Coal Geology of the White Oak Quadrangle Magoffin and Morgan Counties, Kentucky

GEOLOGICAL SURVEY BULLETIN 1047-A

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By W. L. ADKISON

GEOLOGY OF THE DINGUS AREA, KENTUCKY

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COAL GEOLOGY OF THE WHITE OAK QUADRANGLE, MAGOFFIN AND MORGAN COUNTIES, KENTUCKY

By W. L. Adkison

ABSTRACT

The White Oak quadrangle lies near the western edge of the eastern Kentucky coalfield and includes approximately 59 square miles of parts of Magoffin and Morgan Counties, Ky. The outcropping rocks are equivalent to most of the Breathitt formation of Pennsylvanian age. The regional southeast dip of the rocks is interrupted by the Irvine-Paint Creek fault, the Caney anticline, the Grape Creek syncline, and the Johnson Creek fault.

The Breathitt formation is comprised mainly of sandstone, siltstone, and shale; the remaining rocks consist of underclay, coal, limestone, and calcareous siltstone and shale. Eight of the coal beds—Tom Cooper, Cannel City, Fire Clay, Hamlin(?), Colvin, Index, Nickell, and Sebastian—are more than 14 inches thick in parts of the quadrangle. None of the beds have been mined extensively, and only one, the Nickell bed, was being mined in 1951. All coal in the quadrangle is of high volatile bituminous rank, and 4 beds—Cannel City, Fire Clay, Colvin, and Nickell—contain cannel coal locally. The total of estimated original coal reserves in beds more than 14 inches thick is at least 92 million tons.

INTRODUCTION

The U. S. Geological Survey is currently conducting investigations of the geology and coal resources of the Dingus area in eastern Kentucky. This is the first report resulting from these investigations.

The White Oak quadrangle includes about 59 square miles of parts of Magoffin and Morgan Counties, Ky. It occupies the southwestern part of the Dingus area, and lies near the western edge of the eastern Kentucky coalfield. The village of White Oak, which lies in the north-central part of the quadrangle, is about 8 miles southeast of West Liberty and about 14 miles northwest of Salyersville. (figs. 1 and 2).

The area's principal highway, U. S. 460, crosses the quadrangle from the north to the southeast. Kentucky highways 364 in the northeast, 134 in the southeast, and 191 along the western edge also serve the area and are supplemented by several gravel roads. At this writing there are no railroads operating in the quadrangle.

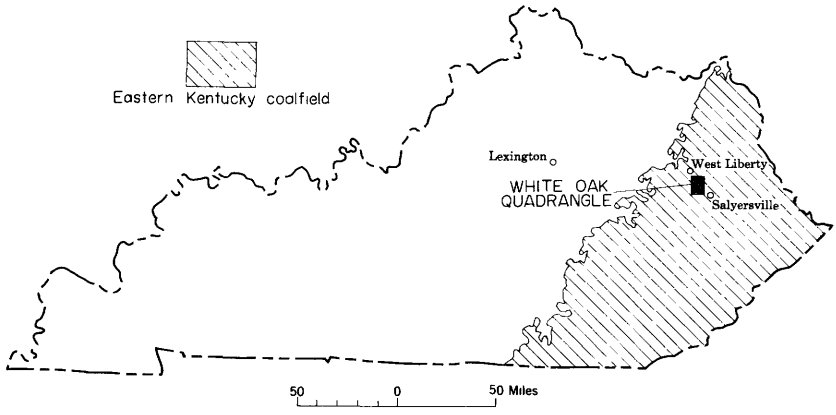

FIGURE 1.—Map showing the location of White Oak quadrangle, Magoffin and Morgan Counties, Ky.

PREVIOUS INVESTIGATIONS

The presence of coal along Caney Creek, which lies about a mile west of the White Oak quadrangle, was reported in 1857 by D. D. Owen (1857, p. 29, 157). A few years later S. S. Lyon (1861, p. 535–538) described the coal and associated rocks on Johnson Fork. In a preliminary report on Morgan and Magoffin Counties, A. R. Crandall (1880 (?), p. 15–19) gave thicknesses and correlations of several coal beds on Caney Creek, Buck Branch, and Johnson Fork. In a later report Crandall (1910, p. 13–18, 25, 26) further described the coal beds on Caney Creek, White Oak Creek, Johnson Fork, and Bend (Ben) Branch. He also recognized an axis of structural disturbance on White Oak Creek and Caney Creek.

The most detailed investigation of the geology of Magoffin County was made by I. B. Browning and P. G. Russell (1919). The report included descriptions and correlations of the coal beds and associated rocks and a description of the structure of the rocks.

Structure maps of Magoffin and Morgan Counties were published by I. B. Browning (1921), J. S. Hudnall and I. B. Browning (1924), and L. C. Robinson and J. S. Hudnall (1925).

In a report on the geology of Morgan County, L. C. Robinson (1927, p. 231–259) described the structure and stratigraphy and correlated some of the coal beds with those of the Big Sandy River and Kentucky River areas. The most recent study of the outcropping rocks in Magoffin and Morgan Counties was made by H. R. Wanless (1939, p. 53–59), who correlated the key beds of this area with those of adjoining counties.

PRESENT INVESTIGATION

The coal geology of the White Oak quadrangle was mapped by the U. S. Geological Survey as a part of a general investigation of the

coal resources of eastern Kentucky. Fieldwork for this report required about 4 months and was done in the spring and fall of 1951 and the spring of 1952.

Fieldwork consisted of measuring and describing several hundred coal outcrops at mines, roadcuts, and natural outcrops. Stratigraphic sections were measured and described along roads and trails at many places. Most of the altitudes of coal outcrops and other key beds were determined by aneroid barometer traverses, and the rest were determined by hand leveling from points of known altitude.

