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DIRECTOR

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The Coal Resources of the Clintwood and Bucu Quadrangles, Virginia

BY

HENRY HINDS

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LETTER OF TRANSMITTAL

VIRGINIA GEOLOGICAL SURVEY,
UNIVERSITY OF VIRGINIA,
CHARLOTTESVILLE, July 15, 1916.

Governor Henry C. Stuart, 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. XII of the Virginia Geological Survey Series of Reports, a manuscript and illustrations of a report on "The Coal Resources of the Clintwood and Bucu Quadrangles, Virginia," by Mr. Henry Hinds.

This report has been prepared by the Virginia Geological Survey in coöperation with the U. S. Geological Survey, and is the second one of a series to be published under the coöperative agreement of the State and Federal Surveys on the coals in southwest Virginia. It embodies a study of the coals in those parts of Dickenson, Buchanan, and Russell counties included in the Clintwood and Bucu quadrangles, and should prove of much economic value in directing attention to an important area possessing in quantity bituminous coals of great purity and value.

Respectfully submitted,

THOMAS L. WATSON,
Director.

THE COAL RESOURCES OF THE CLINTWOOD AND BUCU QUADRANGLES, VIRGINIA

By Henry Hinds.

INTRODUCTION

Location and importance of the area.—The Clintwood and Bucu quadrangles are almost entirely in southwest Virginia (see fig. 1), chiefly in Dickenson, Buchanan, and Russell counties. A small area in the southwest corner of the Clintwood quadrangle is in Wise County and a few square

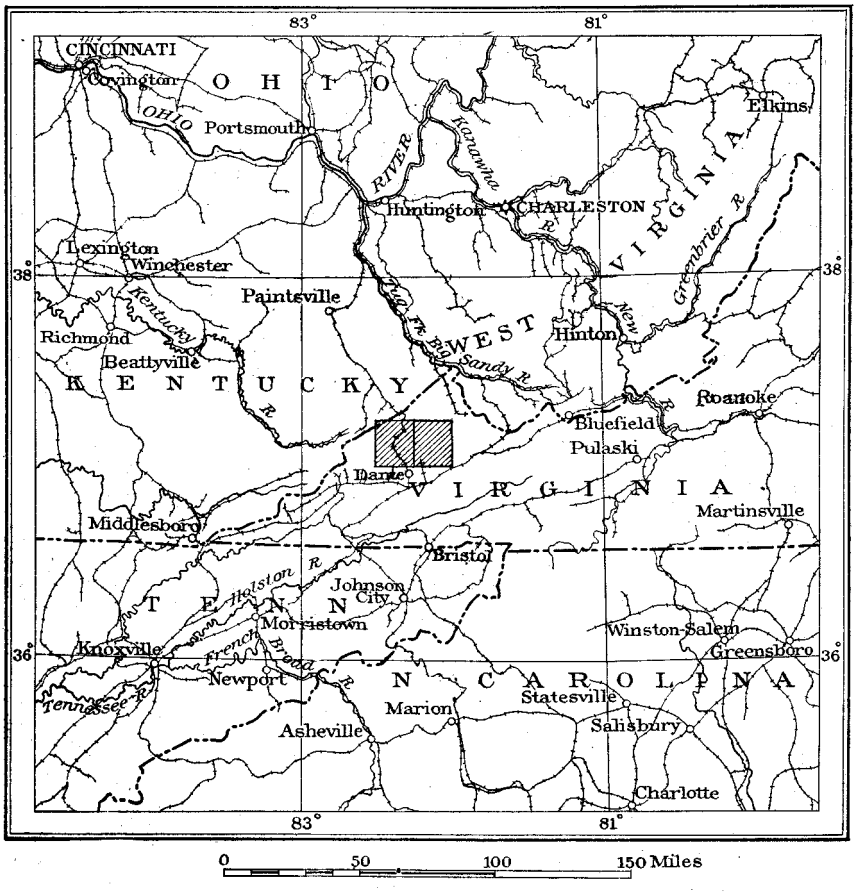


Fig. 1.—Index map showing the location of the Clintwood and Bucu quadrangles.

miles in the northwest corner are in Pike County, Kentucky. These quadrangles form the south half of the old Grundy 30-minute quadrangle and contain 476 square miles.

The quadrangles lie on the southeast border of the central part of the Appalachian coal field and contain large quantities of untouched coal. As will be shown, there are in the ground in beds 14 inches and more in thickness, about 10,367,000,000 tons of high-grade, coking bituminous coal. Because of their former inaccessibility the coal resources of most of the region have not yet been utilized, but the recent construction of the Carolina, Clinchfield & Ohio Railway extension from Dante, Va., to Elkhorn City, Ky., has furnished communication with both the South and the Middle West for a large area. The near future should bring the installation of large mining plants, the building of busy coal camps, and the shipping of great quantities of valuable fuel to other parts of the country. A start in this direction has already been made in the southern part of the quadrangles, in an area which has been relatively more accessible.

The survey upon which this report is based was undertaken primarily because of the great potential value of the coal resources of the region and the lack of knowledge concerning them, even among the inhabitants of the area. This report is preliminary and is issued in advance of the preparation of engraved geologic maps in order to meet demands for immediate information. It is planned to include in a later report engraved maps, showing geologic formations and structure, coal outcrops, topography, drainage, and culture on the same sheet.

Method of work.—The northwest corner of the Clintwood quadrangle, including the Kentucky area on the north and Georges Fork and Brush Creek on the south, was surveyed geologically by Charles Butts in 1912. The rest of the region was surveyed in 1913 and 1914 by T. K. Harnsberger and the author, with the help of C. M. Bauer for six weeks, and of C. A. Davidson for a few days. Mr. Harnsberger assisted in the office during nearly all the preparation of this report. The expense of the undertaking was shared by the United States Geological Survey and the Virginia Geological Survey, the former organization being represented by Mr. Butts and the author, and the latter by Messrs. Harnsberger, Bauer, and Davidson. David White, Chief Geologist of the United States Geological Survey, had general supervision of the work, and added materially to its value by his identifications of fossil plants and critical examination of coal analyses.

The geologic survey was made at the same time as a detailed topographic survey in charge of J. I. Gayetty, and the topographic corps rendered

valuable aid in determining the location and elevation of a number of coal openings and exposures. By this method the geologists had available many more instrumentally determined elevations than appear on the printed maps, but were handicapped in making locations by the lack of completed and adjusted topographic sketching. Geologic profiles were made of all roads and paths and all reported coal openings were visited, but it was soon seen that the lack of well-defined stratigraphic markers, the heavily timbered condition of the country, the rarity of natural coal exposures, and structural irregularities made additional work necessary. Sections 400 to 800 feet long were, therefore, measured at intervals of half a mile to a mile along all the principal valleys. The elevations of the principal exposures were usually read both in going up and coming down, and the barometer was frequently checked at stadia stations to correct errors arising from variations in atmospheric pressure. It may be confidently asserted that the work was more detailed than any other that has been conducted by public geological surveys in the coal fields of the Appalachian region.

Acknowledgments.—The writer is greatly indebted to W. D. Tyler, of the Clinchfield Coal Corporation, for records of many diamond-drill holes (Pls. II and III), maps of accurate transit surveys of coal outcrops, and measurements of coal beds in hundreds of prospect pits. These data were available for the most important parts of the Russell Fork drainage basin, and for nearly all of the Clinch River drainage basin except the Lewis Creek area. Outcrop maps and coal measurements, chiefly in the Levisa Fork drainage basin, were furnished by E. V. d'Invilliers and J. B. Dilworth, and by Charles Catlett.

The only publication describing the geology and coal resources of the quadrangles is the result of a hurried reconnaissance survey by R. W. Stone in the Russell Fork area,[1] and this has been drawn upon for several coal measurements. The Tazewell and Bristol folios of the U. S. Geological Survey, by M. R. Campbell, describing adjacent quadrangles on the east and south, respectively, and recent reports by Charles Butts on the Pound quadrangle [2] were of material assistance.

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

[2] Butts, Charles, The coal resources and general geology of the Pound quadrangle in Virginia: Va. Geol. Survey Bull. IX, 1914.

The coal resources and general geology of the Pound quadrangle in Virginia and Kentucky: U. S. Geol. Survey Bull. 541, 1914.

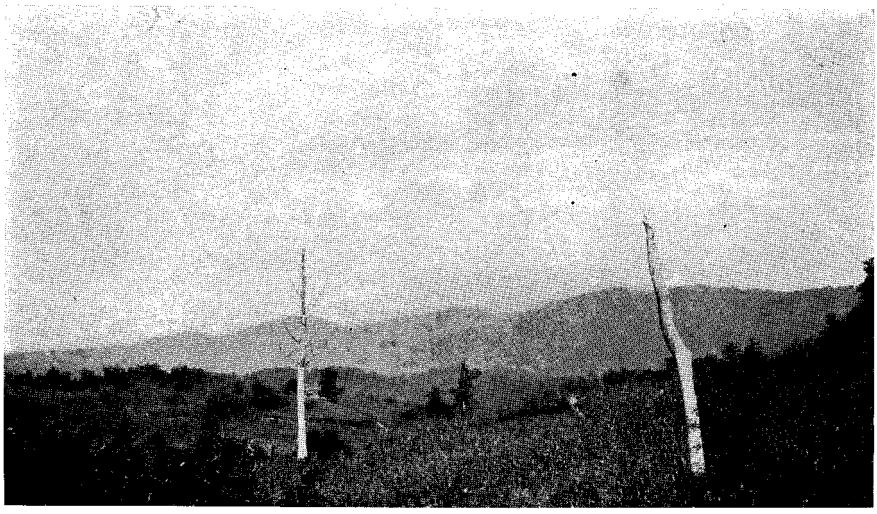
GEOGRAPHY

TOPOGRAPHIC FEATURES.

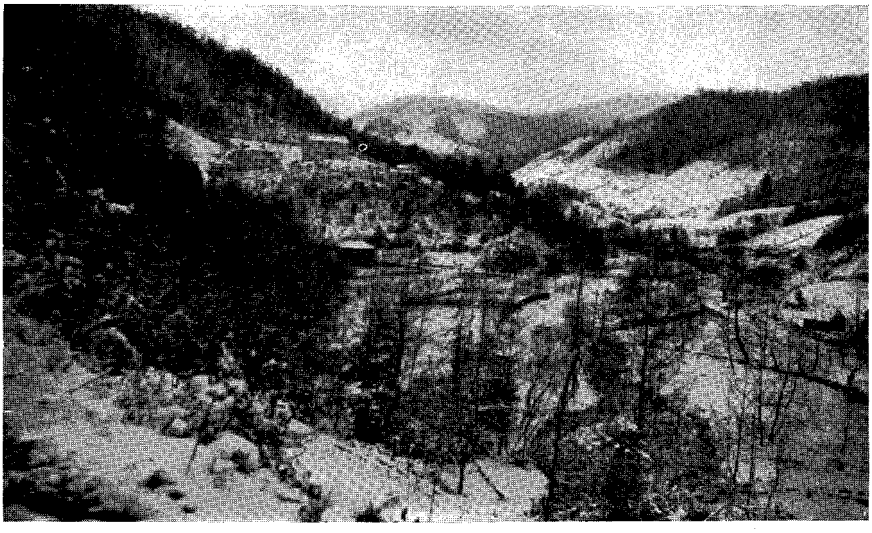
Relief.—The surface of the country is decidedly hilly and is mountainous in some respects. Flat lands even a few acres in extent are rare and valley slopes, though not precipitous, are very steep nearly everywhere. The entire region is thoroughly dissected by streams, the principal water courses being only a few miles apart and separated by ridges that rise 500 to 1,000 feet above them. Except in parts of the southeastern corner of the Bucu quadrangle, which is outside the coal field and need not be considered here, the valleys are deep, narrow, and V-shaped, with little or no flat bottom lands. Some valleys, notably those of Russell Fork and Fryingpan Creek, are remarkably straight for long distances; others, notably those of Pound and Cranesnest rivers, are winding, so that water in the streams travels long distances between points not far apart. The ridges are steep sided, winding, and very irregular in horizontal outline, with many side spurs. Most of the few small flat areas in the region are on the divides, but by far the greater part of the ridge tops are very narrow. The heights of neighboring ridges are approximately the same in most districts.

The maximum relief of the quadrangles is 2,665 feet, the lowest point being on Levisa Fork, with an elevation of 1,070 feet above sea-level, and the highest on Big A Mountain, with an elevation of 3,735 feet. The most conspicuous topographic features are Big A Mountain and Pine Mountain, locally known as "Cumberland Mountain." Big A is an exceptionally high part of Sandy Ridge about 2½ miles long and bearing several knobs. Pine Mountain is a long, nearly straight ridge with a serrated sky-line. It extends from Russell Fork on the northeast into Tennessee on the southwest. The highest point on it in the Clintwood quadrangle has an elevation of 3,137 feet. The southern slopes of the mountain are long and comparatively gentle, but the northern slopes are very steep and descend a vertical distance of nearly 2,000 feet in a distance of less than 1½ miles between the mountain crest and Elkhorn Creek, in Kentucky.

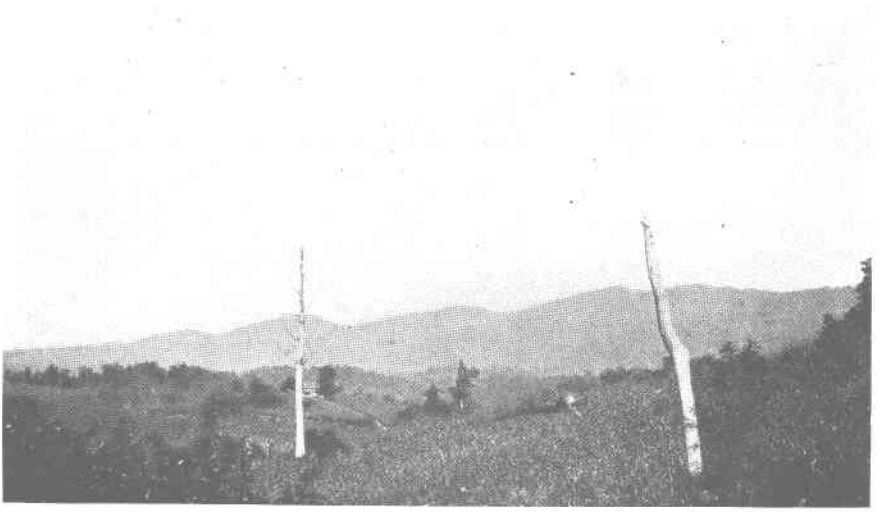
There are several other ridges that deserve special mention. Sandy Ridge is a conspicuous feature that forms the divide on the north side of the Clinch River drainage basin. It is nearly as high as Pine Mountain and winds irregularly across the Bucu quadrangle, merging with Big A Mountain. It enters the Clintwood quadrangle only near the head of



(A) View of Pine Mountain from ridge near the mouth of Pound River.



(B) View of Russell Fork valley from Council, with northeast end of Big A Mountain in distance.



(A) View of Pine Mountain from ridge near the mouth of Pound River.

(B) View of Russell Fork valley from Council, with northeast end of Big A Mountain in distance.

McClure River, but lies only a short distance south of the boundary elsewhere. Big Ridge extends from Sandy Ridge northeastward to the mouth of Pound River, forming the divide between Cranesnest and McClure rivers. Fletcher Ridge is the divide on the southwest side of the Garden Creek drainage basin, extending from Sandy Ridge northwestward to join Winding Ridge. A dome-shaped knob on Fletcher Ridge, 3 miles north of Council, can be seen for many miles.

Drainage.—The streams of the quadrangles are tributary to two great drainage systems. Those on the south side of Sandy Ridge flow into Clinch River, which joins the Tennessee, a river that flows as far south as Alabama and then turns west and north to the Ohio. Streams north of Sandy Ridge are tributary to either Russell or Levisa forks of the Big Sandy River and reach the Ohio by a direct northerly route. The largest tributaries of Russell Fork are Pound, Cranesnest, and McClure rivers, and those of Levisa Fork are Dismal, Garden, and Prater creeks. Only the upper parts of moderately large creeks belonging to the Clinch River drainage system are included in the quadrangles.

Although even small tributaries contain some running water during most of the year, none of the streams have a very large flow. Even row boats have trouble in navigating Russell and Levisa forks, the largest streams, for any considerable distance, and bridges are considered a luxury rather than a necessity. Logs are floated down the Levisa to a small extent, and a large number of them are sent down the lower part of Russell Fork by means of a splash dam just north of the mouth of Pound River. The rainfall of the region is exceptionally great, but the sandy soil, dense growth of trees and brush, and high stream gradients prevent floods. According to common usage in this region, the "right" and "left" sides or forks of a stream are considered relative to the position of a person facing upstream.

INDUSTRIAL FEATURES.

Settlement.—The original settlers subsisted chiefly by hunting, but now squirrels and a few rabbits and birds are practically the only wild game. Corn, raised in small cleared patches on steep slopes, a little garden truck, and hogs that are allowed to run wild during most of the year are the chief, and almost the only, farm products. Except in the growing coal mining camp at Wilder, about the only occupations of the people are farming and lumbering. The largest towns are Clintwood, the Dickenson County seat, with a population of about 350, and Wilder. The population

of both quadrangles is roughly estimated at 11,000 or 12,000 people. Negroes are not at present encouraged to enter the territory north of Sandy Ridge.

Accessibility.—The area south of Sandy Ridge has had easy access to the outside world since the construction of the Clinch River division of the Norfolk and Western Railway many years ago. The area north of Sandy Ridge, however, has been more or less isolated by Sandy Ridge on the south and Pine Mountain on the north, as well as by the hilly character of the entire region. The completion in 1915 of the extension of the Carolina, Clinchfield, and Ohio Railway, under Sandy Ridge and down McClure River and Russell Fork, has opened rail communication both to the south and to the north. The logging railroad of the Honaker Lumber Company carries some freight between Indian and Putnam, a station on the Norfolk and Western.

Wagon roads are rocky and very steep in places, and the usual method of travel is on horseback. Recently, however, an excellent road with low grades has been constructed from Clintwood southwestward to Darwin and Wise, and southeastward across Bearpen Gap to McClure River. Many of the ridge roads are fairly good, but wind so much that they are commonly less direct than the valley roads. There are few ridge roads in the north half of the Bucu quadrangle.

Present and future coal production and markets.—Until a few years ago the only coal mined in the quadrangles was taken from small country mines for use in the immediate neighborhood. Recently mine 2 of the Clinchfield Coal Corporation at Dante and the Cranesnest mine of the same company near Toms Creek have been driven through Sandy Ridge, and considerable coal is being taken from under lands on the southern border of the Clintwood quadrangle. The same company is also operating two large mines at Wilder, in the southwestern part of the Bucu quadrangle, and a slope mine that, though south of the quadrangle, has a main entry driven to within a few hundred feet of it. These mines are now producing much coal and have an even greater capacity. They are equipped with electric haulage and are under scientific management that considers the future as well as the present.

Present production is, however, very small when compared with that which would be justified by the coal resources of the region, and it is confidently expected that much more mining will be begun in the near future. The new railroad has opened new fields to development, and advantage of that fact will probably be taken soon. Expansion of the

industry, outside districts now active, will probably begin by the mining of the Upper Banner bed along Squirrel Camp Branch, Mill Creek, and neighboring parts of McClure River. The thick deposits in the Clintwood bed southwest of Clintwood can be reached by a railroad from McClure River under Bearpen Gap and up Cranesnest River, or one from the Toms Creek field down the Cranesnest, with a long tunnel under Sandy Ridge. Coals along the upper part of Russell Fork and along Indian and Frying-pan creeks can be hauled out over a railroad down Russell Fork to the mouth of McClure River, though it is probable that most deposits near Sandy Ridge will be reached by mines entering on the south side of that divide. To obtain rail communication for the Levisa Fork drainage basin, it would be necessary to build a rather long line, possibly involving tunneling under Sandy or other ridges, but there are several feasible routes.

Mining conditions are good. The coal beds are only gently inclined so that electric haulage may be employed, and advantage may usually be taken of the dip in order to secure natural drainage. Most of the coal beds lie above the levels of the principal streams, and may be entered by drifts. Gas is not likely to be troublesome. The underclays of the coal bed are commonly so hard and sandy that heaving and squeezing will not be common in mine workings, and the mine roofs will be of kinds of rock that are not particularly hard to support. The supply of mine timber is notably abundant, and water for power plants and camps can be obtained with little trouble.

The natural market for most of this region is the southeastern States, with their growing industrial centers. The C. C. & O. Ry. also offers direct rail communication with Charleston, where huge new coal-loading docks have been constructed with the expectation that this city will become a great shipping point for coal exported to Central and South America, especially through the Panama Canal. Ships destined for those points save more than a day by loading at Charleston instead of the principal coal ports farther north. Another market is now available through direct rail communication over the C. C. & O. and the C. & O railways with the Ohio Valley and the Middle West, but in this direction the competition of other fields with shorter hauls must be met. Shipments to the East and to the seaboard via N. & W. Ry. meet competition with high-grade coals that have shorter hauls. Mention of the relative quality of this coal and its probable competitors is made in another part of this report.

GENERAL GEOLOGY

STRATIGRAPHY.

General statement.

The rocks exposed in the Clintwood quadrangle, exclusive of residual soils and small alluvial deposits in the bottoms of the valleys, belong to the Devonian and Carboniferous systems. The Upper Devonian underlies the Carboniferous, and comes to the surface only on the northwest escarpment of Pine Mountain in Kentucky, where it consists of about 800 feet of dark to black shale, the upper part of which may be of Carboniferous age. The Carboniferous system is divided into the Mississippian series below and the Pennsylvanian series above, and each of these series, which are unconformable, is made up of a number of formations that are described below. Although a little coal has been found in the Mississippian, the Pennsylvanian contains all the minable coal beds of this region.

The indurated rocks exposed in the Bucu quadrangle include those in the systems outcropping in the Clintwood quadrangle, and also older rocks belonging to the Cambrian, Ordovician, Silurian, and Devonian systems. The pre-Pennsylvanian formations of the Bucu quadrangle, however, are intricately folded and faulted, and have been thrust up from the southeast over the younger rocks. A description of their character and distribution would have no bearing upon the coal resources of the area, and is reserved for a later geologic report.

Mississippian series.

The Mississippian series of this region consists of at least the upper part of the Grainger shale at the base, the Newman limestone near the middle, and the Pennington shale at the top. The series is exposed on the northwest slope of Pine Mountain in the Clintwood quadrangle, and in a small area in the southeastern part of the Bucu quadrangle. According to Charles Butts, the thickness of the Mississippian series along Pine Mountain is 1,700 to 1,800 feet. In the same locality the Mississippian part of the Grainger is composed chiefly of green shale and brownish sandstone with considerable red sandstone in the upper 50 feet, and is 400 to 500 feet thick. The Newman limestone is about 500 feet thick. It is oolitic and thick bedded in the lower half, but thinner bedded and containing only

a few oolitic layers in the upper half. The Pennington shale is about 800 feet thick, and is composed of red, green, and drab shale, thin-bedded, fine-grained green sandstone, and one persistent stratum of resistant siliceous sandstone 100 feet thick. Most of the Pennington was penetrated by drill hole S 1 on Cranesnest River (Pl. II).

In the southeastern part of the Bucu quadrangle the Mississippian part of the Grainger is chiefly shale. Only the lower part of the Newman is exposed, and it is thick-bedded, very fine-grained limestone. The Pennington is much thicker than on Pine Mountain, and contains several well-cemented beds of coarse sandstone. Both in this district and on Pine Mountain much of the Pennington resembles lithologically most of the Pennsylvanian series, and the lower formation is distinguished chiefly by certain beds of red or green hues—colors that are very uncommon in the commercially coal-bearing rocks.

Pennsylvanian series.

GENERAL STATEMENT.

The Pennsylvanian series, in which are all the commercially important coal beds of this area, consists of sandstone, shale, coal, and thin beds of clay. The only limestone is in small nodules at a very few horizons. These rocks, which are all of Pottsville age, were divided by Campbell in his reports on the Big Stone Gap coal field into the following formations, named in ascending order: Lee formation, Norton formation, Gladeville sandstone, and Wise formation. These formations can not be differentiated from one another by any lithologic or stratigraphic peculiarities that have wide application. No formation contains any type of bed that is not present in one or more of the others, and no member exhibits the same thickness or exactly the same lithologic character in all localities. The intervals between coal or other horizons are different in different parts of the field, so that the members of a measured section can rarely be certainly identified by comparing it with a known section 5 miles or more distant. In spite of these facts, however, and difficulties due to the thick brush and timber, the more or less omnipresent residual soil, and the local irregularities in dips, it is possible to accurately ascertain stratigraphic relations by careful tracing of a number of beds from place to place.

Sandstone constitutes one-third to nearly one-half of the Pennsylvanian rocks. It includes considerable fine-grained and thin-bedded material that has the appearance of sandy shale in weathered exposures. The most

persistent sandstone beds are thick-bedded and coarse-grained and form cliffs and benches on the valley sides. By far the greater part are buff or brownish and arkosic, stained with iron oxide and containing decomposed feldspars, mica, and other minerals, as well as the much more abundant quartz grains. Other beds, especially some in the lower part of the series, are gray and contain a large proportion of quartz grains that are firmly held together by siliceous cement. Another type of sandstone that is not very common and is confined to horizons above the Norton formation is almost pure white, fine-grained, and very resistant to weathering.

Sandstones containing rounded quartz pebbles an inch or less in diameter are common in the Lee and Norton but not in higher formations. The Gladeville contains pebbles at a few localities. This conglomeratic phase is not persistent in any of the beds, though more common in the Lee and lower half of the Norton than elsewhere.

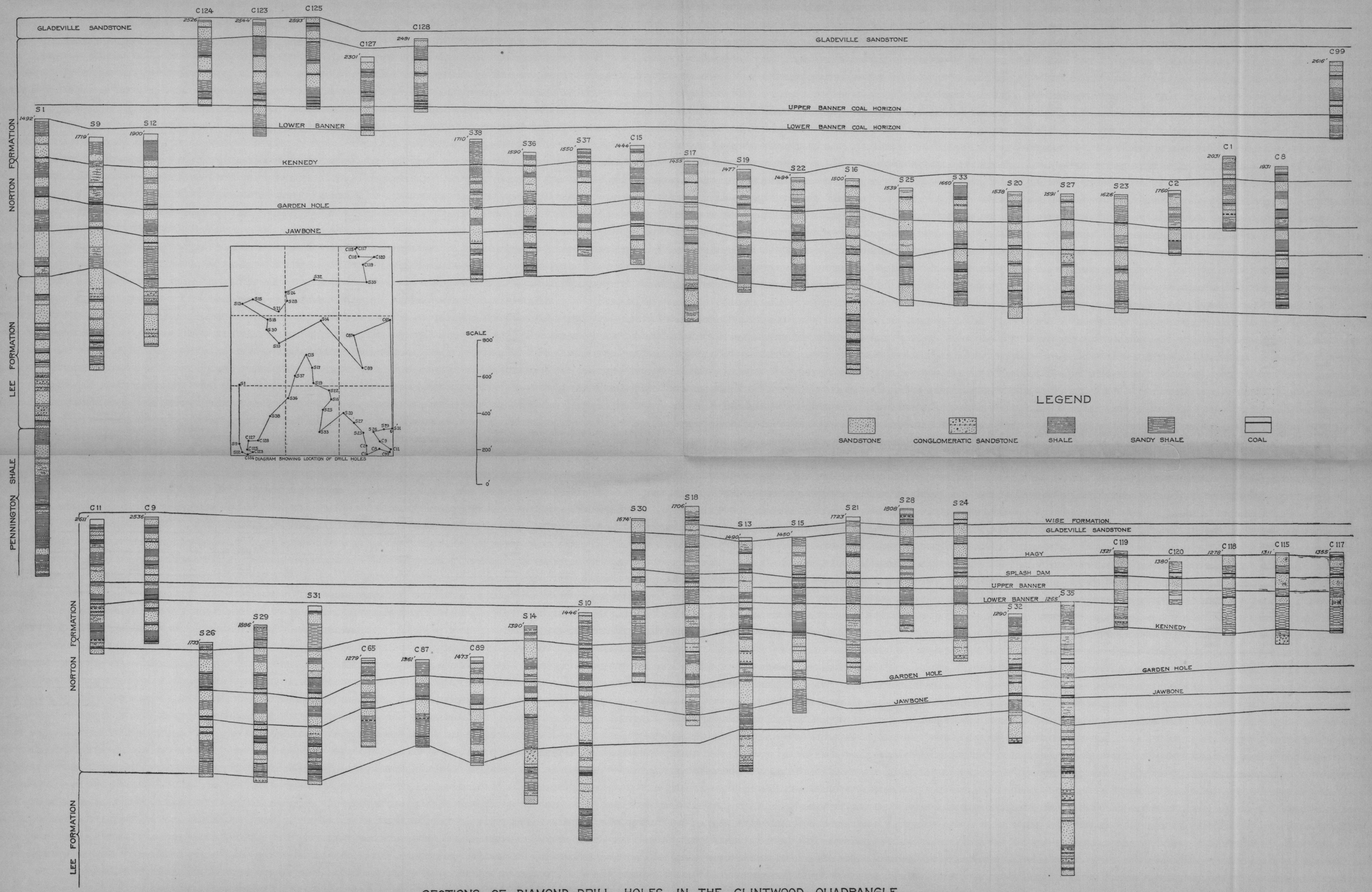
Most of the shales are very sandy and grade into sandstone. Drab is the most common shade, though fresh exposures of several beds, especially among the lower rocks, are distinctly blue. Some of the more argillaceous shales are yellowish, and thin beds, commonly those within a few feet of coal beds, are black.

The coal beds will be discussed later. The clay beds are usually associated with coal, either as very thin partings between coal layers or as the stratum upon which the coal rests. The underclays are a few inches to a few feet thick, most of them are sandy, and many are slightly laminated, so that they resemble and grade into true shales.

LEE FORMATION.

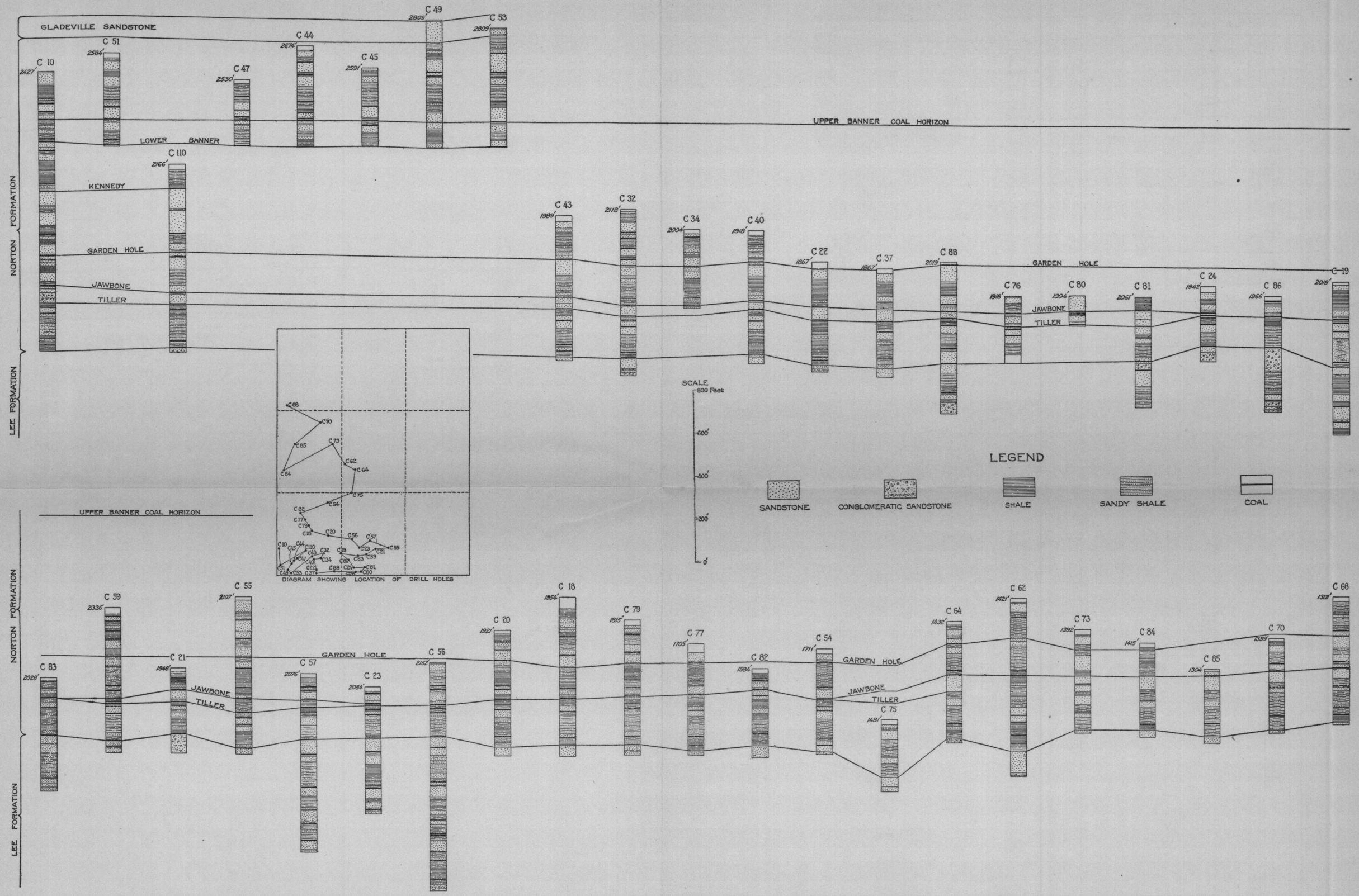
The Lee formation, named from Lee County, Virginia, is exposed along the upper slopes of Pine Mountain, in small areas in Kentucky, near the thrust fault southwest of Big A Mountain, and low down in the valleys of Indian Creek and its principal tributaries. Only a few beds at the top of the formation are above the surface on Indian Creek, and the exact succession of strata in the other localities can not be ascertained because of steep dips, poor exposures, and heavy brush cover. A nearly complete section is exposed in The Breaks, a few miles north of the Clintwood quadrangle, one drill hole on Cranesnest River (S 1 in Pl. II) is through the entire formation, and other borings were continued into the upper part of it.

In the boring on Cranesnest River, a mile south of Darwin, the Lee is 830 feet thick, and consists largely of sandstone, conglomeratic in the



SECTIONS OF DIAMOND-DRILL HOLES IN THE CLINTWOOD QUADRANGLE

The records were furnished by the Clinchfield Coal Corporation and bear its serial numbers.
Numbers at upper left hand corners of sections show elevation of surface above sea level.



SECTIONS OF DIAMOND-DRILL HOLES IN THE BUCU QUADRANGLE.

The records were furnished by the Clinchfield Coal Corporation and bear its serial numbers.
Numbers at upper left hand corners of sections show elevation of surface above sea level.

lower part, with comparatively thin shales, and several coal beds. Along Pine Mountain the formation has probably about the same thickness, and the most conspicuous member is a massive sandstone, 100 to 300 feet thick, that forms the crest of Pine Mountain northeast of Blowing Rock Gap, and high points southwest of the gap that are a short distance south of the divide. This sandstone, which is at the base of the Lee, contains many smoothly rounded, white and cream-colored quartz pebbles that weather out and lie on the surface like hailstones. Like most other standstones in the formation, this rock is grayish white and composed almost entirely of large clear quartz grains, very firmly cemented with a siliceous cement. As the dips are slightly greater than the mountain slope, successively higher beds are crossed in descending the mountain on the Virginia side. In this area the upper beds of the Lee are not well exposed, but in The Breaks the top of the formation consists chiefly of conglomeratic sandstone that is 400 to 500 feet thick and forms the lower part of the canyon walls. The only coal beds seen in the Lee of this area were two beds only a few inches thick in The Breaks.

A conglomeratic sandstone that forms a low hogback in the lower slope of Pine Mountain in Virginia and the cliff at the top of The Breaks has all the lithologic characteristics of Lee sandstones, and has been called the top of the Lee in the reports by Stone and Butts previously mentioned. The work upon which this report is based, confirmed by a study of fossil plants by David White, has shown that this bed is the bottom-rock of the Kennedy coal bed, and that its top is 400 to 550 feet above the top of the Lee.

The Lee rocks low down on the northwest side of Pine Mountain are segments of conglomerate that have been broken off and thrust upward along a fault. They dip steeply and irregularly, and probably overlie undisturbed beds in the Wise formation.

As shown by drill records (Pls. II and III), at least the upper part of the Lee contains a large proportion of sandstone and conglomerate in all of the Clintwood quadrangle about which information is available. In the southern part of the Bucu quadrangle, however, there is more shale, and the sandstones appear to be no thicker or more conglomeratic than those in the Norton formation. The exposures on Indian Creek show a coarse, thin sandstone at the top, and a 30-inch coal bed about 50 feet below the top of the formation. It is possible that the top beds of the Lee may be exposed in a very small area on Russell Fork, among the disturbed rocks between Hurricane Creek and Council, but the rocks specifically

correlated with the Lee by Stone, on Indian and Hurricane creeks and on Russell Fork, are in the lower part of the Norton.

All of the Lee is exposed southwest of Big A Mountain, where it is overturned and dips at high angles to the southeast. In this area there is a moderately thick conglomerate at or near the base of the formation, but other sandstone beds are not notably coarse-grained or siliceous, and shale constitutes a half or a third of all beds. The thickness of the Lee here is about 1,500 feet, indicating a thickening from Pine Mountain to the southeast. No coal beds more than a few inches thick were seen, though exposures are far from perfect.

NORTON FORMATION.

The Norton formation, named from Norton in Wise County, forms by far the greater part of the surface of the Clintwood and Bucu quadrangles, outcropping in most districts from the bottoms of the valleys nearly to the ridge tops. The thickness of the Norton has been obtained at many points by combining drill records (see Pls. II and III) with outcrop observations, and ranges from 920 feet in the northern part of the Clintwood quadrangle to 1,485 feet in the southern part of the Bucu quadrangle. The direction in which the greatest thickening takes place is slightly east of south, and all parts of the section are involved in the increase. This feature and the stratigraphic succession and thickness of intervals is shown by the drill records (Pls. II and III), the generalized sections (Pl. IV), and the local sections. The local intervals between coal beds are also mentioned in the detailed descriptions of each drainage basin.

The formation consists chiefly of alternating beds of sandstone and shale, with a number of coal beds, and thin layers of clay in and under some coal deposits. Small limestone nodules were found at a very few horizons. The most significant and important deposits are the coal beds, which will be described later in the section devoted to economic geology. Other beds are most readily described in connection with the coal beds with which they are associated, and that method of treatment will be adopted. Only a few facts of a general nature will be mentioned here.

The most easily identified horizon, considering the field as a whole, is that of the Kennedy coal, near the middle of the Norton. As this bed is underlain everywhere by coarse sandstone that forms ledges and cliffs, and overlain by nearly 200 feet of shale and thin-bedded, fine-grained sandstone that forms long slopes, its position is usually easy to find. Its usefulness as a stratigraphic marker is increased by the fact that the general north-

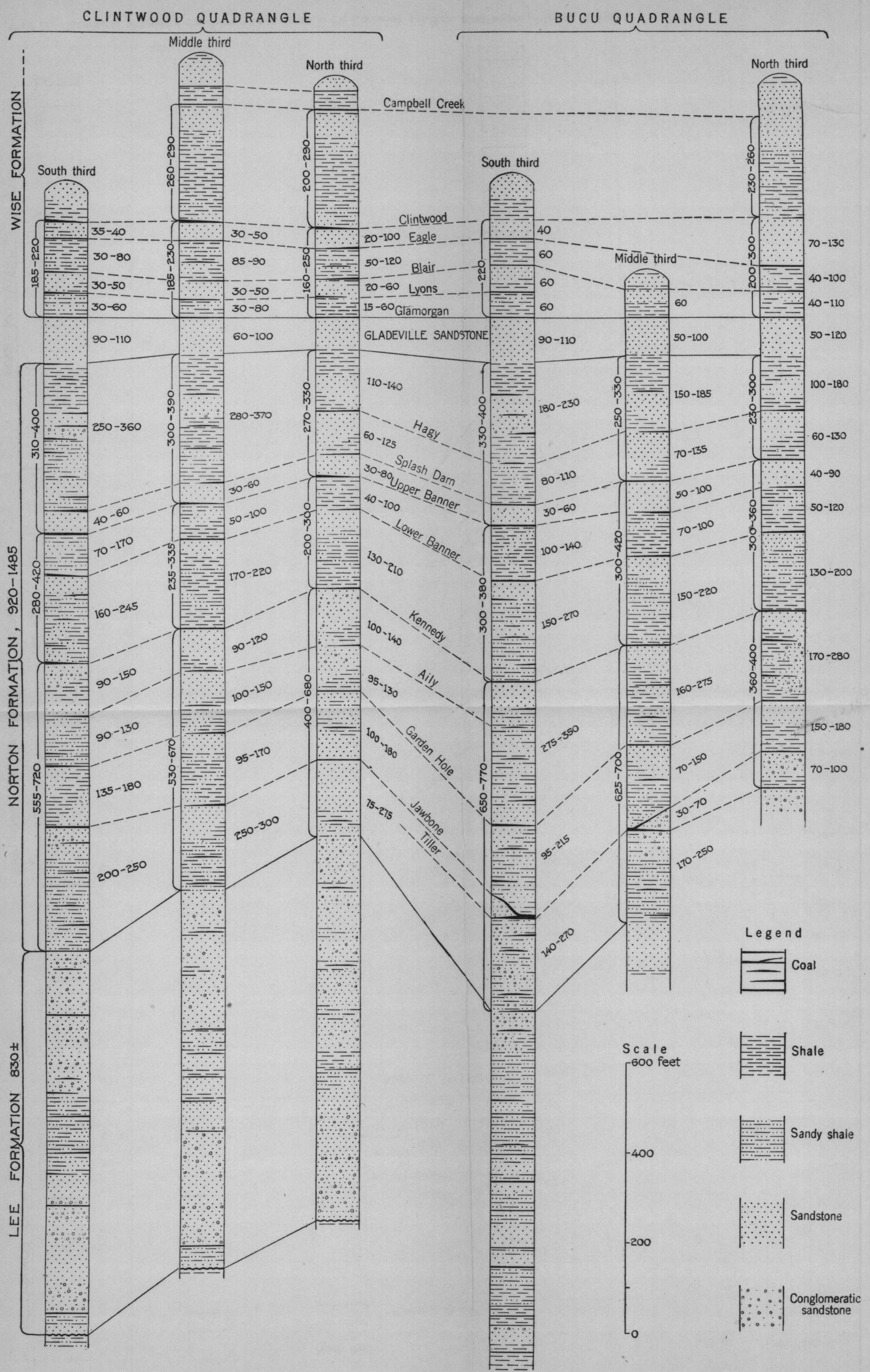


Plate IV. Generalized sections of the Pennsylvanian series in the Clintwood and Bucu quadrangles. (Intervals in feet)

westerly dip causes it to outcrop for long distances a few hundred feet above the principal streams. Except on the eastern border of the quadrangles and locally elsewhere there is a large proportion of sandstone, and more of the coarse-grained type below the Kennedy than above it. The sandstone underlying the Kennedy is 50 to 200 feet thick and contains at least a few pebbles in parts of most districts. This conglomeratic feature is conspicuous only along Dismal Creek and at the foot of Pine Mountain, where the sandstone is gray and siliceous and forms high cliffs. The Kennedy bottom-rock of the Pine Mountain district has been called the top of the Lee in reports by both Butts and Stone. The Kennedy bottom-rock on Dismal Creek is the same as the Dismal conglomerate lentil of Campbell, described in the Tazewell folio.

Several other sandstone beds are locally conglomeratic and exceptionally coarse and form conspicuous ledges and cliffs. One of these is a gray, quartzose bed that lies between the Tiller and Jawbone coal beds along Russell Fork near Council, along parts of Indian Creek, and along Dismal Creek and Levisa Fork near Dismal Creek. This bed resembles certain sandstones in the Lee formation and has been mistaken for them. A similar bed underlies the Tiller coal bed in places. A buff, more arkosic sandstone, about 60 feet thick and with thin layers of pebbles near the base, is a useful marker in the southern part of the Bucu quadrangle and all except the northeastern part of the Clintwood quadrangle. This bed is separated from the top of the Norton by shale 60 to 100 feet thick. Near the eastern boundary of the Bucu quadrangle the interval between the top of this sandstone and the Upper Banner coal horizon is occupied chiefly by coarse, rather poorly cemented sandstone.

Many shale beds are sandy and of the types described as most common in the Pennsylvanian series. The most persistent bed is at the top of the Norton, is not very sandy, and is in part yellowish. Where traced by Hennen in Mingo and McDowell counties, West Virginia, there is a persistent marine horizon in this shale at which there are invertebrates of a type found also on Keen Mountain in the Bucu quadrangle, between Dismal Creek and Levisa Fork.

GLADEVILLE SANDSTONE.

The Gladeville sandstone was named from Gladeville, now Wise, the county seat of Wise County, where it is an important stratigraphic marker. In most parts of these quadrangles it is also a useful marker, though no better than several other beds not separately mapped. According to Butts,

who traced the bed from its type locality to the Clintwood quadrangle, it is hard, white, and siliceous at Wise, and more arkosic and thinner on the north side of Sandy Ridge. In the Clintwood and Bucu quadrangles the Gladeville is 60 to 110 feet thick, is stained brownish by iron, and contains considerable argillaceous matter, mica, and other minerals. Although coarse-grained and thick-bedded to massive, it rarely forms strong cliffs, and readily breaks up on weathering into its constituent grains. In many districts this sandstone forms the upper parts of the principal ridges and many small patches of corn thrive upon it. In the northwestern part of the area between Russell and Levisa forks the bed has its minimum thickness and is more compact than elsewhere.

WISE FORMATION.

The Wise formation, named from Wise County, Virginia, differs little in essential particulars from the Norton formation. The Wise is very thick farther west, but only the lower 575 feet are exposed in these quadrangles. Except near Clintwood, the Wise is confined to the upper parts of the ridges and occurs only in small patches in much of the region. The stratigraphic succession and thicknesses of intervals may be ascertained by consulting the generalized sections (Pl. IV), the local sections, and the detailed descriptions of each drainage basin.

The lower 200 feet of the Wise formation contains fine coal beds that will be described in the section devoted to economic geology, and a considerable proportion of sandstone. The resistant sandstone bed noted by Butts just above the Clintwood coal in the Pound quadrangle is a good marker only near Clintwood, being nonresistant or absent elsewhere. West of McClure River, the best marker is a white, firmly cemented, siliceous sandstone that, though not thick, outcrops conspicuously 15 to 60 feet above the Gladeville. The best marker in other districts is a grayish, resistant sandstone that lies between the Eagle and Clintwood coal beds and forms cliffs 100 feet or less in height. For about 200 feet above the Clintwood coal the sediments are chiefly shales, and these are succeeded by thick beds of brownish-buff, medium-grained, nonresistant sandstone, within which there is another coal bed.

Correlations with adjoining areas.

The correlations made by the writer between coal beds in southwest Virginia and the Elkhorn coal field in Kentucky differ from those previously made (see Pl. V) chiefly because early ties were necessarily made across

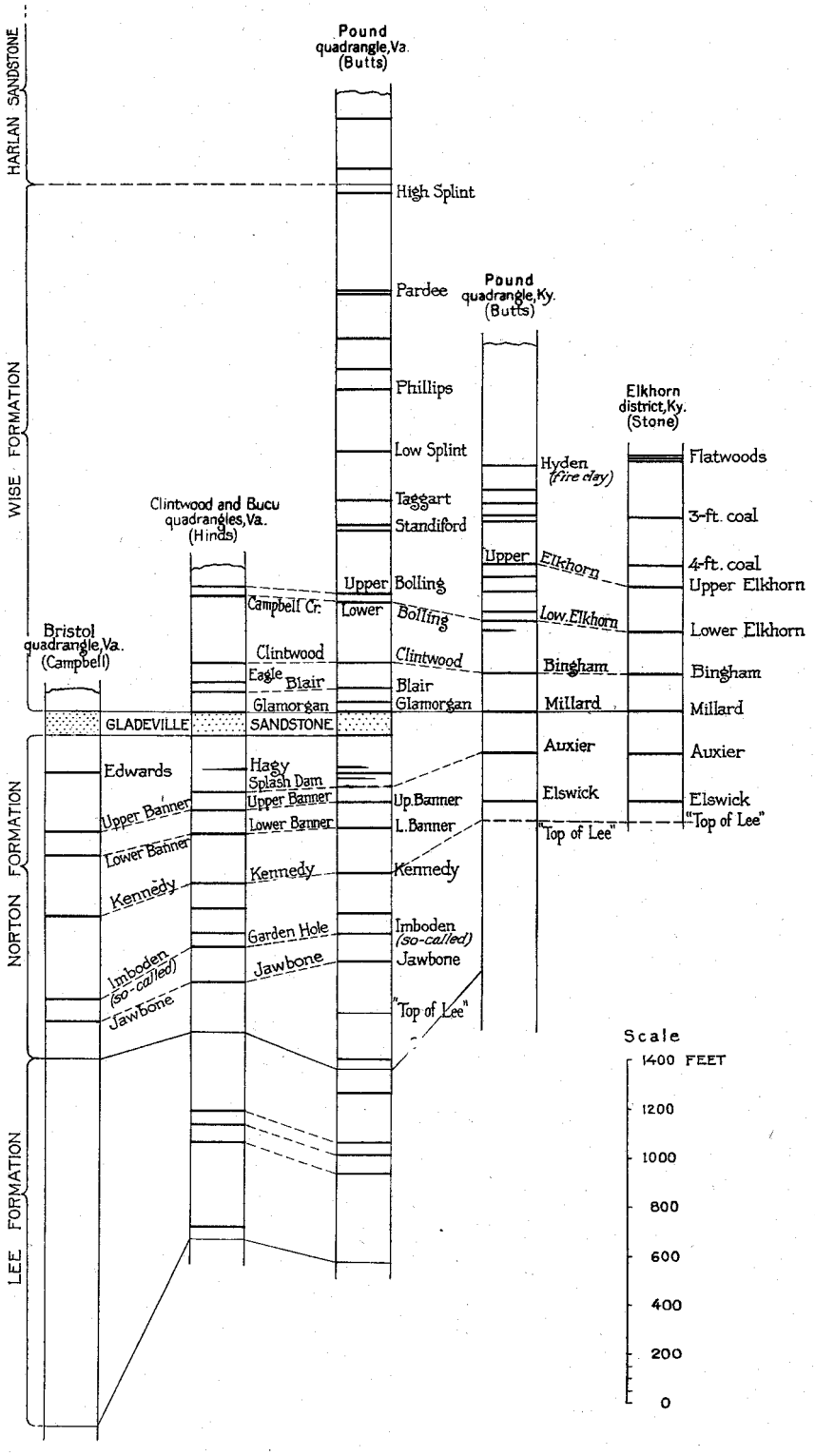


PLATE V. SECTIONS SHOWING CORRELATIONS WITH ADJOINING AREAS

the gap formed by Pine Mountain and the Pine Mountain fault, where no actual tracing of beds from one field to the other is possible. The work upon which the present report is based was continued so as to include the northern half of Buchanan County to the boundaries of Kentucky and West Virginia, and a tie line was made by the author in 1915 from Elkhorn City down Russell Fork, up Marrowbone Creek, and over the Flatwoods to Shelby Creek, where it joined detailed private surveys carried from Jenkins. The results of detailed private surveys in southeastern Pike County confirmed the conclusions reached. Correlations were also greatly strengthened by a preliminary examination of fossil plant collections by David White.

There can be no question concerning the accuracy of the identifications of the Upper and Lower Banner and Kennedy coal beds in the Clintwood and Bucu quadrangles. The position of the Jawbone coal bed and the top of the Lee formation in this area is based upon the stratigraphic intervals and somewhat meager lithologic descriptions given by Campbell for neighboring parts of the Bristol quadrangle. If the Jawbone correlation is correct the "so-called Imboden" is the equivalent of the Garden Hole coal bed. The Gladeville sandstone was traced by Butts from its type locality at Wise through the Pound quadrangle to the Clintwood. On parts of the Sandy Ridge, Campbell has apparently included in his mapping of the Gladeville a thin but conspicuous resistant white sandstone that is separated from the Gladeville of Butts by a moderately thick shale bed.

The identification of horizons above the Norton in this report agrees essentially with those made by Butts in the Virginia portion of the Pound quadrangle. His identifications of certain Norton coal beds and of the top of the Lee formation in drill holes S 1, S 13, and S 15, which are in the Clintwood quadrangle, have been slightly changed on the basis of a careful study of outcrops and many drill records east of the Pound quadrangle where the available data concerning the lower two Pennsylvanian formations are exceptionally good. As previously explained, the Lee-like sandstone near the foot of Pine Mountain and at the top of the canyon at The Breaks, naturally considered by both Butts and Stone to be the top of the Lee, is now known to be the stratum lying a few feet below the Kennedy coal bed, near the middle of the Norton formation. This sandstone is the cliff-former upon which Elkhorn City, Ky., is built, and the change in its correlation necessitates an entirely new conception of the stratigraphic position of strata in the Elkhorn district of eastern Kentucky (Pl. V).

In recent reports on Mingo and McDowell counties, West Virginia,[1] great cliffs on Tug Fork at and near War Eagle are correlated with the Nuttall sandstone and placed at the top of what is called the New River group, underlying the Kanawha group. The top of the Nuttall is a few feet below the Lower Banner coal horizon, and is the same as Campbell's Dotson sandstone. The bed mapped by Campbell as Dotson farther south, in the western and central parts of the Tazewell quadrangle, appears to be slightly higher in the section, probably just above the Upper Banner horizon. The sandstone mapped by Campbell as the Raleigh in the western part of the Tazewell quadrangle is the bottom-rock of the Jawbone coal, and is probably higher than the bed mapped as Raleigh in the eastern part of that quadrangle.

The coal beds called the Eagle and Campbell Creek (No. 2 Gas) by the West Virginia Geological Survey have been traced into the Clintwood and Bucu quadrangles and the names retained. The Eagle coal is locally known as the Middle War Eagle and Mohawk on Tug Fork. The Campbell Creek coal is the bed to which the name Lower Bolling was applied in the Pound quadrange. This coal is locally called the Lower Elkhorn, Lower Marrowbone, Warfield, Freeburn, Burnwell, and Upper War Eagle in Pike County, Kentucky, and Mingo County, West Virginia. The Lower War Eagle coal of Tug Fork is the same as the Hagy of Virginia.

Local sections.

The following sections are inserted without comment, as it is believed that they are self-explanatory. They have been chosen from among a large number chiefly because they show an exceptional number of exposed beds and were made where dips are low. These local sections should be used with caution, as parts of every one of them are poorly exposed, and the intervals are not in every case the averages for the locality. Corrections that should be made in thicknesses of beds because of dip are indicated for each section; in the column showing intervals the necessary correction for dip has already been made.

[1] Hennen, R. V., and Reger, D. B., Logan and Mingo counties, West Va. Geol. Survey, 1914.
Hennen, R. V., Wyoming and McDowell counties, idem, 1915.

Local Section 1.

On trails from mouth of Jerry Branch of Pound River to spur on west.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Coal (Clintwood), elevation 1,795	..	
Sandstone, buff, coarse, shaly at base	70	
Coal (Eagle), elevation 1,725	..	70
Sandstone, as last above	40	
Concealed, probably shale and shaly sandstone, horizon of Blair coal bed near base	55	
Sandstone, white, compact, siliceous	20	
Shale, poorly exposed, horizon of Lyons coal bed near top	45	160
Coal (Glamorgan), elevation 1,565	..	
Gladeville sandstone:		
Sandstone, brownish-buff, coarse, weathers granular	70	70
Norton formation:		
Shale, poorly exposed	50	
Sandstone, to river at mouth of Jerry branch	25	75
	375	375

Local Section 2.

