bed conditions favored the formation of clinkers in which the iron was chiefly in the ferrous state; consequently the values obtained in the laboratory tests are, in this respect, comparable to such conditions, and the tests give the lowest temperatures at which the intimately mixed ash will soften with the formation of clinker."

The coals occurring in Wise and Scott counties are all of bituminous rank. The samples of coal from which the following ash fusibility determinations were made were collected according to a standard method by representatives of the United States Geological Survey. In all cases but one (the outcrop sample taken at Dooley) the samples were collected in mines or prospects. In the following table are given the names of the locality, the mine, the coal bed, and the laboratory number, the number of samples from each mine, the lowest, highest, and average softening temperature in degrees Fahrenheit and the percentage of ash and sulphur in the dry coal are tabulated for each mine. Samples of ash remaining unfused at 3,010° F., which was the highest temperature attained in the tests, are marked +3010 and used as such in figuring the average values for the mine.

The authors of Bulletin 209 in discussing the fusibility values of the coals of the United States first define the classes of fusibility and then give brief comparisons of the tests of the ash from eastern, interior, and western

[1] Fieldner, A. C., Hall, A. E., and Field, A. L., The fusibility of coal ash and the determination of the softening temperature: Bull, 129, Bureau of Mines, 1918, 146 pp.

Softening temperatures of coal ash from coals of Wise and Scott counties, Va.

Locality.	Mine.	Coal bed.	Analysis No.	Number of samples from mine.	Softening temperature ° F.			Average analysis of dry coal, percentage of—	
					Lowest.	Highest.	Average.	Ash.	Sulphur.
WISE COUNTY.									
Arno	Rock Heading No. 2	Imboden	75964–66	3	2,620	2,700	2,670	4.19	.65
Banner	Lower Banner No. 1	Lower Banner	32509–10	2	2,410	2,420	2,420	7.65	.72
Do.	No. 1	Upper Banner	32512	1			2,270	4.66	.91
Dorchester	Haskell No. 3	Dorchester	75440–41	2	2,200	2,240	2,220	5.03	1.45
Dunbar	Stonega	Taggart Marker	32962	1			2,330	2.78	.77
Do.	do.	Taggart	32963	1			2,370	3.06	.63
Esserville	Esser No. 4	Blair	75359–61	3	2,500	2,620	2,570	5.31	1.00
Flat Gap	Reuben Bolling	Imboden	15174	1			2,720	8.74	1.12
Glamorgan	Glamorgan No. 3	Dorchester	15100–01	2	2,130	2,190	2,160	5.86	1.22
Do.	Stone Gap No. 3	do.	32842–43	2	2,220	2,370	2,300	5.40	1.17
Imboden	Imboden No. 2	Imboden	75973–74	2	2,450	2,680	2,570	5.11	.84
Inman	Virginia Iron No. 2	do.	75969–70	2	2,390	2,390	2,390	7.13	.80
Josephine	Intermont No. 6	Dorchester	32067–68	2	2,540	2,640	2,590	10.25	.90
Norton	Norton No. 2	do.	75363–65	3	2,140	2,190	2,160	6.84	2.29
Do.	Norton No. 4	Blair	10390	1			2,600	3.89	.93
Osaka	Osaka	Imboden	33182–84	3	2,950	2,980	2,970	5.49	.72
Pardee	Pardee	Pardee (Parsons)	33140–41	2	2,890	2,950	2,920	9.52	1.23
Do.	Pardee No. 1	do.	15099, 22279	2	2,420	2,500	2,460	8.04	1.59
Roaring Fork	Roaring Fork	Kelly	33143–44	2	2,370	2,890	2,630	6.53	.94
Roda	Stonega No. 3	Taggart	33203–06	4	2,190	2,370	2,320	2.28	.53
St. Paul	Twin City No. 1	Imboden	32275	1			2,240	12.69	2.22
Do.	Twin City No. 2	Jawbone	32276	1			2,910	13.22	.73
Do.	Twin City No. 3	do.	32277	1			2,240	19.86	1.03
Stonega	Stonega No. 2	Imboden	33188	1			2,980	4.96	.77
Do.	Stonega No. 3	do.	33186–87	2	2,870	2,960	2,920	8.03	.77
Sutherland	Clark No. 2	Dorchester	75436–38	3	2,100	2,180	2,130	6.64	2.37
Tacoma	Beaver	Lower Banner	75446–47	2	2,720	2,910	2,820	10.50	.98
Do.	Bolling	Raven	75443–44	2	2,560	2,590	2,580	6.70	.94
Toms Creek	Caney	Upper Banner	32407–08	2	2,370	2,640	2,510	6.31	.57
Do.	Cranesnest No. 1	do.	18226–28	3	2,510	2,660	2,580	5.28	.55
Do.	Lee No. 6	do.	32410–11	2	2,370	2,580	2,480	5.25	.51
Do.	Sexton No. 2	do.	32413	1			2,380	14.84	.62
Do.	Thelma No. 1	do.	32404–05	2	2,270	2,430	2,350	8.90	.55
Toms Creek	Swansea	Upper Banner	10386	1			2,520	5.65	.53
Virginia City	Virginia Iron	Jawbone	32503–06	4	2,220	2,470	2,320	17.42	1.28
Wise	Dean Brothers	Rocky Fork	75746	1			2,820	6.45	.78
Do.	Gladeville No. 3	Norton	75367–69	3	2,270	2,460	2,360	7.76	1.47
SCOTT COUNTY.									
Adamar	Hagan	Burtons Ford	10359	1			2,530	29.61	1.01
Dungannon	J. S. T.	do.	75743–44	2	2,740	2,780	2,760	7.12	.91
Ka	Milner prospect	Milner	10358	1			2,120	5.89	1.69
Do.	Hagan prospect	Duncan	10361	1			2,160	6.65	.88

coals. Only that portion of this discussion which is of value in comparing the fusibility tests of coals of Wise and Scott counties will be quoted here.[1]

CLASSES OF FUSIBILITY.

> "In general, the softening temperature of coal ash from the coals of the United States ranges from 1,900° to 3,100° F. For convenience in discussion, the order of fusibility of ash may be expressed by subdividing this range of softening temperature into three groups, as follows:
>
> "Classes 1, refractory, softening above 2,600° F.
>
> "Class 2, ashes of medium fusibility, softening between 2,200° and 2,600° F.
>
> "Class 3, easily fusible ashes, softening below 2,200° F."

A study of the 73 tests of the coals of Wise County shows that the average fusibility of the ash is very close to 2,500° F. The average fusibility of the Upper Banner coal ash is a little less than 2,500° F., and the ash belongs to the class of medium fusibility. The average fusibility of the Imboden ash exceeds 2,650° F., and it belongs to the "refractory" class. The Dorchester coal ash is characterized by low fusibility. The silica content of the ash varies in different beds and for different parts of the same bed, however; hence the desirability and importance of having as many determinations as possible for each bed to arrive at a fair average of ash fusibility. The Upper Banner, Dorchester and Imboden coal beds are the only ones in this field that have been sampled at five or more mines and for which it might be said a fair average could be ascertained.

[1] Op. cit., pp. 10-11.

CLINTON IRON ORES OF WISE COUNTY

OCCURRENCE.

Beds of iron ore, the red hematite or oxide of iron, outcrop in southwest Wise County on the slopes of Wallen Ridge that lies south and southwest of Big Stone Gap. The beds, four in number, occur in rocks of the Clinton formation,[1] of early middle Silurian age, which formation lies about 2,000 feet below the coal-bearing rocks of Wise County. From their occurrence in the Clinton formation the beds have received the name of Clinton ores, and they are so called from their type locality at Clinton, New York, to Birmingham, Alabama.

The ore beds outcrop most extensively along the southeast slope of Wallen Ridge from the Lee County line northeast into Wise County for a distance of 3½ miles, and in a belt about 1½ miles wide. Between Irondale and Big Stone Gap the ore beds outcrop on both sides of Wallen Ridge but only a very small portion of the total acreage lies northwest of the crest of the ridge. A narrow band of Clinton rocks outcrops along the southeast side of Powell River from Big Stone Gap to the Wise County line but the ore beds are poorly exposed and have not been mined. Clinton rocks also outcrop along Butcher Creek about five miles northeast of Big Stone Gap but include in general only the top members of the formation and the ore beds, occurring in the lower half of the Clinton, are not exposed. The total acreage of ore-bearing rocks in Wise County is about 2,500 acres of which about 15 per cent has already had all minable ore taken out, leaving approximately 2,100 acres of ore-bearing rocks from which no ore has yet been removed.

CLINTON FORMATION.

The rocks of the Clinton (ore-bearing) formation, which in Wise County is about 400 feet thick, consist chiefly of beds of sandstone, quartzite, shale and red hematite. The upper half of the formation is dominantly a red sandstone which is capped by hard white quartzite making the top member of the formation. The upper half of the Clinton is here barren of iron ore in commercial quantity. The lower half of the Clinton

[1] See pp. 32-36.

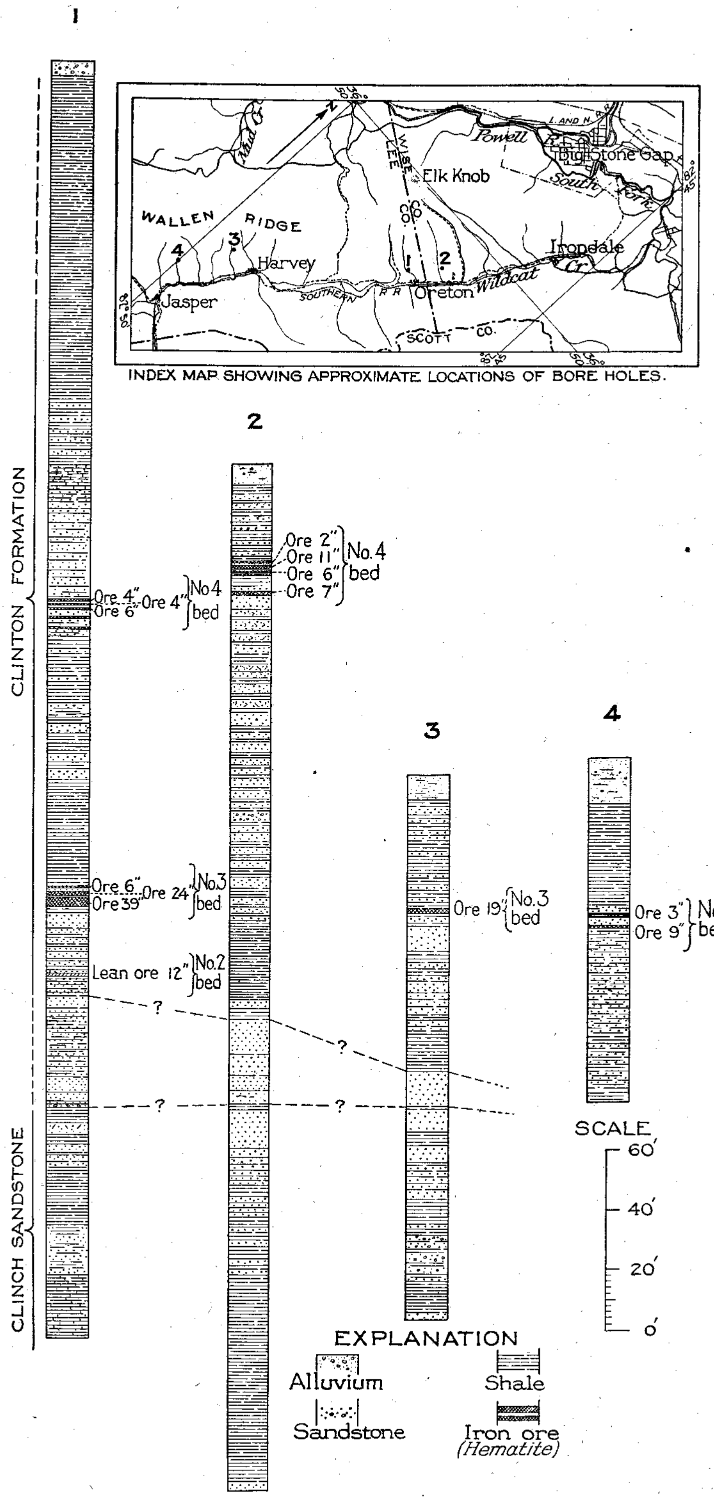


Fig. 55.—Bore-hole sections showing iron ore beds in rocks of the Clinton formation.

has four ore-bearing horizons, but only the upper two carry commercially important beds of hematite. The general character of the rocks comprising the Clinton formation are shown in the following section of the formation. The section is somewhat generalized, having been compiled from several borehole records (see figure 55) and partial sections measured at surface outcrops.

Section of Clinton formation in Wise County.

	Ft. In.	Ft. In.
Quartzite, white, slabby, weathers rust-stained, rough bedding surfaces. Carries Scolithus tubes. Keefer sandstone (?)	15±	
Sandstone, red, thick bedded at top. Gray to chocolate and pink shale, sandy shale, and thin gray sandstone full of rusty colored ostracods on bedding surface	200±	235
Shale, soft olive to drab, platy, with numerous plicated shells, (Moplotheca); thin sandstone	20±	
Ore, fine-grained, oolitic, No. 4 bed.............	2 to 4 feet	
Shale, gray to brown, few thin beds of sandstone.	90	90
Ore, coarse, pebbly, No. 3 bed..................	2 to 4 feet	
Sandstone, thick, red, with shale beds near bottom	23	23
Ore, very lean, No. 2 bed	1	
Quartzite, hard, with thin sandstone and shale beds. Conglomerate at base containing pyrite and galena. Ferruginous at places and is horizon of No. 1 iron ore bed	45	45
	400±	400±

The stratigraphy of the ore bed three miles east of Rose Hill, in Lee County, Virginia, where the ore is mined by the Boones Path Iron Company, is shown by the following section:

Iron ore beds at Boones Path, Lee County, Virginia.

	Ft.	In.
Ore, lean; No. 4 bed		6 to 8
Shale, soft yellow	100±	
Ore, rich, soft, fossil; No. 3 bed........................	2 to 3	
Shale and sandstone	200	
Ore, rich, soft, fossil, but lower grade than No. 3; No. 2 bed	3	4
Shale	76	
Ore, lean; No. 1 bed		4 to 6
	380±	

From the above sections the Clinton formation appears to thicken rapidly to the southwest from Wise County. There is about 200 feet greater interval between the No. 1 and No. 4 beds at Boones Path than in Wise County.

The character of the lower Clinton rocks is shown in much greater detail by four borings put down on the southeast slope of Wallen Ridge by the Interstate Coal and Iron Company about 30 years ago. The company is no longer in existence and the exact location of the borings could not be determined. The records of the boreholes were obtained from Mr. Thomas Gemmell, Bristol, Virginia, a former officer in the company. Only one of the borings, Prospect boring No. 1, was put down in Wise County, and it will be the only boring to be given in text form. The correlation of the ore beds disclosed in four boreholes is graphically shown on figure 55.

Prospect boring No. 1, of Interstate Coal and Iron Company, see figure 55.

(Location about ½-mile north of Oreton.)

		Thickness.		Depth.	
		Ft.	In.	Ft.	In.
Alluvium:					
Sand and gravel		5		5	
Clinton formation:					
Shale		8	6	13	6
Shale, blue and pink		13	6	27	
Shale, gray and blue, with seams of clay		21		48	
Shale, gray and blue		37		85	
Shale, gray, blue, and brown, with bands of sandstone		38		123	
Shale, with sandstone bands		10		133	
Shale, calcareous, with sandstone bands and fossils at 134-feet depth		8		141	
Shale with sandstone		14		155	
Shale with sandstone		22	8	177	8
Ore mixed	No. 4 bed		2	177	10
Ore	No. 4 bed		2	178	
Sandstone and shale	No. 4 bed		10	178	10
Ore	No. 4 bed		4	179	2
Sandstone and shale	No. 4 bed	1	3	180	5
Ore	No. 4 bed		6	180	11
Sandstone with bands of ore and shale		9	1	190	
Shale		1		191	
Shale, brown, with a few sandstone bands		25		216	
Shale, brown, with wide sandstone bands		24		240	
Shale, brown		11		251	
Shale, brown and gray		21	9	272	9
Ore			6	273	3
Sandstone and shale		1	6	274	9
Ore	No. 3 bed	1	3	276	
Shale	No. 3 bed		2	276	2
Ore	No. 3 bed	3	3	279	5
Shale and sandstone		1	7	281	
Sandstone, red		5	6	286	6
Sandstone, hard, close-grained, and blue shale		13	9	300	3
Sandstone, red, with 1 foot of lean ore 301′ 6″ to 302′ 6″ No. 2 bed		3	3	303	6

	Thickness. Ft.	In.	Depth. Ft.	In.
Sandstone and layers of shale	6	4	309	10
Sandstone, hard, close-grained, gray	4		313	10
Sandstone and shale	23		336	10
Sandstone, hard, gray	5		341	10
Sandstone	3		344	10
Sandstone, gray	1		345	10
Clinch sandstone and lower formations:				
Conglomerate	1	3	347	1
Shale, dark	5	9	352	10
Quartzite, bands of shale, hard sandstone, decomposed granular sandstone.	3		355	10
Shale, dark	3		358	10
Sandstone, hard, gray, with shale partings	9		367	10
Shale, mottled dark gray	18		385	10
Shale, mottled, sandy, and sandstone	17		402	10
Shale, mottled lime	19	6	422	4

STRUCTURE.

The structure of the Clinton rocks of Wise County and its general relationship to the geologic structure of the other pre-Pennsylvanian rocks exposed in the same region are previously described in this report (pp. 119 to 129). The attitude of the Clinton rocks and its effect on the commercial availability of their included beds of iron ore will here be briefly described. The rocks of the Clinton formation have been brought to the surface by the folding of the Powell Valley anticline and the subsequent deep erosion into its crest. The axis of the anticline roughly coincides with the crest of Wallen Ridge. The anticline from Big Stone Gap southwest to Lee County is unsymmetrical and has notably steeper dips on the northwest flank. The fold is further modified by faults and the relationship of these faults to the anticline is graphically shown in the structure sections given on Pl. II.

The dip of the Clinton rocks on the southeast slope of Wallen Ridge, is 5 to 20 degrees to the southeast and the dip of the Clinton rocks on the northwest side of the ridge between Big Stone Gap and Lee County ranges from 20 degrees northwest to 45 degrees southeast, overturned. Thus the outcrop of Clinton rocks on the southeast side of Wallen Ridge is a broad belt as compared with the very narrow strip of Clinton rocks along Powell River. From Big Stone Gap to Irondale and thence to Oreton the dip of the rocks, in general, is from 5 to 10 degrees greater than the normal gradients of the streams flowing off Wallen Ridge. This type of structure causes the Clinton to plunge under the younger Cayuga limestone in Wildcat Creek Valley and to overlie stratigraphically the massive Clinch sandstone, which, with the underlying Sequatchie sandstone, makes the present crest of Wallen Ridge.

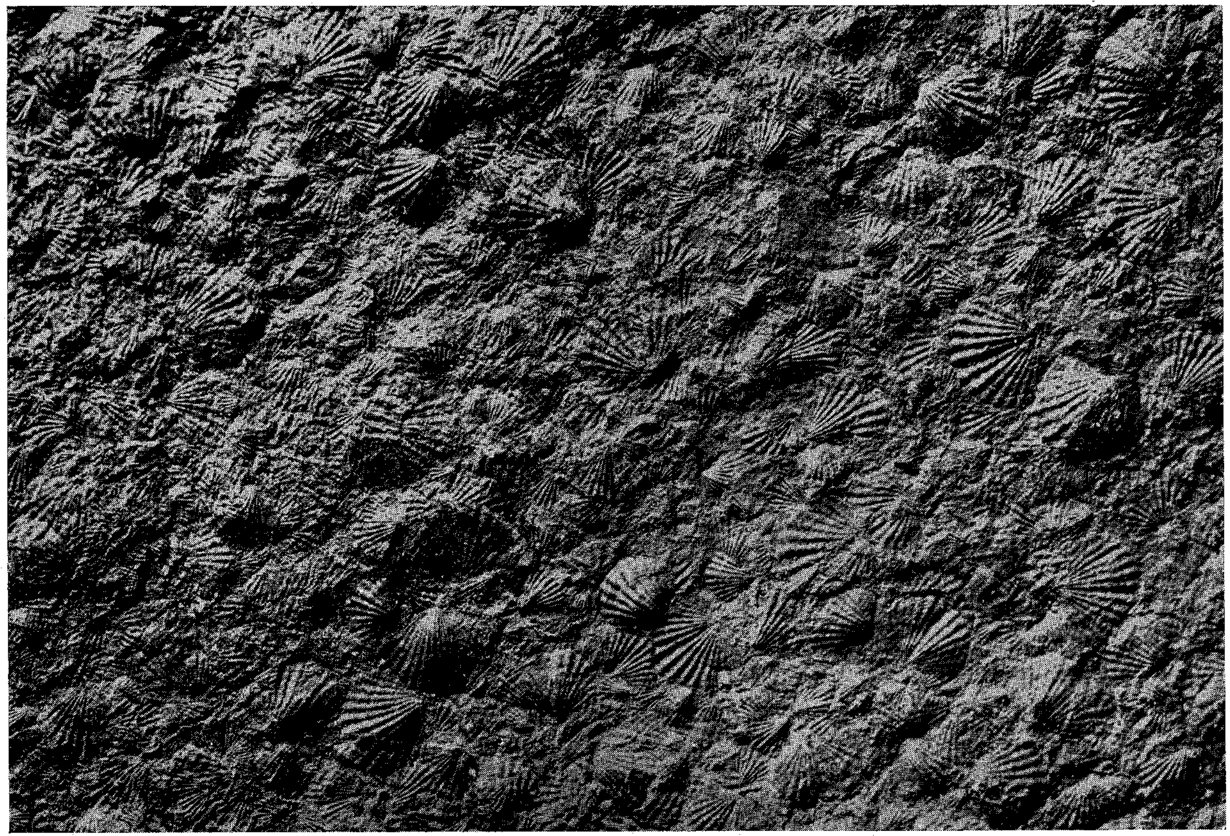
The outcrop of the ore beds between Irondale and Lee County crosses the side spurs of Wallen Ridge near the summit of the ridge and crosses the gullies near their mouths at Wildcat Creek Valley. On the crests of the spurs for considerable distances back from the actual outcrop of the beds, the dip of the rocks is only slightly greater than the slope of the topographic surface and the ore beds have here been readily mined by surface stripping. Further back from the outcrop on the crests of the spurs, however, the over-burden is too great to be removed and underground mining is required.

GENERAL DESCRIPTION OF THE ORE BEDS.

PHYSICAL CHARACTERISTICS.

The Clinton iron ores of Wise County consist of a mixture of two types of material distinct in texture—the red fossil hematite (see Pl. XXXIV A) and the oolitic hematite (see Pl. XXXIV B), of which the latter is more abundant. The fossiliferous material consists of aggregates of fossil organic remains such as bryozoans, crinoids, ostracods and brachiopods (see Pl. XXXII), which have been largely replaced by the iron oxide. The fossil remains are usually broken and waterworn and cemented together by calcium carbonate and ferric oxide. In the oolitic material the ore consists of aggregates of flaxseed-like grains cemented by calcium carbonate and iron oxide. The oolites or flaxseed-like grains have a nucleus of a sand particle or a fossil fragment around which are concentric layers of iron oxide, and some layers of silica and alumina.

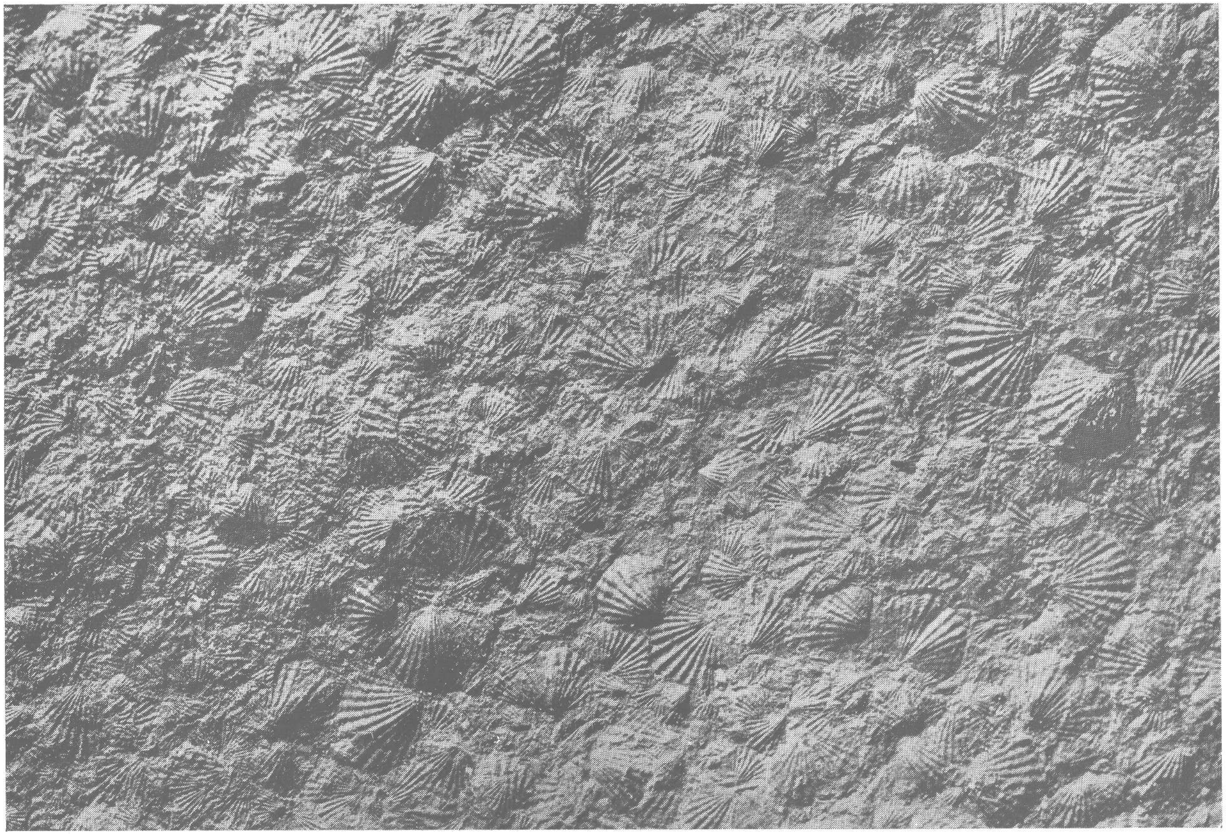
The Clinton iron ores in this field apparently were deposited originally with an intimate admixture of more or less lime carbonate and where the beds are buried below the ground water table the ores are hard, calcareous, and relatively lean in iron content. Such ore is called "hard ore." The Clinton ores exposed at the surface and under cover but within the reach of surface and ground waters have had much of their lime dissolved out and carried away, thereby relatively increasing the percentage of the iron, silica and other insoluble constituents in the ore. Such ore is popularly called "soft ore," an appropriate term as the ore is soft, friable, and porous. This is the type of ore that has been mined in Wise County. The soft ore averages 40 to 45 per cent metallic iron as against 35 per cent and less metallic iron in the hard ore.



FOSSILS FOUND WITH CLINTON IRON ORE.

Small fossil shells (natural size) found in great abundance in the calcareous beds immediately overlying the beds of iron ore. Not unusually the fossils are entirely replaced by the ore, whence the term "fossil ore" which is commonly applied to the Clinton ores. The fossils are brachiopods with the scientific name, *Anoplotheca hemispherica* Sowerby. Collected from roof shale in No. 10 mine of Boone's Path Iron Co., 2 miles east of Rose Hill, Va.

Photo by G. D. Jenkins.