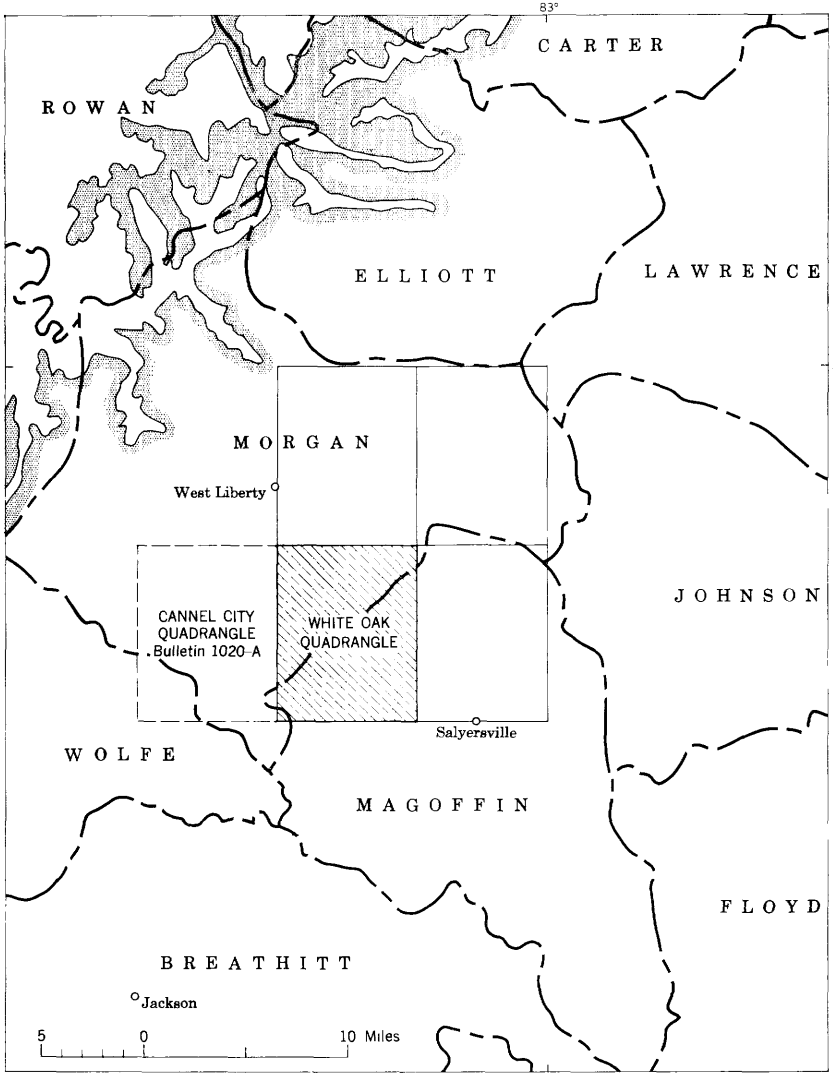

FIGURE 2.—Map showing the position of the White Oak 7½-minute quadrangle (shaded) within the Dingus area and its relation to the western boundary of Pennsylvanian strata.

ACKNOWLEDGMENTS

This report was prepared with the cooperation of the University of Kentucky and the Kentucky Geological Survey. The writer wishes to thank the local residents and mine operators for their cooperation during the fieldwork for this report. Chabot Kilburn assisted in the field for several weeks. The U. S. Bureau of Mines analyzed the coal samples.

TOPOGRAPHY

The White Oak quadrangle lies near the western edge of the highly dissected Cumberland Plateau. The lowest point, approximately 780 feet above sea level, is along the Licking River at the north edge of the quadrangle. Several points on the ridge in the southern part of the quadrangle are slightly more than 1,300 feet above sea level. Local relief is 300 to 400 feet.

The width of the Licking River flood plain ranges from about 500 feet in the north and south parts to nearly 1,000 feet in the east-central part where the river flows across the Caney anticline (pl. 1). On the Left Fork of White Oak Creek, the flood plain is about 700 feet wide just north of the Irvine-Paint Creek fault but narrows to about 300 feet on the north flank of the Caney anticline. From the crest of the anticline southward, for about 2 miles, it is 400 to 600 feet wide. Elsewhere in the quadrangle the other principal tributaries of the Licking River have flood plains which locally attain widths of 800 feet. The smaller creeks and branches have narrow steep-sided valleys and very narrow bands of alluvium in the bottoms.

Hillsides in the area generally consist of alternating benches and slopes formed by the differential erosion of beds of shale and sandstone.

STRATIGRAPHY

PENNSYLVANIAN SYSTEM—BREATHITT FORMATION

The bedrock exposed in the White Oak quadrangle is equivalent to most of the Breathitt formation named by Campbell (1898, p. 3) from exposures in Breathitt County, Ky. In Breathitt County this formation includes all Pennsylvanian rocks above the Lee formation. This formation is considered by Wanless (1946, p. 10) to be about equivalent to the upper Norton, Gladeville, Wise, and Harlan formations of Campbell (1893, p. 28, 31–36) in Virginia and to the Briceville, Jellico, Scott, and Anderson formations of Keith, (revised by Glenn, 1925, p. 16–36) in Tennessee.

The Breathitt formation has a maximum exposed thickness of about 650 feet in this quadrangle, but the base is not exposed. The oldest exposed beds crop out along the two forks of White Oak Creek

on the Caney anticline. The youngest beds are poorly exposed on the ridges in the southern half of the quadrangle.

This formation comprises mainly sandstone, siltstone, and shale, and includes small amounts of underclay, coal, limestone, and calcareous siltstone and shale. The environment of deposition for most of this formation was probably nonmarine, but the fossiliferous limestone, siltstone, and shale were probably deposited under marine conditions.

The sandstone consists chiefly of subrounded, very fine to medium-size quartz grains and a clay, silica, iron oxide, or calcareous cement. The color is generally medium light gray when freshly exposed, but weathering usually produces shades of reddish brown. Crossbedding is fairly common. Many of the sandstone beds lie in channels cut in the underlying rocks. The base of a sandstone channel deposit is generally sharp and undulating, but the upper contact is commonly gradational into finer grained sediments. These channel fillings of sandstone are not restricted to any particular part of the Breathitt formation.

The siltstone is generally medium light gray and ranges from quartzose to clayey. Most of the siltstone is thin to thick bedded, but some is nonbedded and stigmarian. For the most part the beds of stigmarian siltstone grade upward into silty underclay.

The shale is light gray to black, is usually medium gray, and upon weathering changes to shades of olive gray. Ironstone nodules and bands are abundant locally, and at many places the shale beds are heavily stained with iron oxide. Generally the shale is silty and commonly contains thin beds of siltstone. Plant imprints are present on the bedding planes of many of the shale beds. The beds of black shale are very carbonaceous and contain thin stringers of coal at many places.

