Geology and Coal Resources of the Cannel City Quadrangle Kentucky

GEOLOGICAL SURVEY BULLETIN 1020–A

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By KENNETH J. ENGLUND

GEOLOGY OF THE CANNEL CITY AREA, KENTUCKY

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FOREWORD

"Geology of the Cannel City area, Kentucky" describes the geology and mineral resources, especially the occurrence of coal, oil, and gas, in the Cannel City 15-minute quadrangle. The report was undertaken as a part of a general study by the U. S. Geological Survey of the coal and coal-bearing rocks in eastern Kentucky. The general study will provide information about the amounts of coal available in relation to thickness of beds, depth of overburden, quality, and reliability of the information.

The Cannel City 15-minute quadrangle covers about 236 square miles near the western edge of the eastern Kentucky coalfield. It lies in the western half of Morgan County and in parts of Menifee, Wolfe, and Magoffin Counties. West Liberty, near the eastern edge of the quadrangle, is the largest town in the area and the seat of Morgan County. The area is accessible by U. S. 460, the main east–west highway, and by State Highways 7, 191, 203, and 205, which are north-south all-weather roads. In some areas road construction is hampered by local relief, which ranges from 100 to 600 feet, and by deep, narrow valleys cut in massive sandstones by the Licking and Red Rivers and their tributaries. There are no railroads within the quadrangle.

Chapters of the report describe the coal resources of each of the 7½-minute quadrangles—Ezel, Hazel Green, West Liberty, and Cannel City—which make up the 15-minute Cannel City quadrangle. Also included in the chapters are discussions of the occurrence of oil and gas, history of its production, well records, subsurface maps, discussions of the rocks penetrated by the drill, descriptive geology, and the occurrence of clay, limestone, and other nonfuel mineral resources.

The University of Kentucky provided office space for the preparation of reports and for field-party headquarters. The geology department of the University of Kentucky and the Geological Survey of Kentucky have been helpful in offering suggestions and providing unpublished information.

John W. Huddle

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By KENNETH J. ENGLUND

ABSTRACT

The Cannel City 7½-minute quadrangle, located near the western edge of the eastern Kentucky coalfield, covers an area of 59 square miles in parts of Morgan, Wolfe, and Magoffin Counties. The rocks exposed in the quadrangle are of the Breathitt formation of Pennsylvanian age. They consist of sandstone, siltstone, shale, underclay, coal, and limestone, and are partly of continental and partly of marine origin. The gentle southeast dip of these rocks is interrupted by the Irvine-Paint Creek fault and the Caney anticline, which extend east-west across the center of the quadrangle.

Seven of the coal beds in the quadrangle—the Grassy, Little Caney, Cannel City, Fire Clay, Adele, Nickell, and Sebastian—are more than 14 inches thick over extensive areas. Of these, only the Cannel City coal bed has been widely mined. The coal in the quadrangle is of high volatile bituminous rank, and three of the beds—the Grassy, Cannel City, and Fire Clay—are composed locally of cannel coal. An estimated reserve of about 200,000,000 tons of coal is contained in beds more than 14 inches thick that crop out in the quadrangle.

INTRODUCTION

LOCATION AND EXTENT OF THE AREA

The Cannel City 7½-minute quadrangle, located near the western edge of the eastern Kentucky coalfield, covers an area of 59 square miles in parts of Morgan, Wolfe, and Magoffin Counties (fig. 1). The town of Cannel City, in the center of abandoned coal and oil developments, is 13 miles southwest of West Liberty and 30 miles north of Jackson (fig. 2). U. S. 460, the principal highway into the area, crosses the northwest corner of the quadrangle. State Highway 191, serving the eastern and southeastern parts of the quadrangle, extends from U. S. 460 southward to State Highway 205 in the southwest corner. A railroad that formerly extended into the quadrangle from the south is now abandoned.

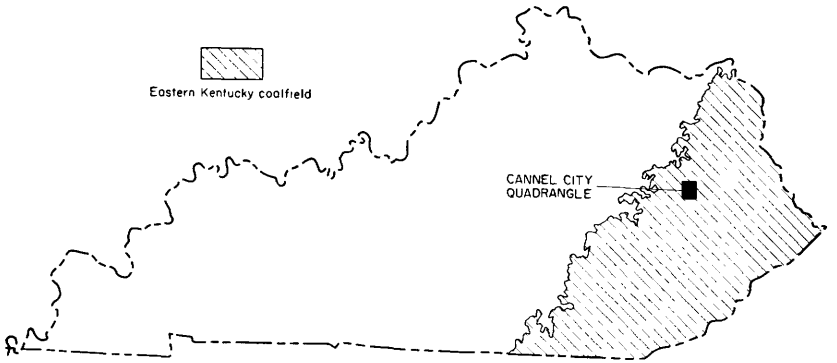

FIGURE 1.—Map of Kentucky showing the location of the Cannel City 7½-minute quadrangle in the eastern Kentucky coalfield (shaded area).