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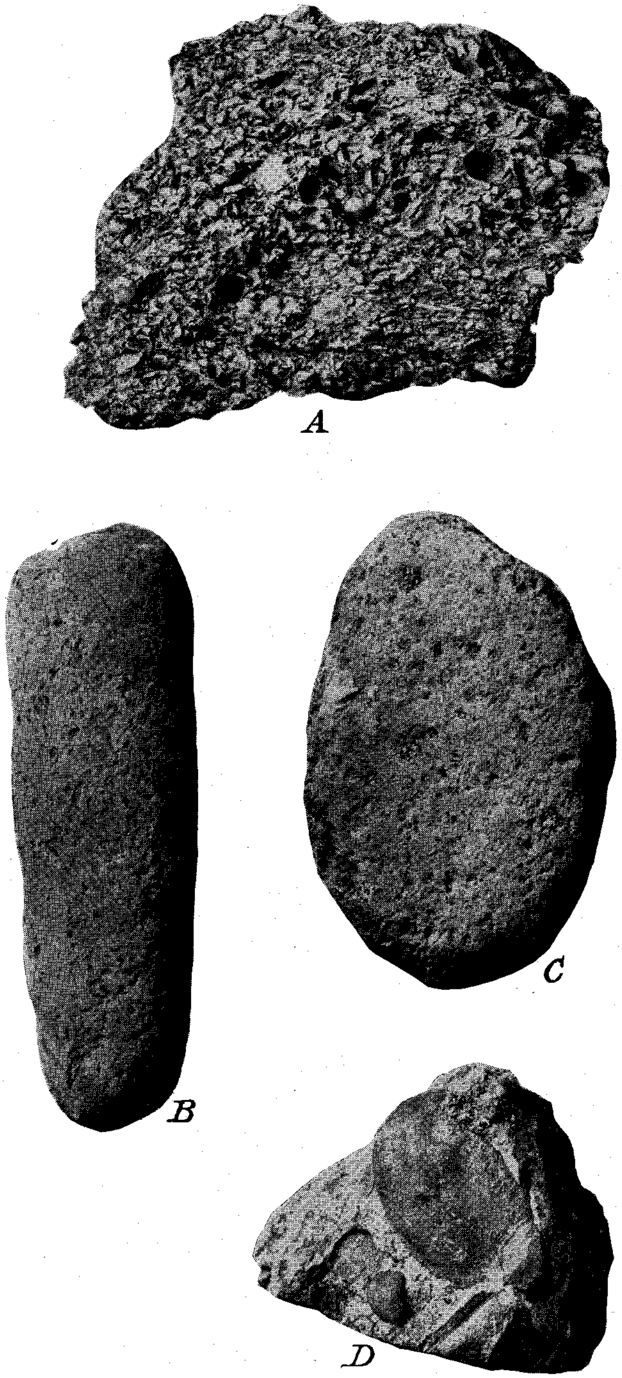
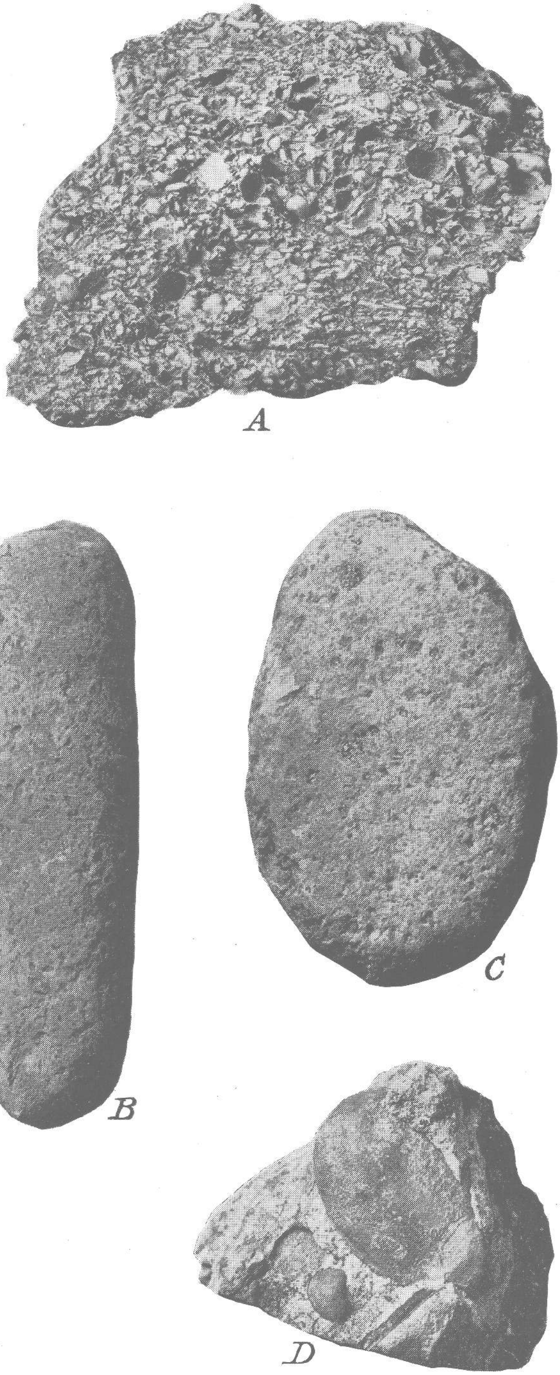


Clinton iron ore from Bed No. 3, Irondale Mine, Wise Co., Va.
A. Fine pebbly ore, containing small quartz pebbles.
B., C. Large pebbles of fossiliferous hematite ore.
D. Pebbles of carbonate of iron in sandstone matrix, from deeper workings of the mine.



Clinton iron ore from Bed No. 3, Irondale Mine, Wise Co., Va.
A. Fine pebbly ore, containing small quartz pebbles.
B., C. Large pebbles of fossiliferous hematite ore.
D. Pebbles of carbonate of iron in sandstone matrix, from deeper workings of the mine.

CHEMICAL COMPOSITION.

The ores mined in Wise County are similar in chemical composition to the Clinton ores mined elsewhere in the Appalachian region. The minable beds (No. 3 and No. 4) contain ore that has in general the following range in composition; metallic iron, 38 to 46 per cent; lime oxide, from a trace to 10 per cent; alumina .2 to 5 per cent; phosphorus .3 to .66 per cent; and sulphur in minute quantity. The ore is not suitable for the making of Bessemer steel as the phosphorus content is much too great to permit the use of the Bessemer "acid"[1] process and too low to permit the use of the Bessemer "basic" process. The acid process requires an ore of less than one-twentieth of one per cent phosphorus and also of sulphur, and the "basic" process requires an ore of at least two per cent phosphorus. The Clinton ores may be mixed with other types of iron ore to give the appropriate proportions of these elements to make a suitable Bessemer ore.

The hard Clinton ore usually contains so much lime that the ore is self-fluxing although the yield in iron is less than a similar charge of soft ore to which limestone has been added. In the Wise County field, limestone is abundantly exposed and has been used with the soft ore in the blast furnace near Big Stone Gap. The large percentage of lime in the hard ore materially aids in the fluxing and reducing of the ore. The high percentage of silica in the Wise County ores would render them worthless were it not for the presence of the lime, which compensates for the silica impurity by rendering the ores more fusible. Manganese was not reported in the analyses of ore samples collected in Wise or Lee counties.

Analyses of two samples of ore from the Irondale mines, Wise County, are given in the following table and compare with analyses of Clinton iron ore from Lee County, Virginia, Huntington County, Pennsylvania, and the Birmingham district, Alabama. The Virginia ore ranks with the best of the Clinton ores as shown in the table. The Pennsylvania and Birmingham analyses are of interest as showing the relative amounts of iron and lime in the hard and soft ores.

[1] Campbell, H. H., The Manufacture and Properties of Iron and Steel, Hill Publishing Company, New York and London, 1907, pp. 9-11.

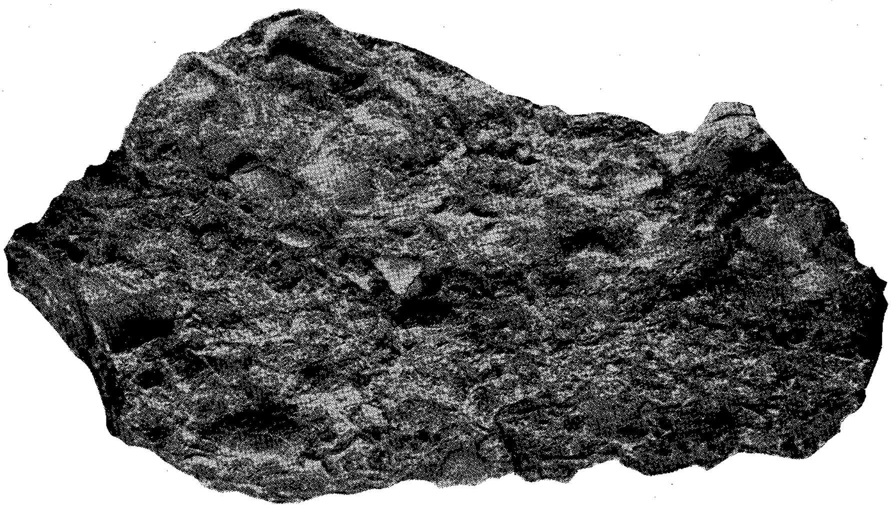
Analyses of Samples of Clinton Iron Ore from Wise and Lee Counties, Virginia, Huntingdon County Pennsylvania, and Range in Alabama Ores.

Sample No.	05852* (Irondale.)	05853* (Irondale.)	05865* (Harvey.)	05866* (Harvey.)	05851* (Boonespath.)	05854* (Boonespath.)	1† (Huntingdon Co., Pa.)	2† (Huntingdon Co., Pa.)	3‡ (Birmingham, Ala.)	4‡ (Birmingham, Ala.)	5‡ (Birmingham, Ala.)	6‡ (Birmingham, Ala.)
Samples air-dried. (Air-drying loss.)	3.00	4.91	8.37	3.70	5.44	3.00						
SiO_2	14.47	18.54	38.01	11.30	29.98	31.40	15.18	2.58	13.70	12.10	12.76	7.14
AL_2O_3	3.18	4.60	4.92	0.19	4.80	3.98	6.39	4.80	5.66	6.06	4.74	3.81
Fe_2O_3	55.55	60.48	54.06	52.79	61.14	60.97	68.35	48.06	....	....	....	....
FeO	4.36	5.59	0.50	4.23	Trace	0.42	0.16	1.66	....	....	....	....
MgO	2.54	1.03	0.13	2.27	0.21	0.20	0.04	0.56	....	....	....	....
CaO	8.62	3.48	Trace	7.12	0.64	0.38	0.16	22.06	0.50	4.65	8.70	19.20
SO_3	0.08	0.09	0.02	0.08	0.06	0.03	....	....	(S) 0.08	0.07	0.08	0.08
P_2O_5	0.50	0.46	0.30	0.66	0.63	0.37	0.52	1.04	(P) 0.10	0.46	0.49	0.30
MnO	....	....	....	....	....	....	0.31	0.17	(Mn) .23	0.21	0.19	0.23
K_2O	....	....	....	....	....	....	0.48	0.19	....	....	....	....
CO_2	....	....	....	....	....	....	0.16	18.84	....	....	....	....
H_2O & organic	....	....	....	....	....	....	8.15	....	....	....	....	....
Fe, Metallic..	46.64	38.22	42.80	43.00	42.24	47.21	47.97	34.64	54.70	50.44	45.70	37.00

LOCATION OF ORE SAMPLES

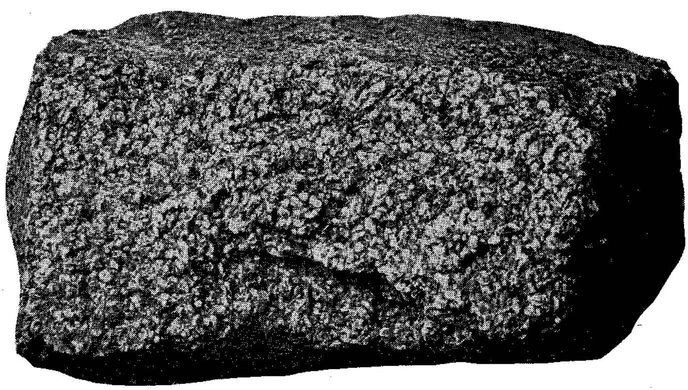
No. 05852: Intermont Coal & Iron Co., Irondale, Wise Co., Va., from "Old Mule" drift, No. 3 bed, 500 ft. in; 28 inches thickness.
No. 05853: Intermont Coal & Iron Co., Irondale, Wise Co., Va., from "south" drift, 30 ft. in. Thickness 23 inches, No. 3 bed.
No. 05865: Intermont Coal & Iron Co., Harvey, Lee Co., Va., car sample of ore from operation in No. 3 bed.
No. 05866: Intermont Coal & Iron Co., Harvey, Lee Co., Va., car sample of ore from operation in No. 3 bed.
No. 05851: Boone's Path Iron Co., Boone's Path, Lee Co., Va., composite sample from three locations in mine No. 10, from heading at east end 1600 ft. in; from No. 10 slope on 90 ft. level east end 260 ft. from slope; and from west end heading 250 ft. from slope. Average thickness 30 inches. No. 3 bed.
No. 05854: Boone's Path Iron Co., Boone's Path, Lee Co., Va., from No. 8 mine 700 feet foot of slope into mine. No. 3 bed.
No. 1: Soft ore from Brush Ridge mine in Huntingdon Co., Pa.
No. 2: Hard ore from Parker drift, Brush Ridge, Huntingdon Co., Pa.
Nos. 3, 4, 5, and 6: Four samples of ore from Big Seam in Red Mountain near Birmingham, Alabama. The analyses are of samples from a single slope and show the range in composition from soft ore (No. 3), to hard ore (No. 6), with two intermediate or semihard grades of ore (Nos. 4 and 5) between. Samples Nos. 3, 4, 5, and 6 were taken at distances respectively of 240, 420, 480, and 540 feet from the mouth of the slope.

*Samples collected by J. Brian Eby; analysis by U. S. Geol. Survey.
†Samples collected by J. J. Rutledge; analysis by Penniman & Browne.
‡Samples collected by E. F. Burchard; analysis by U. S. Geol. Survey; published in U. S. Geol. Survey Bulletin 315, Part 1, 1906, p. 135.



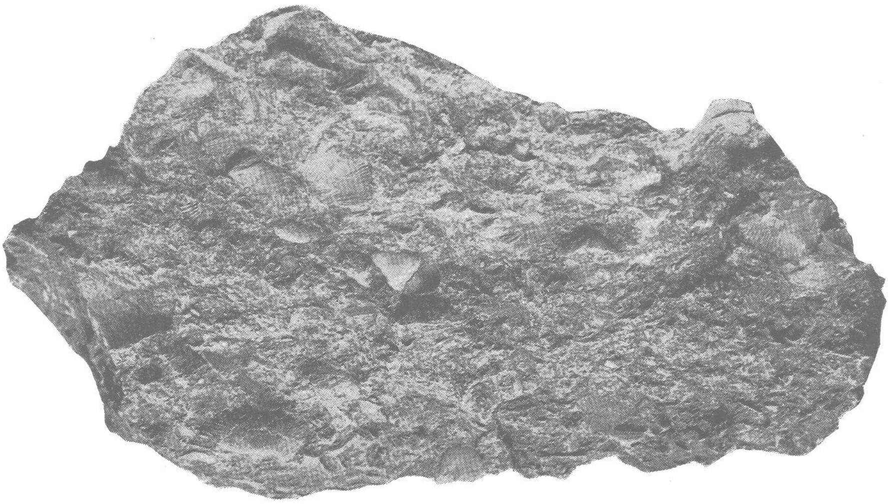
(A) Fossil iron ore from deeper workings of a mine near Estelle, Ga. The ore is hard red calcareous hematite of Clinton age.

By courtesy of E. F. Burchard.



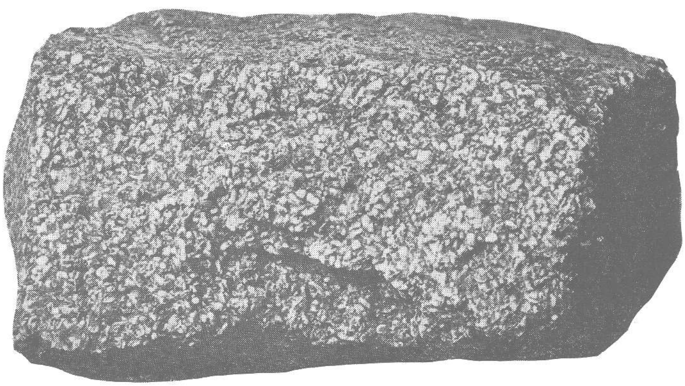
(B) Oolitic iron ore, from Browns Switch, Lee Co., Va. The ore is soft red hematite of Clinton age.

By courtesy of E. F. Burchard.



(A) Fossil iron ore from deeper workings of a mine near Estelle, Ga. The ore is hard red calcareous hematite of Clinton age.

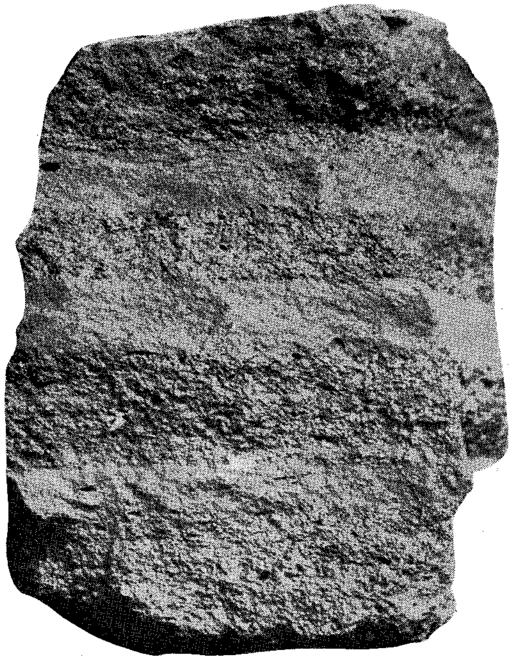
By courtesy of E. F. Burchard.



(B) Oolitic iron ore, from Browns Switch, Lee Co., Va. The ore is soft red hematite of Clinton age.

By courtesy of E. F. Burchard.

(A) *Pebbly hematite ore and partly replaced sandstone,* of Bed No. 3, Irondale, Wise Co., Va. The sandstone between layers of pebbly ore has been partly replaced by iron oxide.



(B) *Banded hematite ore,* Bed No. 3, Irondale, Wise Co., Va. Layers containing small quartz pebbles inter-bedded with layers of fine grained hematite.

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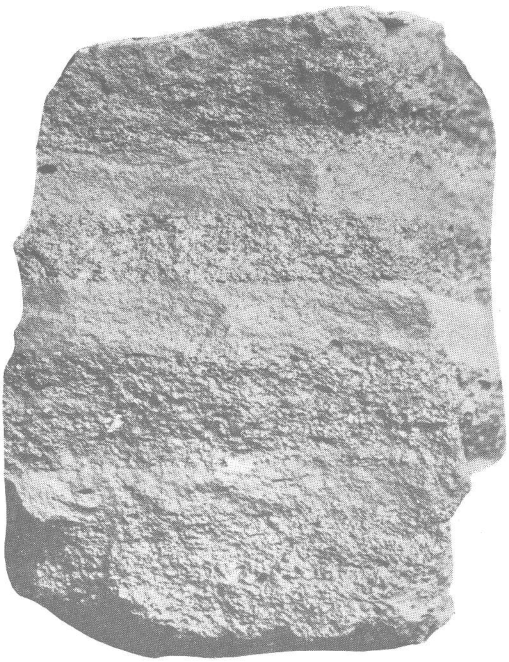

(B) *Banded hematite ore,* Bed No. 3, Irondale, Wise Co., Va. Layers containing small quartz pebbles inter-bedded with layers of fine grained hematite.

DETAILED DESCRIPTION OF ORE BEDS.

BEDS NO. 1 AND NO. 2.

The two lower ore beds in the Clinton formation known as No. 1 and No. 2 beds, named from the bottom toward the top of the formation, are so lean that neither bed can be mined. The No. 1 bed at the base of the formation is scarcely to be classed as ore, consisting as it does chiefly of ferruginous sandstone and thin bands of hematite. In Lee County the bed is 4 to 6 inches thick consisting of a poor grade ore. The No. 1 bed is not mined in Wise County and is too thin and worthless to be considered even as a possible future source of ore. The No. 2 bed is thicker than the No. 1 bed and is as much as 40 inches thick in Lee County. In Wise County it has not been mined and very little prospected. In the borehole put down near Oreton (figure 55) the No. 2 bed shows 1 foot of lean ore. Thus, the No. 2 bed like the No. 1 bed may scarcely be considered an asset to the economic resources of Wise County.

BEDS NO. 3 AND NO. 4.

The two upper ore beds known from lower to higher, respectively, as No. 3 bed and No. 4 bed are the commercially important hematite occurrences of Wise County. Both beds range in thickness from 20 to 40 inches and both beds have been widely prospected and mined within the field. Many of the prospect and mine locations are indicated on the geologic map and those at which sections of the ore beds were taken or at which the dip of the rocks was measured will be described in the text. The pits will be described starting from the head of Wildcat Creek Valley and going northwest along the slope of Wallen Ridge to Irondale and thence over the ridge to Big Stone Gap. The pits are numbered in the same direction starting with No. 801, which continues the series of location numbers used in the coal section of this report.

Mining operations in the vicinity of Oreton were discontinued 10 to 15 years ago and practically all of the old drift mines have fallen in and the outcrops are largely covered by talus and debris. The beds mined were the No. 3 and No. 4, but sections of the beds are not available. Local prospectors, however, describe the No. 4 bed as the better of the two beds, averaging 25 to 30 inches of ore. A sample of ore taken from No. 4 bed in one of the old mines at Oreton and analyzed by the Union Iron and Steel Company showed metallic iron 44.90 per cent; silica 15.81 per cent; lime .22 per cent; and phosphorous .29 per cent. The rocks exposed near the slumped entrance of one of the old Oreton mines (loc. 801, el. 1,890 feet, B) show a dip of 20 degrees south 45 degrees east. The steep dip here brings the bed (No. 4) to an outcrop across the spur less than one-eighth of a mile up the slope from the old mine mouth. The bed at this outcrop was largely mined by surface stripping.

Two old mines were visited in Midway Hollow (loc. 802, el. 1,850 fee, B) which lies about midway between Oreton and Irondale. The mines were in the No. 4 bed, but the available ore from this bed has been so largely removed that it will probably never pay to mine what is left. The rocks here dip 15 degrees south 45 degrees east.

A number of caved prospect and mine pits (loc. 803, el. 1,900 to 1,950 feet, B) were seen in the next ravine to the northeast, called Sawmill Hollow, but the ore was not measured in place. Near the head of the next hollow, called Short Hollow, two pits were opened in the No. 4 bed and the ore body largely removed. The pits (loc. 804, el. 2,010 feet, B, and loc. 805, el. 2,150 feet, B) were caved, but the bed is clearly exposed for a long distance down the side of the hollow toward Wildcat Creek Valley and shows 20 inches of ore. The dip of the bed at the pit at loc. 804, is 9 degrees south 30 degrees east, and the dip increases uniformly approaching the mouth of the hollow.

The only ore that has been mined in recent years in Wise County has been taken from mines in the vicinity of Irondale and carried by tram-lines to a small tipple at Irondale for shipment to the blast furnace near Big Stone Gap. Numerous openings, principally in the No. 3 bed, have been made on the southeast slope of Wallen Ridge in the vicinity of Irondale. Old tram-lines are found in every ravine. The No. 3 bed here is a coarse, oolitic to pebbly ore, and is thicker and richer in iron than the fine-grained No. 4 ore.

The fork of the trail one-half mile north of Irondale marks the foot of an incline, 270 feet high (vertically) that is used to raise and lower tram cars from the lower level to the higher level system of tracks. The incline extends south 65 degrees west up the hill from the trail fork. The No. 3 bed outcrops conspicuously in the vicinity of this incline. Near the base of the incline a mine entry (loc. 806, el. 1,820 feet, B) was visited and 25 inches of ore was seen in place. The opening had only recently been abandoned and the tracks taken up. The No. 3 bed takes cover practically at the trail fork.

Several openings into No. 3 and No. 4 beds have been made at the highest points of their outcrop northwest of Irondale. Three old mines were driven into the No. 3 bed at loc. 807, el. 1,950 feet (B), but all are now abandoned. The ore in these mines averaged from 20 to 22 inches thick. These mines were opened 20 years ago and are the first openings made in Wise County from which iron ore was mined and shipped. The samples of the No. 3 ore taken for analysis and given in the table on page 552, were taken in small drifts now being worked between this location, No. 807, and the next location to be described, No. 808. At loc. 808, el. 2,235 feet (B), the ore has been recently mined from bed No. 3, 22 inches thick. The overlying No. 4 bed was mined to some extent at loc. 809 and loc. 810, but the pits were abandoned and caved.

On the northeast side of the main hollow north of Irondale several entries were driven into the No. 3 and No. 4 beds. At loc. 811, el. 1,890 feet (B) the No. 3 bed was prospected but the pit was caved and the ore not seen in place. The pit and adjacent rocks indicate that the bed had in part been mined by surface stripping. The rocks here dip 12 degrees due east. Both the No. 3 and No. 4 beds were opened at loc. 812, the No. 3 bed at el. 1,850 feet (B) and the No. 4 bed at el. 1,930 feet (B), but here again the bed is not exposed. The dip of the rocks at these pits is 8 degrees north 80 degrees east. None of the mines on this side of the hollow, however, have gone very far into the hill and almost the entire acreage of Clinton rocks (see geologic map) occurring north and northeast of Irondale and southeast of Big Stone Gap contain their beds of ore still practically untouched except for several small pits at the northwest and southwest edges of the field. This ore field is the only field of commercial importance in Wise County that remains to be developed.

Ore has been mined to some extent on the northwest slope of Wallen Ridge, particularly in the hollow followed by the trail from Irondale to Big Stone Gap. The bed mined most extensively is the No. 3 and much of the mining was carried on by surface cuts or stripping. Short entries were driven into the bed at several localities but they seldom went in as much as one-quarter of a mile. At loc. 813, el. 1,700 feet (B) the No. 3 bed was mined by stripping and short underground pits. The rocks at this location dip 12 degrees north 40 degrees east.

Near the head of the ravine and on the opposite side from location 813, the No. 3 bed was prospected and to a very small extent mined. Several caved pits were seen at loc. 814, el. 1,870 feet (B). The rocks here dip 9 degrees north 75 degrees east. About one-quarter of a mile to the northeast a large mine in the No. 3 bed shows a thickness of ore ranging from 25 to 30 inches. The mine (loc. 815, el. 1,740 feet, B) was caved a short distance back from the entry and apparently had not been used for many years. The entry is reported not to have been driven in over one-quarter of a mile. The No. 4 bed is reported prospected about 80 feet above the old No. 3 bed mine. Old workings in the No. 3 bed are found along the outcrop of that bed as far to the northeast as location 816, but all the pits are closed and mining in this vicinity is abandoned. Loc. 817, el, 2,100 feet (B) marks the highest of a series of old strip pits in the No. 3 bed south of Big Stone Gap.

Although mining has stopped on the north slope of Wallen Ridge much ore can still be obtained if the demand for iron ore is great enough. The ore, particularly of the No. 3 bed, is of good quality. A sample of this ore taken from an old mine in the vicinity formerly operated by W. E. Yeary, and analyzed by the Union Iron and Steel Company, contained the following: metallic iron, 42.34 per cent; silica 18.36 per cent; phosphorus .29 per cent; and lime .11 per cent.

MINING DEVELOPMENT.

HISTORY OF IRON ORE MINING IN WISE COUNTY.

The commercial importance of the Clinton ores of Wise County was first recognized in the early nineties when the building of the Louisville and Nashville Railroad and the present Southern Railroad into the field made the ore beds available for the mining and shipping of ore. The presence of the iron ore, in proximity to boundless supplies of coal and limestone, imparted all the flavor of an "oil boom" to the then growing town of Big Stone Gap and it was hailed as the second Pittsburgh of the east. The town was laid off in elaborate style, lots sold for enormous prices, and solid Pullman trains were run into the field from New York and Pittsburgh. An expensive hotel was erected to care for the influential visitors from the financial centers. The boom was short-lived, however, and it was not until ten years later, in 1902, that the only blast furnace in Wise County was erected by the Union Iron and Steel Company.

Ore was first mined in Wise County at the Irondale operation about the year 1892. The ore was then shipped to Rockwood and other points in Tennessee for reduction. The ore was mined by Kelly and Irving, of Big Stone Gap. Southeast of Short Hollow (see loc. 804) the ore beds were opened soon after the Irondale operation by the Keystone Coal and Iron Company, of Philadelphia, Pa. About the same time, W. E. Yeary opened the beds on the northwest slope of Wallen Ridge in sight of Big Stone Gap.

The production of iron ore in Wise County received an impetus in 1902 when the blast furnace at East Stone Gap was completed. From that time up to the recent suspension of iron mining in Wise County, the ore mined at Big Stone Gap, Irondale, and Oreton, was largely shipped to this furnace for reduction. No figures for the production of iron ore from Wise County have been kept but the total amount is only a very slight portion of the total State production of iron ore for the same period.

In the year 1920, the banner year for coal and coke, the value of the coke used to charge the blast furnace, plus operating expenses, exceeded the value of the pig iron produced and consequently the furnace was shut down and with it the ore mining. At the time of the suspension of the iron ore mining and production of pig iron, the Irondale mines and the blast furnace were being operated by the Intermont Coal and Iron Company, Big Stone Gap.

OUTLOOK FOR FUTURE IRON ORE DEVELOPMENT.