The underclay is commonly medium light gray but ranges from light to dark gray. In general it is nonbedded and stigmarian and ranges from clayey to silty. Scattered ironstone nodules are fairly common, and most weathered outcrops are stained with iron oxide.

Limestone, in the form of concretions and beds, makes up a very small part of the Breathitt formation. The color of unweathered limestone beds ranges from medium gray to dark bluish gray but changes to shades of reddish brown upon weathering. The limestone is hard, dense, and silty, grading laterally to calcareous siltstone at several localities. Marine fossils are generally sparse to absent in the concretions but are more abundant in the beds of limestone and calcareous siltstone. The concretions, ellipsoidal in shape, locally attain a thickness of 4 feet and a diameter of about 10 feet. Com-

monly, these are septarian, and locally cone-in-cone structure is well developed.

For the purpose of a more detailed description, the rocks of the Breathitt formation are subdivided informally and arbitrarily at the bases of the mappable coal beds. An additional division is made for the Magoffin beds of Morse. (See pl. 2.)

STRATA BELOW THE TOM COOPER COAL

The oldest exposed rocks of the Breathitt formation crop out along the Caney anticline where they have a maximum thickness of about 120 feet. The lower part of this unit is poorly exposed, but at several places as much as 20 to 45 feet of massive sandstone is exposed in the upper part (pl. 2, secs. 4 and 8). This sandstone is commonly overlain by a few feet of siltstone, which is in turn overlain by the underclay of the Tom Cooper coal bed.

STRATA FROM THE BASE OF THE TOM COOPER COAL TO THE BASE OF THE CANNEL CITY COAL

The Tom Cooper bed was named from exposures on Brushy Fork of Lick Creek in the Salyersville North quadrangle (Browning and Russell, 1919, p. 29, 314). This bed is equivalent to the Little Caney coal bed of Englund (1955, p. 7, 15) and is probably equivalent to the Upper Elkhorn No. 3 of Pike County.

The rocks of this unit range in thickness from 25 to 50 feet. The lowermost bed above the Little Caney coal consists of black, carbonaceous shale less than 5 feet thick at most localities. In the east-central part of the quadrangle, the rocks above the black shale consist of gray shale and siltstone (pl. 2, secs. 8 and 9), but in the area west of Ditney Ridge, the black shale is overlain at most places by sandstone or siltstone. This sandstone is more than 12 feet thick on Spring Branch (pl. 2, sec. 4), and is overlain by shale and siltstone. The underclay of the Cannel City coal bed is about 2 feet thick and lies at the top of this unit of rocks.

STRATA FROM THE BASE OF THE CANNEL CITY COAL TO THE BASE OF THE FIRE CLAY COAL

The Cannel City coal bed was named from a bed that has been mined at Cannel City, Ky. (Englund, 1955, p. 8, 17–18). Browning and Russell (1919, p. 78) called this bed the Gun Creek coal in the vicinity of Ben Branch, but this name is not used in this report because of the uncertainty of correlation with the type section. The Cannel City bed is equivalent to the Amburgy coal bed of the North Fork of Kentucky River (Englund, 1955, p. 4, 8). This coal bed is less than 14 inches thick at most localities but is a useful marker bed in much of the northeastern quarter of the quadrangle because it commonly contains a thin (less than half an inch) parting of hard, dense medium-grayish-brown flint clay.

This part of the Breathitt formation ranges in thickness from 80 to 100 feet and is mainly shale, but at several places beds of massive sandstone are present in this unit. At most places the basal bed above the Cannel City coal is a gray shale which grades upward into the Kendrick shale of Jillson (1919, p. 96–104). At several localities a thin bed of coal is present 2 to 6 feet above the Cannel City coal bed.

The Kendrick shale of Jillson (1919) is a sparsely fossiliferous medium- to dark-gray shale which contains silty limestone concretions at most outcrops. The thickness is difficult to determine because both upper and lower contacts are gradational, but the average is probably close to 30 feet. The concretions are medium to dark gray, hard, and dense, and show septarian development at several places. These concretions have an average thickness of 2 feet and an average diameter of 5 feet. They are not restricted to one part of the shale but are present at several stratigraphic positions (pl. 2). In general, marine fossils are sparse, but some were found in a silty limestone bed 7 inches thick in the creek bed at the mouth of the right fork of Webb Branch. Marine fossils were also found in silty limestone concretions and in the enclosing shale in a branch of Vance Fork a third of a mile west of the Vance Fork School (fig. 3).

FIGURE 3.—Exposure of the Kendrick shale of Jillson on the right fork of Vance Fork 0.36 mile west of the Vance Fork School showing (*a*) dark-gray to grayish-black shale, (*b*) dark-gray fossiliferous siltstone, (*c*) dark bluish-gray dense fossiliferous concretionary limestone, (*d*) medium-gray silty shale, and (*e*) hammer.

In the vicinity of Carpenter Bend a massive cliff-forming sandstone about 40 feet thick lies in the stratigraphic position of the Kendrick shale of Jillson (1919) (pl. 2, sec. 8), but this sandstone becomes thinner to the west and south (pl. 2, sec. 7).

The strata between the Kendrick shale of Jillson (1919) and the Fire Clay coal bed are composed mainly of siltstone and shale, and smaller amounts of sandstone. In most places these rocks contain 2 or 3 thin beds of coal or black shale and associated beds of underclay (pl. 2). One of these coal beds, 15 to 30 feet below the Fire Clay coal bed, may be the equivalent of the Whitesburg coal bed of Letcher County.

A massive sandstone, the top of which lies 5 feet below the Fire Clay coal bed, crops out along the Licking River about a mile east of the mouth of Griffit Hollow (pl. 2, sec. 1). This sandstone, more than 40 feet thick, probably contains several sandstone lentils, for at the Matthew Post Office and also in Griffit Hollow this part of the section contains 2 or 3 thin coal beds separated by beds of shale and sandstone. Although this sandstone probably represents a channel-fill, the extent and direction of the channel could not be determined. The uppermost bed of this unit of rocks is composed of medium- to light-gray underclay having an average thickness of about 2 feet.