From drill hole S 32, near the mouth of Cranesnest River, along road to top of ridge south of Davis School. Section 60 feet too long because of dip.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, buff, weathers red and granular, coarse, massive	35	
(Lyons coal horizon, elevation 1,847)	..	32
Shale, chiefly, may include thin sandstones	65	
(Glamorgan coal horizon, elevation 1,782)	..	58
Gladeville sandstone:		
Sandstone, buff, compact, massive, middle part not well exposed	55	50
Norton formation:		
Shale	55	
Sandstone, compact, massive, cross-bedded	30	
Shale, upper half doubtful	40	
Shale streak, black, carbonaceous (Hagy coal horizon), elevation 1,602	..	112
Interval, probably shale	20	
Sandstone, compact, massive	20	
Shale	40	
Coal bloom (Splash Dam, upper bench), elevation 1,522	..	72
Shale	10	
Coal bloom (Splash Dam, lower bench), elevation 1,512	..	9

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Shale	8	
Sandstone, compact, massive	22	
Interval, chiefly shale	40	
Sandstone	5	
Concealed	12	
(Estimated position of Upper Banner coal horizon, elevation 1,425)	..	78
Concealed	83	
Shale	22	
Sandstone	5	
Concealed	25	121
	592	532

Section continued in log of drill hole S 32.

Local Section 3.

From drill hole S 1 on Cranesnest River up road to Hibbitts Gap, thence west to top of ridge near triangulation station. Section 130 feet too short because of dip.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, not well exposed	30	
Shale	10	
Coal (Clintwood) and partings, elevation 2,045	8	60
Concealed	15	
Sandstone, white, compact, siliceous	18	
Shale, probably, not well exposed	20	
Coal (Blair), elevation 1,992	..	65
Sandstone, medium- to fine-grained	20	
Shale, apparently, not well exposed	15	
Coal, thin	..	44
Shale	10	
Coal (Lyons), elevation 1,947	..	12
Shale (Glamorgan coal horizon near base)	50	60
Gladeville sandstone:		
Sandstone, coarse, friable, fine-grained and thin-bedded at top	85	100
Norton formation:		
Shale	75	
Coal bloom	..	95
Sandstone, coarse-grained, conglomeratic in middle	25	
Coal bloom	..	30
Shale, sandy	15	
Sandstone, coarse-grained	5	
Concealed	5	
Coal	..	30
Shale, sandy	50	
Coal streak	..	60
Shale	15	

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Sandstone, coarse-grained at top, medium- to fine-grained below	50	
(Upper Banner coal horizon, elevation 1,572)	..	80
Shale	50	
Sandstone, medium-grained	10	
Shale, not well exposed	20	95
	601	731

Section continued in log of drill hole S 1.

Local Section 4.

From Trace Fork of Cranesnest River at south boundary of Clintwood quadrangle, west to top of ridge. Section 50 feet too short because of dip.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, white, siliceous, compact, very resistant	35	
Shale, poorly exposed in upper part (Glamorgan coal horizon near base)	100	145
Gladeville sandstone:		
Sandstone, buff, weathers brownish-red and granular, coarse, massive, forms cliffs	100	100
Norton formation:		
Shale, very poorly exposed	95	
Sandstone, buff, very coarse-grained in part, forms cliffs	25	
Concealed	50	
Sandstone, medium-grained to coarse	30	
Concealed	60	
Sandstone, medium-grained	15	
Concealed	10	
Sandstone, coarse-grained, massive	15	
Concealed	20	
(Estimated position of Upper Banner coal, elevation 2,080)	..	360
Concealed	10	
Sandstone, medium-grained to coarse	15	25
	580	630

Stratigraphic interval to top of drill hole S 12 is 135 feet.

Local Section 5.

West along road from McClure River near Road Branch to knob on Big Ridge near Burnt Field School.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, white, siliceous, very compact	15	
Shale with some shaly sandstone (Glamorgan coal horizon near base)	70	85
Gladeville sandstone:		
Sandstone, reddish-brown, arkosic, coarse, massive	75	75
Norton formation:		
Shale	75	
Sandstone, buff, coarse	35	
Shale	40	
Coal (Hagy), elevation 1,745	1	151
Shale	5	
Sandstone, brownish-buff, coarse, compact	45	
Shale, with a little sandstone	35	
Coal bloom (Splash Dam), elevation 1,660	..	85
Sandstone, buff, compact, with a little shale and faint coal bloom in middle	65	
Shale	10	
Coal bloom (Upper Banner, upper bench), elevation 1,595	..	75
Shale, sandy	10	
Coal bloom (Upper Banner, lower bench), elevation 1,585)	..	10
Shale	70	
Coal bloom (Lower Banner), elevation 1,515	..	70
Sandstone, buff, coarse, compact	25	
Shale and a little fine-grained sandstone	60	85
	636	636

Local Section 6.

From McClure River near Big Branch to Bearpen Gap, thence south on Big Ridge.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, white, weathers red and granular	45	
Concealed	48	
Sandstone, white, siliceous, compact	22	
Shale, black at base	25	
Coal (Glamorgan), elevation 2,078	1	141
Gladeville sandstone:		
Sandstone, light buff, coarse, massive, weathers red and granular	100	100
Norton formation:		
Shale, dark blue and drab, lower part exposed in Bearpen Gap	70	

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Sandstone, buff, very coarse, forms cliffs	40	
Shale, blue	20	
Sandstone, as last above	40	
Shale and inconspicuous sandstone	70	
Shale, sandy, with 3 coal beds 15 feet apart, and each less than 13 inches thick (Splash Dam)	30	
Sandstone, buff, shaly at top, coarse and massive below	50	
Coal bloom (Upper Banner, upper bench), elevation 1,658	..	320
Shale, sandy, and shaly sandstone	100	
Coal bloom (Lower Banner), elevation 1,558	..	100
Sandstone, buff, coarse to fine-grained	70	
Sandstone, buff, fine-grained, mostly thin-bedded	70	140
	801	801

Local Section 7.

Along road from mouth of Roaring Fork northeast to top of ridge. Section 30 feet too long because of dip.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, white, weathers reddish, granular, shaly, with ferruginous bands in middle	35	
Coal bloom (Glamorgan), elevation 2,597	..	35
Gladeville sandstone:		
Sandstone, weathers reddish, granular, shaly in part	70	
Sandstone, light brownish-gray, coarse-grained, massive	65	125
Norton formation:		
Shale, with some sandstone, not well exposed	165	
Sandstone, brownish-gray, in part very coarse, massive	40	
Concealed	10	
Sandstone, thin-bedded, resistant	40	
Sandstone, thin-bedded, and shale	45	
Coal bloom (Splash Dam), elevation 2,162	..	280
Sandstone, very coarse-grained, massive	13	
Sandstone, fine-grained, thin-bedded	15	
Sandstone, coarse-grained, massive, thin-bedded in part	35	
Concealed	25	
Coal (Upper Banner), elevation 2,074	..	88
Concealed	15	
Sandstone, coarse-grained, massive	20	
Concealed	80	
Sandstone, drab, coarse-grained	5	
Coal (Lower Banner), elevation 1,951	3	123
Sandstone, coarse-grained, massive	40	
Sandstone, drab, mostly fine-grained and thin-bedded	135	
Concealed	45	

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Shale and sandy shale	20	
Coal bloom (Kennedy), elevation 1,711	..	240
Sandstone, coarse-grained, massive	35	
Concealed	35	
Sandstone, massive	15	85
	1,006	976

Section continued in log of drill hole S 23.

Local Section 8.

Up spur to west and north at sharp bend in Buffalo Creek, one mile east of mouth.

	Thickness. Feet.	Intervals. Feet.
Gladeville sandstone:		
Sandstone, weathers brownish-red, coarse, massive, not well exposed at top	70	70
Norton formation:		
Shale	70	
Sandstone, medium-grained, not well exposed	25	
Shale	15	
Sandstone, very coarse, massive	20	
Shale	20	
Sandstone, coarse, massive, forms cliffs	50	
Shale, mostly sandy and with some fine-grained sandstone	180	
Sandstone, fine-grained	10	
(Upper Banner coal horizon, elevation 1,812)	..	390
Shale	45	
Sandstone, medium-grained	12	
Shale	30	
(Lower Banner coal horizon, elevation 1,725)	..	87
Sandstone, coarse, massive, forms cliffs	55	
Shale, sandy in part, and with some fine-grained sandstone	80	135
	682	682

Local Section 9.

Up spur to northeast at the mouth of Buffalo Creek.

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Shale	100	
Sandstone, coarse, massive	30	
Concealed	5	
(Upper Banner coal horizon, elevation 1,875)	..	135
Shale, sandy, and fine-grained, thin-bedded sandstone	59	
Sandstone, medium- to fine-grained, thin-bedded	12	
Shale, and some fine-grained, thin-bedded sandstone	55	
(Lower Banner coal horizon, elevation 1,749	..	125

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Sandstone, coarse, massive, cliff-making	50	
Concealed	30	
Shale, sandy in part	110	
Concealed	15	
(Kennedy coal horizon, elevation 1,544)	..	205
Sandstone, coarse, massive, cross-bedded	50	50
	515	515

Section continued in log of drill hole S 22.

Local Section 10.

Up trail to north from Lick Creek of Russell Fork, one-half mile northeast of Counts School.

	Thickness. Feet.	Intervals. Feet.
Gladeville sandstone:		
Sandstone, buff, weathers reddish-brown, coarse, massive	60	60
Norton formation:		
Shale, light drab	45	
Sandstone, coarse, massive	40	
Shale	55	
(Hagy coal horizon, elevation 1,885)	..	140
Sandstone, massive	20	
Shale, drab, in part contorted	50	
Coal bloom (Splash Dam, upper bench), elevation 1,815	..	70
Shale, drab, in part contorted	35	
Sandstone, coarse, massive, weathers granular	25	
Shale	10	
Sandstone, coarse, massive, weathers granular	25	
(Upper Banner coal horizon, elevation 1,720)	..	95
Shale	80	
(Lower Banner coal horizon, elevation 1,640)	..	80
Sandstone, coarse-grained, massive	35	
Shale, dark drab	25	60
	505	505

Local Section 11.

Up trail to east and southeast from drill hole C 82 on Fryingpan Creek, three-quarters of a mile south of Bucu. Section 40 feet too long because of dip.

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Sandstone, light buff, coarse-grained, weathers granular	120	
Shale	90	
Coal bloom (Splash Dam, upper bench), elevation 2,425	1	211

Norton formation:	Thickness. Feet.	Intervals. Feet.
Shale	20	
Coal (Splash Dam, lower bench), elevation 2,405	..	20
Sandstone, medium-grained in upper part, coarse below	85	
Coal bloom (Upper Banner), elevation 2,315	5	90
Shale, and thin sandstones	105	
(Lower Banner coal horizon, elevation 2,210)	..	100
Sandstone, medium-grained to coarse, massive	100	
Shale	40	
Sandstone, mostly medium-grained, forms bench	30	
Shale	50	
Sandstone, medium-grained to coarse at top, fine-grained and shaly below	35	
Shale	15	
(Kennedy coal horizon, elevation 1,940)	..	255
Sandstone, coarse, massive, forms strong cliff	65	
Shale, not well exposed at base	35	
Sandstone, medium-grained to coarse, forms cliff	61	
Concealed	165	
(Garden Hole coal horizon, elevation 1,614)	..	316
Concealed	30	30
	1,062	1,022

Section continued in log of drill hole C 82.

Local Section 12.

From Cane Gap southwest along road to top of Sandy Ridge.

Norton formation:	Thickness. Feet.	Intervals. Feet.
Sandstone, badly weathered	10	
Shale	30	
Sandstone, fine-grained	15	
Shale	70	
Coal bloom (Kennedy), elevation 2,505	..	125
Sandstone, fine-grained in upper half, coarse below	65	
	65	
Coal bloom (Aily ?), elevation 2,440	..	65
Sandstone, fine-grained, shaly in part	60	
Sandstone	95	
Shale	5	
Coal bloom, elevation 2,280	..	160
Shale, with thin sandstone in middle	30	
Concealed	20	
Sandstone, medium-grained	15	
Concealed, some sandstone in lower part	45	
(Garden Hole coal horizon, elevation 2,170)	..	110
Sandstone, fairly coarse, compact, massive	30	
Shale	15	
Sandstone, medium-grained	45	
Shale, blue	10	
Shale and fine-grained, shaly sandstone	40	

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Sandstone, medium-grained	15	
Shale	15	
Coal bloom, elevation 2,000	..	170
Sandstone, coarse-grained, not well exposed	24	
Coal (Tiller and Jawbone), elevation 1,965, reported thickness	11	35
	665	665

Local Section 13.

Up spur to northwest from Lambert Fork of Indian Creek, one-half mile northeast of mouth.

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Sandstone, medium-grained to coarse and massive, lower part not well exposed	60	
Concealed, probably shale	40	
Sandstone, not well exposed	15	
Shale	15	
Sandstone, coarse at top, medium-grained below, forms conspicuous cliff	25	
Coal	..	155
Shale	20	
Coal (Garden Hole), elevation 2,025	..	20
Concealed	10	
Sandstone, coarse and very massive, forms cliff	55	
Concealed, shaly at top	70	
Coal (Jawbone), elevation 1,890	..	135
Sandstone, medium-grained	20	
Concealed, partly sandstone	70	
Coal (Tiller), elevation 1,800	..	90
Concealed	30	
Sandstone, medium-grained to very coarse, with a few pebbles, not well exposed at top	65	
Concealed, some sandstone in middle part	60	155
Lee formation:		
Sandstone, compact, resistant, very coarse	45	45
	600	600

Local Section 14.

From Council north along road to top of ridge.

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
(Splash Dam coal horizon, elevation 2,520)	..	
Sandstone, reddish-brown, coarse, granular	25	
Shale, sandy shale, and some sandstone, poorly exposed	115	
Shale, good exposure	40	
(Lower Banner coal horizon, elevation 2,340)	..	180

Norton formation:	Thickness. Feet.	Intervals. Feet.
Sandstone, mostly coarse and granular, forms ledge	40	
Shale, in part sandy	40	
Sandstone, fairly coarse, forms ledge	8	
Shale	20	
Sandstone, fairly coarse	5	
Shale, with some sandstone near top, not well exposed	80	
Coal and partings (Kennedy, location 319), elevation 2,142	5	198
Clay and shale	10	
Sandstone, coarse, resistant, forms conspicuous ledge	20	
Shale, chiefly, not well exposed	72	
Coal bloom, elevation 2,040	..	102
Shale	5	
Sandstone, fairly coarse, shaly at top	25	
Coal bloom, elevation 2,010	..	30
Shale	8	
Sandstone, not conspicuous	25	
Shale	37	
Coal bloom (Garden Hole) thin, elevation 1,940	..	75
Sandstone, fairly coarse, resistant	29	
Shale, well exposed in upper part	140	
(Jawbone coal horizon, elevation 1,771)	..	169
Sandstone, coarse, weathers granular, few small pebbles at base	50	
Shale	5	
Coal bloom (Tiller), elevation 1,716	..	55
Sandstone, coarse, very compact	30	
Concealed, probably sandstone	15	
Shale, bluish	25	70
	874	874

Local Section 15.

From Hurricane Creek at mouth of Rockhouse Branch up spur to northeast.

Norton formation:	Thickness. Feet.	Intervals. Feet.
Sandstone, medium-grained, weathers soft	15	
Shale	15	
Sandstone, coarse, weathers soft and granular	20	
Shale, with thin, fine-grained sandstones in upper part	110	
(Lower Banner coal horizon, elevation 2,110)	..	160
Sandstone, coarse, massive	35	
Shale	70	
Sandstone, fairly coarse	10	
Shale	65	
(Kennedy coal horizon, elevation 1,930)	..	180
Sandstone, mostly coarse, weathers soft at top, lower 50 feet forms cliff	86	
Shale, mostly drab	42	

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Shale, mostly sandy, with some fine-grained sandstone	92	
Sandstone, fairly coarse	5	
Shale, not well exposed	10	
(Garden Hole coal horizon, elevation 1,695)	..	235
Sandstone, fairly coarse and massive at top, medium-grained, thin-bedded and cross-bedded below	75	75
	650	650

Local Section 16.

From Fox Creek, one mile east of the mouth of Left Fork, up spur to northwest.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Shale	30	30
Gladeville sandstone:		
Sandstone, coarse-grained, weathers reddish-brown and granular, forms conspicuous cliff	75	75
Norton formation:		
Shale, grayish-yellow to drab	80	
Sandstone, fine-grained at top to fairly coarse below	30	
Concealed, probably sandstone	10	
Shale	20	
(Hagy coal horizon, elevation 1,885)	..	140
Sandstone, medium-grained to fairly coarse	30	
Concealed	15	
Sandstone, fine-grained, shaly	20	
Shale, mostly sandy	55	
(Splash Dam coal horizon, elevation 1,765)	..	120
Sandstone, medium-grained to coarse, lower part compact and forms conspicuous cliff	70	
(Upper Banner coal horizon, elevation 1,695)	..	70
Sandstone, fine-grained, shaly	30	
Sandstone, medium-grained to fairly coarse	20	
Concealed, probably mostly shale	25	
(Lower Banner coal horizon, elevation 1,620)	..	75
Sandstone, medium-grained	20	
Concealed	25	
Sandstone, fine-grained, shaly	25	70
	580	580

Local Section 17.

From Russell Fork at mouth of Fox Creek up spur to southeast.

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
Shale	25	
(Splash Dam coal horizon, elevation 1,795)	..	25
Sandstone, coarse, cliff-forming, not well exposed in upper part	80	
(Upper Banner coal horizon, elevation 1,715)	..	80
Shale, mostly bluish, good exposure	75	
(Lower Banner coal horizon, elevation 1,640)	..	75
Sandstone, very coarse and massive	30	
Shale, very sandy, and shaly sandstone	125	
Sandstone, medium-grained	25	
Concealed	10	
(Kennedy coal horizon, elevation 1,450)	..	190
Sandstone, medium-grained to fairly coarse	30	
Sandstone, fine-grained and in part shaly	70	
Sandstone, medium-grained	15	115
	485	485

Local Section 18.

Northeast from Russell Prater Creek at location 355 to high knob northwest of Russell Prater—Poplar Creek gap.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, white, compact, weathers orange-red, coarse-grained	10	
Shale, sandy, at top and with thin medium-grained sandstone	170	
(Clintwood coal horizon, elevation 2,138)	..	180
Sandstone, coarse, arkosic, weathers granular, massive	90	
Concealed	15	
Coal (Eagle), elevation 2,033	..	105
Interval, chiefly shale	130	
(Glamorgan coal horizon, elevation 1,903)	..	130
Gladeville sandstone:		
Sandstone, buff, medium-grained to coarse, forms cliff, not well exposed at base	60	60
Norton formation:		
Concealed	30	
Shale, sandy in part	120	
Coal (Hagy, location 355), elevation 1,690	3	153
	628	628

Local Section 19.

From Russell Prater Creek, about one mile southwest of Prater, north to top of ridge.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Shale	50	
(Clintwood coal horizon, elevation 2,060)	..	50
Sandstone, buff, mostly coarse, massive, forms cliffs	95	
(Eagle coal horizon, elevation 1,965)	..	95
Shale and a few thin sandstones, not well exposed	165	
(Glamorgan coal horizon, elevation 1,800)	..	165
Gladeville sandstone:		
Sandstone, medium-grained to coarse	60	
Norton formation:		
Shale	60	
Sandstone, medium-grained, resistant in part	50	
Shale	30	
(Hagy coal horizon, elevation 1,600)	..	200
Sandstone, medium-grained, coarse at base	50	
Concealed	50	
Shale	10	
Sandstone, medium-grained	10	
Shale	10	
Sandstone, medium-grained	10	140
	650	650

Local Section 20.

From Russell Prater Creek one-fourth mile northeast of Mart, up spur to north and west to triangulation station.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Concealed to triangulation station (elevation 1,973)	13	
Shale	30	
Concealed	50	
Sandstone, very coarse-grained and light-gray at top, massive	60	
Shale, sandy	15	
Coal (Eagle), elevation 1,805	..	168
Shale, sandy in part	70	
Coal (Blair), elevation 1,735	..	70
Sandstone, coarse-grained, massive	50	
Concealed, probably shale in lower part	50	
(Glamorgan coal horizon, elevation 1,635)	..	100
Gladeville sandstone:		
Sandstone, medium-grained to coarse, massive	50	50
Norton formation:		
Shale	72	
Sandstone, medium-grained, forms cliff	35	

Norton formation:	Thickness. Feet.	Intervals. Feet.
Concealed	95	
Sandstone, fine-grained	10	
Shale, sandy	15	
Coal (Splash Dam, location 346), elevation 1,355	3	230
Sandstone, fairly coarse, massive	55	
Shale, drab	15	70
	688	688

Local Section 21.

From location 389, on Levisa Fork three-fourths mile northwest of Hanger, along road to southeast for one-half mile, thence up spur to north.

Norton formation:	Thickness. Feet.	Intervals. Feet.
Sandstone, coarse, resistant, forms cliff	30	
Shale	100	
(Lower Banner coal horizon, elevation 1,870)	..	130
Sandstone, mostly fine-grained and thin-bedded and sandy shale	50	
Sandstone, fairly coarse at top, medium-grained below	70	
Concealed	60	
(Kennedy coal horizon, elevation 1,690)	..	180
Sandstone, coarse, forming strong cliffs	90	
Shale, in part blue, interbedded with thin sandstones	115	
(Garden Hole coal horizon, elevation 1,485)	..	205
Sandstone, fairly coarse, micaceous, forms cliff	60	
Shale, mostly blue-black	50	
Shale, blue at base, with thin beds of sandstone	44	
Coal (Tiller), elevation 1,329	2	156
Shale	10	
Sandstone, coarse, forms cliff in lower part	60	70
	741	741

Local Section 22.

From Levisa Fork near mouth of Bens Branch (location 391) up spur to north.

Norton formation:	Thickness. Feet.	Intervals. Feet.
Kennedy coal horizon, elevation 1,500	..	
Sandstone, upper half coarse and compact, lower half finer-grained, forms conspicuous cliffs	115	
Concealed, probably mostly sandy shale, with some sandstone in lower part (Garden Hole coal horizon near base)	105	
Sandstone, very fine-grained, forms ledge	10	
Concealed, mostly shaly	80	
(Jawbone coal horizon, elevation 1,190)	..	310

Norton formation:	Thickness. Feet.	Intervals. Feet.
Sandstone, very coarse, quartz pebbles at base....	30	
Shale	11	
Sandstone	20	
Shale, blue	18	
Coal (Tiller, location 391), elevation 1,110....	1	80
Clay, blue, with abundant stems.....	4	
Shale, drab, sandy, ripple-marked.....	4	8
	398	398

Local Section 23.

Up spur to northeast from forks of road opposite mouth of Little Prater Creek.

Norton formation:	Thickness. Feet.	Intervals. Feet.
Sandstone, fairly coarse, forms conspicuous cliff..	80	
Shale, sandy	25	
Sandstone, medium-grained, forms ledge.....	20	
Shale, sandy	20	
(Splash Dam coal horizon, elevation 1,630)...	..	145
Sandstone, coarse, massive, forms conspicuous cliff	65	
(Upper Banner coal horizon).....	..	65
Shale, mostly sandy.....	55	
Sandstone, medium-grained	10	
Shale, sandy	35	
(Lower Banner coal horizon, elevation 1,465)	..	100
Sandstone, fairly coarse at top, fine-grained below, forms cliffs	75	
Shale, sandy, and some fine-grained, shaly sandstone	75	
(Kennedy coal horizon, elevation 1,315).....	..	150
Sandstone, coarse, massive, forms very conspicuous cliff	100	
Shale, sandy, with fine-grained, shaly sandstone at base	72½	
Coal (Garden Hole), elevation 1,140.....	2½	175
Shale, in part sandy.....	8	
Sandstone, forms cliff.....	20	
Shale, in part blue.....	30	58
	693	693

Local Section 24.

From mouth of Big Lick Branch of Trace Fork of Prater Creek northwest along road to gap, thence up spur to north. Section 50 feet too short because of dip.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Shale	20	
(Clintwood coal horizon, elevation 2,252)	..	20
Sandstone, coarse, massive, white in lower part	60	
Concealed	20	
(Approximate position of Eagle coal, elevation 2,172)	..	80
Concealed	30	
Shale	40	
Sandstone, not well exposed	10	
Interval, chiefly shale	70	
(Glamorgan coal horizon, elevation 2,022)	..	150
Gladeville sandstone:		
Sandstone, mostly coarse, not well exposed	65	65
Norton formation:		
Concealed	25	
Shale, mostly sandy, and thin sandstones	115	
Sandstone, fine-grained	25	
Shale	40	
Sandstone, coarse in part, micaceous	20	
Coal (Splash Dam, location 439), elevation 1,730	2	272
Concealed, some sandstone in upper part	30	
Sandstone, not well exposed at top	20	
Concealed	85	
Shale, mostly sandy, with some thin, fine-grained sandstones	135	
Sandstone, fine-grained, thin-bedded	10	
(Kennedy coal horizon, elevation 1,450)	..	280
Sandstone, not well exposed	65	
Concealed	50	
Sandstone, fine-grained to coarse	40	
Shale, sandy, and fine-grained, thin-bedded sandstone	38	
Coal (Garden Hole, location 417), elevation 1,255	2	202
	1,017	1,067

Local Section 25.

Southward on road along upper part of Trace Fork of Prater Creek, from a mile southwest of Leemaster to gap, thence up spur to west.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, coarse, massive, weathers soft and granular	40	
Shale, sandy in part, with thin sandstone bed near middle	65	
(Glamorgan coal horizon, elevation 2,135)	..	105

	Thickness. Feet.	Intervals. Feet.
Gladeville sandstone:		
Sandstone, uniformly coarse and very massive, top weathers round and smooth	60	60
Norton formation:		
Shale, top not well exposed, sandy at base	100	
Concealed	20	
Sandstone, coarse, forms ledge	20	
Shale, sandy at top, drab to blue at base	30	
Coal (Hagy, location 444), elevation 1,911	3	173
Concealed, probably shale	10	
Sandstone, medium-grained, massive	15	
Shale, sandy	35	60
	398	398

Local Section 26.

From coal opening 100 yards southwest of location 419, on Crooked Branch of Prater Creek, one-fourth mile southeast along road, thence up spur to northwest.

	Thickness. Feet.	Intervals. Feet.
Norton formation:		
(Splash Dam coal horizon, elevation 2,225)	..	
Sandstone, coarse to medium-grained, very massive in upper part, forms conspicuous cliffs	60	
(Upper Banner coal horizon, elevation 2,165)	..	60
Shale, in part sandy	155	
Sandstone, fine-grained	10	
Shale	53	
Sandstone, medium-grained, resistant	15	
Shale, mostly sandy	76	
Coal bloom (Kennedy), elevation 1,856	..	309
Sandstone, medium-grained to coarse, mostly compact, but weathers granular in parts, lower part most conspicuous	55	
Shale	52	
Sandstone, medium-grained, compact	15	
Shale, sandy	15	
Coal (location 419), elevation 1,717	2	139
Shale, sandy	60	
Coal (Garden Hole), elevation 1,655	2	62
	570	570

Local Section 27.

From location 458 on Young's Branch of Garden Creek northwestward along path to gap, thence south along ridge.

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Shale	80	
Coal bloom (Glamorgan), elevation 2,490	..	80

	Thickness. Feet.	Intervals. Feet.
Gladeville sandstone:		
Sandstone, coarse, weathers reddish-brown and granular, massive, not well exposed in lower part	90	90
Norton formation:		
Shale	51	
Concealed, probably mostly shale	70	
Sandstone, fairly coarse, weathers granular, upper part not well exposed	90	
Shale	40	
Sandstone, coarse, resistant, forms ledge	25	
Shale, not exposed at base	55	
(Splash Dam coal horizon 2,078)	..	232
Sandstone, coarse, forms ledge	20	
Concealed, probably mostly sandy shale and fine-grained sandstone, includes Lower Banner coal horizon in lower part	178	
Shale, sandy, chiefly, with thin fine-grained shaly sandstones	136	
Coal (Kennedy, location 458), elevation 1,740	5	339
Sandstone, coarse, massive, compact	65	65
	907	907

Local Section 28.

Southward on road along upper part of Whitt Fork of Garden Creek to gap, thence westward along path up spur to top of ridge. Section 40 feet long because of dip in lower part.

Norton ~~Wise~~ formation:	Thickness. Feet.	Intervals. Feet.
Sandstone, coarse	10	
Concealed, probably mostly shale	40	
(Hagy coal horizon, elevation 2,727)	..	50
Sandstone, coarse, massive	65	
Shale, sandy	20	
(Splash Dam coal horizon, elevation 2,642)	..	85
Sandstone, coarse to medium-grained	45	
Shale	15	
Sandstone, fine-grained	10	
Shale, sandy	30	
(Lower Banner coal horizon, elevation 2,542)	..	100
Sandstone, coarse to medium-grained	35	
Shale, sandy	25	
Sandstone, fine-grained, and shale, not well exposed in lower part	175	
Coal (Kennedy, location 467), elevation 2,305	2	237
Sandstone, coarse, compact, resistant	60	
Concealed	40	
Shale	40	
Coal, in opening under road, elevation 2,165	..	120
Concealed	25	
Sandstone	20	
Shale, sandy and fine-grained, shaly sandstone, poor exposure	40	

	Thickness. Feet.	Intervals. Feet.
Wise formation:		
Sandstone, forms ledge	15	
Concealed	35	
Coal (Garden Hole) in opening under road, elevation 2,030	..	115
	747	707

LOCAL SECTION 29.

Northward along road from mouth of Negro Camp Branch of Road Fork to Carrie, thence one-fourth mile east on Sandy Ridge.

	Thickness. Feet.	Intervals. Feet.
Gladeville sandstone:		
Sandstone, orange-colored to reddish-brown, grades from fine-grained at base to very coarse and with a few small pebbles at top, upper part very resistant to weathering	115	115
Norton formation:		
Shale, with two thin sandstones	100	
Sandstone, coarse and compact, weathers light gray to brown	75	
Concealed	67	
Shale, in part sandy and with some fine-grained, thin-bedded sandstone	45	
Sandstone, coarse at base to fine-grained at top, resistant, forms cliff	45	
Concealed	10	
Coal bloom (Splash Dam), elevation 2,433	..	342
Sandstone, medium-grained, forms strong ledge	30	
Concealed, probably shale	8	
Coal bloom (Upper Banner), elevation 2,395	..	38
Shale, sandy	30	
Sandstone, fine-grained	5	
Concealed	80	
(Lower Banner coal horizon, elevation 2,280)	..	115
Sandstone, fine-grained at top, lower part coarse, forms strong cliff	60	
Shale, sandy	12	
Sandstone, fine-grained, forms ledge	20	92
	702	702

GEOLOGIC STRUCTURE.

Method of representation.

The position in which coal and other beds lie in a region in which there are few sharp folds is most readily shown by means of structure contours,—lines drawn so that each one of them connects points at which some easily recognizable reference stratum is at the same elevation. In part of the

quadrangles the Upper Banner coal bed has been chosen as the reference stratum, and in another part the Splash Dam coal bed, which is about 70 feet above the Upper Banner. By this method the direction of the dip and its magnitude in feet per mile or other unit can be quickly ascertained from the map.

Another use of the structure contours is to show the position of the outcrop of any bed on the topographic map or its depth beneath the surface where it is covered by other rocks. For example, if it is desired to find the position of the Kennedy coal bed at some point along Indian Creek, the elevation of the Upper Banner horizon shown by the structure contours is first noted. Then the interval between the Kennedy and the Upper Banner is ascertained by consulting the detailed descriptions of the Kennedy in the Indian Creek drainage basin, the generalized sections in Plate IV, or a local section for a neighboring exposure. As the Kennedy is below the Upper Banner, this interval subtracted from the elevation of the latter bed will give the elevation of the Kennedy. By turning to the topographic map the Kennedy outcrop can then be located by noting the position of the surface contour with the same elevation. If the bed under discussion is below the surface, the depth to which it is necessary to drill in order to reach it can be determined by subtracting the elevation of the bed from that shown by the topographic map at that point.

The usefulness of structure contours naturally depends largely on their accuracy. There are so many possible sources of error in this region that it is not maintained that absolute accuracy has been achieved. It is believed, however, that inaccuracies of more than 50 feet in vertical distance are very rare. Errors are most likely to be made where dips are exceptionally steep, as along Pine Mountain, near faulted and buckled areas like those on Russell Fork and in the southeastern part of the Bucu quadrangle, and where few coal beds were found, as along Pawpaw and Fox creeks and in some other areas.

Folds.

In the greater part of the quadrangles there is a general dip to the northwest averaging a little more than 50 feet to the mile. This general dip is not uniform, however, and is modified and to a large extent governed by a few large open folds, and is also locally modified by short low folds or wrinkles that are irregularly distributed and whose axes trend in different directions.

Middlesboro syncline.—All of the Virginia portion of the Clintwood quadrangle and part of the Bucu quadrangle lies in a broad fold that is synclinal, or concave upward. This fold, named by Campbell the Middlesboro syncline, extends from a few miles northeast of the Clintwood quadrangle southwest into Tennessee, being commonly 12 to 20 miles broad, and lying between Pine Mountain on the northwest and a broad arch or anticline on the southeast. It fades out northeast of Russell Fork, as will be explained in the description of the Pine Mountain fault.

The axis, or imaginary line toward which the strata on each side dip and which connects the lowest parts of the syncline, corresponds closely in position with the valley of Pound River and is continued in the same direction northeast of Russell Fork. Strata southeast of the axis dip, in general, to the northwest at very low angles, descending, for example, a vertical distance of 950 feet between the southeast corner of the Clintwood quadrangle and the mouth of Cranesnest River, a horizontal distance of 16½ miles. Northwest of the axis the dip is to the southeast and gradually increases to about 33 degrees near the top of Pine Mountain. The southeast dips are caused by the Pine Mountain fault and continue to the points where it comes to the surface on the northwest slopes of the mountain. (See fig. 2.)

Sourwood Mountain anticline.—In the south-central part of the Bucu quadrangle there is a structure that is the reverse of a syncline, strata being convex upward and dipping away from the axis. This feature is the Sourwood Mountain anticline. Its axis is a curved line having a general north-south trend and terminating at both ends at faulted areas. Dips are, in general, to the west and northwest on its west side and east on its east side and average about 250 feet to the mile. The anticline plunges slightly to the north and is slightly modified by a very shallow cross-syncline at its south end.

Dry Fork anticline.—Another anticline affects a small area in the southeastern part of the Bucu quadrangle. This arch has a broad, flat top and a northeast-southwest trend and plunges slightly to the west. Except that strata south of the axis have general southerly dips, the anticline has not greatly affected the structure of the area. It is a stronger feature farther east, however, entering West Virginia at the head of Dry Fork and reaching as far northeast as Bramwell, W. Va. It appears to end on the southwest at the buckled and faulted area along Russell Fork, but may have extended farther southwest before differential movement took place in that area.

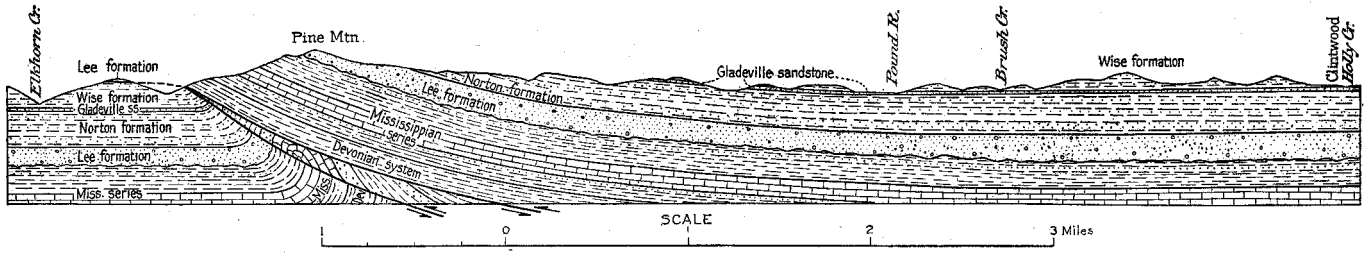


Fig. 2.—Cross-section from the northwest corner of the Clintwood quadrangle to Clintwood.

Faults.

In addition to the folds, faults have profoundly modified the structure and have exerted a marked influence on the economic possibilities of the region. A large part of the potentially coal-producing territory of southwest Virginia is bounded on both the northwest and the southeast by great thrust faults, the value of parts of several coal beds has been decreased by movements connected with this faulting, and buckling and faulting have made unavailable the deposits in narrow zones within the coal field.

Pine Mountain fault.—The rocks of the Virginia area were thrust up over those in Kentucky along the great Pine Mountain fault, which comes to the surface along the north face of Pine Mountain from Russell Fork into Tennessee. The fault dies out rapidly northeast of Russell Fork, and on Levisa Fork there is no trace of it or of the anticline from which it developed. According to recent work by Butts in the Clintwood and Pound quadrangles, the fault is compound in places, breaks having occurred along two planes that are close together everywhere and join in places (fig. 2). The first effect of the tremendous pressure from the southeast was probably the formation of a sharply overturned fold, near the axis of which the first fault originated. The rocks belonging to the Lee formation, on the hills northwest of the Pine Mountain escarpment in the Clintwood quadrangle were probably carried to that position by the first fault and are only small remnants that have escaped erosion. These rocks, which overlie undisturbed strata of the Wise formation, are nearly vertical in places, and at one place 1½ miles west of Blowing Rock Gap are separated from Devonian black shale, brought up by the second fault, by overturned remnants of Pennington shale and Newman limestone. The second fault was at a lower angle and carried the rocks still higher, so that now the lower part of the Devonian black shale is in contact with beds in the Wise formation.

The vertical component of the thrust along the outcrop of the fault in the Clintwood quadrangle is 5,000 to 5,300 feet. In The Breaks, where the fault crosses Russell Fork north of the Clintwood quadrangle, the vertical displacement is only 600 to 800 feet and there is no evidence of overfolding or of more than one fault. It is probable that one of the faults ends near Skegg Gap, 2 miles west of The Breaks, where there has been differential movement or shearing along a nearly vertical plane in line with the zone of faulting and buckling on Russell Fork, in the Clintwood quadrangle.

Russell Fork faulted and buckled areas.—The rocks in several narrow areas along Russell Fork, one of which extends to Fryingpan Creek, are

shown on the geologic maps in the undifferentiated Pennsylvanian symbol because the rocks in them dip so steeply and irregularly in places that the exact position of formation boundaries is uncertain. The structure of these areas is complicated and will be explained only in outline.

One faulted area less than a mile wide lies along Russell Fork from near Sand Lick to the north boundary of the Clintwood quadrangle and continues on the north to Skegg Gap on Pine Mountain. Dips in this area, especially along its eastern border north of McClure River, are chiefly south of northeast at all angles between 5 and nearly 90 degrees. In places, however, there are steep dips to other points of the compass, and some shale beds are irregularly buckled and crumpled. In other places there has been little disturbance. This structural feature is primarily the result of shearing along one or more lines parallel with its long axis. The movements were evidently connected with the Pine Mountain faulting, and resulted in rocks on the southwest side of the faulted area moving farther to the northwest and becoming relatively higher than those on the northeast side. The northeasterly dips and much of the apparently irregular buckling were caused by a crowding together of the rocks on each side of the shearing planes. Finally, a reaction brought about normal faulting with the downthrow on the southwest, though not sufficient to lower the strata to the level of those on the northeast. The line of weakness developed by the fracturing of the rocks has determined the position of Russell Fork. The remarkably straight course of Fryingpan Creek in a continuation of the same northwest-southeast direction suggests a continuation of the shearing to the southeast, but no positive evidence of such an extension could be obtained along the lower part of the stream.

Dips in different directions, some at high angles, were noted at several places near the mouths of Pawpaw and Little Pawpaw creeks and along Russell Fork for a short distance southeast. The disturbance is most noticeable along the county road where it makes a cut-off near a sharp bend of the river half a mile south of Pawpaw Creek. The dips appear to have been caused by buckling resulting from incipient shearing.

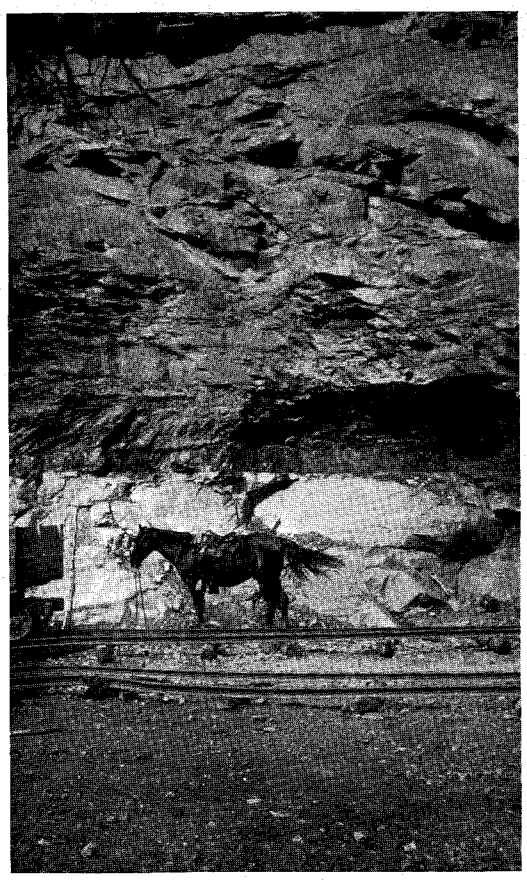
A disturbed area whose long axis is in line with that of the one just mentioned was noted a short distance up Russell Fork. Along the river between Murphy and a point about a mile northeast, and for short distances back from the stream, there are dips of 50 degrees and less in several directions. There are distinct evidences of faulting at two points but the relationships are not very clear. It is probable that there has been shearing, accompanied by faulting, along a line from Indian northwest to Murphy

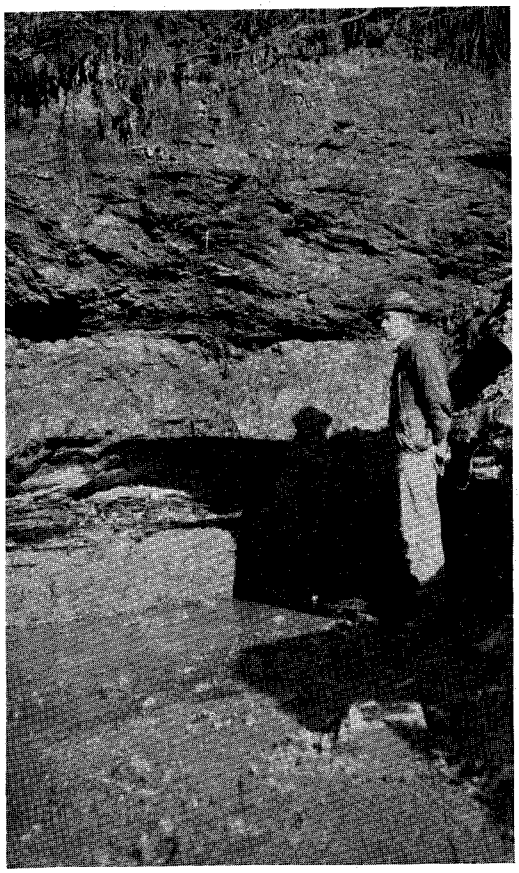
and beyond. As along the lower part of Russell Fork, strata on the southwest side of the fault moved to the northwest past those on the northeast side, but not far.

A very long, narrow area in which the strata are buckled and faulted extends from the north end of Big A Mountain northwest down Russell Fork for 8 miles, and thence to a point north of Abners Gap and beyond. This structural feature was caused by shearing along a fault whose position can not be exactly located everywhere, but which lies approximately as shown on the geologic map of the Bucu quadrangle. Beds north of the fault remained nearly stationary during the movement, but those on the south side were forced a short distance northwest and were folded to form or accentuate the feature described as the Sourwood Mountain anticline. Beds for a short distance on both sides of the fault are buckled in places, but less than in other areas mentioned. Buckling was greatest at the northwest end of the area, on Priest Fork, where there was probably no clean-cut faulting. The shearing was evidently the result of the great pressures which deformed the rocks in the southeast corner of the quadrangle.

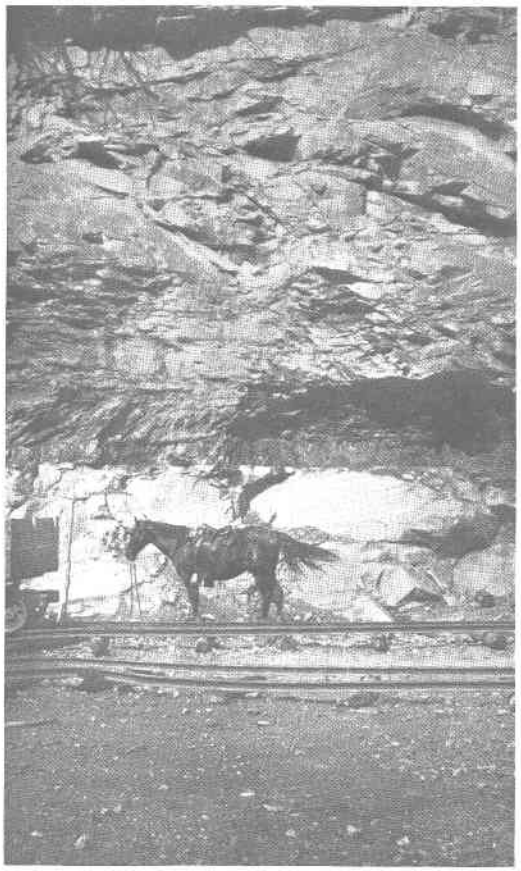
Faults in the southeast corner of the Bucu quadrangle.—Rocks in the southeast corner of the Bucu quadrangle were strongly folded, overturned, and overthrust to the northwest along at least ten great faults. Except in a narrow area west of Weaver Creek, however, the strata are all pre-Pennsylvanian and contain no commercial coal deposits, so that details of the structure will not be given here. Since the coal-bearing beds that formerly overlay the older rocks have been raised and completely removed by erosion, the coal field is bounded on the southeast by these overthrust beds. Pennsylvanian strata underlie the border of the faulted area in places, but the coal in them can never be profitably mined. Southwest of Big A Mountain there are rocks shown on the geologic map in the undifferentiated Pennsylvanian symbol. These beds all dip southeast at angles of 30 to 70 degrees and include the Lee and lower part of the Norton formation, overturned and forced over younger Pennsylvanian beds along a thrust fault. Coal-bearing rocks west and north of the faulted area are not much disturbed, and even those close to the overthrusts dip less than 1 degree except in a few small areas.

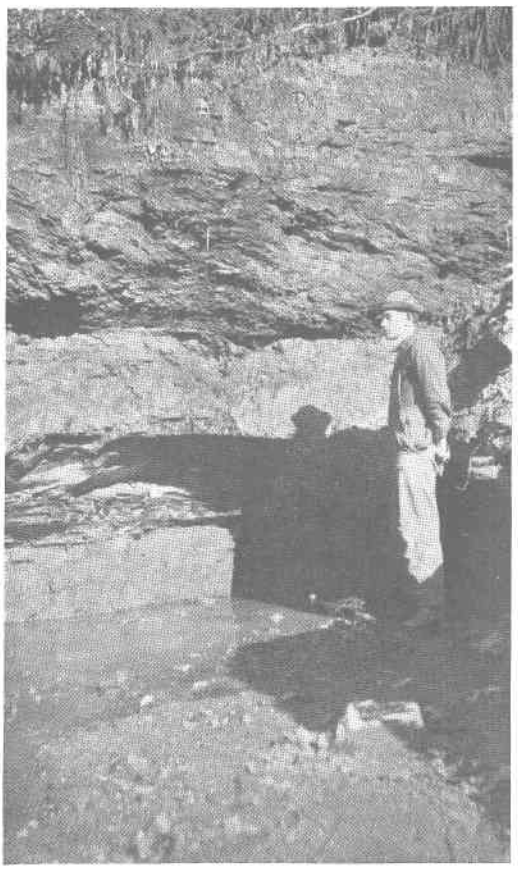
Other movements.—During the movements described above there was a general tendency for higher beds to be forced slightly farther northwest than those below them. This differential movement has been effected chiefly by buckling within shale beds, so that many exposures of shale show steep and irregular dips in localities in which all the more massive sand-





Views of coal beds showing movement along bedding planes: (A) Kennedy coal in railroad cut near mouth of Roaring Fork; (B) Tiller and Jawbone coal one mile southwest of Duty (location 244).





Views of coal beds showing movement along bedding planes: (A) Kennedy coal in railroad cut near mouth of Roaring Fork; (B) Tiller and Jawbone coal one mile southwest of Duty (location 244).

stones and most other beds have only the very gentle dips that characterize the greater part of the coal field. Movement has taken place in several coal beds also, so that the coal is crushed and fractured and in places mixed with slickensided shale fragments to form "rash." Movement along the Kennedy coal bed and the rocks immediately over it has been especially common in the area south and west of Russell Fork, the coarse, massive sandstone beneath the coal forming a comparatively immovable stratum over which rode the thin-bedded rocks above. Parts of the Jawbone and partings in other coal beds are similarly affected, especially near faulted areas.

Normal faults are uncommon but are not unknown. All those observed were small, the beds on the downthrow side having been dropped only a few inches to 30 feet below their normal position.

ECONOMIC GEOLOGY

GENERAL DESCRIPTION OF COAL BEDS.

Introduction.

The Clintwood and Bucu quadrangles contain many beds of high-grade coking coal, the quality of which will be described more completely in another part of this report. At least thirteen of these beds are minable in one or more localities under present commercial conditions, though no bed is sufficiently thick in all localities to compete with thicker deposits that will be available in this and neighboring areas for years to come. As shown by the tables of ultimately available tonnages, there is a great quantity of coal that will form an important reserve for the near and distant future.

The thicknesses and general characters of each coal bed have a wide range, even in neighboring localities. Only the most complete and thorough prospecting can determine the exact possibilities in advance of mining, and such detailed prospecting has been undertaken in only about a fourth of the area. In addition to the differences in the tonnage per acre of a bed or zone from place to place, another factor of uncertainty arises from the fact that many beds split into two or more parts where shale partings thicken considerably. Very few exposures show more than 3 feet of coal without partings half an inch or more thick, the most common being shale or hard clay. The term "rash" is locally applied to an intimate mixture of coal and shale, in many places contorted and slickensided by movements along the bedding planes. Thin layers of bone and also of cannel form parts of some coal beds.

The thicknesses of coal, the intervals between beds, and other economic factors are described by drainage basins in a succeeding section of this report. In this place only brief summaries of the characteristics of each bed will be given. The intervals used are averages only, and will not apply exactly to all parts of the quadrangles. Maximum and minimum intervals are given in the detailed descriptions by drainage basins and in the generalized sections (Pl. IV). Many local intervals are shown in the local sections.

Coal beds in the Lee formation.

The Lee formation is fully exposed in this area only on the southeast slope of Pine Mountain, and where the formation has been overturned and

thrust over younger beds southwest of Big A Mountain. No economically important coal beds were found in these places, though exposures are poor and some fairly thick deposits might have escaped notice. The fact that only very thin Lee coals are present a short distance north of the Clintwood quadrangle in The Breaks, where most of the Lee is clearly exposed, indicates that there is very little minable coal in the formation in at least the northern part of the quadrangles. A number of Lee coal beds are shown in the drill records of the Clinchfield Coal Corporation (Pls. II and III), but their thicknesses have not been made public. A 30-inch bed was found near the top of the formation in exposures on Indian Creek.

In Wise, Lee, and Scott counties, Virginia, where the Lee is exposed in a large area, it contains a number of coal beds that are thin in most places and a few that are fairly thick in small districts. About the same condition probably prevails in the south half of these quadrangles. Rocks equivalent to the Lee in the famous Pocahontas field, about 30 miles east of the quadrangles, include very thick and pure coal beds. These coals thin to the west, however, and the places of some of the most important beds are taken by thick basal conglomerates in at least part of the Clintwood quadrangle.

Tiller coal bed.

Although there are coal deposits in places in the 200-foot interval between it and the top of the Lee formation, the lowest coal bed of much commercial importance is the Tiller. The rocks in the interval are alternating shales and sandstones with no striking characteristics, though an exceptionally coarse and locally conglomeratic sandstone lies a few feet below the coal. The Tiller horizon is exposed only along Indian Creek and its tributaries, along Fryingpan Creek near Bucu, along the upper part of Russell Fork, in a small area on Musick Fork of Weaver Creek, along part of Levisa Fork, and in the southern foothills of Pine Mountain. The name Tiller was applied by Stone in his report on the coal resources of the Russell Fork basin to the thick coal bed on Indian and Cane creeks. As the upper part of this thick deposit is now known to be the equivalent of the Jawbone, the name Tiller is restricted in this report to the lower part.

Although the Tiller is concealed beneath the surface in much of the area, it may be safely estimated that it is a minable bed containing about 4 to 6 feet of coal in the south third of the Bucu quadrangle. It will probably be mined on a large scale in the near future, and a beginning has already been made at the "slope mine" of the Clinchfield Coal Corporation on Hurricane Fork, a short distance south of the Bucu quadrangle. In a

strip extending southeast from Bucu the Tiller is united with the overlying Jawbone coal to form a very thick bed. Exposures in the southern and central parts of the Indian Creek drainage basin show 7 to 15 feet of minable coal in the combined beds, though part of it is somewhat dirty. The Tiller contains a parting that impairs its value on Russell Fork, and thins to the north to about 30 inches on Levisa Fork. No coal was found at the horizon of the Tiller bed on Pine Mountain or in The Breaks, indicating that it thins to the northwest and perhaps also to the west from its exposures near Bucu.

Jawbone coal bed.

The Jawbone coal bed commonly lies above a coarse, quartzose, locally conglomeratic sandstone that separates it from the Tiller, the interval between the two coals being 100 feet or less. The bed takes its name from Jawbone Hollow, a tributary of Bull Run between Virginia City and Banner in the Bristol quadrangle. It has been called the Ratliff in private reports on the upper Levisa Fork drainage basin. The Jawbone is exposed in the Clintwood and Bucu quadrangles in the same localities as the Tiller and, as mentioned above, is united with the Tiller in places in the southern part of the Bucu quadrangle.

The Jawbone makes its best showing where it is united with the Tiller bed. It is probably also thick in other areas in the southwestern part of the Bucu quadrangle, as it includes 3½ to 8 feet of somewhat impure coal in exposures on Hurricane Fork a short distance south of the area herein described. No thick coal was found at its horizon on Musick Creek, however. Along Russell Fork near Council the coal is 2 to 6 feet thick, but it thins to the north to less than 30 inches along Levisa Fork. Drill records show that it is a persistent bed in the Clintwood quadrangle and it may be minable in places. No coal was noted at the Jawbone horizon at its exposures on Pine Mountain or in The Breaks.

Garden Hole coal bed.

The Garden Hole coal is about 340 feet above the Lee formation and 140, more or less, above the Jawbone bed. The name was given it by the prospectors of the Clinchfield Coal Corporation from exposures at the Garden Hole on Russell Fork, near The Breaks. The bed is probably the same as the "so-called Imboden" of Campbell's reports on the Bristol quadrangle. It is exposed low down in the principal valleys in the southern and eastern parts of the Bucu quadrangle and along the foot of Pine Mountain.

The bed is under a ledge-making sandstone in some localities and over one in others, and this fact, combined with the presence of other coal beds not far above it, makes identification of outcrops uncertain.

The Garden Hole bed is less than 3 feet thick nearly everywhere and less than 2 feet in most places. Under and near Sandy Ridge in the vicinity of Kiser and Cane gaps it is an attractive bed 3 to 4 feet thick. It is 44 inches thick in one place at the foot of Pine Mountain, and 1 to 6 feet thick in and near The Breaks.

Aily coal bed.

There are in places several coal beds in an interval 200 feet thick above the Garden Hole bed. These beds are almost everywhere less than 2 or 3 feet thick and are thinner in most exposures. The name Aily, from a post-office on Lick Creek of Russell Fork, has been applied to what appears to be the most persistent and in most places the highest of these beds. The Aily is about 500 feet above the Lee and 160 feet above the Garden Hole coal. It appears in many of the drill records, especially those in the Clintwood quadrangle, but is only about 2 feet or less thick in most of its exposures, even in those near its type locality. It is locally minable under present conditions in small areas.

Kennedy coal bed.