It might appropriately be said of the Wise County Clinton iron ore field that its period of greatest activity is past. The greater portion of its available ore has been removed or rendered unprofitable to mine by the abandonment of old workings and the caving of the entries. The field will never see in the future the large mining development that it has witnessed in the past for the very obvious reason that much of the surface and near-surface ore has been removed. The only large tract of ore-bearing rocks not mined out is about 200 acres lying east of location 812 and south of location 816, or due north of Irondale. In this tract the No. 3 bed excels in the thickness and quality of its ore and in the extent of its occurrence. The No. 3 bed ranges from 20 to 30 inches thick, and contains about 40 per cent metallic iron.

The fact that no figures are obtainable for yearly production in the past makes it hazardous to attempt to estimate the possible life of the field. The uncertainty of mining operations is also an important factor in the life of the field. Mining may not be resumed for one year or many years. A third and equally important factor is the variation in the quality of the ores. As the soft ore is mined out only the hard ore, which is relatively much less rich in iron, remains and will probably not be minable until iron commands a much higher price than at present. These are the chief factors to be taken into account in estimating the life of the field, and as they are so vague and poorly delimited, no estimate as to the life of the field can be given.

While the field has undoubtedly passed its prime it must not be thought that a considerable quantity of ore is no longer available. An estimate, which combines field observations with reported thicknesses of beds, sizes of mines, and extent of old operations, places the amount of ore still available in the No. 3 and No. 4 beds at 38,115,000 tons.[1] This is but an approximation, however, as much of the information upon which the estimate is based is not exact, but approximately exact, information. With this tonnage of ore available, Wise County may still mine Clinton ore for some time to come, but the field as a whole is of decreasing, not increasing, importance.

ORIGIN OF THE CLINTON IRON ORES.

The origin of the Clinton iron ores has been much discussed for many years and geologists still have reached no essential agreement. The point at issue is whether the beds of ore are deposits of sedimentation or are due to the replacement or alteration of beds of different character. The one side of the question postulates that the ores are of the same age as the enclosing rocks, the other side that they are younger than the enclosing rocks. Thus the theories offering to explain the origin of these ores naturally group themselves into those that predicate original deposition and those that predicate a subsequent origin. The chief opposing theories may be briefly described as follows:

1. Original deposition: The ores were deposited essentially as found today and are therefore of the same age as the rocks that enclose them.

2. Residual enrichment: The ore beds are the weathered outcrops of ferriferous limestones. The ground waters have leached out most of the lime, leaving the insoluble portion of the limestone relatively enriched in iron ore that was originally present.

3. Replacement: The ores are due to the replacement of limestone by iron brought in by percolating waters.

4. Alteration of glauconitic beds: The ores were deposited as beds of glauconite—a green sandstone of the composition of a hydrous silicate of iron and potassium, and altered by underground waters.

[1] This estimate is based on an assumed average thickness of 30 inches for each of the beds and that 12 cubic feet of the ore is equivalent to one ton of the ore (see Burchard, E. F., Red Ores of Eastern Tennessee, Tenn. Geol. Survey Bull. 16, 1913, p. 144). The total volume of ore per acre of a bed 5 feet thick is 217,800 cubic feet, which is equivalent to 18,150 tons an acre. The approximate available acreage of ore in Wise County is 2,100 acres.

5. Replacement of iron carbonate: The ore was originally deposited as iron carbonate and subsequently oxidized together with replacement of interbedded sandstone.

The theory of the original deposition of the bedded hematite deposits has long had strong adherents and much of the evidence produced by recent investigations strongly supports this theory. Among the principal advocates of the theory of original deposition are Prof. H. D. Rogers, Prof. J. S. Newberry, Dr. C. H. Smyth, Jr., Dr. J. T. Singewald, Jr., Prof. T. C. Chamberlin, E. C. Eckel, and A. O. Hayes.

Professor Rogers[1] regarded the ores

> ". . . as having originated, with other sedimentary materials, in the form of very extended but thin sheets of ferruginous matter."

He considered that the iron content was derived from the waste of surrounding rocks. There was, in his opinion, an additional deposition of iron from the overlying shale and a relative increase in the iron content in the bed due to weathering; hence his theory combines elements of the replacement theory with those of the theory of original deposition.

Professor Newberry[2] declared that the Clinton deposits were of marine origin and that the iron was derived from the drainage of the rocks to the northeast of the Clinton sea.

> "The chalybeate (iron-bearing) waters flowing from this shore," says Newberry, "apparently deposited the iron they carried in the form of minute concretions of hydrated sesquioxide, just as the 'mustard seed ore'—a granular or oolitic limonite—is now being deposited in some of the Swedish lakes which receive their drainage from ferruginous districts. While in transportation the iron was a soluble protoxide but by oxidation was rendered insoluble and precipitated. In the ages that have since passed these limonite granules have lost their water of combination, as the older limonites have done, and have been converted into red hematite or the anhydrous sesquioxide. They also became somewhat flattened by pressure so as to take the form of flaxseed rather than mustard seed, producing what is sometimes known as flax-seed ore."

Professor Smyth[3] presents a forceful argument for the theory of original deposition as opposed to that of replacement. As the substitution or

[1] Rogers, H. D., Ores of the Surgent (Clinton) series; Geology of Pennsylvania, Vol. II, 1858, pp. 127-729.

[2] Newberry, J. S., The Clinton Group; Geological Survey of Ohio, Geology, Vol. III, 1878, pp. 5-7.

[3] Smyth, C. H., Jr., American Jour. Science, 3d ser., Vol. XLIII, June, 1892, pp. 487-496.

——————: Die Hämatite von Clinton in den östlichen Vereinigten Staaten; Zeitsch. für prakt. Geologie, 1894, p. 304.

replacement theory postulates the derivation of iron from beds above the limestones that are replaced, Smyth examines these beds carefully and concludes that in cases where these overlying beds are composed of shale and sandstone, the derivation of the iron from them is plausible, but where the overlying beds are limestone this theory is scarcely tenable. Here the replacement theory requires that meteoric waters remove iron from the upper part of a limestone and deposit it lower down in the same or an adjoining limestone. Smyth remarks that,

> ". . . two chemical actions diametrically opposing each other are said to have taken place in a distance of a few feet in the same substance and under like relations, which is clearly impossible."

In support of this argument he points out the occurrence of Clinton ore in Dodge County, Wisconsin, and Wayne County, New York, where at the latter locality in particular, the granular ore is overlain by fossil ore and several feet of pure gray limestone. There is no gradual passage from ore to limestone as there should be if the ore were a replacement in the limestone. He further states that,

> "If the ore represents an oolitic limestone, each spherule has been altered from the outside toward the center. This alteration has been by the replacement of calcite by silica and iron carbonate. It would seem as though, after the exterior layers were thus altered, they must, to a greater or less extent, protect the interior layers from change, and that there would be some trace of original calcite. In no case has this been seen, even in the leanest ores, although the layers of silica and iron are often so dense and impervious that hydrochloric acid can not dissolve all the iron present."

Prof. T. C. Chamberlin[1] in discussing the so-called "Clinton" iron ores of Wisconson (now generally believed to be older than the Clinton ore), accepts the theory of original deposition and agrees with Newberry in ascribing an origin similar to that of the "mustard seed" ore of the Swedish lakes.

Singewald,[2] in discussing the origin of the Clinton iron ores of Maryland, presents strong evidence favoring original deposition for the lower Clinton iron ore of Maryland, and replacement for the upper ore beds. In part he says,

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[1] Chamberlin, T. C. The Clinton iron ore; Geol. of Wisconsin, Vol. I, 1873-1879, 179 pp.

[2] Singewald, J. T., Jr., Origin of Maryland Clinton Iron Ores; Md. Geol. Survey, Vol. IX, 1911, pp. 307-308.

"The two beds at the lower horizon are essentially a highly ferruginous sandstone. Fossils in these beds are rare. . . . If these beds were formed by the replacement of calcareous limestone one would expect to find fossils more abundant in them. Moreover, the uniform character of the lower bed affords the strongest evidence against replacement. Any iron solutions reaching this bed had to penetrate first the upper bed and then a parting of shale. One would expect this bed, therefore, to be greatly influenced by the thickness of the overlying ore bed and the thickness of the shale parting. Yet wherever observed, the replacement is complete. It is thus seen that the evidence for the lower Clinton iron ore in Maryland is all in favor of original deposition."

A particularly strong case is presented by Eckel[1] in favor of the sedimentary origin of the Clinton iron ores of Alabama. After a careful review of the theories then extant, he cites the following principal facts as supporting the theory of original deposition:

"1. In mining from slopes running down on the dip of the ore bed, when once the limit of surface weathering is passed—and this may be at any point from 1 to 100 feet below the outcrop—no further important change in the ore is found with increasing depth; though a number of mine workings are now close to 2,000 feet from the outcrop.

"2. A number of borings in Alabama have struck the ore at points from one-half to one mile back from the outcrop and at depths of 400 to 800 feet below the surface. The ore encountered in these borings was hard ore of the usual quality and not merely a 'ferruginous limestone.' Several borings in New York have struck Clinton ore at distances of from 10 to 15 miles back from the outcrop. These borings showed good hard ore at depths of 644 to 995 feet below the surface.

"3. The physical character of the oolitic ore can not readily be explained on any replacement theory, while the formation at the present day of original oolitic materials is a matter of common knowledge.

"4. The occurrence of fragments of the ore in overlying beds of limestone in the Clinton formation, as described by Smith,[2] points to the fact that the ore had been formed prior to the deposition of this limestone.

"5. If the replacement theory were accepted, one would expect that the ore beds would show a greater vertical range; that is, that

[1] Eckel, E. C., The origin of the Clinton iron ores, Bull. 400, U. S. Geol. Survey, 1910, pp. 28-39.

[2] Op. cit., p. 493.

they would at places occur in rocks of other than Clinton age. Throughout their entire extent the Clinton beds are closely associated with Silurian and Devonian limestones and shales, some of which offer excellent receptacles for replacement deposits, but the characteristic red ores are confined to the Clinton itself."

The bedded hematite deposits of Newfoundland, known as the Wabana iron ores, were studied in detail by Hayes.[1] The ores lie lower in the geologic column than the Clinton ores, being of Lower Ordovician age, but in physical and chemical characteristics they are similar to the Clinton ores. Hayes, after presenting many convincing arguments, comes to the conclusion that,

> "they are primary bedded ore deposits mined today in essentially the same condition, except for induration, faulting, and the addition of small amounts of secondary calcite and quartz in fault cracks, as when they were laid down."

In support of this conclusion he cites the fact that the beds are characterized by ripplemarked surfaces and cross-bedded layers and contain remains of animals which lived in shallow water. He likewise points out that there are no limestones present anywhere in the ore-bearing series of rocks and that the orignial calcium content of the ore, averaging about 2.5 per cent, is present in the form of fossil remains. Nowhere could he find evidence of the transformation of an oolitic limestone to an oolitic iron ore, or evidence that iron had concentrated since the original deposition of the ferruginous beds.

The theory of residual enrichment of leached limestones as applicable to the origin of the Clinton iron ores is practically discarded. This theory requires that all ore beds end as such below the ground water table changing into a thicker ferriferous limestone. This change is not found in deep mines and borings that have entered the ore far below the ground water level. Assuming that the ground water table may have been lower at some earlier time, another serious difficulty must be overcome to validate the residual enrichment theory,—namely, evidence of shrinkage of the original limestone beds is entirely lacking. As pointed out by Singewald,[2]

> "In the case of the upper ore in Maryland, the ratio of the iron to the iron in the underlying limestone is four to one; in the Stone Valley ores of Pennsylvania, it is fourteen to one. In the Birming-

[1] Hayes, A. O., Origin of the Wabana Iron Ore, Trans. Canadian Mining Institute, Vol. XVIII, 1915, pp. 225-246.

[2] Op. cit. p. 302.

> ham district, where the ore reaches a thickness of thirty feet the amount of shrinkage required becomes enormous. Any evidence of the structural effects such shrinkages would produce is lacking. Hence, we may safely rule out this theory."

Next to the theory of original deposition, the theory that has received widest attention is that of the replacement of limestone by iron brought in by circulating waters. The chief exponents of the replacement theory have been Prof. N. S. Shaler, Dr. August F. Foerste, James P. Kimball, Dr. J. J. Rutledge, Prof. L. Cayeux, and R. B. Earle.

In Professor Shaler's opinion the ores were not included in the present iron ore beds at the time of their deposition but that the ore occurrences are due to the replacement of limestone by iron-bearing waters which have derived their iron from overlying shales.[1] He explains his stand as follows:

> "It is evident from a study of the varied conditions under which the beds of this section were deposited that if the ore was laid down at the time when the beds were formed, then it must have been deposited under the most diverse conditions imaginable."

Since the beds in Kentucky must have formed at the bottom of a deep sea, he adds that,

> "a deposit of iron under such circumstances is impossible."

Doctor Foerste,[2] upon a microscopic examination of Clinton ores, found all stages of replacement by ferric oxide of the calcium carbonate amount of the ores and of the oolitic granule. He also brought out the fact that the oolitic granules did not manifest the spherical character of oolites of other geological ages and were not due to the concretionary segregation of the iron oxide, but to the gradual replacement of bryozoan fragments.

Kimball[3] considers replacement the origin of the Clinton ores of the Appalachians. He believes that,

> "all these ores owe their development exclusively to secular replacement of elevated parts of these limestones, not as sometimes explained, to direct sedimentation in whole or in part. For wherever oolitic iron ores are developed within the Clinton series they are found to graduate into non-ferriferous limestones, more or less crinoidal, and usually in

[1] Shaler, N. S., Notes on the Investigations of the Kentucky Geological Survey during the years 1873, 1874, and 1875, Vol. 3, Pt. III, 2d series, 1877, p. 36.

[2] Foerste, A. F., On the Clinton Oolitic Iron Ores, Amer. Jour. of Sci., 3d ser., Vol. XLI, No. 241, pp. 28-29, 1891.

[3] Kimball, J. P., Genesis of Iron Ores, Amer. Geologist, Vol. VIII, Dec. 1891, pp. 352-376.

> circumstances only moderately favorable to weathering action. An equally significant fact is the absence of valuable iron ores where the Clinton limestone, as in Southern Ohio, is massive and unaccompanied by a considerable thickness of overlying shales. Whenever, on the other hand, the limestone occurs in numerous thin beds and so alternates with more or less ferruginous shales, it seldom fails, especially in steep dips, to graduate unequally into oolitic hematite by replacement."

He further notes,

> "that the distribution of the Clinton iron ores clearly depends on secondary, and wholly adventitious conditions connected with topography and environment."

Doctor Rutledge[1] makes out a clear case for the replacement origin of the Clinton iron ores of Stone Valley, Pennsylvania. He finds that the ore bodies lie upon the sides of small ridges in conditions favorable to an easy and slow movement of meteoric waters and that the soft ores occur only where the adjoining shales had weathered to clays. More direct evidence of replacement was found such as tracing out a limestone bed until it becomes a bed of hard or soft ore and at one of the mines unreplaced limestone in the hard ore was found. Doctor Rutledge states that the iron content of the siliceous concretions is original but that it forms only a small percentage of the total iron content and that the iron oxide found in the calcite cement and forming coatings around the organic fragments, which represents the far greater amount of the iron in the ore, is there entirely by replacement of limestone.

Professor Cayeux,[2] in discussing bedded hematite deposits occurring in the Amoricain Peninsula, France, proposed the theory that these ores were the replacement products of oolitic limestones. He suggests the application of this theory to all the bedded Paleozoic hematite deposits.

Earle[3] has proposed a modification of the replacement theory under the name of the artesian replacement theory. He maintains that the Paleozoic bedded hematites, the Clinton ores in particular, are replacements of porous strata of ordinary mechanical sediments by iron oxide, the agency

[1] Rutledge, J. J., The Clinton Iron ores of Stone Valley, Huntington County, Pennsylvania; Dissertation, Johns Hopkins University, 1904.

——— Trans. Am. Inst. Min. Eng., Bi-Monthly Bull. No. 24, Nov., 1908, pp. 1070-1087.

[2] Cayeux, L., Les Minerais de Fer Primaires, Paris Impr. Nat. 1909, 4vo., viii + 344 pages.

[3] Earle, R. B., The Genesis of Certain Palezoic Interbedded Iron Ore Deposits; Ann. N. Y. Acad. Sci. Vol. XXIV pp. 115-170, August, 1914.

being iron-bearing waters acting under artesian flow. He cites numerous measured sections to show the porous ore bed adjoined at the top and bottom by beds of impervious clay or shale; thus forming artesian channels as runways. Earle comes to the following conclusions as regards the origin of the bedded hematite ores:

> "1. The Clinton strata were favorable for the deep penetration of surface water along well defined runways of porous rocks, protected top and bottom by impervious strata.
>
> "2. Iron-bearing solutions actually did penetrate these artesian slopes and were to a large extent responsible for the deposition of the Clinton hematites and other interbedded iron-ore deposits.
>
> "3. The strata were evidently marine but chiefly of a near-shore type, as shown by shallow-water conditions such as the accumulation of large deposits of fossil fragments, evidently broken to pieces by the action of shore waves and ocean currents.
>
> "4. Corals were found in sufficient number to indicate that conditions necessary for successful growth of the polyp, such as mild climate, shallow water, open sea, and lack of fresh water, must have existed."

Another theory on the origin of the Clinton iron ores to be reviewed here is that of the alteration of glauconite beds,—a theory first proposed for the Clinton ores in 1908, by S. W. McCallie,[1] State Geologist of Georgia. He shows that the condition under which the Clinton rocks were laid down were identical with those under which glauconite is now being formed on the sea bottom. The facts upon which he bases his arguments are, that under the microscope he found many of the iron ore sphurules to contain a yellow-greenish nucleus which he takes to be glauconite, and that a large number of chemical analyses of the ore show that its chemical composition is in harmony with this view. He states that the Alabama ore carries little glauconite near the outcrop, but a large amount of glauconite was revealed in a boring a half mile back from the outcrop and at a depth 800 feet. This theory is one that is possible but highly improbable and Singewald[2] attacks it in no uncertain terms as follows,

> "The Alabama region to which he refers in support of his theory offers the most conclusive evidence of its failure to explain the origin of the ores. The slopes of some of the mines in this district now exceed 1,800 feet in length, and have gone down to a depth of 650

[1] McCallie, S. W., Fossil Iron Ores of Georgia, Bull. 17, Geol. Survey of Georgia, 1908, pp. 185-194.

[2] Op. cit. 304-405.

feet. If the ore is formed by the alteration of glauconite, it is reasonable to expect that at such a depth there would still remain somewhere patches of the original bed which had not been altered. Yet not a single instance of such an occurrence has been reported and except for the single instance mentioned by McCallie, no increase in the quantity of the green nuclei has been noted by any of the workers in this field."

The theory of the oxidation of iron carbonate ore accompanied by the replacement of some of the interbedded sandstone is proposed by G. W. Stose,[1] of the U. S. Geological Survey, to apply to some occurrences of the Clinton hematite deposits. Mr. Stose bases his theory on evidence obtained during field work in Wise County, Virginia, while mapping the pre-Pennsylvanian rocks. In his own words, Mr. Stose describes his observations and conclusions as follows:

"The generally accepted explanation of the origin of the Clinton hematite iron ores of New York and the Appalachians is that they were originally deposited as ferric oxide with the other sediments. The finding of ore composed of carbonate of iron in the deeper workings of the Irondale Mine, Wise County, Va., therefore, is of considerable interest and importance in unravelling the origin of the ore.

"The upper (No. 4) iron ore bed is generally composed of hematite enclosing numerous crinoid stem segments, Ostracods, gasteropods, and brachiopods which have been replaced by iron oxide, similar to the fossil ore from Georgia, illustrated in Pl. XXXIV A. The lower (No. 3) bed is generally composed of thin layers of oolitic to pebbly hematite ore containing some fossils, interbedded with fine-grained dense hematite ore. (See Pl. XXXV B.) The pebble layers enclose large pebbles of red hematite, up to 5 inches in longest diameter. (See Pl. XXXIII b, c.) These pebbles contain molds and casts of replaced fossils, have a bedded structure, and are generally flattened parallel to the bedding, showing that they were derived from fragments of sedimentary beds of similar character. Their surfaces, although finely pitted, are otherwise smooth and rounded. That fragments of soft hematite, such as the pebbles are now composed of, could be worn so smoothly rounded seems unlikely. Such pebbles could better be formed from harder material, such as carbonate rock.

"Some of the ore brought from tunnel workings at considerable depth below the surface is a gray, hard, bedded rock composed of carbonate of iron and containing scattered grains and small pebbles of quartz and replaced fossils. This rock is exactly similar in structure to the pebbles of hematite

[1] Personal communication.

in the surface ore and is believed to be the material from which these pebbles were derived. Some of the ore is a conglomerate of rounded gray pebble-like masses composed of dense, nearly pure carbonate of iron inclosed in quartz sand. These pebbles were undoubtedly derived from concretions of carbonate of iron in the bedded rock. This rock was apparently temporarily exposed to erosion, and pebbles of the bedded carbonate rock and of the concretions were re-deposited with rounded grains and pebbles of quartz, forming thin beds of conglomerate in sandstone. The flat carbonate pebbles are tilted at various angles in the conglomerate. It is definitely established, therefore, that at the Irondale mine in Wise County the original ore is a sedimentary carbonate of iron containing quartz grains and pebbles and a conglomerate composed of small quartz pebbles and larger pebbles of hard concretionary iron carbonate. Although no oolitic ore was observed in the material from the deeper workings, it is probable that such oolites were also originally carbonate of iron deposited in concentric layers around quartz nuclei.

"In the zone of circulating ground water, the carbonate ore is oxidized to hematite by carbonated waters descending from the surface, and ferruginous solutions derived from the ore layer penetrate the adjacent rock and partly replace it. Various stages of replacement have been observed in specimens obtained from the Irondale mine. The sandstone immediately adjacent to the pebbly layers, which is first permeated by the solutions, is generally completely replaced by hematite, forming a layer of solid dense hematite ore. This grades through ferruginous sandstone into iron-stained sandstone and ultimately into unaltered sandstone farthest from the pebbly layer. Upon complete oxidation of the ore the whole may be converted into alternate layers of dense hematite and fine pebbly hematite (see Pl. XXXV).

"These observations lead the author to the conclusion that the hematite ore in the Clinton formation at the Irondale mine, if not throughout Wise and Lee counties, Va., was originally deposited as a carbonate of iron; that the iron carbonate was changed to ferric iron oxide in the zone of groundwater, and not only were the carbonate bed rock and pebbles changed to hematite but hematite replaced to a greater or less extent the adjacent sandstone, converting it in places into a dense hematite. The present form and richness of the ore at the surface is therefore due largely to the oxidation of thin layers of carbonate ore and the replacement of interbedded sandstone. Although the finding of carbonate ore at one mine is insufficient to warrant a sweeping conclusion that all Clinton hematite ores were originally deposited as carbonate of iron, the difficulty of explaining the conditions under which ferric iron would be deposited as a sediment in nature, especially in the form of concentric layers in oolite is so largely removed if the iron were deposited in a carbonate, that this theory will be welcomed by many. Further study in other regions may establish the fact that the original form of hematite ore beds is carbonate of iron is not restricted to the deposits at Irondale."

The diversity of opinion shown by the above quotations regarding the origin of the Clinton iron ores arises from the attempt to apply one theory to all occurrences of such ores. In one locality the evidence points clearly to replacement of limestone. As indicated in the above outline, however, the trend of present opinion is all on the side of original deposition of the Clinton and similar ores, with replacement of limestone an important factor in localized areas.

The evidence of the Wise County Clinton iron ores points to orignal deposition with very slight subsequent replacement or impregnation along the contacts of the adjoining beds in the zone of oxidation. Limestones are entirely absent in the Clinton formation in Wise County and if the ores are replacements of limestone it would mean that the replacement would have to be one hundred per cent complete within the entire formation, which is possible but not probable. Calcareous greenish shales, which on analysis show from two to four per cent of lime (CaO), overlie the important ore beds in this region and show remarkably regular contact zones between the ore and the shale. By regular contact zones is meant that the thickness of the ore bed is constant and that the ore at its upper limit grades uniformly from pure ore to pure shale in a vertical distance ranging from a fraction of an inch to a few inches. This indicates, first, that the greenish shale could not be the material replaced by ore if the replacement theory holds, and, second, that a small amount of replacement or impregnation of the green shale did take place locally along the contact of the shale with the ore. Many mine drifts have been driven in from 100 to 200 feet showing the above conditions to hold for the upper contact zone. These entries likewise show that the ore is unusually uniform in character and quality, a fact that militates against replacement.

Under the microscope, in thin sections, specimens of the Irondale ore showed that the oolites consist of coatings of hematite about rounded quartz grains as nuclei. The hematite coatings may have been deposited as siderite or carbonate but none was seen. However, as only the soft or oxidized ore was examined it is to be expected that carbonate was not present. The oolites are cemented together by amorphous hematite and to a less extent by yellow-stained calcite. No fossil fragments were found serving as nuclei for the oolites. The orientation of the flax-seed-like oolites. with their flattened sides parallel to the bedding plane, is a strong indication that the oolites themselves are of sedimentary origin. The conclusion, therefore, in regard to the origin of the Clinton iron ores of Wise County is that these beds are essentially of original deposition, with minor addition of iron oxides by circulating iron-bearing waters.

The problem of the origin of the Clinton iron ores has a definite bearing on the mining development of these ores. If the beds are of original deposition, it means they can be expected, though not necessarily, of course, to hold their general character for depths below the zone of oxidation or for indefinite distances back from an outcrop. On the other hand, if the ores owe their origin to the residual enrichment of ferriferous limestones, the distribution of ore of economic value may be very limited. In the first case a new mine entering the bed has the potential prospect of extensive operation, but in the second case it is limited to working the enriched ore of the oxidized zone. The general experience of mining operations in the Clinton ores has practically established their sedimentary origin and the problem has now largely resolved itself from one of primarily economic importance to one of primarily scientific interest.

STONE AND CLAY

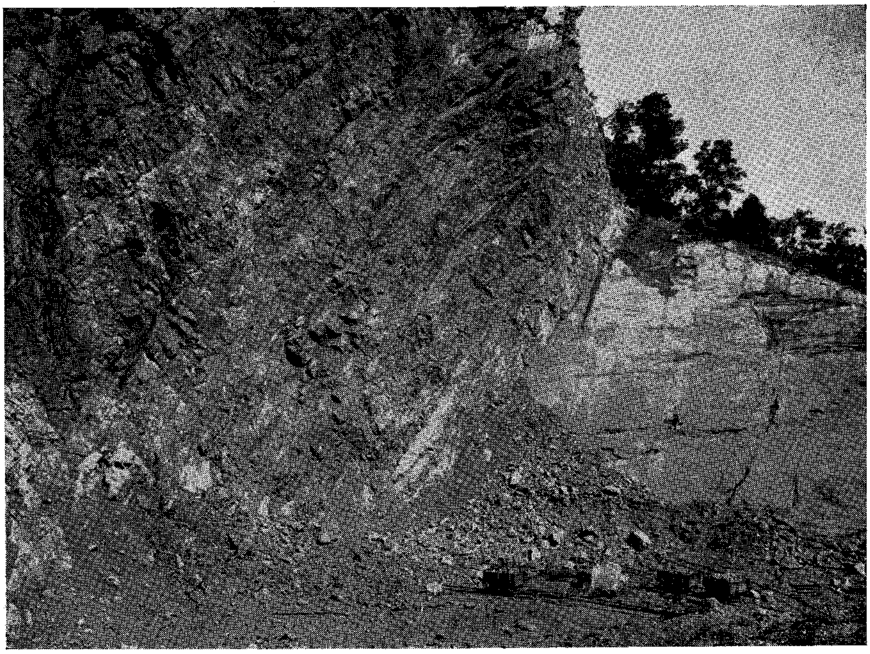
STONE.

Sandstone and limestone are the two common types of stone outcropping in Wise County. Both serve many useful purposes; the sandstone for building, road foundation, ballast and a source for pure sand, and the latter for building, a road metal, a flux for iron ores, and a source for lime. Beds of sandstone are found throughout the geologic column, whereas the limestone beds lie wholly beneath the strata of the coal measures. The limestone outcrops exclusively within Powells Valley or its vicinity, and various points along the Hunter Valley fault.