STRATA FROM THE BASE OF THE FIRE CLAY COAL TO THE BASE OF THE MAGOFFIN BEDS OF MORSE

The Fire Clay coal bed, named by J. M. Hodge (1908, p. 40, 41), commonly contains a parting of flint clay ranging in thickness from a knife edge to 5 inches. At most places it is medium brownish gray, hard, dense, and nonbedded with a conchoidal fracture. This parting is absent in the Pricy Creek area, in the head of Big Spring Branch, and near the north edge of the quadrangle about a mile east of the mouth of Griffit Hollow (pl. 2, sec. 1). The flint clay is rather soft in the vicinity of the Matthew Post Office and locally in the southeastern corner of the quadrangle (Greasy Branch and pl. 2, sec. 11). This distinctive parting makes the Fire Clay coal bed one of the most useful stratigraphic markers in the Breathitt formation.

The rocks between the Fire Clay coal bed and the Magoffin beds of Morse range in thickness from 42 to 65 feet. This unit is thinnest in the northwest part of the quadrangle and along the northwest side of the Grape Creek syncline. It is thickest in the southeastern part of the quadrangle and in the vicinity of Pricy Creek.

The lower part of this unit is composed of medium-gray shale as much as 28 feet thick. At several places part or all of the shale has been eroded and replaced by a massive sandstone, commonly 10 to 20 feet thick. In general, siltstone makes up a small part of this unit of rocks. Figure 4 shows the generalized lithology of the roof rock of the

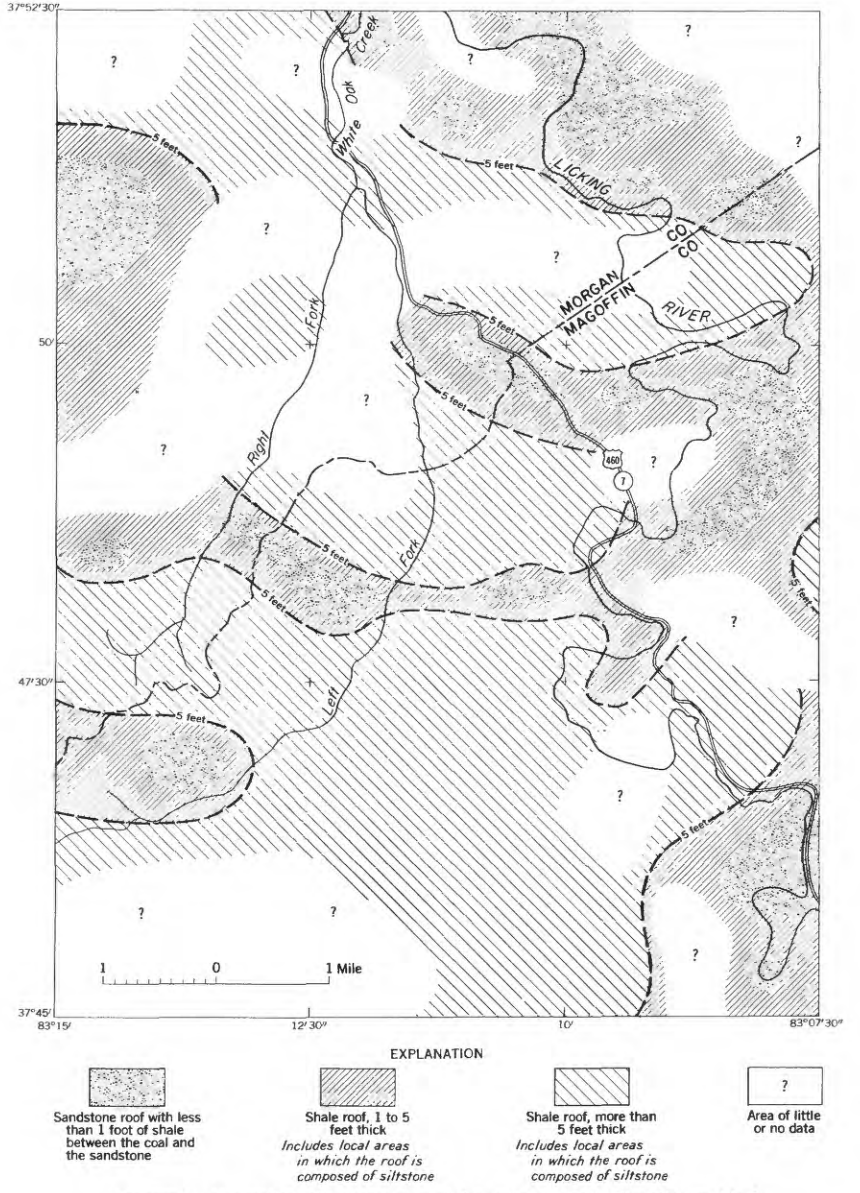

FIGURE 4.—Generalized lithofacies map of the roof rock of the Fire Clay coal bed.

Fire Clay coal bed. This part of the Breathitt formation was chosen for a lithofacies map because it lies directly above an extensive, easily recognizable horizon, and sufficient data were available for most of the quadrangle. This map outlines areas of probable channeling which were subsequently filled with sand. The pattern of distribution of the sandstone gives some suggestion of stream meanders,

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especially in the central part of the quadrangle, but a detailed stream pattern could not be determined.

A persistent and rather uniform coal bed lies 20 to 30 feet above the Fire Clay coal bed. This bed, which is probably equivalent to the Hamlin coal bed of Perry County, is commonly 12 to 16 inches thick and contains an underclay parting about 2 inches thick. A black carbonaceous shale, with an approximate average thickness of one foot, forms the roof of this coal.

The rocks above the black shale are dominantly gray shale, siltstone, and sandstone. At most localities a thin coal bed and an associated bed of underclay are present 10 to 20 feet above the Hamlin(?) bed. On Patrick Branch, in the southwestern part of the quadrangle, a massive sandstone about 20 feet thick lies a few inches above the Hamlin(?) coal bed. Less than half a mile northwest of Wolf Branch, along U. S. 460, the black shale roof of the Hamlin(?) coal bed is overlain by 15 feet of massive sandstone. This sandstone is overlain by about 15 feet of shale which has been entirely replaced by sandstone in the southeastern part of the exposure (pl. 2, sec. 10).

