COAL RESOURCES OF THE CHEROKEE GROUP IN EASTERN KANSAS
I. Mulky Coal

by

Walter H. Schoewe

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ABSTRACT

The Mulky coal is the uppermost coal in the Cherokee Group of rocks (Pennsylvanian). It occurs in Bourbon and Crawford Counties, Kansas, where it has been mined, either by stripping or by drifting into the hillsides, only along the edge of the Fort Scott Limestone escarpment. Where mined, the Mulky coal is 7 to 22 inches thick, but averages only 12 inches. Mulky coal is classified as bituminous coal of high volatile A to B rank. Ash content is 10 to 25 percent, volatile matter 30 to 36 percent, moisture less than 2 percent, sulfur 3 to 6 percent, and heating value (moisture free basis) 10,000 to 13,000 Btu. Of the 3,582,630 tons of Mulky coal estimated and computed to have been mined, Bourbon County produced 2,415,360 tons and Crawford County 1,167,270 tons. Measured coal reserves 12 to 22 inches thick are estimated to underlie an area of 21,159 acres, all but 366 acres of which is in Bourbon County, and to total 47,020,450 tons. Indicated reserves underlie 53,679 acres, all in Bourbon County, and total 126,416,550 tons. Recoverable measured Mulky coal is estimated at 35,265,388 tons.

INTRODUCTION

Most of the coal seams of economic importance in Kansas are in the Cherokee Group, which in southeastern Kansas comprises the lower strata of Middle Pennsylvanian age (Fig. 1). Of the 11,618,608 tons of coal mined in Kansas between 1950 and 1957, about 75 percent (8,688,283 tons) was derived from the Cherokee in Bourbon, Crawford, Cherokee, and Labette Counties. In former years Cherokee coals were mined also at Atchison in Atchison County and at Lansing and Leavenworth in Leavenworth County. At least twelve coal seams, most of which at one time or another were mined, are known in the Cherokee Group, eight in the Cabaniss Subgroup (upper part of the Cherokee Group) and four in the underlying Krebs Subgroup (Fig. 2). This report is concerned only with the Mulky coal, which is the uppermost coal in the Cherokee Group.

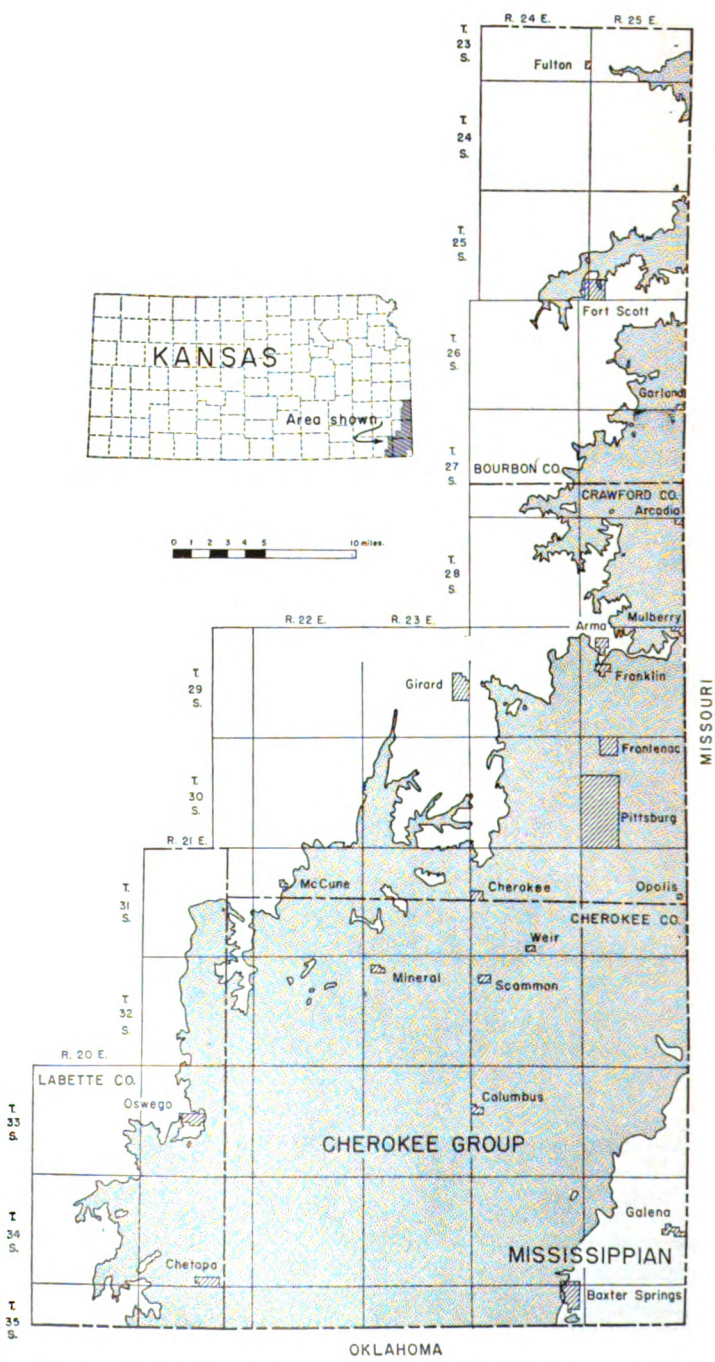

FIG. 1.—Map of southeastern Kansas showing outcrop area of Cherokee Group.