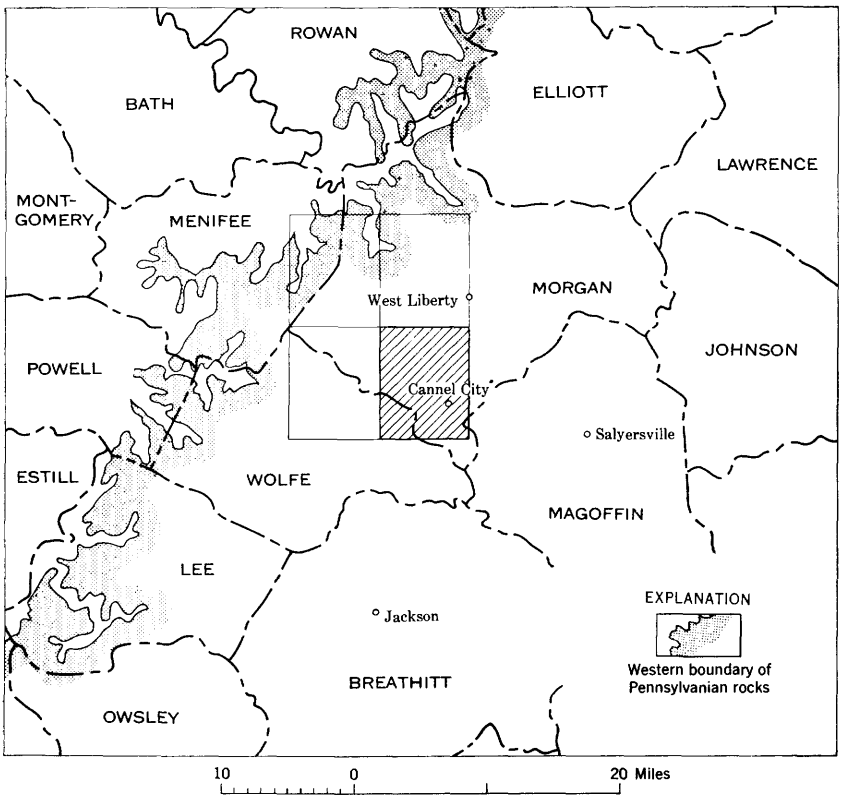

FIGURE 2.—Map showing the position of the Cannel City 7½-minute quadrangle (shaded) within the Cannel City 15-minute quadrangle and its relation to the western boundary of Pennsylvanian strata.

PREVIOUS INVESTIGATIONS

Coal outcrops along Caney and Grassy Creeks were reported in 1857 by D. D. Owen (1857, p. 29). Later, A. R. Crandall (1880?, p. 15–19) measured and correlated several coal beds along Caney Creek for a preliminary report on the geology of Morgan County. In the sequence of coal beds near the town of Caney, he designated a fairly thick cannel coal as the No. 2 coal (Crandall, 1880?, p. 329), and subsequently this bed was known as the No. 2 cannel coal (fig. 3). or Cannel City coal. Crandall (1910, p. 13–15) also recognized a line of structural disturbance, including the Caney anticline and the Irvine-Paint Creek fault, extending across the area from Daysboro to Caney Creek.

In a report on the geology of Morgan County, L. C. Robinson (1927, p. 251) correlated the principal coal beds with those of the Big Sandy and Kentucky River basins. In addition, Robinson prepared a reconnaisance structure map on the Fire Clay coal. A report on the Eastern Interior and Appalachian coalfields (Wanless, 1939, p. 53–59) lists several key beds, including the Dingess limestone, Fire Clay coal, and Magoffin beds in Morgan County, which are useful for correlation.

PRESENT INVESTIGATION

The Cannel City quadrangle was mapped (pl. 1) as a part of a general investigation of the coal resources of eastern Kentucky. Field work for this report was in progress from April 4 to June 13, 1951, and from October 22 to December 12, 1951. For several weeks during the latter period the writer was assisted by R. J. Burnside. The maps, tables, and text were prepared during the summer of 1952. Several hundred coal outcrops and stratigraphic sections were measured and described in mines, domestic openings, and road cuts to determine the extent, thickness, and lithology of the coal beds. Key beds, such as the flint-clay parting of the Fire Clay coal and the calcareous and fossiliferous zones of the Magoffin beds of Morse and the Kendrick shale of Jillson, proved useful in correlating the coal beds. The altitudes of most coal beds were determined by aneroid barometer traverses; corrections for atmospheric variations affecting the readings were made by reference to the many temporary and permanent benchmarks in the area. Altitudes were also determined by transit traverses and hand leveling.

TOPOGRAPHY

The Cannel City quadrangle is on the western edge of the dissected Cumberland plateau. The principal streams have flood plains ranging from one-eighth to one-third of a mile in width, and they are bordered by low, smooth-sloped hills. In contrast, the tributary

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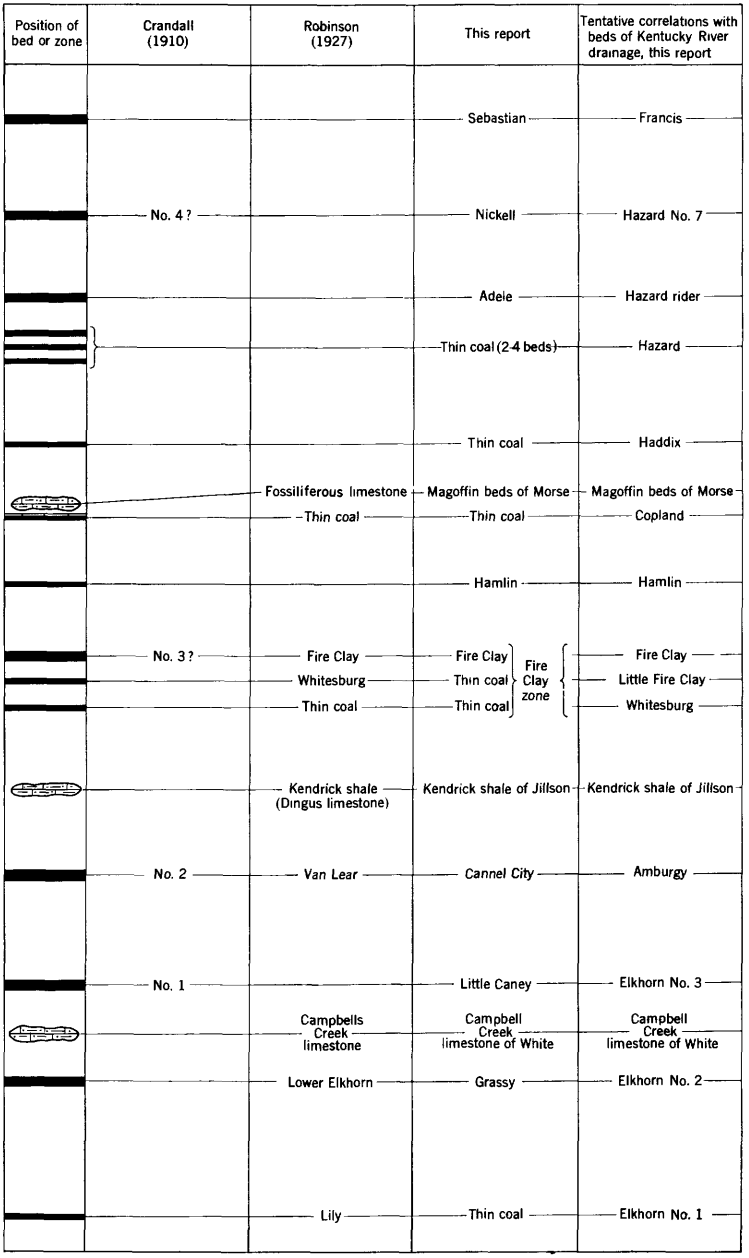