Although the upper part of this unit of rocks is commonly shale, at a few places the uppermost bed consists of underclay (pl. 2, sec. 5) or sandstone (head of Big Spring Branch).

THE MAGOFFIN BEDS OF MORSE

The Magoffin beds of Morse (1931, p. 301–303) are present throughout the quadrangle except for a few local areas. These beds, where typically developed (pl. 2, sec. 7, 8, and 10), consist of a lower bed of medium-dark-gray silty fossiliferous limestone 2 to 6 inches thick and an overlying bed of gray to black shale about 3 feet thick. This shale contains medium-dark-gray hard dense silty limestone concretions 1 to 2 feet thick (fig. 5). The shale immediately below the lower limestone bed is locally fossiliferous. The lower limestone bed commonly contains many macerated shell fragments, crinoid stem plates, and brachiopods. The overlying shale and concretionary limestone are locally fossiliferous.

In the extreme northeastern corner of the quadrangle, the Magoffin beds of Morse consist of a lower bed of silty fossiliferous limestone 8 to 10 inches thick, a bed of medium- to dark-gray shale 3 to 5 feet thick, and an upper bed of silty fossiliferous limestone 18 to 21 inches thick. In other places the Magoffin beds are represented by the following types of rock: a bed of calcareous, fossiliferous siltstone 4 to 12 inches thick (pl. 2, secs. 1 and 5); silty limestone concretions (pl. 2, sec. 2); and a massive bed of silty fossiliferous limestone 1 to 2 feet thick (pl. 2, secs. 3 and 6), which is commonly very fossiliferous in the lower 2 to 4 inches and sparsely fossiliferous in the remainder

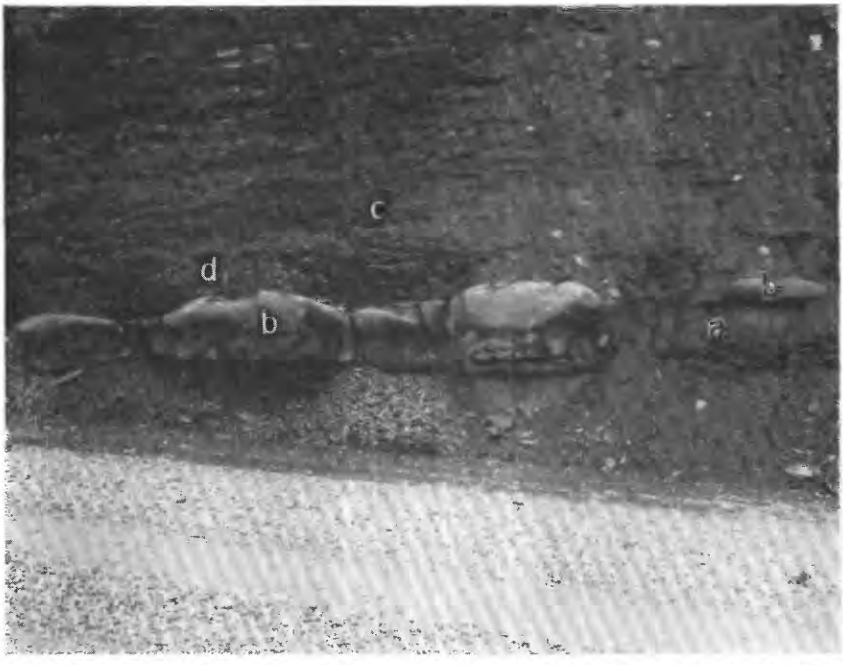

FIGURE 5.—Exposure of Magoffin beds of Morse on Vance Fork about a quarter of a mile east of the Vance Fork School showing (*a*) medium-gray fossiliferous shale, (*b*) medium-gray to medium dark bluish-gray dense fossiliferous concretionary limestone, (*c*) medium olive-gray shale, and (*d*) hammer.

of the bed. Even though the lateral changes in the Magoffin beds at most places take place rather abruptly, these beds are easily recognized because of the abundance of marine fossils.

STRATA FROM THE TOP OF THE MAGOFFIN BEDS OF MORSE TO THE BASE OF THE INDEX COAL

The rocks lying above the Magoffin beds of Morse and below the Index coal bed range in thickness from 65 to 90 feet and consist mainly of shale and sandstone. This unit includes some siltstone and 1 to 3 coal beds and associated beds of underclay. The Magoffin beds are normally overlain by a medium-gray shale, but in several areas south of the Irvine-Paint Creek fault this shale, and locally the underlying limestone, have been removed by channeling and their position occupied by massive sandstone (pl. 2, sec. 4). This sandstone is about 40 feet thick in the head of Big Spring Branch but is generally less than 25 feet thick in the southern part of the quadrangle.

One coal bed, lying 20 to 35 feet above the Magoffin beds, has been mined at several places in the southeastern part of the quadrangle. This coal (pl. 3, sec. 57) is here given the name Colvin coal bed from old mining operations on Buck Branch (also called Colvin Branch). This bed, which was described by Crandall (1880 (?), p. 19), was called the Haddix coal by Browning and Russell (1919, p. 333–335),

but this name is not used here because of the uncertainty of correlation with the type section.

In the northern part of the quadrangle 1 to 3 thin coal beds and associated beds of underclay are present 20 to 55 feet above the Magoffin beds (pl. 2, sec. 1, 2, and 3). These thin beds are separated by beds of sandstone and shale, and one or more may correlate with the Colvin coal bed to the south. The rocks between the upper of these coal beds and the Index coal bed are composed chiefly of sandstone in the north-central part (pl. 2, sec. 1 and 2), but in the northwestern part a bed of shale, and some siltstone, occupies more than half of this interval (pl. 2, sec. 3).

The underclay of the Index coal bed lies at the top of this unit and ranges in thickness from a knife edge to about 10 feet. At one locality on Wells Branch (pl. 2, sec. 3) this underclay contains a bed of medium-grayish-brown nonbedded, fairly hard flint clay about 3 inches thick lying 10 inches below the Index coal bed.