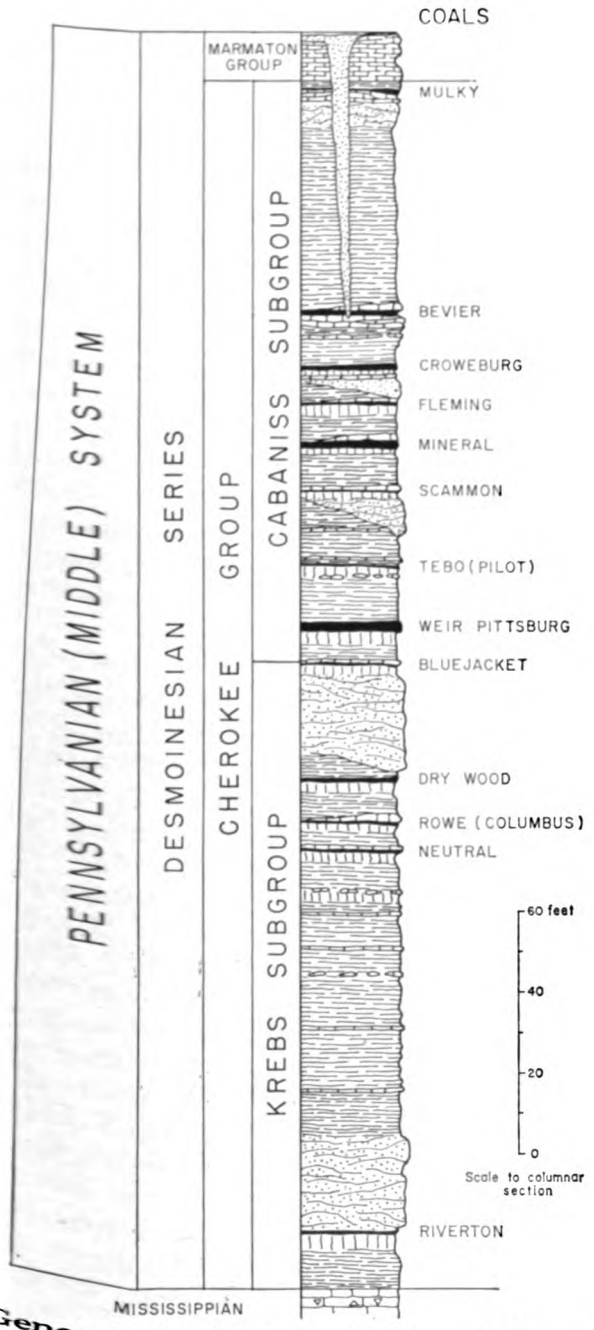

FIG. 2.—Generalized section of Cherokee Group in Kansas (after Howe, 1956).

Purpose of study.—This report is the eighth in a series on Kansas coal started by the State Geological Survey of Kansas in 1942. The report describes the coal resources of the Mulky Formation in the uppermost part of the Cherokee Group of rocks.

The other inventory coal reports thus far published include the coals of the Douglas Group (Bowsher and Jewett, 1943), the Kansas City Group (Schoewe, 1951), the Cretaceous (Dakota) lignites (Schoewe, 1952), the Marmaton Group (Schoewe, 1955), and the coal reserves in Kansas (Abernathy, Jewett, and Schoewe, 1947). In addition, Abernathy (1944) reported on mined areas of the Weir-Pittsburg coal and on the strip-mined areas in the Southeastern Kansas coal field (Abernathy, 1946). Other publications dealing with coal include a "Special Report on Coal" by Haworth and Crane (1898) and a report by Young and Allen (1925), also reports on the post-Cherokee coals (Whitla, 1940), the coals of the southeastern Kansas coal fields (Pierce and Courtier, 1937a), coal research in Kansas (Schoewe, 1951a), the petrography of southeastern Kansas coals (Hambleton, 1953), and the petrology of the Nodaway underclay (McMillan, 1956).

Previous work.—The Mulky coal was one of the first if not the first coal mined in southeastern Kansas. According to Brown (1896, p. 15), the coal was mined for use at the United States military post established at Fort Scott in 1842. During the Civil War period, government transport wagons loaded at Fort Leavenworth in Leavenworth County with commissary supplies for the Fort Scott post returned to Leavenworth loaded with Mulky coal. In 1854 and before, the Fort Scott Town Company in promoting their townsite advertised to advantage the presence of coal and proclaimed, "the country around Fort Scott abounds in coal of the very best quality. It crops out from nearly every hill and underlies the townsite. It is in general use in town for fuel" (Malin, 1950, p. 87). From that time to the present, the Mulky coal has been mined continuously. Mudge, first State Geologist of Kansas, as early as 1864 observed coal cropping out in the banks of Marais des Cygnes and Little Osage Rivers in Bourbon County and in various places farther southwest into Indian Territory (Mudge, 1866, p. 9, 20). He thought that the coal he observed was the coal currently classified as the Mulberry seam in the Marmaton Group (Schoewe, 1955), but it is

to be noted that although some of it was Mulberry coal, some of it undoubtedly was the Mulky and lower coals in the Cherokee. Swallow (1866, p. 25, 56), second State Geologist of Kansas, and Hawn (1866, p. 110) noted coal in Bourbon County and correlated it with the Mulberry coal of Linn County. Present knowledge of the distribution of the Mulky coal in northern Bourbon County suggests that Swallow's and Hawn's correlations of this coal with the Mulberry coal in parts of Linn County and northern Bourbon County are in error. As geologist for the Kansas State Board of Agriculture, Mudge wrote (1878, p. 86) that three principal coal seams were being worked in Kansas—the Osage, Cherokee, and Fort Scott seams. Regarding the Fort Scott (Mulky) coal, he stated that it appears at and near the surface in various places in Bourbon and Linn Counties, but is irregular, appearing and disappearing erratically. The coal was said to be less than 2 feet thick except in a few places. It coked well, and good gas coal was obtainable from it, producing 8,000 to 9,000 cubic feet of gas per ton. Coal was shipped from various stations along the line of the Missouri River, Fort Scott & Gulf Railroad between 1872 and 1877. It is reasonably certain that the 3,620 tons of coal shipped from Fort Scott was Mulky coal, but it is uncertain whether all coal shipped from the stations south of Fort Scott was Mulky coal. Probably some of it came from seams lower in the Cherokee. Miscorrelations of the Mulky coal with other coals persisted as late as 1940. In 1929, Moore (p. 4) incorrectly named the Mulky coal the Lexington coal, which he stated was mined locally in the vicinity of Fort Scott. The Lexington coal is in the Labette Shale, which overlies the Fort Scott Limestone, whereas the Mulky coal is below the base of the Excello Formation, in the upper part of the Cherokee Group, next below the Fort Scott. Moore's description of the rocks associated with the coal is correct, however, as is his classification of the Fort Scott Limestone. Similarly, Whitla (1940, p. 29) correlated some of the Mulky coal mined northeast of Hammond in northern Bourbon County with the Summit coal of the Marmaton Group. The Summit coal is in the Little Osage Shale member between the two limestone members of the Fort Scott Limestone. Stratigraphically the Summit coal is no more than 12 feet above the Mulky or Fort Scott coal. From Whitla's description of the coal-containing