FIGURE 3.—Comparison of coal-bed names used in the Cannel City quadrangle.

streams occupy V-shaped valleys and head into benched ridges. The area is drained by Grassy and Caney Creeks (which flow northward into the Licking River), except in the southwestern part, which is drained by the Red River and its tributaries. Altitudes range from a little below 800 feet on Grassy Creek to slightly more than 1,400 feet along the southeast border of the quadrangle. Local relief averages between 300 and 400 feet.

ACKNOWLEDGMENT

The writer wishes to thank the many local residents and mine operators who kindly contributed information during the field work for this report.

STRATIGRAPHY

PENNSYLVANIAN SYSTEM—BREATHITT FORMATION

The outcropping bedrock in the Cannel City quadrangle consists of the Breathitt formation of Pennsylvanian age. It was named from exposures in Breathitt County, Kentucky, by Campbell (1898, p. 3) and includes all Carboniferous rocks lying above the top of the Lee formation. Although Campbell did not designate an upper boundary, it is presumed to be at least as high, stratigraphically, as the youngest Pennsylvanian rocks of Breathitt County. Wanless (1939, p. 78) recognizes the Breathitt formation as the upper division of the Pennsylvanian of eastern Kentucky, and he includes in it all beds above the Lee formation. He further states that the Breathitt formation is approximately the equivalent of the Briceville, Jellico, Scott, and Anderson formations in Tennessee and of the upper Norton, Gladeville, Wise, and Harlan formations in Virginia (Wanless, 1946, p. 10). Wanless' definition of the Breathitt is followed in this report.

The formation reaches a maximum thickness of about 750 feet in the Cannel City quadrangle. Its base is about 30 feet below drainage level in the northern part of the area near Mize and Grassy Creek, and rocks high in the formation are represented by hilltop exposures of sandstone at the head of Caney Creek. Rocks of continental and marine origin consist of alternating beds of sandstone, siltstone, underclay, coal, shale, and limestone.

The sandstone consists dominantly of subrounded, fine-to-medium grains of quartz with siliceous cementing material. Although the sandstone is light gray when fresh, it commonly weathers to shades of reddish brown. Deposits range from thin-bedded lenses to massive crossbedded channels. The base of a channel deposit is sharp and undulating, whereas the top commonly grades upward from sandstone into finer textured sediments, such as siltstone and underclay. Siltstone also occurs as laminae and lenses in other sediments. It is thin-

to thick-bedded and is light- to dark-gray in fresh exposures. The underclay, ranging from light- to dark-gray in color, is nonlaminated and stigmarian. At most localities the underclay is associated with an overlying coal bed.

The shale ranges from clayey to silty, and it is generally even bedded. The color, ranging from light gray to black in fresh exposures, is altered in weathered outcrops to shades of reddish brown by iron oxide staining. Spheroidal weathering also has occurred in many exposures. Some shale beds include thin ironstone bands and small ironstone concretions.

The limestone is dense, silty, and light- to dark-gray in color. It occurs in concretions and in thin beds that are associated with calcareous shale and siltstone. The concretions are silty to sandy, ellipsoidal, and as much as 15 feet in diameter. They occur in shale and, less commonly, in siltstone and sandstone. At some localities marine fossils are abundant in the limestone beds and concretions.

Natural outcrops are few throughout the quadrangle and consist mainly of sandstone, which forms benches and cliffs. Exposures of the less resistant sediments are limited to creek beds, mine openings, and road cuts.

The columnar sections (pl. 2) show the sequence of rocks in relation to the seven main coal beds. Although a stratum between coal beds may change, laterally, in thickness and lithology, the total thickness of the strata between coal beds is fairly uniform. Many lateral variations in the rock sequence are present where beds have been eliminated in unconformities below the broad sandstone channels.

Informal and arbitrary subdivisions are used in the following detailed description of the Breathitt formation.

STRATA BELOW THE GRASSY COAL BED

Rocks below the Grassy coal bed are near the base of the Breathitt formation and include the lowest exposed strata in the quadrangle. The thickest section of these rocks, about 90 feet, is exposed near the mouth of Caskey Fork, and smaller sections are exposed to the east on Grassy Creek and to the south in valleys along the axis of the Caney anticline. Beds in this sequence consist mainly of shale and sandstone, which change in thickness from place to place, and 2 or 3 thin coal beds (the 2 lowest coal beds of section 2, pl. 2). The lowest exposed bed, a dark-gray shale with abundant ironstone bands, grades upward into massive sandstone, which is overlain by shale containing 1 or 2 thin coal beds and associated underclays. About 20 feet below the top of the unit a calcareous siltstone occurs locally; 10 feet below the top, a thin coal was found in the northern part of the quadrangle. The underclay of the Grassy coal is at the top of this unit.