A bed that lies about 600 feet above the Lee has long been known as the Kennedy or Widow Kennedy in the mining districts a short distance south of the Clintwood quadrangle. It has yielded considerable coal at shipping mines at Dante and elsewhere, but has not yielded much profit to the operators and is not now extensively mined. Some coal is shipped from it, however, from mines in the Bucu quadrangle, near Drill, on Lewis Creek. One of its most marked characteristics in the region south and west of Russell Fork is its generally crushed condition and great irregularity in thickness. In the Levisa Fork drainage basin, where it is called the Harris seam in private reports, the coal is clean and as regular in thickness as any other bed. Its characteristic sandstone bottom-rock has already been described.

The Kennedy contains a large aggregate of coal in the south half of the Clintwood quadrangle in deposits that range from a few inches to 10 feet thick within short distances. It thins to the northwest and was not found along the foot of Pine Mountain. In the Bucu quadrangle the bed

is less than 2 feet thick, except locally, in most parts of the Russell Fork and Clinch River drainage basins. Near the heads of Russell Fork and Lewis Creek, however, the Kennedy's thickness averages about 3 feet, and it is slightly more along part of Fryingpan Creek. The bed is persistent in the Levisa Fork basin, and thickens to the east from about 27 inches along Little Prater Creek to 4 or 5 feet at the east boundary of the quadrangle (fig. 3).

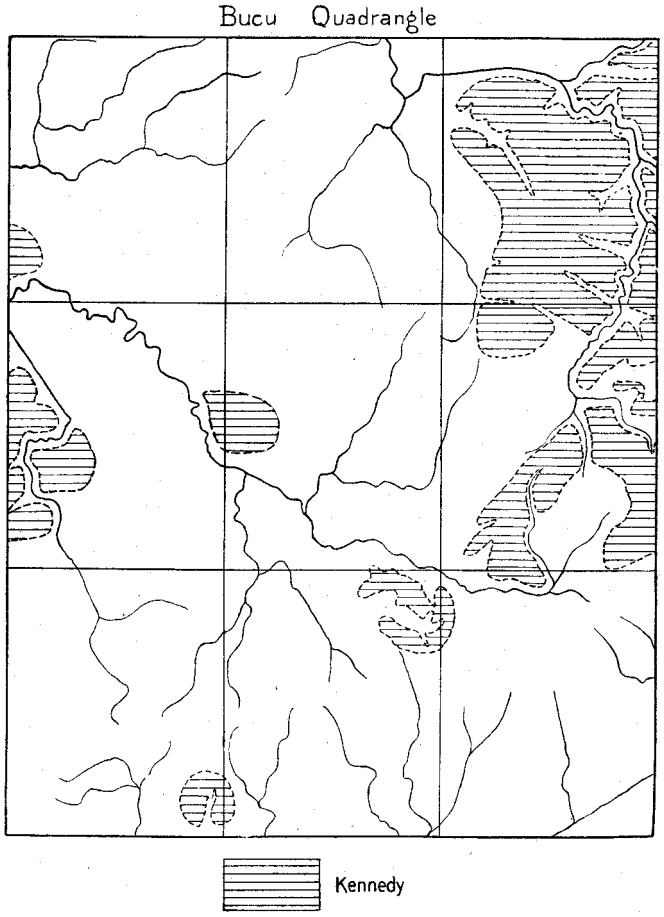


Fig. 3.—Sketch map of Bucu quadrangle, showing areas in which the Kennedy bed contains 3 feet or more of minable coal.

Lower Banner coal bed.

A bed about 200 feet above the Kennedy and 800 feet above the Lee formation is widely known as the Lower Banner in the mining districts in the general region of its type locality at Banner, on the Norfolk and Western Railway. Along upper Levisa River the same bed has been called the Cary by private investigators. This coal is extensively mined at Wilder in the Bucu quadrangle, and at Dante, a short distance south of the Clintwood quadrangle. Like the Kennedy, the Lower Banner has a sandstone bottom-rock, but it is much thinner and less conspicuous on hillsides. The strata from the Kennedy to the bottom-rock and from the Lower Banner to the Upper Banner coal are shales and thin-bedded sandstones in most places.

The Lower Banner is minable, even under present commercial conditions, in several areas. (See fig. 4.) One of the best areas is under and in the vicinity of Sandy Ridge from Coon Branch of Open Fork east to Cane Creek and the ridge east of Road Fork, where the average thickness of coal is 3 to 5 feet. Another very promising area is north of Drill, along the eastern border of the Bucu quadrangle, where the bed is about 4 to 5 feet thick. In the greater part of both areas it is exceptionally free from partings. The Lower Banner is about 3 feet thick in four small areas and 2 to 3 feet in many places. It is a very persistent bed, though locally thin, in most of the area of the quadrangles.

Upper Banner coal bed.

The Upper Banner is one of the best known and most important coal beds in southwest Virginia, and is extensively mined at Wilder, Dante, Toms Creek, and elsewhere. The mine at Wilder is in the Bucu quadrangle, and one of the largest mines near Dante and another near Toms Creek extend northward under Sandy Ridge into the Clintwood quadrangle. The average distance of the bed above the Lower Banner is 100 feet and that above the Lee formation is about 900 feet. There are shales and thin-bedded sandstones below the coal and a ledge-making, coarse-grained sandstone about 20 feet or less above it. One of the most marked characteristics of the Upper Banner is the persistent sandstone parting less than 2 inches thick in the upper half of the bed.

There are two large areas and three smaller ones in which the Upper Banner is especially attractive for mining. One of these includes the territory under and near Sandy Ridge from the southwest corner of the

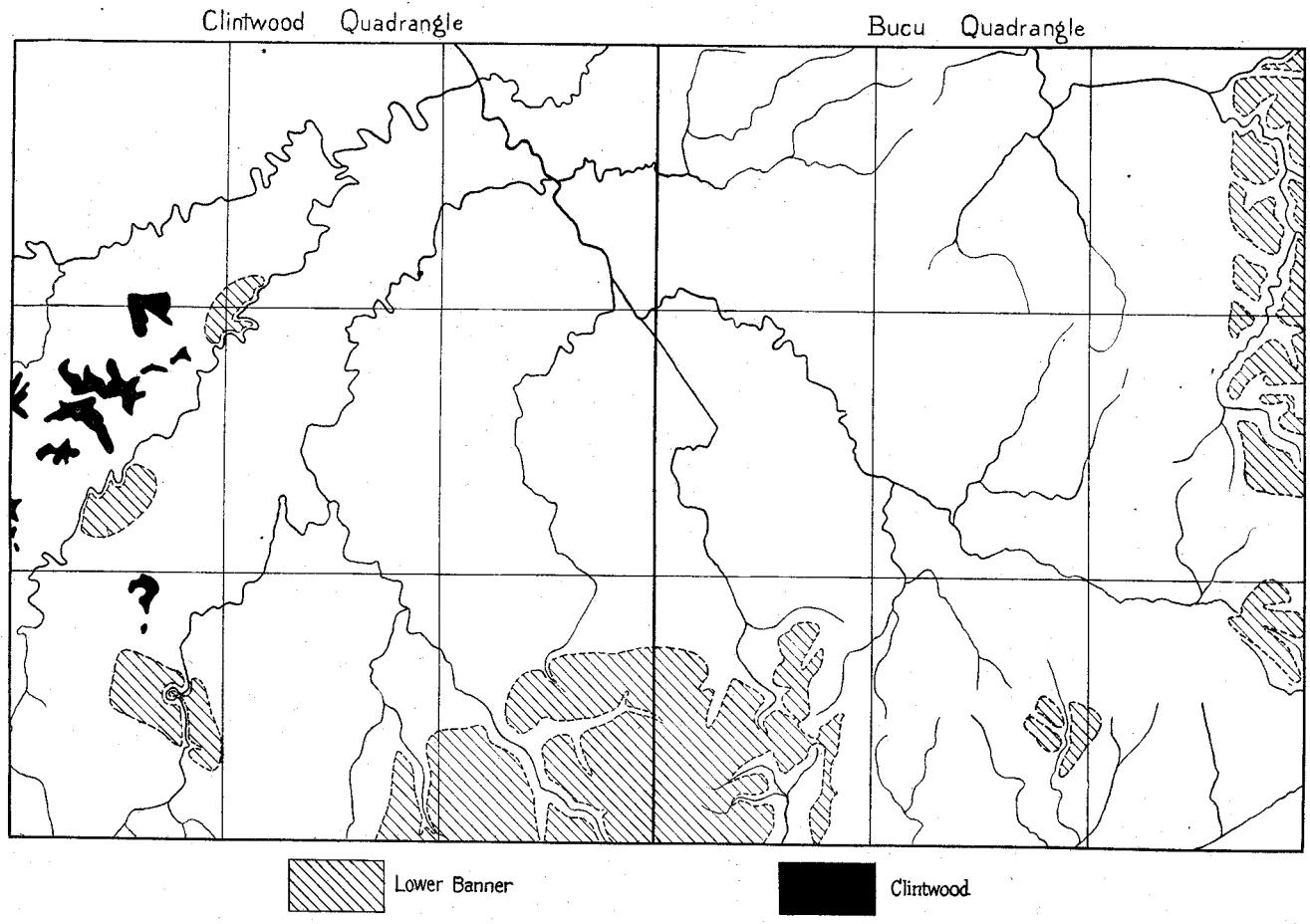


Fig. 4.—Sketch map of Clintwood and Bucu quadrangles, showing areas in which the Lower Banner and Clintwood beds contain 3 feet or more of minable coal.

quadrangle east to Road Fork, where the bed contains coal averaging 4 to 6 feet in thickness and only thin partings. Another is on both sides of McClure River north of Big Branch, extending westward to and beyond Cranesnest River and eastward to and beyond Lick Creek. In this area the average thickness of coal is 4 to 5 feet and partings are thin. In smaller areas on the west side and at the head of Fryingpan Creek the bed is in similar condition. Outside these districts, which are shown in Figure 5, the Upper Banner is split into two or three parts by a thickening of shale partings above and below the thin sandstone parting. These parts are so widely separated that they could not be mined as one bed, and commonly so close that only one could be utilized. In places one or the other of the separated parts contains 2 to 4 feet of coal. Northeast of Russell Fork all the divisions of the Upper Banner are so thin, except locally, that they can not be regarded as an important economic resource. Indeed, it is probable that coal is lacking at the Upper Banner horizon in most of the Levisa Fork drainage basin except along parts of Prater Creek.

Splash Dam coal bed.

The Splash Dam bed, so named on maps of the Clinchfield Coal Corporation because it rises from beneath Russell Fork near the splash dam, a short distance north of the mouth of Pound River, is about 70 feet above the Upper Banner bed and 970 feet above the Lee formation. It is probably the same as the Wilson bed of private investigators in the upper Levisa Fork country, though slightly lower than a bed that has been called Wilson on Prater Creek. It lies a few feet above the sandstone cap-rock of the Upper Banner, which is a conspicuous cliff-former along Levisa Fork and elsewhere. The rocks above the coal differ from place to place, being chiefly shales in some localities and coarse sandstone in others.

Coal appears at the Splash Dam horizon in many localities, but it is less than 30 inches thick in some places and is split into thin benches in many others. It makes its best showing in the southern part of the Open Fork drainage basin, where it includes 3 to 4 feet of coal. It is also thick on Lyons Fork of Cranesnest River. It is a more or less uniform bed averaging 3 or 3½ feet in thickness in the northeast corner of the Clintwood quadrangle, and is thicker farther northeast, on Bull and Poplar creeks in the Hurley quadrangle. This bed has not been thoroughly prospected and may be found to be thick in several localities where it is now unknown.

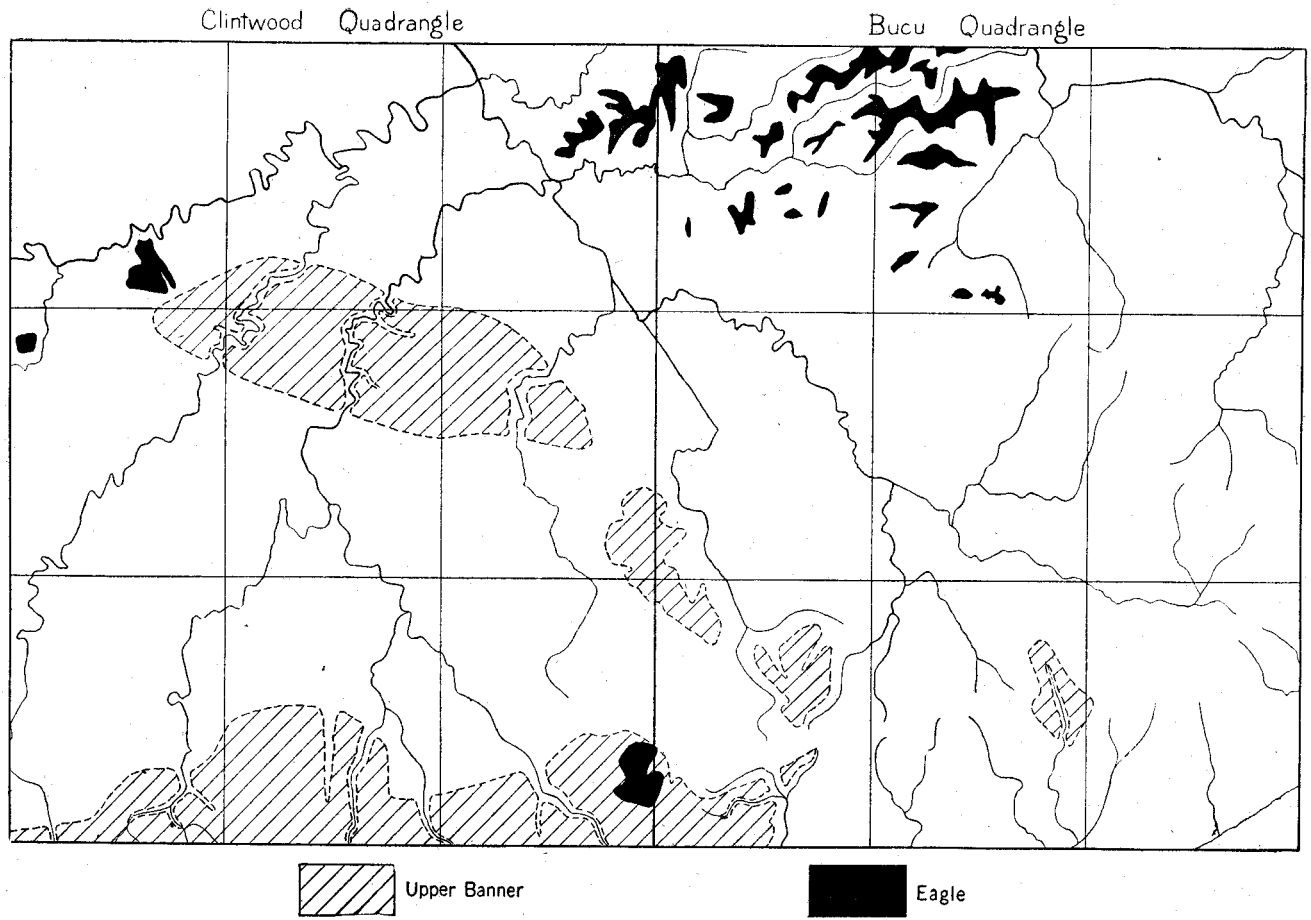


Fig. 5.—Sketch map of Clintwood and Bucu quadrangles, showing areas in which the Upper Banner and Eagle beds contain 3 feet or more of minable coal.

Hagy coal bed.

A bed here named the Hagy, from exposures near Hagy School at Leemaster and in the mine of Mr. Hagy on Trace Fork of Prater Creek, is about 100 feet above the Splash Dam and 1,070 feet above the Lee formation. Northeast of Russell Fork it commonly has a coarse sandstone bottom-rock. Its identification in the southern part of the quadrangles is somewhat uncertain, but it is probable it there lies only a few feet below the coarse sandstone that is near the top of the Norton formation. It may be the same as the Edwards bed of Campbell, which he tentatively correlates with the true Imboden seam of the Big Stone Gap coal field.

The Hagy is only about 2 feet or less thick in most places, but is 3 to 4½ feet thick near the heads of Russell Prater Creek and its principal tributaries and near the head of Trace Fork of Prater Creek.

Glamorgan coal bed.

The Glamorgan coal, named from mines at Glamorgan in Wise County, is about 1,305 feet above the top of the Lee formation, and less than 25 feet above the Gladeville sandstone and the base of the Wise formation.

Coal is persistent at the Glamorgan horizon but it is not more than 2 feet thick in many localities. Between Clintwood and Pound River and in the northeastern and southeastern corners of the Clintwood quadrangle and adjacent parts of the Bucu, the aggregate thickness of coal layers is 2 to 4 feet, but one or more detrimental shale partings are also commonly present.

Lyons coal bed.

A bed that is about 60 feet above the Glamorgan in the southwestern part of the Clintwood quadrangle is here named the Lyons, from a post-office on Big Ridge. It is separated from the Glamorgan by shale in most places and, in the Clintwood quadrangle, lies under a rather thin but conspicuous white sandstone that has already been mentioned. In places the Lyons and Glamorgan are so close that it is difficult to distinguish the former from a split off the latter. The Lyons is too thin, except in a very few small areas, to be mined on a large scale, but can be utilized for local fuel supplies.

Blair coal bed.

The Blair bed, so named by Butts from exposures on the Blair property on Indian Creek, Wise County, is about 80 feet above the Glamorgan, and is

separated from the Lyons seam chiefly by the white sandstone cap-rock of the latter. Locally in and near the northeast corner of the Clintwood quadrangle the Blair is in two benches, separated by 30 feet or less of shale. The bed contains 2 to 3 feet of coal in the Clintwood district, 1½ to 5½ feet in the Russell Prater Creek drainage basin and adjacent areas, and probably less elsewhere. Nearly everywhere, however, there are several shale partings interbedded with the coal.

Eagle coal bed.

A coal bed that lies about 125 feet above the Glamorgan seam has been traced to War Eagle, W. Va., where it is locally called the Middle War Eagle. This bed has been correlated with the Eagle coal of Fayette County, West Virginia, by the West Virginia Geological Survey, and the name Eagle is used here. The bed is overlain by coarse gray sandstone that makes conspicuous cliffs from Russell Fork northeast into Kentucky and West Virginia, making one of the best stratigraphic markers in the entire Pottsville group. The sandstone thins between Russell Fork and Clintwood, but may still be identified near the county seat. One of the peculiarities of the Eagle near Russell Prater and Barts Lick creeks is a local development of a thin sandstone parting, almost identical in appearance with the one that is characteristic of the Upper Banner bed.

The Eagle includes thick coal deposits that underlie only rather small areas near the ridge tops (see fig. 5). In the northwestern part of the Bucu quadrangle and adjoining parts of the Clintwood quadrangle the average thickness of coal is 4 to 5 feet. It is about the same on and near Flat Spur and nearly as thick in small areas near Clintwood, but is thinner elsewhere.

Clintwood coal bed.

The Clintwood bed is 200 feet above the Glamorgan and only a few feet above the sandstone cap-rock of the Eagle bed. In most of the region it is overlain by nearly 200 feet of shale and inconspicuous fine-grained sandstone, but along the western border it has a thin but conspicuous white sandstone cap-rock.

The Clintwood is a remarkably thick bed just west of the central part of the Clintwood quadrangle, and contains 4 to 11 feet of coal in small areas near Clintwood and Darwin and an outlier on Big Ridge (see fig. 4). The bed thins north and northeast of Clintwood. The horizon of the Clintwood was found on Flat Spur and high in the ridges in the northwestern

part of the Bucu quadrangle, but no coal was seen. As coal is present and fairly thick in the Hurley quadrangle, a short distance north of the Bucu, it is probable that it extends southward into the latter area.

Campbell Creek coal bed.

The Campbell Creek bed derives its name from exposures in Kanawha County, West Virginia, and has been traced to the Virginia boundary on Tug Fork by the West Virginia Geological Survey, and thence into the Bucu quadrangle by the writer. It is about 270 feet above the Clintwood bed and lies between thick beds of medium-grained sandstone. It was called the Lower Bolling coal by Butts in the Pound quadrangle and, as mentioned in the description of correlations with adjoining areas, is known under several names in Pike County, Kentucky. In the Virginia portion of these quadrangles, the bed has been removed by erosion from all but a few small outliers on high ridges near Clintwood and the heads of Russell Prater Creek. No coal was found but some is probably present, as the horizon is productive in the Kentucky portion of the Clintwood quadrangle, and in neighboring parts of the Pound and Hurley quadrangles.

DETAILED DESCRIPTION OF COAL BEDS.

Method of statement.

In this region the construction of railroads and exploitation of coal resources will necessarily be planned with special reference to the positions of the principal valleys, as well as to the location of the thickest and most widespread coal deposits. It has been deemed advisable, therefore, to treat each of the principal drainage basins separately. Each coal bed in each of these basins is described separately, beginning with the lowest, and its outcrop is traced along one side of the major stream, including tributaries on that side, and back along the other side. A brief summary of the stratigraphy, structure, and principal coal resources of each basin is given in a geologic outline, and summaries of the principal points of interest concerning each coal bed are given at the beginning of the description of that bed.

A number is given to each measured coal exposure and its location shown on both the geologic and topographic maps. Since the numbers are assigned in the order in which the exposure is mentioned in the text, it is

easy to refer from the maps to the written descriptions. Unless otherwise stated, all measurements were made by the writer or his assistants.

The elevations given are not all of the same degree of accuracy and so certain symbols are used to show the method by which they were obtained. Those marked B. were taken with an aneroid barometer and may be subject to correction. Those with an S. were determined by J. I. Gayetty with stadia, and those with C. C. C. are on transit lines of the Clinchfield Coal Corporation. The symbol H. L. indicates that an elevation was obtained by hand-leveling from neighboring stadia or transit stations.

Many measurements of coal more than 30 inches thick are shown in graphic sections and also described in the text. The numbers at the sides of the graphic sections indicate thicknesses in inches, those on the right being for layers of coal, and those on the left for partings that would be discarded in mining.

Russell Fork drainage basin.

POUND RIVER AND TRIBUTARIES OTHER THAN CRANESNEST RIVER.

Geologic outline.—Pound River flows along or near the axis of the Middlesboro syncline, so that the strata dip toward it from both sides. This dip is gentle on the south side of the river and also on the north side for a short distance from the main valley, but it increases gradually toward the crest of Pine Mountain, where it is 33 degrees to the southeast. Beds which lie far below Pound River rise so as to reach the surface far up the mountain slopes, and Mississippian and Devonian strata form the upper part of the mountain on the Kentucky side and have there been thrust up over the Wise formation along the great Pine Mountain fault.

The lowest formation exposed in the Virginia part of the Clintwood quadrangle is the Pennington shale, which caps Pine Mountain west of Blowing Rock Gap. The next higher formation is the Lee, which caps the mountain east of Blowing Rock Gap, and everywhere outcrops near the mountain top on the Virginia slopes. The most conspicuous members of the Lee are massive conglomeratic sandstones.

The Norton formation outcrops near the foot of Pine Mountain and also in the valley of Pound River as far up as Laurel and Jerry branches, in most of the area on each side of the lower part of the river, and in a small inlier on Georges Fork. The lower part of the formation is exposed only on the mountain slopes, where the Kennedy bottom-rock is a massive quartzose conglomeratic sandstone similar to the Lee and, like the Lee,

making dip slopes and small hogbacks facing the mountain crest. There are 200 or more feet of shales and inconspicuous sandstones between the Kennedy bottom-rock and the Lee, but outcrops are poor. The upper part of the Norton, however, is well exposed along and near the lower part of Pound River.

The Gladeville sandstone and Wise formation appear only on the ridge tops on each side of the lower part of Pound River, but farther upstream the Gladeville is low down in the valley and Wise outcrops are more extensive. The Gladeville is commonly slightly less than 100 feet thick, brownish, crumbly or fairly compact, and massive, though it contains some shaly layers in a few localities and is nowhere a particularly good stratigraphic marker. The maximum thickness of Wise present is about 575 feet, the upper 300 feet being poorly exposed, present in only a few places, and apparently containing considerable shale. The most easily identified stratum is a thin but very resistant white siliceous sandstone that lies about 60 feet above the base of the Wise.

The stratigraphic succession of the coal-bearing formations is shown by the generalized section of the north third of the Clintwood quadrangle (Pl. IV), by several drill records (Pl. II), and by local sections 1, 2, and 3.

Part of the area drained by Pound River and its tributaries other than Cranesnest River is not particularly rich in coal resources. The Pennington is practically barren and no workable coal was found in outcrops of the Lee. Prospecting in the Norton and higher formations north of Pound River is said by the people living in that vicinity to have revealed no beds much thicker than 3 feet, and the best measurement obtained during the recent geologic survey showed only 44 inches of dirty coal. Outcrops are very poor, however, and prospecting has not been thorough, so it is possible that better results may reward further search, especially in the Wise formation.

South of Pound River, no coal as much as 3 feet thick was found east of Rocky Branch, and the Upper Banner bed, though thick on lower Cranesnest River, appears to be thin elsewhere in the Pound River drainage basin. No coal was found at the Lower Banner or Kennedy horizons, though they are probably not barren everywhere. Considerable coal has been found in the Wise formation as the result of thorough prospecting of the Clintwood and associated beds between Pound and Cranesnest rivers. There are five coal beds in the lower 200 feet of the Wise that are fairly persistent and contain from 2 to 4 feet of coal, though the average for any one of them is not more than 3 feet. (See figs. 4, 5, and 6.) The Campbell Creek coal, which is a double bed nearly 300 feet above the base of the Wise, contains

workable coal a few miles west of the Clintwood quadrangle, and may eventually be found near the tops of a few knobs bordering Georges Fork and Brush Creek.

Garden Hole coal bed.—The lowest bed of commercial importance found near Pine Mountain is the Garden Hole, which lies 400 to 500 feet below

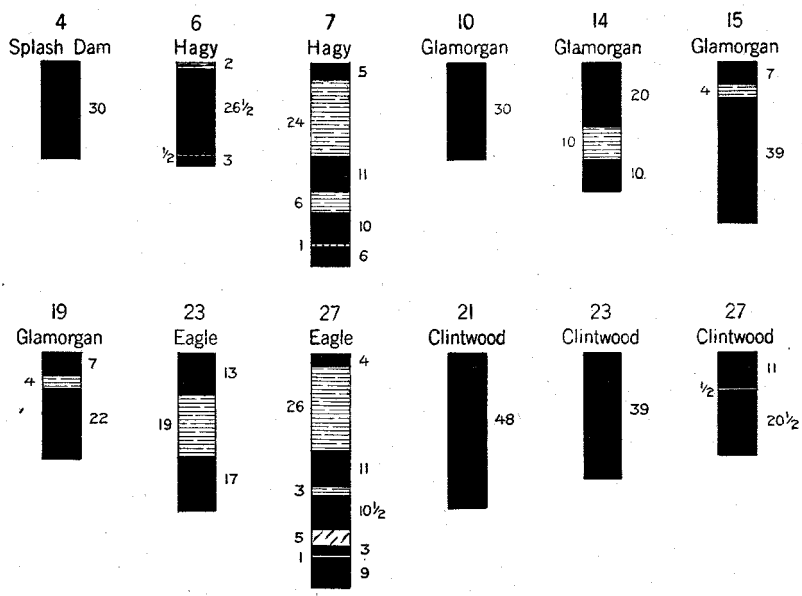


Fig. 6.—Sections of coal beds in the Pound River drainage basin.

the Upper Banner coal horizon and a few feet below the thick conglomeratic sandstone that forms a low hogback at the foot of Pine Mountain.. The Garden Hole is an impure and fractured bed 44 inches thick where Skeet Rock Branch crosses the wagon road a quarter of a mile north of the Clintwood quadrangle, and may outcrop in a few places farther southwest, north of the line mapped as the Kennedy horizon.

Upper Banner coal bed.—The Upper Banner bed, which lies 210 to 300 feet above the Kennedy horizon, is represented only by road blooms of an apparently thin coal, except, possibly, at one place on Cane Creek, where the following is tentatively correlated with that bed:

Section of Upper Banner (?) coal bed on Cane Creek, half a mile north of Huckleberry.

(Location 1, elevation 1,550 B.)

	Ft.	in.
Sandstone.		
Coal		7
Shale	2	6
Coal		6
Sandstone		1
Coal, with 5 inches cannel near top, bottom not seen	1	9+
Coal	2	3+
Partings		1

Splash Dam coal bed.—The Splash Dam horizon averages 60 feet above the Upper Banner and overlies the fairly coarse sandstone that forms the cap-rock of the latter bed. Coal blossoms in roads were noticed in a number of places, and measurements were obtained in three openings. The only exposure found north of Pound River is near Cane Creek and the road from that stream to Huckleberry (location 2, elevation 1,453 H. L.), where the bed is 18 inches thick, and what is probably another bench of that bed is 8 inches thick a short distance down the creek. South of the lower part of Pound River the Splash Dam contains 30 inches of hard, bright coal under a roof of firm shale at two places on Cane Branch,—one a small local mine 200 yards north of the road crossing (location 3, elevation 1,492 H. L.), and the other an opening on the north fork (location 4).

Hagy coal bed.—The Hagy coal bed lies above a sandstone that is not quite so good a ledge-maker as the one under the Splash Dam horizon, and is about 150 feet above the Upper Banner horizon. Blooms of this bed appear in most of the roads that cross its horizon in the lower part of the Pound River drainage basin, but no full measurements were obtained. The Hagy is 20 inches thick in a hollow three-quarters of a mile south of Skeet Rock (location 5, elevation 1,525 B.). The same bed is 32 inches thick at an exposure 1¼ miles south of Skeet Rock, near Pound River (location 6, elevation 1,460 B.), the upper 2 inches being bony. Northwest of Skeet Rock the bed is as follows:

Section of Hagy coal bed half a mile northwest of Skeet Rock.

(Location 7, elevation 1,710 B.)

	Ft.	in
Sandstone, shaly.		
Coal, cannel at top		5
Shale	2	
Coal		11
Shale		6
Coal		10
Sandstone, shaly		1
Coal		6
Coal	2	3
Partings		7

Two measurements were taken on Laurel Branch, north of Isom, on coal that is either at the Hagy horizon or near it; one, on the right-hand fork (location 8, elevation 1,580 B.), is about 30 inches, and the other, on the left-hand fork (location 9, elevation 1,640 B.), is 20 inches.

Glamorgan and Lyons coal beds.—The Glamorgan bed appears to be persistent in this area, though rarely more than 30 inches thick. It is 320 to 400 feet above the Upper Banner horizon and 15 feet or less above the base of the Wise formation, so that its outcrop is practically the same as that of the top of the Gladeville sandstone. The Lyons coal is not commonly workable, lies 20 to 60 feet above the Glamorgan in many places, and can be easily identified by means of the white siliceous sandstone which lies a short distance above it.

At four openings east (location 10) and south (locations 11, 12, and 13) of Skeet Rock, the Glamorgan is 26 to 30 inches thick and lies near the tops of rather broad spurs. The roof is commonly a drab sandy shale containing fossil plants. Farther west, in the vicinity of Isom, the Glamorgan includes one or more shale partings and on the road leading west from Laurel Branch (location 14, elevation 1,645 B.) shows 30 inches of coal with 10 inches of clay 10 inches from the bottom. The floor is a few feet of sandy clay or shale resting on sandstone.

The Glamorgan is exceptionally thick at an opening measured by Butts near Freeling, on Howell Branch of Georges Fork:

Section of Glamorgan coal bed near Freeling.

(Location 15, elevation 1,510 B.)

	Ft.	in.
Coal		7
Clay		4
Coal	3	3
Coal	3	10
Parting		4

The Lyons coal was not measured on Georges Fork, but blooms of the Glamorgan appear low in the valley for a considerable distance upstream. The Glamorgan is 28 inches thick on the new road 1½ miles west of Clintwood (location 16, elevation 1,694 S.).

Near Brush Creek School (location 17, elevation 1,570 B.) the Glamorgan is in two benches as at Freeling, but the lower bench is only 18 to 21 inches thick and the clay parting is 7 to 10 inches thick. A bed measured by W. A. Nelson near the mouth of Brush Creek is probably the Lyons:

Section of Lyons (?) coal bed northeast of the mouth of Brush Creek.

(Location 18, elevation 1,570 B.)

	Ft.	in.
Coal, impure at top		9
Shale	4	10
Coal, with half an inch of clay near base	2	
Clay and shale, with coal streak near top	3	
Coal	1	

The Glamorgan and Lyons coal beds lie near the top of the Pound-Cranesnest divide east of Rocky Branch and both beds form several blooms on the ridge road. The Lyons is probably thin. The Glamorgan is reported to be about 2 feet thick at several places, and the following measurement is remarkably similar to the one near Brush Creek School:

Section of Glamorgan coal bed near Anderson School.

(Location 19, elevation 1,750 B.)

	Ft.	in.
Coal		7
Shale		4
Coal	1	10
Coal	2	5
Parting		4

The two beds also lie near the top of the divide south of the lower part of Pound River and show in the ridge roads east from the mouth of Cranesnest River. In this district both the Glamorgan and Lyons are less than 2 feet thick.

Blair coal bed.—The Blair bed lies 10 to 20 feet above the white siliceous sandstone that makes the first conspicuous ledge above the Lyons coal, and averages about 80 feet above the base of the Wise formation. The divide between Pound and McClure rivers is too low to contain this bed and it occurs north of Pound River only near the spur tops west of Cane Creek and near the Pound. Between Pound and Cranesnest rivers its area is more extensive. An opening measured by Nelson 1 mile northwest of Clintwood (location 20) on what may be the Blair shows a bed 27 inches thick, including two thin partings. Full measurements were not made elsewhere on Georges Fork, Brush Creek, and Jerry Branch, but the bed is reported to be about 30 inches thick at the few places it shows. A few road blooms seemed to indicate a thickness of only about 1 foot and it is possible the bed thins locally.

Eagle and Clintwood coal beds.—The Eagle bed lies about 90 feet above the Blair, and the Clintwood bed is 20 to 50 feet higher—about 200 feet above the base of the Wise formation and 510 to 610 feet above the Upper Banner horizon. As indicated by the Clintwood outcrop on the accompanying geologic map, these beds underlie only small areas in the Clintwood quadrangle, except near Georges Fork, and in most places outcrop well up in the hills. The Clintwood is a very thick and valuable bed in small outliers south of Clintwood and in a larger area west of the quadrangle on Georges and Lick forks; but it thins notably to the northeast and north, and is less than 4 feet thick on Jerry Branch, Brush Creek, and the lower part of Georges Fork. The Eagle bed contains 2 to 4 feet of coal in addition to clay partings that impair its value. It is commonly considered by prospectors to be the lower bench of the Clintwood, and it may be that the two beds unite in places.

The Clintwood bed of this area is at its best near the head of Laurel Creek of Georges Fork. There are 4 feet of clean coal at a small mine 1½ miles southwest of Clintwood (location 21, elevation 1,975 C. C. C.), and openings on Cranesnest River drainage in this and neighboring outliers of the same bed make an even better showing. The Eagle bed is 19 inches thick and is separated from the Clintwood by 20 feet of shale.

The Clintwood is only 22 inches thick on a tributary of Brush Creek 1 mile northwest of Clintwood (location 22), but is thicker a short distance east, as shown in the following measurement by Nelson:

Sections of Eagle and Clintwood coal beds near head of Brush Creek.

(Location 23, elevation 1,810 B.)

	Ft.	in.
Shale.		
Coal (Clintwood)	3	3
Interval, chiefly shale	20	
Coal (Eagle)	1	1
Clay (Eagle)	1	7
Coal (Eagle)	1	5

A pit half a mile east of Brush Creek School (location 24) shows the Eagle to be essentially the same as at location 23, and it is not much different at a small mine near the school (location 25), though the clay parting is there only 9 inches thick and the coal below it is somewhat thicker than at the other places. The measurement of the Eagle given below was made at a small mine half a mile southeast of the mouth of Brush Creek. The bed is the same half a mile north (location 27), and the Clintwood is about 35 feet above it in that locality and about 32 inches thick.

Section of Eagle coal bed near mouth of Brush Creek.

(Location 26, elevation 1,720 B.)

	Ft.	in.
Sandstone.		
Coal	1	
Shale, coal, and pyrite		3
Coal		10
Bone		1
Coal	1	
Shale		10
Coal	1	
Coal	3	10
Partings	1	2

Near the head of a small branch three-quarters of a mile northwest of Dwale (location 28, elevation 1,860 C. C. C.), there are pits on two benches of the Clintwood coal, one 15 feet above the other. The upper bench contains coal about 2 feet thick and the lower a bed that is slightly thicker but contains several shale partings.

CRANESNEST RIVER.

Geologic outline.—The Cranesnest River drainage basin in the Clintwood quadrangle includes a long narrow strip from 1½ to 6 miles wide extending from the mouth of the river to the southwest corner of the quadrangle. A gentle northwesterly dip prevails throughout the area and is such that about the same beds are exposed in all of the river valley, the downstream component of the dip being nearly the same as the river gradient.

The lowest beds exposed lie a short distance above the Kennedy coal horizon, the upper part of the Norton formation is exposed in all of the main valleys, and the Gladeville sandstone and the lower part of the Wise formation cap nearly all of the main ridges bounding the sides of the basin. The highest beds present are near the horizon of the Campbell Creek coal. The characteristics of the formations are shown by the generalized columnar sections for the Clintwood quadrangle (Pl. IV), by a number of drill records (Pl. II), and by local sections 2, 3, 4, 5, and 6. The intervals between coal and other beds decrease, in general, from south to north, so that maximum intervals given in the following pages apply to the southern part of the basin and minimum intervals to the northern part. There are no reliable stratigraphic markers except the Upper Banner coal

bed, which has a characteristic sandstone parting. The Gladeville sandstone and the white sandstone near the base of the Wise are useful aids to correlation.

The Cranesnest drainage basin contains coal at sixteen or more horizons, with a thickness of more than 2 feet in parts of eight or nine beds. (See figs. 4, 5, and 7.) The bed that promises most for future development is the Upper Banner between Long and Tarpon branches, where it contains an average of about 4 feet of coal along the outcrop, and is evidently thick under Big Ridge on the east and perhaps also under part of the Pound-Cranesnest divide on the west. The same bed is nearly as thick along Trace Fork. The thickest coal bed in the area is the Clintwood south and southwest of the town of Clintwood, where it is locally 9 feet or more thick, exclusive of partings. Other coal beds, as well as the Upper Banner and Clintwood outside the areas mentioned, are commonly less than 3 feet thick.

Lower Banner coal bed.—The Lower Banner bed outcrops a short distance above water level from the mouth of the river nearly to its head, except in two small areas where it is below drainage. It lies 40 to 100 feet below the Upper Banner horizon, the distance in most places being close to 100 feet, and 170 to 245 feet above the Kennedy horizon. The bed contains one to nearly four feet of coal.

The Lower Banner was reported to be 41 inches thick, including 5 inches of clay, near the mouth of Bartley Branch, but the first measurement obtained on the west side of the river above its mouth was a little south of the mouth of Holly Creek (under location 40, elevation 1,458 H. L.), where the bed is 37 inches thick and apparently clean. At the mouth of Long Branch (location 29, elevation 1,465 H. L.) the Lower Banner is only 20 inches thick and lies 87 feet below a pit on the Upper Banner. No measurements of the Lower Banner coal were obtained south of Honeycamp Branch, on either Cranesnest River or its tributaries, though the bed was reported to be more than 3 feet thick in an opening near the head of Ellis (Alleys) Creek and in another on Buck Branch.

The Lower Banner was measured at several places on the east side of the river. Just below the mouth of Honeycamp Branch (location 30, elevation 1,505 B.) it contains 36 inches of coal and 2½ inches of clay near the middle. On Camp Creek (location 31, elevation 1,560 B.) the bed consists of 27 inches of coal and 8 inches of carbonaceous shale 8 inches from the bottom. Between Camp Creek and Big Branch (location 32, elevation 1,465 B.) the Lower Banner is 35 inches thick, including three thin partings of "rash." Between Big and Lick branches (location 33)

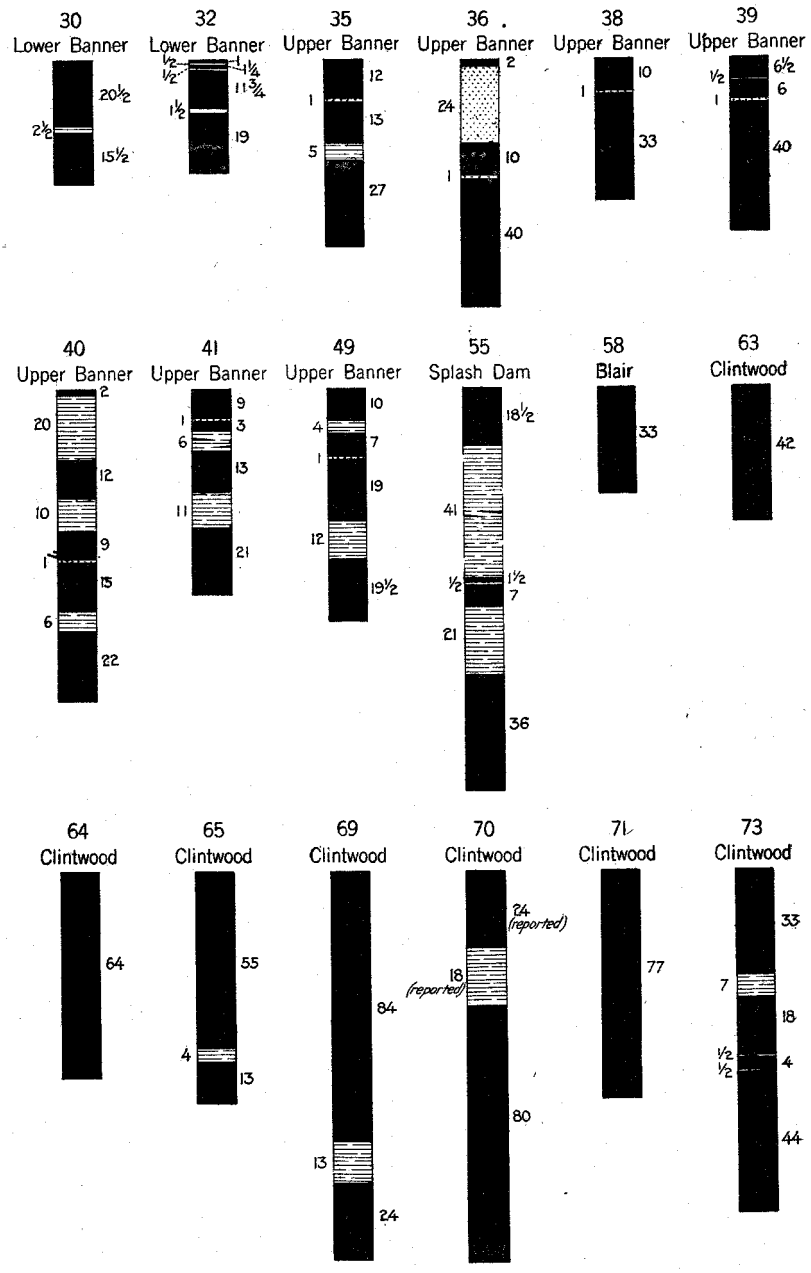


Fig. 7.—Sections of coal beds in the Cranesnest River drainage basin.

there are 32 inches of coal and 3 inches of clay near the middle of the bed. Near Poplar Branch (location 34, elevation 1,430 B.) the bed is poorly exposed, but contains a 3-inch clay parting 15 inches below the top and at least 21 inches of coal. In nearly all these openings the roof is shale or shaly sandstone and the floor a hard clay or shale.

Upper Banner coal bed.—The Upper Banner bed lies, in this area, 850 to 1,030 feet above the base of the Norton formation and 330 to 470 feet below the top of the Gladeville sandstone, the intervals increasing to the south. The coal bed outcrops low down in the valley of Cranesnest River from its mouth to its head-waters, and extends a short distance up the western tributaries and farther up the eastern tributaries. A massive sandstone which is about 30 feet thick in most areas and lies 5 to 20 feet above the Upper Banner is a useful marker for the latter, and the characteristic thin sandstone parting also serves to identify the coal in most, but not all, of its exposures. The thickest exposures of coal, averaging about 4 feet, are along and near Cranesnest River between Tarpon and Long branches and near Keel Branch. The bed was found at only a few places south of Camp Branch, and is apparently thin and perhaps split into two or more beds, except on Trace and Steele forks, where it is 1½ to 4 feet thick.

No coal was found at the Upper Banner horizon near the mouth of Cranesnest River and the first measurement obtained on the west side of the valley was 2¼ miles south of the mouth:

Section of Upper Banner coal bed on Cranesnest River, two and one-half miles south of its mouth.

(Location 35, elevation 1,550 B.)

	Ft.	in.
Sandstone.		
Coal	1	
Sandstone		1
Coal	1	1
Shale		5
Coal	2	3
Coal	4	4
Partings		6

Half a mile up the valley Stone noted that the shale parting is lacking, the coal below the sandstone parting being 37 inches thick and that above at 12 inches; in the next tributary from the north (location 36, elevation 1,477 C. C. C.) the section is the same except that the lower coal is 40 inches thick and the upper coal 10 inches. Two exposures on Bartley Branch are as follows:

Sections of Upper Banner coal bed on Bartley Branch.

(Location 37, elevation 1,486 C. C. C.)

	Ft.	in.
Coal		3
Sandstone		10
Coal		5
Shale		1
Coal		7
Sandstone		½
Coal	2	3
Coal	3	6
Partings		11½

(Location 38, elevation 1,450 B.)

Sandstone	Ft.	in.
Coal		10
Sandstone		1
Coal	2	9
Coal	3	7
Parting		1

Stone found that the Upper Banner a short distance south of the mouth of Bartley Branch (location 39, elevation 1,526 C. C. C.) consists of 40 inches of coal below the standstone parting and 12½ inches above it, and that half a mile farther up Cranesnest River there are 32 inches in the lower part and 17 inches in the upper; at both places there is a thin shale parting in the upper part of the bed. He gives the thickness of the bed on Holly Creek as 40½ inches, including 1½ inches of sandstone. Two measurements by Harnsberger between Holly Creek and Long Branch follow:

Sections of Upper Banner coal bed on Cranesnest River between Holly Creek and Long Branch.

(Location 40, elevation 1,550 C. C. C.)

	Ft.	in.
Coal		2
Shale	1	8
Coal	1	
Shale		10
Coal		9
Sandstone		1
Coal	1	3
Shale		6
Coal	1	10
Coal	4	10
Partings	1	5

(Location 41, elevation 1,593 C. C. C.)

Sandstone.	Ft.	in.
Coal		9
Sandstone		1
Coal		3
Bone and shale		6
Coal	1	1
Shale		11
Coal	1	9
Coal	3	10
Partings	1	6

At the mouth of Long Branch (location 42, elevation 1,564 C. C. C.), the Upper Banner consists only of 2 inches of coal at the top and 28 inches at the bottom, with 5 inches of clay between; the roof is 7 feet or more of shale, so that it is evident that the upper part of the bed shown in preceding sections was either never deposited or lies more than 7 feet above the lower part.

The Upper Banner was not seen in the Cranesnest River drainage basin above the mouth of Camp Creek except between Keel and Honeycamp branches and on Steele, Trace, and Lyons forks. The part of this area in which the bed was not found has not been thoroughly prospected, but it is thought that little thick coal is present in most of it.

Stone cites several openings on the west side of Steele Fork, just outside the Clintwood quadrangle, that show the Upper Banner to contain 17 to 40 inches of coal and only thin partings, and one pit at which there is 44 inches of coal and two shale partings aggregating 63 inches. In the extreme southwest corner of the Clintwood quadrangle, on the east side of Steele Fork, the Upper Banner consists of 44 inches of coal, 1 inch of sandstone, and 7 inches of shale near the top.

Near the head of Trace Fork, south of the Clintwood quadrangle, the Upper Banner is nearly 3 feet thick. At John Lodge's house, 1¾ miles above the mouth of the fork, the bed, according to Stone, is 35 inches thick on the west side of the valley and 26 inches on the east side, including 1 inch of sandstone near the middle. Stone states that the bed is 27 inches thick at Harrison Adkins's (location 43 ?), and that a quarter of a mile farther downstream an additional 21 inches of coal was found, separated from the 27-inch lower bench by 11 inches of clay and coal. Across the ridge to the north, on the south side of Lyons Fork near its mouth (location 44), Nelson visited an opening which is tentatively correlated with the Upper Banner and which was reported to be 84 inches thick, including 14 inches of shale. This exceptional thickness, if accurately reported, is probably local, as it has not been found elsewhere in this part of the basin. The bed is less than 2 feet thick at the head of Lyons Fork.

On the east side of Cranesnest River, between the mouths of Honeycamp and Keel branches, Stone cites the two measurements on the Upper Banner given below. The locations on the maps are only approximate, as the openings could not be found by the writer. The occurrence of such thick coal in this locality is rather surprising and is probably only a local feature.

Sections of Upper Banner coal bed on Cranesnest River near Keel Branch.[1]

(Location 45.)

	Ft.	in.
Shale.		
Coal		10½
Shale		8
Coal		6½
Sandstone		1½
Coal	1	5
Shale		½
Coal	1	8½
Coal	4	6½
Partings		10

(Location 46.)

	Ft.	in.
Shale		
Coal		10
Shale		4
Coal		6½
Sandstone		1½
Coal	1	6
Clay		10
Coal	1	9½
Coal	4	8
Partings	1	3½

The bloom of the Upper Banner coal may be seen at several places on the new road up Camp Creek, and the full thickness of a bed that is directly overlain by the sandstone cap-rock (location 47, elevation 1,635 B.) is 21 inches; there is coal bloom at an horizon about 20 feet lower, however, so that it is probable that the bed is split into two parts, the lower part being the same as that measured at the mouth of Long Branch (location 42). A short distance down the Cranesnest the bed makes a better showing, and the following sections indicate its character on both sides of the mouth of Big Branch:

Sections of Upper Banner coal bed on Cranesnest River near Big Branch.

(Location 48, elevation 1,570 B.)

	Ft.	in.
Sandstone.		
Coal		½-3
Shale	2	3
Coal		9
Sandstone		½
Coal	1	1
Shale, carbonaceous		1
Coal	2	3
Shale.		
Coal	4	1
Partings		1½

(Location 49, elevation 1,590 C. C. C.)

	Ft.	in.
Shale, under sandstone		5
Coal		10
Shale		4
Coal		7
Sandstone		1
Coal	1	7
Shale	1	
Coal	1	7½
Shale.		
Coal	4	7½
Partings	1	5

The Upper Banner east of the river is a thick bed with little waste in partings nearly as far north as Tarpon Branch. On Tarpon, however, it is so split by shale that it is of comparatively little value, and farther north it appears to be an unimportant bed.

[1] Stone, R. W., Coal resources of the Russell Fork basin in Kentucky and Virginia: U. S. Geol. Survey Bull. 348, p. 110, 1908.

Section of Upper Banner coal bed on Tarpon Branch.

(Location 50, elevation 1,609 C. C. C.)

	Ft.	in.
Coal		½
Shale		½
Coal		2
Sandstone		¾
Coal		9
Clay		3
Coal		4
Shale	7	2
Coal		2
Clay		1
Coal	1	7
Coal	3	½
Partings	7	7¼

Splash Dam and higher coal beds in Norton formation.—Coal outcrops at nine or more horizons between the Upper Banner coal horizon and the Gladeville sandstone, but there are only a few localities where any of the exposures show more than 2 feet of coal in any one bed. A typical example may be seen on Lick Fork a few rods east of the quadrangle boundary, where seven coal beds, all less than 14 inches thick, were measured in a vertical interval of 150 feet above the Upper Banner horizon. There are only three beds that can be regarded as at all persistent or important. The Splash Dam bed, which lies just above the sandstone forming the Upper Banner cap-rock and is 50 to 80 feet above the Upper Banner, contains more than 3 feet of coal on Lyons Fork and more than 2 feet in several localities. The Hagy bed is 120 to 180 feet above the Upper Banner, and has a maximum thickness of 30 inches. A bed lying just above a coarse sandstone and 180 to 250 feet above the Upper Banner horizon contains 2 feet or less of coal in some exposures.

No complete measurements were obtained on any of the beds in this interval in the lower part of the Cranesnest River basin, but there are a number of road blooms and a few caved pits, especially at the Splash Dam and Hagy horizons. There are probably at least 2 feet of coal in the Splash Dam and Hagy beds in part of this area. On the new Clintwood road up Long Branch and Camp Creek, the Splash Dam appears to be in two or three very thin benches and the Hagy is also thin. A higher bed is 21 inches thick on Long Branch (location 51, elevation 1,680 B.), including 1 inch of shale near its base, and is 24 inches thick in a pit at the mouth of that stream. The Hagy bed is reported as 30 inches thick on Lick Branch near Darwin (location 52, elevation 1,585 B.), and a higher bed as 18 inches thick in a small hollow by the store.

South of Foraker the Splash Dam has been opened at several places and is locally fairly thick. An opening measured by Nelson beside the Wise road, opposite Lyons Branch (location 53, elevation 1,850 B.), contains 28 inches of coal and 4½ inches of shale 10 inches from the top of the bed. This bed is 50 feet above a bloom of the Upper Banner and eight other coals are indicated by blooms or pits along 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 by 13 inches of shale near the middle, and another bed, 40 feet higher, has 22 inches of coal and 1½ inches of clay.

Nelson visited two openings near the head of Lyons Fork that are somewhat doubtfully considered to be on the Splash Dam bed and the location of which on the map is only approximate. One of these, southeast of Alka (location 54), shows 28 inches of coal and 1½ inches of bone near the middle. The other pit includes higher benches of coal and is as follows:

Section of Splash Dam coal bed northeast of Alka.

(Location 55.)

	Ft.	in.
Coal	1	6½
Shale, with coal streak	3	5
Coal		1½
"Rash"		½
Coal		7
Shale	1	9
Coal	3	

Glamorgan and Lyons coal beds.—These two coals lie in a shale interval averaging about 60 feet thick and between the granular, brownish Gladeville sandstone at the base and a compact white siliceous sandstone at the top. The Glamorgan is 350 to 470 feet above the Upper Banner horizon and less than 25 feet above the Gladeville. The Lyons bed lies near the top of the shale interval and underlies only a little less territory than the Glamorgan. Both beds lie near the tops of the divides that bound the Cranesnest River drainage basin. Neither bed attains a thickness of more than 3 feet and both are commonly less than 2 feet thick.

The Glamorgan is about 2 feet thick on the northern part of the Pound-Cranesnest divide, but at the head of Bartley Branch contains only 17 inches of coal split by 12 inches of shale near the middle. The bed is thin and contains the same comparatively thick shale parting near the mouth of Long Branch and on Keel Branch.

The Lyons coal is said to be nearly 3 feet thick on the southern end of Big Ridge, and the Glamorgan is 21 inches thick at the only place measured in that district (location 56, elevation 2,575 B.). Farther north on Big Ridge neither the Glamorgan nor the Lyons has been opened in many places, though road blooms are numerous and indicate beds less than 2 feet thick. On the northern end of the ridge, half a mile north of Tarpon (location 57, elevation 1,855 H. L.), the Glamorgan is at least 2 feet thick in a road exposure and the Lyons is 50 feet higher and at least 18 inches thick.

Blair coal bed.—The Blair bed is 60 to 125 feet above the base of the Wise formation and lies a few feet above the hard white sandstone that forms the cap-rock of the Lyons coal. It underlies the higher parts of the Pound-Cranesnest divide and lies near the top of much of Big Ridge. Except where the Clintwood coal is also present, however, the Blair lies too near the surface and in areas that are too small for utilization. The coal is 2 to 3 feet thick near Clintwood and road blooms indicate that it is thinner on Big Ridge. It has not been thoroughly prospected and most of the openings that have been made are now caved.

The Blair coal has been opened on Flemming Branch (location 58, elevation 1,725 B.), where it is 33 inches thick and without noticeable partings. Three-fourths of a mile east of Clintwood (location 59, elevation 1,930 B.), the bed is 29 inches thick and has shale both above and below.