rock and Schoewe's (1955, p. 57) field investigation of coals in northern Bourbon County, it is clear that Whitla's mined "Summit coal" is definitely Mulky coal. Although the Summit coal is reported to have been mined, the writer has nowhere seen any thick enough to mine nor any places where it was mined. Saunders (1873, p. 388; 1896, p. 31) reported a fine vein of coal about 30 inches thick that cropped out in northern Bourbon County and farther northeast and southwest. This vein, called the Osage vein and also the Fort Scott coal, appeared in commerce under two names—black and red. The red is now recognized as the Fort Scott or Mulky coal, whereas the black, which yielded considerable gas, is probably the Mulberry coal. Hay (1887, unnumbered figure facing p. 205; 1887a, p. 60) recognized the Fort Scott coal, although not by name, in a report on natural gas in eastern Kansas. He included a cross-section of strata exposed between Fort Scott, Kansas, and Nevada, Missouri. This section shows the Fort Scott Limestone [Higginsville Limestone member], an unnamed shale [Little Osage Shale member], the Fort Scott "Cement" [Limestone] [Blackjack Creek Limestone member], and a shale [Excello Shale] containing an unnamed coal seam [Mulky coal]. Several years later, in a report on the stratigraphy and coal deposits of the Fort Scott area, Hay (1893, p. 113, 132) called attention to the Fort Scott (Mulky) coal, which was also called Mound coal because of its outcroppings near the top of the promontories and mounds that overlook the lower levels of the land toward Dry Wood Creek and as far south as northeastern Crawford County near Fort Scott. In addition, Hay (1893, p. 132) presented the following stratigraphic section, which he stated is a typical section in the city of Fort Scott (Table 1). Except that the uppermost limestone is called the Pawnee limestone, a unit that crops out farther west and which is at least 50 feet stratigraphically above the uppermost limestone unit (Higginsville Limestone member of Fort Scott Limestone), the section is correct. In commenting on some of the beds Hay writes that, "The 'cement' rock, No. 4, is very persistent, and is characteristic of the district topography. It thickens in places to six or seven feet. No. 7 is the Fort Scott coal. It is probably the coal worked just east of Girard in Crawford County; . . . . ." Except for noting the presence of the Fort Scott or Mulky coal and giving general information as to its thickness, production, and

the mining methods employed, the early reports, published mainly by the Kansas State Board of Agriculture, include little of scientific value relative to the Mulky coal. In 1895, detailed stratigraphic studies of Kansas rocks were begun by the University Geological Survey.

TABLE 1.—*Section measured by Robert Hay at Fort Scott, Bourbon County, Kansas, in 1891.*

1. Fragment of the hard, rough layer, limestone, 2 to 10 feet (this is the Pawnee limestone, which further west runs up to 60 feet thick)	[Higginsville Limestone member, Fort Scott Limestone]
2. Black laminated slate (almost coal), 5 feet	[Little Osage Shale member, Fort Scott Limestone]
3. Yellowish and greenish clay shale, 4 feet	
4. The hydraulic limestone (cement rock), 4 feet	[Blackjack Creek Limestone member, Fort Scott Limestone]
5. Clay with nodules, 6 inches to 1 foot	[Excello Shale]
6. Laminated coal shale, 2 feet	
7. Coal, 18 inches to 2 feet	[Mulky]
8. Laminated yellow shale, 20 feet	

(Names in brackets are those in current use by the State Geological Survey of Kansas.)

The first preliminary report on the coals of the Cherokee Group was included in Haworth's report on the coal fields of Kansas. In referring to the Mulky coal, Haworth (1895a, p. 301) wrote, "Farther north in the vicinity of Fort Scott coal is found within 8 or 10 feet of the Cherokee shales. The veins average about 13 inches in thickness, but in places it is a little more. It is so close to the 'cement' rock that usually the latter has to be removed to obtain the coal." The coal was exposed in the banks of the numerous creeks and in the many ravines for miles around Fort Scott. According to Haworth, the coal had been mined in "hundreds of places by the 'stripping' process, the coal having been followed back into the bank 10, 20, 30 or more feet." The coal was known in the markets as the Fort Scott "red" coal. In his report Haworth discusses the physical and chemical properties of Kansas coals and summarizes Blake's (1889, p. 45) and Bailey's (1889, p. 48) chemical analyses of Kansas coals. In a table taken from A. C. Gallagher (1894, p. 179), showing the number of pounds of coal equal to one cord of standard oak wood, Haworth lists 2,670 pounds for the Fort Scott coal. Much

of the same information is repeated (Haworth, 1898) in his first report on the mineral resources of Kansas and in his more elaborate report (Haworth and Crane, 1898) published in the same year by the University Geological Survey.

The report by Young and Allen (1925) brings much of the information presented by Haworth and Crane up to date as of that year. The most detailed report on the coals of southeastern Kansas (Pierce and Courtier, 1937a) does not include Bourbon County, but the strata associated with the Mulky coal are described for Crawford, Cherokee, and Labette Counties. The Fort Scott coal is discussed (p. 78), and two tables on chemical analyses of the coal are included. The report contains an excellent geologic map of the southeastern Kansas coal field (Plate 1) showing in addition the location of the various coal strip pits and the traces of some of the Cherokee coals. Previous to the publication of their coal report, Pierce and Courtier (1937, p. 17) briefly discussed the general stratigraphy of the Cherokee.

A paper by Jewett and Schoewe (1942, p. 77) refers to the coal fields of Kansas, briefly discussing the history of the coal fields of the southeastern part of the state, the products, and coal reserves. The "Summit coal" in northeastern Bourbon County, referred to on page 84 of that report, is now identified as Mulky coal. Abernathy's map (1946) showed coal strip mines in southeastern Kansas as of January 1, 1946, including the name and location of every Mulky coal strip mine known at that time. The accompanying report briefly describes the strata associated with the Mulky coal and includes data pertaining to the coal itself. In a later report (Abernathy, Jewett, and Schoewe, 1947), the proved (measured and indicated) and potential or inferred reserves of Mulky coal are estimated. The most recent comprehensive paper describing the Mulky coal and associated strata (Howe, 1956) is concerned primarily with description of strata of the Cherokee Group and contains numerous stratigraphic sections describing and showing graphically the Mulky coal. This is also the first report to use the new classification of Desmoinesian (Pennsylvanian) rocks, although a preliminary announcement appeared 3 years earlier (Searight and others, 1953).