GRASSY COAL BED

A coal bed exposed in a small mine near the town of Grassy Creek is designated Grassy coal in this report (locality 109, pl. 1, and section 2, pl. 2). This bed, occurring from 140 to 170 feet below the Fire Clay coal, is tentatively correlated with the Elkhorn No. 2 coal of Pike County, Kentucky.

STRATA BETWEEN THE GRASSY AND LITTLE CANEY COAL BEDS

About 30 to 40 feet of sandstone, siltstone, and shale lie between the Grassy and Little Caney coal beds. The lowest bed in this sequence, which is fine-to medium-grained sandstone, crops out as a ledge above the Grassy coal near Grassy Creek. Here the sandstone has a maximum thickness of 12 feet; toward the southeast it thins and grades laterally into finer textured strata. In areas where shale overlies the Grassy coal bed, well-preserved fossil leaves and fronds are locally abundant. Beds of shale and siltstone overlie the sandstone in the northwest part of the quadrangle and comprise nearly the total interval in other parts. These beds include thin lenses of sandstone and a zone of silty limestone concretions. The concretions are ellipsoidal, the axes of which are as much as 1 foot and 5 feet in length. On the basis of their stratigraphic position, these concretions are tentatively correlated with the Campbell Creek limestone of White (1885) in West Virginia. Fossils were not found at this horizon in the Cannel City quadrangle, and they are reported to be uncommon in the Campbell Creek limestone (Wanless, 1939, p. 60). The light-gray underclay of the Little Caney coal is at the top of this sequence.

LITTLE CANEY COAL BED

The Little Caney coal is named for a small mine on Little Caney Creek on the north edge of the quadrangle (locality 97, pl. 1). This bed, occurring from 110 to 130 feet below the Fire Clay coal, is tentatively correlated with Elkhorn No. 3 coal bed of Pike County, Kentucky. Throughout the quadrangle the Little Caney coal can be recognized by a characteristic roof rock of fissile black shale (pl. 3).

STRATA BETWEEN THE LITTLE CANEY AND CANNEL CITY COAL BEDS

The Cannel City coal occurs from 30 to 50 feet above the Little Caney coal bed. Between them are a basal bed of black shale, an overlying gray shale, and an upper bed of light-gray underclay. Locally, massive sandstone occupies channels cut in the lower part of these beds. The black shale, averaging about 1 foot in thickness, is thin and is locally absent on the west edge of the quadrangle. The overlying gray shale includes thin beds of siltstone; locally, from 10 to 12 feet above its base, the gray shale includes either a very thin coal with underclay (section 1, pl. 2) or a thin black shale (section 4, pl. 2).

CANNEL CITY COAL BED

The Cannel City coal bed, named for mine workings near Cannel City (localities 68 and 69, pl. 1), occurs from 75 to 90 feet below the Fire Clay coal. On the basis of its stratigraphic position below the base of the Kendrick shale of Jillson (1919, p. 96–104), the Cannel City coal is correlated with the Amburgy coal bed of the North Fork of the Kentucky River.

STRATA BETWEEN THE CANNEL CITY COAL BED AND FIRE CLAY COAL ZONE

The sequence of rocks from the Cannel City coal up to the lowest coal in the Fire Clay coal zone ranges in thickness from 60 to 75 feet and consists predominantly of shale and siltstone with sandstone lentils at various horizons. This sequence also includes the silty limestone concretions of the Kendrick shale of Jillson (1919, p. 96–104). These concretions are ellipsoidal, their axes as much as 2 feet and slightly more than 10 feet in length. They are associated with strata that range from shale and siltstone to fine-grained sandstone (fig. 4). Although the Kendrick shale of Jillson is generally unfossiliferous in the quadrangle, abundant marine fossils, including brachiopods and corals, were found half a mile southeast of the mouth of Stacy Fork. A basal bed of sandstone, averaging 15 feet in thickness, crops out

FIGURE 4.—Large ellipsoidal silty limestone concretions in the bed of Little Caney Creek. These concretions are in the Kendrick shale of Jillson.

above the Cannel City coal on Red River. Locally, this sandstone occupies channels cut into the underlying coal. A sandstone bed near the middle of the interval includes very silty calcareous concretions at some localities, such as Stone Coal Fork (section 6, pl. 2). Sandstone also occurs above the Kendrick shale of Jillson on Stacy Fork and Caney Creek. The top bed of this interval is the underclay of the lowest coal in the Fire Clay zone.

FIRE CLAY COAL ZONE

The Fire Clay coal zone consists of the Fire Clay coal and two thin coal beds that underlie it. Named by Hodge (1908, p. 40–41), the Fire Clay coal is recognized as an important key bed for correlation because of its characteristic flint–clay parting (Wanless, 1939, p. 55). The flint–clay is a dense, hard rock with a conchoidal fracture. In fresh exposures its color ranges from grayish brown to brownish black. This parting, averaging about 3 inches in thickness in the southern part of the quadrangle, is very thin in the vicinity of Haney Branch and Barker Branch of Payton Fork, and is discontinuous farther north.

The two thin coal beds underlying the Fire Clay coal may represent the Little Fire Clay and Whitesburg coal beds of the Kentucky River drainage. Intervals between the three beds increase away from an area near the center of the quadrangle where only thin partings separate them. The thicknesses of these partings range from a few inches (sections 39 to 42, pl. 3) to several feet toward both the south (sections 46 to 50, pl. 3) and the north (sections 25 to 30, pl. 3). The partings, consisting mainly of underclay and shale, also include beds of sandstone where the coal beds are several feet apart. Calcareous lenses or concretions occur between the two lower coal beds in the northern part of the quadrangle (section 2, pl. 2).