Eagle and Clintwood coal beds.—The Clintwood bed lies about 100 feet above the Blair and 185 to 230 feet above the base of the Wise formation. There is arkosic sandstone a few feet below the coal and in some places a resistant siliceous sandstone a short distance above it. The Eagle bed is 30 to 50 feet below the Clintwood. The Clintwood coal is exceptionally thick in many places, but, unfortunately, the area underlain by it in this region is small, including only the higher part of the Pound-Cranesnest divide and a small outlier on the southern part of Big Ridge. The bed splits and thins northeast of Clintwood and is 3½ to 11 feet thick elsewhere. Very few complete measurements were made on the Eagle bed, but it is thought not to exceed 3 feet thick, and to be thinner in most places.

Near the gap between Flemming and Jerry branches (location 60, elevation 1,800 C. C. C.) there are nearly 3 feet of coal in a lower bench of the Clintwood bed, and 17 inches in another bench that lies slightly higher. In the main fork of Flemming Branch the Eagle is in two benches

of 13 inches each, with 29 inches of shale between (location 61, elevation 1,745 B.), and the Clintwood is in two benches with about 2 feet of coal in each (location 62, elevation 1,795 C. C. C.).

Several mines for local fuel supplies have been operated on the south side of Holly Creek, west and south of Clintwood. One of these, 1 mile from town (location 63, elevation 1,944 C. C. C.) shows 42 inches of coal. According to Stone, the old John Lane mine, half a mile west of town, was in 58 inches of coal, and 20 inches lower there were 35 inches more of coal and 6 inches of shale in two thin partings. The same authority states that coal at the neighboring Joe Glenn opening was 6 feet thick, including a 4-inch parting 13 inches above the floor, and that the bed was about the same thickness in openings just south of town. A small mine half a mile southeast of Clintwood (location 64, elevation 1,970 B.) is in 64 inches of clean coal in a small outlier of the Clintwood bed. A few feet below are 50 feet of soft sandstone that forms indistinct benches.

The mine that supplies most of the needs of Clintwood and vicinity is operated by Chase and Damron at the head of Long Branch, less than a mile south of the town:

Section of Clintwood coal bed at the Chase and Damron mine near Clintwood.

(Location 65, elevation 1,988 H. L.)

	Ft.	in.
Shale, black, compact		8
Shale, drab, removed in mining		8
Coal, clean	4	7
Clay		4
Coal		8-18
Coal	5	8
Partings		4

The following measurements were obtained on Keel Branch. The first is a natural exposure in the trail south from Keel triangulation station and the second a neighboring prospect reported by Stone. The poor showing at the trail exposure, as compared with other measurements on this Clintwood outlier, suggests the possibility that it is the Eagle bed or only part of the Clintwood. The third and fourth measurements were made in small mines near the head of Keel Branch.

Sections of Clintwood coal bed on Keel Branch.

(Location 66, elevation 2,025 B.)

	Ft.	in.
Shale, dark		6
Coal	2	3
Clay, with coal streaks	1	2
Coal	1	1
Clay		6
Coal		6
Clay, over sandstone		9
Coal	3	10
Partings	2	5

(Location 67, elevation 2,008 C. C. C.)

Shale.	Ft.	in.
Bone		2
Coal	5	7
Shale		½
Coal, with pyrite streak	2	11
Coal	8	6
Partings		½

(Location 68, elevation 1,962 C. C. C.)

Sandstone.	Ft.	in.
Coal	5	2
Shale, carbonaceous	2	
Coal	1	5
Coal	6	7
Partings	2	

(Location 69, elevation 1,972 C. C. C.)

	Ft.	in.
Coal	7	
Shale	1	1
Coal	2	
Coal	9	
Partings	1	1

The Clintwood coal makes an excellent showing on Honeycamp Branch, but the area underlain by it is small. The R. W. Beverly mine, on the north side of the branch (location 70, elevation 2,020 B.), is in 80 inches of clean coal. It is reported that 18 inches of coal above the bench mined are separated from it by shale, and that a coal bed 22 inches thick lies 20 feet below the mine. At the Wm. Ward bank, on the south side of the valley (location 71, elevation 2,045 C. C. C.), there are 77 inches of coal that is clean except for the common knife-edge partings of mother coal. The J. E. Beverly bank is a few rods south, on the opposite side of a narrow ridge, and shows a main bench of 78 inches and a 22-inch higher bench separated from it by 18 inches of shale.

The Clintwood is remarkably thick north of Lick Fork, but only the eastern extremities of this body of coal lie within the quadrangle. Half a mile southwest of Darwin (location 72, elevation 2,025 B.) the coal is probably correctly reported as 11 feet thick.

A measurement on the Caney Creek side of a small Clintwood outlier on Big Ridge, 5 miles south of Clintwood, is given on page 88. The section at the Elbert Powers local mine, on the Cranesnest River side, is as follows:

Section of Clintwood coal bed at Elbert Powers mine on Big Ridge.

(Location 73, elevation 2,324 H. L.)

	Ft.	in.
Sandstone, shaly.		
Coal	2	9
Shale		7
Coal	1	6
Clay		½
Coal		4
Clay		½
Coal	3	8
Coal	8	3
Partings		8

MC CLURE RIVER NORTHEAST OF CANEY CREEK.

Geologic outline.—The rocks exposed in the McClure River drainage basin below the mouth of Caney Creek include the Kennedy bottom-rock at the base and the lower 150 feet of the Wise formation at the top. The central part of this drainage basin lies in a structural terrace in which the only dips are minor undulations. On the southern, western, and northern borders of the basin there are northerly and northwesterly dips averaging 75 feet to the mile. The principal features of the stratigraphy of the exposed rocks are shown by the generalized columnar sections for the north and middle thirds of the Clintwood quadrangle (Pl. IV),—maximum intervals being most characteristic in the case of the north third and average intervals in the middle third. The local stratigraphy of rocks below drainage levels is shown by drill records (Pl. II), and of rocks above drainage by local sections 5 and 6.

The Kennedy, Lower Banner, Splash Dam, Glamorgan, and two other coal beds were found in this area, but the Upper Banner bed is the only one in which extensive mining could be profitably undertaken at present. (See figs. 5 and 8.) On both sides of McClure River between the mouths of Big and Road branches, the Upper Banner contains 3½ to 6 feet of coal with only thin shale and sandstone partings, and lies sufficiently low to be easily reached from the main valleys. It is likely that mining operations on a large scale will follow the completion of the railroad along the river. Especially favorable localities are on Mill Creek and Squirrel Camp Branch.

Kennedy coal bed.—The Kennedy lies 250 to 300 feet below the Upper Banner coal horizon and is exposed only in the bottom of McClure River valley north of the mouths of Road Branch and Caney Creek. The horizon of the bed is easily identified by the coarse sandstone which is just below it,

but there appears to be little or no coal present in most places. In a railroad cut near the mouth of Spring Branch (location 74, elevation 1,340 B.), there are 16 inches of coal in what is probably the Kennedy bed, but a short distance down grade this is replaced by shale dipping about 15 degrees in what is either a slide or a local buckling. The Kennedy is 3 to 40 inches thick and greatly crushed and contorted in the tunnel at the mouth of

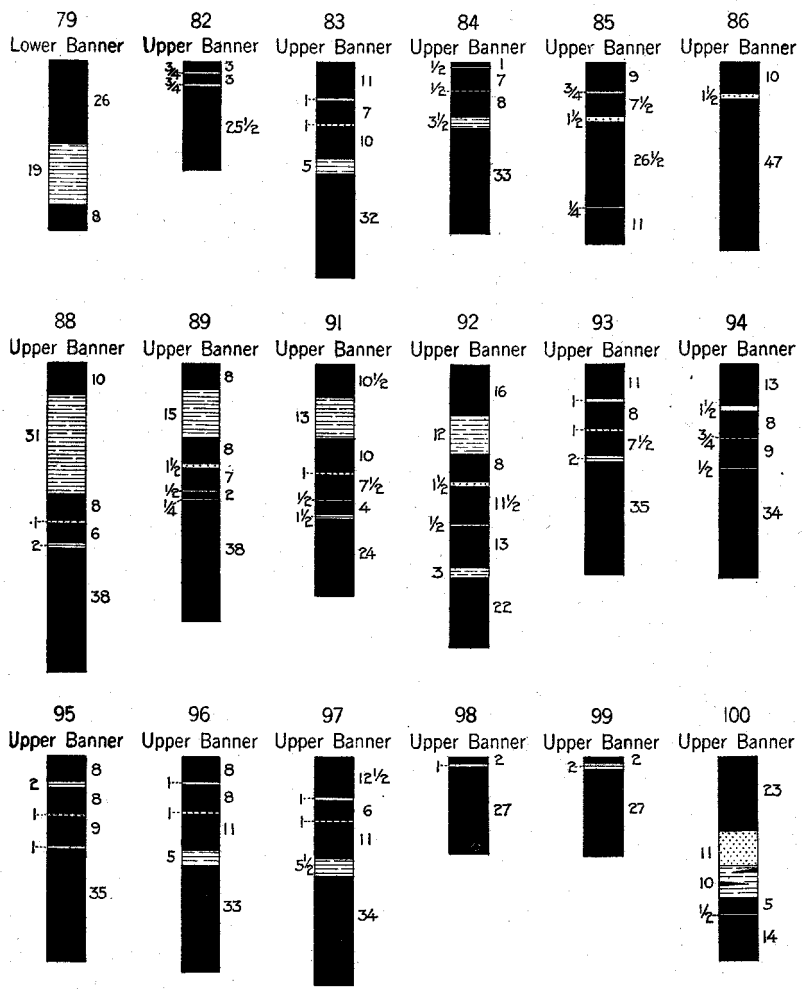


Fig. 8.—Sections of coal beds in the northern part of the McClure River drainage basin.

Caney Creek; a short distance south coal is lacking. Locally there are one or two very thin coal beds 50 feet or less above the Kennedy.

Lower Banner coal bed.—The Lower Banner lies 70 to 100 feet below the Upper Banner and outcrops low down in all of the valley of McClure River and in the lower parts of its tributaries. It has a thin sandstone bottom-rock, but can best be identified by its relations to the Upper Banner and Kennedy beds or their horizons. The coal bed is persistent, but commonly less than 2 feet thick.

The Lower Banner, 18 to 24 inches thick is exposed at the north end of the tunnel opposite the mouth of Squirrel Camp Branch (location 75, elevation 1,500 B.). Many road blooms, seeps, and a few caved pits were seen at the Lower Banner horizon west of McClure River, but no other complete measurements were obtained.

The bed is 15 and 16 inches thick, respectively, at two places in the upper part of Big Branch (locations 76 and 78). Several strip pits near the bridge at the forks of Big Branch (location 77, elevation 1,726 H. L.) show 13 to 30 inches of coal with both sandstone and shale roofs, and 2 inches more of coal 9 feet below the main bench.

No measurements were made between Big Branch and Mill Creek, and in the valley of the latter stream the value of at least the upper part of the bed is greatly impaired by shale partings.

Coal in a pit beside the ridge road near the mouth of McClure River (location 79, elevation 1,527 S.) is tentatively correlated with the Lower Banner. A short distance east the rocks dip steeply, indicating buckling, perhaps accompanied by faulting. In this pit there are 26 inches of coal underlain by 19 inches of shale under which there are 8 inches more of coal. A short distance below there is coarse-grained massive sandstone.

Upper Banner coal bed.—The Upper Banner outcrops in the valley of McClure River from its mouth to Caney Creek and also nearly to the heads of the principal tributaries. It lies 235 to 300 feet above the Kennedy horizon and 350 to 470 feet below the top of the Gladeville sandstone, the intervals thickening, in general, to the south. Between points a mile or more north of Mill Creek and a mile or less south of Big Branch and in adjacent territory west of the river, this bed includes an average thickness of 4 to 5 feet of coal and is the best mining proposition in the central or northern parts of the Clintwood quadrangle. Both north and south of this area the bed apparently breaks up into two or more relatively thin benches and it may be lacking in places. Where the bed is thick it can be easily

identified by the thin sandstone parting in its upper half and by a coarse-grained sandstone cap-rock a few inches to 20 feet above the coal.

What is probably the Upper Banner bed is less than 2 feet thick in a natural exposure in Rocky Branch (location 80, elevation 1,485 B.). The bed is 20 inches thick 1½ miles southwest, where there are several small drifts on a point (location 81, elevation 1,615 B.). Near the tunnel opposite Hughes Branch (location 82, elevation 1,577 C. C. C.), a 32-inch bed, including two clay partings each less than 1 inch thick, is exposed in small drifts used in railroad construction work. The roof is 3½ feet of shale under sandstone, and there is said to be another bench of coal several feet from the one mined. As shown in the two following sections, the shale parting between these two benches thins to the southwest and is only 5 inches thick in a small mine on Low Gap Branch and 3½ inches in a drift on a point half a mile farther south:

Sections of Upper Banner coal bed near Low Gap Branch.

(Location 83, elevation 1,597 C. C. C.)

	Ft.	in.
Sandstone.		
Shale	6	
Coal		11
Shale		1
Coal		7
Sandstone		1
Coal		10
Shale		5
Coal (reported)	2	8
Coal	5	
Partings		7

(Location 84, elevation 1,606 C. C. C.)

	Ft.	in.
Sandstone.		
Shale	5	
Coal	1	
Shale		½
Coal		7
Sandstone		½
Coal		8
Shale		3½
Coal	2	9
Coal	5	
Partings		4½

On the west side of McClure River the Upper Banner contains 4 to 5½ feet of coal, with only thin partings, as far south as the mouth of Squirrel Camp Branch and a little beyond. The following was measured in a drift used in railroad construction work near the mouth of Camp Branch:

Section of Upper Banner coal bed near Camp Branch.

(Location 85, elevation 1,615 B.)

	Ft.	in.
Sandstone.		
Coal		9
Shale		¾
Coal		7½
Sandstone		1½
Coal	2	2½
Shale		¼
Coal		11
Coal	4	6
Partings		2½

Stone cites an opening on the west side of the river a quarter of a mile northwest of Squirrel Camp Branch, in which there are 8 inches of coal above the thin sandstone parting and 45 inches below it. A half a mile south (location 86, elevation 1,619 C. C. C.) the sandstone parting is 1½ inches thick, the coal above it 10 inches, and that below it 47 inches; no partings more than a quarter of an inch thick were seen, and there are reported to be 15 inches more of coal 11½ inches above the part of the bed now exposed. No measurements of the Upper Banner were obtained either west or east of McClure River between the pit last mentioned and Caney Creek, and it is probable that the bed is either thin or split into several benches in most of that area. It may be thick near the head of Big Branch, however, and a pit near the Stratton road (location 87, elevation 1,845 B.) is said to have shown nearly 3 feet of coal.

On Squirrel Camp Branch and neighboring parts of McClure River, the Upper Banner contains 3½ to 5½ feet of coal in a lower bench that has only thin partings, and commonly also a top bench that would probably be left up in mining. The following is exposed in a small drift mine half a mile south of the mouth of the branch:

Section of Upper Banner coal bed south of mouth of Squirrel Camp Branch.

(Location 88, elevation 1,633 C. C. C.)

	Ft.	in.
Shale.		
Coal		10
Shale, carbonaceous at base	2	7
Coal		8
Sandstone		1
Coal		6
Shale		2
Coal	3	2
Coal	4	4
Partings		3

Stone states that two measurements in the upper part of the south fork of Squirrel Camp Branch were as follows:

Sections of Upper Banner coal bed on right fork of Squirrel Camp Branch.

	Ft.	in.
Coal		8½
Sandstone		1½
Coal		11½
Shale		1
Coal	2	9½
Coal	4	5½
Partings		2½

	Ft.	in.
Coal		10
Sandstone		1
Coal		9½
Shale		4½
Coal		2
Shale		2½
Coal	2	11
Coal	4	8½
Partings		8

Following are thicknesses of the bed, as given by Stone, at two places on the north fork of the same stream:

Sections of Upper Banner coal bed on left fork of Squirrel Camp Branch.

(Location 89, elevation 1,606 C. C. C.)

	Ft.	in.
Coal		8
Shale	1	3
Coal		8
Sandstone		1½
Coal		7
Shale		½
Coal		2
Shale		¼
Coal	3	2
Coal	4	7
Partings		2¼

(Location 90, elevation 1,583 C. C. C.)

	Ft.	in.
Coal		9
Sandstone		1½
Coal		8½
Shale		¼
Coal		2
Shale		1
Coal	2	8½
Coal	4	4
Partings		2¾

The first of the following sections was measured at the mouth of a small mine at the forks of Squirrel Camp Branch; at the working face the coal below the sandstone parting is 42 inches thick and without shale partings. The second of the following sections is given by Stone as nearly half a mile north of the mouth of Squirrel Camp Branch.

Sections of Upper Banner coal bed near mouth of Squirrel Camp Branch.

(Location 91, elevation 1,597 C. C. C.)

	Ft.	in.
Coal		10½
Shale	1	1
Coal		10
Sandstone		1
Coal		7½
Shale		½
Coal		4
Shale		1½
Coal	2	
Coal	3	9½
Partings		3

(Location 92, elevation 1,629 C. C. C.)

	Ft.	in.
Coal	1	4
Clay	1	
Coal		8
Sandstone		1½
Coal		11½
Shale		½
Coal	1	1
Shale		3
Coal	1	10
Coal	4	6½
Partings		5

The highest shale parting, which is sufficiently thick on Squirrel Camp Branch to render the coal above it unrecoverable, thins to the north to a few inches. The rest of the bed is about the same, so that on Mill Creek and neighboring parts of McClure Creek there are 4 to 6 feet of coal with only thin partings. The first of the following two measurements was made at a drift half a mile southwest of the mouth of Mill Creek, 90 feet above

a thin coal bed at the Lower Banner horizon; the second measurement was made at a small mine on the east side of the mouth of House Fork of Mill Creek:

Sections of Upper Banner coal bed near mouth of Mill Creek.

(Location 93, elevation 1,590 C. C. C.)

Shale.	Ft.	in.
Coal		11
Shale		1
Coal		8
Sandstone		1
Coal		7½
Shale		2
Coal	2	11
Coal	5	1½
Partings		4

(Location 94, elevation 1,596 C. C. C.)

	Ft.	in.
Sandstone		1½
Coal	1	1
Shale		1½
Coal		8
Sandstone		¾
Coal		9
Shale		½
Coal	2	10
Coal	5	4
Partings		2¾

About the same thicknesses prevail farther east, as shown by the following two sections at small mines, the first on Toms Fork of Mill Creek and the second on Mill Creek near Tenso:

Sections of Upper Banner coal bed on Toms Fork and Mill Creek.

(Location 95, elevation 1,617 C. C. C.)

Sandstone.	Ft.	in.
Coal		8
Shale		2
Coal		8
Sandstone		1
Coal		9
Shale		1
Coal	2	11
Coal	5	
Partings		4

(Location 96, elevation 1,612 C. C. C.)

Sandstone.	Ft.	in.
Coal		8
Shale		1
Coal		8
Sandstone		1
Coal		11
Shale		5
Coal	2	9
Coal	5	
Partings		7

Stone describes a section near the mouth of Bowling Branch (location 97, elevation 1,612 C. C. C.) that is nearly identical with the one on Mill Creek near Tenso, the thickness of coal being 63½ inches and of partings 7½ inches. Less than a mile north of this the lowest shale parting, which is only 5 inches thick at locations 96 and 97, thickens, and still farther north is as much as 12 feet thick. As a result of this splitting, only the lower bench appears to be available for use on Road Branch, as shown by two openings (location 98, elevation 1,565 B.; and location 99, elevation 1,630 B.) at which there are 29 inches of coal and 1 or 2 inches of shale two inches from the top. The roofs are shale and the floor sandy shale

and shaly sandstone; traces of what seems to be a thin coal bed show about 10 feet above the pits, overlain by 40 feet of massive sandstone on top of which there are traces of the Splash Dam coal.

There are no openings on the Upper Banner on the east side of the McClure between Road Branch and the mouth of the river. The upper bench is only 11 inches thick where exposed near the north end of the ridge road east of the McClure, and both benches are known to be very thin near the mouth of the river. What is probably either the lower bench or both benches is exposed a mile up Camp Creek:

Section of Upper Banner coal bed on Camp Creek.

(Location 100, elevation 1,620 B.)

	Ft.	in.
Coal	1	11
Sandstone, coarse-grained		8-15
Shale, with coal streaks		10
Coal		5
Shale		½
Coal	1	2
Sandstone.		
Coal	3	6
Partings	1	10

The lower bench of the Upper Banner is 23 inches thick at the head of Camp Creek (location 101, elevation 1,670 B.), and rests upon medium-grained sandstone.

Splash Dam and higher coal beds in Norton formation.—In this area there are at least five or six Norton coal beds above the Upper Banner horizon, but only one of them—the Splash Dam—was found to be more than 13 inches thick. The Splash Dam bed is 40 to 80 feet above the Upper Banner and only a few feet above the sandstone cap-rock of the latter bed. It is nearly 3 feet thick near the mouth of the McClure, but less than 2 feet thick farther southwest. Few measurements were obtained, but the lack of prospect pits and small mines indicates that the bed is relatively unimportant.

An exposure half a mile south of Millard (location 102, elevation 1,730 B.) shows 18 inches of coal at the Splash Dam horizon, and a little more may be concealed. The same bed is reported 18 inches thick near the mouth of Road Branch (location 103, elevation 1,660 B.), and is 19 inches thick at the head of Camp Creek (on slope above location 101, elevation 1,780 B.). Coal in a pit on what is probably the Splash Dam at the mouth of McClure River (location 104, elevation 1,425 B.) appears to be about 3 feet thick. This pit is near steeply dipping beds and may not be correctly correlated.

Coal beds in Wise formation.—The Glamorgan and Lyons coal beds show as blooms in the tops of the main ridges, but underlie only small areas and are probably very thin in most places. The Blair coal has been eroded except on one or two very small outliers and the Clintwood has been removed everywhere. The Glamorgan attains a thickness of 2 feet on the northern end of Big Ridge and is probably the bed that is 25 inches thick near Hill School, northwest of Haysi (location 105, elevation 1,828 H. L.).

CANEY CREEK.

Geologic outline.—The rocks exposed in the Caney Creek drainage basin include part of the Kennedy bottom-rock at the base and the lower 300 feet of the Wise formation at the top. These are shown by the generalized columnar section for the south third of the Clintwood quadrangle (Pl. IV), by drill records C 128 and C 123 (Pl. II), and by local sections 4 and 6. Rocks not exposed are shown in drill records S 17, S 37, S 36, and S 38 (Pl. II). The Norton formation outcrops in by far the greater part of the area, as the Gladeville and Wise appear only on the tops of the highest ridges. The dips are, in general, to the northwest at 30 to 300 feet per mile.

The north half of the Caney Creek basin contains little coal that is likely to be utilized in the near future, though beds 2 feet or less thick are common and coal 3 feet thick is not unknown. Outliers of the Clintwood bed on Big Ridge contain more than 7 feet of coal and only thin partings, but are too small for any except local mines. The southern part of the basin, however, possesses rich deposits in the Upper Banner bed, which contains an average of 5 feet of excellent coal on Hurricane, Road, and Trace forks. (See figs. 4, 5, and 9.) Part of this thick coal is already being mined by the Clinchfield Coal Corporation and hauled more than a mile and a half under Sandy Ridge to the mine mouth on Fuller Branch of Big Tom Creek, whence it is shipped over the Clinch Valley division of the Norfolk and Western Railway.

Kennedy coal bed.—The Kennedy coal, which lies 250 to 330 feet below the Upper Banner horizon, is below the surface except near the mouth of Caney Creek. In the railroad tunnel near the Caney Creek bridge (location 106, elevation 1,493 H. L.) the bed is 3 to 40 inches thick and is greatly contorted and crushed, the fracture planes striking in general S. 80° E. The coal disappears a few yards north of the tunnel. The Kennedy, though locally thick, is so irregular in thickness and so crushed and fractured

that it is not a profitable mining proposition. At the tunnel there is a coarse massive sandstone under it and 100 feet of fine-grained, rather shaly sandstone above it.

Lower Banner coal bed.—The Lower Banner lies at an average distance of 100 feet below the Upper Banner horizon. It outcrops low in the valley of Caney Creek from its mouth nearly to its head and a considerable distance up its tributaries, especially those from the east. The bed averages about 2 feet thick, though locally a little more than 3 feet.

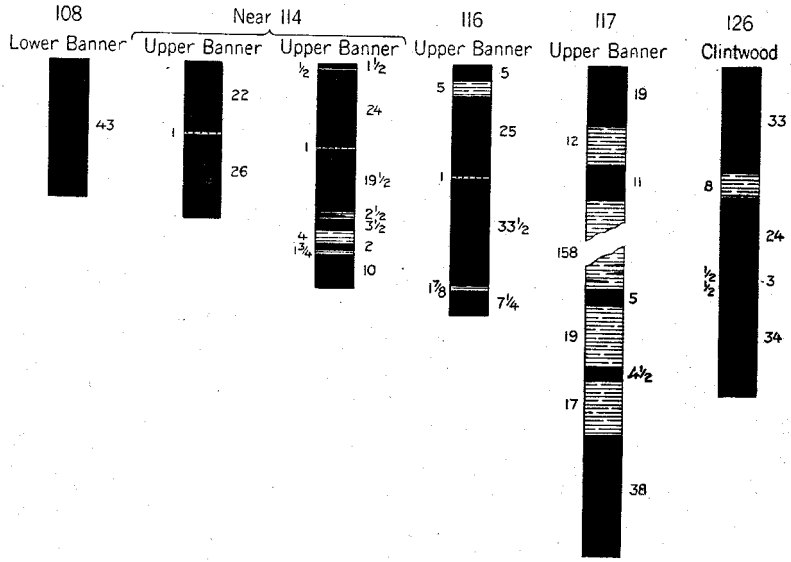


Fig. 9.—Sections of coal beds in the Caney Creek drainage basin.

No complete measurements of the Lower Banner were made on the west side of Caney Creek, though a caved pit on Mill Branch indicates a thickness of at least 2 feet, and another at the mouth of Long Branch (location 107, elevation 1,775 B.) is apparently in at least 3 feet of coal. Stone states that the bed is 21 inches thick on the upper part of Hurricane Fork, just south of the quadrangle boundary.

The bed is mined for local use on the eastern Big Branch (location 108, elevation 1,830 B.), where it is clean and 43 inches thick and is overlain by 6 feet of sandy shale and sandstone. The bed is reported to be thick in pits on the east side of the loop of Caney Creek, opposite the mouth of Long Branch. Half a mile northeast of the loop (location 109, elevation 1,790 B.) there are 34 inches of coal in an upper bench and a few inches

more below a shale parting. In the bed of the upper part of Bad Branch (location 110, elevation 1,910 B.), an exposure that appears to be the Lower Banner contains only 7 inches of coal badly split by shale partings. It is possible that this exposure is not the principal bench of coal. A prospect on Rockhouse Branch (location 111, elevation 1,820 S.) shows 26 inches of clean coal.

Upper Banner coal bed.—The Upper Banner is by far the most important coal bed in this area and outcrops 300 feet or less above Caney Creek and its tributaries from their mouths nearly to their heads. The bed contains 3½ to 8 feet of coal, with an average of 5 feet on Hurricane, Road, and Trace forks. It is now being taken out east and west of Hurricane Fork by the Cranesnest mine of the Clinchfield Coal Corporation, the entrance to which is on the south side of Sandy Ridge and the workings of which have been driven northward a short distance into the Clintwood quadrangle. North of this district the Upper Banner splits into several parts the thickest of which contains only 2 to 3 feet of coal, and the lack of prospect pits and exposures north of Rockhouse and Mill branches indicates that there is still less coal in that district. Where the bed is thick it is characterized by an inch of sandstone in the middle or the upper half.

In a hollow near the loop of Caney Creek (location 112, elevation 1,880 B.) the Upper Banner is split into three parts occupying an interval of about 35 feet, with coarse-grained sandstone above and medium-grained sandstone below. The upper bench of coal is 18 inches thick, the middle bench 9 inches, and the lower is reported to be 30 inches. Farther south the shale between these benches thins to a few inches and the bed is the excellent mining proposition described in the last paragraph. On the right fork of Hurricane Fork (location 113, elevation 2,074 C. C. C.) small pits show the bed to be less than 2 feet thick, but either the coal is thin in a very small area here or part of the bed is not shown at the pits. At the main Caney entry of the Cranesnest mine (location 114, elevation 2,117 C. C. C.) the bed contains 6 feet of coal. The details of the bed are best shown by the following measurements in the mine, the first being 500 feet northeast of the main Caney entry and the second 1,500 feet southwest of it. The first measurement probably does not include the lower part of the bed.

Sections of Upper Banner coal bed in Cranesnest mine.

Shale.	Ft.	in.
Coal	1	10
Sandstone		1
Coal	2	2
Coal	4	0
Partings		1

Shale.	Ft.	in.
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

The coal available for mining thins slightly to the north, and near the junction of Hurricane and Road forks (location 115, elevation 2,060 B.) a small mine is in 42 inches of coal with the typical thin sandstone parting near the middle. Farther southeast, near the head of Trace Fork, the bed is thicker:

Section of Upper Banner coal bed near head of Trace Fork.

(Location 116, elevation 2,160 C. C. C.)

	Ft.	in.
Sandstone, bluish, medium-grained	6	
Coal		5
Shale		5
Coal	2	1
Sandstone		1
Coal	2	9½
Shale		1⅞
Coal		7¼
Coal	5	10¾
Partings		7⅞

The following measurement in pits beside the path west of Bad Ridge School apparently shows the Upper Banner in two parts, though it is barely possible that the upper part is the Splash Dam bed. The lowest and thickest bench of coal is reported to contain the typical thin sandstone parting in a few pits in the vicinity.

Section of Upper Banner coal bed half a mile west of Bad Ridge School.

(Location 117, elevation of base 1,987 S.)

	Ft.	in.
Sandstone, buff, fine-grained, shaly at base	5	
Coal	1	7
Shale, drab and black, carbonaceous in part	1	
Coal		11
Interval, including shale at top	8	
Shale, mostly drab, with streaks of coal in lower part; contains fossil plants	5	2
Coal		5
Shale, drab; contains fossil plants	1	7
Coal		4½
Shale, drab; contains fossil plants	1	5
Coal	3	2

The same beds are exposed in pits near the road on a tributary of Bad Branch, as follows:

Section of Upper Banner coal bed half a mile east of Bad Ridge School.

(Location 118, elevation of base 2,000 H. L.)

	Ft.	in.
Sandstone, buff, fine-grained, cross-bedded	12	
Coal, with shale streaks near top	1	3
Shale, very compact and sandy		2
Coal		6
Interval, including shale at top	20	
Shale, drab; contains fossil plants	6	
Coal		9½
Shale, carbonaceous in part		7
Coal	1	7
Sandstone, fine-grained, compact, massive	9	

On Little Rockhouse Branch (location 119, elevation 1,980 B.) the coal at the Upper Banner horizon is only 2 feet thick, and the presence of massive sandstone both above and below indicates that other benches are lacking.

Splash Dam and higher coal beds in Norton formation.—There is coal at several horizons in the Norton formation above the Upper Banner, but all the beds are less than 2 feet thick except locally. It is likely that the Splash Dam bed, which lies about 50 feet above the Upper Banner, contains as much as 2 or 3 feet of coal in places, but only blooms were found at its horizon.

The thickness of a bed that lies just above a coarse sandstone, and 280 feet and less above the Upper Banner horizon, was ascertained at two places. In one pit, in a hollow north of Pound Branch (location 120, elevation 1,980 B.), the bed contains 28 inches of coal separated by a shale parting

from 8 inches more in an upper bench. At the other pit, on Lick Branch (location 121, elevation 2,100 B.), there are only 18 inches of coal. Another bed which is 18 inches thick near Big Oak School (location 122, elevation 2,030 B.) is apparently at a lower horizon and is perhaps the Hagy.

Glamorgan and Lyons coal beds.—The characteristics of the Glamorgan and Lyons coal beds on Big Ridge have been previously mentioned in the description of coal in the Cranesnest River drainage basin. Nearly all of the exposures of these beds on the divide east of Caney Creek are on upper McClure River drainage and will be described in the section devoted to that basin.

The beds were seen at a few places on the east side of Big Ridge. A caved pit in the Glamorgan bed nearly a mile south of Bearpen Gap (location 123, elevation 2,115 B.) shows more than 18 inches of coal with 3 inches of shale near the top and a roof of 10 feet of shale. Half a mile due south the bed was reported 21 inches thick and was said to be 18 inches near the head of Pound Branch (location 124, elevation 2,215 B.). A small mine in the Lyons bed a mile northeast of Lyons (location 125, elevation 2,570 B.) was filled with water when visited, but the coal appeared to be about 3 feet thick.

Clintwood coal bed.—The Clintwood bed occurs only in small outliers on Big Ridge at the heads of Pound, Lick, and Mill branches, where it is 185 feet above the base of the Wise formation and 580 feet above the Upper Banner horizon. As shown by the following measurement at the F. T. Kenady local mine at the head of Mill Branch and by one on page 75 (location 73), it is an exceptionally thick bed in this small area. The Eagle and Blair beds, which are less than 100 feet below the Clintwood, are represented by road blooms only.

Section of Clintwood coal bed at Kenady mine on Big Ridge.

(Location 126, elevation 2,386 S.)

	Ft.	in.
Shale.		
Coal	2	9
Shale		8
Coal	2	
Shale		½
Coal		3
Shale		½
Coal	2	10
Coal	7	10
Partings		9

MC CLURE RIVER SOUTHEAST OF CANEY CREEK.

Geologic outline.—The lowest stratum exposed in the drainage basin of upper McClure River is the massive sandstone beneath the Kennedy coal bed, and the highest is a massive white sandstone the top of which is 320 feet above the base of the Wise formation. The Gladeville sandstone and the Wise formation, however, are restricted to the tops of the main ridges. The stratigraphy of strata above and below drainage is shown by generalized columnar sections (Pl. IV), by many drill records (Pls. II and III), and by local sections 7, 8, and 9. Dips are to the northwest and north at less than 100 feet per mile except locally. One normal fault with a displacement of about 30 feet has been found in mine workings in the southeast corner of the Clintwood quadrangle.

There are some important coal deposits in this area, chiefly in its southern part, near Sandy Ridge. (See figs. 4, 5, and 10.) The Kennedy coal is more than 9 feet thick in a few pockets, but is thin in many places and is everywhere crushed and very irregular in thickness. The Lower Banner is 2 to 3 feet thick in many places and contains an average of more than 3 feet of coal in the southeastern part of the area. The Lower Banner is being mined on a large scale at Dante, a short distance south of the McClure River drainage basin, where it is much the same as in part of the latter area. In the northern part of the basin the Upper Banner is split into several beds each containing less than 3 feet of coal, but these beds unite in the southeastern part of the basin, where the coal averages about 5 feet thick and contains only very thin partings of incombustible matter. A large tonnage is being derived from the Upper Banner near Dante, and the largest mine has already extended its workings north under Sandy Ridge and into the territory at the head of McClure River. A large mine at Wilder, on Dumps Creek, is also driving an entry toward the head of Roaring Fork. The Splash Dam bed is 3 to 4 feet thick in the southern part of the Open Fork drainage basin and may be fairly thick in a few other areas. Higher beds are either too thin or occupy too small an area to be of great importance. The Glamorgan and Lyons beds show 3 or 4 feet of coal locally, but commonly contain several shale partings. The Eagle bed is 30 to 51 inches thick, but underlies only about one square mile.

Kennedy coal bed.—The Kennedy coal is 300 to 420 feet below the Upper Banner horizon and outcrops low in the valley of McClure River

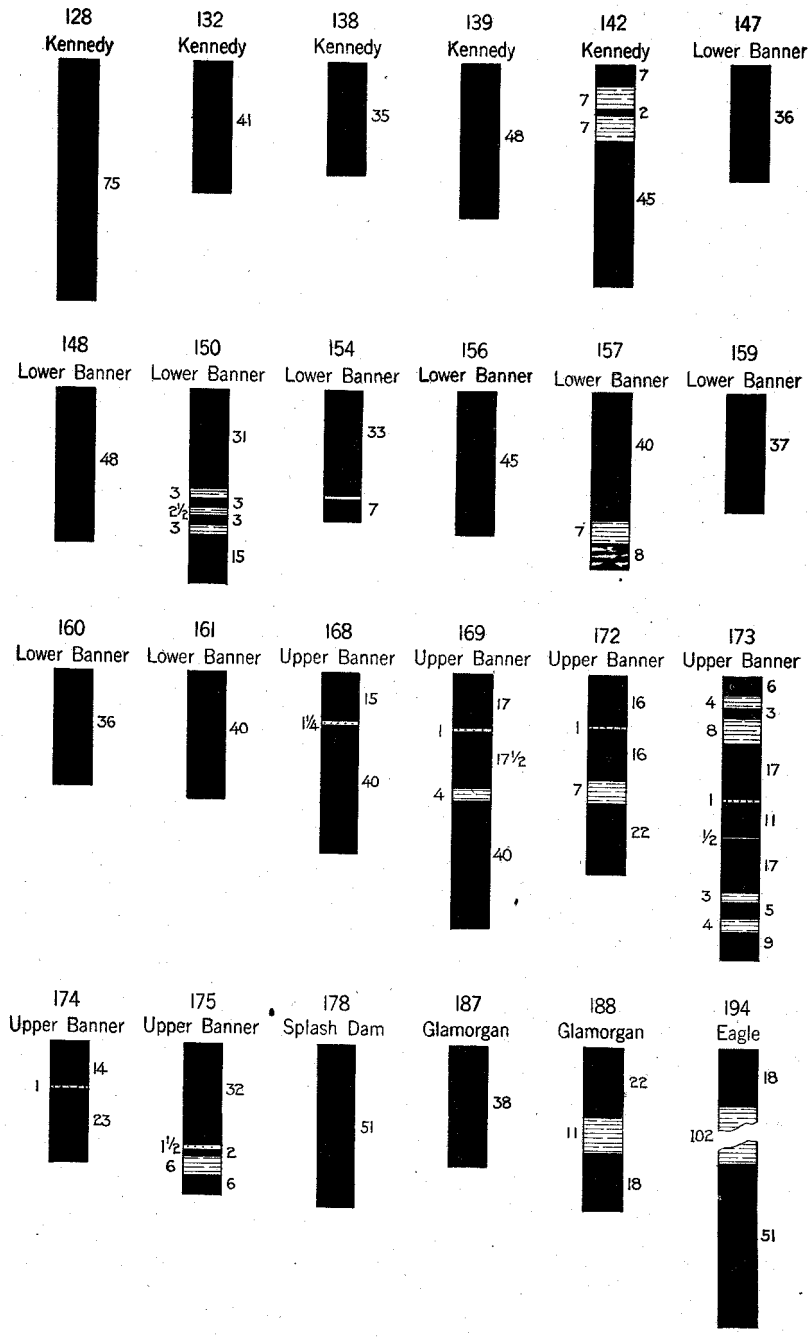


Fig. 10.—Sections of coal beds in the southern part of the McClure River drainage basin.

and the lower parts of its tributaries. The coal lies near the level of the railroad from the Sandy Ridge tunnel to Caney Creek and can be seen in many railroad cuts. The Kennedy is everywhere crushed and slickensided in greater part, and is fractured in a way that plainly shows that the beds above it were shoved to the northwest along the plane of the coal bed. As a result of this movement the thickness of the coal is remarkably irregular and the bed, though locally thick, is not likely to yield a large profit in mining. There is a coarse massive sandstone a few feet below the coal and fine-grained sandstone or sandy shale above it. There are in places several coal beds above the Kennedy and below the Lower Banner, but they are too thin or impure nearly everywhere to be of commercial importance.

The Kennedy is 3 to 40 inches thick in the tunnel at the mouth of Caney Creek, 10 to 15 inches a quarter of a mile southeast, and 12 inches half a mile farther up the railroad grade (location 127, elevation 1,501 H. L.), where it is 9 feet above the track. The Kennedy and a coal bed 30 feet higher are exposed at intervals in the cuts between Spraddle Branch and Buffalo Creek, but are too thin and irregular to be mined in even a small way.

Two small drifts on Open Fork near Rush Branch (location 128, elevation 1,600 B.) show 70 to 76 inches of coal with a sandstone roof. A small mine at the mouth of the road fork of Spring Fork (location 129, elevation 1,647 S.) is in 30 inches of coal with sandstone roof and floor. There is a large prospect pit on Middle Fork (location 130, elevation 1,630 B.) in which the Kennedy is reported 9½ feet thick, and a small stripping a few rods south is in at least 4 feet of coal. Three feet of coal, more or less, in the pit on the opposite side of the stream are in a bed about 50 feet higher than the Kennedy. A small drift just below the mouth of Rush Branch (location 131, elevation 1,607 S.) contains only 24 to 30 inches of coal. The average thickness of the Kennedy on Open Fork drainage is much less than is indicated by these measurements.

The Kennedy is 33 feet above the grade and only 2 inches thick at the deep railroad cut at the mouth of Open Fork, and only 3 to 15 inches thick in cuts half a mile south. A little farther up grade (location 132, elevation 1,575 B.) the bed contains 41 inches of coal near track level, but is thinner not far distant. At the tunnel at the mouth of Long Branch, the following section is exposed:

Section at mouth of Long Branch of McClure River.

(Location 133, elevation of base 1,635 B.)

	Ft.	in.
Sandstone, bluish-buff, fine-grained, thick-bedded	45	
Shale, dark blue, slaty, buckled, with coal streaks	6	
Sandstone, reddish-drab, fine-grained, massive, much fractured	19	
Coal		3-24
Shale, dark blue, slaty, buckled	5	
Sandstone, dark blue, argillaceous, much fractured along planes dipping 45 degrees	20	
Coal (Kennedy)		2-12
Sandstone, bluish, fairly coarse, massive, to railroad grade	2	
Concealed, probably sandstone	5	
Sandstone, yellowish-buff, coarse	20	

The Kennedy is 10 to 24 inches thick in cuts near the mouth of Honey Branch (location 134, elevation 1,690 B.) and is reported 30 to 36 inches where it dips under the track a short distance north. Opposite Roaring Fork (location 135, elevation 1,700 B.), at railroad level, the bed is 24 to 37 inches thick. In cuts a short distance south the bed contains 30 inches of coal split by a foot of carbonaceous shale 10 inches from the top. Near the mouth of Bear Hollow the coal is 15 to 30 inches thick and includes irregular shale partings. Farther south (location 136, elevation 1,770 B.) the bed is 18 inches thick and has a shale parting near the middle in places. The Kennedy was utilized in railroad construction work at a mine near the end of the Sandy Ridge tunnel (location 137, elevation 1,831 S.), where it is 3 to 7 feet thick and contains shale partings of irregular thickness. The roof is 15 feet of drab, fine-grained sandstone that needs little timbering in the rooms, and 30 feet of coarse massive sandstone shows in cuts below the coal.

There are comparatively few exposures on the east side of the river, but it may be safely assumed that the Kennedy is as irregular there as along the railroad. A pit half a mile south of Nora (location 138, elevation 1,580 B.) shows coal 35 inches thick, separated from sandstone above and below by only a few inches of shale. A quarter of a mile north of Nora (location 139, elevation 1,572 S.) there is a small mine in 3 to 5 feet of coal that is clean except for irregular sandstone lenses. An analysis of coal from this mine is given elsewhere in this report. A small mine at Stratton (location 140, elevation 1,530 H. L.) is in 2 to 3 feet of coal. The bed has also been utilized about a mile northwest (location 141, elevation 1,500 B.), where it is 25 inches thick. Beside the wagon road near the mouth of Caney Creek (location 142, elevation 1,493 S.) there is a small mine in coal 54 inches thick, exclusive of two 7-inch shale partings near the top. Caved

pits a short distance north indicate that the bed is as irregular here as in the tunnel on the opposite side of the river.

Lower Banner coal bed.—The Lower Banner is 80 to 170 feet below the Upper Banner. It is separated by a few feet of shale or clay from a moderately coarse sandstone bottom-rock that is a fair marker. Its outcrop is less than 400 feet above the level of McClure River and extends a considerable distance up most of the tributaries. The coal is more regular in thickness and character than that in either the Kennedy or the Upper Banner bed; nevertheless, it is far from uniform. The bed is 2 to 3 feet thick north of Open Fork and Hatchet Branch drainage basins. It is rather thin or split by a shale parting in most of the Open Fork basin, but contains an average of more than 3 feet of coal on the upper part of the main fork. There are 3 to 4 feet of coal in most places south and southeast of Blair and Hatchet branches; although the lower part of the bed is rather impure in the northern part of this area, there is a large body of coal that will undoubtedly be mined in the near future.

The bed is poorly exposed in a stripping at water level on Spraddle Branch (location 143, elevation 1,760 B.) and is reported on unverifiable authority to be 2 to 3 feet thick.

On the tributaries and branches of Open Fork the value of the Lower Banner is impaired in many places by a shale parting near the middle. Near the head of the main fork, however, there are 3 to more than 4 feet of coal in one bench. The shale parting is 14 inches thick in a small mine on Rush Branch (location 144, elevation 1,800 B.), with 21 inches of coal above it and 13 inches below. The roof is 10 feet or more of bluish shaly sandstone. Caved pits on Spring and Middle forks do not indicate that the bed is very thick, and near the quadrangle boundary (location 145, elevation 1,965 B.) it contains only 11½ inches of coal with 2 inches of shale near the top. A partially filled strip-pit in the bed of Coon Branch (location 146, elevation 1,955 S.) and a road exposure nearly half a mile north indicate about 30 inches of coal. According to Stone this bench is separated by 2½ feet of shale from a lower bench of coal a foot thick. East of this, on Open Fork (location 147, elevation 1,945 B.), the Lower Banner is 3 feet thick and 140 feet below the Upper Banner outcrop. Nearly a mile south (location 148, elevation 1,970 B.) another small mine is in about 4 feet of coal with a sandy shale roof. The following measurements show the character of the bed farther south, the first having been made in a small mine at the mouth of Dismal Fork, and the second in a pit 40 feet below the Open Fork road.

Sections of Lower Banner coal bed near head of Open Fork.

(Location 149, elevation 1,950 B.)

Sandstone.	Ft.	in.
Coal	2	2
Shale		4
Coal		1½
Clay		1½
Coal		3
Shale		1½
Coal		7
Coal	3	1½
Partings		7

(Location 150, elevation 1,955 S.)

Sandstone.	Ft.	in.
Coal	2	7
Shale		3
Coal		3
Shale		2½
Coal		3
Shale		3
Coal	1	3
Coal	4	4
Partings		8½

Another small mine on Open Fork (location 151, elevation 1,960 B.) contains 32 inches of clean coal at the top and 27 inches of coal with several shale partings at the bottom. Less than a mile north (location 152, elevation 1,935 B.) there are 32 inches of coal in the bed. Northeast of this, on Long Branch of McClure River (location 153, elevation 1,930 B.) the coal is 34 inches thick. In the next hollow to the south (location 154, elevation 1,900 B.) the bed is 41 inches thick, but with thin shale layers in the lower 8 inches. The floor is 6 feet of hard clay and the roof is clay shale. A short distance south of this (location 155, elevation 1,910 B.) a small mine used by railroad contractors was in 32 inches of coal with rather soft clay floor and sandstone roof over 2 inches of clay. The following sections show the character of the bed at the head of Trammel Branch:

Sections of Lower Banner coal bed at head of Trammel Branch.

(Location 156, elevation 2,136 S.)

Sandstone.	Ft.	in.
Shale	1	2
Coal, clean	3	9
Clay		3
Coal	3	9

(Location 157, elevation 2,145 B.)

	Ft.	in.
Shale	2	9
Coal, clean	3	4
Shale		7
Coal, bony		8
Clay, soft		6
Coal	4	
Partings		7

A small mine near the head of McClure River (location 158, elevation 2,075 B.) is in 45 inches of coal, with 6 inches more separated from its top by 26 inches of shale. A lower seam of 6 inches is reported to be separated from the main part of the bed by 4 inches of shale. The next exposure found east of the river, in going down the McClure, was at a small mine opposite Bear Hollow (location 159), where the bed is 37 inches thick. A

small drift beside the Roaring Fork road (location 160, elevation 1,955 S.) is in 3 feet of coal that is slightly bony at base and has a sandstone roof. This thickness is below the average of the Lower Banner on Roaring Fork and the bed is also thicker in the next hollow north (location 161), where there are 40 inches of coal separated from a sandstone roof by 3 inches of shale.

The following measurements were made on Hatchet Branch, the first in a small mine on the right fork and the second in a pit beside the wagon road on the left fork:

Sections of Lower Banner coal bed on Hatchet Branch.

(Location 162, elevation 1,905 B.)

	Ft.	in.
Sandstone.		
Shale, black		10
Coal, clean	2	1
Shale		½
Coal, rather dirty		7
Clay, hard.		
Coal	2	8
Parting		½

(Location 163, elevation 1,871 S.)

	Ft.	in.
Sandstone.		
Coal	1	11½
"Rash"	1	5
Clay		
Coal	1	11½

The "rash" in the last section is composed of interlaminated layers of coal and shale, mixed and crumpled. The bed has the same section between the forks of Hatchet Branch, in a pit just 100 feet below an opening on the Upper Banner bed.

Coal 31 inches thick was measured in a small mine in the Lower Banner on the right fork of Buffalo Creek (location 164, elevation 1,760 H. L.), the roof being a few inches of shale under sandstone and the floor 8 feet of shale over sandstone. A slightly greater thickness is reported for a caved pit in the main fork of Buffalo Creek (location 165, elevation 1,700 B.). On Crooked Creek, however, in a pit beside the wagon road (location 166, elevation 1,744 H. L.), there are only 21 inches of coal overlain by a foot of shale under sandstone.

Upper Banner coal bed.—The outcrop of the Upper Banner is well up in the hills along McClure River and extends a considerable distance up the chief tributaries. The bed is characterized by a very thin sandstone parting near the middle of the coal, and by a sandstone cap-rock commonly separated from the coal by shale. North of the basins of Open Fork and Hatchet Branch little coal was found in this area and blooms indicate that a thickening of the first shale partings above and below the thin sandstone layer has split the Upper Banner into three beds, none of which is more

than 2 or 3 feet thick. These partings are much thinner in much of the Open Fork drainage basin and on both sides of the upper part of the McClure, and there are in places five or six feet of coal in the bed. The value of this thick coal is greatly impaired in many places by partings that are sufficiently thick to make the ultimate recovery of all the coal doubtful. In the vicinity of Trammel Branch and the heads of McClure River and Roaring Fork, however, the Upper Banner is in splendid condition and is being utilized in connection with extensive operations of the Clinchfield Coal Corporation. Mines 2 and 5 have already taken out most of the Upper Banner between Trammel Branch and the head of the McClure, and coal is being mined south of Knot Hollow Branch and hauled 1½ miles south under Sandy Ridge to the main mine mouths near Dante. The bed averages slightly more than 5 feet thick in these mines, with much of it 6 feet and some 7 feet, and sandstone and shale partings aggregate only a few inches in thickness. The main entry of mine 6 at Wilder is being driven southwest towards the head of Roaring Fork and the northeastern workings of mine 2, in coal averaging 6 feet thick.

If the following measurement, made in a small abandoned mine on Rush Branch of Open Fork, is of the Upper Banner, as appears probable, the bed is badly split by partings in this district. There is a possibility that the bed measured is the Splash Dam.

Section of Upper Banner (?) coal bed on Rush Branch.

(Location 167, elevation 1,973 C. C. C.)

	Ft.	in.
Sandstone, buff	4	
Shale, blue to black, in part carbonaceous	1	10
Coal	1	5
Sandstone, shaly	6	
Coal		2
Shale, very sandy at top		7
Coal		4
Shale		1
Coal		3
Shale	1	
Coal		5
Shale		4
Coal, bottom not seen	1	1
Coal in lower bed	2	3
Partings	2	

Near the head of Spring Fork (location 168, elevation 2,071 C. C. C.) the Upper Banner consists of 55 inches of coal with 1¼ inches of sandstone 15 inches from the top and a shale roof. The bed is thicker on Middle

Fork, as shown by the following measurements on its west side, the first being in a small mine 1½ miles from the mouth of the fork and the second in a pit 60 feet south of the boundary of the quadrangle.

Sections of Upper Banner coal bed on Middle Fork.

(Location 169, elevation 2,052 C. C. C.)

	Ft.	in.
Sandstone	3	
Coal	1	5
Sandstone		1
Coal	1	5½
Clay		4
Coal	3	4
Coal	6	2½
Partings		5

(Near mouth of Kilgore Branch.)

Shale.	Ft.	in.
Coal		8
Shale		3½
Coal	1	5
Sandstone		1½
Coal	1	6½
Clay		3
Coal	1	1
Clay		7
Coal		6
Coal	5	2½
Partings	1	3

The first clay parting below the thin sandstone layer is thicker on Coon Branch. Stone cites a pit that is only approximately located on the map accompanying this report (location 170) and in which the thickness of the parting was reported as 35 inches, of the coal above it as 33 inches, and of the coal below it as 41 inches. There is an inch of sandstone 15 inches below the top of the upper bench of coal. A pit below the wagon road farther south (location 171, elevation 2,053 S.) shows 35 inches of coal in what is probably the upper bench of the Upper Banner, and there is reported to be 41 inches more below, separated from it by 3 feet of shale.

The character of the bed near the head of the main branch of Open Fork is shown by the following measurements, the first in a small mine and the second in a prospect pit:

Sections of Upper Banner coal bed near head of Open Fork.

(Location 172, elevation 2,140 B.)

Sandstone.	Ft.	in.
Coal	1	4
Sandstone		1
Coal	1	4
Shale		7
Coal	1	10
Coal	4	6
Partings		8

(Location 173, elevation 2,100 B.)

Sandstone.	Ft.	in.
Coal		6
Shale		4
Coal		3
Clay		8
Coal	1	5
Sandstone		1
Coal		11
Shale		½
Coal	1	5
Clay		3
Coal		5
Clay		4
Coal		9
Coal	5	8
Partings	1	8½

The thickness of the Upper Banner in the mines near the head of McClure River has been mentioned and details of the bed are shown in the following sections. The first measurement was made a few yards south of the Clintwood quadrangle, in a small mine near the wagon road up Trammel Branch; the second was obtained between Knot Hollow Branch and McClure River, in the workings of mine 2 of the Clinchfield Coal Corporation.

Sections of Upper Banner coal bed near head of McClure River.

	Ft.	in.
Shale	6	
Coal	1	11½
Sandstone		1
Coal		7½
Clay		½
Coal	2	3
Coal	4	10
Partings		1½

Sandstone.	Ft.	in.
Coal	1	10
Sandstone		1½
Coal	1	2½
Sandstone		½
Coal	2	5
Coal	5	5
Partings		2

The bed is thinner and more irregular on Roaring Fork, as indicated by the following sections:

Sections of Upper Banner coal bed on Roaring Fork.

(Location 174, elevation 2,110 B.)

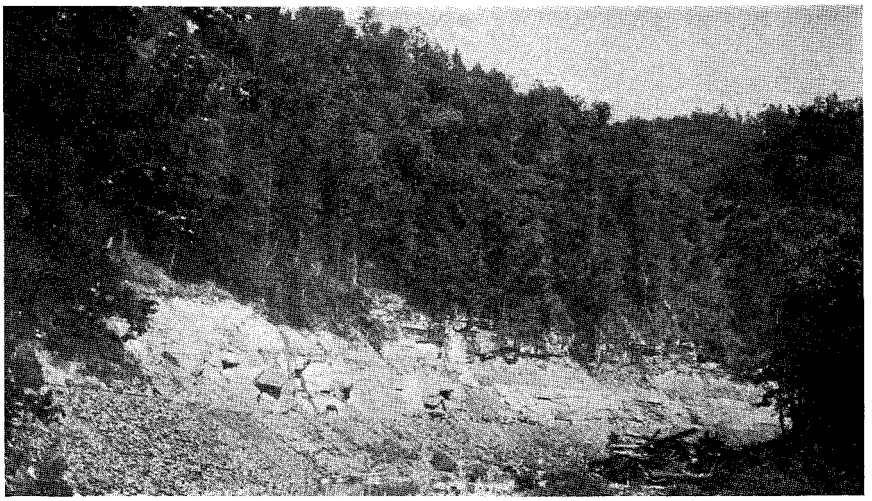
	Ft.	in.
Coal	1	2
Sandstone		1
Coal	1	11
Coal	3	1
Parting		1

(Location 175, elevation 2,125 B.)