STRATA FROM THE BASE OF THE INDEX COAL TO THE BASE OF THE NICKELL COAL

The Index coal bed is here named from mine exposures along U. S. 460 a few feet below the gap in the ridge between Index and West Liberty in the West Liberty quadrangle. At this locality the coal contains a parting of flint clay similar to that found in the Fire Clay coal bed in the White Oak quadrangle. The Index bed is probably equivalent to the Adele coal bed of Englund (1955, p. 11, 18–19), but this correlation is uncertain due to the difficulty of tracing this coal across the Caney anticline.

In the area north of the Caney anticline the rocks of this unit are 20 to 30 feet thick and are composed of shale, siltstone, underclay, and a small amount of sandstone (pl. 2, sec. 1–3). Locally, one or two thin coal beds are present in this unit.

This part of the Breathitt formation is poorly exposed in the area south of the Caney anticline. On Granddaddy Branch (pl. 2, sec. 6) these rocks are composed chiefly of sandstone, but to the southwest, on Keeton Branch, they are composed primarily of shale (pl. 2, sec. 5). At the latter locality a thin coal bed is present about 7 feet above the Index coal bed.

A bed of underclay, 10 feet thick at a few places, lies at the top of this unit.

STRATA FROM THE BASE OF THE NICKELL COAL TO THE BASE OF THE SEBASTIAN COAL

The Nickell coal bed was named from exposures in the southern part of the Cannel City quadrangle (Englund, 1955, p. 11). In the ridge south of the head of Right Fork of White Oak Creek this bed was called the Hazard coal by Browning and Russell (1919, p. 57–68).

This name is not used here because of the uncertainty of correlation with the type locality.

The approximate thickness of the overlying rocks is from 25 to 45 feet. The basal bed is commonly a black, carbonaceous thin-bedded shale in the southwestern part of the quadrangle. This black shale ranges in thickness from a film to 6 feet. A medium-gray shale, 25 feet thick locally (pl. 2, sec. 3), lies above the black shale. In the area between the two forks of White Oak Creek and southwest of Lick Branch, a massive sandstone lies in channels cut in the gray shale. Locally these channels have been cut through the gray shale and the black shale and into the Nickell coal bed.

In the northern part of the quadrangle the rocks of this unit are chiefly shale, but a small amount of sandstone is present in the upper part. At three localities—the head of Lykins Branch, the head of Wells Branch (pl. 2, sec. 3), and the head of Jones Creek—marine fossils, mainly brachiopods, were found in an iron-oxide-stained zone 3 to 6 inches thick about 13 to 17 feet above the Nickell coal bed.

In the northeastern part, a massive sandstone, 25 feet thick at several places, lies above the Nickell coal bed. At one locality, near the mouth of Sebastian Branch of Rockhouse Creek, a few inches of medium-gray shale lie between the coal and the sandstone.

A bed of underclay, generally medium light gray and about 1 to 2 feet thick, lies at the top of this unit.

STRATA ABOVE THE SEBASTIAN COAL

The Sebastian coal bed is here named from a small mining operation on the Carl Sebastian farm at the head of the third left hollow of Webb Branch of Caney Creek. At this place the coal has an altitude of about 1,080 feet and lies about 150 feet above the Magoffin beds of Morse.

The basal beds of this unit consist chiefly of shale, siltstone, and underclay in the area north of the Irvine-Paint Creek fault and west of the Licking River. These beds are 12 to 20 feet thick and are overlain by a thin (12 inches or less) coal bed. A massive cliff-forming sandstone 25 to 35 feet thick lies above this thin coal.

At the head of Tim Branch, in the southwestern part of the quadrangle, the Sebastian coal bed is overlain by about 10 feet of shale; but at the head of Turkey Branch, three quarters of a mile to the east, a massive sandstone 30 feet thick lies 5 feet above this coal. Approximately 150 feet of poorly exposed strata lie above this sandstone in the southwestern part of the quadrangle.

QUATERNARY SYSTEM—ALLUVIUM

Sediments of Quaternary age consist of unconsolidated deposits of silt, sand, and larger fragments of rocks which were probably derived

entirely from the Breathitt formation. These deposits occur in the valleys and commonly merge into the slopewash on the hillsides.

STRUCTURE

The White Oak quadrangle lies on the western flank of the eastern Kentucky structural basin. The regional southeast dip is interrupted by the Irvine-Paint Creek fault, the Caney anticline, the Grape Creek syncline, and the Johnson Creek fault. The general structure of the Breathitt formation is shown on plate 1 by structure contours on the Fire Clay coal bed.

The Caney uplift was reported by Crandall (1910, p. 13, 16) and later mapped by Browning and Russell (1919, p. 19–21), Browning (1921), Hudnall and Browning (1924) and Robinson and Hudnall (1925). The Johnson Creek fault was described by Browning and Russell (1919, p. 20, 89, 100–104, 106, 328).

The Irvine-Paint Creek fault is a normal fault which has a displacement of about 100 to 250 feet. The fault plane was not seen, but the approximate trace of the fault can be determined by the displacement of key beds and by abrupt changes in the dips of the rocks as the fault is crossed. The rocks on the north (upthrown) side dip to the north at 100 to 160 feet per mile into a shallow syncline which lies 1 to 2 miles north of the fault. Rocks on the south side dip sharply to the north, the dip increasing as the fault is approached. Dips of 10° to 15° are common near the fault, and one dip of 28° was measured on Keeton Branch.

The Caney anticline, which extends beyond the borders of the quadrangle, is slightly asymmetrical and plunges to the east at the rate of 15 to 30 feet per mile. The axis lies from 1 to 1½ miles south of the Irvine-Paint Creek fault and is subparallel to it. The north flank of the anticline dips at the rate of 120 to 280 feet per mile, increasing as the Irvine-Paint Creek fault is approached, but the south flank has a more gentle dip of 50 to 140 feet per mile.

The Grape Creek syncline, described by Browning and Russell (1919, p. 22), is a broad, shallow syncline south of and subparallel to the Caney anticline. It was also called the Harper syncline (Hudnall and Browning, 1924, map). In the southwestern part of the quadrangle this syncline is split by a low eastward-plunging nose. The south flank of the syncline rises at the rate of 60 to 120 feet per mile toward the Johnson Creek fault.