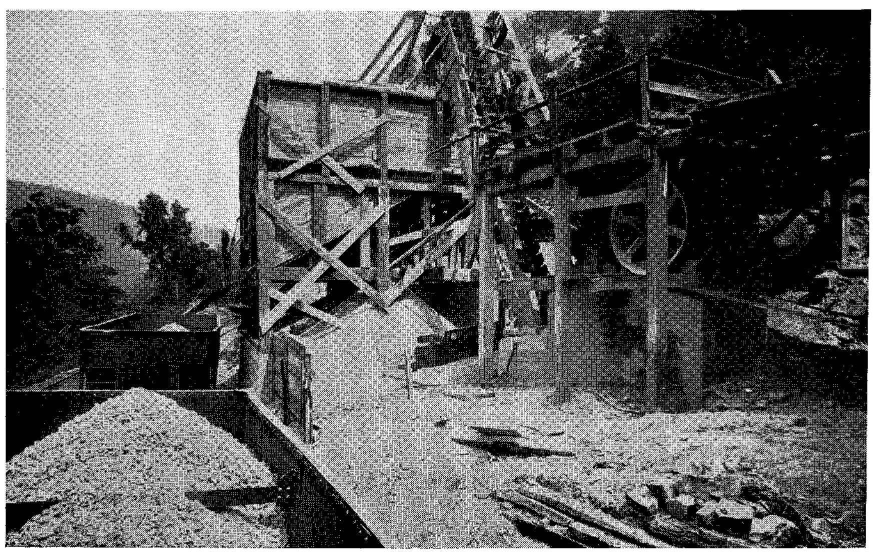
The most valuable beds of sandstone in the county are found in the pre-Carboniferous rocks, or below the coal-bearing strata. They occur at the top of a mass of sedimentary beds representing the Maccrady shale and Price sandstone. The sandstones lie in two beds separated by about 300 feet of shale. The upper bed is a fine-grained, compact, reddish-brown, stone that makes a very desirable building stone. The lower bed is equally fine-grained and compact, but possesses a pale green color. This stone likewise makes an excellent building stone and has been used locally to a large extent. The colors of both sandstones permit of many pleasing decorative effects, and have been used for that purpose in several of the larger homes and public buildings of Big Stone Gap.

The brown sandstone, or as locally called, "brownstone," has a uniform thickness of 30 feet and lies about 60 feet beneath the great mass of limestone known as the Newman limestone. The "brownstone" has been quarried at its exposure on the southeast side of the Big Stone Gap, but practically never except for use within the county, although shipping facilities are close at hand, in the Appalachia division of the Southern Railway.

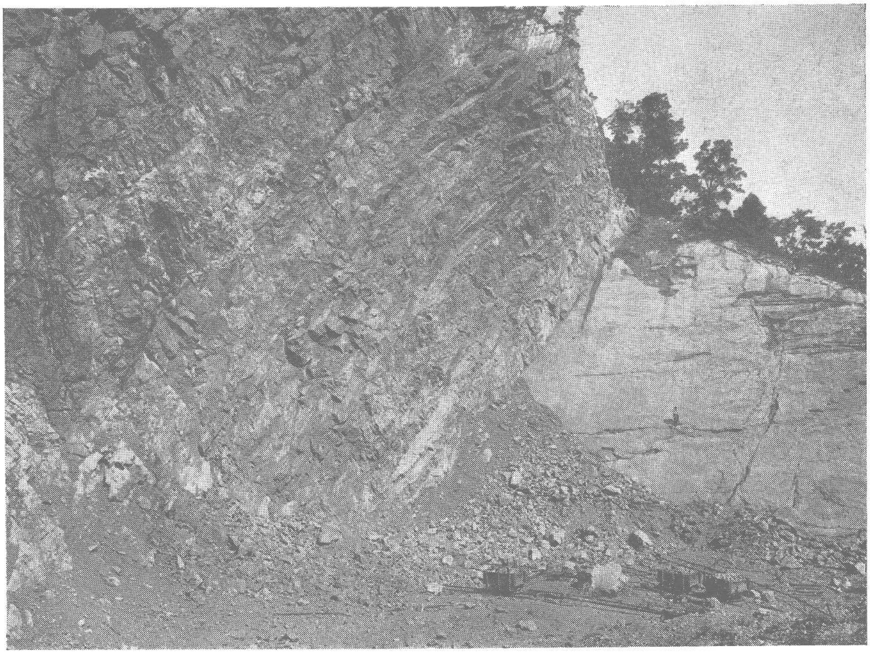
The "brownstone" and "greenstone," as the green sandstone is locally known, possess an extraordinary hardness. The result of a series of compressive strength tests conducted by the United States Bureau of Standards reveals a hardness for these stones that excels by a wide margin many of the granites and marbles of other regions, and that more than doubles many of the sandstones of other States. The results of these tests are given in Table I on pages 572 and 573.



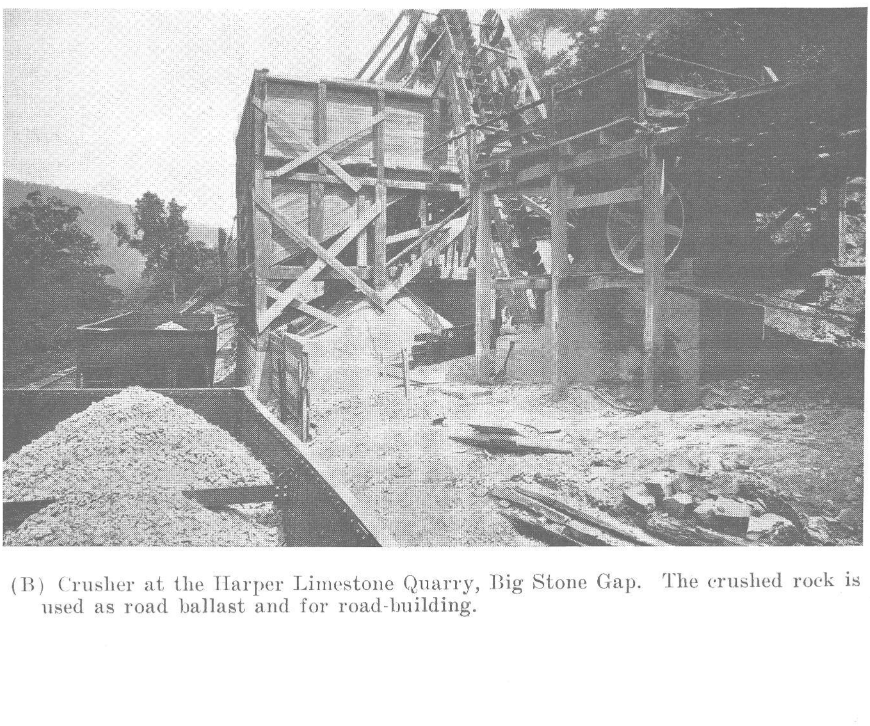
(A) Newman limestone in Harper Quarry at Big Stone Gap. The bed dips as high as 60 degrees to the north, having been tilted up in the arching of the Powell Valley anticline.



(B) Crusher at the Harper Limestone Quarry, Big Stone Gap. The crushed rock is used as road ballast and for road-building.



(A) Newman limestone in Harper Quarry at Big Stone Gap. The bed dips as high as 60 degrees to the north, having been tilted up in the arching of the Powell Valley anticline.



(B) Crusher at the Harper Limestone Quarry, Big Stone Gap. The crushed rock is used as road ballast and for road-building.

It will be noticed that, with the exceptions of Nos. 16 and 17, all of the crushing strength tests given were performed by the same organization, under similar and standard conditions, and the results are therefore, thoroughly comparable. In general the specimen crushed was a carefully cut 2 or 3-inch cube, which was prepared from a field sample of approximately a cubic foot. For a detailed description of the processes involved in determining the crushing strength of stones, reference should be made to Technologic Paper No. 123 of the U. S. Bureau of Standards, July, 1919, by D. W. Kessler. This report presents the results of crushing tests on 50 commercial marbles of the United States, from which Nos. 28 to 36, inclusive, in Table I, have been extracted and given with the Wise County stones for comparison. It is remarkable to note how closely the Wise sandstones correspond in hardness with many of these famous building stones.

The compressive strength tests of the Wise County stones, including the three limestone samples, were made on 3-inch cubes. Some of the cubes were tested with the bedding plane of the stones parallel to the plane of the crushing plates, which results are given under the column "On bed," whereas other cubes were tested with the bedding plane of the stone at right angles to the plane of the crushing plates, which results are given under the column "On edge." A few tests were made on specimens after soaking in water for 30 days. The results, briefly stated, are that all fine stones show high strength and low absorptive values, two facts which greatly enhance their value as building stones.

The sandstones of the coal measures occur in massive beds but are poorly adapted for building purposes. They are usually coarse-grained stone, with conchoidal fracture, and a displeasing gray color. A greater defect is the rapid staining of the stone on weathering, due to the presence of oxides of iron, a fault that is almost universal with sandstones of the coal measures. The stone, however, is largely used in foundations, retaining walls, abutments, fences, and ballast.

The limestones of Wise County are quarried at several points near Big Stone Gap, the largest quarry being that of Simpson and Crawford, one-eighth mile north of Big Stone Gap (see Pl. XXXVI A and B). This quarry has been in operation over 30 years and thousands of cubic yards of stone have been removed. It is called the Harper Quarry. During the summer of 1920 the average daily output of stone was 150 tons, when railroad cars were available. The stone was crushed and screened, producing sizes from 3 inches to 3/4 of an inch, and was being used for road ballast and concrete rock (see Pl. XXXVI B).

Table I—Compressive strength tests, absorption, specific gravity and weight per cubic foot of commercial stones.

Reference No.	Laboratory No. U. S. Bureau of Standards.	Locality and type of stone.	No. of stone samples averaged.	Compressive strength.								Percentage of water absorption.			Apparent specific gravity.		Weight of dry stone per cubic foot.
				Dry.				Wet.									
				On bed.		On edge.		On bed.		On edge.							
				No. of tests.	Pounds per square inch.	No. of tests.	Pounds per square inch.	No. of tests.	Pounds per square inch.	No. of tests.	Pounds per square inch.	No. of tests.	Average by weight.	Average by volume.	No. of tests.		
1	46404	Sandstone, green, called "Greenstone," near Big Stone Gap, Va.	1	2	21,982	2	25,024	1	17,350	......	....	3	1.53	3.94	3	2.58	161.2
2	46405	Limestone, compact, Harper Quarry, Big Stone Gap, Va.	1	2	24,052	1	13,559	2	14,848	......	....	3	0.30	0.81	3	2.74	171.2
3	46406	Limestone, compact, Harper Quarry, Big Stone Gap, Va.	1	1	24,750	2	28,590	1	26,480	......	....	3	0.32	0.88	3	2.73	170.6
4	46407	Limestone, fossiliferous, south of High School, Big Stone Gap, Va.	1	2	21,818	2	18,028	1	12,380	......	....	3	0.51	1.41	3	2.68	167.5
5	46408	Sandstone, brown, near Harper Quarry, Big Stone Gap, Va.	1	2	24,256	2	19,612	1	18,218	......	....	3	2.09	5.37	3	2.57	160.6
6	7889	Sandstone, Kettle River, Minn...	1	2	9,353	2	8,808	2	6,488	2	7,696	4	4.18	9.30	4	2.23	139.0
7	7893	Sandstone, Split Rock, Ohio....	1	2	10,854	2	7,898	2	6,977	2	7,236	4	5.72	12.52	4	2.19	137.0
8	7894	Sandstone, Spider Rock, Ohio...	1	2	8,923	2	6,692	2	3,395	2	3,187	4	6.44	13.81	4	2.14	134.0
9	8292	Brownstone, Hummelstown, Pa.	1	2	12,869	2	9,342	2	9,419	2	11,592	4	2.82	6.58	4	2.33	146.0
10	8875	Sandstone, Lacyville, Pa.......	1	2	15,159	2	15,692	2	9,264	2	11,010	4	1.12	2.94	4	2.62	164.0
11	6120	Sandstone, Potsdam, N. Y.......	1	2	21,062	2	19,925	2	15,810	2	8,836	4	1.90	4.76	4	2.50	156.0
12	7141	Sandstone, Egg Harbor, N. Y...	1	2	14,378	2	12,003	2	10,532	2	8,334	4	2.44	6.03	4	2.48	155.0
13	40592	Granite, Mt. Airy, S. C.........	1	3	18,902	......	....	......	....	......	....	3	0.25	....	3	2.64	165.0
14	41985	Granite, Rion, S. C.............	1	3	25,140	......	....	......	....	......	....	3	0.29	....	3	2.64	165.0
15	11564	Granite, Bethesda, Md..........	1	3	20,476	......	....	3	16,902	......	....	3	0.14	....	3	2.70	169.0
16	†	Granite, Port Deposit, Md.......	1	......	19,750	......	13,100	......	....	......	....	......	....	....	......	2.72	170.0
17	‡	Granite, Barre, Vt.............	1	......	19,957	......	....	......	....	......	....	......	....	....	......	2.62	166.8
18	19851–56	Limestone, Indiana, Grade AA§.	6	12	6,525	12	6,320	12	6,148	12	5,931	48	5.52	12.32	24	2.24	140.0
19	19857–73	Limestone, Indiana, Grade A....	17	34	7,426	34	6,743	34	6,837	34	6,290	131	4.75	11.14	62	2.30	144.0
20	19874–86	Limestone, Indiana, Grade B....	13	26	6,251	26	5,455	26	6,260	26	5,458	100	4.97	11.27	47	2.28	142.0
21	19887–96	Limestone, Indiana, Grade C....	10	20	5,954	20	5,333	20	5,607	20	5,089	77	5.36	12.13	40	2.27	142.0
22	19897–05	Limestone, Indiana, Grade D....	9	18	8,519	18	7,121	18	7,655	18	6,781	72	4.26	9.86	35	2.32	145.0
23	19906–09	Limestone, Indiana, Grade E....	4	8	7,093	8	6,064	8	6,889	8	5,951	12	4.28	9.87	12	2.35	147.0
24	19910–17	Limestone, Indiana, Grade F....	8	16	7,319	16	6,328	16	6,656	16	5,792	39	4.70	10.82	32	2.31	144.0
25	19918–20	Limestone, Indiana, Grade G....	3	6	7,962	6	6,708	6	7,642	6	6,623	14	3.98	9.28	12	2.33	146.0
26	19921–22	Limestone, Indiana, Grade H....	2	4	12,769	4	13,080	4	10,417	4	10,036	14	3.60	8.52	8	2.40	150.0
27	3942	Verd Antique, Vermont Marble Co., Roxbury, Vt.	1	2	24,414	2	20,383	2	23,682	2	13,878	4	0.131	0.366	4	2.79	174.6
28	3943	Marble, Oriental, Vermont Marble Co., Swanton, Vt.	1	2	28,132	2	29,526	2	24,765	2	24,765	4	0.073	0.206	4	2.83	177.1

Table I—Compressive strength tests, absorption, specific gravity and weight per cubic foot of commercial stones.—Contd.

Reference No.	Laboratory Number U. S. Bureau of Standards.	Locality and type of stone.	No. of stone samples averaged.	Compressive strength. Dry. On bed. No. of tests.	Pounds per square inch.	Dry. On edge. No. of tests.	Pounds per square inch.	Wet. On bed. No. of tests.	Pounds per square inch.	Wet. On edge. No. of tests.	Pounds per square inch.	Percentage of water absorption. No. of tests.	Average by weight.	Average by volume.	Apparent specific gravity. No. of tests.		Weight of dry stone per cubic foot.
29	10206	Marble, Burlington Marble Co., Burlington, Vt.	1	1	19,415	1	31,017	1	25,079	2	18,676	3	0.053	0.151	4	2.84	177.7
30	10208	Marble, Burlington Marble Co., Burlington, Vt.	1	2	50,205	1	44,470	1	28,906	1	36,156	3	0.030	0.085	4	2.84	177.6
31	3483	Marble, White Beaver Dam. Beaver Dam Marble Co., Cockeysville, Md.	1	2	21,622	2	20,970	2	20,861	2	19,601	3	0.091	0.260	3	2.858	178.6
32	3936	Marble, Mar Villa, Beaver Dam Marble Co., Cockeysville, Md.	1	2	12,658	2	14,241	2	12,704	2	12,459	4	0.138	0.295	3	2.858	178.6
33	3234	Marble, Virginia Marble and Stone Co., Harrisonburg, Va.	1	1	27,390	2	25,682	2	29,416	2	28,559	2	0.054	0.146	3	2.720	170.0
34	3235	Marble, Virginia Marble and Stone Co., Harrisonburg, Va.	1	2	22,624	2	22,003	1	15,061	2	13,240	4	0.016	0.043	4	2.716	169.8
35	2634	Marble, Victoria Marble Co., Knoxville, Tenn.	1	3	17,077	......	....	2	17,214	......	....	3	0.065	0.175	3	2.703	168.9
36	2643	Marble, Royal Marble Co., Knoxville, Tenn.	1	3	17,664	......	....	3	16,892	......	....	3	0.037	0.100	3	2.707	169.2

†Gillmore, Q. A., Ann. Rep. Chief of Engineers, 1875.
‡20th Ann. Rep. U. S. Geol. Survey, Part 6, p. 447.
§The grades of Indiana oolitic limestone are as follows: (G. F. Loughlin, U. S. Geological Survey.)

AA.—Especially fine and uniform grain stone, particularly adapted to carving and other ornamental work. The stone occurs in considerable quantity only in a few of the many quarries of the Indiana district and for general purposes is omitted from the list of grades.

A.—Grade A or select stone is fine and reasonably uniform grain with only occasional small holes (hollow shells) or glassy spots (shells filled with glassy calcite). From a distance of three or four yards the bedding panes are not very conspicuous and the general texture appears uniform.

B. Grade B or standard stone consists of alternating fine and medium grain layers which make the bedding very distinct from a considerable distance and which, after prolonged weathering, present a somewhat roughened surface because of the larger grains or shell fragments remaining in relief whereas the finer and more oolitic grains have been weathered to a depth of a sixteenth of an inch or less.

C.—Grade C or rustic stone is prevailingly coarse grain and the bedding is even more distinct than in grade B.

D.—Grade D or select gray stone is generally similar in texture to grade A, but has a bluish gray color. The buff varieties are the oxidized equivalent of the bluish gray and are quarried in the upper parts of the formation. Grade D or standard gray stone is equivalent to grade B.

Grades E and F are select and standard variegated stone, each block of stone being in part bluish gray and in part buff in color.

Grade H includes stone of unusual hardness and in texture may be classified as marble whereas the other grades are relatively porous stone.

This limestone, the Newman, has in some few cases been used as a building stone. It is extremely hard, as shown in Table I under Nos. 2 and 4, more than tripling the strengths displayed by the majority of the Indiana limestones. The Newman limestone, in fact, is harder than many granites and commercial marbles. The specimens of the Wise County Newman limestone were cut from large boulders of the stone found a short distance east of the quarry and near the outcrop. The purpose of avoiding the quarry in selecting samples was to prevent obtaining specimens that may have been fractured by the repeated blasting in the quarry.

The stone is very easily "tooled" and takes a highly lustrous polish. The color of a typical hand-specimen of the stone, after polishing, is deep gray, a color not usually very satisfactory for either interior or exterior decoration. The extreme hardness of the stone, its ease of cutting, its ability to take a high polish, its occurrence in unlimited supply, and its accessibility, are among the features that fit this limestone for building purposes. The use of this stone for interior work, however, is greatly restricted by its rather uninviting gray color.

Two beds of limestone having large exposures in Wise County occur beneath the Newman limestone. Approximately 2,000 feet stratigraphically beneath the Newman is found a 100 foot bed of limestone called the Cayuga, while somewhat over 2,500 feet below this bed occurs the Catheys limestone. These beds are brought to the surface in Wise County by the bowing up of the Powell Valley anticline and the subsequent erosion of its crest.

The Cayuga limestone (in previous reports called Hancock limestone) has been quarried for many years near the blast furnace at East Stone Gap, to furnish flux in reducing the iron ores. The bed is very fossiliferous and the limestone is well crystallized. Near the top of this bed there occurs a thin stratum of exceptionally hard limestone that has been used locally to a large extent for building. The stratum varies from 4 to 8 feet thick and has been called the hardest stone in the county. Specimen No. 4 in Table I is a sample from this stratum, and as indicated, is an unusually hard stone.

Chemical analyses of limestone from the three formations show that the stone of all three is relatively pure and has great agricultural value, either as lime or ground limestone. Table II gives the results of analyses of two samples each from the three formations. The Newman and Catheys limestones average 90 per cent pure limestone, whereas the presence of considerable magnesia lowers appreciably the pure limestone content of the

Cayuga rock. The purity of these limestone masses, and their proximity to the coal fields and railroad connections, makes the Powell Valley region, at Big Stone Gap, ideal for the location of cement plants.

Analyses of the Newman limestone in Tazewell County are given in Table II for comparison with the Wise County analyses.

Table II—Analyses of Newman, Cayuga and Catheys limestones.

(Chemical Laboratory, U. S. Geological Survey.)

	I	II	III	IV	V	VI
Insoluble siliceous matter	6.94	5.02	2.80	2.02	6.04	9.04
Iron and aluminum oxides	0.80	0.46	0.54	0.08	0.64	1.34
Calcium oxide	50.74	51.64	41.34	49.32	50.00	46.00
Magnesium oxide	0.49	1.24	10.79	4.61	2.19	3.39
Carbon dioxide (calculated).	40.42	41.93	44.25	43.78	41.69	39.85
Total	99.39	100.29	99.72	99.81	100.56	99.62
Pure limestone ($CaCo_3$) (calculated).	90.56	91.91	75.76	88.02	89.23	82.09

I. Catheys limestone, Lee County, ¾ mile south of Elk Knob; weathered fragments collected near middle of exposure, near stream forks.
II. Catheys limestone, Lee county, ¾ mile south of Elk Knob; collected from ledge in place, north valley elevation 2,300 feet (B).
III. & IV. Cayuga limestone, Big Stone Gap; samples collected from ledge exposed on old road ⅛ mile east of High School.
V. Newman limestone, Simpson and Crawford Quarry, Big Stone Gap. Crushed limestone screenings.
VI. Newman limestone, Simpson and Crawford Quarry, Big Stone Gap; fragments from quarry cars loading limestone.

Analyses of Newman limestone.[1]

(Penniman and Brown, Analysts.)

	I	II	III	IV	V	VI
Insoluble siliceous matter	6.68	6.56	4.27	6.13	6.53	7.91
Oxide of iron	0.59	0.32	0.32	0.48	0.40	0.24
Alumina	0.36	0.38	0.18	0.20	0.26	0.63
Lime	49.14	50.75	51.94	51.87	61.45	48.51
Magnesia	2.27	0.93	1.18	0.40	0.44	2.13
Pure limestone (calculated).	87.54	90.62	92.75	92.62	91.88	86.62

I. Crockett Cove; three thin beds in lower 100 feet of formation.
II. Crockett Cove; 50-foot bed 200 feet above base of formation.

[1] Harnesberger, T. K., The Geology and Coal Resources of the coal-bearing portion of Tazewell County, Va., Bull. No. XIX, Va. Geol. Survey, 1919, p. 11.

III. Crockett Cove; 100-foot bed 150 feet below top of formation.
IV. Horsepen Cove; 40-foot bed at top of formation.
V. Horsepen Cove; 50-foot bed 150 feet below top of formation.
VI. Railroad cut, 1½ miles northeast of Cedar Bluff; 40-foot bed.

CLAY.

Beds of clay are found at several horizons in the Pennsylvanian series of rocks but are rarely of sufficient thickness, purity or extent to offer encouragement for economic development. As the nearest brick plants to Wise County are those at Rose Hill, in Lee County and Richlands in Tazewell County, a bed of clay suitable for brick material and extensive enough to permit the establishment of a plant would be a valuable asset to the county.

One of the largest clay beds noted in the Pennsylvanian rocks during the survey of Wise and Scott counties occurs on the Corder farm 4½ miles south of Coeburn and 6 miles north of the Carolina, Clinchfield and Ohio Railroad. A bed of clay is found here averaging 4 feet in thickness and covering 90 acres. The clay lies beneath 2 feet of black soil which makes the surface of a flat poorly drained plain. The bed is sandy in the upper two feet. Samples of the clay taken from the middle of the bed were sent to the United States Bureau of Standards, Pittsburgh, Pa., to determine its refractory properties and its economic value. Two reports on the clay were returned by the Bureau of Standards, the first as follows:

> "This material is of a very sandy character, although it possesses sufficient plasticity to be worked. When worked up it required 23.04 per cent of water for proper working quality. In drying, it showed a shrinkage of 12.79 per cent in terms of the original volume. When fired to a temperature corresponding to standard cone No. 3, it showed an expansion of .6 per cent. This expansion increased to 2.03 at cone 6, and 5.12 at cone 9. The color of the clay fired to cone 9 is a very clean buff free from any discolorations. No evidence of vitrification is shown and the structure is still very porous. It appears that it is impossible to vitrify this material within reasonable kiln temperatures. The mechanical strength of the specimens was comparatively low as is to be expected. It is evident that the material being of a very sandy nature is lacking in clay binding material. When admixed with a fatter clay the combination should be a very desirable one. The clay by itself would be suited for fire-proofing, but is not adapted for the manufacture of building or face bricks, paving brick, sewer pipe, hollow tile, etc., for the reasons stated above, viz., its extremely sandy character and lack of mechanical strength."

The second report submitted by the Bureau of Standards supplements the first as follows:

> "The sample was found to be very sandy and but slightly plastic so that it offers some difficulty in molding. The content of water plasticity was found to be 28.59 per cent and a drying shrinkage of 15.77 per cent in terms of the dry volume. When fired to cone 1 the porosity was 33.25 per cent and the volume shrinkage 2.41 per cent in terms of the dry volume. At the temperature corresponding to Cone No. 3 the porosity was 32.82 per cent and the firing shrinkage 4.59 per cent. At cone No. 5 the porosity was 30.96 per cent and the shrinkage of 4.91 per cent. At cone No. 8 the porosity was 25.34 per cent and the burning shrinkage 10.52 per cent.
>
> "The color of the specimens was a light brown which blended to a pale brown at cone No. 8. From these results it would appear that the clay is of a very siliceous nature and can not be fired to a vitrified structure. The material could be used for the manufacture of common bricks though its working qualities operate against the use of the auger machine. The so-called soft mud machine would probably mold the clay into bricks most satisfactorily. The color of the fired clay is not disagreeable, in fact, somewhat unique in differing from the usual red color. No discoloration was observed nor did the clay offer any difficulty in drying."

Briefly summarized, the foregoing reports show the clay to be highly refractory, somewhat sandy, but capable of producing brick of usable strength and unique color. The clay of the upper half of the bed would not be usable, however, unless mixed with less sandy clay, for example with the lower clay. Assuming the clay bed maintains its character and thickness over the entire 90 acres of its extent, the bed could furnish approximately 387 million bricks (8½″ x 4″ x 2″). The bed could not be worked, however, unless railroad or tram-road connections were made between the field of its occurrence and the main-line railroads.

Three-quarters of a mile west of Fairview school on Sandy Ridge a plastic clay is found in considerable quantity but in more erratic occurrence.

The beds lying within the first 40 feet below the Gladeville sandstone consist largely of lenticular bodies of sand and clay mostly white or gray but in some places containing zones stained by ferric oxide. The material varies all the way from a medium grained slightly cemented sand to a very fine plastic clay. The clay is plastic even when largely admixed with sand. In view of the lenticular character of the clay, the amount present can not safely be estimated. From an exposure slightly west of B. M. 2,792 it appears that of the 40 feet of sand and clay nearly one-third of the thickness is composed of plastic clay.

Numerous small clay beds are scattered throughout the rocks of the Wise formation but none are of large extent. It might be said of the Pennsylvanian rocks that they, in general, represent littoral and swamp sediments, resulting in mudstones, shales, sandstones and coals; hence clay, an off-shore sediment, is not found in extensive deposits.

OIL AND GAS POSSIBILITIES IN WISE COUNTY.

Many have searched for oil and gas in Virginia and have cherished the ambition to be the first to find these valuable resources within the limits of the State. Years have elapsed, however, and the efforts to locate a productive well of oil or gas have been unavailing and today there is none in the State. Boring has been carried on to a limited extent in southwest Virginia but in no case has it yielded a better reward than a meager showing of gas. Only one deep borehole has been sunk for oil and gas in Wise County and this boring, 2,153 feet deep, has given only a showing of gas.

It is the purpose here to discuss the possibilities of oil and gas occurring in commercial quantity only in Wise County and the coal-bearing portion of Scott County, Virginia. To do this, however, it will be necessary to consider briefly first, the geologic and geographic distribution of known occurrences of oil and gas in neighboring states, and secondly, the important factor of the degree of regional metamorphism [1] of the rocks of southwest Virginia as compared with that of the rocks of the oil producing fields.

The nearest oil and gas field to Wise County lies in Knott and Floyd counties, Kentucky, and is called the Beaver Creek field. This field lies about 40 miles north and slightly west of Norton. The oil of this field is of high quality and "is a green to brown-green fluid crude, and high in gasoline." [2]

The oil occurs in three sands in the "Pottsville conglomerate" (Lee formation) of the Lower Pennsylvanian. The nearest West Virginia oil and gas field is the Griffithsville field in Lincoln, Putnam, and Cabell

[1] Regional metamorphism:—By this term is meant the change or alteration of one or more of the properties of the rocks of a region as a whole brought about by the heat and pressure developed by geologic movements of regional magnitude.