	Ft.	in.
Coal	2	8
Sandstone		1½
Coal		2
Shale		6
Coal		6
Coal	3	4
Partings		8

A pit on Hatchet Branch (location 176, elevation 2,000 B.) shows only 27 inches in the Upper Banner bed, including 3 inches of clay 2 inches below the top of the coal. The roof is 8 feet of drab shale and the floor 18 inches or more of yellow clay.

Splash Dam and higher coal beds in Norton formation.—There are Norton coal beds at 5 or 6 horizons above the Upper Banner, but most of them are everywhere very thin and were laid down in rather small areas. The Splash Dam bed lies 30 to 90 feet above the Upper Banner and is separated from it chiefly by sandstone. The bed is thin in most places, but is known to contain 3 to 4 feet of coal in the southern part of the Open Fork drainage basin and is probably workable in a few other areas



Views showing forested conditions; (A) Railway cut 2½ miles southwest of the mouth of McClure River; (B) Ridges east of the head of Hatchet Branch of McClure River.

Views showing forested conditions; (A) Railway cut 2½ miles southwest of the mouth of McClure River; (B) Ridges east of the head of Hatchet Branch of McClure River.

where it has not been thoroughly prospected. The Hagy bed, which is about 185 feet above the Upper Banner, was found to contain 24 to 30 inches of workable coal at two places.

There is a caved prospect pit in the Splash Dam bed just above the wagon road up Coon Branch of Open Fork (location 177, elevation 2,097 S.), 41 feet above the top of the Upper Banner. A road bloom near this indicates that the bed is about 5 feet thick, including, perhaps, one or two thin shale partings. A pit near the head of the main branch of Open Fork (location 178, elevation 2,190 B.) is 50 feet above an opening in the Upper Banner and is in coal 51 inches thick. Farther down the fork (location 179, elevation 2,110 B.) the bed is about 4 feet thick, including two shale partings.

The Hagy bed, which lies under a conglomeratic sandstone in this area, contains 34 inches of coal on Low Gap Branch of Spring Fork (location 180, elevation 2,285 B.), but is split by 13 inches of shale 10 inches above the base. A partial exposure in the bed of a tributary of Buffalo Creek (location 181, elevation 2,055 B.) shows 30 inches of coal at the top and 12 inches at the bottom, separated by an interval of 32 inches that may be in part coal.

Glamorgan and Lyons coal beds.—The Glamorgan and Lyons beds outcrop only close to the tops of the main ridges and, consequently, underlie only a small area. The Glamorgan is 10 to 25 feet above the top of the thick Gladeville sandstone and in places is split into two beds 10 or 20 feet apart. The Lyons is about 50 feet higher and is not far below the base of a conspicuous white siliceous sandstone. The Lyons is poorly exposed and is commonly thin. The Glamorgan has been utilized by people living on the ridges and appears in many natural exposures. It contains 2 to more than 3 feet of coal in many places, but several shale partings greatly impair its value. It is thickest in the southern part of the area.

The Glamorgan was reported to be 2 feet thick in post-holes near Big Oak School, north of Spraddle Branch, and 30 to 36 inches thick in pits near Smith School, south of the same stream. Shale partings were probably included in the thicknesses given. Many blooms were seen, but no reliable measurements were obtained in this district.

Two small mines on the ridge west of Spring Fork, the first near Leck and the second at the head of Low Gap Branch, show many irregular partings in the Glamorgan:

Sections of Glamorgan coal bed near Leck.

(Location 182, elevation 2,615 S.)

	Ft.	in.
Shale	2	
Coal		10
Clay	2	6
Coal	1	9
Clay		10
Coal		8
Coal	3	3
Partings	4	

(Location 184, elevation 2,585 B.)

	Ft.	in.
Shale	15	
Coal		6½
Shale		½
Coal		5½
Shale		2½
Coal		8½
Rash		1
Coal		8
Clay		5¼
Coal		7½
Coal	3	
Partings		9¼

The Glamorgan contains 35 inches of coal and 4 inches of clay 11 inches below the top at a spring on the ridge between House and Low Gap branches (location 183, elevation 2,590 B.). The upper part is rather dirty and has the argillaceous shale roof characteristic of the bed; friable reddish sandstone outcrops a few feet below the coal. A coal bed 30 feet above the one previously mentioned is said to be 2 feet thick on the ridge south of Low Gap Branch, and one of these two beds is reported on apparently good authority to have 4 feet of clean coal near the head of Spring Fork (location 185, elevation 2,580 B.). At Rasnake School, at the head of Coon Branch, shale partings that are very irregular in thickness may be seen in a small mine:

Section of Glamorgan coal bed at head of Coon Branch.

(Location 186, elevation 2,550 B.)

	Ft.	in.
Shale.		
Coal	1	
Shale		8-12
Coal	1	3
Shale		18-24
Coal		6
Shale	12	
Coal		12-14
Coal	2	9
Partings	2	7

Clean coal 38 inches thick was seen in a small mine near Smith School, by the ridge road west of McClure River (location 187, elevation 2,673 H. L.). This bed may be a little higher stratigraphically than the one mined at Rasnake School.

There is sandstone a short distance above, as well as below, the Glamorgan on Flat Spur and neighboring parts of Sandy Ridge. A small mine near the southern part of Flat Spur (location 188, elevation 2,798 H. L.) shows 40 inches of coal in the bed, but with a parting of 11 inches of shale near the middle. Road blooms in this district show several thin coal beds in an interval of 100 feet above the Glamorgan, but the Lyons bed is nowhere fully exposed. The Lyons is 30 inches thick in the Sandy Ridge road east of Roaring Fork (location 189, elevation 2,840 B.), but is only 13 inches thick half a mile north, near the school.

No complete exposures of the Glamorgan or Lyons beds were seen on the ridges northwest of Flat Spur, but the former bed is reported to be 2 or 3 feet thick in a shallow well near the triangulation station at the head of Hatchet Branch, and 12 to 18 inches thick on the divide between McClure River and Crooked Branch (location 190, elevation 2,320 B.).

Blair and Eagle coal beds.—The Blair coal lies a few feet above a ledge-making sandstone and about 120 feet above the base of the Wise formation. The Eagle is about 60 feet higher, beneath a more or less massive sandstone. These beds outcrop only on Flat Spur and a few of the highest parts of other ridges. The Clintwood coal was not found, though its horizon outcrops in a small area on the end of Flat Spur.

The Blair bed contains 20 inches of coal and 3 inches of shale on the northern part of Flat Spur (location 191). On the southern part of the spur there are 22 inches of coal split in the middle by a 9-inch shale parting.

The Eagle bed was measured at the head of Hollow Branch (location 192, elevation 2,830 B.), where there are at least 30 inches of coal in a lower bench and 6 inches more 3 feet higher. The roof is 22 inches of shale under a thick sandstone. The same measurements were obtained in an opening 500 feet to the north. There are at least 35 inches of coal in the Eagle bed on the east side of Flat Spur (location 193, elevation 2,870 B.). A small outlier of the same bed north of Roaring Fork (location 194, elevation 2,890 B.) contains one bench of coal about 51 inches thick and another 18 inches thick and 8½ feet above the first.

LICK CREEK.

Geologic outline.—Rocks exposed in the drainage basin of Lick Creek of Russell Fork extend from about 180 feet below the Kennedy coal horizon to 250 feet above the base of the Wise formation. The Gladeville sand-

stone, however, appears only on the tops of high ridges and the Wise only on high knobs on the western and southern borders of the basin. Stratigraphic features are shown graphically in the generalized columnar sections for the south and middle thirds of the Clintwood quadrangle (Pl. IV), the intervals being nearly the maximum shown in both sections. The graphic records of borings within the area (Pl. II) show the succession of rocks below the surface, and those of holes bored on the ridges farther south and southeast (Pls. II and III) are applicable in a general way to the outcropping rocks of the area. Local sections 7 and 10 also show stratigraphic details. Except near the mouth of Lick Creek, where the proximity of a shearing zone has caused minor complications, the structure is simple and dips are, in general, northwest and north at about 50 feet per mile.

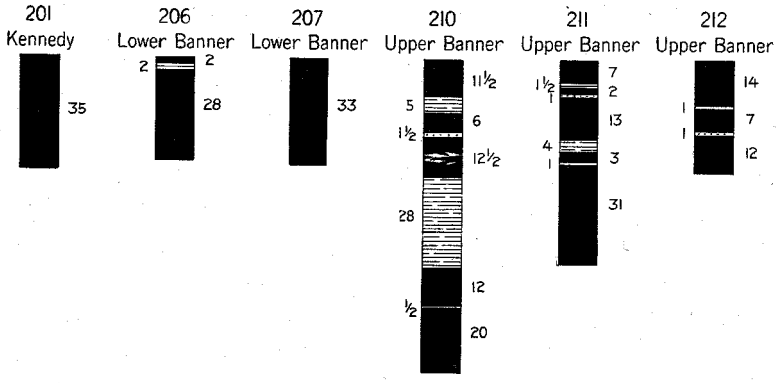


Fig. 11.—Sections of coal beds in the Lick Creek drainage basin.

The Lick Creek basin contains a number of coal beds, but the only ones of special commercial importance are the Kennedy, Lower Banner, and Upper Banner. (See figs. 4, 5, and 11.) The Kennedy is as much as 5 feet thick in places, but is commonly much thinner. The Lower Banner is 2 to 3½ feet thick in the southern part of the basin and averages less elsewhere. The Upper Banner is the most important bed, especially on Beech Branch and neighboring parts of Lick Creek. The bed contains 4 to 6 feet of coal, but is split by shale partings into two or more parts except on Beech Branch and, possibly, under the ridges near Flint Gap School. The parts of the bed are so far apart in most places that they must be mined separately, and in places neither part is as much as 2 feet thick.

Aily coal bed.—The lowest exposed coal bed in the area is the Aily, which is about 90 feet below the Kennedy coal horizon and outcrops near the level

of Lick Creek from near its mouth nearly to Josh Branch. As exposed in a pit at Aily (location 195, elevation 1,410 B.) it is 18 inches thick and rests upon sandstone. The roof in this district is a few feet of sandy shale containing fossil plants and overlain by thick beds of sandstone. The Aily is 19 inches thick at the mouth of Hurricane Branch (location 196, elevation 1,320 B.), where it has the same type of roof and floor.

Kennedy coal bed.—The Kennedy is 250 to 320 feet below the Upper Banner and outcrops low down in the valley of Lick Creek. In this area, as elsewhere west of Russell Fork and Indian Creek, the Kennedy is very irregular in thickness, ranging from a few inches to 5 feet or more. The horizon of the bed is easily determined, as it lies only a few feet above a conspicuous coarse and massive sandstone and underlies shale and fine-grained sandstone of considerable thickness.

The Kennedy is reported a little more than 2 feet thick near the mouth of Lick Creek (location 197, elevation 1,405 B.). The bed is thicker farther south, for it is reported to be 4 feet thick at the mouth of the southern Linn Branch (location 198, elevation 1,575 B.) and 5 feet at the mouth of Cabin Creek (location 199, elevation 1,580 B.). The accuracy of these reports could not be verified. The following section was measured on Left Fork, half a mile from its mouth:

Section of Kennedy coal bed on Left Fork of Lick Creek.

(Location 200, elevation 1,480 B.)

	Ft.	in.
Coal		1
Shale		½
Coal	1	11
Shale		1
Coal		6
Coal	2	6
Partings		1½

The coal is 35 inches thick on Upper Hurricane Branch (location 201, elevation 1,485 H. L.) and has a massive sandstone floor and fossiliferous shale in the roof.

Lower Banner coal bed.—The Lower Banner coal is 50 to 110 feet below the Upper Banner and outcrops in the valleys of Lick Creek and its tributaries from their mouths nearly to their heads. The bed has not been thoroughly prospected, but probably averages about 30 inches thick, being, in general, 2 feet or less in the northern part of the drainage basin and 2 to 3½ feet in the southern part. The roof is commonly a very sandy shale and there is a sandstone bottom-rock a few feet below the coal.

The Lower Banner is at least 18 inches thick at Aily (location 202, elevation 1,690 B.), where all of the bed may not have been exposed. At the mouth of Wolfpen Branch (location 203, elevation 1,853 S.) the roof is a very sandy shale and the coal is 28 inches thick and somewhat fractured and crushed. A stripping in 16 inches of coal near the head of Wolfpen Branch (location 204, elevation 1,930 B.) has not reached the bottom of the bed. The bed is reported to be 42 inches thick near the head of Long Branch (location 205, elevation 1,935 B.); but this may not be accurate. Less than half a mile north, near Debusk (location 206, elevation 1,915 B.), the bed is 32 inches thick, including 2 inches of shale 2 inches from the top. The Lower Banner consists of 33 inches of clean coal in a pit on Low Gap Branch (location 207, elevation 1,950 B.).

The only measurement of the bed obtained east of the lower part of Lick Creek was on Hurricane Branch (location 208, elevation 1,680 B.), where it is at least 19 inches thick and contains two very thin shale partings. It is possible that all of the bed was not seen at this place.

Upper Banner coal bed.—The outcrop of the Upper Banner is 300 to 500 feet above stream level along most of Lick Creek and extends up its tributaries nearly to their heads. The characteristics of the bed are much the same as on lower McClure River. On the upper part of Beech Branch the coal is 4 to 6 feet thick and contains only thin partings, being evidently part of the body of thick coal on Mill Creek and Squirrel Camp Branch of the McClure. At the mouth of Beech Branch, however, the partings thicken and the coal splits into two or three separate beds to both the north and south on Lick Creek. The distance between the two principal benches along the creek near Beech and Turkey branches and Aily is only a few feet and the lower bench is as much as 3 feet thick. About a mile south of Aily the two benches are 45 feet apart. Comparatively little is known about the Upper Banner in the southern and northeastern parts of the Lick Creek drainage basin, but there are indications that the bed is split into at least two distinct and rather thin benches in all of that territory except near Flint Gap School. The 1-inch sandstone parting that is characteristic of the Upper Banner is near the middle of the upper bench where the bed is split.

Coal in a pit on a spur east of the northern Linn Branch (location 209, elevation 1,710 B.) is said to be only 18 inches thick and is evidently in the lower split of the Upper Banner, as massive sandstone shows just below it. As shown by the following two measurements, the parting between the two benches is only 28 inches thick on the spur west of Turkey Branch,

and is 4 inches thick near the head of Beech Branch. The upper part of the Beech Branch section was measured by Stone, and a 7-inch coal seam was found about 8 feet above the principal bed.

Sections of Upper Banner coal bed on Turkey and Beech branches.

(Location 210, elevation 1,763 C. C. C.)

	Ft.	in.
Shale	3	
Coal		11½
Shale, carbonaceous		5
Coal		6
Sandstone		1½
Coal, in part bony	1	½
Shale	2	4
Coal	1	
Rash		½
Coal	1	8
Coal	5	2
Partings	2	11

(Location 211, elevation 1,724 C. C. C.)

Sandstone.	Ft.	in.
Coal		7
Shale		1½
Coal		2
Sandstone		1
Coal	1	1
Clay		4
Coal		3
Clay		1
Coal (reported)	2	7
Coal	4	8
Partings		7½

An opening on Laurel Branch, west of Flint Gap School (location 212, elevation 1,960 B.) shows 33 inches of coal, with an inch of shale 14 inches from the top and an inch of sandstone a foot from the bottom. The lower part of the Upper Banner, seen on Turkey and Beech branches, was not found here, though the parting between it and the upper part is only a foot thick a mile northeast, on Breeden Branch of Fryingpan Creek.

The Upper Banner was reported to be 43 inches thick near the mouth of Big Branch of Left Fork (location 213, elevation 1,820 B.), but the thickness of shale partings is not known.

Higher coal beds.—Coal was found at a number of places at horizons higher than that of the Upper Banner, but in nearly all cases it was too thin to be of even local importance. The Splash Dam bed, which is about 50 feet above the Upper Banner, is probably 2 or 3 feet thick in small areas, and one or more higher coal beds in the Norton formation may be 2 feet thick in places. The Glamorgan and Lyons beds, near the base of the Wise formation, are poorly exposed and occupy only very small areas on some of the ridge tops. The Glamorgan is reported to be 3 feet thick at a stripping on Wampler Ridge, at the head of Spring Branch (location 214, elevation 2,720 H. L.), and has a roof of fossiliferous clay shale that is very soft at base. In the road near this, the Lyons bed is 23 inches thick. The Blair and Eagle beds underlie only a few very small areas on the highest parts of the ridges, but have not been prospected.

FRYINGPAN CREEK.

Geologic outline.—All of the Norton formation except the lower 150 feet is exposed in the Fryingpan Creek drainage basin, the Gladeville sandstone caps some of the highest ridges, and 250 feet of the Wise formation still remain on part of Wampler Ridge. The stratigraphic character of the rocks both above and below drainage is shown graphically by the generalized columnar sections for the middle and south thirds of the Bucu quadrangle (Pl. IV) and by the logs of numerous borings in the southwestern part of the Bucu quadrangle (Pl. III). Exposed rocks are also shown in local sections 10, 11, and 29. There is a general thinning of strata to the north, though the sandstone cap-rock of the Upper Banner coal bed thickens slightly in that direction.

The direction of the dip is, in general, northwest at 50 to 250 feet per mile, but in part of the basin the dip is nearly due west and in another part due north. North of Bucu, moreover, there is a small dome, so that some dips in that district are to the south and east. In a small area near Priest Fork and neighboring parts of Fryingpan Creek, there are in places steep and irregular dips caused by buckling and shearing. It is almost certain that all the exposed rocks in this area are of Norton age, but no attempt has been made to define the position of coal outcrops and structure contours on the map.

Very little coal was found in the northern part of the area and it is not likely that many deposits more than 2 or 3 feet thick exist. The Kennedy is locally thick, but is thin in most places. In the west-central and southern parts of the area, however, there is thick coal in parts of the Tiller and Jawbone, Garden Hole, Lower Banner, and Upper Banner beds, as well as coal about 4 feet thick in an outlier of the Eagle bed that is too small to be of commercial significance. (See figs. 3, 4, 5, and 12.) The Tiller and Jawbone coals, which are so close together that they are practically one bed, contain 4 to 6 feet of slightly impure coal where they are exposed along Fryingpan Creek near Bucu. The united beds probably also form a thick deposit in the region east and southeast of Bucu, where they are below drainage levels. The Garden Hole bed is less than 30 inches thick in most places, but is as much as 4½ feet thick a short distance south and southeast of Bucu. The Lower Banner is a clean bed 2 to 4 feet thick between Lick Branch and Sandy Ridge. The Upper Banner includes 3 to 7 feet of recoverable coal between Breeden and Hardin branches and in the district east of Fryingpan Creek and south of Lick Branch. Elsewhere the

thickening of a shale parting is thought to separate the bed into two parts, though it is possible that more extensive prospecting may increase the known acreage of thick coal.

Tiller and Jawbone coal beds.—The Tiller and Jawbone beds lie 750 to 825 feet below the Upper Banner horizon, and are only a few inches apart where they are exposed along Fryingpan Creek between Hardin and Lick branches. There is a thin sandstone stratum a few feet above the coal, separated from it by shale, and a siliceous conglomeratic sandstone a few feet below it. The coal is 4 to 6 feet thick where openings were found, but is rather impure and commonly contains a thick parting of shale mixed with coal ("rash").

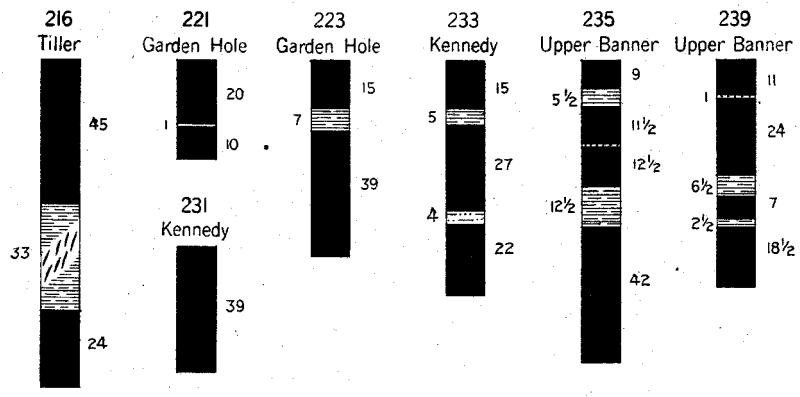


Fig. 12.—Sections of coal beds in the Fryingpan Creek drainage basin.

The bed has been utilized at several openings at Bucu. In a small mine on the west side of the creek (location 215, elevation 1,522 S.) there are 42 inches of coal that is somewhat bony in the middle, overlain by 10 feet of shale, and underlain by at least 24 inches of coal and clay mixed and interfoliated and with slickensided surfaces. That all of the bed is not exposed is indicated by the folowing section, measured in another small mine a short distance south:

Section of Tiller and Jawbone coal beds at Bucu.

(Location 216, elevation 1,496 S.)

	Ft.	in.
Shale, yellowish-gray, argillaceous	1	
Coal	3	9
Shale, in part mixed with coal, irregularly foliated along curved planes	2	9
Coal, not well exposed	2	
Coal	5	9
Parting	2	9

The upper bench of coal, 45 inches thick, is mined on a small scale in front of the store at Bucu (location 217, elevation 1,525 H. L.). Near the wagon road, a little more than half a mile north of Bucu (location 218, elevation 1,565 B.), the coal is 40 inches thick and all except the upper 10 inches is foliated and slickensided. The roof is 4 feet of thin-bedded sandstone. The coal is reported to be about the same thickness half a mile down the creek and a thick coal bloom shows in the road.

A bed that lies 25 to 60 feet above the Tiller and Jawbone commonly contains less than 30 inches of coal in this area and is less than a foot thick in many places. Half a mile west of the mouth of Priest Fork (location 219, elevation 1,390 B.) this bed is 21 inches thick, but is split into two parts by shale a short distance down the creek. An exposure at stream level at the mouth of Hardin Branch (location 220, elevation 1,425 B.) contains 17 inches of coal under 50 feet of thin-bedded sandstone and sandy shale. At Bucu the coal is about 20 inches thick and 25 feet above the Tiller and Jawbone beds.

Garden Hole and associated coal beds.—The Garden Hole bed is 110 to 200 feet above the Jawbone horizon and is thin in most places. It contains 24 to 30 inches of coal in places in the northern part of the area and 2 to 4½ feet along Lick Branch and neighboring parts of Fryingpan Creek; elsewhere it is thin and commercially unimportant. There is also coal at four or five horizons between the Garden Hole and Kennedy beds, but no exposure of more than 2 feet of coal was seen and it is probable that these beds are everywhere thin. There are no reliable stratigraphic markers in this part of the section, so that the identification of the Garden Hole is difficult and may be in error in places.

The Garden Hole bed is 31 inches thick, including an inch of shale in its lower half, at a small mine near Bucu (location 221, elevation 1,640 B.), and has a thin-bedded sandstone roof. On the opposite or south side of Cabin Branch the bed is 15 feet lower and there is a foot of coal 6 feet above the thicker bench. An exposure of 27 inches of coal with a dark blue shale roof near stream level at Lick Branch School (location 222, elevation 1,650 B.) may be the Garden Hole, but is probably a bed a short distance above it. A small mine above the road near the mouth of Lick Branch (location 223, elevation 1,613 S.) is certainly in the Garden Hole bed. The roof is sandstone and the bed contains 54 inches of coal and a 7-inch shale parting 15 inches from the top. The Garden Hole appears to be in two benches about 30 feet apart farther south, and the upper bench was reported to be about 3 feet thick in a stream cut at the mouth of Breeden Branch (location 224, elevation 1,403 H. L.).

Coal 16 inches thick is exposed at the level of a small tributary of Priest Fork (location 225, elevation 1,340 B.). The irregular laminæ of the coal have slickensided surfaces caused by movement along the bed, and the irregular dips of strata in the vicinity make it uncertain whether this is the Garden Hole or one of the higher beds. The same features characterize an exposure beside the path up Priest Fork (location 226, elevation 1,400 B.), where the coal is 22 inches thick. Farther up Priest Fork (location 227, elevation 1,455 B.) an opening in what is probably the upper bench of the Garden Hole bed shows 22 inches of coal split in the middle by 5 inches of shale and dipping 2° west of south. Both benches are exposed opposite a house half a mile southeast, as follows:

Section of Garden Hole coal bed on Priest Fork.

(Location 228, elevation 1,510 B.)

	Ft.	in.
Shale, blue to dark drab, with coal streak near base	5	6
Coal		9
Clay and coal, mixed		2½
Coal	1	1½
Concealed	13	
Sandstone, medium-grained	5	
Coal bloom	..	

One of the beds between the Garden Hole and Kennedy horizons is 19 inches thick where exposed in the bottom of a small hollow near Abners Gap (location 229, elevation 1,560 B.). Coal 16 inches thick may be seen by the road near the forks of Priest Fork, but the irregular dips of strata in the vicinity make its correlation doubtful.

Kennedy coal bed.—The Kennedy lies 280 to 380 feet below the Upper Banner horizon, the interval decreasing to the north. It has not been prospected much in this area, so that its thickness is not well known. Its character in neighboring areas suggests that it is irregular in thickness, is locally thick, and is thin in most places. It contains 64 inches of coal at one place, as described below.

The Kennedy appears to be about 3 feet thick in a caved pit on Rock Lick Branch (location 230, elevation 1,540 B.). There are 39 inches of clean coal with sandstone roof and floor in a small mine near the mouth of Breeden Branch (location 231, elevation 1,655 B.). Near the head of Fryingpan Creek (location 232, elevation 1,950 B.) the bed is only 15 inches thick, but it is much thicker in at least one place in the northern part of the area, as shown in the following section:

Section of Kennedy coal bed 1 mile southwest of the mouth of Priest Fork.

(Location 233, elevation 1,570 B.)

	Ft.	in.
Sandstone.		
Coal	1	3
Shale		5
Coal	2	3
Shale and fine-grained sandstone		4
Coal	1	10
Sandstone.		
Coal	5	4
Partings		9

Lower Banner coal bed.—The Lower Banner lies about 100 feet below the Upper Banner. No complete measurements were obtained, but the bed is reported to be nearly free from shale partings and to contain 2 to 4 feet of coal in the southern part of the area, near Sandy Ridge and as far north as Lick Branch. The thickness of 34 inches of clean coal measured above the wagon road at the head of Fryingpan Creek (location 234, elevation 2,220 B.) is below rather than above the average for this district. North of Lick Branch the bed is probably thinner in most places and may be absent in part of the district between lower Fryingpan Creek and Russell Fork.

Upper Banner coal bed.—The Upper Banner lies only a few hundred feet below the tops of the higher ridges in this area, and is a thick and important bed in two districts, where it includes 3 to 7 feet of coal, the characteristic very thin sandstone parting, and two or more shale partings commonly aggregating less than 1 foot in thickness. One of these districts, as now known, lies between the heads of Breeden and Hardin branches and will probably be shown by additional prospecting to extend somewhat farther north and south. The other district is in the area east of the upper part of Fryingpan Creek and south of Lick Branch. Outside these districts the principal shale parting below the thin sandstone layer thickens and separates the bed into two parts, each containing less than 3 feet of coal. Nothing is known about the condition of the bed east of Fryingpan Creek and north of Lick Branch, but it is probable that it is split into two parts in nearly all of the area and that both parts thin to the north.

The most southern measurement was obtained in a pit below the wagon road on the upper part of Breeden Branch, and is as follows:

Section of Upper Banner coal bed on Breeden Branch.

(Location 235, elevation 1,925 B.)

	Ft.	in.
Shale, sandy	2	
Coal		9
Clay, carbonaceous		5½
Coal		11½
Sandstone, carbonaceous		1
Coal	1	½
Shale	1	½
Coal	3	6
Coal	6	3
Partings	1	7

The partings are thinner at the head of Hardin Branch, where the total bed was reported to be 6 or 7 feet thick at two caved prospects (locations 236 and 237, elevation 1,990 B.) lying under a massive sandstone 35 to 50 feet thick. The following two measurements in the same locality are cited by Stone:

Sections of Upper Banner coal bed on Hardin Branch.

	Ft.	in.		Ft.	in.
Shale, under sandstone		6	Shale		4
Coal		11	Coal		9
Clay		½	Coal, laminated		½
Coal		10	Coal		9
Sandstone		1¼	Sandstone		1½
Coal	1	5	Coal	1	
Clay		6	Coal, laminated		4
Coal (seen)	2	6	Shale		10
			Coal	1	5
Coal	5	8	Shale		1
Partings		7¾	Coal	1	6
			Coal	5	9½
			Partings	1	½

The following two sections show the character of the bed in the district south of Lick Branch. The first section is cited in Stone's report and the location is only approximate; the second is from a pit on a spur southeast of the mouth of Lick Branch. Other measurements are given in the description of the Upper Banner in the Indian Creek drainage basin.

Sections of Upper Banner coal bed south of Lick Branch.

(Location 238, elevation 2,340 ?.)

	Ft.	in.
Shale, under sandstone..		8
Coal		8
Sandstone		1
Coal	1	7
Clay and coal.....	1	
Coal	1	5
Shale		3
Coal	1	3
Coal	4	11
Partings	1	4

(Location 239, elevation 2,310 B.)

Sandstone.	Ft.	in.
Coal		11
Sandstone		1
Coal	2	
Clay		6½
Coal		7
Shale		2½
Coal	1	6½
Coal	5	½
Partings		10

Splash Dam and higher coal beds.—There is coal at a number of horizons above the Upper Banner, but only one complete measurement of any of them was obtained in this area. It is probable that the Norton beds above the Upper Banner are less than 3 feet thick everywhere, and less than 2 feet nearly everywhere. The Glamorgan, Lyons, and Eagle coal beds, in the Wise formation, occupy small areas on Wampler Ridge and measurements of them have been given in the description of coal in the Lick Creek and upper McClure River drainage basins.

The Splash Dam bed was measured at one place, at the head of Hardin Branch (location 240, elevation 2,200 B.), where it is 23 inches thick and has a thin streak of sandstone near the middle. The sandstone streak is much like that in the upper part of the Upper Banner bed, but the stratigraphic relations and topographic position of this exposure indicate that it is the Splash Dam.

INDIAN CREEK.

Geologic outline.—The upper 150 feet of the Lee formation, all of the Norton formation and Gladeville sandstone, and the lower 250 feet of the Wise formation are exposed in the Indian Creek drainage basin. The upper part of the Lee appears only in the bottoms of parts of the principal valleys, and other Lee rocks are exposed in the small faulted area at the head of Lambert Fork. The Gladeville and Wise were found only in small outliers on the high ridges on the southwest and in a small area near the head of Lambert Fork. The stratigraphic succession is indicated by generalized sections on Plate IV, by local sections 11, 12, and 13, and by drill records (Pl. III).

The dominant structural feature of the central part of the area is the Sourwood Mountain anticline, an elongated dome with rather steep sides

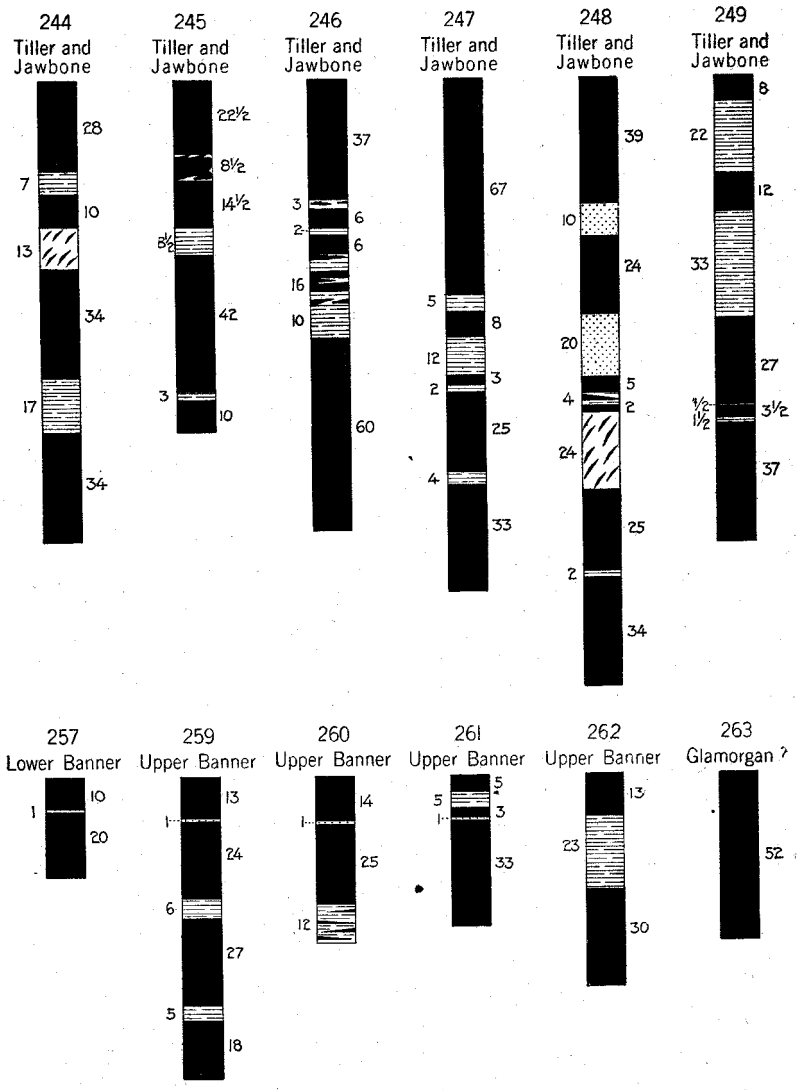


Fig. 13.—Sections of coal beds in the Indian Creek drainage basin.

and comparatively flat top. West of the axis of this anticline beds dip to the northwest and north at about 80 to 400 feet per mile; east of it the general dip is east and southeast at 150 to 550 feet per mile. At the head of Lambert Fork, however, the Lee and older formations have been thrust up over younger rocks along the fault shown on the geologic map and dip southeast at angles of 30° or more. Rocks of Norton age at the mouth of Indian Creek also dip steeply in places and have been buckled and sheared.

The Indian Creek drainage basin contains exceptionally thick coal deposits in parts of the Tiller, Jawbone, and Upper Banner beds, and important deposits at other horizons. (See figs. 3, 4, 5, and 13). In the southern and central parts of the area the Tiller and Jawbone are so close together that they could be mined as one bed containing 7 to 15 feet of coal and underlying a large area. The upper or Jawbone part of the combined beds contains several shale partings and is dirty in places, but even the lower or Tiller part alone is an attractive mining proposition. In the northern and northeastern parts of the area the Tiller and Jawbone are separated by 70 feet or less of shale and sandstone, both beds being thinner than in the districts where they are united. Where the beds are separated the Tiller is the cleanest and thickest, being especially good on part of Lambert Fork and under the ridges north and south of it.

The Upper Banner contains about 5½ feet of excellent coal on Long Ridge, near the head of Cane Creek, and its shale partings are not so thick as to be seriously detrimental. In most other districts the Upper Banner is separated into two parts by an increase in the thickness of one of its partings.

Coal less than 3 feet thick is common at a number of horizons and in many places. Coal beds that are locally 3 to 4 feet thick are the Garden Hole near Sandy Ridge, the Kennedy north of Indian Creek and Lambert Fork, and the Lower Banner near upper Cane Creek. A bed that is tentatively correlated with the Glamorgan is 52 inches thick in an opening at the head of Lambert Fork, but occupies only a small area.

Coal beds lower than the Tiller.—In addition to several thin and unimportant coal beds in the basal part of the Norton formation, there is a fairly persistent bed 30 to 60 feet below the top of the Lee formation. This bed is 28 inches thick in a hollow near the mouth of Lambert Fork (location 241, elevation 1,660 B.), and at least 30 inches thick half a mile north (location 242, elevation 1,530 B.).

Tiller and Jawbone coal beds.—The Tiller lies 800 to 880 feet below the Upper Banner horizon and outcrops low down in all the principal valleys.

Along Cane Creek and its tributaries and the upper part of Indian Creek it combines with the Jawbone coal to form a remarkable bed containing 5 to 15 feet of coal. The upper or Jawbone part of the combined beds contains several layers of shale and other impurities and could not be profitably mined in some localities. There are also layers of "rash", or crushed flaky coal, mixed with more or less shale. Some of the "rash" might be utilized for certain purposes, but most of it is simply waste that would give much trouble in mines. Along Lambert Fork and lower Indian Creek the two beds are too far apart to be mined as one, but the Tiller contains some thick coal along its outcrop south and east of the mouth of Lambert Fork.

The first of the following measurements is a slight modification of one cited by Stone as made in a small mine, now caved, near the forks of Cane Creek. North of this opening the coal separates into two or more thin beds. The second measurement was made at one of two openings a short distance west of the first.

Sections of Tiller and Jawbone coal beds about 1 mile southwest of Duty.

(Location 243, elevation 1,600 B.)

Shale, under sandstone.	Ft.	in.
Coal	2	10
Shale	1	7
Bone		5
Coal		7
Shale		3
Coal		5½
Shale and coal	3	1
Coal	2	
Shale	1	9
Coal	2	2½
Coal	8	1
Partings	7	1

(Location 244, elevation 1,565 B.)

Sandstone.	Ft.	in.
Coal	2	4
Shale		7
Coal		10
"Rash"	1	1
Coal	2	10
Shale	1	5
Coal	2	10
Coal	8	10
Partings	3	1

Partings are less detrimental to the value of the beds south of the openings just described. The following measurements were made at small strip pits,—the first at the level of Cane Creek and the second near the mouth of Middle Fork. Two openings on the southside of Cane Creek, near these strip pits, are also in 8 or 9 feet of coal with shale partings aggregating 10 to 20 inches:

Sections of Tiller and Jawbone coal beds near forks of Cane Creek.

(Location 245, elevation 1,599 S.)

	Ft.	in.
Shale	3	
Coal	1	10½
Coal, bony in part.		8½
Coal	1	2½
Shale		8½
Coal	3	6
Shale		3
Coal		10
Coal	8	1½
Partings		11½

(Location 246, elevation 1,760 B.)

Shale.	Ft.	in.
Coal	3	1
Bone		3
Coal		6
Shale		2
Coal		6
Bone, shale, and coal	1	4
Shale		10
Coal	5	
Coal	9	1
Partings	2	7

The coal is at its best on the upper parts of Middle and Left forks of Cane Creek, the following measurements, made at a strip pit less than a mile north of Kiser Gap, being typical:

Section of Tiller and Jawbone coal beds two and one-half miles south of Duty.

(Location 247, elevation 1,790 B.)

Sandstone.	Ft.	in.
Coal	5	7
Shale		5
Coal		8
Shale	1	
Coal		3
Shale		2
Coal	2	1
Shale		4
Coal	2	9
Coal	11	4
Partings	1	11

The coal is exceptionally thick along most of Cane Gap Creek, John Fork, and Patton Branch. The proportion of shale in the Jawbone member of the bed is greater near the mouths of those streams, however, and the two members are rather widely separated by shale and sandstone farther south on Indian Creek. The first of the following measurements was made near the head of John Fork, and the second opposite the mouth of that stream:

Sections of Tiller and Jawbone coal beds on John Fork of Indian Creek.

(Location 248, elevation 2,020 B.)

Sandstone.	Ft.	in.
Coal	3	3
Sandstone		10
Coal	2	
Sandstone	1	8
Coal		5
Shale and coal		4
Coal		2
"Rash"	2	
Coal	2	1
Shale		2
Coal	2	10
Coal	10	9
Partings	5	

(Location 249, elevation 1,820 B.)

	Ft.	in.
Shale	7	
Coal		8
Shale	1	10
Coal	1	
Shale	2	9
Coal	2	3
Shale		½
Coal		3½
Shale		1½
Coal	3	1
Coal	7	3½
Partings	4	9

The Tiller was found by Stone near the mouth of Puncheon Camp Branch of Lambert Fork (location 250, elevation 1,720), and was reported to be 57 inches thick, including an inch of shale and 3 inches of "rash" near the middle. Half a mile farther up Lambert Fork (location 251, elevation 1,690 S.) the same bed is 32 inches thick. Northwest of the mouth of Lambert Fork the bed is probably thinner.

No full measurement of the Jawbone bed was obtained on Lambert Fork or on lower Indian Creek except in the Indian Creek road near Sullivan Branch (location 252, elevation 1,462 S.), where the coal is 29 inches thick. Blooms and caved pits do not indicate that the Jawbone is very thick where separated from the Tiller.

Garden Hole and associated coal beds.—The Garden Hole coal bed lies about 190 feet above the Tiller and 650 feet below the Upper Banner coal horizon. In the northern part of the area it is in most places only 1 or 2 feet thick, but in the southern part, near Sandy Ridge, it commonly contains 3 to 4 feet of coal with thin shale partings in its middle. The bed has been thoroughly prospected, but most of the prospect pits are caved and are difficult to find because of the position of most of the outcrop on wooded slopes 200 to 400 feet above the principal streams. One pit near the head of Middle Fork of Cane Creek (location 253, elevation 1,955 B.), in the area where the bed is thickest, is reported to be in about 4 feet of coal with a very thin shale parting in the middle.

There are several coal beds between the Garden Hole and the Kennedy, but they are less than 2 feet thick nearly everywhere. One persistent bed is 30 to 50 feet above the Garden Hole and another about 150 feet above the same horizon. It may be the latter bed that is 24 inches thick in the road

near the mouth of Indian Creek (location 254, elevation 1,495 H. L.), but steep dips a short distance north make correlations uncertain. Coal 28 inches thick near the head of Cane Creek (location 255, elevation 1,920 B.) is 143 feet above the Garden Hole in a neighboring boring, and coal of the same thickness near Cane Gap (location 256, elevation 2,280 B.) is at the same stratigraphic horizon. This last measurement was made in a small mine, in which the roof is 8 inches of drab shale under sandstone.

Kennedy coal bed.—The Kennedy lies 300 to 350 feet below the Upper Banner bed and outcrops high in the hills in most of this area. In the southern part of the basin it is only 12 to 24 inches thick, a typical section being at an opening near Cane Creek, 1¾ miles southwest of Duty, where 21 inches of coal are overlain by drab sandy shale and a coarse sandstone forms a ledge a few feet below. On the divide north of Indian Creek and Lambert Fork the bed is reported to contain 12 to 48 inches of coal.

Lower Banner coal bed.—The Lower Banner lies about 100 feet below the upper Banner and outcrops only high on the ridges. West and south of the upper part of Cane Creek the thickness of the bed averages between 3 and 3½ feet; elsewhere the coal is thinner. Near the head of Sullivan Branch (location 257, elevation 2,190 B.) the bed is 31 inches thick, including an inch of shale 10 inches from the top. In a spring near the triangulation station at the head of Patton Branch (location 258, elevation 2,440 B.) the coal is 30 inches thick, but blooms elsewhere in this locality indicate a thinner bed at the Lower Banner horizon.

Upper Banner coal bed.—The Upper Banner is an important coal bed in part of the area and outcrops high on the ridges on its western and eastern sides. Under the divide west of the head of Cane Creek the Upper Banner contains an average thickness of 5½ feet of coal, with the characteristic sandstone parting in the upper part and two thicker shale partings in the lower part. On Sandy Ridge at the heads of the eastern tributaries of Indian Creek, the bed is in two parts with less than 3 feet of coal in each, except in a small area between the head of Puncheon Camp Branch and Lambert Fork. Very little is known about the condition of the Upper Banner northwest of the lower part of Cane Creek and west of lower Indian Creek, but the lack of exposures or openings showing thick coal indicates that the bed thins to the north.

The following two sections show the details of the Upper Banner in small mines near the head of Cane Creek. The first measurement was made near the triangulation station on Long Ridge, and the second, which evidently does not include the lower 3 or 4 feet of the bed, at Smith Gap.

Sections of Upper Banner coal bed near head of Cane Creek.

(Location 259, elevation 2,369 C. C. C.)

Sandstone.	Ft.	in.
Coal	1	1
Sandstone		1
Coal	2	
Shale		6
Coal	2	3
Shale		5
Coal	1	6
Coal	6	10
Partings	1	

(Location 260, elevation 2,405 B.)

Shale.	Ft.	in.
Coal	1	2
Sandstone		1
Coal	2	1
Shale and coal	1	
Coal	3	3
Parting		1

The following two measurements were made at openings in which the thickness of coal in one bench is greater than in most places in the district in which they are located. The first section is on a small western tributary of Lambert Fork, a short distance south of the mouth of Cowpen (Copperhead) Branch; the second, which may not include all of the coal, is at the head of Cowpen Branch:

Sections of Upper Banner bed near upper part of Lambert Fork.

(Location 261, elevation 2,339 C. C. C.)

Sandstone.	Ft.	in.
Coal		5
Shale		5
Coal		3
Sandstone		1
Coal	2	9
Sandstone.		
Coal	3	5
Partings		6

(Location 262, elevation 2,400 B.)

Sandstone.	Ft.	in.
Coal	1	1
Shale	1	11
Coal	2	6
Coal	3	7
Parting	1	11

Splash Dam and higher coal beds.—What may be the Glamorgan bed consists of 52 inches of coal under 3 feet of shale in an opening near the wagon road near the head of Lambert Fork (location 263, elevation 2,358 S.). The outcrop of this bed is very close to the fault which bounds the coal field on the south, so that the area of available coal is small. There is undoubtedly some coal at several other horizons above the Upper Banner, especially in the Splash Dam bed, but no complete measurements were obtained and no thick blooms were seen.

RUSSELL FORK AND SMALL TRIBUTARIES NORTHWEST OF INDIAN CREEK.

Geologic outline.—The area to be considered under this heading includes only the valley of Russell Fork below Indian Creek and the drainage basins of small tributaries not described elsewhere, and is, therefore, a long, narrow strip extending only a short distance back from the river. Rocks exposed include those from near the Garden Hole coal horizon, and perhaps lower, to beds 425 feet above the base of the Wise formation. The strata mapped as undifferentiated Pennsylvanian include chiefly rocks belonging to the part of the Norton formation that is above the Garden Hole horizon, with a few Wise and Gladeville beds in the district north of McClure River. Strata mapped as Gladeville and Wise occur only near the tops of a few ridges. The stratigraphic succession is shown by the generalized columnar sections for the north third of the Clintwood quadrangle and the middle third of the Bucu quadrangle (Pl. IV), by logs of borings in the valley of Russell Fork (Pls. II and III), and by local sections 10, 16, 17, and 20.

The structure of the area is complicated. Beds not mapped as undifferentiated dip, in general, to the northwest and north at very low angles as far north as the axis of the Middlesboro syncline near Pound River. North of the axis they dip to the southeast. Beds mapped as undifferentiated northwest of Sand Lick and the mouth of Lick Creek dip chiefly northeast at high angles, though there are places where there are dips in other directions at all angles up to 90 degrees. The apparent structure in places is that of a monocline dipping steeply to the northeast, but this feature is really subordinate to shearing and buckling along one or more faults parallel to the long axis of the area. This is explained more fully on page 41.

The structure of the beds mapped as undifferentiated southeast of Pawpaw Creek is even more obscure. The beds are nearly level in some places, but in others dip irregularly in different directions. Strata on the southwest have probably been moved past those on the northeast along two vertical or very steep fault planes and have been more or less buckled and folded during the process. One of these faults extends from Indian through a point a short distance north of Abners Gap, and the other from near Indian to a point northwest of Murphy. The irregular dips on Russell Fork between Fox and Pawpaw creeks were probably caused by buckling without faulting.

The area has only a few thick coal deposits. (See figs. 3 and 14.) Coal beds included among the rocks mapped as undifferentiated Pennsyl-

vanian are nearly all thin and are commonly crushed and fractured so that they could not be mined with profit. Beds below the Kennedy horizons are exposed in only a small area and are less than 2 feet thick. The Kennedy is thin in most places, though locally 3 or 4 feet thick. The Lower and Upper Banner are both less than 2 feet thick, so far as now known, and are lacking in places. The Splash Dam bed is thin in most places, but contains about 3½ feet of coal north of McClure River and Russell Prater Creek. The Hagy is persistent in the northwestern part of the area, but is not more than 2 feet thick. The Glamorgan, Lyons, and Blair beds con-

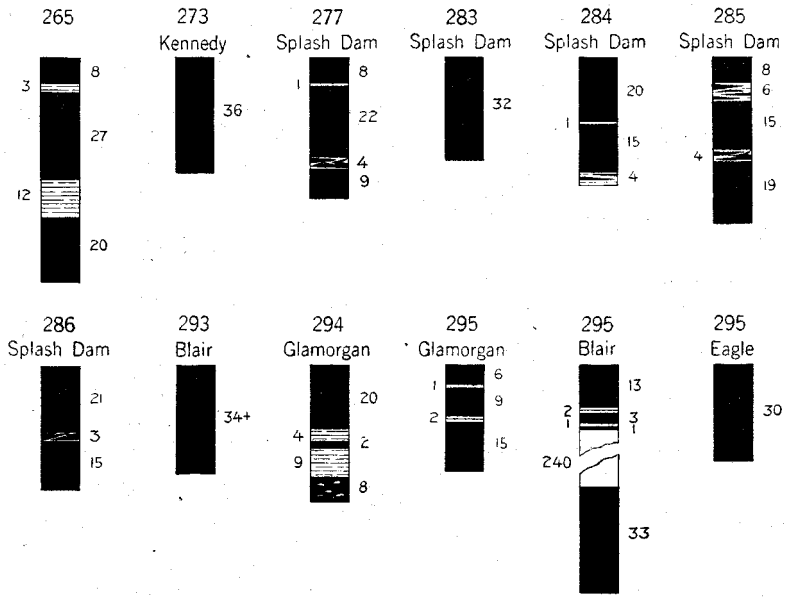


Fig. 14.—Sections of coal beds on and near Russell Fork northwest of Indian Creek.

tain 2 or 3 feet of coal in the small areas in which they have escaped erosion, but commonly include several shale partings. The Eagle bed is 2 to 5 feet thick, but no coal was found at the Clintwood or higher horizons.

Outcrops not correlated.—Thin and moderately thick coal beds were seen in a number of places within the areas mapped as undifferentiated Pennsylvanian. The occurrence in these areas of irregular dips, indicating buckling and possible faulting, makes it unsafe to assign these exposures to any definite bed, though the approximate stratigraphic position of many may be ascertained.

A coal bed that is at least 16 inches thick is exposed in the road southwest of the mouth of Pound River (location 264, elevation 1,669 S.) and may be the Glamorgan. What may be the Lyons bed is 23 inches thick a short distance up the road (elevation 1,705 B.), and a 2-foot bed of doubtful stratigraphic position was seen northeast of location 264 (elevation 1,565 B.). Steep dips in different directions may be seen along the road on both sides of these outcrops, involving several coal blooms. The following measurement of a bed that resembles the Splash Dam was made in a western tributary of Russell Fork, north of Hill School. The bed is nearly level where measured, but strata in other parts of the hollow dip more or less steeply, chiefly to the east or northeast.

Section of coal bed one and one-fourth miles south of mouth of Pound River.

(Location 265, elevation 1,500 B.)

	Ft.	in.
Coal		8
Shale		3
Coal	2	3
Shale	1	
Coal	1	8
Shale, compact	1	6
Coal	4	7
Partings	1	3

Stone states that coal about 4 feet thick was reported at a caved pit just south of Sand Lick, by the wagon road (location 266, elevation 1,355 S.). Strata associated with this coal bed, which is probably the Kennedy, dip at an angle of about 7° in a neighboring exposure. Farther down Russell Fork, at the mouth of Duty Branch (location 267, elevation 1,284 H. L), there are 18 to 24 inches of slightly impure and crushed coal. There appears to be a fault at the side of this opening and beds dip steeply northeast for a few rods up Duty Branch. A few yards behind the house at the mouth of Duty Branch coal 16 inches thick dips 23° to the N. 65° E.

There are only a few uncorrelated coal exposures, probably of beds between the Tiller and Kennedy horizons, in the areas mapped as undifferentiated Pennsylvanian along Russell Fork between Pawpaw and Indian creeks. One of these is at the sharp bend in Russell Fork south of Murphy (location 268, elevation 1,456 S.), where there are 18 inches of coal with a sandstone roof. There are 16 inches of coal, dipping southeast, in the road on the north side of the river at Indian (location 269, elevation 1,440 B.). A coal bed 23 inches thick outcrops beside the same road just south of Murphy (location 270, elevation 1,403 H. L.).

Garden Hole and associated coal beds.—The Garden Hole bed is below stream levels in most of this area, but is exposed in the lower part of Abners Branch, which heads near Abners Gap. It has been opened at a few places along the logging tramway near Bee (location 271, elevation 1,483 H. L.), where it is 3 to 26 inches thick, has a roof of 4 feet of blue to drab shale under sandstone, and dips slightly down the branch.

As shown by blooms and a few caved pits, there are at least 2 thin coal beds between the Garden Hole and Kennedy horizons. The only complete measurement obtained was at Abners Gap (location 272, elevation 1,550 B.), where a 22-inch coal bed about 150 feet below the Kennedy horizon is overlain by 2 feet of blue to drab shale under sandstone.

Kennedy coal bed.—The Kennedy horizon is about 300 feet below that of the Upper Banner in the area in which it is exposed. It is irregular in thickness and probably thin in most places, though it is locally as much as 4 feet thick. A short distance west of Murphy (location 273, elevation 1,589 S.) the coal is 3 feet thick and has 4 feet of irregularly bedded shale in the roof. The coal is at least 30 inches thick near the mouth of Laurel Branch, in a pit beside the road (location 274, elevation 1,336 S.), where it lies on a very coarse sandstone that outcrops conspicuously along this part of Russell Fork. The bed is reported to be 42 inches thick in a pit on the west side of the river a mile southeast of Sand Lick, and to be slightly thicker at Sand Lick, as previously mentioned.

Lower and Upper Banner coal beds.—Both the Lower and Upper Banner coal beds are thin in this area and may be lacking in a large part of it. The Lower Banner was measured only in a pit near stream level in the upper part of Laurel Branch (location 275, elevation 1,547 S.), where it is 19 inches thick. The Upper Banner was seen only by a path on the spur north of Lazarus Branch (location 276, elevation 1,580 B.), where what is probably only one bench of a split bed is about 15 inches thick.

Splash Dam coal bed.—The Splash Dam coal lies 40 to 100 feet above the Upper Banner horizon and only a few feet above a massive sandstone that makes conspicuous ledges and cliffs. It is probably thin southeast of the mouth of Fryingpan Creek, but northwest of that place there are many openings showing 1½ to 4 feet of coal. The bed is at its best north of Russell Prater Creek, where the average thickness of coal is about 3½ feet. Where the coal is thick there are commonly a few very thin shale partings and a characteristic layer of very hard, slightly bony coal.

The Splash Dam is exposed at railroad level 1 mile north of McClure River (location 277, elevation 1,267 S.) and was utilized in railroad con-

struction work. In small drifts the bed is 44 inches thick, including an inch of shale 8 inches from the top and a slightly bony layer in the lower part. The floor is shale that is carbonaceous at the top and the roof is 20 feet of blue shale that grades into an overlying sandstone.

The Splash Dam is 18 to 24 inches thick at four openings in different western tributaries of Russell Fork between McClure River and Lick Creek. The pit farthest north (location 278, elevation 1,670 B.) contains 19 inches of coal, including at the top 5 inches of impure cannel over an inch of bony coal.

In the part of the area that lies east of Russell Fork, the coal is at least 18 inches thick on a tributary of Tilda Anderson Branch (location 279, elevation 1,645 B.); 21 inches thick east of Sand Lick (location 280, elevation 1,640 B.), 18 inches half a mile north of the village (location 281, elevation 1,655 B.), and 19 inches opposite the mouth of Lazarus Branch (location 282, elevation 1,525 B.). At the pit last mentioned a thin layer of cannel coal caps the bed as at location 278, and the roof is a blocky black shale at all pits near Sand Lick.

The Splash Dam coal is 32 inches thick in a pit opposite the mouth of McClure River (location 283, elevation 1,400 B.), and about 44 inches in another a short distance north. At a small mine half a mile north of location 283 (location 284, elevation 1,350 B.), the bed is 40 inches thick, including an inch of coaly shale in the middle and 4 inches of worthless coal and shale at the base. The bed has about the same thickness for nearly 2 miles north of the mouth of Russell Prater Creek and then disappears beneath the river because of a gentle northward dip. Its horizon is plainly marked by a massive 60-foot sandstone the top of which is 5 or 10 feet below the coal. At the tunnel 2¼ miles from the mouth of the Russell Prater, the coal again appears at river level and has been mined for railroad construction purposes. The dip at the mouth of the drift is 18° NE. and a measurement of the bed is as follows:

Section of Splash Dam coal bed at tunnel south of Barts Lick Creek.