The Johnson Creek fault is a normal fault with a displacement of about 50 to 140 feet. The rocks on the south (downthrown) side dip to the north at 60 to 100 feet per mile. This fault is poorly exposed except at one place on Johnson Creek about half a mile below the mouth of Trapp Branch where the fault plane, which dips 40° to

FIGURE 6.—Exposure of Johnson Creek fault along Kentucky Route 134 about 0.45 mile below the mouth of Trapp Branch of Johnson Fork showing (*a*) fault plane dipping 40° south with about a 2-inch-thick zone of dark-gray clayey gouge, (*b*) massive sandstone dipping about 5° N. having several joints and one small fault that are subparallel to the main fault, (*c*) medium-gray silty shale, (*d*) thin (less than 6 inches) beds of medium- to light-gray siltstone, and (*e*) lower bench of Cannel City coal.

the south, is well exposed in a roadcut on Kentucky Route 134 (fig. 6). In contrast to the dipping fractured sandstone on the south side of the fault, the shale and siltstone on the north side are nearly flat-lying and undistorted.

Several minor folds and faults are present in the quadrangle but are not shown on the structure map because the poor exposures and small displacements (1 to 10 feet) of the faults, made it impossible to map these smaller features.

DESCRIPTION OF COAL BEDS AND COAL RESERVES

The Breathitt formation contains 8 mappable coal beds in the White Oak quadrangle, but 2 of these beds are less than 14 inches thick over most of the area. Coal outcrops are shown on plate 1, but thickness data were not obtained at many of the locations. Many of the small mines that produced coal for domestic use were completely caved when visited.

Coal reserves of the 6 major beds were divided into the following categories: Indicated reserves include coal lying within 1½ miles of an outcrop along which the extent and thickness of the coal are well defined. Inferred reserves include the remaining coal lying beyond

the area of indicated reserves. The reserves were further subdivided into categories based on the coal thickness, excluding partings. The coal was assumed to weigh 1,800 tons per acre-foot. All of the calculated reserves have less than 1,000 feet of cover.

TOM COOPER COAL BED

This coal has been mined for domestic use at several places along the Caney anticline where it ranges in thickness from 10 to 30 inches, the average thickness being approximately 18 inches. The coal is fairly bright, consisting of thin to medium bands of vitrain in a moderately bright attrital matrix. It has no parting of bone or shale, but at one locality near the Holliday Post Office (pl. 3, sec. 5), a band of pyrite an eighth of an inch thick is present 8 inches above the base of the coal. The total estimated original reserves in this bed are 16,662,000 tons (table 1). Of this total only 628,000 tons are in the 28- to 42-inch thickness category. The amount of coal mined and lost in mining is believed to be small.

TABLE 1.—*Estimated original coal reserves of the White Oak quadrangle*

[In thousands of short tons. Covered by less than 1,000 feet of overburden]

Bed	Indicated reserves in beds—			Inferred reserves in beds—			Total		
	14–28 in. thick	28–42 in. thick	Total	14–28 in. thick	28–42 in. thick	Total	In beds 14 to 28 in. thick	In beds 28 to 42 in. thick	Total
Sebastian	5,748		5,748				5,748		5,748
Nickell	7,416	249	7,665				7,416	249	7,665
Index	15,173		15,173	639		639	15,812		15,812
Colvin	10,115	1,390	11,505				10,115	1,390	11,505
Fire Clay	31,951	2,756	34,707				31,951	2,756	34,707
Tom Cooper	16,034	628	16,662				16,034	628	16,662
Totals	86,437	5,023	91,460	639		639	87,076	5,023	92,099

CANNEL CITY COAL BED

The Cannel City coal bed has been mined in a small area along the western edge of the quadrangle on Spring Branch, Stinson Branch, and Yearling Branch. In this area the bed is composed mainly of cannel coal 33 inches thick locally (pl. 3, sec. 12). Elsewhere in the quadrangle this bed ranges in thickness from 10 to 14 inches and commonly contains one or more shale or underclay partings. At several places in the east-central part of the area the coal contains a thin (less than half an inch) parting of medium-grayish-brown flint clay (pl. 3, sec. 7, 9, and 10). The reserves in this bed were not calculated because the area containing coal more than 14 inches thick is very small and is believed to be nearly mined out.

FIRE CLAY COAL BED

Operations in this bed have been confined to small mines. The coal ranges in thickness from a few inches to 36 inches, but the area underlain by coal more than 28 inches thick is very small (pl. 4). The coal is commonly composed of thin to medium bands of vitrain in a bright to dull attrital matrix. Cannel coal is present in this bed at several places in the northeastern corner of the quadrangle (pl. 3, sec. 13–17) and on Jones Creek near the edge of the quadrangle. Farther up Jones Creek this bed contains much dull attrital coal (pl. 3, sec 22 and 23). At several other places the coal lying immediately above or below the flint clay parting contains much dull attrital matrix.

The most widespread parting in this coal is the bed of flint clay described previously. The Fire Clay coal bed also contains partings of underclay, shale, and siltstone, but these lack the persistence and distinctive character of the flint clay parting.

This coal was sampled at two places. One sample from locality 36 on the Left Fork of White Oak Creek contained 5.6 percent ash, and the other sample (cannel) from locality 14 on Pricy Creek contained 21.2 percent ash (table 2).

The total estimated original reserves in the Fire Clay coal bed are 34,707,000 tons, of which 2,756,000 tons are in the 28- to 42-inch thickness category. The amount of coal mined and lost in mining is unknown, but is probably rather small.

HAMLIN(?) COAL BED

The Hamlin (?) coal bed has been truck-mined at one place along the Licking River about a third of a mile east of the mouth of Cripple Creek (pl. 3, sec. 52). Here the coal is 25 inches thick and consists of thin to thick bands of vitrain in a moderate to bright attrital matrix. Elsewhere in the quadrangle this coal has an average thickness of 12 to 16 inches and commonly contains a clay parting resembling underclay which ranges in thickness from 1 to 2½ inches. Reserves for this bed were not calculated because of the general thinness of the coal and the lack of information.

COLVIN COAL BED

The Colvin coal bed has been truck-mined at several places in the southeastern part of the quadrangle. This bed consists mainly of cannel coal in the head of Buck Branch (pl. 3, sec. 57) and on Cripple Creek, but to the west of this area the coal consists of thin to medium bands of vitrain in a moderately dull to bright attrital matrix. At the mouth of Trapp Branch this bed is partly composed of canneloid coal.