[2] Jillson, W. R., The Oil and gas resources of Kentucky. Ky. Geol. Survey, Ser. V, Bull. I, 1920, p. 91.

counties, about 100 miles north and slightly east of Norton. The oil in this field occurs in the Pottsville group of the Lower Pennsylvanian series. The oil in both fields is found almost entirely in anticlinal structures. The stratigraphic distribution of the oil in the other fields of Kentucky and West Virginia is not limited to rocks of Lower Pennsylvanian age. In Kentucky oil is also found in the Mississippian, Devonian, Silurian, Ordovician and Upper Cambrian systems of rocks. In West Virginia, oil is found from the Monongahela formation of the Carboniferous down to and including Chemung and Portage formations of Devonian age. The rocks outcropping in the territory here considered include beds of Lower Pennsylvanian, Mississippian, Devonian, Silurian and Ordovician ages, and in places are folded into anticlines favorable for the accumulation of oil. The fact that they do not now contain oil does not necessarily imply that they never did, particularly in the light of recent investigations that have about established a law governing the distribution of oil along the eastern margin of the Appalachian oil field. The law, which subsequent researches have shown applicable to all the major oil fields of the world, is here referred to as White's law, for David White, its proponent.[1] As the law is such an important factor in the geologic and geographic distribution and present occurrence of oil in the Appalachian field, it will be expanded here in detail and applied to the southwest Virginia region.

In arriving at his original hypothesis, White noted that the rocks of the Appalachian coal field had been regionally affected by the enormous thrust exerted from the southeast, the degree of metamorphism being progressively less to the west and northwest. This degree is roughly indicated by the percentage of fixed carbon of the coal on a moisture and ash-free basis which was noted. The percentages of fixed carbon were plotted on a map at the localities where samples were collected and lines, "isocarbs," were drawn connecting points of equal carbon percentages. These isocarbs show the progressive devolatilization of the coals toward the southeast and the corresponding increase in carbon in the same direction. White, in superimposing the isocarb contours on the oil and gas map of the Appalachian coal field, noted that where the coals were devolatilized to the extent of 70 per cent or greater of fixed carbon oil does not occur, and that the easternmost limit of the oil fields is more nearly marked by the 65 per cent contour. In other words, where the rocks were sufficiently affected regionally by metamorphosing influences to devolatilize coals to

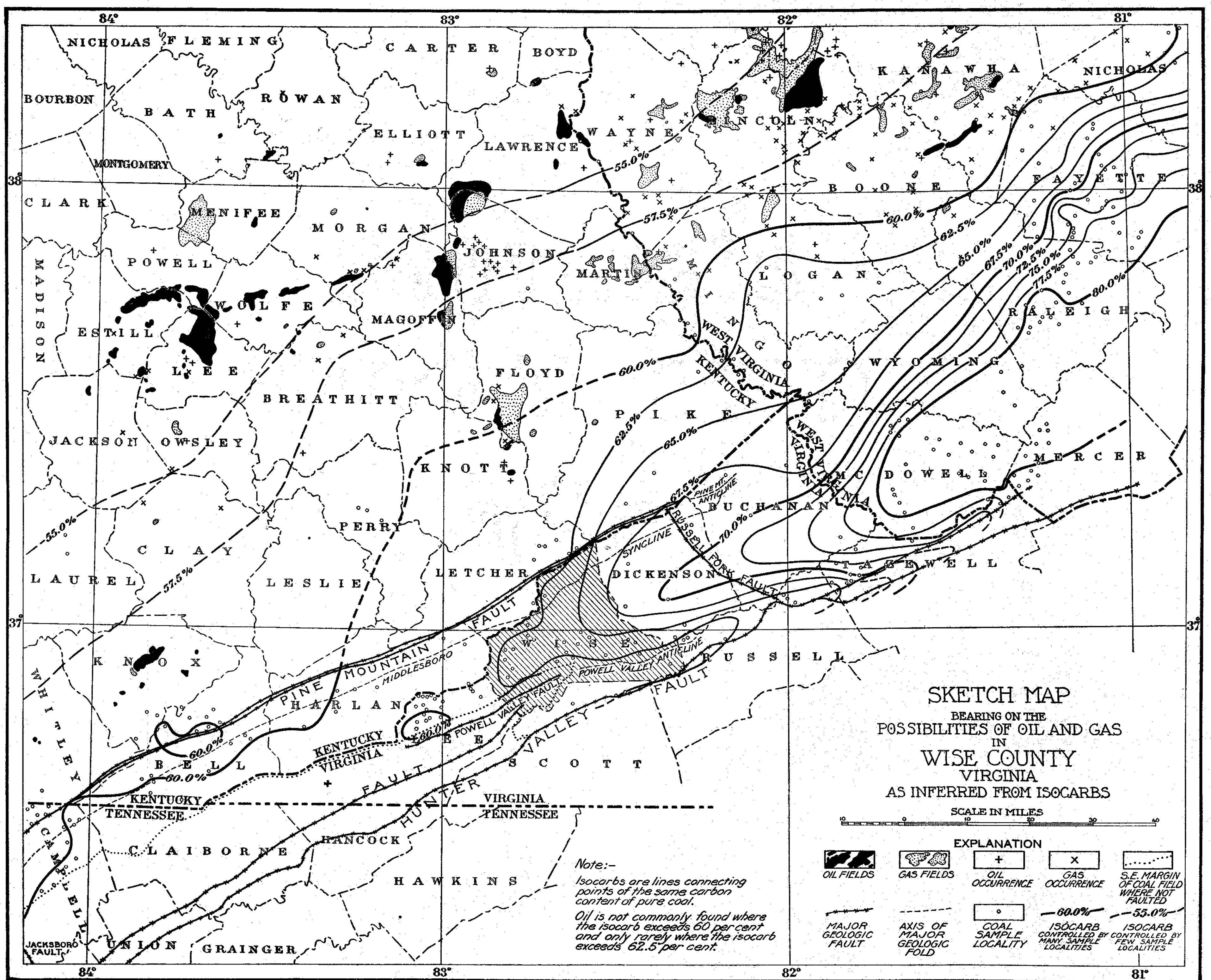
[1] White, David, Jour. Wash. Acad. Sci., vol. V, No. 6, pp. 189-212, March 19, 1915.

65 per cent of fixed carbon or greater, any oil the rocks may have previously contained was devolatilized and driven off. Later refinement and additional detail would place 63 per cent of fixed carbon as the probable limit of the occurrence of commercial pools of oil. Although 63 per cent may be taken as the "dead line" above which oil in all probability does not occur in commercial amounts, it is a fact that oil is not commonly found in commercial quantity above the 60 per cent of fixed carbon contour. Following White's pronouncement in 1915, thousands of applications in all parts of the world have firmly established this relationship of oil distribution to regional metamorphism.

White's law when applied to southwest Virginia offers an explanation for the lack of oil in commercial quantity in this region. Plate XXXVII represents southern West Virginia, southwest Virginia, eastern Kentucky and an adjacent portion of Tennessee. On this map are shown the known oil and gas fields, the oil fields appearing in black and the gas fields in stippled patterns. The localities from which coal samples were collected for analysis are shown and isocarbs are drawn over the coal field portion of the map with a contour interval of 2.5 per cent fixed carbon. Where there are many sample localities the contouring of the fixed carbon ratios is better controlled than in areas where few samples have been collected. For this reason the solid line is used to represent a well controlled contour and a broken line to indicate lack of data or generalization.

The first and important feature to be noted in Plate XXXVII is the relationship of the eastern edge of the oil fields to the fixed carbon percentages of the coal. The 60 per cent isocarb practically marks the eastward limit of the oil fields. No oil is found in this region southwest or east of this isocarb. The contours show clearly that in Buchanan, Tazewell, Dickenson, Russell and eastern Wise County the coals have fixed carbon percentages of 65 and greater, and that the chances of oil occurring in commercial quantity in this region are negligible. In central, southern, and western Wise County the average fixed carbon percentage is practically 62.5 and here also the oil possibilities are reduced to a discouraging minimum. In Lee County, on the strength of only a small number of analyses, it appears the average fixed-carbon ratio is close to 60 per cent, which, as far as the law of regional metamorphism is concerned, offers some slight encouragement for the occurrence of oil.

Closer inspection of the isocarbs shows a "southwestward plunging high" with an axis entering the coal field at McDowell County, West Virginia about 20 miles dues west of Bluefield and running through southern


SKETCH MAP
BEARING ON THE
POSSIBILITIES OF OIL AND GAS
IN
WISE COUNTY
VIRGINIA
AS INFERRED FROM ISOCARBS
SCALE IN MILES
EXPLANATION
OIL FIELDS
GAS FIELDS
OIL OCCURRENCE
GAS OCCURRENCE
S.E. MARGIN OF COAL FIELD WHERE NOT FAULTED
MAJOR GEOLOGIC FAULT
AXIS OF MAJOR GEOLOGIC FOLD
COAL SAMPLE LOCALITY
60.0% ISOCARB CONTROLLED BY MANY SAMPLE LOCALITIES
55.0% ISOCARB CONTROLLED BY FEW SAMPLE LOCALITIES
Note:-
Isocarbs are lines connecting points of the same carbon content of pure coal.
Oil is not commonly found where the isocarb exceeds 60 per cent and only rarely where the isocarb exceeds 62.5 per cent.
84°
83°
82°
81°
38°
37°
NICHOLAS
FLEMING
CARTER
BOYD
KANAWHA
BOURBON
BATH
ROWAN
ELLIOTT
LAWRENCE
WAYNE
LINCOLN
MONTGOMERY
CLARK
MENIFEE
MORGAN
JOHNSON
MARTIN
BOONE
FAYETTE
MADISON
POWELL
WOLFE
MAGOFFIN
MINGO
LOGAN
RALEIGH
ESTILL
LEE
FLOYD
WYOMING
BREATHITT
PIKE
JACKSON
OWSLEY
KNOTT
MC DOWELL
MERCER
PERRY
BUCHANAN
CLAY
TAZEWELL
LAUREL
LESLIE
LETCHER
DICKENSON
WISE
RUSSELL
KNOX
WHITLEY
HARLAN
BELL
LEE
SCOTT
CLAIBORNE
HANCOCK
HAWKINS
CAMPBELL
UNION
GRAINGER
WEST VIRGINIA
KENTUCKY
VIRGINIA
TENNESSEE
PINE MOUNTAIN FAULT
MIDDLESBORO
PINE MT. ANTICLINE
SYNCLINE
RUSSELL FORK FAULT
POWELL VALLEY ANTICLINE
POWELL VALLEY FAULT
HUNTER VALLEY FAULT
JACKSBORO FAULT
55.0%
57.5%
60.0%
62.5%
65.0%
67.5%
70.0%
72.5%
75.0%
77.5%
80.0%

Buchanan and central Wise County. A "low" is represented along the southeastern edge of the coal basin, the axis entering from Lee County and passing through southern Wise County and the coal-bearing portions of Scott and Russell counties. A high signifies a progressively higher percentage, in the carbonization of the coal, toward the axial line and a low a corresponding lower percentage. Thus, as the carbonization is a direct function of the metamorphism undergone by the rocks of each particular locality, an isocarb map points out instantly the areas of greatly affected and little affected rocks. The relationship of the isocarbs in Wise County shows that the coals of the Middlesboro syncline are more highly carbonized than those of the Powell Mountain field, north of the upturned rocks along Hunter Valley. It appears somewhat anomalous to have the less affected rocks of Wise County further from the oil fields of Kentucky than the more greatly metamorphosed beds. A glance at the geologic structure of Wise County readily gives the answer. When the entire Wise County region came under the tremendous compressive forces exerted from the southeast the rocks of the Powell Mountain area were arched up like the bending of a bow and except for their position were little changed by their experience. The rocks of the Middlesboro syncline on the other hand were not relieved of their pressure by such a simple fold, and in consequence suffered regional metamorphism to a more marked extent than the rocks on Powell Mountain. The rocks of the Middlesboro basin were folded in several minor anticlines and synclines and were thus more intimately affected by the forces of regional metamorphism than the rocks on Powell Mountain. In both cases, however, the folding of the beds and the influence of regional metamorphism appears to have been sufficiently ample to have dissipated any oil that originally may have occurred within the beds involved.

The deep well put down in Wise County prospecting for oil and gas was drilled on the Nettle Patch property of G. W. Gish, on Clear Creek, two miles south of Ramsey (see Plate II). The well was sunk in the early nineties to a depth of 2,153 feet and only a slight flow of gas was encountered, at a depth, it is reported, of 626 feet. No log of the well has been kept for record but certain data are reported by the present owner. At a depth of 60 feet, 8 feet of coal is reported to occur and red sand is said to have been drilled through at approximately 800 feet. A white "lime" is said to occur at 1,000 feet below the surface. At 1,400 feet "gold strata" are reported which probably represent pyritiferous sandstones. The last 700 feet of the well is reported to have been drilled in shale. No water is reported to have been struck which, if being the case, is most inauspicious for oil, as oil is seldom found in association with dry rocks. The boring starts approximately 300 to 400 feet above the base of the Lee formation and apparently does not penetrate to the Newman formation as no mention in the reported record of the well is made of the massive sandstone at the base of the Pennington. The bottom of the well must undoubtedly be close to this sandstone. The slight showing of gas in this well was taken by many in the field to indicate the proximity of an oil pool. The occurrence of gas in the rocks of a coal field, however, is not an indication of oil and there are numerous occurrences of gas at various points in the coal fields where oil is not known to exist. Only recently gas seepages have been discovered in two shallow water wells of central Buchanan county. Gas may be found there in quantity but there appears to be slight chance for oil. The law of White, which so well establishes the eastern margin of the oil fields, has not yet been applied to determine any fixed line beyond which gas may not occur.

The finding of gas in commercial quantity in Wise County would indeed be a boon. It was proposed by the owner of the Nettle Patch well, if his quest for oil were fruitless, to "shoot"[1] his well in the hope of augmenting the gas flow sufficiently to supply Norton, Coeburn, and other nearby towns with gas. When the well was visited by the writer in the fall of 1920, the flow of gas was insignificantly small. It is very doubtful whether this flow would be materially increased if the well were "shot," as the borehole lies considerably north of the axis of the Powell Valley anticline, which greatly lessens the chances of finding gas in quantity.

The most favorable geologic structure for the accumulation of gas in the Wise County field appears to be the Buck Knob anticline (Pl. II). If drilling is contemplated in Wise County it should be done on the crests of the anticlines as the experience in all gas fields clearly indicates that this is the most likely point for gas accumulation. The axis of the Buck Knob anticline is well located by a great number of elevations on coal beds and key-sandstones. The axis is shown on Plate II. The structural domes about one mile north of Glamorgan and at Wise may prove receptacles for gas, although the rocks here are probably too intensely folded. The domes are indicated on Plate II, by means of structure contours[2] which

[1] By exploding a heavy charge of nitroglycerine in the well at or near the gas horizon the rocks would be greatly fractured, permitting a fuller and freer flow of gas.

[2] For definition of structure and structure contours see pages 114 to 118.

appear on the map as concentric circles or rounded loops with the highest structure contour in the center of the group. The rocks dip off in all directions from the highest point of the dome, and it is toward this highest point in the subsurface cap-rock of an oil or gas reservoir that the gas tends to migrate. The domes at Wise and near Glamorgan are more sharply folded than the usual type of oil and gas-bearing domes. The only remaining anticline of promise is the Powell Valley anticline (see pages 119 to 129). This anticline has not been drilled into on its axis but the Nettle Patch well was drilled about 1 mile north of the axis. West along the axis from the vicinity of the Nettle Patch property the chances of finding gas are progressively less, as the rocks that would normally contain the gas are brought to the surface in Powell Valley less than 5 miles away. The chances of obtaining gas in the Powell Valley anticline would be improved by drilling nearly anywhere on the axis to the east of the Nettle Patch well.

In conclusion it might be well to emphasize the improbability of finding oil in commercial quantity in this area. As shown in Plate XXXVII the degree of devolatilization of the organic matter in the rocks of this field appears unquestionably sufficient to preclude the occurrence of oil in commercial pools. As regards gas in commercial quantity, there is nothing to condemn its occurrence, as shown above, and there is a fair probability that it does occur, but this can only be tested by the drill.

THE FORESTS OF WISE COUNTY, VIRGINIA

FRED C. PEDERSON.

LOCATION AND AREA.

Wise County is one of the extreme southwestern counties in Virginia. (See fig. 1.) It is separated from Pike, Letcher, and Harlan counties, Kentucky, on the northwest by Pine and Black mountains, which are part of the Cumberland Mountain range. It is bounded on the southwest by Lee County, Virginia, the extreme southwestern county in the State; on the south by Scott County, on the extreme east by Russell County and on the northeast by Dickenson County. The county is one of the smallest in southwest Virginia. Its area is only 420 square miles, or 268,800 acres, according to U. S. Census figures.

TOPOGRAPHY AND DRAINAGE.[a]

The greater part of the county is rough and mountainous, with deep narrow valleys and steep slopes. Although it is not as mountainous as its neighboring county, Dickenson, less than one-fifth of the total area is adapted to agriculture, the remainder being "absolute forest land." Three distinct areas in the county stand out in strong contrast to the rest of the county, by reason of their comparatively level surface. In these sections both the topography and the soil conditions are well adapted to agriculture. The first of these is the relatively broad limestone valley formed by Butcher and Beaverdam creeks, lying between Little Stone and Powell mountains; the second consists of the bottom lands of Guest River, east of Tacoma, and the comparatively gentle slopes adjacent; the third consists of the high plateau section centering around Wise Court House.

The mountain ranges have a general northeast-southwest trend, the most conspicuous being Pine and Black mountains on the northwest, Powell's mountain on the south and southwest, Little Stone Mountain on the southwest, Sandy Ridge on the east, and what is locally known as Guest Mountain in the central portion of the county. The ridges are uniformly narrow, and practically all the lands that are devoted to agri-

[a] For a more detailed discussion of topography, see pages 13 to 18.

culture in the mountainous sections occur on the mountain slopes. Pine and Black mountains, which form the boundary line between Virginia and Kentucky, are conspicuous features from nearly every high point in the county. Unlike their northwest slope, which breaks off into a sharp escarpment, the southern slopes in Wise County are long and comparatively gentle. The maximum relief of the county is 2,753 feet, the highest point being High Knob, which lies just south of Norton, with an elevation of 4,162 feet, and the lowest altitude being the point of junction of Guest and Clinch rivers, with an elevation of 1,409 feet.

The streams of Wise County are tributary to two great drainage systems, the Tennessee and the Ohio. Generally speaking, it may be said that all the drainage north of Sandy Ridge and Guest Mountain flows into the Ohio, and all the drainage south of these mountains flows south into the Tennessee.

In the past, when the poplar was first taken out of the county, the lower reaches of Pound River in Wise County were utilized to some extent in floating out the poplar logs, during the time of the spring freshets. At the present time no attempt is made to utilize these water courses for logging purposes, and generally speaking it may be said that it would not be practicable with present transportation facilities to endeavor to do so.

CLIMATE AND SOIL.

According to Zon's map, published in 1908, in which the country is divided into life and crop zones, giving the precipitation of the different regions in the latter, the average rainfall in this general region is about 47 inches per year. The temperature range is very great, from $-25°$ Fahrenheit to $100°$, with a mean annual range of about $50°$. The winters as a rule are open, the snow is seldom over 6 inches deep and does not usually stay on the ground for any length of time.

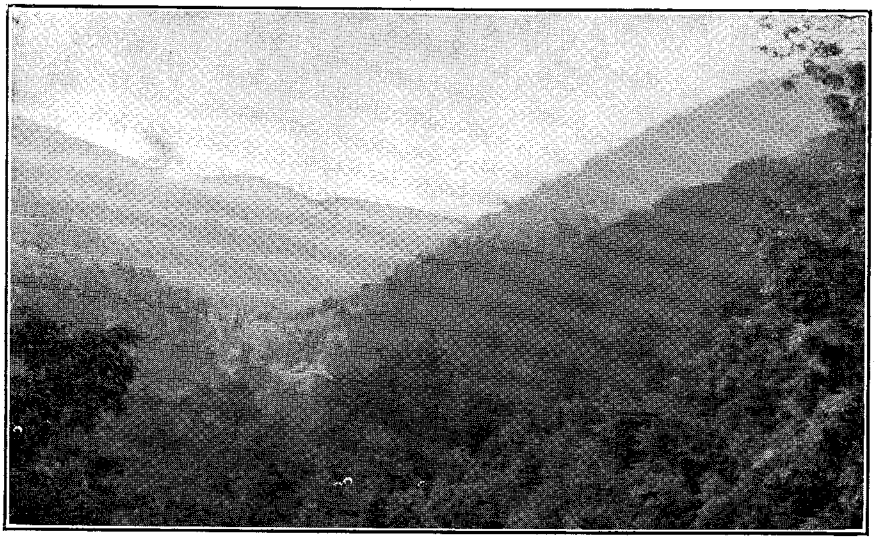
The soils are of residual origin, the underlying rocks being mostly sandstone, limestone or shale. There is a great variety of conditions as to fertility, but over four-fifths of the entire land surface of the county is unsuited for agriculture, due to the thinness of the soil or because of the steepness of the slopes. The limestones are restricted to two distinct sections. The greater area is in the southwestern part of the county, in the valley between Little Stone and Powell's mountains, drained by Butcher and Beaverdam creeks. This limestone formation includes this whole valley section, extending to the top of Powell's Mountain on the south and to about an average elevation of 2,000 feet on Little Stone Mountain on the north. It runs east to High Knob, and east of this point it continues as a relatively shallow layer, in Powell's Mountain, in a sandstone formation. The other limestone section is confined to the immediate vicinity of St. Paul, in the extreme eastern part of the county.

POPULATION.

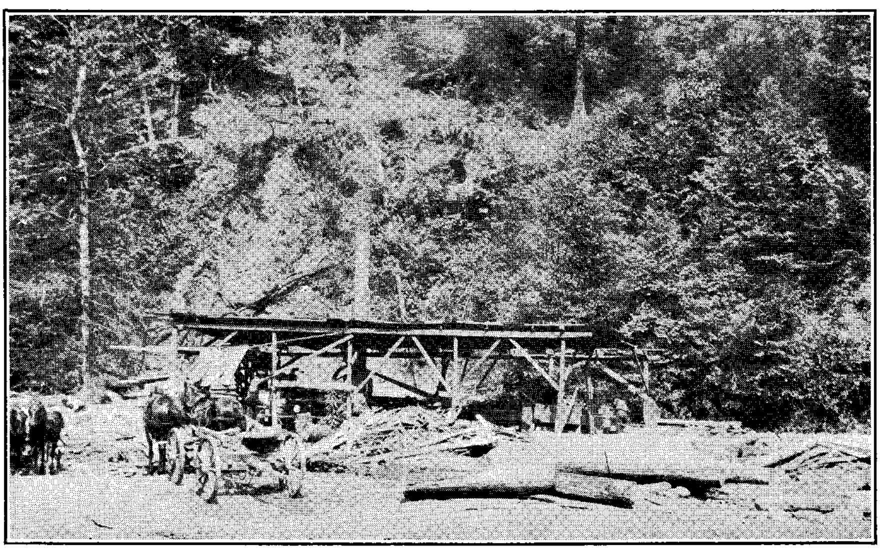
Wise County is the most densely populated county in southwest Virginia, having 110 persons per square mile, and a total population, according to the 1920 census, of 46,500. This density of population is due to the extensive mining activities. Wise County is by far the greatest coal producing county in the State, and it bids fair to continue to hold this distinction for some time in the future. Probably three-fourths of the population is confined to the limits of a relatively narrow central coal belt, which extends from Lee County on the west to St. Paul in the extreme eastern portion of the county, and lying north of the North Fork of Powell's River and south of Guest River, with an average width of perhaps four miles. No attempt has yet been made to exploit the coal resources on the Pound drainage in the northern part of the county, and no serious attempt to mine the coal along the southern border of the county. All the larger towns in the county lie within this "central coal belt." Outside of this coal-producing field, the county is sparsely settled.

TRANSPORTATION FACILITIES.

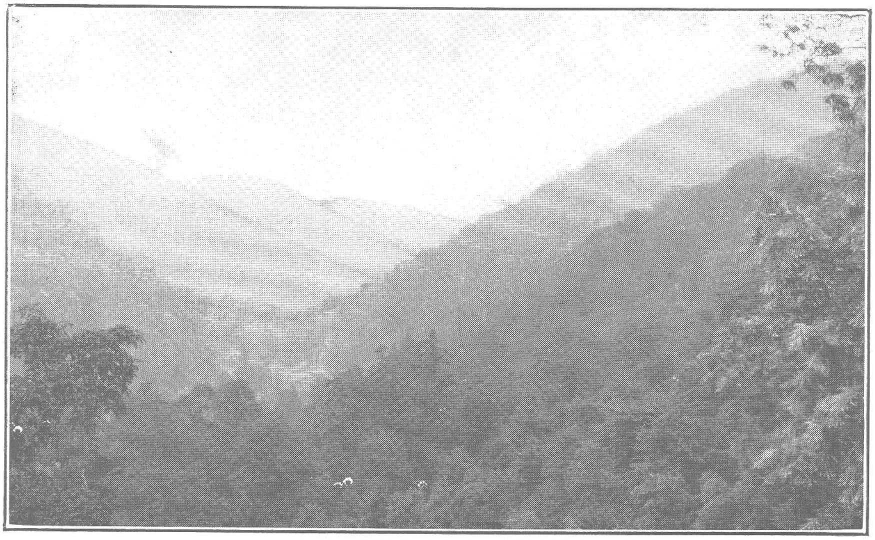
Wise County has excellent transportation facilities. In 1891 the Clinch Valley Division of the Norfork and Western Railroad, running from Bluefield, West Virginia, to Norton, was completed. The same year marked the completion of the Louisville and Nashville Railroad from Cumberland Gap to Norton, where it connects with the Norfolk and Western. A branch of the Southern Railway runs from St. Charles in Lee County through Appalachia to Bristol, Virginia, connecting there with a main line of the Southern and also with the Norfolk and Western. It has numerous branch lines which extend to all the principal coal-producing centers in the southwestern portion of the county. The Carolina, Clinchfield and Ohio Railroad runs from Elkhorn City, Kentucky, with connections there with the Chesapeake and Ohio system, to Forest City, North Carolina, and has railroad connections with the Norfolk and Western at St. Paul. This recently completed line affords excellent transportation facilities to the markets



(A) Looking down Trace Fork. Showing the steep and rugged slopes. Portable sawmill in the creek bottom.



(B) The portable sawmill shown in (A) above. Typical of such mills. August, 1922.