STRATA BETWEEN THE FIRE CLAY COAL ZONE AND THE MAGOFFIN BEDS OF MORSE

The Magoffin beds of Morse occur from 40 to 55 feet above the Fire Clay coal. Beds of shale, siltstone, and sandstone, and a thin bed of coal, intervene. In the southern part of the quadrangle a bed of sandstone locally overlies the Fire Clay coal. A thin coal bed, found near the center of the interval, averages about 1 foot in thickness. This coal is tentatively correlated with the Hamlin coal of Hodge (1915, p. 8) on the basis of its position in relation to the Magoffin beds of Morse and the Fire Clay coal. At the top of this interval a few inches of coal locally underlies the Magoffin beds of Morse.

MAGOFFIN BEDS OF MORSE

A fossiliferous unit consisting of beds of silty limestone and calcareous shale is considered the equivalent of the Magoffin beds of Morse (1931, p. 301–303). Where typically developed, it includes a basal ledge of dense silty limestone, an intervening bed of dark-gray calcareous shale or siltstone, and an overlying ledge of concretionary limestone (fig. 5). The lower ledge ranges in thickness from 3 to 8 inches and includes an abundance of crinoid stem plates. The intervening bed ranges from 1 to 5 feet in thickness and is sparsely fossiliferous. The top ledge, which is as much as 1 foot 6 inches in thickness, is locally represented by large ellipsoidal concretions. Most of the fossils in the upper bed are brachiopods. At some localities the Magoffin beds of Morse are represented by fossiliferous shale or siltstone (section 7, pl. 2).

STRATA BETWEEN THE MAGOFFIN BEDS OF MORSE AND THE NICKELL COAL BED

The Nickell coal bed lies 100 to 120 feet above the Magoffin beds of Morse. A sequence of rocks consisting of sandstone, siltstone, shale, underclay, and several coal beds, intervenes. The most persistent bed, which is massive fine- to medium-grained sandstone, occupies broad channels which locally cut out the underlying Magoffin beds of

FIGURE 5.—Exposure of the Magoffin beds of Morse along U. S. 460 at the head of Greear Branch. The two prominent ledges of silty limestone (a) are separated by calcareous shale (b) and are underlain by 3 inches of coal (c) (section 2, pl. 2).

Morse (section 5, pl. 2). The sandstone has a maximum thickness of 50 feet in the southern part of the quadrangle, where it crops out as ledges or cliffs in many localities. In the northeastern part of the quadrangle, where the sandstone is thin or absent, a very thin coal and underclay occur about 25 feet above the Magoffin beds of Morse. Overlying the sandstone is a sequence of 2 to 4 thin coal beds and associated underclays. This zone is tentatively correlated with the Hazard coal bed of the Kentucky River drainage. Overlying these beds is a shale that includes a zone of silty limestone concretions which are fossiliferous at one locality. The Adele coal, named for a small abandoned mine on State Road Fork near Adele (locality 24, pl. 1), is 70 to 90 feet above the Magoffin beds of Morse. This coal is probably a rider of the Hazard coal. The roof rock of the Adele coal is generally a dark-gray or black shale. On State Road Fork a massive sandstone is present between this coal and the overlying Nickell coal bed. The underclay of the latter is the top bed of this unit.

NICKELL COAL BED

The Nickell coal bed, occurring 140 to 175 feet above the Fire Clay coal, is named for the Nickell mines at the head of Stone Coal Fork of Caney Creek (locality 16, pl. 1). Here the bed is about 35 feet below mines in the Sebastian coal bed.

STRATA BETWEEN THE NICKELL AND SEBASTIAN COAL BEDS

The rocks between the Nickell and Sebastian coal beds are mostly shale and siltstone, and they range from 30 to 45 feet in thickness. At most localities the basal bed of the sequence is dark-gray or black shale overlain by gray shales, siltstones, and thin beds of sandstone. Two very thin coal beds with underclays also occur in this interval. On State Road Fork a massive sandstone bed, near the middle of the sequence, lies in channels that locally cut out the basal beds. Marine fossils occur about 10 feet below the Sebastian coal in the southern part of the quadrangle. The underclay of the Sebastian coal is at the top of this unit.

SEBASTIAN COAL BED

The Sebastian coal is the highest coal mined on the C. Sebastian farm on Webb Branch of Caney Creek.[1] At this locality, half a mile beyond the east edge of the quadrangle, the bed is about 200 feet above the Fire Clay coal; in the Cannel City quadrangle it ranges from 180 to 220 feet above the Fire Clay coal.

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[1] Adkison, W. L., Coal geology of the White Oak quadrangle, Magoffin and Morgan Counties, Ky. In preparation as a Geological Survey report.

STRATA ABOVE THE SEBASTIAN COAL BED

Slightly more than 250 feet of rock overlies the Sebastian coal on hilltops in the southern part of the quadrangle. A basal bed of gray shale, as much as 50 feet in thickness, locally includes thin sandstone beds; near its top are 1 or 2 thin coal beds. Overlying the shale is 50 feet of massive cliff-forming sandstone. Higher strata, consisting mainly of sandstone, are exposed locally in cliffs. That these higher strata may include 1 or 2 coal beds is indicated by a few caved openings near the hilltops at the heads of Caney Creek and Brushy Fork.

QUATERNARY SYSTEM—ALLUVIUM

Alluvial deposits of Recent age occur along the main valley bottoms (pl. 1). They consist mainly of silt, sand, and gravel.

STRUCTURE OF COAL-BEARING ROCKS

The general structure of the Pennsylvania strata exposed in the Cannel City quadrangle is shown by the structure contours on the Fire Clay coal in plate 1. A gentle southeast dip, typical of the west flank of the eastern Kentucky structural basin, is sharply modified in the Cannel City quadrangle by the Irvine-Paint Creek fault and Caney anticline.