(Location 285, elevation 1,210 B.)

	Ft.	in.
Sandstone, massive at top, thin-bedded at base	20	
Shale	1	
Coal		8
Coal in some places, "rash" and shale in others		6
Coal	1	3
Bone		4
Coal	1	7
Coal	4	
Parting		4

The coal is below river level from the north end of the tunnel to the splash dam just below the mouth of Pound River, where a northward rise causes it to reappear. Measurements in a pit at railroad level 50 feet north of the dam and at a small mine a short distance farther north and 90 feet higher (location 286, elevation 1,300 C. C. C.) show 37 to 39 inches of coal, including a 3-inch, slightly bony layer 21 inches below the top. The roof is 6 feet of sandy shale under sandstone, and the thick massive sandstone bottom-rock is only 2 feet below the coal.

Hagy coal bed.—The Hagy coal bed is commonly 100 feet above the Splash Dam and is 2 feet or less thick. It lies a few feet above a massive sandstone that makes more or less conspicuous ledges and commonly has a blue shale roof that is overlain by a thin bed of sandstone. Four measurements were made east of Russell Fork in Dickenson County, but only thin blooms were found elsewhere.

The Hagy is 24 inches thick at the head of the right fork of Tilda Anderson Branch (location 287, elevation 1,700 B.) and 19 inches on a left fork (location 288, elevation 1,740 B.). The coal is 18 inches thick at the end of the tunnel south of Barts Lick Creek (location 289, elevation 1,260 B.), and is exposed in railroad cuts from the tunnel to a few rods beyond the creek (location 290, elevation 1,245 B.), where it is 23 inches thick.

Coal beds in Wise formation.—There are four coal beds in the lower 200 feet of the Wise formation: The Glamorgan near the base, the Lyons 20 to 40 feet higher, the Blair about 100 feet above the Glamorgan, and the Eagle 50 to 90 feet above the Blair. These beds contain 2 or 3 feet of coal in most places, but underlie only small areas near the tops of a few ridges and will not be described separately.

The Lyons bed is 23 inches thick 1½ miles southwest of the mouth of Pound River (location 291, elevation 1,880 B.), and the Glamorgan is about the same thickness at the neighboring road corner, though split into two parts by shale.

In the ridge road 1½ miles northeast of Sand Lick (location 292, elevation 1,951 S.) the Glamorgan is at least 34 inches thick, as is also the Blair at the head of the right fork of Tilda Anderson Branch (location 293, elevation 2,040 B.).

The first of the following measurements of the Glamorgan was made at a small mine above the tunnel south of Barts Lick Creek, and the second in a small hollow a few rods north of the mouth of the creek.

Sections of Glamorgan coal bed on Russell Fork near Barts Lick Creek.

Location 294, elevation 1,435 B.)

	Ft.	in.
Sandstone	20	
Shale	1	
Coal	1	8
Clay		4
Coal		2
Clay		9
Coal, impure		8
Coal	2	6
Partings	1	1

(Location 295, elevation 1,420 B.)

	Ft.	in.
Sandstone.		
Slate, thin.		
Coal		6
"Rash"		1
Coal		9
Shale		2
Coal	1	3
Coal	2	6
Partings		3

In the hollow in which the last section was measured several higher beds are exposed. The Lyons coal (elevation 1,455 B.) is 20 inches thick, with two coal streaks in the thin shale roof. The lower bench of the Blair is 33 inches thick (elevation 1,550 B.), and the upper bench is about 20 feet higher and contains only 13 inches of coal that could be utilized. The Eagle bed (elevation 1,630 B.) is 30 inches thick. Because of rather steep dips and an error in the topographic map that makes locations uncertain, the elevations of these beds do not furnish a means of calculating the exact intervals between them.

RUSSELL FORK AND ALL TRIBUTARIES EAST OF INDIAN CREEK.

Geologic outline.—The part of the Russell Fork drainage basin that lies east of Indian and the mouth of Indian Creek includes exposures of nearly all the Norton formation, the Gladeville sandstone, and the lower 300 feet of the Wise formation. The Pennsylvanian rocks in a narrow strip extending from northwest to southeast near Russell Fork are not differentiated on the accompanying geologic map, but probably include only the Norton and Gladeville, the latter only at the southeast end of the area. Elsewhere the Gladeville has been removed by erosion except on two small knobs on Fletcher Ridge and in a small area near Big A Mountain. The Wise formation remains only near Big A. The stratigraphy of the greater part of the Pennsylvanian series is shown graphically by the columnar section of the middle third of the Bucu quadrangle (Pl. IV). Exposed rocks are also shown in local sections 13, 14, and 15.

Formations in which there are commercially important coal beds are exposed only northwest of a great thrust fault, southeast of which the surface strata are all pre-Pennsylvanian and contain no workable coal.

There is also a fault, probably nearly vertical, from the north end of Big A Mountain to Indian and beyond, and strata for a short distance on each side of it dip so irregularly in places that no attempt has been made to map coal beds or to indicate the exact structure. Beds south of this fault have been shoved to the northwest past those north of it and have been folded into an arch here named the Sourwood Mountain anticline. Dips east of this anticline are chiefly to the east and those west of it to the west. North

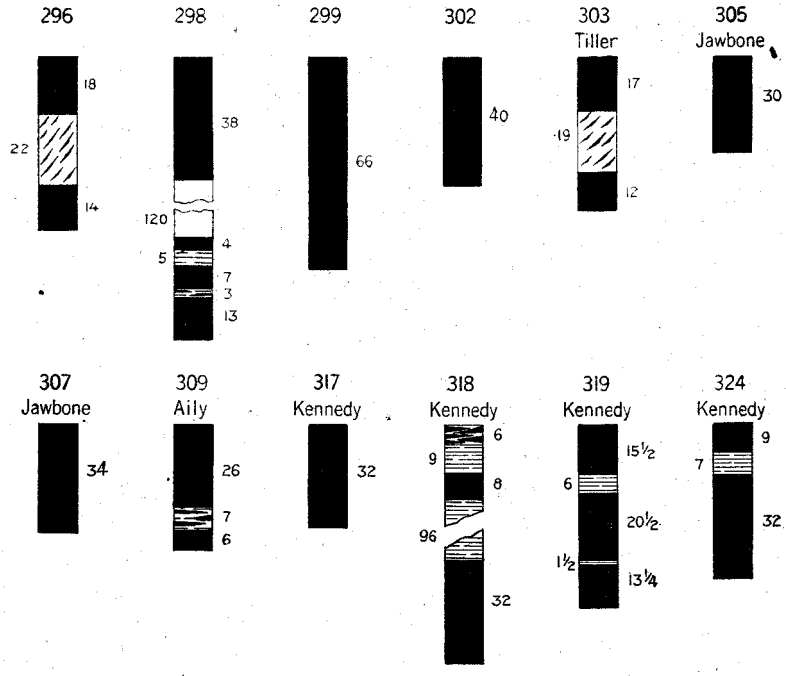


Fig. 15.—Sections of coal beds in the Russell Fork drainage basin east of Indian Creek.

of Russell Fork there is a low, broad arch at the west end of the Dry Fork anticline. Strata are almost horizontal near this arch and dip very gently to the northwest on one side of it and to the south and southeast on the other.

The thickest coal beds in the area are the Tiller, Jawbone, and Kennedy. (See figs. 4 and 15.) Other coal beds are less than 3 feet thick nearly everywhere and are very thin or lacking in some districts. The Tiller contains 2 to 4 feet of coal near Council, but is split by a thick shale and

"rash" parting. The Jawbone coal is 2 to 6 feet thick and could be profitably mined in some localities. The Kennedy is 18 to 50 inches thick and is the bed that is being mined at Drill, on Lewis Creek. There are only a few openings in part of the area, and the reader is referred to the descriptions of pits near the heads of Garden and Prater creeks for additional information concerning beds underlying Winding and Fletcher ridges.

Outcrops not correlated.—The rocks along and near Russell Fork that are mapped as undifferentiated Pennsylvanian include several coal beds and there are many prospect pits in coal 1 to 5 feet thick. Most of these pits are on the slopes facing Russell Fork on its south side and are chiefly in the Tiller and Jawbone beds. The presence of one or more faults and of steep and irregular dips in parts of this district makes it inadvisable to attempt to make exact correlations.

Coal in a small mine southeast of Davenport (location 296, elevation 1,690 B.) is directly overlain with a thick bed of coarse sandstone containing a few pebbles and has the characteristics of the Tiller bed. There are 22 inches of "rash" in the middle, with 18 inches of coal above it and 14 inches below. Another opening in the same neighborhood (location 297, elevation 1,575 B.) is in 30 inches of coal under a sandstone cap like that just mentioned. There are several exposures and pits near the mouth of Carroll Presley Branch, one of which shows coal 30 inches thick at an elevation of 1,730 feet, and another 22 inches of coal at an elevation of 1,600 feet. The following measurements were made at a pit a short distance west of the two just mentioned:

Section of coal beds on Carroll Presley Branch.

(Location 298, elevation 1,750 B.)

	Ft.	in.
Shale.		
Coal	3	2
Concealed	10	
Coal		4
Clay shale		5
Coal		7
Shale and coal		3
Coal	1	1

A clean bed of coal 66 inches thick was seen half a mile southwest of Council (location 299, elevation 2,085 B.). A few feet of shale that forms the roof is overlain by 50 feet of sandstone. Coal at least 28 inches thick lies under a thinner sandstone bed half a mile south of Council (location 300, elevation 1,900 B.).

Only a few prospect pits in what appeared to be thin beds were found among the strata mapped as undifferentiated Pennsylvanian on the north side of Russell Fork. One bed is about 2 feet thick near Indian (location 301, elevation 1,450 B.).

Coal beds lower than the Tiller.—The only correlated coal exposure found below the Tiller horizon is near the level of Russell Fork half a mile southeast of the mouth of Hurricane Creek (location 302, elevation 1,503 S.), where there is a clean bed 40 inches thick and about 170 feet below the Tiller. Only sandstone shows at the coal horizon a short distance from the prospect pit.

Tiller coal bed.—The Tiller lies about 830 feet below the Splash Dam horizon and a few feet below a coarse, siliceous sandstone containing quartz pebbles. The coal is below stream levels except near Russell Fork and is 2 to 4 feet thick. A thick parting of impure coal and shale ("rash") in the middle of the bed greatly impairs its commercial value.

The Tiller has been opened at many places near Council and is well exposed in a mine a few feet above the level of Russell Fork less than half a mile southeast of the village (location 303, elevation 1,686 S.). In this district the bed is in two benches separated by 19 to 36 inches of shale and a mixture of crushed coal and shale. The upper bench of coal is 12 to 18 inches thick and the lower bench is 9 to 22 inches thick. In one pit on Tiller Branch at Council the shale and impure coal parting is 5 feet thick.

Jawbone coal bed.—The Jawbone coal is 30 to 90 feet above the Tiller and only a few feet above the conglomeratic sandstone cap-rock of the latter bed. The Jawbone coal is clean in most places and is 2 to about 6 feet thick. The roof of the coal is a blue shale overlain by medium-grained sandstone.

The Jawbone is at least 22 inches thick by the wagon road up the right fork of Russell Fork (location 304, elevation 1,740 B.), and is 30 inches thick on Tiller Branch, north of Council (location 305, elevation 1,720 B.), where it is 60 feet above a pit in the Tiller bed. The coal is reported to be more than 3 feet thick at an abandoned mine on Dry Pen Branch (location 306, elevation 1,660 B.). A small mine on Russell Fork west of Dry Pen Branch (location 307, elevation 1,680 B.) is in a bed that is either the Jawbone or about 35 feet higher and is 34 inches thick. A partially caved pit in the Jawbone in a small hollow nearly a mile east of Davenport (location 308, elevation 1,645 B.) is in coal 5 or 6 feet thick. Shale occupies the position of the lower part of this coal near Davenport.

Garden Hole and associated coal beds.—The Garden Hole bed is 600 to 675 feet below the Splash Dam horizon. There are several coal beds between it and the Kennedy, one being 50 to 100 feet above it and another, the Aily, about 100 feet higher. Each of these coals is only a few inches to about 36 inches thick, but, because they are exposed low down in the principal valleys, they are used to supply local needs in a few places.

The only correlated exposure of these beds south of Russell Fork is at a pit in the Aily on McFarlan Branch (location 309, elevation 1,985 B.). The coal is 39 inches thick, including 7 inches of impure coal and shale near the bottom, and lies under 80 feet of coarse sandstone that forms the bottom-rock of the Kennedy bed.

The Garden Hole bed is about 30 inches thick in two pits near the mouth of Sycamore Fork and only 15 inches a short distance north, 20 feet above the railroad track up Grissen Creek (location 310, elevation 1,850 B.). A mile farther up Grissen Creek (location 311, elevation 2,070 B.) a coal bed 24 inches thick and 100 feet above the Garden Hole horizon is 65 feet above the stream. The same bed is 19 to 27 inches thick on Harris Fork (location 312, elevation 1,995 B.), and has a roof of 2 feet of clay shale under sandstone.

The Garden Hole and associated beds are exposed low down in the valleys of both forks of Hurricane Creek. The Garden Hole bed has been opened beside the road up Rockhouse Branch of the right fork (location 313, elevation 1,723 S.), where it is 22 to 25 inches thick and lies under 9 feet of blue shale that grades upward into sandstone. The coal is reported to be about the same thickness in pits farther north on Hurricane Creek, but only 16 inches of what may not be a complete exposure shows in the road near the mouth of this fork (location 314, elevation 1,601 S.). Half a mile west (location 315, elevation 1,530 B.), the coal is 19 inches thick and underlies 7 feet of blue shale. The Garden Hole is reported to be slightly thicker in pits farther north. No complete measurements of the coal beds between the Garden Hole and Kennedy horizons were obtained in the Hurricane Creek drainage basin, but the Aily was reported 2 to 3 feet thick at a few caved pits.

Kennedy coal bed.—The Kennedy is 300 to 380 feet below the Splash Dam coal horizon and its outcrop, even on wooded slopes, may be easily found because of its position a few feet above a coarse-grained, cliff-making sandstone and under nearly 200 feet of shale and rather fine-grained sandstone that make long gentle slopes. The bed is about 18 to 50 inches thick, the average being about 2 feet in the Hurricane drainage basin and nearly 3 feet elsewhere.

The Kennedy makes a conspicuous bloom in the wagon road at the head of Russell Fork, and 25 inches of coal is exposed near it and 25 feet higher stratigraphically (location 316, elevation 2,215 B.). The Kennedy is clean and 32 inches thick at the head of Grissen Creek, and shows plainly in a railroad cut (location 317, elevation 2,290 B.), the roof being a few feet of sandy shale under thin-bedded sandstone and the floor of sandstone. The first of the following measurements was made near the head of Harris Fork and the second in a pit beside the road up Tiller Branch, half a mile northeast of Council.

Sections of Kennedy coal bed on Harris Fork and Tiller Branch.

(Location 318, elevation 2,115 B.)

	Ft.	in.
Shale, blue	10	
Coal, dirty		6
Shale		9
Coal		8
Shale	8	
Coal	2	8
Coal	3	10
Partings	8	9

(Location 319, elevation 2,142 S.)

	Ft.	in.
Shale	4	
Coal	1	3½
Clay		6
Coal	1	8½
Clay		1½
Coal	1	1¼
Coal	4	1¼
Partings		7½

The coal is about 2 feet thick and overlain by 5 feet of sandy shale on the east side of the principal fork of Hurricane Creek (location 320, elevation 1,915 B.), and is 25 inches thick in two pits near the head of the same fork (location 321, elevation 1,880 B., and location 322, elevation 1,990 B.). Less than half a mile from the pit last mentioned (location 323, elevation 1,960 B.) the coal is in two benches separated by 56 inches of shale, the lower bench being 18 inches thick and the upper 8 inches. Near the head of the left fork of Hurricane Creek (location 324, elevation 1,815 B.), where the bed has a sandy shale roof and a sandstone floor, an upper bench of coal 9 inches thick and a lower bench 32 inches thick are separated by 7 inches of carbonaceous shale. On a tributary 2½ miles southwest (location 325, elevation 1,785 B.) the coal is only 24 inches thick.

Lower and Upper Banner coal beds.—The Lower Banner horizon is 110 to 200 feet above that of the Splash Dam. The coal is 2 to 3 feet thick near Grissen Creek and other streams at the head of Russell Fork, but is probably thinner elsewhere in this area. The only complete measurement obtained was in a railroad cut near the head of Grissen Creek (location 326, elevation 2,470 B.), where the coal is 28 inches thick and is overlain by shale and underlain by at least a foot of clay resting on sandstone. The Upper

Banner coal bed lies about half way between the Lower Banner and the Splash Dam horizons and appears to be very thin in all or most of the area.

Splash Dam and higher coal beds.—The Splash Dam coal outcrops well up on the principal ridges and is not well exposed in many places. It lies a few feet above a massive sandstone that forms the cap-rock of the Upper Banner coal bed and contains many pebbles on the ridge northeast of Indian, as well as a few in some other localities. There is a large proportion of sandstone between the coal and the top of the Norton formation, most of it being coarse, friable, and brownish.

At the three places measured the coal is 22 to about 36 inches thick and it is not likely to be much thicker elsewhere. In a pit at the north end of Big A mountain (location 327, elevation 2,610 B.) the coal is 30 or 36 inches thick. At least 3 feet of coal bloom shows in the road on Fletcher Ridge, at the head of Hurricane Creek (location 328, elevation 2,395 B.), with about 2 feet more 15 feet higher and a thinner bed 25 feet lower. Near the head of New Camp Branch of the left fork of Hurricane Creek (location 329, elevation 2,065 B.) the bed is only 23 inches thick, including an inch of shale 5 inches from the bottom.

There are several coal beds above the Splash Dam in this area, but none was measured except a 14-inch bed that lies 60 feet below the Gladeville sandstone on the high knob on Fletcher Ridge. The Hagy bed, which is 100 feet above the Splash Dam, may be 2 or 3 feet thick in the Hurricane Creek drainage basin, and there may be several moderately thick coal beds in the small area in which the Wise formation is exposed near Big A Mountain.

LITTLE FOX, FOX, PAWPAW, AND LITTLE PAWPAW CREEKS.

Geologic outline.—The exposed beds of this area embrace those from about 100 feet below the Kennedy coal horizon to those 350 feet above the base of the Wise formation. The stratigraphic succession is much the same as that shown by the average intervals in the graphic columnar section for the north third of the Bucu quadrangle (Pl. IV). Details are shown in local sections 16, 17, and 25. Rocks mapped as undifferentiated Pennsylvanian at the mouths of the Pawpaw creeks are of Norton age, but dip so irregularly in places that no attempt has been made to show the exact position of coal beds. Outside this area of irregular dips, the structure is simple and dips are to the northwest nearly everywhere.

Very few prospect pits have been opened in this area and little is known about its coal resources. All coal exposures found in the Norton formation are less than 30 inches thick, but pits in neighboring areas indicate that the Hagy bed may be 3 or 4 feet thick near the heads of Fox and Pawpaw creeks. The coal beds in the lower 200 feet of the Wise formation are fairly thick, but underlie only small areas near the ridge tops, and all except the Eagle contain several shale partings. The Glamorgan and Blair beds contain coal layers aggregating 2 to 3 feet thick and the Eagle bed is 3 to possibly 5 or 6 feet thick. (See fig. 5.)

Kennedy coal bed.—The Kennedy is 325 to 370 feet below the Splash Dam horizon and outcrops only near the bottoms of the principal valleys. Although the coal is only about 2 feet thick, it is mined in a number of pits for family use. The bed is commonly overlaid and underlain by shale, and there is coarse-grained sandstone 5 to 15 feet below it.

The Kennedy is 23 inches thick in a pit on the upper part of Little Fox Creek (location 330, elevation 1,630 B.) and 25 inches on the lower part (location 331, elevation 1,480 B.). It is 2 feet thick in two small mines near the mouth of Fox Creek (locations 332 and 333, elevation 1,420 B.). The coal is 28 inches thick a little farther up the creek (location 334, elevation 1,433 S.), but the top 6 inches are slightly impure and slickensided. A pit on Pawpaw Creek (location 335, elevation 1,390 B.) is in coal only 22 inches thick.

Coal beds above the Kennedy.—So few openings were found in beds higher than the Kennedy that little can be said as to their general characteristics. It seems very probable, however, that all beds in the Norton formation contain coal less than 2 feet thick except in small areas. The following generalizations can be made from measurements made in neighboring parts of the Russell Prater and Prater Creek drainage basins. The Hagy coal, which is about 100 feet above the Splash Dam horizon, may be 3 or 4 feet thick near the heads of Pawpaw and Fox creeks. The Eagle bed, which is about 160 feet above the base of the Wise formation and directly under a thick sandstone, is 3 to 6 feet thick at the head of Pawpaw Creek. The Blair coal, 50 feet below the Eagle, is probably 2 or 3 feet thick.

Traces of the Lower and Upper Banner coal beds were found only on Pawpaw and Little Pawpaw creeks, and the only complete measurement was of the Upper Banner on the former stream (location 336, elevation 1,660 B.), where it is 25 inches thick, including 5 inches of clay, and lies 80 feet below the Splash Dam horizon. The Splash Dam bed contains 30 inches of coal on the upper part of Fox Creek (location 337, elevation 1,800 B.),

split in the middle by shale 10 inches thick. The Hagy bed is reported to be 2 feet thick at the head of Little Pawpaw Creek (location 338, elevation 1,695 B.), and may be slightly thicker. The Blair bed is 30 inches thick near the head of Little Pawpaw Creek (location 339, elevation 2,080 B.). The Eagle has the following section on the ridge south of Pawpaw Creek:

Section of Eagle coal bed near head of Pawpaw Creek.

(Location 340, elevation 2,190 B.)

	Ft.	in.
Clay, under sandstone	1	2
Coal		11
Shale		3
Coal	1	4
Bone		1½
Coal	1	4½
Coal	3	7½
Partings		4½

RUSSELL PRATER AND BARTS LICK CREEKS.

Geologic outline.—Beds exposed in the drainage basins of Russell Prater and Barts Lick creeks include those from 140 feet below the Splash Dam coal horizon to 500 feet above the base of the Wise formation. The stratigraphy is shown by the generalized columnar sections for the north thirds of the Clintwood and the Bucu quadrangles (Pl. IV), by logs of borings in the northeast corner of the Clintwood quadrangle (Pl. II), and by local sections 18, 19, 20, and 24. Dips are low and their direction is governed chiefly by the Middlesboro syncline, the axis of which extends from southwest to northeast in the Barts Lick Creek drainage basin. In the small area north of this axis beds dip southeast, and elsewhere to the northwest or west. A short but well-defined syncline, whose axis corresponds closely to the position of War Fork of Russell Prater Creek, causes southwesterly dips in a small area, and there are a few other minor structural irregularities.

The area contains some coal deposits that afford possibilities of profitable extraction in the near future. (See figs. 5 and 16.) The Upper Banner bed, which is thick in many localities farther south and southwest, is only a few inches thick in this part of the field. The Splash Dam bed contains about 3 feet of coal along the lower part of Russell Prater Creek, but splits to the east. The Hagy bed is about 2 feet thick along Barts Lick Creek and the lower part of Russell Prater Creek, and thickens to the east, reach-

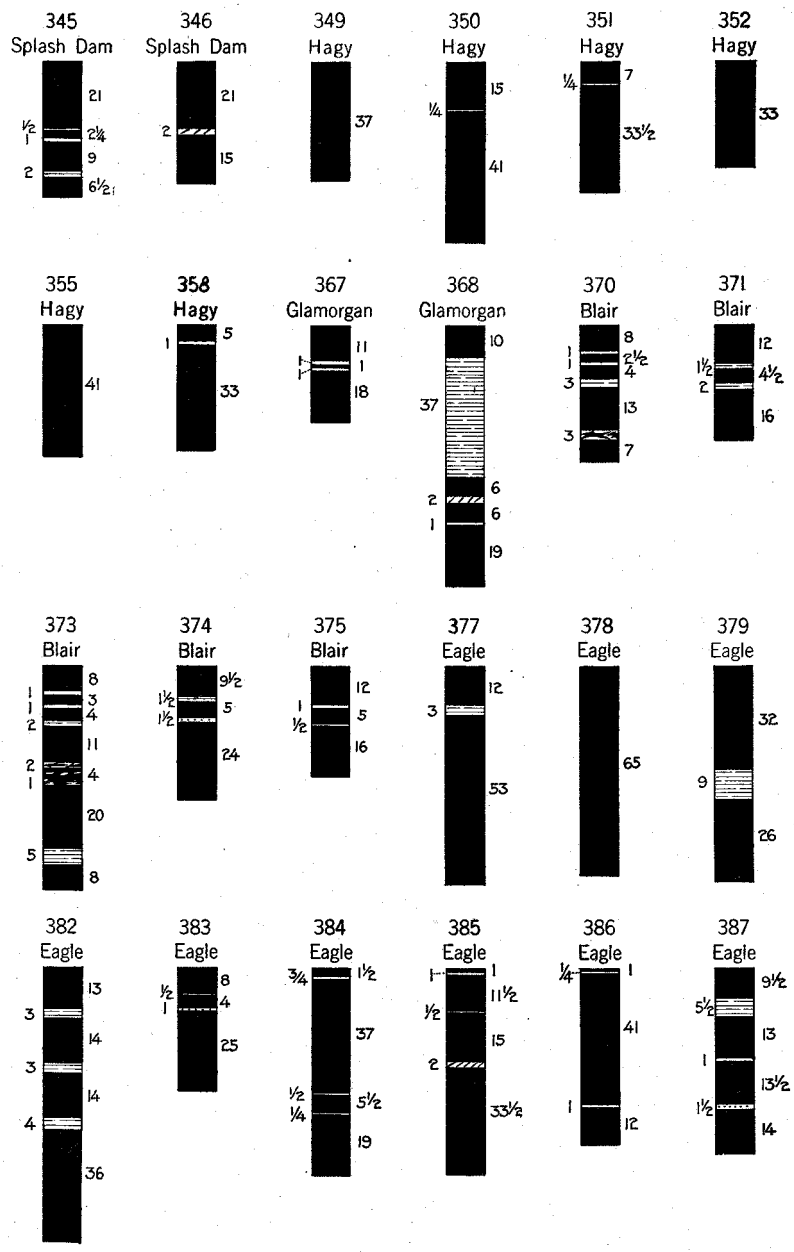


Fig. 16.—Sections of coal beds in the drainage basins of Russell Prater and Barts Lick creeks.

ing a maximum of nearly 5 feet in an opening on War Fork. The Glamorgan, Lyons, and Blair beds are thin in many places and contain several layers of shale. Locally, however, the layers of coal are as much as 3½ feet in aggregate thickness in the Glamorgan bed and 5½ feet in the Blair bed.

The Eagle bed would be by far the most valuable bed in the area if it were not for the fact that it underlies only small areas near the ridge tops. It contains coal 4 to 5 feet thick on both side of most of Russell Prater Creek and its tributaries, and includes few partings that would give trouble in mining. The Clintwood and Campbell Creek beds have not been found in the small areas in which they might outcrop near the tops of some ridges, though the Clintwood is about 4 feet thick a short distance north of the eastern part of the Russell Fork drainage basin.

Splash Dam coal bed.—The Splash dam bed lies a few feet above a massive sandstone and is exposed a short distance above stream level along Russell Prater Creek from its mouth nearly to the head of the left fork and of War Fork. The bed contains about 3 feet of coal with only thin shale partings along the lower part of Russell Prater Creek, but at and east of the mouth of Greenbrier Creek it is split by thin shale beds into two or three parts, none of which is more than 2 feet thick.

Half way between the mouths of Greenbrier Creek and War Fork, in a spring beside the road (location 341, elevation 1,462 S.), what is probably the thickest bench of the Splash Dam includes 16 inches of coal and an inch of shale and is overlain by 5 inches of black shale under sandstone. The roads east of this and up both forks of Russell Prater Creek cross the Splash Dam bed many times. One bench, capped by 7 feet of shale, is 22 inches thick near the head of War Fork (location 342, elevation 1,700 B.). Three benches, each separated from the other by 10 feet of shale, are exposed in the road half a mile north of Prater, the upper bench (location 343, elevation 1,530 S.) being 19 inches thick, and the other two not measurable. The lower bench is 19 inches thick, including an inch of shale, in a pit between Prater and the exposure just mentioned, and the upper bench is 21 to 24 inches thick in several exposures farther northeast. The middle bench, however, is probably very thin. The coal is in two benches 16 feet apart near the mouth of Greenbrier Creek, as shown in a road cut (location 344, elevation 1,410 B.) in which the lower bench is 16 inches thick and the upper is 17 inches.

The coal is thicker and probably in only one bench on the lower part of Russell Prater Creek, as shown by the following measurements, the first made at a small mine near the road between Russell Prater and Barts Lick creeks and the second at an exposure a short distance west. An analysis of the coal at the mine is given in another part of this report.

Sections of Splash Dam coal bed on lower Russell Prater Creek.

(Location 345, elevation 1,378 S.)

	Ft.	in.
Shale	3	
Coal	1	9
Shale		½
Coal		2¼
Shale		1
Coal		9
Shale		2
Coal		6½
Coal	3	2¾
Partings		3½

(Location 346, elevation 1,355 B.)

	Ft.	in.
Shale	4	
Coal	1	9
"Rash"		2
Coal	1	3
Coal	3	
Partings		2

A short distance down the creek (location 347, elevation 1,381 C. C. C.) the bed is 29 inches thick, with only a few streaks of impurities.

Hagy coal bed.—The Hagy coal is 60 to 120 feet above the Splash Dam bed, the average distance being about 100 feet. It has a sandstone bottom-rock that is slightly thinner than that of the Splash Dam and is characterized by a roof of deep blue shale. The bed is exposed low in the valley of Russell Prater Creek from its mouth nearly to the heads of the principal branches and also along the lower part of Barts Lick Creek. The coal is only 15 to 26 inches thick along Barts Lick Creek and Russell Prater Creek west of Prater, but is 2 to 3½ feet thick along Greenbrier Creek and the left fork of Russell Prater and 2½ to 4½ feet along War Fork and its tributaries. The bed is clean, shale partings being very thin in some localities and absent from others.

A caved pit in a small tributary south of Prater School (location 348, elevation 1,585 B.) is in coal at least 2 feet thick. Three miles east of this, on a southern tributary of War Fork (location 349, elevation 1,730 B.), the coal is 37 inches thick. The following two sections near the heads of War Fork, the first at Larkin Owens's on the right branch of the stream, and the second on the left branch, show the bed at its best:

Sections of Hagy coal bed on War Fork of Russell Prater Creek.

(Location 350, elevation 1,810 B.)

	Ft.	in.
Shale	8	6
Coal	1	3
Shale		¼
Coal	3	5
Coal	4	8
Partings		¼

(Location 351, elevation 1,810 B.)

	Ft.	in.
Shale	4	
Coal		7
Shale		¼
Coal	2	9½
Coal	3	4½
Partings		¼

The coal is 33 inches thick on Bear Branch of War Fork (location 352, elevation 1,760 B.) and about the same on Laurel Branch. Coal 30 inches thick was reported in the hollow back of Prater store (location 353, elevation 1,660 B.). The coal is 32 inches thick in one pit near the road at the head of the left fork of Russell Prater Creek (location 354, elevation 1,722 S.), the upper part being very impure, and at another pit is 41 inches thick, including three streaks of shale (location 355, elevation 1,690 B.).

The Hagy is only 20 inches thick a mile west of Prater (location 356, elevation 1,565 B.) and also half a mile distant on Greenbrier Creek (location 357, elevation 1,530 B.). It is 23 inches thick on the north side of the creek, northwest of location 357. Northwest of Prater, on a tributary of Greenbrier Creek (location 358, elevation 1,565 B.), the bed is 39 inches thick, including an inch of shale 5 inches from the top, but farther north, at the mouth of Rough Branch, it is only 25 inches thick.

The Hagy is 26 inches thick in a small mine beside the road from Russell Prater to Barts Lick Creek (location 359, elevation 1,473 S.), and is probably about the same elsewhere along the lower part of Russell Prater Creek. It is 25 inches thick near Barts Lick School (location 360, elevation 1,430 B.), but is only 15 to 22 inches thick along lower parts of Barts Lick Creek (location 361, elevation 1,375 B.; location 362, elevation 1,330 B.; location 363, elevation 1,275 B.).

Glamorgan and Lyons coal beds.—The Glamorgan coal is 250 to 340 feet above the Splash Dam coal and only a few feet above the base of the Wise formation. The thickness of coal aggregates a few inches to about 3½ feet, but the bed commonly contains thin shale partings that impair its commercial value. The Lyons bed is 20 to 40 feet above the Glamorgan and is less than 2 feet thick. Neither bed was found along War Fork and the upper part of Russell Prater Creek, and both are probably thin in those districts.

The Glamorgan is about 3 feet thick on the ridge south of lower Russell Prater Creek, and 32 inches of it, the upper part being removed by erosion,

shows in the road east of Prater triangulation station (location 364, elevation 1,916 S.). Here the coal is only 4 inches from the underlying Gladeville sandstone. The Glamorgan is apparently in two thin benches several feet apart in the Greenbrier Creek drainage basin, and near the head of Little Greenbrier Creek (location 365, elevation 1,660 B.) the upper bench contains 30 inches of coal separated into thin layers by intercalations of clay that make the bed valueless.

The character of the Glamorgan along lower Barts Lick Creek is shown by the following four sections, the first one south of the stream and the others north of it:

Sections of Glamorgan coal bed on lower Barts Lick Creek.

(Location 366, elevation 1,450 B.)

	Ft.	in.
Shale.		
Coal		2
Shale		2
Coal		4
Shale		1
Coal		4
Shale		1
Coal		7
Shale		1
Coal	1	
Sandstone.		
Coal	2	5
Partings		5

(Location 367, elevation 1,550 B.)

	Ft.	in.
Shale and coal		8
Coal		11
Shale		1
Coal		1
Clay		1
Coal	1	6
Shale.		
Coal	2	6
Partings		2

(Location 368, elevation 1,510 C. C. C.)

	Ft.	in.
Coal		10
Shale	3	1
Coal		6
"Rash"		2
Coal		6
"Rash"		1
Coal	1	7
Shale.		
Coal	3	5
Partings	3	4

(Location 369, elevation 1,530 B.)

	Ft.	in.
Shale.		
Coal		11
Clay		1
Coal		7
Shale		2
Coal		9
Sandstone.		
Coal	2	3
Partings		3

Blair coal bed.—The Blair is 50 to 120 feet above the Glamorgan coal bed. In many places the bed is in two benches separated by shale several feet thick. One of the benches is so thin as to be of no economic importance, and the other, though containing layers of coal aggregating 1½ to 5½ feet thick, commonly includes several thin layers of incombustible material that make its successful utilization problematical. There are undoubtedly localities, however, in which the bed is sufficiently clean to be an important resource. The Blair is thickest in the Greenbrier Creek drainage basin.

The first of the following sections was measured on a southern tributary of War Fork and the second at the head of War Fork:

Sections of Blair coal bed on War Fork.

(Location 370, elevation 2,105 B.)

	Ft.	in.
Coal		8
Shale		1
Coal		2½
Shale		1
Coal		4
Shale		3
Coal	1	1
Bone		3
Coal		7
Coal	2	10½
Partings		8

(Location 371, elevation 2,170 B.)

	Ft.	in.
Shale.		
Coal	1	
Shale		1½
Coal		4½
Shale		2
Coal	1	4
Shale.		
Coal	2	8½
Partings		3½

At the head of a hollow about half a mile west of Prater (location 372, elevation 1,870 B.), the Blair is about 5 feet thick, including shale partings. The first two of the following sections are on southern tributaries of Greenbrier Creek and the last two are on tributaries of Little Greenbrier Creek. All these measurements are probably of the lower bench, the upper being very thin.

Sections of Blair coal bed on Greenbrier and Little Greenbrier creeks.

(Location 373, elevation 1,810 B.)

	Ft.	in.
Shale.		
Coal		8
Shale		1
Coal		3
Shale		1
Coal		4
Shale		2
Coal		11
Bone		2
Coal, impure		4
Bone		1
Coal	1	8
Shale		5
Coal		8
Coal	4	10
Partings	1	

(Location 374, elevation 1,850 B.)

	Ft.	in.
Shale	3	
Coal		9½
Shale		1½
Coal		5
Sandstone		1½
Coal	2	
Shale.		
Coal	3	2½
Partings		3

(Location 375, elevation 1,750 B.)

	Ft.	in.
Shale.		
Coal	1	
"Rash"		1
Coal		5
"Rash"		½
Coal	1	4
Coal	2	9
Partings		1½

(Location 376, elevation 1,720 B.)

	Ft.	in.
Coal	1	
Bone		8
Coal		10
Coal	1	10
Parting		8

Eagle coal bed.—The Eagle bed lies 140 to 200 feet above the Glamorgan coal and a few feet below a thick sandstone that makes conspicuous cliffs. In places this bed is only 20 feet above the Blair, but in others the interval is 50 to 100 feet. The coal is not very thick north of Barts Lick Creek and in part of the Greenbrier Creek drainage basin, but elsewhere in this area it is fairly clean and has an average thickness of 4 or 4½ feet. Near the heads of Russell Prater Creek and War Fork it is about 5 feet thick. The bed lies so high in the hills that it has a comparatively small acreage. One of the peculiarities of the Eagle in places is a very thin sandstone parting much like the one that is characteristic of the Upper Banner bed farther south.

The Eagle is naturally exposed on a slope near Prater triangulation station, south of Russell Prater Creek (location 377, elevation 2,040 B.) and is 68 inches thick, including 3 inches of shale a foot below the top. At the head of War Fork (location 378, elevation 2,215 B.) the bed is 65 inches thick and remarkably clean. The roof is 10 feet of shale under sandstone and there is a 12-inch coal bed 75 feet above the Eagle. The Eagle is nearly as thick 2½ miles northwest, in the bottom of a hollow near the head of Russell Prater Creek (location 379, elevation 2,070 B.), where there are 58 inches of coal in addition to a 9-inch shale parting 32 inches from the top. Sandstone 25 feet thick may be seen resting on the coal, and the total thickness of this cap is probably about 100 feet. The bed appears to be 4 or 5 feet thick at an abandoned strip pit a mile north of this, at the head of Camp Branch of Poplar Creek (location 380, elevation 1,970 B.).

There are no indications of very thick coal at the Eagle horizon along Greenbrier Creek above the mouth of Little Greenbrier, though there may be some near the head of the stream. The bed is 32 inches thick, including an inch of shale, in the first hollow to the right above Little Greenbrier Creek (location 381, elevation 1,830 B.). The four measurements given below show thicker coal on tributaries of Little Greenbrier Creek:

Sections of Eagle coal bed on Little Greenbrier Creek.

(Location 382, elevation 1,850 B.)

	Ft.	in.
Coal	1	1
Shale		3
Coal	1	2
Shale		3
Coal	1	2
Shale		4
Coal	3	
Coal	6	5
Partings		10

(Location 383, elevation 1,800 B.)

	Ft.	in.
Coal	?	?
Shale	1	8
Coal		8
Shale		½
Coal		4
Sandstone		1
Coal	2	1
Coal	3	1
Partings		1½

(Location 384, elevation 1,810 B.)

	Ft.	in.
Shale	1	
Coal		1½
Clay		¾
Coal	3	1
Clay		½
Coal		5½
Sandstone		¼
Coal	1	7
Clay.		
Coal	5	3
Partings		1½

(Location 385, elevation 1,820 B.)

Shale.	Ft.	in
Coal		1
Clay		1
Coal		11½
Clay		½
Coal	1	3
"Rash"		2
Coal	2	9½
Coal	5	1
Partings		3½

The following measurements were made at two small mines that have supplied fuel for lumbering operations, the first being on Wolfpen Branch of Russell Prater Creek, east of Greenbrier Creek, and the second on Slate Branch of Barts Lick Creek:

Sections of Eagle coal bed on Wolfpen and Slate branches.

(Location 386, elevation 1,925 C. C. C.)

	Ft.	in.
Shale	11	
Coal		1
Clay		¼
Coal	3	5
Clay		1
Coal	1	
Shale.		
Coal	4	6
Partings		1¼

(Location 387, elevation 1,827 C. C. C.)

Sandstone.	Ft.	in.
Coal		9½
Clay		5½
Coal	1	1
Clay		1
Coal	1	1½
Sandstone		1½
Coal	1	2
Coal	4	2
Partings		8

Levisa Fork drainage basin.

LEVISA FORK AND TRIBUTARIES OTHER THAN PRATER AND GARDEN CREEKS.

Geologic outline.—This area, which embraces the valley of Levisa Fork, the drainage basins of Little Prater and Dismal creeks, and a number of small tributaries of the Levisa, contains exposures of rocks from the sandstone bottom rock of the Tiller coal bed to beds about 450 feet above the base of the Wise formation. The stratigraphy is shown by a generalized columnar section for the north third of the Bucu quadrangle (Pl. IV) and by local sections 18, 21, 22, and 23. Dips are to the northwest, west, and north and are very gentle in most places.

The most important beds commercially are the Lower Banner (Cary) east of Dismal Creek, the Kennedy (Harris), and the Eagle. (See figs.

3, 4, 5, and 17.) The lowest coal bed exposed is the Tiller (Garden), which is 30 inches or less thick. Both the Jawbone (Ratliff) and Garden Hole beds are less than 30 inches thick. The Kennedy is a persistent bed which is about 3 to 4 feet thick east of Prater and Dismal creeks and thins gradually to the north and west. The Lower Banner is a clean bed 4 to 5½ feet thick southeast of Dismal Creek, but much thinner farther west. The Upper Banner is probably not present and the Splash Dam and Hagy, as far as now known, are less than 30 inches thick except near the head of Little Prater Creek, where they are nearly 3 feet thick. Several beds in

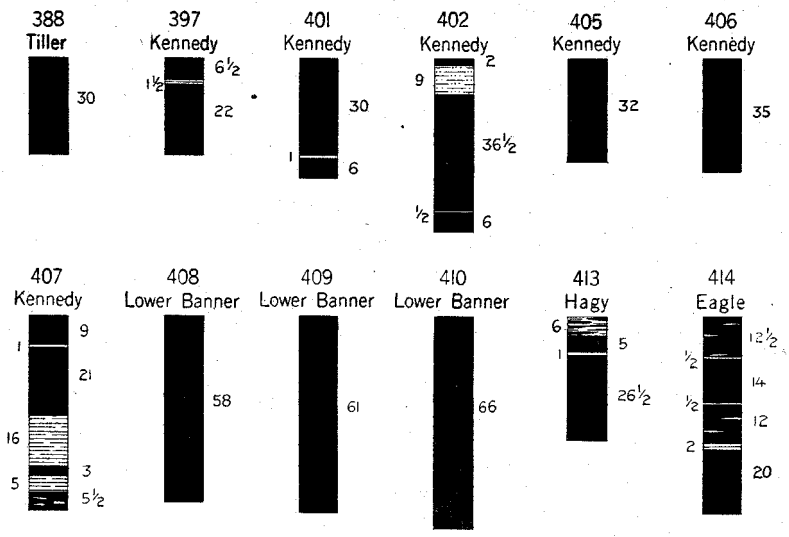


Fig. 17.—Sections of coal beds on and near Levisa Fork.

the Wise formation, found only on the ridges near Little Prater Creek, may be moderately thick, and the Eagle is known to be about 5 feet thick in the small area it underlies.

Tiller coal bed.—The Tiller is the lowest coal bed exposed in the area and outcrops a short distance above Levisa Fork east of a point a mile northeast of Van Sant. It is called the Garden bed in a private report by d'Invilliers. The bed lies above a coarse-grained, massive conglomeratic sandstone and is 690 to 750 feet below the Splash Dam horizon. Above the Tiller there are commonly 20 to 50 feet of blue and drab shale underlying a large 50-foot lentil of siliceous conglomeratic sandstone. The coal is 27 to 30 inches thick near Dismal and Garden creeks and thinner farther west.

There is a small mine in the bank of the Levisa opposite the mouth of Garden Creek (location 388, elevation 1,320 H. L.), in which the Tiller coal is 30 inches thick and has a sandstone roof and shale floor. A mile northwest of this, beside the road (location 389, elevation 1,329 S.), and at the mouth of Dismal Creek (location 390, elevation 1,170 B.), the coal is 27 inches thick. Near river level a mile northeast of Van Sant (location 391, elevation 1,110 B.), the bed is only 19 inches thick, including a 4-inch shale layer in the middle.

Jawbone coal bed.—The Jawbone is less than 2 feet thick and is 50 to 100 feet above the Tiller, lying on the conglomeratic lentil previously mentioned. This bed is locally known as the Ratliff. The coal is 20 inches thick at the mouth of Dismal Creek and 22 inches thick 1¼ miles northeast (location 392, elevation 1,232 S.). At the mouth of Prater Creek (location 393, elevation 1,125 B.) the coal is 20 to 24 inches thick and has 10 feet of drab shale in the roof.

Garden Hole coal bed.—The Garden Hole bed is 460 to 525 feet below the Splash Dam horizon and about 200 feet above the Tiller. Under it there is an arkosic sandstone that makes more or less prominent cliffs in places. The bed was measured at only two pits, but is probably less than 30 inches thick elsewhere. At a small mine opposite Little Prater School (location 394, elevation 1,155 B.), the bed is 26 inches thick and has a roof of dark drab shale 8 feet thick. An opening near the mouth of Prater Creek (location 395, elevation 1,200 B.) is in coal 28 to 30 inches thick. The bed is reported 27 inches thick at the mouth of Prater Creek and 21 inches on Mill Branch of Dismal Creek.

Kennedy coal bed.—The Kennedy bed, locally known as the Harris, lies on a thick massive sandstone that makes conspicuous ledges and cliffs, and is 300 to 350 feet below the Splash Dam horizon, in most places a little less than 200 feet above the Garden Hole bed. The roof is sandy shale in most localities. The bed has few partings and contains coal 32 to 45 inches thick east of Prater and Dismal creeks. In general the bed thins gradually to the north and west, and is only about 27 inches thick along Little Prater Creek.

Four small mines on Little Prater Creek (locations 396, 397, 398, and 399, elevations 1,320 to 1,330) utilize the Kennedy bed, which is 27 to 30 inches thick, including one-quarter to 1½ inches of shale 6 inches from the top. The roof is sandy shale at least 25 feet thick.

A little more than a mile east of Van Sant (location 400, elevation 1,600 B.) and at a small mine on Sixteen Mile Branch (location 401,

elevation 1,645 B.) the coal is about 3 feet thick, with an inch of shale in the lower part. D'Invilliers gives the following measurements on Kennel Branch, at the east edge of the Bucu quadrangle:

Section of Kennedy coal bed on Kennel Branch.

(Location 402, elevation 1,680 B.)

	Ft.	in.
Coal		2
Sandstone and shale		9
Coal	3	½
Clay		½
Coal		6
Coal	3	8½
Partings		9½

The same authority gives the thickness of the bed as 3 feet on Pigeon Branch, 32 inches near the mouth of Dismal Creek, and 37½ inches on Mill Branch of Dismal Creek, including shale 1½ inches thick at the last opening. Harnsberger, however, found the thickness to be only 28 inches in a small mine on Mill Branch a few rods east of the quadrangle, possibly because the lower part of the bed was not utilized. On the south side of Harper Creek of Dismal Creek (location 403, elevation 1,560 B.), the coal is 27½ inches thick and has a roof of shaly sandstone. It is the same thickness on Stilton Branch of Levisa Fork (location 404, elevation 1,570 B.), but has there a shale roof. West of this there is a local thickening of the coal, which is 32 inches thick on Bens Branch (location 405, elevation 1,470 B.), 35 inches a short distance southwest (location 406, elevation 1,430 B.), and is as follows at a small mine half a mile farther west:

Section of Kennedy coal bed north of Van Sant.

(Location 407, elevation 1,360 B.)

	Ft.	in.
Shale	6	
Coal		9
Shale		1
Coal	1	9
Shale	1	4
Coal		3
Shale		5
Coal, impure		5½
Shale, compact.		
Coal	3	2½
Partings	1	10

Lower Banner coal bed.—The Lower Banner, locally called the Cary, is 130 to 200 feet above the Kennedy coal and 140 to 200 feet below the Splash Dam horizon, the intervals decreasing from east to west. A few feet below the coal there is a sandstone bed that makes rather inconspicuous ledges, and the roof is commonly shale. The Lower Banner is remarkably clean and contains coal 4 to 5½ feet thick in most of the district between Dismal Creek and Levisa Fork and south of the Levisa near Garden Creek. West of this district the coal thins and becomes unworkable within a short distance.

The Lower Banner coal is reported 50 inches thick just west of the mouth of Garden Creek and is 54 inches on Kennel Branch, a short distance east of the Bucu quadrangle. On Pigeon Branch (location 408, elevation 1,880 B.), the coal is 58 inches thick and it is 61 inches thick less than a mile northwest (location 409, elevation 1,900 B.). West of the last pit the bed thins and is reported by d'Invilliers to be only 2 feet thick at the mouth of Dismal Creek. On Mill Branch, however, the bed is in good condition and is 5½ feet thick at the east edge of the quadrangle (location 410, elevation 1,875 B.). There are reported to be 34 inches of coal on the north side of Dismal Creek near the northeast corner of the quadrangle, but the bed thins to the southwest and is only 10 inches thick on Stilton Branch of Levisa.

Splash Dam coal bed.—The Splash Dam coal lies a few feet above a thick sandstone bed that makes conspicuous cliffs on narrow spurs. The horizon of the bed can be easily identified but the coal itself was found in only a few places. The coal is known to be thick a short distance north of Little Prater Creek and was reported to be 26 to 51 inches thick on that stream. It is thinner farther east and south, perhaps because it is split into two parts by a shale bed, though it is possible that it is about 3 feet thick along the east edge of the Bucu quadrangle.

The Splash Dam bed is 26 inches thick and has a shale roof containing fossil plants on a southern tributary of Little Prater Creek (location 411, elevation 1,650 B.). On Little Prater Creek, three-quarters of a mile southwest of this opening, the bed is reported to be 3 feet thick, and at the head of a southern tributary which enters Little Prater near its mouth, half a mile east of location 411, the bed is reported 54 inches thick, including 3 inches of shale. These reports, however, need confirmation. The reported thickness is 27 inches at the head of Sixteen Mile Branch of Levisa Fork and 21 inches at the head of Bens Branch (location 412, elevation 1,790 B.).

Hagy coal bed.—The Hagy is 60 to 100 feet above the Splash Dam horizon. This bed is about 2½ feet thick near the head of Little Prater Creek, where the measurement given below was made, but is thought to be only 2 feet or less thick elsewhere in this area. In place there is another thin coal bed a short distance above the Hagy.

Section of Hagy coal bed at head of Little Prater Creek.

(Location 413, elevation 1,773 H. L.)

	Ft.	in.
Shale, dark	4	
Coal and shale, interbedded		6
Coal		5
Shale		1
Coal	2	2½
Interval to sandstone ledge	8	
Coal	2	7½
Partings		1

Coal beds in Wise formation.—Coal beds in the Wise are confined, in this area, to the tops of the ridges on both sides of Little Prater Creek. As indicated by exposures in neighboring areas, described in the sections devoted to the Russell Prater and Prater Creek drainage basins, there is probably some coal at the Glamorgan, Blair, and Clintwood horizons. The only measurement obtained in this area, however, was of the Eagle bed near the head of Little Prater Creek, and is given below. The Eagle is 170 feet above the base of the Wise formation and about 460 feet above the Splash Dam horizon. It underlies a light-colored, coarse sandstone that forms strong cliffs and is 50 feet or more thick.

Section of Eagle coal bed near head of Little Prater Creek.

(Location 414, elevation 2,100 B.)

	Ft.	in.
Sandstone, shaly, under coarse, massive sandstone cliff	2	
Coal, with two or three shale streaks	1	½
Shale		½
Coal	1	2
Shale		½
Coal, with two shale streaks	1	
Shale, carbonaceous		2
Coal	1	8
Coal	4	10½
Partings		3

PRATER CREEK.

Geologic outline.—Rocks from a few feet below the Jawbone coal horizon to about 450 feet above the base of the Wise formation are exposed in the Prater Creek drainage basin, but the Wise and Gladeville formations occur only on the tops of a few ridges. The stratigraphy of the exposed rocks is shown graphically by the generalized columnar sections for the middle and north thirds of the Bucu quadrangle (Pl. IV), and by the local sections 24, 25, 26, and 27. There are a few small anticlines and synclines which cause local irregularities, but in general dips are very gentle and are to the

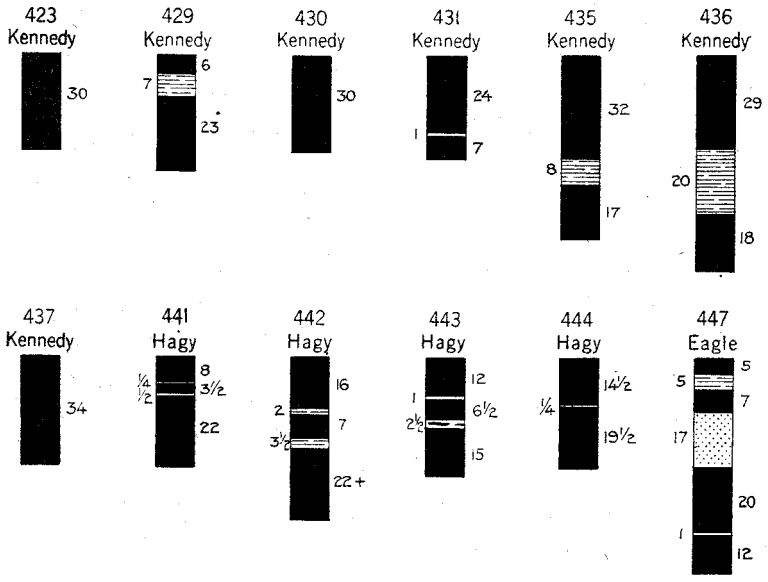


Fig. 18.—Sections of coal beds in the Prater Creek drainage basin.

north or northwest. Dips are slightly greater in the central part of the area than elsewhere.

The Kennedy and Hagy coal beds are commercially the most important in the area, though there are workable beds at other horizons. The Eagle coal is the thickest, but underlies only small areas on high ridges west of Prater Creek. (See figs. 3, 5, and 18.)

The Jawbone and Garden Hole beds and a coal 75 feet above the latter are less than 2 feet thick nearly everywhere in this area. The Kennedy

coal, excluding partings, is about 4 feet thick along the upper part of Dry Fork and thins to the west and northwest to a thickness of 20 or 30 inches. The Upper Banner is probably absent except along part of Trace Fork, and the Splash Dam bed is thin. The Hagy bed is about 3 feet thick in the southwestern part of the area and thinner elsewhere. The Glamorgan bed is less than 30 inches thick and the Blair probably more than 30 inches locally. The Eagle coal is 3½ to about 5 feet thick, exclusive of partings.

Jawbone coal bed.—The Jawbone coal, which is about 620 feet below the Splash Dam, is above drainage levels only along the lower part of Prater Creek and is a thin bed of little economic importance in this district. It is 17 inches thick in the bed of Prater Creek near the mouth of Trace Fork (location 415, elevation 1,171 S.) and 15 inches a few rods down the stream. The coal is 21 to 27 inches thick near the mouth of Dry Fork (location 416, elevation 1,145 B.).

Garden Hole and associated coal beds.—The Garden Hole bed lies about 90 feet above the Jawbone and 520 to 570 feet below the Splash Dam horizon. It outcrops low down in the valley of Prater Creek from its mouth nearly to its head and along the lower parts of the principal tributaries. The thickness of the bed is only about 2 feet. There is a 21-inch coal bed about 75 feet above the Garden Hole near the head of Prater Creek.

The Garden Hole bed is 25 inches thick at the mouth of Big Lick Branch (location 417, elevation 1,255 H. L.) and 19 inches at a neighboring exposure on Trace Fork.