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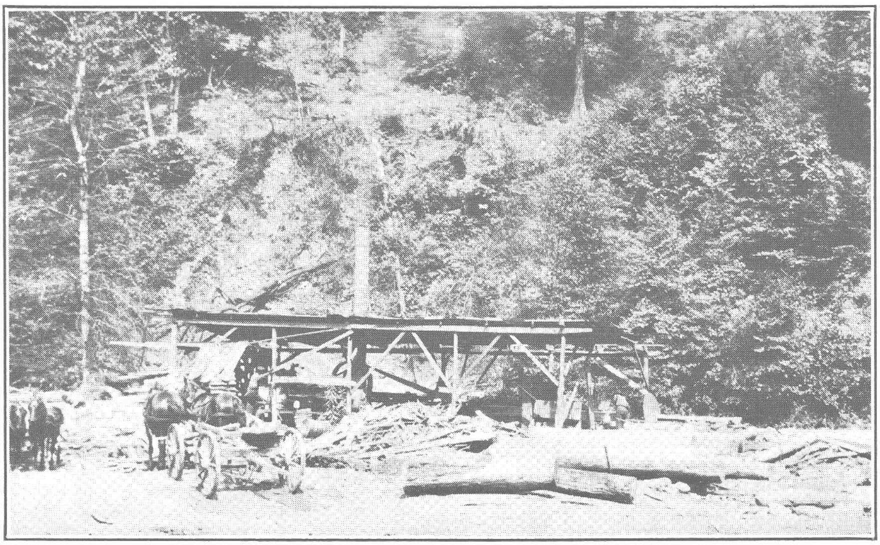
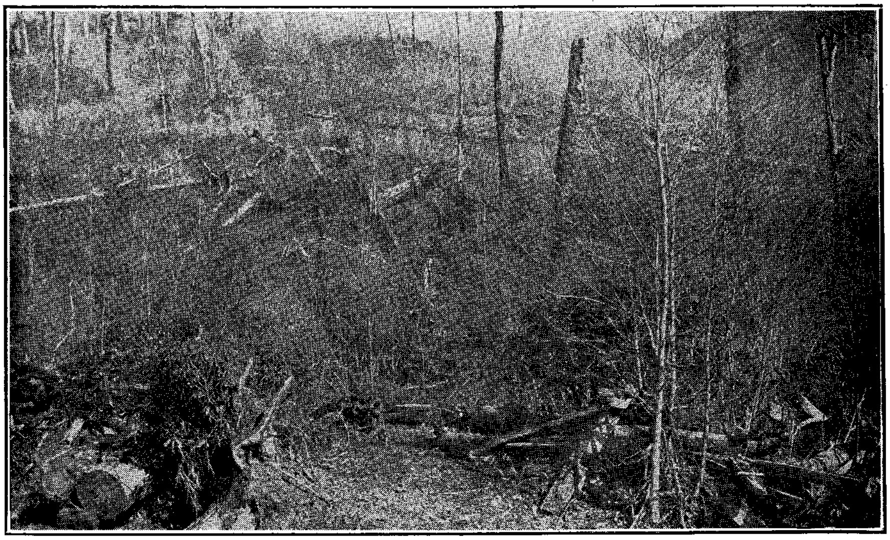
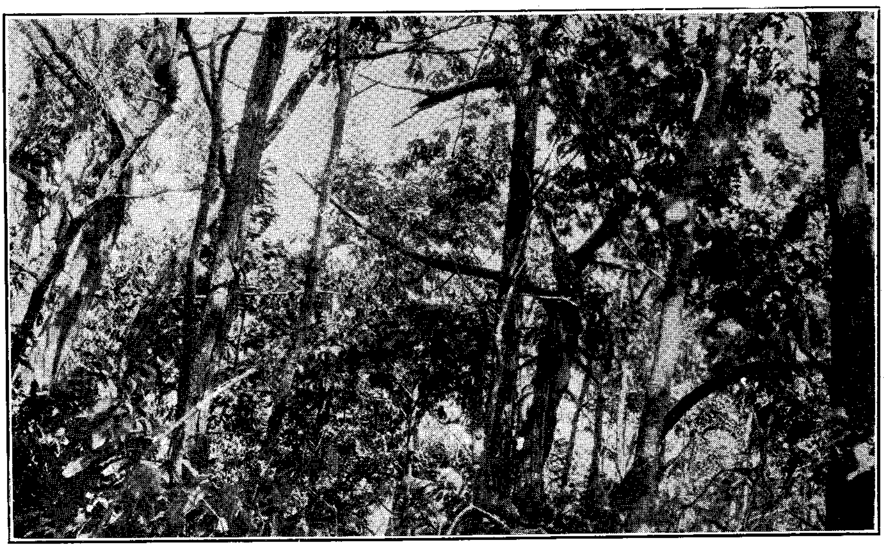


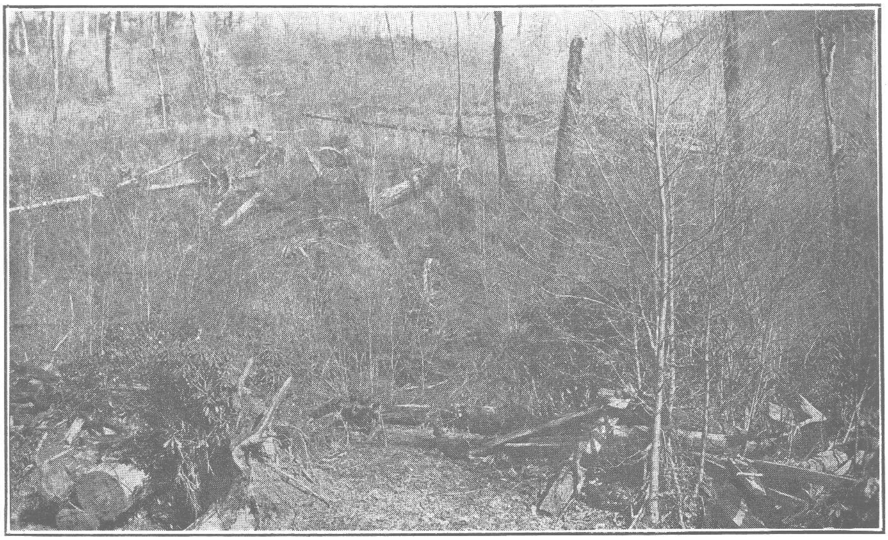
(B) The portable sawmill shown in (A) above. Typical of such mills. August, 1922.



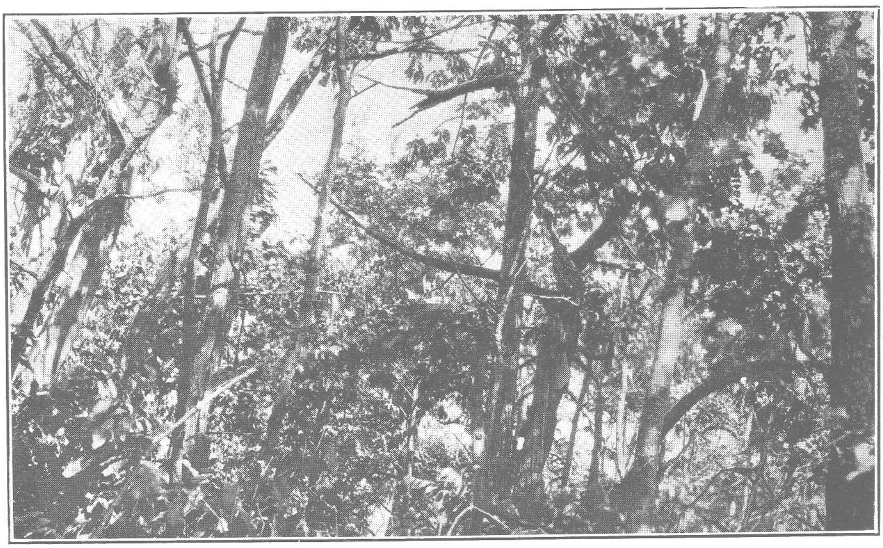
(A) The destruction due to fire in the slashings left after lumbering.



(B) Showing the condition of a large part of the forest, due to indiscriminate cutting and to repeated fires.



(A) The destruction due to fire in the slashings left after lumbering.



(B) Showing the condition of a large part of the forest, due to indiscriminate cutting and to repeated fires.

along the southeastern Atlantic Seaboard. The Interstate Railroad runs from Glamorgan (north of Wise Court House) to Stonega, with branch lines to Roda and up Roaring Fork and Potcamp Fork to Pardee. Work is now being done to extend this line down Guest River to connect with the C. C. & O. Railroad at Bangor. Finally the Norton and Northern Railroad runs from Wise Court House to Norton.

Wise County has many miles of limestone or sandstone macadam roads, with many miles of graded roads not yet surfaced. The improved roads are restricted mainly to the coal-producing field. There are no macadam roads in the northern or southern portions of the county, although in these rather remote sections graded roads have been built along the main routes of travel, and it seems probable that within the course of a few years all these graded roads at least will be macadamized or otherwise surfaced. Already steps have been taken to surface the road from Wise Court House to Pound Gap, where it will connect with a similar road which the State of Kentucky is contemplating building. Its value from an economic standpoint, aside from its scenic aspects, must not be underestimated, as it will connect the principal coal centers of Kentucky with those in Virginia.

INDUSTRIAL FEATURES.

Mining, agriculture, and lumbering are the chief industries, in the order named. Mining has long held the preëminent position, certainly since the advent of the railroads into the county, which was in 1892. The amount of land used for agriculture is declining. According to the Census figures, the total area of land included within "farms" in 1910 was 122,874 acres, but in 1920 only 78,877 acres, while the area of "improved land in farms" declined in the same period from 51,398 acres to 35,470 acres, a decrease of 31 per cent in ten years.

Many acres of land have been cleared for agriculture that were entirely unsuited for it. Steep, almost precipitous slopes have had the forest cover removed, or the trees killed by girdling, and the areas have been planted to corn or other staple crops. Generally speaking, it may be said that the exposed soil on such steep slopes will not hold for over five or six years, due to active erosion. Gullying quickly takes place, which necessitates further clearing, until large areas have been rendered practically barren and sterile. Since the control of the major portion of the land surface of the county has been acquired by the different coal companies, this process has been curtailed in a large measure and in many localities entirely stopped.

The lumber industry has also been declining. Practically all the virgin timber in the county has been cut off by single-band mills, that had a daily capacity of about 30,000 feet. As in the case of the mining industry, when the railroads were built lumbering operations began in earnest in this virgin field, but the resource to be exploited could not sustain it in the way in which it was conducted a few years ago. In capital invested, in number of men employed, and in the amount of the product, the lumber industry has declined very much in the last few years.

LAND OWNERSHIP AND VALUES.

More than two-thirds of the land surface of the county is owned or controlled by four of the largest coal companies which are operating in the county. Outside of the vast area that is included in these large surveys, the average unit of ownership is about 68 acres. The following table shows the number of "farms" in the county, as given in the 1920 Census, including both "improved" and "unimproved" area, and the size of the holdings. A considerable portion of the "unimproved lands" on these "farms" is wooded. Some of these woods are a valuable resource, and a profitable source of income to the owners, either present or potential, while others consist of a haphazard second growth that has little commercial value.

Number of "farms" of different sizes, as given by the 1920 census:

Size of "farm" in acres.	*Number of "farms."*
Under 3 acres	1
3 to 9 acres	124
10 to 19 acres	131
20 to 49 acres	328
50 to 99 acres	259
100 to 174 acres	153
175 to 259 acres	38
250 to 499 acres	32
500 to 999 acres	10
Over 1,000 acres	1

With regard to land values a sharp distinction must be drawn between coal-producing lands, coal lands that are at the present time unproductive, and lands that are primarily agricultural areas. The value of all "farm" land in the county in 1920 was $2,796,663, as compared with a value of $2,800,704 in 1910, as given by the Census. The average value per acre of farm in 1920 was $38.38. Coal lands that are being actively worked have as high a valuation as $500 per acre. Other coal areas that are inaccessible, due to lack of proper transportation facilities, or are known to have small quantities of commercial coal, have only a nominal value, perhaps not over $5.00 per acre.

THE FOREST TREES OF COMMERCIAL IMPORTANCE IN WISE COUNTY.

The forest trees of commercial importance in Wise County, arranged approximately in the order of their abundance, are as follows:

Common or Local Name.	*Scientific Name. (Sargent's Manual, 2d Edition.)*
White oak	*Quercus alba L.*
Chestnut or rock oak	*Quercus montana L.* (formerly *Q. prinus)*
Chestnut	*Castanea dentata Borkh.*
Tulip tree, or yellow poplar	*Liriodendron tulipifera L.*
Red oak (northern), or "water oak"	*Quercus borealis var. maxima Ashe* (formerly *Q. rubra L.)*
Black oak	*Quercus velutina Lam.*
Basswood, or linden, or lin	*Tilia* (species not determined)
Hemlock, or spruce pine	*Tsuga canadensis Carr.*
Beech	*Fagus grandifolia Ehrh.* (perhaps *var. caroliniana)*
Hard or sugar maple	*Acer Saccharum Marsh* (perhaps *var. glabrum)*
Cucumber tree, or mountain magnolia	*Magnolia acuminata L.*
Buckeye (fetid)	*Aesculus glabra Willd.*
River birch, or red birch	*Betula nigra L.*
White ash	*Fraxinus americana L.*
Black locust (or yellow locust)	*Robinia pseudoacacia L.*
Black walnut	*Juglans nigra L.*
Spanish oak, or spotted oak (known as scarlet oak in the North)	*Quercus coccinia Muench.*
Red maple	*Acer rubrum L.*
Scalybark hickory or shell-bark hickory	*Carya ovata K. Koch* (formerly *Hicoria ovata, Britt.)*
Bitternut hickory	*Carya cordiformis K. Koch* (formerly *Hicoria minima Britt)*
Black gum, or tupelo	*Nyssa sylvatica Marsh.*
White walnut, or butternut	*Juglans cinerea L.*
Black birch, or sweet birch	*Betula lenta L.*
White elm	*Ulmus americana L.*
Black pine, or pitch pine	*Pinus rigida Mill.*
Sycamore, or buttonwood	*Platanus occidentalis L.*
Spruce pine, or scrub pine	*Pinus virginiana Mill.*

Other species which are rather common but of no particular commercial importance are as follows: ironwood or hop hornbeam, (*Ostrya virginiana*); sassafras, (*Sassafras sassafras*); red bud or Judas tree, (*Cercis canadensis*); sourwood, (*Oxydendrum arboreum*).

FOREST TYPES.

The forest types recognized in Wise County are as follows:

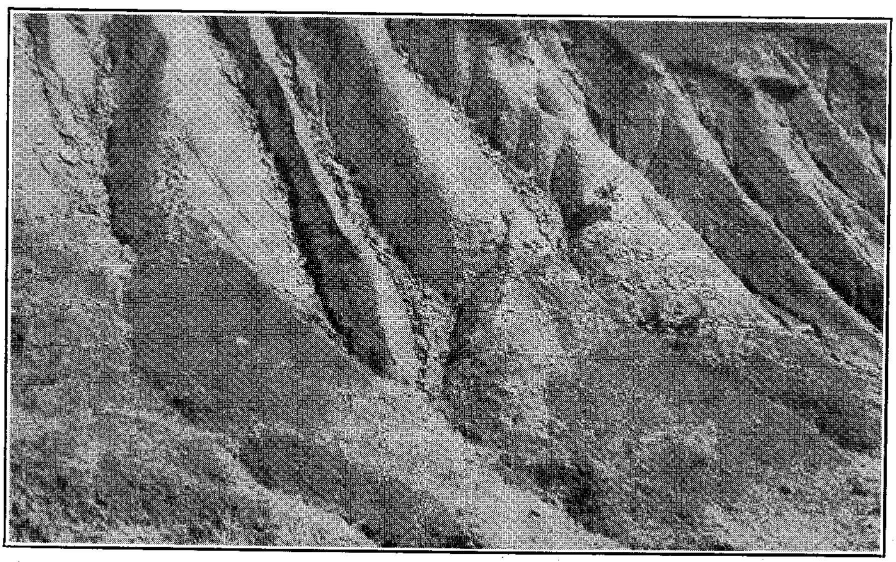
(1) Ridge type.
(2) Slope type.
(3) Cove type.
(4) Hemlock Bottom type.

The characteristics of these types vary considerably, depending upon the composition and depth of the soil, the steepness of slope, the altitude, the drainage and the capacity of the soil to retain moisture. The ridge, slope and cove types extend to lower elevations on southern and western exposures than on northern and eastern exposures.

Ridge type.—This type occurs on the tops of the ridges and spurs and on the upper slopes that face to the south. The dominant species of this type are the chestnut and chestnut oak or rock oak. Associated with them are northern red oak, black oak and occasionally white oak. The soil is usually thin and shallow, resulting in small water-storing capacity, and this fact, together with the rapid evaporation due to the open nature of the stand and the exposure to wind, makes the trees short and scrubby and of no great importance as saw-timber. Tree growth is very slow, especially after the sapling and pole stages. There will be a greater profit in managing these lands for mining timbers, for chestnut extract-wood, for cordwood and chestnut oak tanbark than for lumber, as the rotation is shorter and the period of most rapid growth is thus utilized. Fires are more apt to occur in this type than in any of the others, other factors being equal, as the more open nature of the stand and the exposure to wind produce a dry condition of the soil and the covering litter. Some of the most serious fires originate on these spurs, and their destructiveness is amply testified to by the decay and the unsoundness of the mature timber, and on second growth lands by a failure or at least a marked delay in the establishment of the young growth.

Slope type.—Probably 50 per cent of the forested area of Wise County is included in this type, and hence from a commercial standpoint it is the most important type. The principal species of this type is the white oak. Associated with it on the lower elevations are yellow poplar, hemlock, beech, basswood, cucumber-tree, buckeye, white ash and hard maple, and on the upper slopes northern red and black oaks, rock oak and chestnut. This type is well adapted to the production of merchantable saw-timber,

(A) Fire-line around watershed of the town of Appalachia, to facilitate fire-protection. Picture taken in March, 1917.



(B) Gullying, or "washing," on steep slope in the "coal-measures." This is not true of the "limestone" soils. There gullying is almost unknown.

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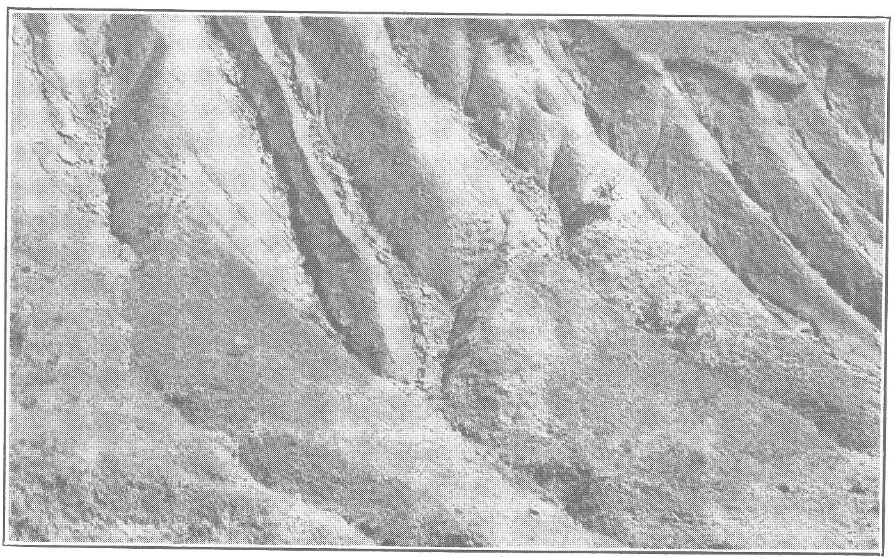

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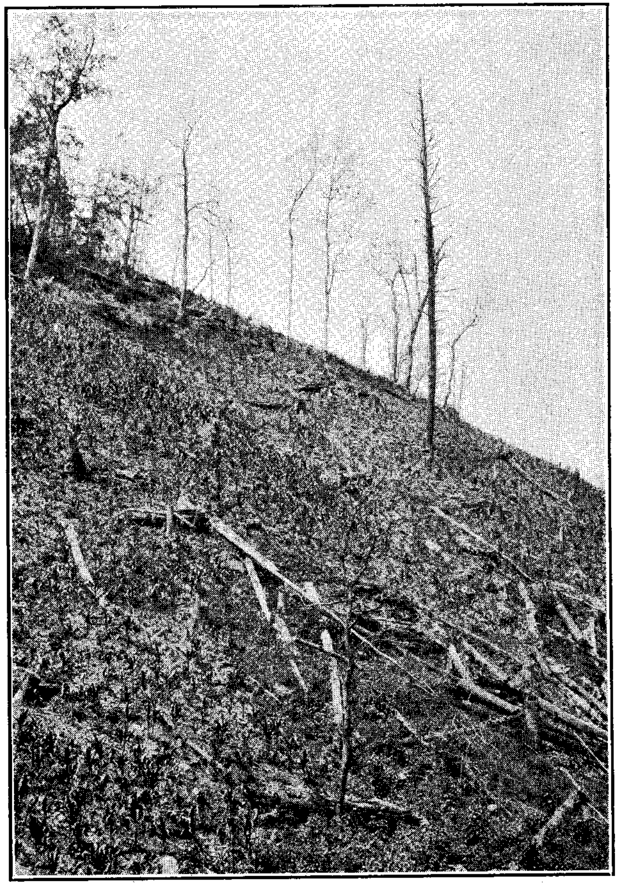
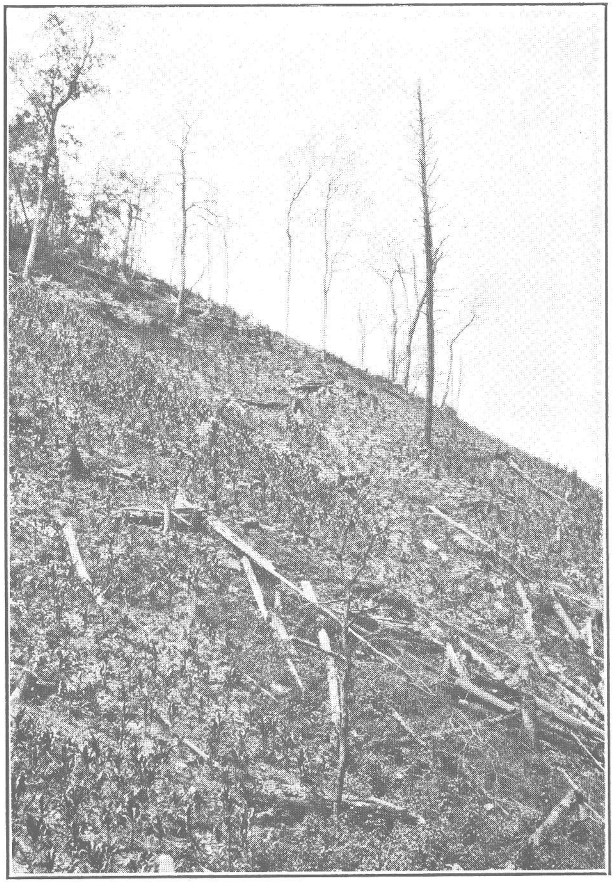


(A) Showing the steepness of the land cleared for farming. Such steep land in the "coal-measures" gullies badly after a few years.

(B) The method of "deadening" trees by girdling. How many years will be required to grow enough corn on this land to equal the value of such a tree?



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particularly the lower slopes, hence every care should be exercised to insure the restocking of cut-over lands in this type with the more desirable species.

White oak and its associated species reach their best development on the northern exposures. This may be attributed mainly to soil conditions, as evaporation is less on these northern slopes than on the southern exposures.

Cove type.—The principal species in this type is the yellow poplar. Associated with it in the coves are cucumber-tree, basswood, white oak, white ash, buckeye, hickory, hard maple, black walnut and beech. This type, while it comprises only about 15 per cent of the forest area of the county, affords soil conditions that produce the best development of the species growing in it, and the most valuable grades of lumber are produced under these favorable conditions. Practically all the virgin poplar in the county was cut about thirty years ago, but the rapid growth of this species in these coves is shown by the relatively high percentage of merchantable poplar that is being lumbered at the present time. Unlike the chestnut, which often forms pure stands on the ridges, poplar occurs singly, averaging about six or eight trees per acre. It reaches its best development at the heads of the coves with a northern exposure. Hardly less important in this type is cucumber-tree and its propagation should at all times be favored. Cucumber-tree is often sold as poplar, as their woods are very similar. Both are used extensively for interior finish, furniture, veneering, cabinet-work, shingles, automobile bodies, wooden-ware, and for general construction purposes.

Hemlock Bottomland type.—The principal species of this type is the hemlock, with such associated species as beech, red maple, black gum, white elm, river birch, and to a lesser extent cucumber-tree, basswood, and yellow poplar. This type does not comprise over ten per cent of the total area of the county and is of relatively small commercial importance. Only the hemlock and river birch reach their best development in this type.

FOREST FLOOR SPECIES AND UNDERBRUSH.

Familiar herbaceous plants on the forest floor are hay-scented ferns, christmas ferns, jack-in-the-pulpit, Solomon's seal, Indian cucumber root, trilliums, spring beauty, wild columbine, hepatica, bloodroot, may-apple, white dog-toothed violet and ginseng. This list could be much enlarged and more accurately determined.

The underbrush consists of such species as mountain laurel, rhododendron, sassafras, azaleas, alders in moist situations, striped maple, redbud, etc., but as a rule the forest is quite open, without any dense underbrush.

CLASSIFICATION OF THE FORESTS.

Of the entire land area of the county, 268,800 acres, 27.1%, or a total of 72,877 acres, consists of "farm lands," according to the Census usage of the term. However, of this total acreage, 31,905 acres is stated by the Census to be wooded, leaving 40,739 acres of cleared land or 15.2% of the land surface of the county, and 227,261 acres covered with some form of forest growth.

The forests may be divided into four distinct classes, as follows, the classification being based on the extent of cuttings up to the present time:

(1) *Virgin with poplar.*—This class includes all the forest land in which there have been no cuttings, with the possible exception of black walnut. The extent of past lumbering operations is apparent when it is realized that there are only 2,000 acres, less than 1% of the total forested area of the county at the present time, that contains timber which has been untouched by the axe and the saw. Estimating this stand at about 6,000 board feet to the acre, there are approximately 12,000,000 board feet of saw-timber included in this class.

(2) *Virgin without poplar.*—This class covers about 24,272 acres, or 10.6% of the forest area. Most of the merchantable poplar to be found in the county is included in this class, although the virgin poplar was removed about thirty years ago. At that time a cutting diameter limit of 20 inches on the stump was observed, and as a result seed-trees were left to restock the ground, and the trees left under that limit are to-day merchantable, in fact will provide some of the best grades of poplar lumber. In some instances there has been some white oak removed from this class, but the cuttings have been so light that for the purpose of this discussion we may class it as virgin with the exception of poplar. Estimating this class at 4,500 board feet to the acre, there are about 97,088,000 board feet in this class in the county.

(3) *Forests that have been lightly culled, but have saw-milling possibilities at the present time.*—The timber in this class is primarily adapted because of the previous cuttings, to small portable sawmills only. It comprises 12,971 acres or 5.7% of the forest area. It occurs in isolated tracts averaging about 1,400 acres to the stand. There are areas included in

this class, and the same statement might be made of class number 2, that would not permit of sawmill operations, but no attempt was made to isolate these relatively small unmerchantable areas from the general classes mentioned. Taking this class of the forest as a whole into consideration, 3,500 board feet to the acre is probably a fair average, giving a total of 45,398,500 board feet of merchantable saw-timber that is adapted to portable or circular mill operations.

(4) *Forests that consist principally of mining timbers.*—This class comprises the lands that have been very heavily cut over, leaving for the most part only the smaller second growth. By far the greater percentage of the forest lands in Wise County is included in this, the most undesirable of all the classes of forest. Approximately 83% of the total forest area, or 188,018 acres, is in this class. Estimating this class at 1,000 board feet to the acre, we have a total of 188,018,000 board feet of lumber of all kinds, most of it of inferior grades, growing on these heavily culled lands.

Cleared land.—There are 40,739 acres of cleared land in the entire county, according to the Census figures. The bulk of this cleared area is to be found along the valleys of Guest River and Powell's River or their tributaries and on the high plateau section centering around Wise Court House. The remainder consists of isolated small clearings on the steep slopes in the more mountainous sections of the county.

ESTIMATE OF THE STAND OF TIMBER IN WISE COUNTY. (AUGUST, 1922.)

Class of Forest.	*Area. (Acres.)*	*Average Stand per Acre. (Board Feet.)*	*Total Estimate. (Board Feet.)*
Virgin with Poplar.....	2,000	6,000	12,000,000
Virgin without Poplar...	24,272	4,500	97,088,000
Culled Forest but with sawmilling possibilities	12,971	3,500	45,398,500
Principally mining Timber	188,018	1,000	188,018,000
Total	277,261		342,504,500

It should be understood that these figures are only approximate. It should be also borne in mind that in the case of the fourth class of forest, that described as consisting principally of mining timbers, the trees large enough to yield lumber are usually so scattered as to make sawing them into lumber not a feasible proposition from a business standpoint.

HISTORY OF LUMBERING.

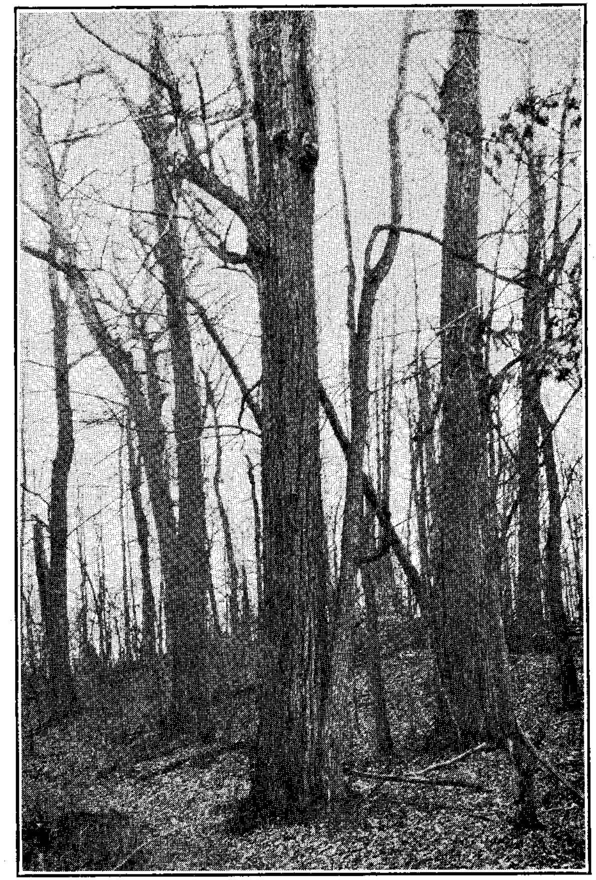
Lumbering operations began in the county about thirty-five years ago (about 1887). At that time a firm by the name of Horsely Tate bought up all the black walnut in the county, at a price ranging from $.60 to $1.00 per thousand board feet on the stump. The mill value per thousand feet of walnut at the present time is about $80. Horsely Tate later sold out their interests in the county, before they had done any cutting in fact, to the Singer Manufacturing Company, who cut all the black walnut down to a twenty-inch cutting diameter on the stump. Many of these logs were hauled to Abingdon on wagons, a distance of about 55 miles, as the logging operations started before the completion of the railroads into the county. With the completion of the Norfolk and Western in 1892 the operations received further stimulus, and within a year or two all the virgin black walnut had been removed. All this material was shipped out of the county in the log.