The Irvine-Paint Creek fault, extending from west to east across the quadrangle, separates areas that differ greatly in structure. To the north, on the upthrown block, the dip is away from the fault in slight rolls for a distance of ½ to 1 mile. This inclination, about 100 feet per mile, forms the south side of a syncline that extends into the area from the east. The syncline parallels the Irvine-Paint Creek fault and may be an extension of the Spaws Creek Basin of Robinson (1927, p. 243). Strata on the north flank of the syncline dip 20 to 40 feet per mile to the east and southeast.

South of the fault, strata of the downthrown block form the north flank of the Caney anticline. The strata dip as much as 19 degrees where cut by the fault plane, but the dip decreases southward to the axis of the anticline. This uplift, first reported by A. R. Crandall (1910, p. 13) and later mapped by Robinson and Hudnall (1925, map), is 2 to 3 miles wide and parallels the Irvine-Paint Creek fault. On the south flank the dip averages about 1½°, or 140 feet per mile, decreasing southward toward the axis of the Grape Creek syncline of Browning and Russell (1919, p. 22), which extends into the quadrangle from the east.

The Irvine-Paint Creek fault is a normal fault with a displacement ranging from about 160 feet on Stacy and Walters Forks to slightly less than 50 feet on Phipps and Sellars Forks. On Phipps Fork the fault plane dips approximately 35° to the south. Although the fault

plane is rarely exposed elsewhere and lacks distinct topographic expression, its position is revealed by the displacement of key beds and the abrupt change in the dip of strata at the fault. Locally, shales and siltstones lying near the fault are highly distorted.

Although minor faults are common in the quadrangle, they have not been traced far because of the lack of large or continuous outcrops. The displacement along most of them is less than 10 feet; therefore, they have little affected the structure of coal beds. One mile above the mouth of Phils Branch, in the northwestern part of the quadrangle, the Grassy coal bed is displaced several feet by a normal fault. Two miles northeast of this locality, at Greear Branch, this bed and adjacent strata are displaced 9 feet. Both of these faults have upthrown sides to the north. On Sellars Fork (locality 119, pl. 1) a normal fault dipping 20 degrees to the south drops the Grassy coal about 3 feet (fig. 6). On Eighth Branch near the southwest corner of the quadrangle (locality 50, pl. 1), the lower coal bed of the Fire Clay zone is displaced 4 feet by a reverse fault. Another small reverse fault on upper Caney Creek, opposite the mouth of Big Staff Branch, displaces the Hamlin coal 3 feet; the fault plane, which dips about 60° to the northeast, is less distinct in an overlying sandstone. Several other small faults were observed by the writer or reported in mine workings.

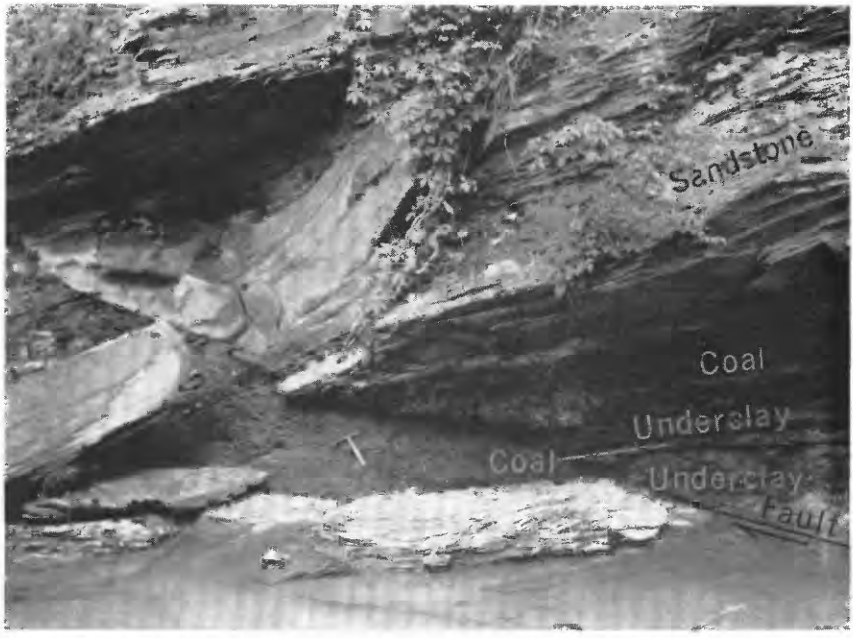

FIGURE 6.—The Grassy coal bed, on Sellars Fork near the Irvine-Paint Creek fault, displaced by a low-angle, normal fault (locality 119, pl. 1). The coal bed on the upthrown block is crumpled and concealed behind the slump block in the left foreground.

COAL

GENERAL DESCRIPTION

The Cannel City quadrangle contains seven coal beds of mappable extent and thickness. On plate 1 the outcrop lines of these beds are shown where measurements indicate a thickness of 14 inches or more. The outcrop line of the key bed—the Fire Clay coal—is shown even where its thickness is less than 14 inches. The locations of control points are indicated on plate 1, and graphic sections of the beds are shown on plate 3. The thickness and extent of coal in four of the more widespread beds—the Grassy, Little Caney, Cannel City, and Fire Clay—are shown on plate 4. The distribution of coal was estimated from outcrop measurements and mine data.

Coal reserves (see table 1) of the seven main beds that crop out in the quadrangle are classed as measured reserves if they lie within half a mile of an outcrop along which the extent and thickness of the coal are well defined; as indicated reserves if they extend 1 mile beyond the area of measured coal; and, as inferred reserves if they lie more than 1½ miles from a mapped outcrop or mine working. On plate 4 lines were drawn bounding areas within which the coal beds are estimated to be from 14 to 28 inches and from 28 to 42 inches in thickness, excluding partings, and on table 1 reserves are reported separately for these two categories. All of the calculated reserves are under less than 1,000 feet of cover.