TABLE 2.—*Analyses of coals*

[Rank: HVBB, high volatile B bituminous; HVBB NA, high volatile B bituminous, nonagglomerating, cannel. Form of analysis: A, as received; B, moisture and ash free]

Coal bed	Location on pl. 1	Bureau of Mines laboratory no.	Rank [1]	Form of analysis [2]	Proximate analysis			Ultimate analysis						Heating value (Btu)	Free swelling index	Ash softening temperature
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen			
Sebastian	87	D-87746	HVBB	A	7.4	35.5	48.8	8.3	0.6	5.5	68.9	1.4	15.3	12,350	1½	[1] 2,910+
				B		42.1	57.9		.8	5.5	81.7	1.7	10.3	14,650		
Nickell	80	D-87745	HVBB NA	A	2.3	[2] 45.8	38.1	13.8	1.6	6.2	69.0	1.3	8.1	13,070	1	2,080
				B		[2] 54.6	45.4		1.9	7.0	82.2	1.6	7.3	15,580		
Index	71	D-87744	HVBB	A	8.7	37.3	49.5	4.5	.8	5.8	71.0	1.5	16.4	12,750	4	[1] 2,910+
				B		42.9	57.1		.9	5.6	81.7	1.7	10.1	14,690		
Colvin	58	D-87741	HVBB	A	5.7	39.1	50.3	4.9	.8	5.6	73.0	1.7	14.0	13,160	4½	2,910+
				B		43.7	56.3		.8	5.6	81.6	1.9	10.1	14,720		
Fire Clay	14	D-87739	HVBB NA	A	1.4	42.9	34.5	21.2	2.1	5.6	63.1	1.2	6.8	11,980	1	2,550
				B		55.4	44.6		2.7	7.1	81.5	1.5	7.2	15,480		
Fire Clay	36	D-87740	HVBB	A	5.4	40.0	49.0	5.6	1.8	5.7	72.4	1.5	13.0	13,090	3	2,500
				B		44.9	55.1		2.0	5.7	81.3	1.7	9.3	14,700		

[1] Initial deformation temperature.
[2] Determined by modified method.

The Colvin coal bed has a thickness of more than 55 inches on Grape Creek opposite the mouth of Boardtree Branch (pl. 3, sec. 59), and is more than 40 inches thick on Johnson Fork a fifth of a mile southeast of locality 59 (pl. 3, sec. 60). In this area the thickness of the coal ranges considerably because of the undulating floor and the presence of channels cut in the upper part of the coal. No reserves in the +42-inch category are shown in table 1 because of this irregular thickness. An analysis of this bed from locality 58 on Licking River showed that the coal contains 4.9 percent ash.

The total estimated original reserves in the Colvin coal bed are 11,505,000 tons, of which 1,390,000 tons are in the 28- to 42-inch category. The amount of coal mined and lost in mining is unknown.

INDEX COAL BED

This coal has been mined for domestic use in the area north of the Caney anticline and in the southwestern part of the quadrangle. In the northern part the coal ranges in thickness from 17 to 29 inches and averages about 22 inches. It consists of thin to medium bands of vitrain in a bright to dull attrital matrix. Partings of underclay are fairly common, especially in the upper part of the coal. At one locality (pl. 3, sec. 68), a quarter of a mile north of the Matthew Post Office, a shale parting 2 inches thick contains lenses of hard medium-gray flint clay. These lenses have a maximum thickness of about half an inch.

In the area south of the Caney anticline the Index coal bed is poorly exposed. At the head of Spring Branch (pl. 2, sec. 4) this coal is apparently represented by 4½ feet of black fissile coaly shale, somewhat resembling cannel coal.

This coal was sampled in Griffit Hollow (locality 71), and the analysis showed the coal to contain 4.5 percent ash.

The total estimated original reserves in the Index coal bed are 15,812,000 tons in the 14- to 28-inch category. Mined areas are probably small.

NICKELL COAL BED

The Nickell coal bed was being strip mined in 1951 at one place in the head of the Right Fork of White Oak Creek (pl. 3, sec. 80). Crandall (1910, p. 16) reported mining operations in this area about the turn of the century. The Nickell coal bed has been mined for local use at several other places in the area between the head of Right Fork and the Left Fork of White Oak Creek. Throughout this area the bed is mainly cannel coal which has an average thickness of approximately 22 inches. Although the cannel coal is more than 28 inches thick at several places in this area, all reserves are included in

the 14- to 28-inch category because of the irregular thickness of the bed. At one place at the head of Yearling Branch (pl. 3, sec. 83) the Nickell coal bed consists of 2 beds of cannel coal separated by 3 feet of black shale.

This coal is poorly exposed in the ridge to the south and east of the Left Fork of White Oak Creek. There the bed is composed of thin to medium bands of vitrain in a bright to moderately dull attrital matrix. A maximum thickness of 33 inches was observed on Grape Creek (pl. 3, sec. 84). A coal which is probably equivalent to the Nickell bed has been mined for domestic use at several places in the northeastern part of the quadrangle (pl. 3, sec. 76–79). The coal ranges in thickness from 14 to 25 inches and consists of bands of vitrain in a moderately dull to bright attrital matrix. Elsewhere in the quadrangle the Nickell coal bed appears to be very thin or absent. A sample of the Nickell coal bed (cannel) was taken from locality 80 at the head of the Right Fork of White Oak Creek, and the analysis showed the coal to contain 13.8 percent ash.

The total estimated original reserves in the Nickell coal bed are 7,665,000 tons of which 249,000 tons are in the 28- to 42-inch category. The amount of coal mined and lost in mining is unknown, but much of the cannel coal is probably mined out or left in pillars.

SEBASTIAN COAL BED

This coal has been mined for domestic use at a few places in the area. It ranges in thickness from about 18 to 32 inches and commonly contains a dark-gray to black carbonaceous parting of underclay near the center of the bed (pl. 3, sec. 87).

The coal is composed of thin to thick bands of vitrain in a dull to moderately bright attrital matrix. An analysis of coal from locality 87 on Webb Branch showed an 8.3 percent ash content.

All reserves are placed in the 14- to 28-inch category because of the lack of information on thickness of this bed. The total estimated original reserves in the Sebastian coal bed are 5,748,000 tons. The amount of coal mined and lost in mining is probably very small.

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