The first band mill to operate in Wise County was a single-band mill with a daily capacity of about 30,000 feet, which was built at St. Paul. The management of this operation, however, did not contemplate getting their timber from Wise County, but bought up all the available tracts lying along Clinch River in Russell and Tazewell counties, and utilized the water course for floating the logs to the mill.

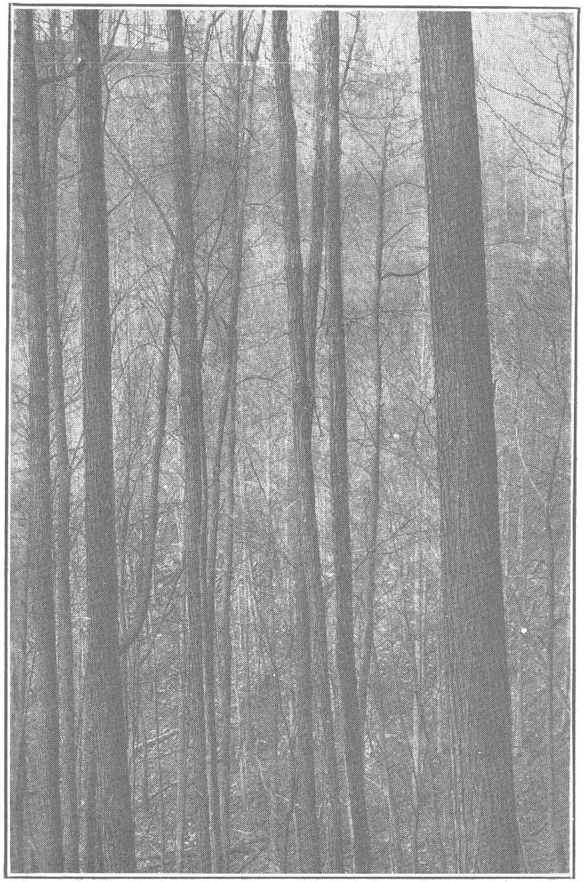
The next serious inroad upon the virgin timber of the county began about 1895, when preparations were made for cutting the yellow poplar. From this date single-band mills have been operating continuously in different sections of the county until very recently. All of these mills were of the single-band type, speaking of the major operations, and had a daily capacity of about 30,000 feet. Mills of this class have operated at Exeter, Pardee, Ramsey, at the head of Powell River (South Fork), and a more recent band-mill operation at Glamorgan removed practically all the merchantable timber on the Pound watershed as far north as the Kentucky-Virginia line. There is a band-mill located at the present time at Exeter, but it has exhausted all the available supplies in that general region and hence is not being operated. Due to these extensive lumbering operations mainly (there have been portable mills operating at the same time), there remain only two or three tracts of timber in the county that would justify a band-mill setting.

The different water courses have not been utilized to any great extent for transportation of the logs. Some of the virgin poplar that was cut on

(A) Chestnut in "slope" type. Young growth. The tallness and straightness due to its occurrence on a "slope" instead of on a "ridge."



(B) Chestnut in "ridge type," trees rather short, crooked and limby. This stand is rather better than the average of this type.



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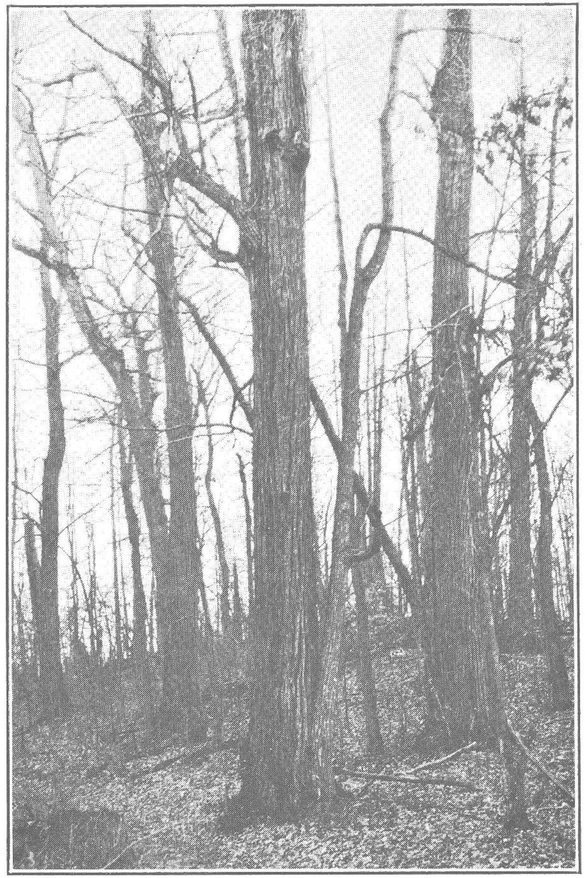

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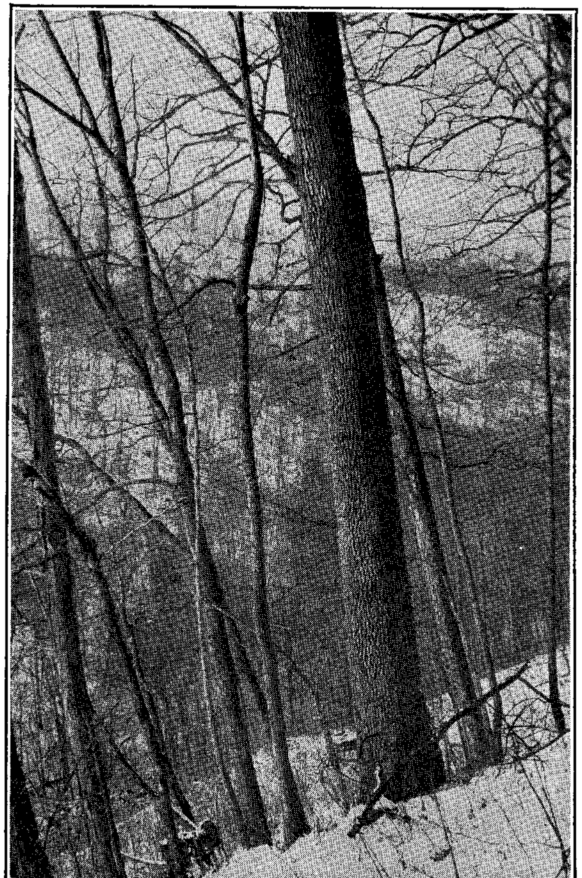
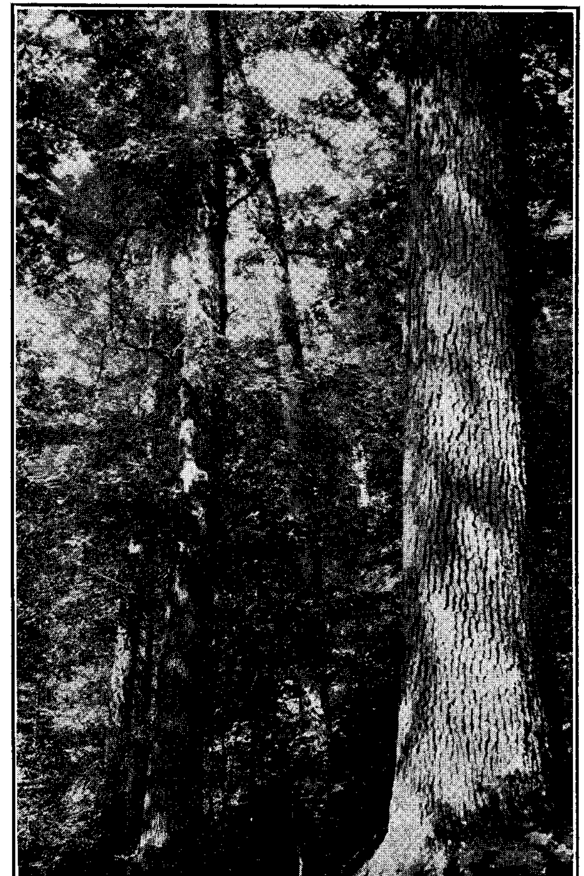
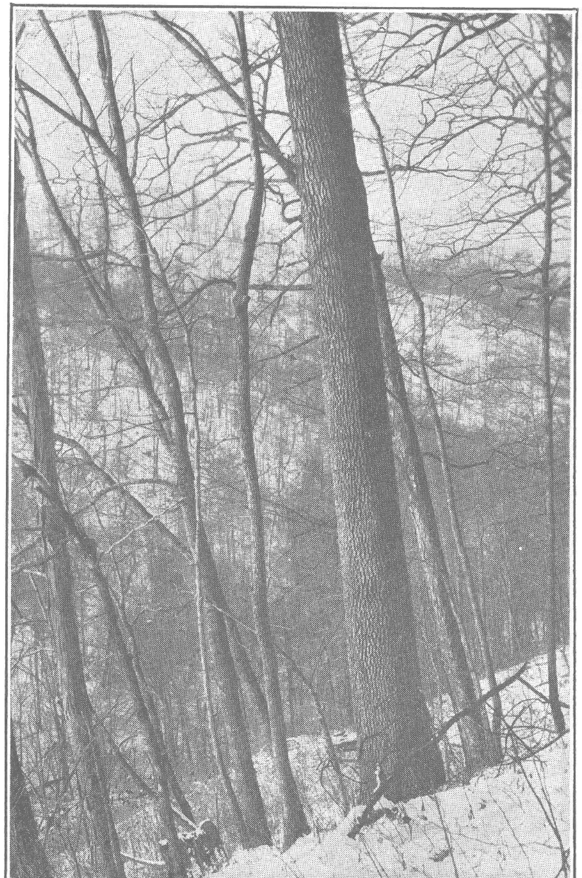


(A) Very high-class white oak in "slope" type. Such timber is now very scarce in Wise County.



(B) "Slope" type, looking down into a "cove." A mixed stand, principally white oak.



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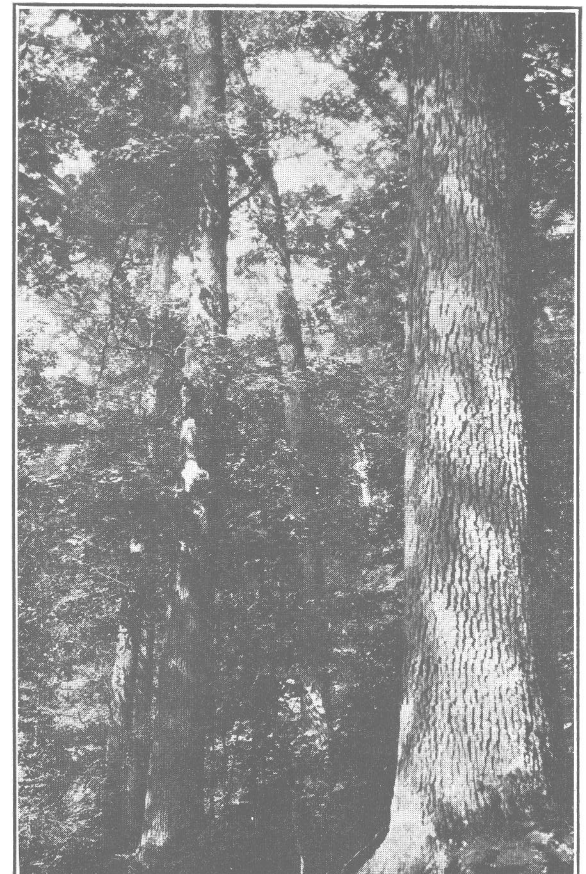


(B) "Slope" type, looking down into a "cove." A mixed stand, principally white oak.

the lower reaches of Pound River in Wise County were floated during the high water season to Russell Fork, and from there they continued by river transportation to the mill at Coal Grove, Ohio. The bulk of the timber, however, has been cut into dimension lumber by the mills operating in the county and shipped to markets outside. Much of the select poplar was formerly cut into panel stock, 5/8 inch thick by 16 inches wide and 24 feet long.

One noticeable difference between past and more recent operations is the closer utilization that is now practiced, to the detriment of the forest, the more valuable and desirable species now being cut to very low diameter limits. That such close utilization was not practiced in the past was not due to the operators' regard for the future condition of the forest, but the timber was more plentiful at that time, and the market demands not so brisk as is the case at present. These early operations were conducted on a "selection" system of cutting, although the cutting was done without any such predetermined object in view. Nevertheless it left the remaining forest in immeasurably better condition than the recent operations, with closer utilization practices, have done. Obviously there must be a resumption of the old cutting standards if a permanent supply of timber is to be expected.

PRESENT METHODS OF LUMBERING.

Present lumbering operations, due to the depletion of the virgin timber, are carried on exclusively by circular mills, with a capacity of from 4,000 to 6,000 board feet daily. The work is done entirely by local labor, and often a mill has to stop operating during the harvesting season or when there is other urgent work on the farm to be done. Some of the operators have their mills simply to give them employment when they are not otherwise occupied, and only operate them for short periods during the year. The wages paid for cutting, logging or roughworking the logs in the woods average about $1.75 a day and board, or $2.50 without "keep" (August, 1922). The average for mill wages is about the same, with the exception of the sawyer, who usually receives about five dollars for a ten-hour day. Six dollars per day is the generally accepted payment for driver and team.

The logs are "bruted" or "ballhooted" down the steep slopes to a side valley or draw, where they are fastened together by means of grabs, four to six in series, depending on the slope and on the size of the logs, and skidded to the mill. When this method is impracticable, rough trails are cut on the sides of the slopes, with only such obstructions removed as to make skidding feasible, and eight to twelve logs are then fastened together by grabs and snaked down the steep slopes to be sawed.

The milling equipment usually consists of a fifty to seventy-five horse-power boiler, a fifteen to twenty-five horse power engine, carriage, (a Wheeland No. 10 carriage is common), 54 and 60-inch circular saws, and a gang-edger. The sawyer usually takes care of his own saws and will saw about ten thousand feet of lumber to each filing.

The average cost from stump to stick is approximately ten dollars per thousand feet, board measure, of which amount the logging operations, felling, swamping and bucking, and transportation to the mill cost about \$5.50, and the milling charges are about \$4.50. The cost of delivery to the shipping point depends of course upon the distance that the lumber has to be hauled and the character of the roads. One operation that has its mill about two and one-half miles from the railroad figures its delivery charges at \$3 per thousand and \$1 for loading on to the cars.

Practically all the dimension lumber is cut into 4/4-inch and 8/4-inch stock, and outside of the immense quantities of "bill lumber" that are supplied to the mining industries it is all shipped to points outside of the county. Some of the principal markets are Pittsburgh, Philadelphia, Hagerstown, Md., Cincinnati, and points in Indiana. Considerable quantities of white oak and rock oak for wagon stock material have been shipped for export trade, but the market at the present writing is very quiet. This stock is commonly sawed 4½ inches or 5 inches by 12 inches, random lengths.

Jobbers or wood manufacturing industries purchase their lumber, as a rule, by specified grades and dimensions. The basis for grading is the quality of the lumber as determined by the number and the size of standard defects, such as stain, worm-holes, shake, knots and dote. The width of the material is also taken into consideration. Four standard grades are employed in this section: (1) First and seconds; (2) No. 1 Com.; (3) No. 2 A; (4) No. 2 B, and sometimes a number 3 Common.

PRESENT METHODS OF PURCHASING TIMBER.

Timber is bought by the tract or acre, by the thousand board feet, mill run and log run, and by the individual tree. In the latter case four diameter classes are employed; 12 to 16 inches, inside the bark on the stump; 16 to 20 inches, 20 to 24 inches, and 24 inches and over. In general, it may be stated that it is much more satisfactory for the timberland owner to dispose of his timber on the basis of actual mill scale, since these scales usually overrun from 15 to 30 per cent the log scales that are commonly used. By selling in this manner the seller secures the full market value for his product. Selling timber by the tract usually favors the buyer, since his better knowledge of the yield per acre and his better knowledge of values give him an advantage over the owner. Keen competition tends to a degree to offset this advantage. In general, however, this manner of selling should be avoided, unless the owner is a competent judge of timber and has a good knowledge of values and general market conditions. Moreover as accurate as possible an estimate of the standing timber should be made, as many bids as possible secured for its sale, and the contract should state specifically the restrictions in the manner of cutting that the seller wants to have observed. For the more valuable species, such as white oak, yellow poplar, cucumber, etc., the diameter-limit should be not less than 16 inches, otherwise the future value of the forests will be seriously impaired.

STUMPAGE VALUES.

There seems to be little if any difference in stumpage values throughout the county, regardless of the location and accessibility of the timber, and the character of the roads over which the logs must be hauled. Perhaps this may be accounted for by the keen competition for standing timber, but it indicates that the cost of hauling is not usually given as much weight as it warrants.

The following prices are the ones commonly paid for stumpage at the present time (August, 1922):

Species.	*Value on the Stump per M board feet.*
Black walnut	$35
Yellow poplar	10
Cucumber-tree	10
White ash	10
White oak and red oak	8 to $10
Chestnut oak	6
Chestnut	6
Black oak	5
Basswood, or lin	4 to 5
Sugar maple	4
Hemlock	4
Hickory	2 to 3
Beech	2

TANNIN EXTRACT.

The bark of hemlock and chestnut oak, and to some extent the bark of red, white, and black oaks are used rather extensively in the tannin extract industry. The scarcity of these barks led to the substitution of certain kinds of wood, the principal substitute in the east being chestnut extract wood.

The average per cents of tannin contained in the bark of the different species common to this section are as follows:

Hemlock	13.11 per cent
Chestnut oak	6.25 per cent
Black oak	5.90 per cent
White oak	5.99 per cent
Red oak	4.56 per cent

One of the largest extract plants in southwest Virginia is The Clinch River Extract Company, located at St. Paul. It uses about 25,000 cords of chestnut extract wood each year, and 23,000 cords of oak bark. A cord of chestnut wood sold for this purpose is a stack of wood cut into five-foot lengths, and piled eight feet long and four feet high, and contains, therefore, 160 cubic feet instead of the standard for cordwood, 128 cubic feet. A cord of the bark is equivalent to a long ton, 2,240 pounds, and it is bought by this standard. The bark is carefully piled under long sheds, and permitted to dry or season for about a year if possible, as the tannin is then more readily extracted than is possible if the bark is green. Great care must be observed to prevent the bark from getting moist or wet, as it tends to mould and the tannin under these conditions will leach out.

Seventy per cent of all the bark used at the plant mentioned above is chestnut oak, 20 per cent hemlock, and 10 per cent divided between the black and white oaks. A common product is what is termed the "blend extract," which is a tannin made from using 30 per cent bark and 70 per cent chestnut wood.

The principal sources of supply of chestnut wood and the various barks are points along the C. C. & O. Railroad, especially in North Carolina. Not over fifteen per cent of the wood and bark used by the Clinch River Extract Company is obtained from Wise County.

The following prices were in effect in August, 1922:

Chestnut wood	$ 6.00	f.o.b. cars at any station on the C.C.& O.R.R.
Chestnut oak bark	13.44	f.o.b. cars at any station on the C.C.& O.R.R.
Hemlock bark	11.20	f.o.b. cars at any station on the C.C.& O.R.R.
Black oak bark	10.08	f.o.b. cars at any station on the C.C.& O.R.R.
Red & white oak bark	8.00	delivered at the plant.

These prices are subject to constant fluctuations.

FOREST FIRES.

Evidences of seriously destructive forest-fires are to be seen in almost any section of the county, especially in the immediate neighborhood of the mining towns and along the railroad lines that extend to these towns. The result of them has been a large loss to the mature timber from rot and decay, (in many instances even the larger trees being killed outright), the death of the second growth and reproduction, and the failure of these burned-over areas to restock themselves with the more desirable species, or at least a marked delay in this young growth getting established. Furthermore, fires severely injure the soil through chemical and physical changes, open the way to extensive soil erosion, destroy the seeds and seedlings of the more valuable species, reduce the density of the stands, and in time so modify the composition of the stands that they have but very little commercial value.

Adequate protection from forest-fires is a prerequisite to all other measures for the conservation and perpetuation of these forests. Large areas of unproductive lands, now covered with a haphazard second growth, and composed of many species of an undesirable nature, cannot be restored to their former state of fertility and productivity unless they are protected from fire.

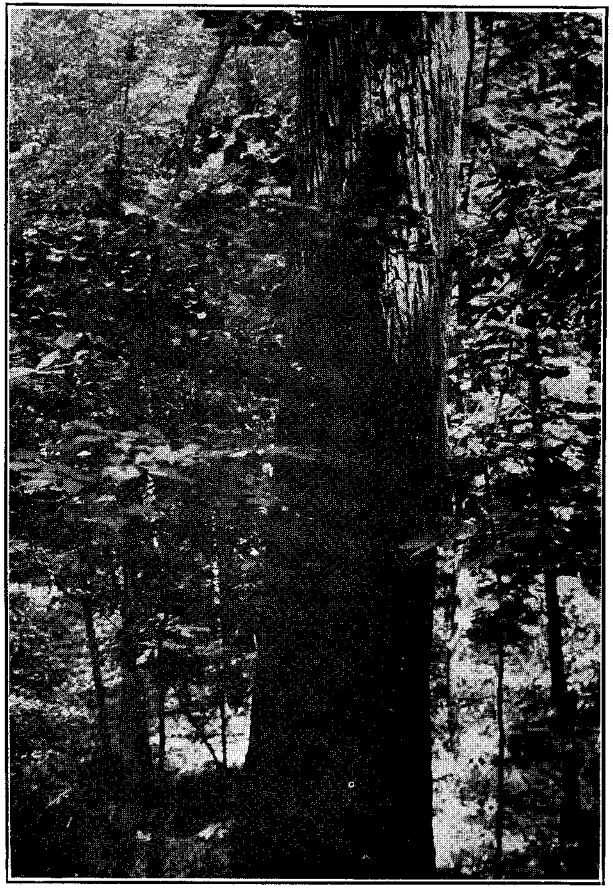
A plan of coöperation for fire prevention and suppression has been in effect for a few years between the State Forester and the Virginia Coal and Iron Company, with the assistance of the U. S. Forest Service. More recently the coöperation of the County Supervisors has been secured and a system of fire protection is being organized throughout the county. Under this plan of coöperation a Chief Forest Warden for the county has been appointed, who is responsible for the organization and the maintenance of the force of district wardens, for assisting the Commonwealth's Attorney in the enforcement of the law and for the direction of all work that it may seem advisable to undertake. The duties of the district wardens are to patrol their respective districts during the dangerous days of the spring and fall fire seasons, to see that their districts are at all times well posted with forest fire warnings, to investigate the causes of all fires, and to assist in bringing action in case of a flagrant violation of the law, to visit sawmill-sites and land-clearing operations, and to seek at all times the coöperation of every citizen in this campaign against forest fires. Local forest wardens are also being appointed whose duties are to take leadership and responsibility in suppressing any forest fire in their districts. All these men receive their appointments from the Governor of Virginia on the recommendation of the State Forester, and have the backing and the support of the State in the discharge of their duties.

THE FUTURE OF THE FORESTS.

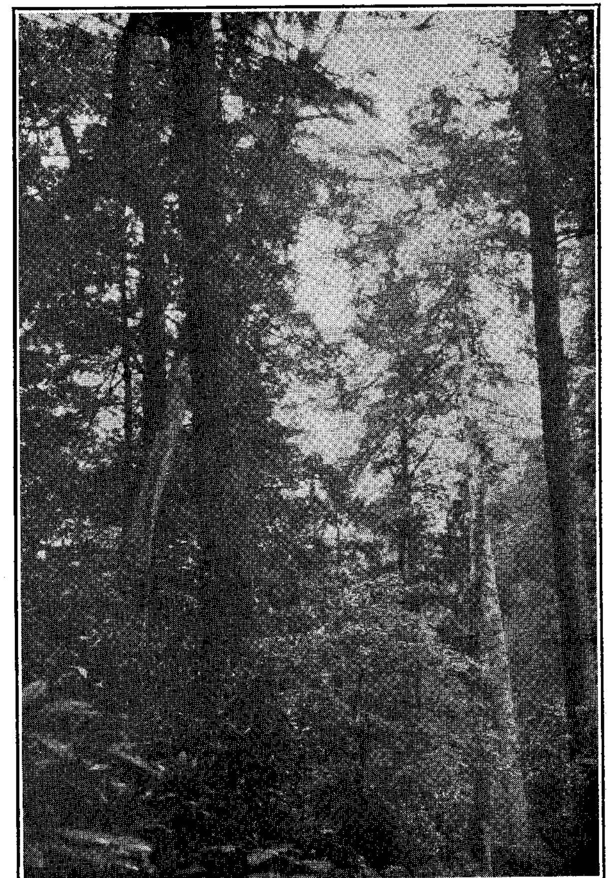
There are only three small sections in the county (for details see the chapter on Topography and Drainage) where there is any large amount of farming done. In the county as a whole the slopes are so steep and the soil is so thin and gullies so badly that probably 80% of the surface of the county is better adapted to timber growing than to any other purpose and will be used for this purpose. In connection with most of the farms there are small areas of woods which should be managed as adjuncts to the farms for the purpose of raising the wood materials that will be needed on the farm and which will be comparatively cheap to the farmer if grown at home but expensive to him if he has to have them shipped in. The area of such forest land in Wise County will be a very small percentage of the county. With this exception it seems apparent that the future supply of timber in the county will all be consumed by the demands of the mining industry, and practically all of the forest land of the county should be managed with this object in view. In fact, it is evident that the second growth now occupying the cut-over lands of the county, even if it is successfully protected from fire, is not cut before maturity, and the most favorable conditions for its rapid growth prevail, will not by any means suffice to meet the future requirements of the mining industry. The amount of timber needed in mining is enormous and even at the best it will be necessary as long as mining is practiced on a large scale to bring in certain classes of timbers from outside the mining region. Obviously under these conditions it should be profitable to raise as much mining timber as possible on the coal lands themselves. The forests can be made to yield mining timbers of some sort in perpetuity if protected from fire, while the amount and value of the timber grown will depend upon the extent to which intelligence is applied in cutting the timber in accordance with the principles of forestry.

THE NECESSITY OF MORE CONSERVATIVE CUTTING.

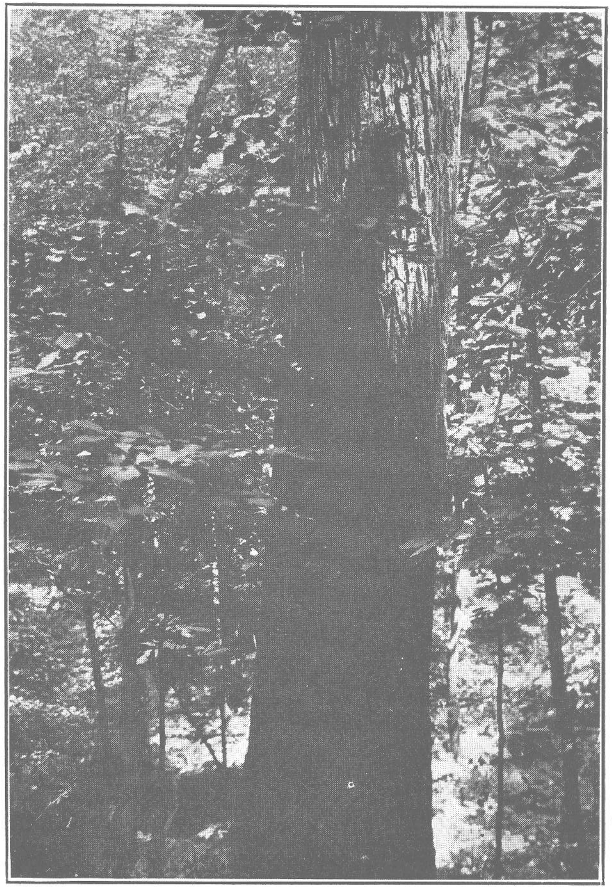
The earlier cuttings took only the most valuable trees, hence the walnut has almost entirely disappeared from the forests and the proportion of high-class tulip poplar has diminished, while the proportion of the inferior trees, such as beech, buckeye, black gum, red maple, etc., has increased. In spite



(A) An original-growth yellow poplar in a cove. This tree contains about 6 M board feet of lumber. There is rarely more than one such large tree per acre.



(B) Large hemlocks in "hemlock bottom" type. Note the undergrowth of rhododendron.