TABLE 1.—*Estimated original and remaining coal reserves of the Cannel City quadrangle.*

[In thousands of short tons. Covered by less than 1,000 feet of overburden. Remaining reserves, as of Jan. 1, 1952, are the same as original reserves, except as indicated by footnote]

Coal bed	Original reserves											
	Measured			Indicated			Inferred			Total		
	In beds 14–28 in. thick	In beds 28–42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	Total
Sebastian	1,428	562	1,990	4,348	363	4,711	------	------	------	5,776	925	6,701
Nickell	4,112	------	4,112	2,569	------	2,569	------	------	------	6,681	------	6,681
Adele	184	------	184	1,322	122	1,444	------	------	------	1,506	122	1,628
Fire clay	8,242	2,753	10,995	1,887	225	2,112	923	------	923	11,052	2,978	14,030
Cannel City	[1] 8,399	[2] 18,430	[3] 26,829	6,795	15,373	22,168	9,041	1,532	10,573	[1] 24,235	[2] 35,335	[3] 59,570
Little Caney	19,936	------	19,936	19,313	------	19,313	16,064	------	16,064	55,313	------	55,313
Grassy	19,266	582	19,848	26,765	------	26,765	17,872	------	17,872	63,903	582	64,485
Total	[1] 61,567	[2] 22,327	[3] 83,894	62,999	16,083	79,082	43,900	1,532	45,432	[1] 168,466	[2] 39,942	[3] [4] 208,408

[1] 693 mined and lost in mining.
[2] 5,931 mined and lost in mining.
[3] 6,624 mined and lost in mining.
[4] Recoverable reserves, as of Jan. 1, 1952, assuming 50 percent recovery: 100,892.

GRASSY COAL BED

The thinness of the Grassy coal has limited mining to underground and strip operations that provide coal for local use only. A small truck mine was temporarily operated in 1951 on Red River (locality 123, pl. 1).

The Grassy coal bed ranges from 7 to 46 inches in thickness and averages about 20 inches. In the northwestern part of the quadrangle (graphic sections 103–110, pl. 3), the coal averages about 19 inches in thickness and includes a bench of cannel coal northwest of Grassy Creek (graphic sections 103, 105, and 106, pl. 3). At most of these localities the roof rock is sandstone, the base of which locally undulates into the coal. Toward the southeast, the coal bed thins in a belt from 1 to 2 miles wide (map D, pl. 4). Much of this thinning is due to erosion, which took place along the top surface of the coal bed before deposition of the overlying sandstone. Beyond this thin belt, the coal increases in thickness. Along Payton and Salem Forks it ranges from 19 to 20 inches in thickness (graphic sections 113–116 and 119, pl. 3), and on Phipps Fork, farther south, it is from 22 to 26 inches in thickness (graphic sections 117–118, pl. 3).

On Gillmore Creek and on Red River near the axis of the Caney anticline, the Grassy coal bed reaches its maximum thickness of 46 inches, which includes a shale parting near the top of the bed. The parting averages about 10 inches in thickness and is typical of the bed in this vicinity (graphic sections 121–126, pl. 3). Other measurements of the bed along the axis of the anticline are 17 to 19 inches on Sellars Fork, 15 to 17 inches on Stacy Fork, and 18 to 26 inches on Caney Creek.

The coal consists of bands of vitrain in a dull-to-bright attrital matrix. It is reported to be of good burning quality, and an analysis (table 2) indicates a low ash content. The total estimated original reserves in all categories of the Grassy coal bed are 64,485,000 tons. As mined areas are very small, they are considered negligible in the estimate of reserves.

LITTLE CANEY COAL BED

At most localities the Little Caney coal is bright, consisting of vitrain bands in a dull attrital matrix, and it is without partings. It has been mined in several entries, now abandoned, on Little Caney Creek near the north edge of the quadrangle. Other workings in the bed are confined to shallow diggings along outcrops.

Although the Little Caney coal bed is persistent in areal extent, it is not very thick. It ranges from a few inches to 21 inches, a thickness of 16 inches being fairly constant in outcrops along the tributaries of Salem Fork. Toward the northeast, in the vicinity of Grassy Creek,

TABLE 2.—*Analyses of coal of the Cannel City quadrangle*

[Analyses by U. S. Bureau of Mines]

Coal bed	Map locality	Bureau of Mines laboratory No.	Rank [1]	Condition of sample [2]	Proximate analysis (percent)			Ultimate analysis (percent)						Air-drying loss (percent)	Heat value (Btu)	Free-swelling index	Ash-softening temperature (° F.)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen				
Sebastian	8	D-77811	HVBB	A	8.2	35.8	43.1	12.9	2.5	5.3	63.1	1.2	15.0	5.9	11,360	2	2,580
				B	-------	45.4	54.6	-------	3.2	5.6	80.0	1.5	9.7	-------	14,390		
Sebastian	(3)	D-77813	HVBB	A	5.4	38.1	47.1	9.4	2.7	5.4	69.0	1.3	12.2	2.7	12,470	3½	2,210
				B	-------	44.8	55.2	-------	3.2	5.6	81.1	1.6	8.5	-------	14,650		
Nickell	(3)	D-77814	HVAB	A	4.8	44.5	44.8	5.9	3.6	5.8	71.6	1.5	11.6	2.6	13,130	4	2,310
				B	-------	49.8	50.2	-------	4.0	5.9	80.2	1.7	8.2	-------	14,700		
Cannel City	68	D-77810	HVAB (cannel)	A	3.4	42.7	47.7	6.2	0.7	5.9	75.1	1.7	10.4	1.7	13,690	2½	-------
				B	-------	47.2	52.8	-------	0.8	6.1	83.1	1.8	8.2	-------	15,150		
Cannel City	53	D-77815	HVBB	A	7.5	38.3	48.9	5.3	2.0	5.8	70.4	1.6	14.9	5.1	12,740	5	2,310
				B	-------	43.9	56.1	-------	2.3	5.7	80.6	1.8	9.6	-------	14,590		
Grassy	114	D-77812	HVBB	A	7.4	37.3	53.3	2.0	0.7	5.9	74.8	1.6	15.0	4.6	13,330	4½	2,890
				B	-------	41.1	58.9	-------	0.8	5.6	82.6	1.8	9.2	-------	14,710		

[1] HVBB, high volatile B bituminous; HVAB, high volatile A bituminous.