The first published analyses of Kansas coal (Saunders, 1873) include analyses of the Mulky coal showing volatile matter 33.35 percent, fixed carbon 54.10 percent, and ash 12.05 percent. Blake

(1889, p. 45) discussed the evaporative power of Kansas coals; Bailey (1889, p. 47) also reported the composition of Kansas coals, but Bailey's analyses differ somewhat from Saunders' in that Bailey's show the volatile matter greater by 8.41 percent, the fixed carbon less by 6.55 percent, and the ash content less by 4.3 percent. Both sets of analyses were quoted by writers of later reports dealing with Kansas coal.

In addition to papers describing the stratigraphy of rock associated with the Mulky coal by Swallow (1866), Hay (1887), Haworth and Kirk (1894), Bennett (1896), Adams (1896), and Haworth (1898) should be mentioned the work of Adams, Girty, and White (1903), who give an outline of the detailed stratigraphy of Kansas rocks, including preliminary faunal lists. Also, Jewett (1941, 1945) discusses the stratigraphy and classification of the Marmaton Group, and Howe (1956) presents the most recent and thorough description of the Cherokee Group and includes numerous stratigraphic sections. In addition, Abernathy (1936) reviewed the Cherokee shale of southeastern Kansas and proposed a classification of lithologic units based on the cyclical sedimentation. He later published a summary of this work (Abernathy, 1937, 1938). Abernathy is the first to attempt to classify the Cherokee as a group divisible into fifteen formations or cyclothems. Other reports of a general nature are those of Moore (1936, 1940), Landes (1937), and Moore and others (1944, 1951).

Field and laboratory investigations—Field work that forms the basis of this report was started in July 1955 and was completed in 1958. Effort was made to trace and locate all Mulky coal throughout Bourbon and Crawford Counties. The stratigraphic position, occurrence, physical nature, and thickness of the coal and adjacent rocks, and the nature and thickness of overburden were studied in the field. All active and abandoned mines were located on maps. Data concerning production, mines, mining methods, and history of mining were obtained for old settlers and miners living in the mining district and from publications. Air photographs were used in obtaining the location, size or area, and pattern of the larger strip-pit mines. Coal samples were collected and were analyzed in the geochemistry laboratories of the State Geological Survey under the supervision of Russell Runnels.

Acknowledgments—Mr. Allen Diller assisted in the field during the field seasons of 1955 and 1956, Mr. Thomas Thompson in 1957, and Mr. Leonard Howard in 1958. Their many varied services are appreciated. Much help relative to the location and history of the old abandoned mines was obtained from local residents of Bourbon and Crawford Counties. Thanks are also due to the Fort Scott Chamber of Commerce and members of the Fort Scott Kiwanis Club for providing city maps of Fort Scott and supplying names of persons well acquainted with the mining of the Mulky coal in the early days at Fort Scott and vicinity.

THE CHEROKEE COAL-BEARING AREA

Geography

The Cherokee Groups of rocks crops out in an area of about 1,000 square miles in southeastern Kansas, including parts of Labette, Cherokee, Crawford, and Bourbon Counties (Fig. 1). Physiographically, the area of outcrop of Cherokee rocks constitutes the Cherokee Lowland (Schoewe, 1949, p. 276) developed upon the weak shales and sandstones of the Cherokee Group, which at the outcrop in Kansas ranges in thickness from 200 to 500 feet, averaging about 450 feet. Topographically the area is a lowlying erosional plain whose surface slopes to the west at an average grade of about 10 feet per mile (Abernathy, 1946, p. 129); the total relief is about 250 feet. The surface is gently undulating except for a few sandstone-capped erosional remnants, of which the broad, flat-topped, mesa-like Timbered Hills constitute the largest. The Timbered Hills rise 80 feet above the level of the surrounding country about 7 to 8 miles north of Baxter Springs in Cherokee County. The valleys are wide, shallow, and flat. Neosho, Spring, and Marmaton Rivers and Dry Wood Creek and their tributaries drain the Cherokee Lowland. Pittsburg and Columbus are within the lowland, whereas Fort Scott, Oswego, and Baxter Springs are at its border. Smaller tows located in the unit include Cherokee, Weir City, Mineral, Sherman, Hallowell, Chetopa, Girard, Frontenac, Arma, Mulberry, and Arcadia. The Cherokee Lowland is traversed north-south by U. S. Highways 59 and 69 and east-west by U.S. Highways 54 and 160. State Highways 31, 39, 57, 96, 102, 103, 104, and 126 cross the area in east-west direction, whereas State Highways 7 and 26 traverse the lowland

north-south. The Cherokee Lowland is also served by six railroads: Missouri Pacific; Missouri-Kansas-Texas; St. Louis-San Francisco; Kansas City Southern; Kansas, Oklahoma and Gulf; and Atchison, Topeka, and Santa Fe.

Stratigraphy

The Cherokee Group, averaging approximately 450 feet thick, is middle Pennsylvanian in age and comprises the oldest Pennsylvanian rocks in southeastern Kansas. It overlies the lead- and zinc-bearing limestone, of Mississippian age, and is overlain by the Marmaton Group of rocks, which contains the Mulberry coal (Schoewe, 1955). In 1953 at a conference held at Nevada, Missouri, representatives from the State Geological Surveys of Kansas, Missouri, Oklahoma, Nebraska, and Iowa agreed on a division of the Cherokee shales into two groups, Krebs and Cabaniss, and eighteen formations (Searight and others, 1953). Subsequently, October 17, 1955 (Howe, 1956, p. 8, 21) the State Geological Survey of Kansas re-adopted the discarded group term Cherokee and relegated the Krebs and Cabaniss Groups to the rank of subgroups. The Cherokee Group is now subdivided by the State Geological Survey of Kansas into eighteen formations, twelve of which are in the upper (Cabaniss) subgroup and six in the lower (Krebs) subgroup (Table 2)*. Each formation, except in a few special cases, is composed of lithologic units extending from the top of a specified coal bed to the top of the next higher coal bed. Lithologic units constituting the formation consist of dark shale, dark irregular limestone, gray shale, limestone, sandstone, underclay, and coal. The Cherokee Group is economically important for its coal. At least fourteen coals are known in the group, twelve of which have been or are now being mined (Fig. 2). The Mulky coal of this report is the uppermost coal in the Cherokee Group and occurs stratigraphically in the Mulky Formation near the top of the Cabaniss Subgroup. For the purpose of this report only the Excello and Mulky Formations of the Cherokee Group and the Fort Scott Limestone formation and the Englevale Sandstone member of the Labette Shale of the overlying Marmaton Group require discussion.