The coal bed 75 feet above the Garden Hole is 23 inches thick on Whitt Branch of Prater Creek (location 418, elevation 1,670 S.), and 21 inches thick by the road up Crooked Branch (location 419, elevation 1,717 S.) and in a pit half a mile southwest. The Garden Hole bed is about 2 feet thick in this locality, but is only 15 to 20 inches thick on Box Camp Branch (location 420, elevation 1,620 B.). An opening on Murphy Fork (location 421, elevation 1,600 B.) shows the Garden Hole to be 24 to 28 inches thick and it is about the same at Deskins and on Three Forks Branch (location 422, elevation 1,585 B.).

Kennedy coal bed.—The Kennedy is 200 feet and more above the Garden Hole bed and 300 to 350 feet below the Splash Dam horizon, the intervals decreasing from southeast to northwest. Coal is very persistent at the Kennedy horizon, and is 20 to 30 inches thick along Trace Fork, 2 to 3 feet along Prater Creek and its small tributaries, and about 4 feet along the upper part of Dry Fork. In general, therefore, the bed thins to the

west. Where the coal is thickest, the bed commonly includes a shale parting. The roof is drab shale, sandy in places, and a coarse, cliff-making sandstone lies a few feet below the coal.

The Kennedy is 30 inches thick in a small mine on the West side of Prater Creek, near its mouth (location 423, elevation 1,445 B.). About a mile southwest of the mouth of Trace Fork (location 424, elevation 1,465 B.), the coal is 21 inches thick and is only 19½ inches a mile farther southwest (location 425, elevation 1,439 S.). A small family mine on Mott Branch of Trace Fork (location 426, elevation 1,485 B.) shows the Kennedy to be only 22½ inches thick, but it is said to be 30 inches in the neighborhood. At the mouth of Trace Fork (location 427, elevation 1,480 B.), the bed is 27 inches thick.

The Kennedy is 29 inches thick opposite the mouth of Devil Branch of Prater Creek (location 428, elevation 1,490 B.). A small mine near a house on Shortridge Branch (location 429, elevation 1,620 B.) and two prospect pits in the vicinity show a carbonaceous shale parting 3 to 12 inches thick, the coal above it being 6 to 8 inches thick and that below it 20 to 26 inches thick. On Whitt Branch, half a mile west of its mouth (location 430, elevation 1,795 B.), the bed is clean and 28 to 32 inches thick. On a northern tributary of Crooked Branch (location 431, elevation 1,850 B.) the bed is 32 inches thick, including an inch of shale, and it is said to be thicker on a southern tributary, near Indian Grave Gap (location 432, elevation 1,855 H. L.). The Kennedy is reported 30 to 32 inches thick on the upper part of Three Forks Branch (location 433, elevation 1,775 B.) and is 29 inches on Vance Branch (location 434, elevation 1,675 B.).

The bed is thickest on the upper part of Dry Fork, as shown by the following measurements in small mines:

Sections of Kennedy coal bed on Dry Fork of Prater Creek.

(Location 435, elevation 1,675 B.)

	Ft.	in.
Coal	2	8
Shale		8
Coal	1	5
Coal	4	1
Parting		8

(Location 436, elevation 1,717 S.)

	Ft.	in
Coal	2	5
Shale	1	8
Coal	1	6
Coal	3	11
Parting	1	8

The bed is 27 inches thick and without the shale parting near the mouth of Dry Fork, and is 34 inches thick in a small mine 300 yards northwest (location 437, elevation 1,475 B.).

Lower and Upper Banner and Splash Dam coal beds.—The Lower Banner bed was not found in this area and is probably thin. The Upper Banner bed was found at only one place, shown in the section given below, and its thickness there is surprising. The Upper Banner is thin or absent in most other parts of the Levisa Fork drainage basin and neighboring parts of the Russell Fork drainage basin.

Section in bed of tributary of Mott Branch of Trace Fork.

(Location 438.)

	Ft.	in.
Shale	10	
Coal (Hagy; elevation 1,920), in caved pit	..	
Concealed	10	
Sandstone, massive at top, thin-bedded at base	86	
Shale, buff, sandy	4	
Coal (Splash Dam, elevation 1,820), with bony streaks	1	1½
Concealed	10	
Sandstone, medium-grained, firmly cemented	35	
Coal (Upper Banner, elevation 1,775), reported 4 feet thick, now exposed	2	1½
	159	

The only other measurement of the Splash Dam bed was made near the head of Big Lick Branch (location 439, elevation 1,730 S.), where the coal is 21 inches thick. The bed is probably less than 2 feet thick in most of the Prater Creek drainage basin.

Hagy coal bed.—The Hagy bed is 80 to 120 feet above the Splash Dam horizon, a few feet above a sandstone that makes fairly strong ledges, and a few feet below a thinner and less conspicuous sandstone. Drab shale commonly lies directly on the coal. The thickness of the coal is exceptionally great on the west side of the southern part of the Trace Fork drainage basin, averaging nearly 3 feet and being about 4 feet at one pit. Elsewhere the bed is probably less than 2 feet thick. Run of mine coal from this district would be high in ash because of thin streaks of shale and bone.

The Hagy is 33 inches thick near the head of Big Lick Branch (location 440, elevation 1,850 B.), but the upper 13 inches is a worthless mixture of interbedded shale and coal and there is an inch of shale 16 inches from the base of the bed. The upper part of the bed improves in quality to the south and includes only a few streaks of shale in the gap between Trace Fork and Pawpaw Creek, where the first of the following sections was measured. The second of these sections is from a pit nearly a mile south of the first and is not complete, as the bottom of the bed was not seen. The

third and fourth sections were obtained a short distance south of the second, the fourth being from a small mine at a sharp bend in the wagon road from Fox Creek, on land of H. E. Hagy.

Sections of Hagy coal bed near head of Trace Fork.

(Location 441, elevation 1,871 S.)

	Ft.	in.
Shale	6	
Coal		8
Shale		¼
Coal		3½
Shale		½
Coal	1	10
Coal	2	9½
Partings		¾

(Location 442, elevation 1,890 B.)

	Ft.	in.
Shale	8	
Coal	1	4
Shale		2
Coal		7
Shale		3½
Coal	1	10+
Coal	3	4+
Partings		5½

(Location 443, elevation 1,895 B.)

Shale.	Ft.	in.
Coal	1	
Bone		1
Coal		6½
Bone		2½
Coal	1	3
Coal	2	9½
Partings		3½

(Location 444, elevation 1,911 S.)

	Ft.	in.
Shale	15	
Coal	1	2½
Bone		¼
Coal	1	7½
Coal	2	10
Parting		¼

The Hagy is reported to be 30 inches thick in a hollow northeast of Leemaster (location 445, elevation 1,895 B.).

Coal beds in Wise formation.—There are known to be three coal beds in the lower part of the Wise formation, but they underlie only small areas on the tops of some of the high ridges. The Glamorgan bed, which is at the base of the formation, is probably thin in most places. It is 29 inches thick, including two 1-inch shale partings, at the head of Big Rock Branch, where it is 300 feet above the Splash Dam horizon. About 200 yards up the same hollow (location 446, elevation 2,130 B.), a bed that is either the Eagle or the Blair has been opened at a level 140 feet above that of the Glamorgan. The coal is reported to be only 29 inches thick here, but this probably includes only the lower part of the bed. The following is a more complete section from an opening 800 feet southeast.

Section of Eagle (?) coal bed at head of Big Rock Branch.

(Location 447, elevation 2,130 B.)

	Ft.	in.
Coal		5
Shale		5
Coal		7
Sandstone	1	5
Coal	1	8
Shale		1
Coal	1	
Coal	3	8
Partings	1	11

The thickness of the Eagle bed farther west is indicated by that in an opening already described on Little Prater Creek (location 414). An exposure of the Eagle in a southern tributary of Big Lick Branch (location 448, elevation 2,190 B.) shows 39 inches of coal, and more is said to be separated from it by a shale parting. There is a thin coal bed a short distance above the Eagle and another, probably the Blair, a short distance below. The excellent character of the Eagle and Blair beds farther south on this ridge is shown at pits in the Russell Prater Creek (locations 371 and 378) and Pawpaw Creek (location 340) drainage basins, described on preceding pages.

The Clintwood coal may be present at the top of some of the high knobs on the west side of the area, but it has not been found by prospectors.

GARDEN CREEK.

Geologic outline.—Rocks exposed in that part of the Garden Creek drainage basin which lies within the Bucu quadrangle include the Norton formation above the Tiller coal, the Gladeville sandstone, and a few feet of rocks at the base of the Wise formation. The Gladeville, however, occurs only on the tops of a few ridges and the Wise only in small patches on the tops of a few knobs. The succession of strata is shown by the generalized columnar sections (Pl. IV) for the north and middle thirds of the Bucu quadrangle and by local sections 21, 27, and 28. Structurally the area is dominated by a general dip to the northwest and north, much steeper on the south than on the north.

The Tiller, Jawbone, Garden Hole, and the next higher coal bed are 30 inches or less thick where they reach the surface, though the first two may thicken under cover to the south. The Kennedy coal is 3 to nearly 5 feet thick in the northeastern part of the area and 2½ to 3 feet elsewhere.

The Lower Banner bed is about 4 feet thick on the eastern border of the area and thins to the west. The Upper Banner is thin and the Splash Dam is fairly thick in places and probably thin in others. (See figs. 3, 4, and 19.)

Tiller and Jawbone coal beds.—The Tiller bed, locally called the Garden, is exposed only in the stream bank near the mouth of Garden Creek (location 449, elevation 1,330 B.), where it is 30 inches thick and 715 feet below the Splash Dam horizon. The Jawbone bed, locally called the Ratliff, was not found, but is probably thin and about 60 feet above the Tiller. Both beds may be thicker under the southern part of the area.

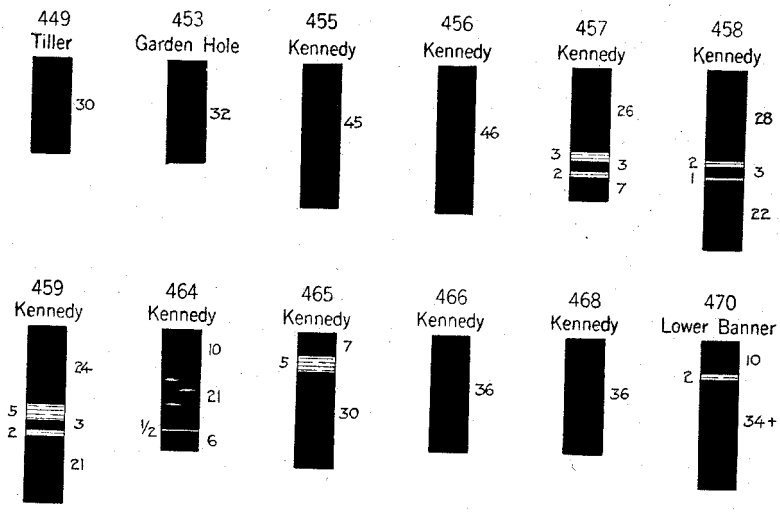


Fig. 19.—Sections of coal beds in the Garden Creek drainage basin.

Garden Hole and associated coal beds.—The Garden Hole coal is 560 to 610 feet below the Splash Dam horizon and is 15 to 30 inches thick. In the southern part of the area there is another bed of about the same thickness 50 to 100 feet above the Garden Hole.

The Garden Hole coal is 20 inches thick near a house on Little Garden Creek (location 450, elevation 1,510 B.), with medium-grained sandstone for a roof. The coal is reported to be 30 inches thick half a mile south of the mouth of Little Garden. The bed above the Garden Hole is 20 inches thick at stream level on Robinson Fork of Right Fork (location 451, elevation 1,735 B.), and is slightly thicker in the road near the mouth of the stream. The Garden Hole bed is 26 inches thick on the right fork of Long

Fork (location 452, elevation 1,820 B.) and 27 to 32 inches thick in two neighboring pits on the left fork (location 453, elevation 1,865 B.). A pit in a small hollow in the upper part of Whitt Fork (location 454, elevation 2,030 B.) shows coal 25 inches thick at the Garden Hole horizon, but there are only 18 inches in a pit under the wagon road a short distance east.

Kennedy coal bed.—The Kennedy coal, locally called the Harris, is a persistent and valuable bed in this area and lies 300 to 360 feet below the Splash Dam horizon. The position of the coal is marked by a massive coarse-grained, ledge-making sandstone a few feet below it. The roof of the coal is commonly drab shale, in places so sandy as to be almost a sandstone. The Kennedy, exclusive of partings, is nearly 4 feet thick along the lower part of Garden Creek, and is 3 to nearly 5 feet thick on both sides of the lower part of Right Fork. Elsewhere in this drainage basin it is about 2½ to 3 feet thick. In some localities the bed is nearly all coal, in others there are several shale partings of irregular thickness.

In a hollow half a mile south of the mouth of Little Garden Creek (location 455, elevation 1,715 B.), the Kennedy is 45 inches thick, possibly including an inch or two of shale. In another hollow three-quarters of a mile farther south (location 456, elevation 1,730 B.) the bed is 46 inches thick.

There are several prospect pits and small mines on the north side of Youngs Branch, two of the sections obtained being shown below. The thickness of coal and partings is not the same in all parts of the mine in which the second section was measured and as much as 59 inches of coal was seen at one place in it.

Sections of Kennedy coal bed on Youngs Branch.

(Location 457, elevation 1,764 S.)

	Ft.	in.
Shale	2	
Coal	2	2
Shale		3
Coal		3
Shale		2
Coal		7
Coal	3	
Partings		5

(Location 458, elevation 1,740 B.)

Shale.	Ft.	in.
Coal	2	4
Shale		2
Coal		3
Shale		1
Coal	1	10
Coal	4	5
Partings		3

The bed is about the same on the upper part of Skeggs Branch, as shown by the following section, the lower part of which was reported by Catlett:

Section of Kennedy coal bed on Skeggs Branch.

(Location 459, elevation 1,780 B.)

	Ft.	in.
Shale, dark blue at base	20	
Coal	2	
Shale		5
Coal		3
Shale		2
Coal	1	9
Interval to top of massive sandstone, about	2	6
Coal	4	
Partings		7

Residents report that there is clean coal 42 inches thick in a caved pit near the mouth of Skeggs Branch (location 460, elevation 1,775 B.). The Kennedy is without partings on Breeden Branch and is reported by Catlett to be 3 feet thick in a pit near the head of the valley (location 461, elevation 1,783 H. L.). Farther south it is 28 inches thick in one pit (location 462, elevation 1,790 B.) and 29 inches in another (location 463, elevation 1,840 B.). The coal is 37 inches thick near the head of Robinson Fork (location 464, elevation 1,820 B.), but is slightly crushed and dirty in the middle.

The Kennedy includes 37 inches of coal on Long Fork (location 465, elevation 2,075 B.), in addition to a 5-inch black shale parting 7 inches from the top. A small mine farther east, on a southern tributary of Whitt Fork (location 466, elevation 2,150 B.), is in clean coal 36 inches thick. A small mine near the road at the head of Whitt Fork (location 467, elevation 2,305 B.) shows 26 inches of coal, crushed and slickensided, underlain by 6 inches of intermingled clay and coal resting on very hard sandy shale.

The Kennedy was found at only two places on the southeast side of Right Fork, at one of which (location 468, elevation 1,900) coal 36 inches thick is separated from sandstone below by only 2 inches of carbonaceous shale. Dilworth states that the coal is 43 inches thick near the mouth of North Branch, and a resident claims that the bed is a little more than 3 feet thick near one of the heads of that stream (location 469, elevation 1,920 B.).

Lower Banner coal bed.—The Lower Banner coal, locally called the Cary, is 130 to 200 feet below the Splash Dam horizon and 130 to 200 feet above the Kennedy. It is a nearly clean coal bed about 4 feet thick along the eastern border of the Bucu quadrangle in this area, but thins to the

west. More thorough prospecting is necessary before the limits of workable coal can be exactly determined.

The Lower Banner coal is reported to be 50 inches thick on the hillside west of the mouth of Garden Creek. It was not found on the tributaries of Right Fork except at the head of Rosin Camp Branch (location 470, elevation 2,440 B.), where it is more than 46 inches thick, including a 2-inch parting of carbonaceous shale 10 inches from the top. On the west side of the left or principal fork of Garden Creek, on the east boundary of the quadrangle (location 471, elevation 1,985 B.), the thickness of coal is at least 47 inches, and may be slightly more.

Upper Banner and Splash Dam coal beds.—The Upper Banner bed, 50 to 100 feet below the Splash Dam, is probably thin in all this area. The only place at which it was found to be more than a few inches thick is on the side of Fletcher Ridge (location 472, elevation 2,310 B.), where 20 inches were seen. Very little is known about the Splash Dam bed, which is probably the same as the Wilson of the upper Levisa Fork region. It is probably an important bed in places, but it seems likely that it would have been more extensively prospected if it were thick in many localities. Several inhabitants said that it was 4 feet thick in a pit west of Breeden Branch (location 473, elevation 2,190 B.). As previously stated, a bloom indicating coal at least 3 feet thick shows at the Splash Dam horizon on Fletcher Ridge (location 328).

Clinch River drainage basin.

LEWIS CREEK.

Geologic outline.—Only a small area on the western side of Lewis Creek drainage basin is in the Bucu quadrangle, and it contains rocks from a few feet below the Aily coal horizon nearly to the top of the Norton formation. The stratigraphic succession is indicated by the generalized columnar sections for the north and middle thirds of the Bucu quadrangle (Pl. IV) and by local section 28.

The axis of the Dry Fork anticline passes from east to west through the northern part of the area and beds near it have almost no dip. In the southern part of the area the dip is to the south and east and is irregular near the great fault which limits this part of the coal field on the southwest. Southwest of this fault the only beds exposed are the pre-Pennsylvanian formations that have been thrust up over the coal-bearing strata.

The most important coal bed is the Kennedy, which is utilized at small shipping mines near Drill. It is very irregular in thickness, ranging from 18 to 77 inches but probably averaging 3 feet. The average thickness of the Lower Banner is also about 3 feet, exclusive of partings. (See figs. 3, 4, and 20.) The Upper Banner, Splash Dam, and Hagy beds contain an unknown amount of coal, but are not thought to be very thick in this area.

Aily coal bed.—A bed that is tentatively correlated with the Aily, which is about 450 feet below the Splash Dam horizon in this area, is mined for a moderately large local trade by W. N. Jackson on Laurel Branch, at the east boundary of the quadrangle (location 474, elevation 2,030 B.). The stratigraphic position of this bed is rendered uncertain by the irregular dips in the vicinity and by the proximity of a great fault. Dips measured in the mine range from 5 to 18 degrees to the northeast and north and thicknesses

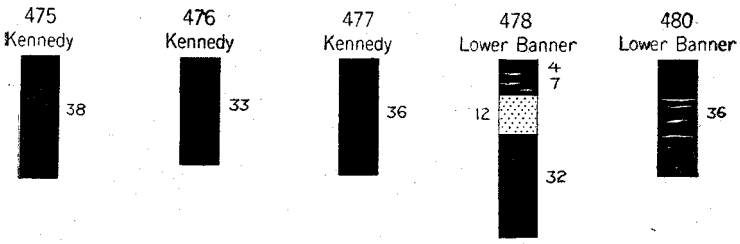


Fig. 20.—Sections of coal beds in the Lewis Creek drainage basin.

of coal from 2½ to 11 feet, the average being about 4 feet. Both the floor and roof are hard clay that gives little trouble. An analysis of a sample from this mine is given in another part of this report. What is probably the same bed has been mined 1,300 feet south of Jackson drift.

Kennedy coal bed.—The Kennedy coal, which is a few feet above coarse-grained, ledge-making sandstone, is about 350 feet below the Splash Dam horizon. It is irregular in thickness, ranging from 18 to as much as 77 inches where found, but averages about 3 feet. It has a shale roof in most places.

A small drift by the wagon road nearly a mile north of Drill, outside the Bucu quadrangle, shows the Kennedy to be 77 inches thick at the mouth and only 54 inches at the face, the irregularity of thickness being due to the uneven roof and to slight movement along the bedding planes of the coal. The same bed is mined in a drift at Drill (location 475, elevation 2,316 S.) to supply the engines on the Honaker Lumber Company railroad,

about ten men being employed in 1914. The thickness of the bed in the mine ranges from 18 to 43 inches. An analysis of a mine sample is given elsewhere in this report. The coal is 33 inches thick a short distance northwest of Drill (location 476, elevation 2,315 B.).

The Sandy Ridge Coal & Coke Company has recently begun operations half a mile south of Drill, and has driven two drifts, one on the north side of a small spur (location 477, elevation 2,334 H. L.) and the other on the south side. Small shipments were being made over the Honaker Lumber Company's railroad when the mine was visited in 1914 and 1915. The thickness of coal is 30 to 62 inches in the mine, averaging about 3 feet. The roof is shale and the floor a hard clay with rolls that cause many of the inequalities in the coal thicknesses.

Lower Banner coal bed.—The Lower Banner bed is about 160 feet below the Splash Dam horizon and is 22 to more than 36 inches thick at the few places it could be measured. The roof is commonly drab shale. The following section was made in a small mine in the head of a hollow near Drill.

Section of Lower Banner coal bed three-quarters of a mile northwest of Drill.

(Location 478, elevation 2,520 B.)

	Ft.	in.
Sandstone, medium-grained	10	
Coal, dirty except at top		11
Sandstone, fine-grained	1	
Coal	2	8
Coal	3	7
Parting	1	

A coal bed that lies 60 or 70 feet above the Lower Banner is 29 inches thick at the side of the railroad gap a short distance southwest of location 478, but this thickness includes that of an 8-inch sandstone parting near the base. Slightly more than a mile south of Drill (location 479, elevation 2,430 B.) the Lower Banner coal is 22 inches thick. A pit on the west side of Grassy Creek (location 480, elevation 2,460 B.) shows the same bed to be 3 feet thick, the middle third being rather dirty. What is probably the Lower Banner is at least 3 feet thick on the upper part of Laurel Branch (location 481, elevation 2,396 S.) and is reported to be 44 inches thick.

WEAVER AND DUMPS CREEKS.

Geologic outline.—The area to be described includes only the drainage basins of Hart and Musick creeks, the valley of Weaver Creek itself and the region east of it being in faulted and folded pre-Pennsylvanian rocks, and Hurricane and Road forks of Dumps Creek. The Pennsylvanian rocks exposed include all of the series from its base to beds about 200 feet above the base of the Wise formation, but the Lee and the lower 200 feet of the Norton formation can be seen only southeast of the great fault, in the district in which they have been overturned and thrust up over younger strata. These rocks, shown on the geologic map in the undifferentiated Pennsylvanian pattern, dip steeply to the southeast at angles of 30 to 70 degrees, so that it is impossible to ascertain the exact stratigraphic succession in an area so heavily forested. The succession in less disturbed areas is shown by the columnar section for the south third of the Bucu quadrangle (Pl. IV), by numerous drill logs (Pl. III), and by local sections 12 and 29.

West of the faulted area dips are relatively very low and the structure is dominated by the Sourwood Mountain anticline, the axis of which trends from south to north. Dips are, in general, to the east on the east side of the anticline and to the west or northwest on the west side. Even near the fault the beds are not much disturbed, for the break appears to have been a sharp one that had little effect on the rocks on the northwest side of it.

This area contains some very important coal deposits. (See figs. 4, 5, and 21.) The Tiller and Jawbone beds are concealed below the surface in most of the region, but are believed to be thick, for reasons stated later. There are several coal beds between the Jawbone and Lower Banner beds, but they are thin in most places. The Garden Hole bed, however, is 3 to 4 feet thick, exclusive of partings, at the head of Skeen Creek, and the Kennedy about 3 feet thick in a few places.

The Lower and Upper Banner coal beds are being mined on a large scale at Wilder by the Clinchfield Coal Corporation. Mine 55, in the Lower Banner bed on both sides of Laurel Branch, is in coal 3½ to 4½ feet thick. Mine 6 in the Upper Banner is on the south side of Laurel Branch in coal 4 to 7½ feet thick, and an entry being driven southwest under Sandy Ridge toward the workings of mine 2 at the head of McClure River is in similarly thick coal. Both these mines are modern and well equipped in every way and have a large producing capacity. The product is shipped over a short spur of the C. C. & O. Railway to Kiser, on the N. & W. Railway. Elsewhere in the Road Fork district the Lower Banner is 3 to 7 feet thick, but

it is thinner in the Hart Creek district. Outside the mining district near Wilder a thickening of a shale parting separates the Upper Banner into two parts, the lower one of which is commonly worthless and the upper 2 to 4 feet thick. There are probably localities in which Norton coal beds higher than the Upper Banner, especially the Splash Dam, are 2 or 3 feet thick, but the only exposures seen were too thin to be considered workable. Beds in the Wise formation on Sandy Ridge may be fairly thick in places.

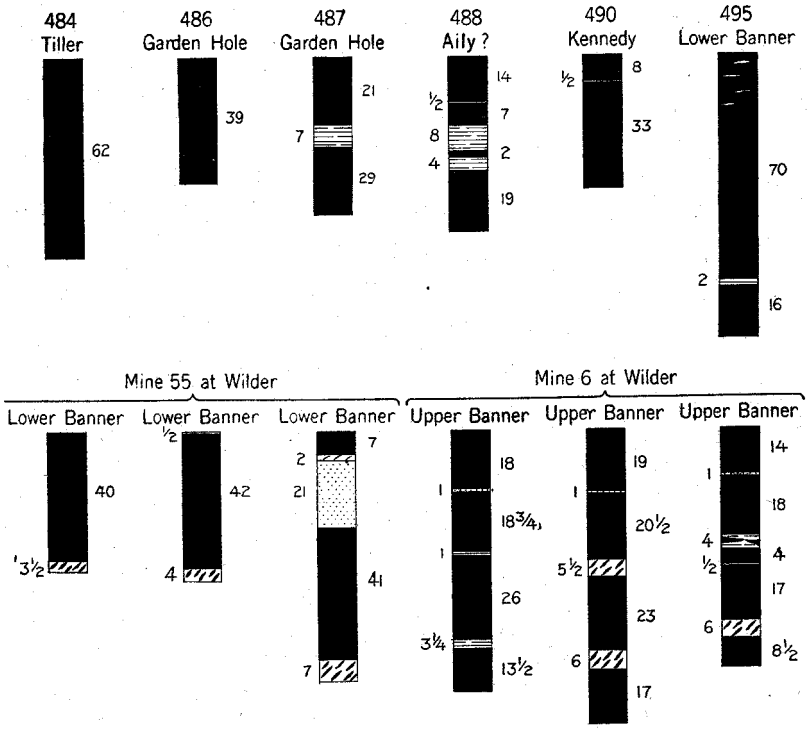


Fig. 21.—Sections of coal beds in the drainage basins of Weaver and Dumps creeks.

Outcrops not correlated.—Exposures are poor in the steeply dipping rocks mapped as undifferentiated Pennsylvanian and few coal beds were found among them. This fact is probably due in part, however, to a lack of thick coal deposits in the Lee formation of this area. One caved opening near the south boundary of the Bucu quadrangle (location 482, elevation 2,120 B.) is said to have been in coal a little more than 4 feet thick, but this report could not be verified. Another coal exposure, which may be of

the same bed, was found on a northeastern tributary of Hart Creek (location 483, elevation 1,950 B.), where coal 4 feet thick was seen and the total thickness may be 5 or 6 feet. The bed dips S. 35° E. at about 55° and is separated from a 50-foot, locally conglomeratic sandstone by about 2 feet of shale containing plants of lower Norton age. The fact that the shale, though now under the coal, has the characteristics of material overlying a coal bed indicates that the beds are overturned. The relations of the coal bed strongly resemble those of the Tiller.

Tiller and Jawbone coal beds.—The Tiller coal lies 850 to 950 feet below the Upper Banner horizon. The Jawbone is as much as 100 feet above the Tiller in parts of this area but, as shown by drill records (Pl. III), the two beds unite under a large part of the Hurricane Fork drainage basin. Where the beds are separated the interval between them is occupied chiefly by coarse-grained, siliceous sandstone that contains quartz pebbles. Both beds are below the surface except near the fault along Musick Creek, where the Tiller is 5 feet or more thick and the Jawbone probably thin. Where the two beds are united under part of the Hurricane Fork area they are probably much like the thick and valuable double bed that is exposed north of Sandy Ridge along the headwaters of Indian and Cane creeks. Both of the beds are probably also workable in much of the area in which they are separate; for the Jawbone includes 3½ to 8 feet of coal where it comes to the surface along Hurricane Fork south of and near the Bucu quadrangle and the Tiller is 4 to 5 feet thick at the "slope mine" of the Clinchfield Coal Corporation, the main entry of which has been driven nearly as far north as the quadrangle boundary south of Taylor triangulation station. The Jawbone coal is somewhat dirty along its outcrop.

The Tiller is 62 inches thick in a small mine 1.7 miles from the mouth of Musick Creek (location 484, elevation 1,850 B.), and has an overlying sandstone cap-rock more than 50 feet thick. A natural exposure of the same bed 1,200 feet down the creek contains 66 inches of coal at one end and twice as much at the other, the greater thickness probably being caused by folding. Coal in a small drift on the Tiller beside the Sourwood Mountain road (location 485, elevation 1,820 B.) is more than 57 inches thick.

Garden Hole and associated coal beds.—The Garden Hole coal bed, which is the lowest one exposed in most of this area, is 600 to 700 feet below the Upper Banner horizon and 150 to 230 feet above the Jawbone. It is below the surface along Road Fork and Hart Creek, except in the steeply dipping area, but is exposed along Hurricane Fork and Musick Creek

nearly to their heads. It is an excellent bed containing 3 to 4 feet of coal at the head of Skeen Creek, but is less than 30 inches thick elsewhere and is less than 14 inches thick in some localities. Two measurements were made near the head of Skeen Creek, the one farther north (location 486, elevation 2,210 C. C. C.) showing coal 39 inches thick. The other section, made at a small mine near the wagon road (location 487, elevation 2,210 C. C. C.), includes a 7-inch shale parting with coal 21 inches thick above it and 29 inches thick below it. The roof is an 8-inch draw shale under sandstone.

There are several more or less lenticular coal beds between the Garden Hole and the Jawbone and between the Garden Hole and the Kennedy, but none of them is of much commercial importance, as a thickness of as much as 2 feet is exceptional. The thickest measurement obtained is the following, which may be the Aily bed, here only 40 feet below the Kennedy horizon:

Section of Aily (?) coal bed on Sourwood Mountain.

(Location 488.)

	Ft.	in.
Shale	3	
Coal	1	2
Shale		½
Coal		7
Shale		8
Coal		2
Shale		4
Coal	1	7
Coal	3	6
Partings	1	½

Kennedy coal bed.—The Kennedy is 300 to 380 feet below the Upper Banner horizon. It is a very thin and commercially unimportant bed in most of this area, but is moderately thick at a few places. In an opening by the road on Hart Creek (location 489, elevation 1,948 S.) coal 30 inches thick may possibly be the Kennedy. The bed is exceptionally thick at the head of a tributary of Hurricane Fork, a mile west of Dumps Creek School (location 490, elevation 2,340 B.), where it is 41½ inches thick, including half an inch of shale, and has a sandy shale roof at least 8 feet thick. The coal is only 23 inches thick in a railroad cut near Wilder (location 491, elevation 2,070 B.), and is overlain by a 50-foot bed of fine-grained sandstone and underlain by coarser sandstone of the same thickness.

Lower Banner coal bed.—The Lower Banner coal is 200 to 270 feet above the Kennedy and 100 to 140 feet below the Upper Banner. It has

been spared by erosion only along Hart Creek and on the ridges on both sides and at the head of Road Fork. In the latter district it is being mined on a large scale by the Clinchfield Coal Corporation, and is a clean bed containing about 3 to 7 feet of coal and very little shale in the form of partings. In the Hart Creek district it is thin in most places, though fairly thick in the pits described below.

The Lower Banner is at least 3 feet thick, and perhaps thicker, in a pit near the level of Hart Creek three-quarters of a mile southeast of Rasnake (location 492, elevation 2,125 B.). An opening at the head of the branch of Musick Creek at Rasnake (location 493, elevation 2,450 H. L.) shows 2 benches of 15-inch coal separated by clay shale 8 inches thick. The roof is a thick sandstone bed.

The following two sections show the character of the bed between Hurricane and Road forks, though the first is thinner than the average and the second is exceptionally thick. The first section is at the south boundary of the quadrangle, at the head of a tributary of Hurricane Fork; the second is on a spur near the mouth of Negro Camp Branch.

Sections of Lower Banner coal bed on east side of Road Branch.

(Location 494, elevation 2,445 B.)

	Ft.	in.
Shale	20	
Coal		6
Shale		11
Coal	2	2
Shale		½
Coal		11
Coal	3	7
Partings		11½

(Location 495, elevation 2,290 B.)

	Ft.	in.
Shale	4	
Coal, dirty at top	5	10
Clay		2
Coal, reported	1	4
Coal	7	2
Parting		2

In most parts of mine 55 of the Clinchfield Coal Corporation, on both sides of Laurel Branch near Wilder (one entrance at location 496, elevation 2,275 C. C. C.), the Lower Banner is 3½ to 4½ feet thick and shale partings are absent or very thin. The floor is, in general, a compact shale and the roof either shale or sandstone. Thin layers of "rash" occur both at the top and at the bottom of the coal. Analyses of mine samples are given elsewhere in this report.

Upper Banner coal bed.—The distribution of the Upper Banner is much the same as that of the Lower Banner. In the Hart Creek district and the northern part of the Road Fork drainage basin the bed is split into two parts by the thickening of a shale parting, the upper bench being 2 to 4

feet thick and the lower bench worthless or nearly so. Near Wilder, and especially south of Laurel Branch, the shale parting thins to a few inches and both benches can be easily mined together. In the Wilder district the layers of coal aggregate 4 to 7½ feet in thickness and are being mined on a large scale.

The character of the upper bench of the bed in the Hart Creek district is shown by the following two sections:

Sections of upper bench of Upper Banner coal bed near Rasnake.

(Location 497, elevation 2,340 B.)

	Ft.	in.
Sandstone	20	
Coal		2
Shale		3
Coal		6
Sandstone		1
Coal	2	4
Coal	3	
Partings		4

(Location 498, elevation 2,460 B.)

Shale.	Ft.	in
Coal		3
Shale		1
Coal		4
Sandstone		1
Coal	1	10
Coal	2	5
Partings		2

The details of the Upper Banner bed where both parts are united are illustrated by the following measurements made in mine 6 of the Clinchfield Coal Corporation, the workings of which are south of Laurel Branch (main entrance at location 499, elevation 2,402 C. C. C.):

Sections of Upper Banner coal bed in mine 6 at Wilder.

Shale.	Ft.	in.
Coal	1	7
Sandstone		1
Coal	1	8½
"Rash"		5½
Coal	1	11
"Rash"		6
Coal	1	5
Shale.		
Coal	6	7½
Partings	1	½

Sandstone.	Ft.	in.
Coal	1	2
Sandstone		1
Coal	1	6
"Rash"		4
Coal		4
Shale		½
Coal	1	5
"Rash"		6
Coal		8½
Shale.		
Coal	5	1½
Partings		11½

AMOUNT OF ULTIMATELY AVAILABLE COAL.

Actual mining operations in Europe have shown that coal of lower grade than that in southwest Virginia can be profitably mined in beds only 14 inches thick and at depths greater than any to which it would be necessary to shaft for any bed in these quadrangles. The tonnages in the following table, therefore, include parts of beds in which the aggregate thickness of coal layers is 14 inches or more, and are on the basis of 1,800 tons of coal per acre-foot.

Although these tables were carefully prepared by T. K. Harnsberger, they are necessarily only rough estimates. The figures for beds which are below the surface in large areas are, of course, most likely to be in error. The calculated totals, though enormous, are thought to be very conservative estimates. The amount of coal already mined or made unavailable by mining operations is comparatively so small as to be negligible, being only one or two hundredths of one per cent of the total original tonnage.

Amount of coal in the Virginia portion of the Clintwood and Bucu quadrangles.

Clintwood quadrangle.

	Acres.	Tons.
Wise formation:		
Clintwood	6,250	37,125,000
Eagle	6,720	27,059,000
Glamorgan	27,610	87,708,000
Other beds	.....	85,622,000
Norton formation:		
Splash Dam	66,110	224,415,000
Upper Banner	88,830	427,201,000
Lower Banner	99,220	381,973,000
Other beds above Kennedy	.....	155,568,000
Kennedy	94,700	340,306,000
Garden Hole	106,190	423,189,000
Jawbone	90,160	418,630,000
Other beds below Kennedy	.....	369,492,000
Lee formation:		
All beds	.....	1,498,749,000
		4,477,037,000

Bucu quadrangle.

	Acres.	Tons.
Wise formation:		
Clintwood	2,680	10,800,000
Eagle	3,750	28,698,000
Glamorgan	10,830	40,026,000
Other beds	.....	43,132,000
Carried forward	.....	122,656,000

	Acres.	Tons.
Brought forward	.....	122,656,000
Norton formation:		
Splash Dam	47,480	186,929,000
Upper Banner	26,720	117,852,000
Lower Banner	42,720	169,139,000
Other beds above Kennedy	.....	130,035,000
Kennedy	103,110	446,227,000
Garden Hole	116,670	427,602,000
Jawbone	122,960	536,657,000
Tiller	122,720	529,916,000
Other beds below Kennedy	.....	1,091,461,000
Lee formation:		
All beds	.....	2,131,908,000
		5,890,382,000

Of the grand total of 10,367,419,000 tons, only about 60 per cent would be recovered, even under the most favorable mining conditions, leaving about 6,220,450,000 tons as a possible production. At the present rate of consumption of bituminous coal, this would supply all of the United States for thirteen or fourteen years. It must be remembered, however, that much of this coal is in beds that are too thin or too far beneath the surface to be profitably mined and sold in competition with coal from more cheaply mined beds now being exploited in the Appalachian coal field. Beds which can not be used to-day, however, are certain to be highly valued at some time in the future.

CHARACTERS AND QUALITY OF THE COALS.

Analyses.

METHOD OF SAMPLING AND ANALYZING.

The analyses on succeeding pages were made from samples collected by members of the State and Federal geological surveys and the United States Bureau of Mines in the Clintwood and Bucu quadrangles or neighboring areas on the west and south. Samples collected before July 1, 1910, were analyzed by the United States Geological Survey, and those taken after that date by the United States Bureau of Mines.

In taking a sample of coal for analysis every effort was made to procure fresh, unweathered coal that would represent as nearly as possible the product of the mine. The bed was faced up and carefully cleaned, for a distance of three feet or more on each side of the point selected for sampling, special care being taken to remove all loose fragments of "slate" from the roof and deposited powder smoke from the coal. A uniform cut, of sufficient

size to yield about 6 pounds of coal for each foot of thickness of the bed, was then made from roof to floor. All partings or binders more than three-eighths of an inch thick and all concretions or "sulphur-balls" having a maximum diameter greater than 2 inches and a thickness of more than half an inch were excluded from the sample. The material thus obtained was crushed until it would pass through a ½-inch mesh and was then thoroughly mixed and reduced by quartering until about 4 pounds remained. The product was placed in a galvanized-iron can, sealed in the mine with adhesive tape, and mailed as soon as possible 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 given under form B. Forms A, C, and D are calculated from form B. Form A represents the coal as it is collected. Form C represents the theoretical condition of the coal if all the moisture were removed, and form D if both moisture and ash were removed.

DESCRIPTION OF SAMPLES.

18239, 18240, 18241, and 18242.—Samples were collected in No. 201 slope mine of the Clinchfield Coal Corporation, on Hurricane Fork of Dumps Creek, about 1 mile south of the Bucu quadrangle, November 26, 1913. Sample 18239 was obtained in the main entry, 4,900 feet N. 30° W. of bottom of slope; sample 18240, about 1,200 feet N. 64° W. of slope and 800 feet west of main entry; and sample 18241 in a right heading about 800 feet from main entry and 2,600 feet N. 20° W. of slope. Sample 18242 was a composite made by mixing 18239, 18240, and 18241.

Sections of Tiller coal bed at points sampled in Clinchfield No. 201 mine.

	18239		18240		18241	
	Ft.	in.	Ft.	in.	Ft.	in.
"Rash"	[a]0	9	..	..	..	..
Coal	2	0	1	9½	1	4½
Shale	..	..	[a]0	5	[a]0	3½
Sandstone	[a]0	3	..	..	..	..
Coal	3	1	2	3	2	3
Included in sample	5	1	4	½	3	7½
Excluded from sample	1	0	0	5	0	3½

[a] Not included in sample.

5217 and 5235.—Samples were collected in the Virginia City No. 1, a slope mine at Virginia City, Va., July 26, 1907. Sample 5217 was obtained in room 8, off the first cross-heading, 2,400 feet northwest of mine opening; sample 5235, in a break-through between the third and fourth cross-entries, 3,200 feet northwest of mine opening.

Sections of Jawbone coal bed at points sampled in Virginia City No. 1 mine.

	5217		5235	
	Ft.	in.	Ft.	in.
Coal	0	6½	0	5
Sandstone	..	..	[a] 0	¼
"Rash"	[a] 0	2	..	..
Coal	1	9½	0	2
"Rash"	..	..	[a] 0	½
Bone coal	0	2	..	..
Coal	1	5	1	4½
Shale and coal	..	..	[a] 0	7
Bone coal	0	2	0	3
Coal	4	½	4	6
Included in sample	8	1½	6	8½
Excluded from sample	0	2	0	7¾

22346.—Sample collected in the Jackson mine, a small local drift mine, 3 miles northwest of Honaker, Va., and near the southeast corner of the Bucu quadrangle (location 474 on map), May 25, 1915. The sample was obtained in the first right entry, 600 feet northwest of mine opening.

Section of coal bed at point sampled in Jackson mine.

	22346	
	Ft.	in.
Coal	1	0
"Rash"	0	⅛
Coal	1	9½
Clay	[a] 0	½
Coal	0	7
Included in sample	3	4⅝
Excluded from sample	0	½

18121-F.—Sample collected from the Kennedy coal bed in mine No. 103 of the Clinchfield Coal Corporation, 1 mile northwest of Dante, Va., November 17, 1913. The sample was obtained in the main entry, 260 feet N. 55° W. of mine opening and represents 5 feet 2 inches of coal, the entire thickness of the bed.

[a] Not included in sample.

17559, 17560, and 17561-F.—Samples collected from a small local drift mine, half a mile north of Nora (location 139 on map), July 12, 1913. Sample 17559 was cut 300 feet east of drift mouth; and sample 17560, about 300 feet northeast of drift mouth. Sample 17561-F was a composite made by mixing 17559 and 17560.

Sections of Kennedy coal bed at points sampled in mine half a mile north of Nora.

	17559		17560	
	Ft.	in.	Ft.	in.
Coal	0	6⅜	0	5½
Bone	0	¼	0	⅛
Coal	1	3	0	6¼
"Rash"	0	⅛	..	..
Shale	..	..	[a]0	1¾
Coal	0	3¾	0	5¾
"Rash"	0	¼	..	..
Bone	..	..	0	¼
Coal	0	2⅝	0	8
"Rash"	0	⅛	..	..
Coal	0	4	..	..
Included in sample	2	8½	2	1⅞
Excluded from sample	0	0	0	1¾

19484.—Sample collected from the Kennedy coal bed in the Drill mine of the Honaker Lumber Company at Drill (location 475 on map), June 5, 1914. The sample was cut about 450 feet northeast of drift mouth, and represents 4 feet of coal, the entire thickness of the bed.

22345-F.—Sample collected from the Kennedy coal bed in the Sandy Ridge mine of the Sandy Ridge Coal & Coke Company, three-quarters of a mile south of Drill (location 477 on map), May 25, 1915. The sample was cut in the north drift, 170 feet S. 70° W. of entrance, and represents 2 feet 9 inches of coal, the entire thickness of the bed.

19528.—Sample collected from the Kennedy coal bed in the Sandy Ridge mine of the Sandy Ridge Coal & Coke Company, three-quarters of a mile south of Drill (location 477), June 15, 1914. The sample was obtained from the south drift in room off main entry, 150 feet north of mine mouth, and represents 2 feet 10 inches of coal, the entire thickness of the bed.

18122, 18123, and 18124-F.—Samples were collected in mine No. 52 of the Clinchfield Coal Corporation at Dante, Va., November 17, 1913.

[a] Not included in sample.

Sample 18122 was cut 325 feet northeast of entrance to No. 0 drift; and sample 18123, about 1,700 feet southwest of entrance to No. 1 drift. Sample 18124-F was a composite obtained by mixing 18122 and 18123.

Sections of Lower Banner coal bed at points sampled in Clinchfield No. 52 mine.

	18122		18123	
	Ft.	in.	Ft.	in.
Coal	3	0	2	6½
Coal and shale	..	..	[a]0	2
Included in sample	3	0	2	6½
Excluded from sample	0	0	0	2

10385.—Sample collected from the Lower Banner bed in mine No. 52 (called Clinchfield when sampled) of the Clinchfield Coal Corporation at Dante, Va., April 30, 1910. The sample was cut in the main entry, 150 feet from the mine mouth, and represents 2 feet 4 inches of coal.

4057.—Sample was collected in mine No. 51 (called No. 2 when sampled) of the Clinchfield Coal Corporation at Dante, Va., October 4, 1906. The sample was obtained in room 4 off the left entry.

Section of Lower Banner coal bed at point sampled on Clinchfield No. 51 mine.

	4057	
	Ft.	in.
Coal, alternate bright and dull bands	1	7
Coal, laminated	0	3
Coal, solid	1	5
Clay	[a]0	6
Coal, bright	[a]0	2
Included in sample	3	3
Excluded from sample	0	8

18243, 18244, 18245, and 18246.—Samples collected in mine No. 55 of the Clinchfield Coal Corporation at Wilder, Va. (location 496 on map), November 25, 1914. Sample 18243 was obtained 900 feet S. 60° W. of No. 3 opening; sample 18244, about 2,500 feet S. 35° E. of No. 5 opening; and sample 18245, about 1,300 feet N. 35° W. of No. 2 opening. Sample 18246 was a composite made by mixing 18243, 18244, and 18245.

[a] Not included in sample.

Sections of Lower Banner coal bed at points sampled in Clinchfield No. 55 mine.

	18243		18244		18245	
	Ft.	in.	Ft.	in.	Ft.	in.
Coal	..	..	0	7	..	..
"Rash"	..	..	[a]0	2	..	..
Sandstone	..	..	[a]1	9	..	..
"Rash"	..	..	..	..	[a]0	½
Coal	3	4	3	5	3	6
"Rash"	[a]0	3½	[a]0	7	[a]0	4
Included in sample	3	4	4	0	3	6
Excluded from sample	0	3½	2	6	..	4½

18226, 18227, 18228, and 18229-F.—Samples were collected in the Cranesnest No. 1 mine of the Clinchfield Coal Corporation, about 1½ miles northwest of Toms Creek station, November 22, 1913. Sample 18226 was obtained 1,500 feet southwest of entrance to main Caney entry (location 114 on map); sample 18227, about 500 feet northeast of main Caney entry; and sample 18228, about 4,100 feet southeast of main Caney entry. The main Caney entry (location 114 on map) is on Hurricane Fork of Caney Creek, about 1½ miles northeast of the main entrance to mine. Sample 18229-F was a composite made by mixing 18226, 18227, and 18228.

Sections of Upper Banner coal bed at points sampled in Cranesnest mine.

	18226		18227		18228	
	Ft.	in.	Ft.	in.	Ft.	in.
Coal	0	1½	..	..	..	..
Sandy shale	[a]0	½	..	..	..	..
Coal	2	0	1	10	2	10
Sandstone	[a]0	1	[a]0	1	[a]0	1
Coal	1	7½	2	2	1	5¾
Coal and shale	[a]0	2½	..	..	..	..
Shale	..	..	..	..	0	¼
Coal	0	3½	..	..	0	3
Shale	[a]0	4	..	..	[a]0	5
Coal	0	2	..	..	0	6
Shale	[a]0	1¾	..	..	0	⅛
Coal	0	10	..	..	0	9½
Included in sample	5	½	4	0	5	10⅝
Excluded from sample	0	9¾	0	1	0	6

10386.—Sample collected from the Swansea mine of the Virginia Iron, Coal & Coke Company, Toms Creek, Va., April 29, 1910. The sample was taken in room 21, off west entry 17, about 2,600 feet from the outcrop.

[a] Not included in sample.

Section of Upper Banner coal bed at point sampled in Swansea mine.

	10386 Ft.	in.
Coal	2	4
Sandstone	[a]0	1½
Coal	1	8
Bone	[a]1	5
Coal	2	7
Included in sample	6	7
Excluded from sample	1	6½

2281 and 2282.—Samples collected from the Coeburn mine of the Virginia Iron, Coal & Coke Company at Toms Creek, Va., October 7, 1905. Sample 2281 was obtained in east heading 17, about 3,000 feet northeast of the mine opening; and sample 2282 in room 3, off west entry 11, about 2,000 feet northeast of mine opening.

Sections of Upper Banner coal bed at points sampled in Coeburn mine.

	2281 Ft.	in.	2282 Ft.	in.
Coal	2	2½	0	10
Sandstone	[a]0	1½	..	..
Mother coal	..	..	0	¼
Coal	1	6	1	6
Shale	[a]0	1½	..	..
Sandstone	..	..	[a]0	1
Coal	[a]0	2	1	8
Shale	[a]0	2	[a]0	1
Coal	[a]0	6	[a]0	2
Shale	[a]0	1½	[a]0	3
Coal	1	8	[a]0	6
Mother coal	0	¼	..	..
Shale	..	..	[a]0	1
Coal	1	0	2	7
Included in sample	6	4¾	6	7¼
Excluded from sample	1	2½	1	2

18128, 18129, 18130, 18131-F.—Samples collected in No. 2 mine of the Clinchfield Coal Corporation, 1¾ miles northeast of Dante, Va., November 18, 1913. Sample 18128 was obtained 2,400 feet N. 18° W. of entrance to drift No. 3, McClure; 18129, about 2,750 feet S. 78° E. of entrance to drift No. 5, tunnel line (on Middle Fork of Lick Creek); and 18130, about 3,400 feet S. 85° E. of entrance to drift No. 1, McClure. Sample 18131-F was a composite made by mixing 18128, 18129, and 18130.

[a] Not included in sample.

Sections of Upper Banner coal bed at points sampled in Clinchfield No. 2 mine.

	18128		18129		18130	
	Ft.	in.	Ft.	in.	Ft.	in.
Coal	1	10	1	4	1	6
Sandstone	[a]0	1½	[a]0	1	[a]0	1
Coal	1	2½	1	2	1	5
Sandstone	[a]0	½	..	..	[a]0	1
Shale	..	..	[a]0	1	..	..
Coal	2	5	1	6	1	10
Included in sample	5	5½	4	0	4	9
Excluded from sample	0	2	0	2	0	2

10734, 10735, and 10736.—Samples collected in mine No. 2 of the Clinchfield Coal Corporation, 1¾ miles northeast of Dante, Va., August 13, 1910. Sample 10734 was obtained at face of butt-heading, off the fourth left drift off the McClure entry; and sample 10735 in room 16, off right heading 3, off the first drift off McClure entry. Sample 10736 was a composite made by mixing 10734 and 10735.

Sections of Upper Banner coal bed at points sampled in Clinchfield No. 2 mine.

	10734		10735	
	Ft.	in.	Ft.	in.
Coal	0	8½	0	6¾
Coal (hard)	0	3½	0	5
Coal	0	5¾	0	7
Sandstone	[a]0	¾	[a]0	1½
Coal	1	4	1	4
Shale	[a]0	¾	[a]0	2¾
Coal	0	5	0	6
Coal (hard)	0	5	0	3¾
Coal	1	5¼	1	1
Included in sample	5	1	4	9½
Excluded from sample	0	1½	0	4¼

10737, 10738, and 10739.—Samples collected in mine No. 5 of the Clinchfield Coal Corporation, 1½ miles northeast of Dante, Va., August 10, 1910. Sample 10737 was obtained at the face of room 14, right heading 5, off drift 9; and sample 10738, from the butt, on left heading 9, off drift 9. Sample 10739 was a composite obtained by mixing 10737 and 10738.

[a] Not included in sample.

Sections of Upper Banner coal bed at points sampled in Clinchfield No. 5 mine.

	10737		10738	
	Ft.	in.	Ft.	in.
Coal	0	4¾	1	10½
Mother coal	..	..	0	⅜
Coal	1	4¾	0	4⅝
Sandstone	[a]0	1½	[a]0	1¾
Coal	0	10	0	4½
Shale	[a]0	¾	[a]0	½
Coal	1	4¼	1	1
Mother coal	0	⅛	..	..
Coal	1	⅜	1	6
Included in sample	5	¼	5	3
Excluded from sample	0	2¼	0	2¼

10387.—Sample collected in mine No. 3 of the Clinchfield Coal Corporation at Dante, Va., April 30, 1910. The sample was obtained in the fourth right entry, 1,000 feet from mine mouth.

Section of Upper Banner coal bed at point sampled in Clinchfield No. 3 mine.

	10387	
	Ft.	in.
Coal	0	2½
Parting	[a]0	2
Coal	1	6
Sandstone	[a]0	1
Coal	1	2½
Parting	[a]0	1
Coal	1	11½
Included in sample	4	10½
Excluded from sample	0	4

3942.—Sample collected in mine No. 2 (called No. 3 when sampled) of the Clinchfield Coal Corporation, 1¾ miles northeast of Dante, October 4, 1906. The sample was cut in butt entry 6, off the main entry.

Section of Upper Banner coal bed at point sampled in Clinchfield No. 2 mine.

	3942	
	Ft.	in.
Coal	1	10
Sandstone	[a]0	1
Coal	0	10
Shale, gritty	[a]0	½
Coal	2	5
Included in sample	5	1
Excluded from sample	0	1½

[a] Not included in sample.

18235, 18236, 18237, 18238.—Samples collected in mine No. 6 of the Clinchfield Coal Corporation at Wilder, Va. (location 499 on map), November 25, 1913. Sample 18235 was obtained 3,000 feet S. 71° W. of No. 1 drift; sample 18236 in room 5, about 1,250 feet S. 35° E. of No. 3 opening; and sample 18237, about 4,000 feet S. 10° W. of No. 3 opening. Sample 18238 was a composite obtained by mixing 18235, 18236, and 18237.

Sections of Upper Banner coal bed at points sampled in Clinchfield No. 6 mine.

	18235		18236		18237	
	Ft.	in.	Ft.	in.	Ft.	in.
Coal	1	6	1	2	1	7
Sandstone	[a]0	1	[a]0	1	[a]0	1
Coal	1	6¾	1	6¼	1	8½
Shale	[a]0	1	..	..	[a]0	1
Coal and shale	..	..	[a]0	4¼	..	..
"Rash"	..	..	..	..	[a]0	4½
Coal	2	2	0	4¼	1	11
Shale	[a]0	3¼	[a]0	½	..	..
"Rash" and clay	..	..	..	..	[a]0	6
Coal	1	1½	1	5	1	5
Coal and shale	..	..	[a]0	6	..	..
Coal	..	..	0	8½	..	..
Included in sample	6	4¼	5	2	6	7½
Excluded from sample	0	5¼	0	11¾	1	½

17751 and 17752.—Samples collected from small local drift mine of C. C. Owens on Russell Prater Creek, 1 mile above mouth (location 345 on map), September 19, 1913. Sample 17751 was obtained 75 feet east of drift mouth and 10 feet north of main drift; sample 17752, about 25 feet south of 17751.

Sections of Splash Dam coal bed at points sampled in C. C. Owens mine.

	17751		17752	
	Ft.	in.	Ft.	in.
Coal	0	8½	1	8
"Rash"	0	¼	..	..
Shale	..	..	[a]0	½
Coal	0	11	0	2
Shale	0	¼	[a]0	1
Coal	0	2	0	3½
Shale	[a]0	1¼	..	..
Shale and pyrites	..	..	0	¼
Coal	0	7½	0	4
Included in sample	2	5½	2	5¾
Excluded from sample	0	1¼	0	1½

[a] Not included in sample.

15100 and 15101.—Samples collected in Glamorgan No. 3 mine of the Stone Gap Colliery Company at Glamorgan, Va., November 5, 1912. Sample 15100 was obtained at the face of the second dip entry, 6,000 feet from the mine mouth; sample 15101, at the face of the Glady entry, 7,000 feet from the mine mouth.