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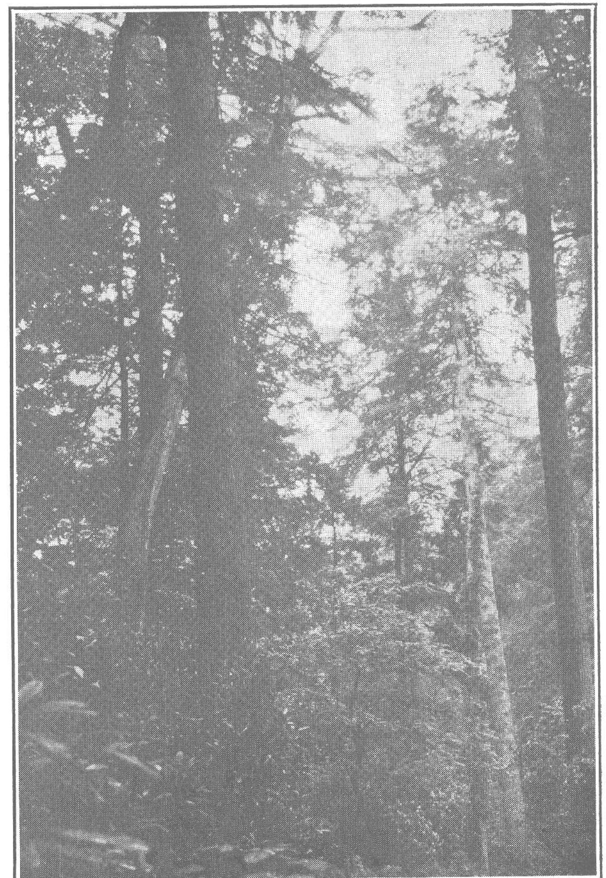

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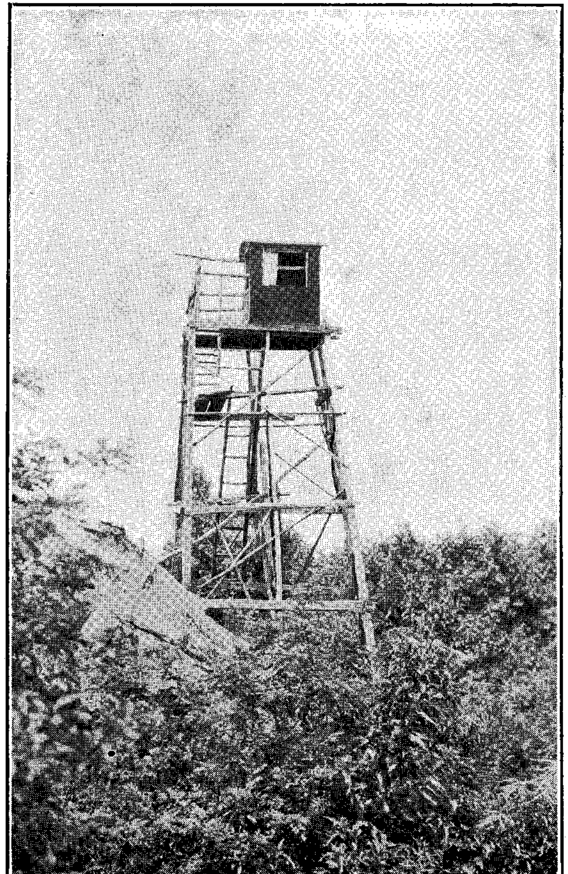
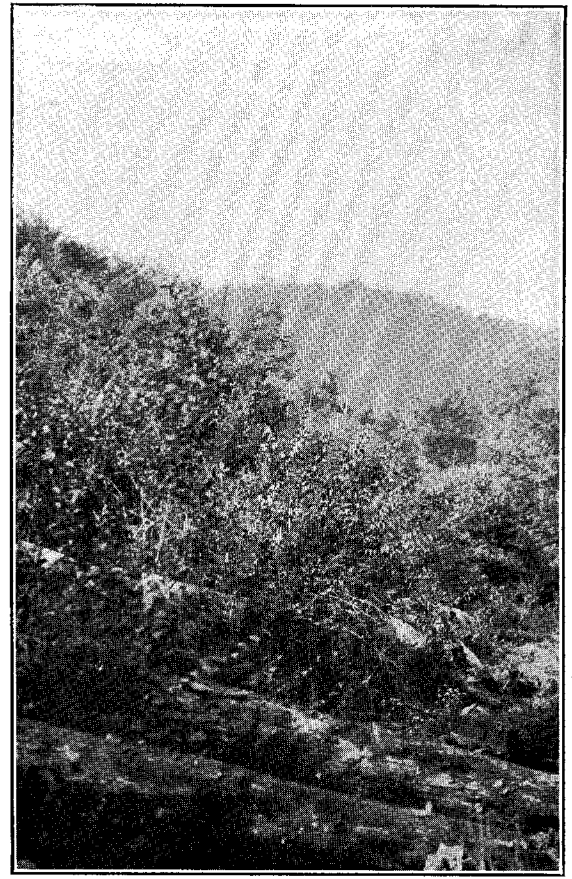
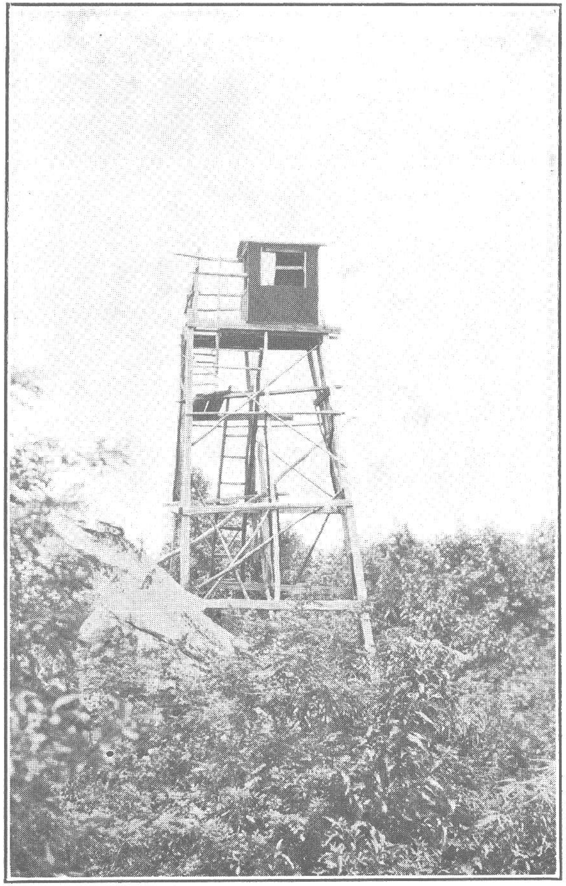


(A) Fire lookout-tower on Little Stone Mountain, built by the Virginia Coal and Iron Co., in coöperation with the Virginia Forestry Dep't.



(B) Lands that have been clear-cut and later burned over, re-stocking to undesirable species.



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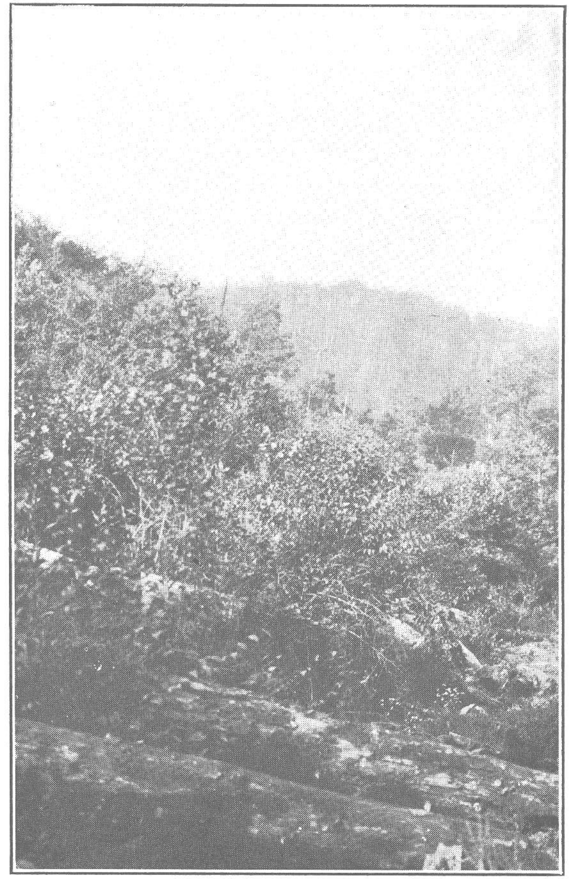


(B) Lands that have been clear-cut and later burned over, re-stocking to undesirable species.

of this fact valuable forests remain, largely because of the fact that the earlier cuttings took only the larger trees, leaving the medium-sized and small trees for future growth. Such cuttings amounted practically to what are technically known as "selection" cuttings, although the operators in making such cuttings were guided only by considerations of temporary expediency and were not considering the future value of the forests. The present cuttings, on the other hand, take trees of the most valuable species down to very small sizes, so that as a rule the stands left after saw-milling operations are exceedingly inferior. Cutting is done at the present time in almost all cases without regard to the condition in which the woods are left for future growth, and a steady and rapid deterioration of the forests is resulting. Unless the present methods of cutting are changed the forests hereafter will be practically worthless, yielding almost nothing.

At the present time unusually large trees of the inferior species are left standing, because they are too large, crooked or tough to be easily worked into ties. These large trees scatter seeds which gives rise to an increasing percentage of the poorer species in the young growth. Relatively small trees of the valuable kinds are taken, because they yield the greatest number of ties for a given amount of effort in cutting them. As a rule the valuable species should be left to grow to larger sizes, instead of being cut for ties. The continuance of this practice will produce a forest of so-called "weed" trees, of little commercial value, not nearly so well adapted to meet the requirements of the mining industry as the present stands.

Other items of waste are the high stumps, unused tops, the leaving of sound wind-falls and wasteful methods of felling. Probably the greatest demand is for mining props 3 or 4 inches square and from 4 to 9 feet long. To secure closer utilization of the present stands it would be better to saw into the required sizes the rougher material from the tops of the trees as well as the entire trunks of those species that are hard to split. The stump height should not be more than 15 inches and felling should be done with a saw. All trees that are cut should be utilized down to 4 inches in diameter in the top, and even less if feasible.

The species which should be favored above others because of the value of their wood or bark, their rapid growth, or for other reasons, are principally tulip poplar, cucumber-tree, white oak, northern red oak, white ash, and basswood (also black walnut where it occurs, although it is extremely rare). The present practice cuts these species down to small sizes, which is bad forest management. These valuable species should not be cut when smaller than 16 or 18 inches in diameter across the stump. All valuable trees smaller than this should be left to grow to larger sizes. On the other hand, all other species should be utilized to as small sizes as is economically feasible, in order to get them out of the way and give more room for the growth of trees of the more valuable species.

This diameter limit is stated only as a guide. It is not claimed that it could be followed absolutely under all circumstances. It would be preferable to have all the trees to be cut selected and marked by a forester in accordance with the principles of forestry. Wherever this is done, variations could be put into effect as made advisable by local conditions, such as the density of the trees in each particular clump, the straightness, quality of the wood and freedom from defects, etc., of the individual trees. In any case if medium-size trees of the valuable species happen to be absent no large openings should be left. In such cases at least one tulip poplar, ash or basswood tree or three or four white or red oaks to the acre should be left to scatter seed rather than make a clear-cutting.

If the more conservative method of cutting here described is put into effect and the forests are protected from fire a permanent supply of high-grade wood products can be secured. Otherwise the forests will rapidly deteriorate.

SUMMARY.

(1) *Location and area.*—Wise County is located in the extreme southwestern part of Virginia. Its area is 420 square miles, or 268,800 acres.

(2) *Topography and drainage.*—The topography is, generally speaking, rough and mountainous. There are three small sections of the county well adapted to agriculture. The county is drained by three distinct drainage systems, Pound, Guest, and Powell's rivers.

(3) *Climate and soil.*—The climate is moderate, the average precipitation is about 47 inches, and the winters are usually open. The soils are of residual origin, the rock formations are limestone, sandstone and shale.

(4) *Population.*—The population according to the 1920 Census was 46,500.

(5) *Transportation facilities.*—The Clinch Valley Division of the Norfolk and Western extends from Bluefield, W. Va., to Norton; the Louisville and Nashville from Norton to its main line at Corbin, Ky.; the Southern passes through the southwestern part of the county; the C. C. &

O. through the eastern section; and the Interstate and the Norton and Northern connect with these principal lines of travel and transportation. There are many miles of sandstone and limestone macadam roads in the county, and also many miles of graded roads that are not yet surfaced.

(6) *Industrial features.*—The most important industries are coal-mining, agriculture, and lumbering, in the order named.

(7) *Land ownership.*—Over two-thirds of the entire land surface of the county is owned or controlled by various coal companies which are operating in the county. These large surveys range in size from about 85,000 acres down to 5,000 or 6,000 acres. The average unit of ownership for farm lands is about 38 acres.

(8) *Forest trees of commercial importance.*—The most valuable trees are the yellow poplar, white and northern red oak, cucumber-tree, and to a lesser extent, chestnut, basswood, hemlock, rock oak and other hardwoods.

(9) *Forest types.*—There are four distinct types, conforming to the general topographic divisions—ridge, slope, cove, and hemlock bottom. There are characteristic species composing each type.

(10) *Classification of the forests.*—The forests may be divided into four general classes, these classifications being based upon the extent of past cuttings: 1—Virgin with poplar; 2—Virgin without poplar; 3—Forests that have been lightly culled, particularly for white oak, but which have saw-milling possibilities to-day; 4—Lands composed chiefly of mining timbers. There are about 2,000 acres of the first-class with an estimated stand of about 6,000 feet to the acre; 24,272 acres of the second, average yield 4,500 feet per acre; 12,971 acres of the third, averaging about 3,500 feet to the acre, and the greater part of the area of the county, 188,018 acres, composed principally of small growth suitable for mining purposes only.

(11) *Total estimate of standing saw-timber in Wise County.*—The total stand of merchantable saw-timber in the county is estimated to be 188,000,000 board feet (excluding isolated trees and stands too small to be cut feasibly).

(12) *History of lumbering.*—Lumbering operations first began in the county about 1887, when the black walnut was logged. With the completion of the railroad lines into the county in 1892 further impetus was

given to the lumbering industry, and single-band mills with a daily capacity of about 30,000 feet have operated almost continuously since that time until about two years ago.

(13) *Present methods of lumbering.*—Present lumbering operations are conducted entirely by circular mills with an average daily cut of about 6,000 board feet.

(14) *Methods of purchasing timber.*—Timber at the present time is bought by the tract, by the acre, by the thousand feet, log or mill run, and by the individual tree. In general, it may be said that it is much more satisfactory if possible for the owner to dispose of his timber by the mill scale.

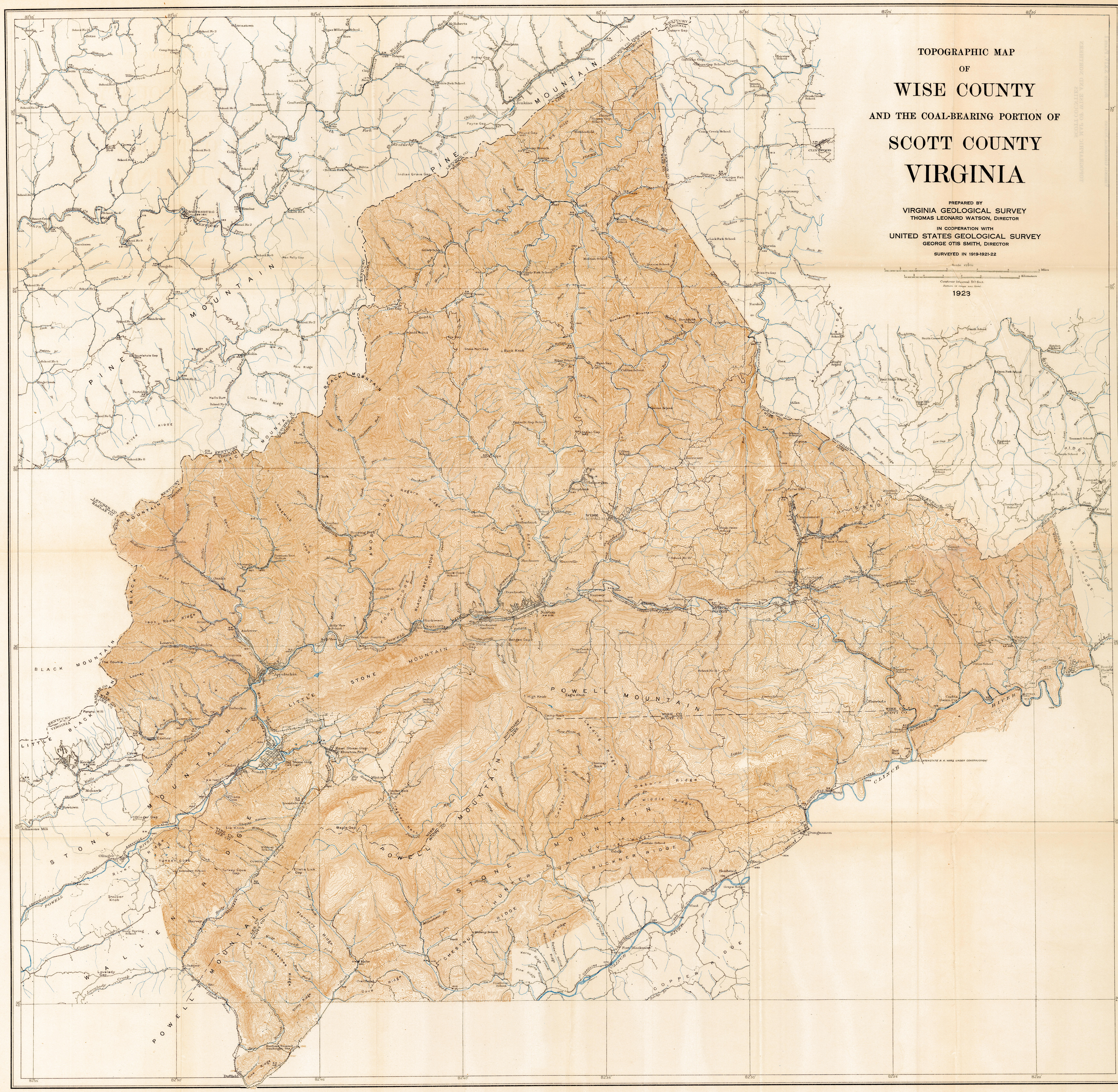
(15) *Stumpage prices.*—Stumpage values are about as follows, (August, 1922): yellow poplar, $10.00 per M. feet; white oak and red oak, $8.00 to $10.00; chestnut oak, $6.00; chestnut, $6.00; basswood, $4.00; hemlock, $4.00; hickory and beech, $2.00. Stumpage values are not greatly influenced by location in the county.

(16) *Forest fires.*—Fires have done enormous damage in the past, but it is hoped that this source of damage and danger will be removed by the plans that have been made for organizing the county on a systematic basis for the prevention and the suppression of forest fires, through coöperation between the State Forester, the U. S. Forest Service, the County Supervisors and the landowners.

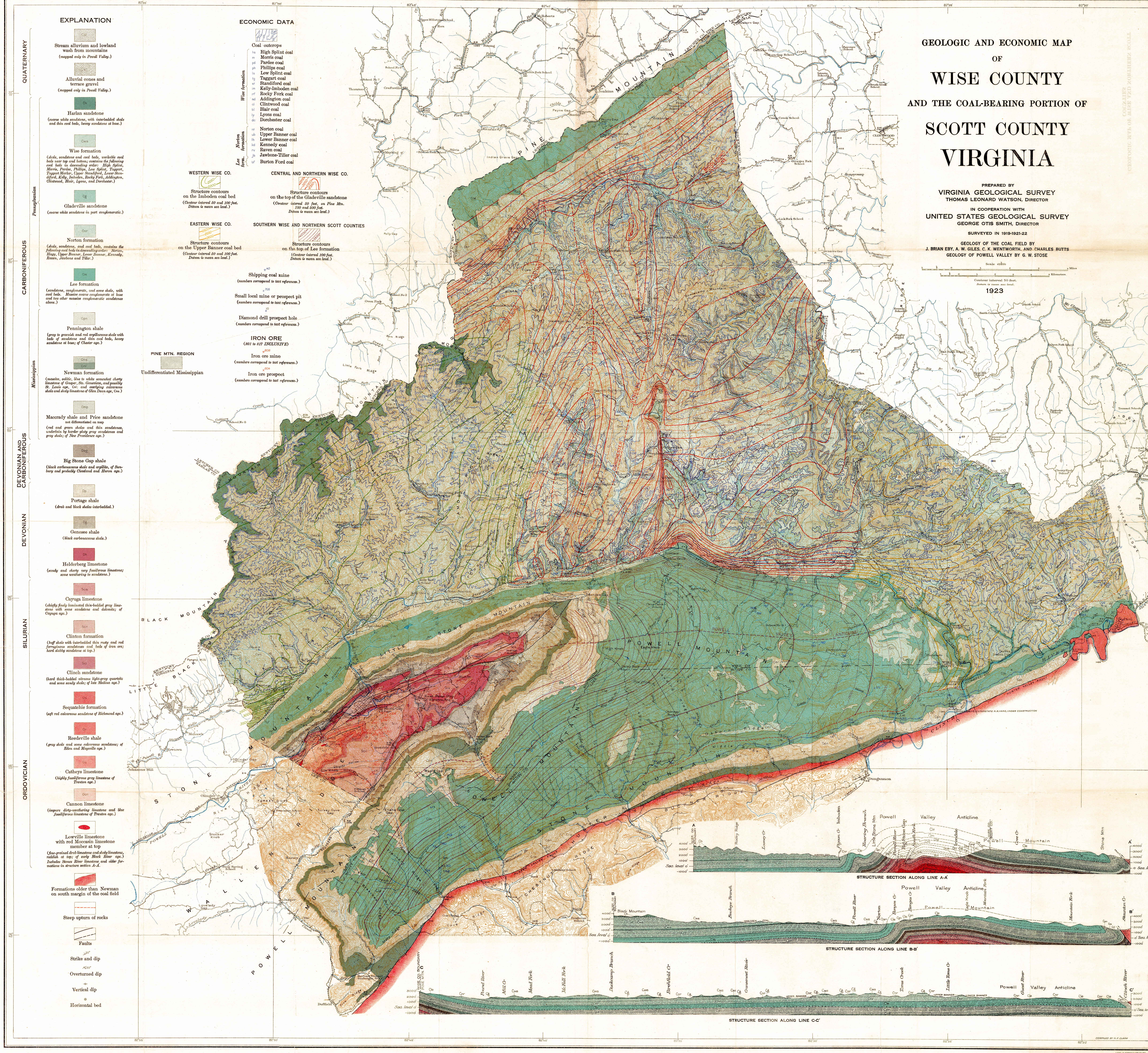
(17) *The future of the forests.*—Whether or not the forests of the county will be an economic asset and a source of revenue to the people and to the industries depends upon how timber is cut and how it is protected from injury. The more valuable species such as poplar, white oak, cucumber-tree, basswood, red oak, white ash, and other hardwoods, should not be cut below a 16-inch diameter limit on the stump. Care should be exercised to see that sufficient seed-trees are left to seed up the ground. Four-fifths of the land surface is "absolute forest land," and these lands should be utilized and managed with a view to their producing the greatest profit and revenue. Forest fire protection is the prerequisite above all other measures for the conservation and perpetuation of these forests.

INDEX[a]

[a] Prepared by Linwood H. Warwick.



TOPOGRAPHIC MAP
OF
WISE COUNTY
AND THE COAL-BEARING PORTION OF
SCOTT COUNTY
VIRGINIA
PREPARED BY
VIRGINIA GEOLOGICAL SURVEY
THOMAS LEONARD WATSON, DIRECTOR
IN COOPERATION WITH
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR
SURVEYED IN 1919-1921-22
Scale 1/62500
Contour interval 50 feet.
Datum is mean sea level.
1923
PINE MOUNTAIN
STONE MOUNTAIN
POWELL MOUNTAIN
LITTLE STONE MOUNTAIN
BLACK MOUNTAIN
WALLEN RIDGE
COPPER RIDGE


GEOLOGIC AND ECONOMIC MAP
OF
WISE COUNTY
AND THE COAL-BEARING PORTION OF
SCOTT COUNTY
VIRGINIA
PREPARED BY
VIRGINIA GEOLOGICAL SURVEY
THOMAS LEONARD WATSON, DIRECTOR
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SURVEYED IN 1919-1921-22
GEOLOGY OF THE COAL FIELD BY
J. BRIAN EBY, A. W. GILES, C. K. WENTWORTH, AND CHARLES BUTTS
GEOLOGY OF POWELL VALLEY BY G. W. STOSE
Scale 1/62500
Contour interval 50 feet.
Datum is mean sea level.
1923
EXPLANATION
QUATERNARY
CARBONIFEROUS
Pennsylvanian
Mississippian
DEVONIAN AND CARBONIFEROUS
DEVONIAN
SILURIAN
ORDOVICIAN
Stream alluvium and lowland wash from mountains
Alluvial cones and terrace gravel
Harlan sandstone
Wise formation
Gladeville sandstone
Norton formation
Lee formation
Pennington shale
Newman formation
Maccrady shale and Price sandstone
Big Stone Gap shale
Portage shale
Genesee shale
Helderberg limestone
Cayuga limestone
Clinton formation
Clinch sandstone
Sequatchie formation
Reedsville shale
Catheys limestone
Cannon limestone
Lowville limestone with red Moccasin limestone member at top
Formations older than Newman on south margin of the coal field
Steep upturn of rocks
Faults
Strike and dip
Overturned dip
Vertical dip
Horizontal bed
ECONOMIC DATA
Coal outcrops
High Splint coal
Morris coal
Pardee coal
Phillips coal
Low Splint coal
Taggart coal
Standiford coal
Kelly-Imboden coal
Rocky Fork coal
Addington coal
Clintwood coal
Blair coal
Lyons coal
Dorchester coal
Norton coal
Upper Banner coal
Lower Banner coal
Kennedy coal
Raven coal
Jawbone-Tiller coal
Burton Ford coal
Wise formation
Norton formation
Lee form.
WESTERN WISE CO.
Structure contours on the Imboden coal bed
CENTRAL AND NORTHERN WISE CO.
Structure contours on the top of the Gladeville sandstone
EASTERN WISE CO.
Structure contours on the Upper Banner coal bed
SOUTHERN WISE AND NORTHERN SCOTT COUNTIES
Structure contours on the top of Lee formation
Shipping coal mine
Small local mine or prospect pit
Diamond drill prospect hole
IRON ORE
Iron ore mine
Iron ore prospect
PINE MTN. REGION
Undifferentiated Mississippian
PINE MOUNTAIN
BLACK MOUNTAIN
STONE MOUNTAIN
POWELL MOUNTAIN
WALLEN RIDGE
Powell Valley Anticline
STRUCTURE SECTION ALONG LINE A-A'
STRUCTURE SECTION ALONG LINE B-B'
STRUCTURE SECTION ALONG LINE C-C'


SECTIONS OF DRILL HOLES IN OR NEAR WISE COUNTY, VIRGINIA
Numbers at upper left hand corners of sections show elevation of surface above sea level
Coal beds showing in the sections of the bore holes of the Virginia Coal & Iron Company, the Stonega Coke & Coal Company, the Norton Coal Company, the Virginia Iron Coal & Coke Company, and the Clinchfield Coal Corporation, are indicated by a line of arbitrary and uniform weight, the thicknesses of these beds being confidential information.
LEGEND
SANDSTONE
CONGLOMERATIC SANDSTONE
SHALE
SANDY SHALE
COAL
SCALE
800'
600'
400'
200'
0'
WISE FORMATION
LOW SPLINT
TAGGART
TAGGART MARKER
UPPER STANDIFORD
LOWER STANDIFORD
PINHOOK
KELLY
IMBODEN
CLINTWOOD
BLAIR
LYONS
DORCHESTER
GLADEVILLE SANDSTONE
NORTON
UPPER BANNER
NORTON FORMATION
KENNEDY
RAVEN
JAWBONE
TILLER
TOP OF LEE
BASE OF LEE
LEE FORMATION
PENNINGTON SHALE
ABBREVIATIONS USED
(S.C.& C.C.) Stonega Coke & Coal Co.
(V.C.& I.C.) Virginia Coal & Iron Co.
(W.C.& C.C.) Wise Coal & Coke Co.
(N.C.C.) Norton Coal Co.
(C.C.C.) Clinchfield Coal Corporation.
(V.I.C.& C.C.) Virginia Iron Coal & Coke Co.
(I.C.& I.C.) Interstate Coal & Iron Co.
INDEX MAP OF WISE COUNTY VIRGINIA
SHOWING LOCATION OF DRILL HOLES
KENTUCKY
LETCHER CO.
DICKENSON CO.
RUSSELL CO.
SCOTT CO.
WISE CO.
LEE CO.
HARLAN CO.
POWELL RIVER
GUEST RIVER
CLINCH RIVER
POUND RIVER
Pound
Flat Gap
Glamorgan
Wise
Esserville
Norton
Dorchester
Toms Creek
Coeburn
Stonega
Roda
Appalachia
Big Stone Gap
Exeter
St. Paul
Bangor
Tacoma
L.B.P. 1923