* The State Geological Survey of Kansas is still studying the classification as there is some uncertainty as to where to draw the line between the Krebs and Cabaniss. The previously accepted classification is therefore followed in discussing the stratigraphy involving the Mulky coal.

TABLE 2.—*Classification of the Cherokee Group in Kansas as of October 17, 1958*

System	Series	Group	Subgroup*	Formation*
Pennsylvanian (Middle)	Desmoinesian	Cherokee	Cabaniss	Excello Mulky Lagonda Bevier Verdigris Croweburg Fleming Robinson Branch Mineral Scammon Tebo Weir
			Krebs	Seville Bluejacket Dry Wood Rowe Warner Riverton

* Some further modification of the classification of the Cherokee Group is being considered by the State Geological Survey of Kansas. The rank of Cabaniss and Krebs may be changed to formations and that of the listed formations to members. Whether the top of the Seville Limestone will be retained as the boundary between the Krebs and Cabaniss has currently not been decided.

Fort Scott Limestone Formation, Marmaton Group

The key to mapping and locating the Mulky coal is the Fort Scott Limestone formation, Marmaton Group, and more especially its lower unit, the Blackjack Creek Limestone member.

Blackjack Creek Limestone member.—The Blackjack Creek Limestone member is a massive limestone generally 3.5 to 17.5 feet thick, although at the outcrop at the spillway of Rock Creek Lake, in the NW¼ sec. 2, T. 26 S., R. 24 E., Bourbon County, the limestone pinches from a thickness of 42 inches to almost nothing in a horizontal distance of no more than 100 feet (Pl. 2A). At several places the Blackjack Creek is missing, as at the strip pit in the NE corner sec. 27, T. 26 S., R. 25 E., where a channel sandstone rests directly on the Excello Shale (Pl. 4A). The Blackjack Creek consists of a single bed or two or three beds. When fresh the rock is ash white to gray but on weathering assumes a yellowish-brown to rusty appearance. It is granular to crystalline, pseudo-brecciated, and dense to lithographic. In the area where the Mulky coal has beend mined, the Blackjack Creek is known to dip in various directions at angles measurable in degrees rather than feet per mile, and it is also faulted at places,

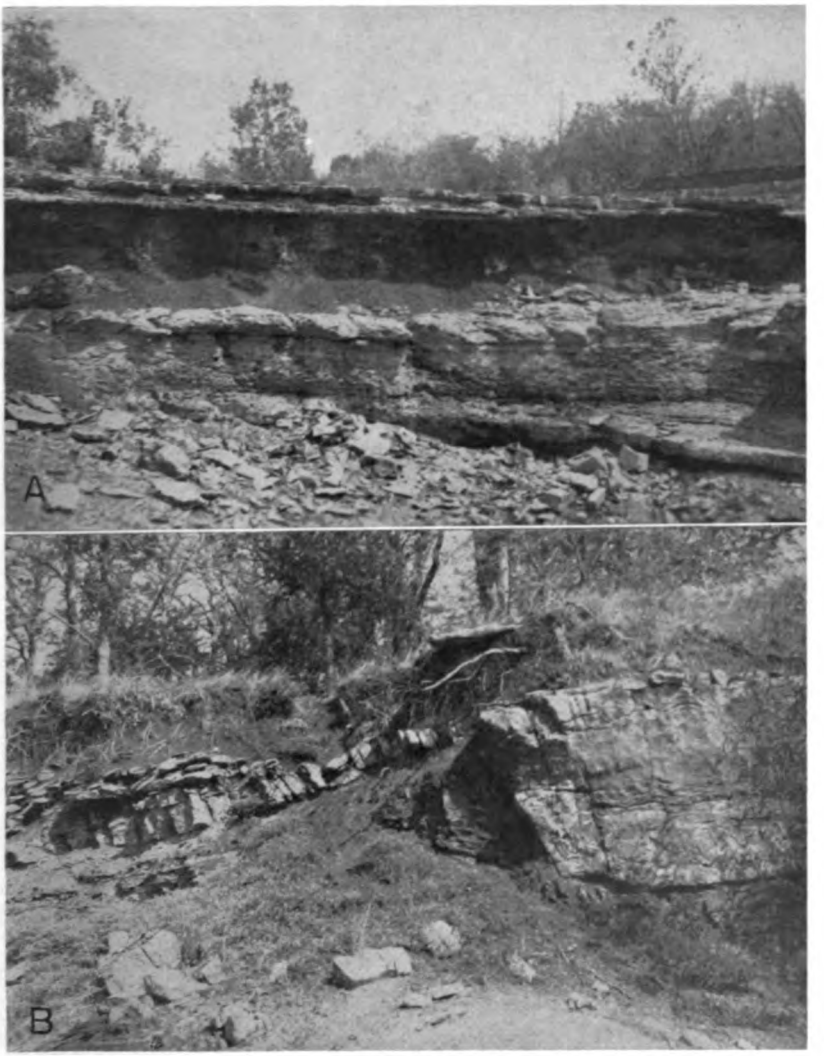

PLATE 2.—**A, Pinching out of Blackjack Creek Limestone** at spillway of **Rock Creek Lake, NE¼ NW¼ sec. 2, T. 26 S., R. 24 E., Bourbon County, Kansas. Blackjack Creek Limestone, first limestone below spillway top, is 42 inches thick at right of exposure and almost nothing at left side shown in this view. B, Normal fault, throw 4.5 feet, in Blackjack Creek Limestone; upthrow side to left; north highwall, strip pit, SW¼ sec. 12, T. 27 S., R. 24 E., Bourbon County, Kansas.**

as in the abandoned strip pit in the SE¼ sec. 12, T. 27 S., R. 24 E., Bourbon County (Pl. 2B). Fossils, chiefly large crinoid stems, brachiopods, bryozoans, trilobite pygidia, fusulinids, cup or horn corals, and colonial corals, are common in the rock. The colonial coral *Chaetetes* is common as single isolated masses, some of which are several feet in diameter, and as reef-like structures of which the largest one seen measures 130 feet horizontally and 18 inches vertically (Pl. 3A). The contact of the Blackjack Creek Limestone with the underlying Excello Shale is at places very irregular (Pl. 3B).