Sections of Glamorgan coal bed at points sampled in Glamorgan No. 3 mine.

	15100		15101	
	Ft.	in.	Ft.	in.
Coal	1	9	..	..
Bone	[a]0	1	..	..
Coal	1	10	3	8
Bone	[a]0	1½	[a]0	1
Coal	0	8	0	7
Included in sample	4	3	4	3
Excluded from sample	0	2½	0	1

17743 and 17744.—Sample collected in small local drift mine of the Yellow Poplar Lumber Company on Slate Branch of Barts Lick Creek, 3 miles east of the mouth of Pound River (location 387 on map), September 17, 1913. Sample 17743 was obtained 200 feet east of entrance to mine; and sample 17744, about 220 feet N. 85° E. of entrance to mine.

Sections of Eagle coal bed at points sampled in Yellow Poplar Lumber Co. mine.

	17743		17744	
	Ft.	in.	Ft.	in.
Coal, pyritiferous	[a]0	8	[a]0	9½
Shale	[a]0	7	[a]0	6½
Coal	0	3	0	3
"Rash"	0	⅛	0	¼
Coal	0	9½	0	8⅛
Bone	[a]0	1	[a]0	1
Coal	1	1½	1	2⅞
Sandstone	[a]0	1½	[a]0	1
Coal	1	3	1	3½
Included in sample	3	5⅛	3	5¾
Excluded from sample	1	5½	1	6

14767.—Sample collected in Elbert Powers small local drift mine on Big Ridge, 5½ miles south of Clintwood, Va. (location 73 in map), September 17, 1912. The sample was cut 20 feet from the drift mouth.

[a] Not included in sample.

Section of Clintwood coal bed at point sampled in Elbert Powers mine.

	14767 Ft.	in.
Coal	[a] 2	7½
Bone	[a] 0	7
Coal	1	11
"Rash"	0	¾
Coal	0	3½
"Rash"	0	¾
Coal	2	4
Included in sample	4	8
Excluded from sample	3	2½

14766.—Sample collected in John A. Yeates small local drift mine, 1 mile southwest of Clintwood, Va., September 21, 1912. The sample was cut at the end of right entry 1, off the main entry, and 100 feet from the main entry.

Section of Clintwood coal bed at point sampled in Yeates mine.

	14766 Ft.	in.
Bone	0	1
Coal	0	9
Bone	0	2
Coal	0	8½
Bone	0	1¼
Coal	0	3½
Bone	0	1½
Coal	0	3
Bone	0	1
Coal	1	8
Included in sample	4	2¾

3827.—Sample collected in the Chase and Damron local drift mine, three-quarters of a mile south of Clintwood, Va. (location 65 on map), September 21, 1906. The sample was taken at the face of a drift about 150 feet from the main entry.

Section of Clintwood coal bed at point sampled in Chase and Damron mine.

	3827 Ft.	in.
Coal	4	4
Pyrite	[a] 0	2
Coal	[a] 1	9
Included in sample	4	4
Excluded from sample	1	11

[a] Not included in sample.

Table of analyses of coal samples from mines in and near the Clintwood and Bucu quadrangles, Virginia.

A = analysis of sample as received, B = air-dried, C = moisture free, D = moisture and ash free.

Coal bed.	Name and location of mine.	Collector.	Laboratory 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.
Tiller	No. 201 of the Clinchfield Coal Corporation on Hurricane Fork of Dumps Creek.	T. K. Harnsberger	18239	1.0	A	1.8	31.4	60.3	6.5	0.52	.....	.....	.....	.....	7,880	14,180
					B	.8	31.8	60.9	6.5	.53	.....	.....	.....	.....	7,960	14,330
					C	.....	32.0	61.4	6.6	.53	.....	.....	.....	.....	8,025	14,440
					D	.....	34.3	65.7	.....	.57	.....	.....	.....	.....	8,590	15,460
Do	do	do	18240	1.8	A	2.5	31.9	59.5	6.1	.44	.....	.....	.....	.....	7,820	14,070
					B	.8	32.4	60.6	6.2	.45	.....	.....	.....	.....	7,960	14,330
					C	.....	32.7	61.1	6.2	.45	.....	.....	.....	.....	8,020	14,430
					D	.....	34.9	65.1	.....	.48	.....	.....	.....	.....	8,555	15,400
Do	do	do	18241	1.9	A	2.4	32.5	58.4	6.7	.49	.....	.....	.....	.....	7,790	14,020
					B	.6	33.1	59.5	6.8	.50	.....	.....	.....	.....	7,940	14,290
					C	.....	33.3	59.8	6.9	.50	.....	.....	.....	.....	7,985	14,380
					D	.....	35.7	64.3	.....	.54	.....	.....	.....	.....	8,575	15,440
Do	do	do	18242	1.6	A	2.2	31.9	59.4	6.50	.46	5.11	79.69	1.04	7.20	7,840	14,110
					B	.6	32.5	60.3	6.60	.47	5.02	80.94	1.06	5.91	7,960	14,330
					C	.....	32.7	60.7	6.65	.47	4.98	81.48	1.06	5.36	8,015	14,430
					D	.....	35.0	65.0	.....	.50	5.33	87.28	1.14	5.75	8,585	15,460
Jawbone	Virginia City No. 1, at 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	29.3	54.3	15.2	1.20	.....	.....	.....	.....	7,060	12,710
					C	.....	29.6	54.9	15.5	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
Ally(?)	Jackson, a small local mine, 3 miles northwest of Honaker, Va.	T. K. Harnsberger	22346	1.1	A	2.5	34.2	50.7	12.6	.94	.....	.....	.....	.....	7,140	12,850
					B	1.4	34.6	51.3	12.7	.95	.....	.....	.....	.....	7,215	12,990
					C	.....	35.1	52.0	12.9	.96	.....	.....	.....	.....	7,320	13,170
					D	.....	40.3	59.7	.....	1.10	.....	.....	.....	.....	8,410	15,140

Table of analyses of coal samples from mines in and near the Clintwood and Bucu quadrangles, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Laboratory 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	No. 103 of the Clinchfield Coal Corporation, 1 mile northwest of Dante, Va.	T. K. Harnsberger	18121F	1.9	A	2.9	31.9	57.8	7.4	1.78	.....	.....	.....	.....	7,655	13,780
					B	1.0	32.5	58.9	7.6	1.81	.....	.....	.....	.....	7,800	14,040
					C	.....	32.8	59.6	7.6	1.83	.....	.....	.....	.....	7,880	14,190
					D	.....	35.5	64.5	.....	1.98	.....	.....	.....	.....	8,535	15,360
Do	Small local mine on McClure River, ½ mile north of Open Fork.	Henry Hinds	17559	1.8	A	2.6	25.5	61.0	10.9	.70	.....	.....	.....	.....	7,470	13,440
					B	.9	25.9	62.1	11.1	.71	.....	.....	.....	.....	7,605	13,690
					C	.....	26.1	62.7	11.2	.72	.....	.....	.....	.....	7,670	13,810
					D	.....	29.5	70.5	.....	.81	.....	.....	.....	.....	8,640	15,550
Do	do	do	17560	1.7	A	2.6	26.0	63.2	8.2	.73	.....	.....	.....	.....	7,725	13,910
					B	.9	26.5	64.3	8.3	.74	.....	.....	.....	.....	7,860	14,150
					C	.....	26.7	64.9	8.4	.75	.....	.....	.....	.....	7,935	14,290
					D	.....	29.2	70.8	.....	.82	.....	.....	.....	.....	8,660	15,590
Do	do	do	17561F	1.8	A	2.6	26.2	61.7	9.48	.74	4.75	77.60	1.57	5.86	7,575	13,640
					B	.9	26.6	62.8	9.65	.75	4.64	78.98	1.60	4.38	7,710	13,880
					C	.....	26.9	63.4	9.74	.76	4.58	79.70	1.61	3.61	7,780	14,010
					D	.....	29.8	70.2	.....	.84	5.07	88.30	1.78	4.01	8,620	15,520
Do	Honaker Lumber Company mine at Drill, Va.	C. M. Bauer	19484	.8	A	2.1	32.4	58.7	6.8	1.01	.....	.....	.....	.....	.....	.....
					B	1.3	32.6	59.2	6.9	1.02	.....	.....	.....	.....	.....	.....
					C	.....	33.1	60.0	6.9	1.03	.....	.....	.....	.....	.....	.....
					D	.....	35.5	64.5	.....	1.11	.....	.....	.....	.....	.....	.....
Do	Sandy Ridge Coal and Coke Company mine, ¾ of a mile south of Drill, Va.	T. K. Harnsberger	22345F	3.5	A	4.7	30.8	59.4	5.14	.96	5.43	78.33	1.40	6.74	7,760	13,960
					B	1.2	31.9	61.6	5.33	1.00	5.22	81.18	1.45	5.82	8,040	14,470
					C	.....	32.3	62.3	5.39	1.01	5.15	82.17	1.47	4.81	8,140	14,650
					D	.....	34.1	65.9	.....	1.07	5.44	86.85	1.55	5.09	8,600	15,480
Do	do	C. M. Bauer	19528	1.8	A	3.2	33.1	57.7	6.0	.96	.....	.....	.....	.....	.....	.....
					B	1.4	33.7	58.8	6.1	.98	.....	.....	.....	.....	.....	.....
					C	.....	34.2	59.6	6.2	.99	.....	.....	.....	.....	.....	.....
					D	.....	36.4	63.6	.....	1.06	.....	.....	.....	.....	.....	.....

Table of analyses of coal samples from mines in and near the Clintwood and Bucu quadrangles, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Laboratory 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.
Lower Banner ..	No. 52 of the Clinchfield Coal Corporation at Dante, Va.	T. K. Harnsberger ..	18122	1.6	A	2.5	35.6	56.2	5.7	0.66	.....	.....	.....	.....	7,930	14,280
					B	.9	36.1	57.2	5.8	.67	.....	.....	.....	.....	8,060	14,510
					C	.....	36.4	57.7	5.9	.68	.....	.....	.....	.....	8,135	14,640
					D	.....	38.7	61.3	.....	.72	.....	.....	.....	.....	8,640	15,550
Do.....	.....do.....	.....do.....	18123	1.1	A	2.0	35.7	54.5	7.8	.66	.....	.....	.....	.....	7,685	13,830
					B	.9	36.1	55.1	7.9	.67	.....	.....	.....	.....	7,770	13,990
					C	.....	36.4	55.6	8.0	.67	.....	.....	.....	.....	7,840	14,110
					D	.....	39.5	60.5	.....	.73	.....	.....	.....	.....	8,520	15,330
Do.....	.....do.....	.....do.....	18124F	1.4	A	2.3	35.5	55.5	6.71	.67	5.26	78.84	1.69	6.83	7,780	14,000
					B	.9	36.0	56.3	6.80	.68	5.18	79.94	1.71	5.69	7,890	14,200
					C	.....	36.3	56.8	6.87	.69	5.13	80.66	1.73	4.92	7,960	14,330
					D	.....	39.	61.0	.....	.74	5.51	86.61	1.86	5.28	8,545	15,390
Do.....	No. 52 (Called Clinchfield when sampled) of the Clinchfield Coal Corporation at Dante, Va.	E. G. Woodruff	10385	1.1	A	2.1	33.7	57.7	6.45	.65	5.44	78.59	1.53	7.34	7,855	14,140
					B	1.0	34.2	58.3	6.52	.66	5.38	79.46	1.55	6.43	7,940	14,290
					C	.....	34.5	58.9	6.59	.66	5.31	80.30	1.56	5.58	8,025	14,440
					D	.....	36.9	63.1	.....	.71	5.68	85.96	1.67	5.98	8,590	15,460
Do.....	No. 51 (called No. 2 when sampled) of the Clinchfield Coal Corporation at Dante, Va.	R. W. Stone.....	4057	1.8	A	2.8	32.1	59.3	5.8	.84	.....	.....	.....	.....	.....	.....
					B	1.0	32.7	60.4	5.9	.85	.....	.....	.....	.....	.....	.....
					C	.....	33.0	61.0	6.0	.86	.....	.....	.....	.....	.....	.....
					D	.....	35.1	64.9	.....	.92	.....	.....	.....	.....	.....	.....
Do.....	No. 55 of the Clinchfield Coal Corporation at Wilder, Va.	T. K. Harnsberger ..	18243	2.4	A	3.1	33.7	57.3	5.9	.79	.....	.....	.....	.....	7,860	14,150
					B	.8	34.5	58.7	6.0	.81	.....	.....	.....	.....	8,050	14,490
					C	.....	34.8	59.1	6.1	.82	.....	.....	.....	.....	8,115	14,600
					D	.....	37.0	63.0	.....	.87	.....	.....	.....	.....	8,640	15,550
Do.....	.....do.....	....do.....	18244	1.6	A	2.4	34.6	57.3	5.7	.83	.....	.....	.....	.....	7,945	14,300
					B	.8	35.2	58.3	5.7	.84	.....	.....	.....	.....	8,075	14,540
					C	.....	35.5	58.7	5.8	.85	.....	.....	.....	.....	8,140	14,660
					D	.....	37.6	62.4	.....	.90	.....	.....	.....	.....	8,645	15,560

Table of analyses of coal samples from mines in and near the Clintwood and Bucu quadrangles, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Laboratory 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.
Lower Banner..	No. 55 of the Clinchfield Coal Corporation at Wilder, Va.	T. K. Harnsberger..	18245	2.0	A	2.7	33.7	57.9	5.7	0.78	.....	.....	.....	.....	7,920	14,260
					B	.8	34.4	59.0	5.8	.80	.....	.....	.....	.....	8,080	14,540
					C	.....	34.7	59.5	5.8	.80	.....	.....	.....	.....	8,145	14,660
					D	.....	36.8	63.2	.....	.85	.....	.....	.....	.....	8,650	15,570
Do.....	.....do.....	.....do.....	18246	2.0	A	2.7	33.8	57.7	5.78	.83	5.27	79.33	1.29	7.50	7,915	14,250
					B	.7	34.5	58.9	5.90	.85	5.15	80.93	1.32	5.85	8,075	14,530
					C	.....	34.8	59.3	5.94	.85	5.11	81.55	1.33	5.22	8,135	14,650
					D	.....	37.0	63.0	.....	.90	5.43	86.70	1.41	5.56	8,650	15,570
Upper Banner...	Cranesnest No. 1, of the Clinchfield Coal Corporation, about 1½ miles northwest of Toms Creek, Va.	T. K. Harnsberger..	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.....	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.....	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	.....	.....	.....	.....	8,100	14,580
					C	.....	33.5	60.6	5.9	.52	.....	.....	.....	.....	8,170	14,710
					D	.....	35.5	64.5	.....	.55	.....	.....	.....	.....	8,685	15,630
Do.....	.....do.....	.....do.....	18229F	1.5	A	2.3	32.9	59.6	5.22	.54	5.18	80.78	1.57	6.71	8,010	14,420
					B	.8	33.4	60.5	5.30	.55	5.09	81.97	1.59	5.50	8,130	14,630
					C	.....	33.7	61.0	5.34	.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
Do.....	Swansea mine of the Virginia Iron, Coal and Coke Company at Toms Creek, Va.	E. G. Woodruff.....	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	6.90	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

Table of analyses of coal samples from mines in and near the Clintwood and Bucu quadrangles, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Laboratory 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.
Upper Banner...	Coeburn mine of the Virginia Iron, Coal and Coke Company at Toms Creek, Va.	J. W. Groves and W. J. von Borries.	2281	1.6	A	2.7	32.4	60.4	4.5	0.52	.....	.....	.....	.....	8,080	14,540
					B	1.1	32.9	61.4	4.6	.53	.....	.....	.....	.....	8,210	14,780
					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	32.6	62.0	4.2	.56	.....	.....	.....	.....	.....	.....
					C	.....	33.0	62.8	4.2	.57	.....	.....	.....	.....	.....	.....
					D	.....	34.4	65.6	.....	.60	.....	.....	.....	.....	.....	.....
Do.....	No. 2 of the Clinchfield Coal Corporation, 1¾ miles northeast of Dante, Va.	T. K. Harnsberger..	18128	1.0	A	1.8	35.3	55.8	7.1	.58	.....	.....	.....	.....	7,800	14,040
					B	.8	35.7	56.3	7.2	.58	.....	.....	.....	.....	7,875	14,180
					C	.....	35.9	56.8	7.3	.59	.....	.....	.....	.....	7,945	14,300
					D	.....	38.8	61.2	.....	.64	.....	.....	.....	.....	8,565	15,420
Do.....	.....do.....	.....do.....	18129	1.4	A	2.4	36.3	55.1	6.2	.52	.....	.....	.....	.....	7,840	14,110
					B	1.0	36.8	55.9	6.3	.53	.....	.....	.....	.....	7,945	14,300
					C	.....	37.2	56.4	6.4	.53	.....	.....	.....	.....	8,025	14,450
					D	.....	39.7	60.3	.....	.57	.....	.....	.....	.....	8,570	15,430
Do.....	.....do.....	.....do.....	18130	0.8	A	1.6	36.7	55.3	6.4	.58	.....	.....	.....	.....	7,870	14,170
					B	.8	37.0	55.8	6.4	.58	.....	.....	.....	.....	7,935	14,290
					C	.....	37.3	56.2	6.5	.59	.....	.....	.....	.....	8,000	14,400
					D	.....	39.9	60.1	.....	.63	.....	.....	.....	.....	8,550	15,390
Do.....	.....do.....	.....do.....	18131F	1.1	A	1.8	36.2	55.5	6.53	.54	5.25	79.28	1.49	6.91	7,830	14,100
					B	.8	36.5	56.1	6.60	.55	5.18	80.12	1.51	6.04	7,915	14,250
					C	.....	36.8	56.5	6.65	.55	5.14	80.76	1.52	5.38	7,980	14,360
					D	.....	39.4	60.6	.....	.59	5.51	86.51	1.63	5.76	8,545	15,380
Do.....	.....do.....	P. M. Riefkin	10734	1.5	A	2.3	35.2	56.2	6.3	.59	.....	.....	.....	.....	7,830	14,100
					B	.8	35.7	57.1	6.4	.60	.....	.....	.....	.....	7,950	14,310
					C	.....	36.1	57.5	6.4	.60	.....	.....	.....	.....	8,020	14,440
					D	.....	38.6	61.4	.....	.64	.....	.....	.....	.....	8,570	15,430

Table of analyses of coal samples from mines in and near the Clintwood and Bucu quadrangles, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Laboratory 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.
Upper Banner...	No. 2 of the Clinchfield Coal Corporation, 1¾ miles northeast of Dante, Va.	P. M. Riefkin.....	10735	2.1	A	3.0	35.2	56.6	5.2	0.59	.....	.....	.....	.....	7,860	14,150
					B	.9	36.0	57.8	5.3	.60	.....	.....	.....	.....	8,030	14,450
					C	.....	36.2	58.4	5.4	.61	.....	.....	.....	.....	8,100	14,580
					D	.....	38.3	61.7	.....	.64	.....	.....	.....	.....	8,560	15,410
Do.....	.....do.....	.....do.....	10736	1.8	A	2.8	34.9	56.5	5.77	.59	5.32	80.13	1.43	6.76	7,860	14,150
					B	1.0	35.5	57.5	5.88	.60	5.21	81.60	1.46	5.25	8,005	14,410
					C	.....	36.0	58.1	5.93	.61	5.15	82.41	1.47	4.43	8,080	14,550
					D	.....	38.2	61.8	.....	.65	5.47	87.60	1.56	4.72	8,590	15,460
Do.....	No. 2 (called No. 3 when sampled) of the Clinchfield Coal Corporation at Dante, Va.	R. W. Stone.....	3942	1.3	A	2.4	32.4	57.9	7.3	.66	.....	.....	.....	.....	.....	.....
					B	1.1	32.8	58.7	7.4	.67	.....	.....	.....	.....	.....	.....
					C	.....	33.2	59.3	7.5	.68	.....	.....	.....	.....	.....	.....
					D	.....	35.9	64.1	.....	.74	.....	.....	.....	.....	.....	.....
Do.....	No. 5 of the Clinchfield Coal Corporation, 1½ miles north of Dante, Va.	P. M. Riefkin	10737	1.4	A	2.3	35.2	57.8	4.7	.55	.....	.....	.....	.....	8,015	14,430
					B	.9	35.7	58.6	4.8	.56	.....	.....	.....	.....	8,130	14,630
					C	.....	36.0	59.2	4.8	.56	.....	.....	.....	.....	8,205	14,770
					D	.....	37.8	62.2	.....	.59	.....	.....	.....	.....	8,625	15,520
Do.....	.....do.....	.....do.....	10738	1.2	A	2.1	35.1	57.1	5.7	.56	.....	.....	.....	.....	7,930	14,280
					B	.9	35.6	57.7	5.8	.57	.....	.....	.....	.....	8,030	14,450
					C	.....	35.9	58.3	5.8	.58	.....	.....	.....	.....	8,100	14,580
					D	.....	38.1	61.9	.....	.62	.....	.....	.....	.....	8,600	15,480
Do.....	.....do.....	.....do.....	10739	1.3	A	2.1	35.9	56.7	5.33	.57	5.45	80.24	1.43	6.98	7,965	14,330
					B	.8	36.4	57.4	5.40	.58	5.37	81.30	1.45	5.90	8,070	14,530
					C	.....	36.7	57.9	5.44	.58	5.33	81.93	1.46	5.26	8,130	14,640
					D	.....	38.8	61.2	.....	.61	5.64	86.64	1.54	5.75	8,600	15,480
Do.....	No. 3, of the Clinchfield Coal Corporation, 1 mile east of Dante, Va.	E. G. Woodruff.....	10387	1.4	A	2.3	35.7	55.0	7.00	.66	5.48	77.91	1.53	7.42	7,740	13,940
					B	.9	36.2	55.8	7.10	.67	5.40	79.02	1.55	6.26	7,850	14,130
					C	.....	36.5	56.3	7.16	.68	5.35	79.73	1.56	5.52	7,920	14,260
					D	.....	39.3	60.7	.....	.73	5.76	85.87	1.68	5.96	8,530	15,360

Table of analyses of coal samples from mines in and near the Clintwood and Bucu quadrangles, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Laboratory 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.
Upper Banner...	No. 6 of the Clinchfield Coal Corporation at Wilder, Va.	T. K. Harnsberger..	18235	2.4	A	3.3	35.7	55.0	6.0	0.55	.....	.....	.....	.....	7,760	13,970
					B	1.0	36.6	56.3	6.1	.56	.....	.....	.....	.....	7,945	14,310
					C	.....	37.0	56.8	6.2	.57	.....	.....	.....	.....	8,030	14,450
					D	.....	39.4	60.6	.....	.61	.....	.....	.....	.....	8,555	15,400
Do.....	.....do.....	.....do.....	18236	2.4	A	3.2	35.4	55.1	6.3	.59	.....	.....	.....	.....	7,760	13,970
					B	.9	36.3	56.4	6.4	.60	.....	.....	.....	.....	7,945	14,300
					C	.....	36.6	56.9	6.5	.61	.....	.....	.....	.....	8,020	14,430
					D	.....	39.1	60.9	.....	.65	.....	.....	.....	.....	8,575	15,440
Do.....	.....do.....	.....do.....	18237	2.4	A	3.3	35.1	56.9	4.7	.50	.....	.....	.....	.....	7,925	14,270
					B	.9	36.0	58.3	4.8	.51	.....	.....	.....	.....	8,115	14,610
					C	.....	36.3	58.8	4.9	.52	.....	.....	.....	.....	8,195	14,750
					D	.....	38.2	61.8	.....	.55	.....	.....	.....	.....	8,615	15,510
Do.....	.....do.....	.....do.....	18238	2.4	A	3.3	35.1	55.9	5.71	.55	5.37	78.72	1.37	8.28	7,820	14,080
					B	1.0	35.9	57.2	5.85	.56	5.23	80.62	1.40	6.34	8,010	14,420
					C	.....	36.3	57.8	5.91	.57	5.17	81.44	1.42	5.49	8,095	14,570
					D	.....	38.5	61.5	.....	.61	5.49	86.55	1.51	5.84	8,600	15,490
Splash Dam	Small local mine of C. C. Owens on Russell Prater Creek, 1 mile northeast of mouth.	.....do.....	17751	1.3	A	2.3	29.4	62.2	6.1	.76	.....	.....	.....	.....	.....	.....
					B	1.0	29.7	63.0	6.2	.77	.....	.....	.....	.....	.....	.....
					C	.....	29.9	63.6	6.3	.78	.....	.....	.....	.....	.....	.....
					D	.....	31.6	67.9	.....	.83	.....	.....	.....	.....	.....	.....
Do.....	.....do.....	.....do.....	17752	1.6	A	2.5	29.2	63.2	5.1	.80	.....	.....	.....	.....	.....	.....
					B	.9	29.7	64.2	5.2	.81	.....	.....	.....	.....	.....	.....
					C	.....	29.9	64.8	5.3	.82	.....	.....	.....	.....	.....	.....
					D	.....	31.6	68.4	.....	.87	.....	.....	.....	.....	.....	.....
Glamorgan.....	Glamorgan No. 3 of the Stone Gap Colliery Co. at Glamorgan, Va.	Chas. Butts.....	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

Table of analyses of coal samples from mines in and near the Clintwood and Bucu quadrangles, Virginia—Contd.

Coal bed.	Name and location of mine.	Collector.	Laboratory 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.
Glamorgan.....	Glamorgan No. 3 of the Stone Gap Colliery Co. at Glamorgan, Va.	Chas. Butts.....	15101	2.0	A	3.2	31.3	59.1	6.37	0.87	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	8,550	14,380
					D	.....	34.6	65.4	.....	.96	5.44	86.33	1.83	5.44	.....	15,390
Eagle.....	Small local mine of the Yellow Poplar Lumber Co., 3 miles east of the mouth of Pound River.	T. K. Harnsberger..	17743	1.7	A	2.8	31.6	58.2	7.4	1.45	.....	.....	.....	.....	7,685	13,840
					B	1.1	32.2	59.1	7.6	1.47	.....	.....	.....	.....	7,815	14,070
					C	.....	32.5	59.8	7.7	1.49	.....	.....	.....	.....	7,905	14,230
					D	.....	35.2	64.8	.....	1.61	.....	.....	.....	.....	8,565	15,410
Do.....	.....do.....	.....do.....	17744	1.8	A	3.0	32.4	58.4	6.2	1.62	.....	.....	.....	.....	7,795	14,030
					B	1.2	33.0	59.5	6.3	1.65	.....	.....	.....	.....	7,935	14,290
					C	.....	33.4	60.2	6.4	1.67	.....	.....	.....	.....	8,030	14,460
					D	.....	35.7	64.3	.....	1.78	.....	.....	.....	.....	8,575	15,440
Clintwood.....	Small local mine of Elbert Powers, on Big Ridge, 5½ miles south of Clintwood, Va.	W. A. Nelson.....	14767	3.3	A	4.3	29.4	62.1	4.2	1.02	.....	.....	.....	.....	.....	.....
					B	1.0	30.4	64.2	4.4	1.05	.....	.....	.....	.....	.....	.....
					C	.....	30.7	64.9	4.4	1.07	.....	.....	.....	.....	.....	.....
					D	.....	32.1	67.9	.....	1.12	.....	.....	.....	.....	.....	.....
Do.....	Small local mine of John A. Yeates, 1 mile southwest of Clintwood, Va.	.....do.....	14766	1.2	A	2.2	34.2	60.4	3.2	.85	.....	.....	.....	.....	8,110	14,590
					B	1.0	34.6	61.2	3.2	.86	.....	.....	.....	.....	8,205	14,770
					C	.....	34.9	61.8	3.3	.87	.....	.....	.....	.....	8,290	14,920
					D	.....	36.1	63.9	.....	.96	.....	.....	.....	.....	8,570	15,420
Do.....	Small local mine of Chase and Damron, ¾ of a mile south of Clintwood, Va.	C. W. Dodge.....	3897	1.2	A	2.2	30.1	63.7	4.0	.87	.....	.....	.....	.....	.....	.....
					B	1.0	30.5	64.5	4.0	.88	.....	.....	.....	.....	.....	.....
					C	.....	30.8	65.1	4.1	.89	.....	.....	.....	.....	.....	.....
					D	.....	32.1	67.9	.....	.93	.....	.....	.....	.....	.....	.....

Tests.

GENERAL STATEMENT.

Samples of coal, from two localities only a short distance south of the area described in this report, were subjected to a series of tests in fuel-testing plants of the U. S. 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, at Virginia City, Va., 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, over a 3½-inch bar screen, from the Upper Banner coal bed in the Coeburn mine of the Virginia Iron, Coal, and Coke Company, at Toms Creek, Va., was tested in the St. Louis plant.

In the following tables the essential results of these tests are summarized in a manner intended to show briefly the adaptability of the coal to the uses for which it was tested. Further information regarding the types of testing apparatus used, conditions under which the tests were made, etc., may be had by referring to the publications cited in the footnotes.

The tests emphasize the excellent qualities of coal that is essentially the same as that in the Clintwood and Bucu quadrangles. The coking tests gave especially favorable results, as did also private coking tests made of coal from the Clintwood bed at the Beverly mine, near Clintwood. The Pishel field test for coking coal was applied to coal from many places in the two quadrangles and indicated excellent coking qualities in all but two trials. Commercial operations have proved that high-grade coke can be made from the Upper Banner bed in the southwest corner of the Clintwood quadrangle, and there is no reason to suppose that any of the coal in the region is not suitable for the same purpose.

STEAMING TESTS.[1]

Test No. 601, Jawbone coal.—The coal burned with a medium-length flame and caked. A porous clinker formed on the dead plate and adhered

[1] Burrows, J. S., Mine sampling and chemical analyses of coals: U. S. Geol. Survey Bull. 362, p. 9, 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, pp. 194-195, 1906.

Breckenridge, L. P., Kreisinger, Henry, and Ray, W. T., Steaming tests of coals and related investigations: Bureau of Mines Bull. 23, 1912.

to the bridge wall. Size of coal as used not recorded. Duration of test, 8 hours. Kind of grate, underfeed.

Test No. 602, Jawbone coal.—The coal burned with a medium-length flame and caked. A small porous clinker formed on the dead plate and adhered to the bridge wall. Size of coal as used not recorded. Duration of test, 8.10 hours. Kind of grate, underfeed.

Test No. 280, Upper Banner coal.—Automatic air admission not operated; clinker and refuse easily removed from furnace. Size of coal as used: Over 1-inch, 44.7 per cent; ½-inch to 1-inch, 20.2 per cent; ¼-inch to ½-inch, 15.7 per cent; under ¼-inch, 19.4 per cent. Duration of test, 9.88 hours. Kind of grate, rocking.

Test No. 283, Upper Banner coal.—Automatic air admission was operated. A thin solid clinker adhered to the grate. Size of coal as used: Over 1-inch, 32.8 per cent; ½-inch to 1-inch, 16.5 per cent; ¼-inch to ½-inch, 15.6 per cent; under ¼-inch, 35.1 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Proximate analyses of coal as used.

	Test 601.	Test 602.	Test 280.	Test 283.
Moisture	1.3	1.6	1.7	3.3
Volatile matter	28.7	28.7	33.3	32.0
Fixed carbon	54.3	53.1	60.3	60.2
Ash	15.7	16.6	4.7	4.5
Sulphur	.94	.94	.64	.56

Ultimate analyses figured on moisture-free basis.

	Test 601.	Test 602.	Test 280.	Test 283.
Carbon	71.14	70.59	82.80	82.95
Hydrogen	4.52	4.47	4.98	4.98
Oxygen	6.21	5.69	5.18	5.19
Nitrogen	1.25	1.22	1.64	1.64
Sulphur	.95	1.16	.65	.58
Ash	15.93	16.87	4.75	4.66

Summary of steaming tests.

	Test 601.	Test 602.	Test 280.	Test 283.
Heating value of coal B. t. u. per lb. dry coal	12,911	12,607	14,908	14,936
Force of draft:				
Under stack damper.....inch water....	0.39	0.35	0.42	0.37
Above fire .....do.....	.31	.23	.15	.16
Furnace temperature .....°F.....	2,336	.....	2,452	2,537
Dry coal used per square foot of grate surface per hour .....pounds....	18.14	21.88	16.40	16.47
Equivalent water evaporated per square foot of water-heating surface per hour .....pounds....	3.28	3.69	2.91	2.99
Water apparently evaporated per pound of coal as fired.....pounds....	7.70	7.07	8.14	8.18
Water evaporated 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 .....do.....	9.06	8.46	9.91	10.12
Per pound of combustible.....do.....	10.97	10.36	10.66	10.84
Efficiency of boiler, including grate, per cent	67.77	64.80	64.19	65.43
Boiler horse-power:				
Builder's rating	210	210	210	210
Developed on test.....	193.0	217.4	171.4	175.9
Analysis of ash:				
Carbon	9.93	11.26	27.88	34.47
Earthy matter	90.07	88.74	72.12	65.53

PRODUCER-GAS TESTS.[1]

Test No. 163, Jawbone coal.—As used, ½ to ⅔ slack. Failure of water supply made it impossible to carry this test beyond 8 hours, a period so short that the accuracy of the results is doubtful. Average B. t. u. of gas per cubic foot, about 149.

Test No. 75, Upper Banner coal.—Size as used: Over 1-inch, 51 per cent; ½-inch to 1-inch, 14 per cent; ¼-inch to ½-inch, 13 per cent; under ¼-inch, 22 per cent. Duration of test, 50 hours. Average B. t. u. of gas per cubic foot, 156.

[1] Burrows, J. S., Mine sampling and chemical analysis of coals: U. S. Geol. Survey Bull. 362, p. 9, 1908.

Fernald, R. H., Preliminary report on the operation of the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., 1905: U. S. Geol. Survey Bull. 290, pp. 193-195, 1906.

Fernald, R. H., and Smith, C. D., Résumé of producer-gas investigations: Bureau of Mines Bull. 13, 1911.

Proximate analyses of coal as fired.

	Test 163.	Test 75.
Moisture	1.3	1.6
Volatile matter	29.7	31.7
Fixed carbon	53.6	61.8
Ash	15.4	4.9
Sulphur	1.14	.49

Analyses of gas (per cent by volume).

	Test 163.	Test 75.
Carbon dioxide (CO_2)	9.7	9.7
Carbon monoxide (CO)	19.7	19.3
Hydrogen (H_2)	14.5	13.8
Methane (CH_4)	2.3	3.1
Nitrogen (N_2)	53.8	54.1

Summary of producer-gas tests.

	Test 163.			Test 75.		
	Coal as fired.	Dry coal	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal used in producer (pounds per horse-power per hour).						
Per electrical horse-power:						
Available for outside purposes	1.23	1.22	1.03	1.21	1.18	1.13
Developed at switch board	1.20	1.19	1.00	1.13	1.11	1.06
Per brake horse-power:						
Available for outside purposes	1.05	1.04	.87	1.03	1.01	.96
Developed at engine	1.02	1.01	.85	.96	.95	.90
Coal used by producer plant, including fuel equivalent of auxiliary power (pounds per horse-power per hour).						
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
Per brake horse-power:						
Available for outside purposes	1.29	1.28	1.07	1.10	1.08	1.03
Developed at engine	1.26	1.24	1.05	1.03	1.01	.96

COKING TESTS.[1]

Two tests, Nos. 61 and 88, were made of the Upper Banner coal from Toms Creek, Va., to determine its coking properties. In test 61 the coal was finely crushed; in test 88 it was as shipped (over 3½-inch bar screen).

Summary of coking tests.

	Test 61.	Test 88.
Duration of test.....hours....	45	50
Specific gravity, real.....	1.93	1.87
Specific gravity, apparent.....	1.25	1.12
Weight per cubic foot, dry.....pounds....	77.72	69.30
Weight per cubic foot, as received (wet).....do.....	99.67	94.26
Percentage coke	65.00	60.00
Percentage cells	35.00	40.00
Six-foot drop test, percentage over 2-inch mesh:		
1	92.00	93.50
2	85.00	89.00
3	78.50	83.50
4	75.00	80.50
Weight of coal.....pounds....	12,000	12,000
Weight of coke.....do.....	8,160	7,907
Weight of breeze.....do.....	240	336
Percentage coke	68.00	65.89
Percentage breeze	2.00	2.80
Total percentage yield	70.00	68. 69

The analysis of a typical 72-hour Connellsville coke is shown in the following table as a standard for comparison. Judged by the analyses, coke made from the Upper Banner coal is as good as that from the Connellsville district.

Analysis of coal as used and resulting coke.

	Connellsvills coke.	Test 61.		Test 88.	
		Coal.	Coke.	Coal.	Coke.
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

[1] 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, pp. 193-196, 1906.

Belden, A. W., Washing and coking tests of coal and cupola tests of coke: U. S. Geol. Survey Bull. 336, 1908.

Test 61, remarks.—Coke of light gray and silvery color; much deposited carbon; metallic ring; cell structure small; breakage good; long, large, heavy pieces; very heavy coke.

Test 88, remarks.—Coke of light gray and silvery color; much deposited carbon; metallic ring; cell structure small; breakage good; good heavy coke; decreased yield of coke and increased amount of breeze probably due to fact that coal was not crushed.

CUPOLA TESTS OF COKE.[1]

Each of the two samples of coke, made from the Upper Banner coal from Toms Creek, Va., was subjected to two cupola tests, the results of which are shown in the following table. The results of a typical test of Connellsville 72-hour coke are given in the first column, to furnish a standard for comparison.

[1] Moldenke, Richard, Washing and coking tests of coal and cupola tests of coke: U. S. Geol. Survey Bull. 336, 1908.

Summary of cupola tests.

	Connellsville Coke.	Coke test 61.		Coke test 88.	
	Test 19.	Test 33.	Test 91.	Test 58.	Test 40.
Charges (Pounds)—					
1 Coke bed	220	230	250	250	240
2 Pig iron	660	690	750	750	720
3 Scrap	220	230	250	250	240
4 Coke	53	50	45	45	48
5 Pig iron	398	390	375	375	383
6 Scrap	133	130	125	125	128
7 Coke	53	50	45	45	48
8 Pig iron	398	390	375	375	383
9 Scrap	133	130	125	125	128
10 Coke	52	50	45	45	47
11 Pig iron	397	390	375	375	382
12 Scrap	132	130	125	125	127
13 Coke	52	50	45	45	47
14 Pig iron	397	390	375	375	382
15 Scrap	132	130	125	125	127
Totals (Pounds)—					
Coke	430	430	430	430	430
Pig iron	2,250	2,250	2,250	2,250	2,250
Scrap	750	750	750	750	750
Ratio of iron to coke	7	7	7	7	7
Maximum blast pressure (oz.)	7¾	7	7	7	7
Iron poured (lbs.)	2,470	1,584	2,422	1,710	1,761
Iron melted (lbs.)	2,470	2,391	2,598	2,200	2,071
Iron recovered (lbs.)	283	255	288	636	683
Coke recovered (lbs.)	20	93	70	104	108
Melting loss (per cent)	8.2	11.80	3.80	5.46	8.20
Melting ratio (iron to coke)	6.02	7.09	7.22	6.75	6.43
Melting rate (lbs. per hour)	5,489	4,947	5,028	4,551	3,358
Blast on at	10.57 A.M.	4.03 P.M.	3.30 P.M.	10.23 A.M.	11.14 A.M.
Iron running	11.03	4.12	3.37	10.36	11.23
Weight and time of each ladle—					
1 lbs	175	85	132	102	64
at	11.07	4.15	3.45	10.45	11.27
2 lbs	115	103	104	107	62
at	11.11	4.19	3.45½	10.45½	11.29
3 lbs	185	98	111	77	80
at	11.13	4.20	3.47	10.50½	11.31
4 lbs	150	94	135	74	62
at	11.14	4.21	3.47½	10.51	11.32
5 lbs	220	88	92	84	72
at	11.16	4.22	3.51	10.51½	11.38

	Connellsville Coke.	Coke test 61.		Coke test 88.	
	Test 19.	Test 33.	Test 91.	Test 58.	Test 40.
Weight and time of each ladle—(Contd.)—					
6 lbs	150	84	110	64	75
at	11.18	4.23	3.51½	10.54	11.38½
7 lbs	225	73	151	64	95
at	11.19	4.24	3.52	10.54½	11.39
8 lbs	155	71	94	83	55
at	11.22	4.25	3.54	10.55	11.41
9 lbs	255	81	112	62	92
at	11.24	4.25½	3.54½	10.56	11.41½
10 lbs	155	80	99	66	75
at	11.26	4.27	3.55	10.56½	11.42
11 lbs	250	60	90	79	88
at	11.27	4.28	3.56	10.57	11.44
12 lbs	125	63	99	56	76
at	11.28	4.30	3.56½	10.58	11.44½
13 lbs	170	66	132	80	91
at	11.29	4.32	3.58	10.58½	11.45
14 lbs	140	98	100	73	84
at	11.30	4.33	3.58½	10.59	11.46
15 lbs	.....	51	80	50	75
at	.....	4.34	3.59	11.00½	11.46½
16 lbs	.....	53	131	84	85
at	.....	4.35	4.01	11.01	11.48
17 lbs	.....	54	90	59	92
at	.....	4.37	4.01½	11.02½	11.48½
18 lbs	.....	58	142	47	36
at	.....	4.38	4.02	11.03	11.49
19 lbs	.....	49	142	66	72
at	.....	4.39	4.04	11.03½	11.53
20 lbs	.....	46	56	90	51
at	.....	4.41	4.04½	11.05	11.53½
21 lbs	.....	27	99	48	98
at	.....	4.42	4.06	11.05½	11.54
22 lbs	.....	37	121	103	60
at	.....	4.44	4.08	11.06	11.58
23 lbs	.....	65	.....	64	77
at	.....	4.45	.....	11.09½	11.59½
24 lbs	.....	.....	.....	28	44
at	.....	.....	.....	11.10	12.00
25 lbs	.....	.....	.....	.....	.....
at	.....	.....	.....	.....	.....
Time melting (minutes)	27	29	31	29	37

Remarks:

Test 19. Iron hot.

Test 33. Iron hot and fluid; melting too fast to handle; blast off 4 minutes.

Test 91. Iron hot.

Test 58. Iron hot; blast off 5 minutes.

Test 40. Temperature of iron medium.

SUMMARY.

An examination of the analyses and tests described in the preceding pages leads to very favorable conclusions as to the purity and value of the coals themselves. The practical features and the essential working qualities of the fuels, as indicated in a limited number of steaming, coking, briqueting, producer, and foundry tests have already been quoted from the official records of the tests. These tests, which are not so numerous as is to be desired, were not in all cases conducted under favorable circumstances or with coal from the best deposits, and the results, gratifying as they may be, probably do not do more than justice to either the samples submitted or the region as a whole.

Information as to the chemical composition, which discloses the purity of the coals, and as to the calorific values, i. e., the heating power of the coals as determined by standard calorimetric methods in the laboratory, is given in the accompanying table of analyses. This table, though not so large as is desirable, contains the results of the analysis and calorific testing of enough cuttings taken from coal beds in widely different parts of the region to entitle it to confidence as approximately representative of the coals of the quadrangles. In fact, it must be noted that the samples from the Splash Dam, the Eagle, and the Clintwood beds, and some of those from the Kennedy, were taken from small local or country mines and therefore may not show either the full rank or the real heat value of the fuels. The proportions of the elements in the organic matter are in some cases given in the form of ultimate analyses.

From an inspection of the analyses, it will be seen that the coals are of high bituminous rank with very low moisture content; with a percentage of fixed carbon in general approximating 60 per cent[a]; with relatively low ash, and with an exceptionally small content of sulphur. In other words, the coals are notably pure. The averages of the moisture, of the ash, the sulphur, and the B. t. u.'s in the samples "as received" (line A) for all the beds except the Jawbone are indicated in the following synopsis:

[a] The percentage in Sample No. 22346, cut in the Jackson bank, 3 miles northwest of Honaker, probably does not represent the fixed carbon of the normal unweathered coal.

Averages of analyses for each coal.

Name of Coal and number of samples.		Moisture.	Fixed Carbon.	Ash.	Sulphur.	B. t. u.'s.
Tiller (4)	A	2.2	59.4	6.5	.48	14,100
	D	.....	65.0	.....	.....	15,500
Kennedy (7)	A	2.9	59.6	6.98	.98	13,750
	D	.....	67.1	.....	.....	15,500
Lower Banner (9)	A	2.5	57.0	6.17	.75	14,150
	D	.....	62.5	.....	.....	15,500
Upper Banner (23)	A	2.5	57.3	5.7	.56	14,200
	D	.....	62.4	.....	.....	15,500
Splash Dam (2)	A	2.4	62.7	5.6	.78	.....
	D	.....	68.2	.....	.....	.....
Glamorgan (2)	A	2.9	59.2	5.7	1.12	14,050
	D	.....	64.8	.....	.....	15,400
Eagle (2)	A	2.9	58.3	6.8	1.54	13,950
	D	.....	64.6	.....	.....	15,450
Clintwood (3)	A	2.9	62.1	3.8	.91	14,600
	D	.....	66.6	.....	.....	15,400
Averages of above coals	A	2.6	59.5	5.9	.89	14,150
	D	.....	65.2	.....	.....	15,450

In line D is shown the corresponding averages of the fixed carbon and British thermal units (B. t. u.'s) on what is sometimes known as the "pure coal basis." This form of representation, which is theoretical and should be used only in the comparative study of the qualities and ranks of coals, is obtained by excluding the moisture, ash, and sulphur from the proximate analysis and recalculating the volatile matter and fixed carbon to total 100 per cent. These percentages should not be employed to describe coals as commercially produced or sold.

The high qualities of most of the coals appear even in the cuttings from small local mines. Those of the Eagle bed, while inferior to some others, are, nevertheless, worthy of comparison with the coals of other regions. The Clintwood is exceptionally pure, and the Kennedy is relatively high in ash only southwest of Russell Fork, where it has been crushed by shearing movements. The three samples from the Jawbone bed are conspicuous among the other coals of the region for their high ash and high moisture. In fact, this coal is well recognized to be relatively impure and inferior at most points at which it has been examined. Hence it will be eliminated from further discussion, though it is but little inferior to many of the competing coals from other fields.

For the purposes of comparison of the coals from other regions and fields of the United States, comprehensive and generally representative

analyses will be found in great numbers in Bulletins 22 and 85 of the Bureau of Mines. To these reports the reader is referred for data concerned in the following discussion.

The examination of the analyses of coals from the Clintwood and Bucu quadrangles presented in the foregoing tables, and a comparison of the same with those representing the principal mining districts of West Virginia, make it evident that the coals of the region studied are equal to the highest rank of the Kanawha coals of southern West Virginia, namely, those along the easternmost border of the Kanawha field, or, in other words, those in a rather narrow zone along the border of the Pocahontas and New River coal fields. They are apparently slightly higher in rank than the coals in the region immediately northwest of Pine Mountain, though neither this difference nor its effects are well marked. Farther west, both in Kentucky and West Virginia, the coals fall off in rank and calorific value and in most areas are more impure. On the whole, the coals of the quadrangles here described present a marked advantage over the latter as to ash and sulphur content.

The Pocahontas and New River coals are distinctly above the coals of this part of the Virginia region as to rank, being 5 to 15 per cent higher in fixed carbon, and are in general their equal in ash and sulphur, while, as is to be expected, their more advanced rank gives them notably 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.

In the Tennessee coal field there are several localities where, on account of the higher rank, as shown by the more advanced elimination of volatile matter, the coals have as great calorific value as those in question, though the ash and sulphur content are higher. Generally the coals of the same rank contain larger proportions of sulphur to which is usually added a higher ash. 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 under that of the Virginia coals, in which, moreover, the sulphur is nearly everywhere smaller in amount.

The coals of Alabama vary greatly in quality. At 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. On the whole, however, higher ash also seems to mark the Alabama coal field, the greater part of which is inferior also as to the rank and calorific value of its fuels.

As compared with the Oklahoma coal field as a whole the Virginia coal possesses marked advantages in rank, purity, and heat value. Even toward the eastern border of the Oklahoma field, in which direction the rank of the coals rises above that of the Virginia fuel, the consequent calorific advantage is at most points neutralized by higher ash and sulphur. On the other hand, most of the Oklahoma localities showing lower ash have coals of rank so much lower as to make them of lower calorific value also. Passing eastward into Arkansas, the Paleozoic coals are all of higher rank; but except at a few points in the semibituminous area, the greater ash and sulphur contents seem to give them inferior heat values. It remains to be seen whether in an export trade the friability of the purest of the Arkansas semibituminous coal will offset its advantages in rank and heat value.

As compared with the coals of the other Mississippi Valley States, including Illinois, Indiana and the western Kentucky coal field, 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 latter, which often exceed 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 cubical and stronger lump in the coals of the upper Mississippi valley.

The coals of Ohio are so much lower in fixed carbon, i. e., in rank, as hardly to equal the Virginia coals in heat value even where the former are at their best. In most cases they are higher in sulphur and in ash.

Although the coals of the Potomac and Georges Creek-Frostburg basins in western Maryland are clearly much higher in rank, they are in many places lower in heat value, probably on account of the higher ash and sulphur. However, in the southern part of the Potomac basin and the neighboring region of West Virginia, the coals appear to be purer and with higher values, and are at some locations clearly superior to the Clintwood-Bucu coals. In these high-rank coals there is, again, a larger proportion of fine coal or slack in the run-of-mine product. The same is true of the high-grade coals of the so-called "Clearfield region" of Clearfield, Cambria,

Blair, and Somerset counties in Pennsylvania, particularly the Windber district. Nevertheless, it is interesting to note that with respect to moisture and sulphur, and, in many cases, to ash, the Virginia coals compare advantageously, though they are not nearly so high in rank and in calorific value.

In the northern Appalachian region the Virginia coals concerned in this study seem to find closest comparisons in the low ash and low sulphur coals of the Fairmont district in northern West Virginia and in the Uniontown-Connellsville zone of Pennsylvania. With these coals the average beds of the Clintwood and Bucu regions are comparable in rank as well as in efficiency, ash, and sulphur, slightly lower sulphur being generally found in the latter area. The low ash, low moisture, and abnormally low sulphur in the Virginia area give these coals an advantage over those farther west in northern West Virginia and in Pennsylvania, toward the western borders of which the lower fixed carbon is attended in general with lower calorific values.

The comparability in rank and other features between the coals of the southwestern Virginia region and the coals of the Uniontown-Connellsville region of Pennsylvania has just been pointed out in the preceding paragraph. Also it will have been noted in the accounts of coking tests that for coking and furnace use coals from these two regions are closely comparable and apparently nearly equal. From the single test made at the experimental plant formerly conducted by the United States Geological Survey, it would seem that the coke made from the Connellsville coal was slightly higher in sulphur than that from the Upper Banner coal of southwestern Virginia. Further tests should precede final conclusions as to the relative merits of these coals for coking. Both the Virginia and Connellsville regions are similar as to the rather large amount of volatile matter, about 35 per cent, pure coal basis, in the beds, the coking of which entails a great and lamentable waste unless by-product ovens are used. This waste should be prevented whenever and wherever possible. The coal from the Toms Creek mines has been coked for more than twenty years.

The samples, analyses of which are presented in the foregoing tables, contain promise of a fuel output of great purity and value. In fact, the expectation seems fully justified that there will be developed in the Clintwood-Bucu region many mines in which the coal will contain about 60 per cent fixed carbon; will run under 2.6 per cent of moisture, 6 per cent of ash, .9 per cent of sulphur; and will contain over 14,200 B. t. u.'s as it is loaded in the cars. Most of this will make a good coke.

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LEGEND:

PENNSYLVANIAN

Wise Formation
Sandstone and shale with Campbell Creek (CC), Clintwood (C), Eagle (E), Glamorgan (at or near base), and other coal beds.

Gladeville Sandstone
Massive brownish sandstone.

Norton Formation
Sandstone and shale with Splash Dam (SD), Upper Banner (UB), Lower Banner (LB), Kennedy (K), and other coal beds.

Lee Formation
Conglomeratic sandstone with a few thin shale and coal beds.

Undifferentiated
Includes Wise, Gladeville and Norton formations in area that is in part buckled and faulted

UNCONFORMITY

MISSISSIPPIAN

Undifferentiated
Includes Pennington shale (variegated shale and sandstone, 800 feet thick) at top; Newman limestone (500 feet thick) in middle; and upper part of Grainger shale (green clay shale and brown and red sandstone, 400 to 500 feet thick) at bottom

DEVONIAN

Undifferentiated.
May include some Mississippian beds at top. Soft fissile shale, predominantly black.

CARBONIFEROUS

Shipping coal mine. (Numbers are text references.)

Small local coal mine or prospect pit. (Numbers are text references.)

Diamond drill prospects. (Numbers are text references.)

Structure Contours
Full lines are on Upper Banner coal horizon and dashed lines are on Splash Dam coal horizon. (Contour interval 50 feet; numbers show feet above sea level.)

Scale $\frac{1}{62500}$

½ 0 2 3 4 Miles

Geology surveyed by Henry Hinds and T. K. Harnsberger in 1913 and by Charles Butts in 1912.

Surveyed in cooperation with the United States Geological Survey

GEOLOGIC MAP OF CLINTWOOD QUADRANGLE

The locations of measured coal openings are also shown on the accompanying topographic map

LEGEND:

PENNSYLVANIAN

Cw

Wise Formation
Sandstone and shale with Eagle (E), Glamorgan (at or near base), and other coal beds.

Gladeville Sandstone
Massive brownish sandstone.

Norton Formation
Sandstone and shale with
Splash Dam (SD)
Upper Banner (UB)
Lower Banner (LB)
Kennedy (K)
Garden Hole (GH)
Tiller (T)
and other coal beds

Lee Formation
Shale and sandstone with a few thin coal beds.

Undifferentiated
Includes Norton and Lee formations in areas that are in part buckled and faulted.

UNCONFORMITY

PRE-PENNSYLVANIAN

Undifferentiated
Includes limestone, shale and sandstone of Mississippian, Devonian, Silurian, Ordovician and Cambrian age; intricately folded and faulted.

CARBONIFEROUS

496 *Shipping coal mine. (Numbers are text references.)*

233 *Small local coal mine or prospect pit. (Numbers are text references.)*

C 81 *Diamond drill prospects. (Numbers are text references.)*

Structure Contours
Full lines are on Upper Banner coal horizon and dashed lines are on Splash Dam coal horizon. (Contour interval 50 feet; numbers show feet above sea level.)

Geology surveyed by
Henry Hinds, T K Harnsberger,
and C. M. Bauer in 1913 and 1914.

Surveyed in cooperation with the
United States Geological Survey

GEOLOGIC MAP OF BUCU QUADRANGLE

The locations of measured coal openings are also shown on the accompanying topographic map

DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, SECRETARY
U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

TOPOGRAPHY

STATE OF VIRGINIA
GEOLOGICAL SURVEY
THOMAS L. WATSON, DIRECTOR

PLATE X

VIRGINIA - KENTUCKY
CLINTWOOD QUADRANGLE

ENGRAVED JAN. 1915 BY U.S.G.S.

R. B. Marshall, Chief Geographer.
Frank Sutton, Geographer in charge.
Topography by J. I. Gayetty, C. W. Arnold,
F. W. Crisp, Roscoe Reeves, and F. W. Farnsworth.
Control by L. F. Biggs, C. W. Arnold, H. S. Senseney,
and Clinchfield Coal Corporation.
Surveyed in 1912-1913.

SURVEYED IN COOPERATION WITH THE STATE OF VIRGINIA.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 50 feet.
Datum is mean sea level.

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION 1913.

Edition of May 1915.

+ 156 = Measured coal exposure with text reference number.

CLINTWOOD

DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, SECRETARY
U.S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

TOPOGRAPHY

STATE OF VIRGINIA
THOMAS L. WATSON
STATE GEOLOGIST

PLATE XI

VIRGINIA
BUCU QUADRANGLE

ENGRAVED NOV 1915 BY U.S.G.S.

R.B. Marshall, Chief Geographer.
Frank Sutton, Geographer in charge.
Topography by J.I. Gayetty, C.W. Arnold, and F.W. Farnsworth.
Control by H.S. Senseney and Clinchfield Coal Corporation.
Surveyed in 1913–14.

SURVEYED IN COOPERATION WITH THE STATE OF VIRGINIA.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 50 feet.
Datum is mean sea level.

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION 1916.

Edition of 1916.

+ 482 = Measured coal exposure with text reference number.

BUCU