[2] A, as received; B, moisture and ash free.

[3] At head of State Road Fork, one-third mile beyond south edge of quadrangle.

Phils Branch, and Caskey Fork, the coal averages less than 14 inches in thickness. The coal is thin, also, along the axis of the Caney anticline on Red River, Stacy Fork, and Caney Creek. The total estimated reserves of the Little Caney coal (55,313,000 tons) are in the 14- to 28-inch-thickness category.

CANNEL CITY COAL BED

The Cannel City coal is the most widely mined in the quadrangle. Several truck mines in the bed on Red River and on Sellars Fork were in operation in 1951. The development of the bed first began in the early 1900's when R. M. Broas core drilled and proved 2,000 acres of cannel coal of workable thickness in the vicinity of Caney and Cannel City (Crandall, 1910, p. 13). The coal was extensively mined by the Kentucky Block Cannel Coal Company, whose workings are now abandoned. Present operations in this area are limited to small strippings of cannel coal that was disregarded in the underground mining of the bed (fig. 7).

FIGURE 7.— Stripping of the Cannel City coal bed on Doe Branch of Caney Creek. Approximately 6 inches of banded coal (at pick-point level) overlies 2 feet of cannel. The sagging of the roof shale may have resulted from the caving of drift workings beyond the stripping face.

The cannel coal, which is as much as 35 inches thick, is moderately bright and is low in ash. Generally, benches of banded coal underlie and overlie the cannel and are separated from it by partings of impure

coal and shale (graphic sections 68–75, pl. 3). The cannel coal thins toward the west, north, and east, and probably toward the south.

In outcrops at the heads of Stacy, Phipps, and Sellars Forks, and on Red River, the coal consists of bands of vitrain in a dull-to-bright attrital matrix. The coal averages about 3 feet in thickness and includes few persistent partings of shale. At a few localities a thin parting of impure flint clay is present near the center of the bed. In addition to the thin shale partings, a band of cannel about 5 inches thick occurs near the top of the bed in the vicinity of Red River. The coal locally includes flakes and nodules of pyrite. One of the shale partings, near the center of the bed, thickens northward from the head of Phipps Fork and separates by 5 feet the two splits of coal on Walters Fork (graphic sections 61–63, pl. 3).

The mined areas (pl. 4) were plotted from mine maps and information supplied by mine operators and former miners. The total estimated original reserves in all categories of the Cannel City coal bed are 59,570,000 tons. Deducting 6,624,000 tons—the estimated total that has been mined—the estimated remaining reserves as of January 1, 1952, are 52,946,000 tons.

FIRE CLAY COAL BED

Mining of the Fire Clay coal bed and the two thin coal beds that underlie it (pl. 3) has been on a small scale for local use only. The three beds converge near the center of the quadrangle to form a bed with a maximum of 42 inches of coal, excluding partings. On the lower part of Stacy Fork the Fire Clay coal is dominantly cannel. It thins toward the north, and a cannel shale occurs in its position at some localities (section 2, pl. 2).

Generally, the Fire Clay coal contains a high percent of dull attritus, and where it is cannel, it is dull and possibly high in ash. A bed of impure flint clay, not more than 6 inches in thickness, is commonly associated with the Fire Clay coal. The total estimated original reserves of Fire Clay coal are 14,030,000 tons. Mined areas in this coal are insignificant.

ADELE COAL BED

The Adele coal bed has been mined in three small truck mines near the south edge of the quadrangle. Its thickness ranges from a few inches to 40 inches. On State Road Fork (section 23, pl. 3) the maximum thickness is 20 inches, and on Red River (section 21, pl. 3) it is 40 inches. In the central and northern parts of the quadrangle the coal is thin and locally absent.

The coal commonly is dull and blocky, consisting of thin vitrain bands in dull attritus. The total estimated reserves of Adele coal in all categories are 1,628,000 tons.

NICKELL COAL BED

The Nickell coal bed crops out on hilltops across the southern part of the quadrangle. Generally, it ranges from 15 to 20 inches in thickness, and its maximum thickness, measured in an abandoned truck mine on Stick Branch of State Road Fork, is 27 inches. It is mined for local use at many places.

The coal is very blocky and is composed predominantly of dull-to-bright attritus. It is reported to be of good burning quality, and an analysis of the bed (table 2) indicates a fairly low ash content. The total estimated original reserves of Nickell coal—6,681,000 tons—are included in the 14- to 28-inch-thickness category.

SEBASTIAN COAL BED

The Sebastian coal crops out on hilltops in the southern part of the quadrangle and on the highest hills between the Caney and Grassy Creek drainages. It has been truck-mined at a few localities.

The coal ranges from 13 to 33 inches in thickness and generally consists of thin vitrain bands in dull-to-bright attritus. A thin parting of impure coal and shale commonly occurs at the center of the bed. Thin bands of impure coal also occur at the top or bottom of the bed in some localities. Analyses of samples from two localities (table 2) indicate that the coal is fairly high in ash. The total estimated original reserves of the Sebastian coal bed in all categories are 6,701,000 tons.

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