The Blackjack Creek Limestone is known locally as the "cement rock" and has been quarried since 1868 for the manfuacture of natural cement. The Fort Scott Hydraulic Cement Company, operated by Mr. E. O. Thomas and his two sons, Earl and F. H., is the oldest cement plant in continuous operation in the state, having had its start in 1887, and it is the only plant in Kansas making natural cement. The suitability of the Blackjack Creek for the making of natural cement was recognized in 1867, when Mr. A. H. Bourne sent a sample of the rock to Professor Louis Agassiz of Harvard University for analysis. Agassiz's comment was, "a very superior quality of hydraulic cement" (Haworth, 1898, p. 66).

Little Osage Shale member.—Of lesser importance than the Blackjack Creek Limestone member in tracing the Mulky coal are the Little Osage Shale and Higginsville Limestone members overlying the Blackjack Creek Limestone. The Little Osage Shale is 4 to 12 feet thick and contains in its lower part the Summit coal, which is 3 to 6 inches thick. This coal has been confused with the Mulky coal, from which it is separated by no more than 12 feet. Although the Summit coal is reported to have been mined, no evidence was seen in the field in Kansas, and at no observed outcrop was the coal thick enough to be mined. The shale overlying the coal is dark gray to black and fissile to blocky, and contains numerous small subspherical phosphatic nodules. A dense limestone, the Houx, less than 12 inches thick, occurs above the black shale and a few inches to 2 feet below the Higginsville Limestone member. Beneath the Summit coal is a light-gray to dark-gray shale.

Higginsville Limestone member.—Above the Little Osage Shale is the Higginsville Limestone, the upper member of the

PLATE 3.—**A, Blackjack Creek Limestone**, showing massive bedding and part of a *Chaetetes* coral reef 130 feet long. Thickest part of reef shown is 18 inches. Highwall, strip pit, NE cor NW¼ sec. 8, T. 27 S., R. 25 E., Bourbon County. **B,** Irregular contact of Blackjack Creek Limestone on Excello Shale, uppermost member of Cherokee Group. Highwall, strip pit, SW¼ sec. 8, T. 35 N., R. 33 W., Missouri, about 0.8 mile east of Kansas-Missouri line and 0.8 mile south of U. S. Highway 54.

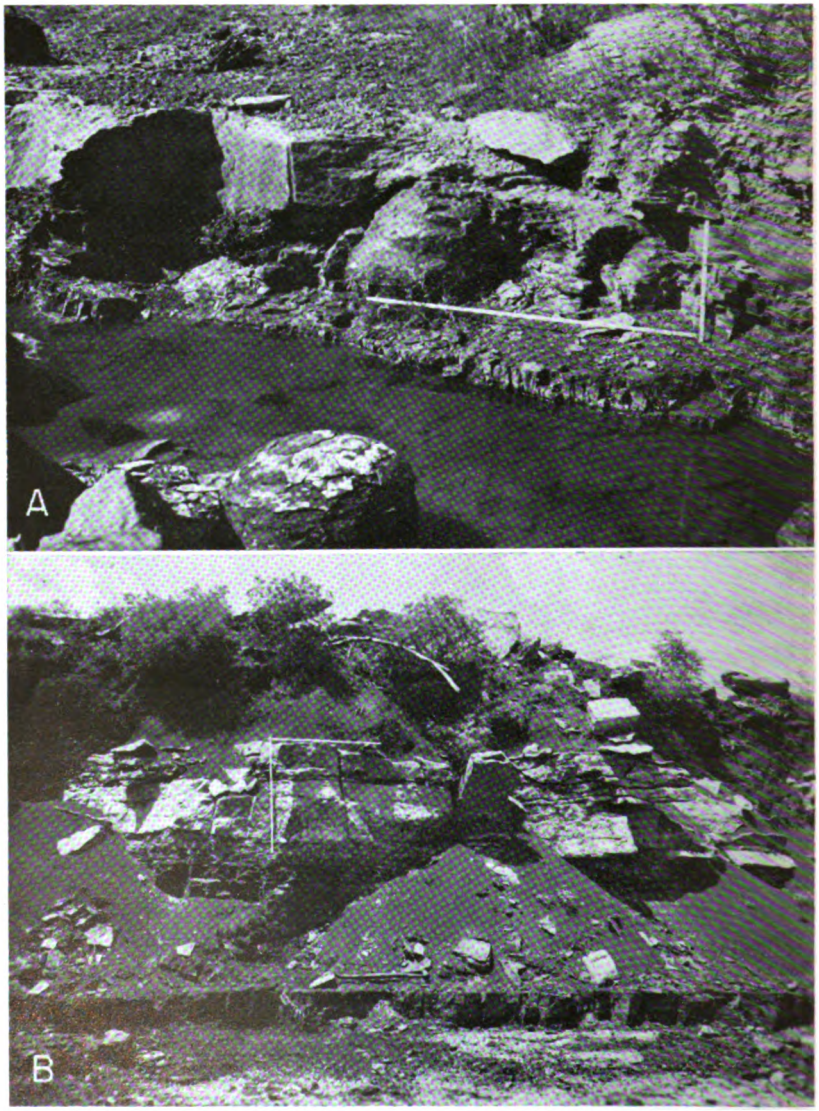

PLATE 4—**A,** Englevale Sandstone, **Labette Shale formation, replacing** Blackjack Creek Limestone. Englevale Sandstone, **a river channel deposit,** rests on about 1 foot of Excello Shale. **Note large spherical concretion in** Excello Shale at left end of folding rule, **which is resting on Mulky coal.** Large Excello concretion in foreground. **North end of strip pit, NE cor. sec. 27,** T. 26 S., R. 25 E., Bourbon County, Kansas. **Compare with B. B,** Normal sequence of strata, Blackjack Creek Limestone, **Excello Shale, and Mulky coal.** Garrett Brothers strip pit, SE¼ sec. **4, T. 27 S., R. 25 E., Bourbon County, Kansas.**

Fort Scott Limestone formation. The rock is mostly thin bedded and is light gray and fossiliferous. Large coral colonies of *Chaetetes* as well as large crinoids stems and numerous small to medium fusulinids are the common fossils found in the limestone. The average thickness of this member is 15 feet. The Higginsville Limestone is important only in tracing the escarpment of the Fort Scott Limestone and thus indicating the nearby presence of the Blackjack Creek Limestone.

Englevale Sandstone member of Labette Shale, Marmaton Group

Although not included in the Cherokee Group, the Englevale Sandstone needs description because of its relation to the Mulky coal and to the computation of Mulky coal reserves. Pierce and Courtier (1935, p. 1061; 1937a, p. 45), while mapping the geology and coal resources of the southeastern Kansas coal field in Crawford, Cherokee, and Labette Counties, discovered and mapped a sandstone for which they proposed the name of Englevale* channel sandstone. The sandstone crops out in discontinuous patches from Arma northwestward for a distance of about 9 miles towards Cato in northeastern Crawford County. The average width of the sandstone belt as mapped by Pierce and Courtier is 0.4 mile. Because the channel in which the sandstone was deposited trenches the Fort Scott Limestone at places, the Englevale is obviously younger than the Fort Scott Limestone, and they thought it probably equivalent to lower Labette Shale (Marmaton). In 1955, while mapping coal in the uppermost part of the Cherokee Group (Mulky or Fort Scott coal) in Bourbon and Crawford Counties, Schoewe discovered and mapped a similar channel sandstone extending from the northeast corner of Bourbon County southwestward for a distance of approximately 25 miles to the northernmost Englevale deposit mapped by Pierce and Courtier in Crawford County near the Bourbon-Crawford County line (Fig. 3). The Bourbon County channel sandstone is definitely to be correlated with the Crawford County sandstone deposit.

The Englevale Sandstone is soft, friable, light- to dark-brown to reddish-brown speckled rock, which weathers to a distinctly reddish to brownish soil. The sandstone is very micaceous and ranges from fine to coarse. Almost everywhere the rock is dis-

* The Englevale channel is being subjected to a special study for a master's thesis, Department of Geology, Kansas University, by Leonard Howard, research assistant to Schoewe for the 1958 field season.

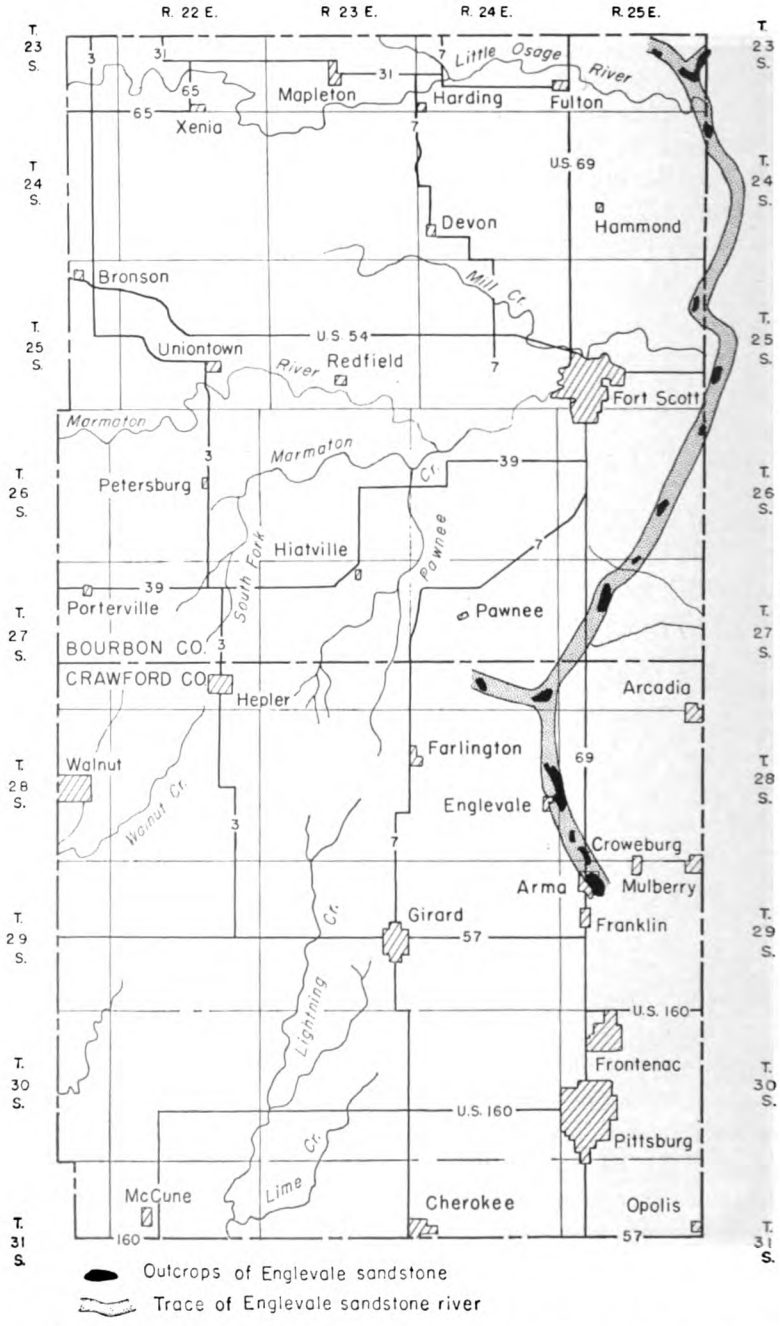

FIG. 3.—Map of Bourbon and Crawford Counties, Kansas, showing course of Englevale river channel.

tinctly cross-bedded (Pl. 5A). The prevailing direction of the cross-bedding is south except at the outcrops 2 miles west of Cato in Crawford County, where the dip is northwestward. A notable characteristic of the Englevale is the association of numerous pieces of petrified wood, a feature which aids greatly in distinguishing this unit from the "Squirrel" sandstone stratigraphically close below in the upper part of the Lagonda Shale. Much of the petrified wood consists of tan to light-brown, hard, slender, elongate, heavy fragments ⅛ to 5 inches thick and as much as 12 inches long. It contains considerable secondary growth of small but megascopic well-developed quartz crystals lining what apparently were linear cracks where the wood had split. In addition to the petrified wood, impressions of such plants as calamites, lepidodendrons, and ferns were observed at several outcrops. The Englevale Sandstone is distinctly stratified, individual beds ranging from 1 to 18 inches in thickness. At places, as in the NE¼ sec. 36 and the SE corner sec. 25, T. 27 S., R. 24 E., somewhat more than 4 miles north of Englevale, the sandstone forms massive overhanging cliffs (Pl. 5B). The uppermost sandstone at this exposure is at least 9 feet thick and has the general appearance of a single unit, but weathered surfaces reveal that the unit is composed entirely of layers about ½ inch thick, some of which are more resistant than others, giving the unit a ribbed effect. Conglomerate containing fragments of older strata, and seemingly not observed by Pierce and Courtier (1937, p. 46), forms the basal part of the Englevale at several places in Crawford and Bourbon Counties, notable in the NE¼ sec. 36, T. 27 S., R. 24 E., Crawford County, which in reality would serve better as type section for the Englevale Sandstone than the outcrop in the vicinity of Englevale. The conglomeratic zone at the first locality constitutes the lowermost 4 feet of the Englevale. It consists of three conglomerate beds and two interfingering sandstone layers all of which vary in thickness in short distances. As the conglomerate thickens, the discontinuous interfingering sandstone layers thin, and all three conglomeratic layers merge into one as much as 22 inches thick (Pl. 6A), only to split again into conglomerate and sandstone layers. Most of the conglomeratic material is coarse and is a poorly sorted mixture of pebbles of Fort Scott Limestone, especially fragments of *Chaetetes* coral as much as 18 inches in diameter, concretions from the

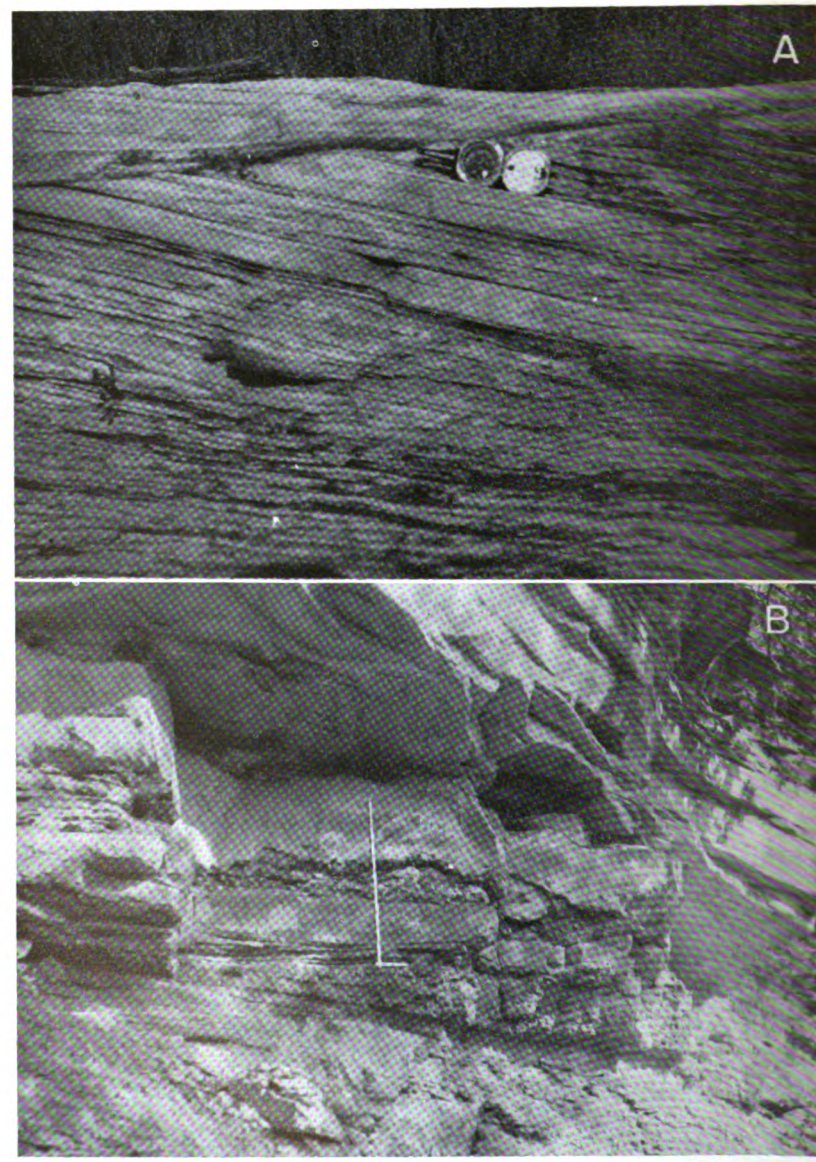

PLATE 5.—**A**, Englevale Sandstone showing prevailing southerly dip of cross-bedding, SE¼ sec. 1, T. 26 S., R. 25 E., Bourbon County, Kansas. **B**, Outcrop of Englevale channel sandstone; conglomeratic zone 4 feet thick forms base resting on Lagonda Shale. Detail of conglomerate shown in Plate 6A. West-facing bluff on West Fork of Dry Wood Creek, SE¼ sec. 25, T. 27 S., R. 25 E., Crawford County, Kansas.

Excello Shale 12 to 18 inches in diameter, black fissile shale as much as 3 inches thick and 2 to 3 feet long, coal streaks as much as 1 inch thick and a few inches to several feet long, crinoid stems as much as 1 inch in diameter, phosphatic nodules, limonitic nodules, and petrified wood. *Chaetetes* fragments occur in the interfingering sandstone. The contact of the conglomeratic zone with the underlying well-bedded sandy shale of the Lagonda is irregular.

The thickness of the Englevale varies from place to place; maximum thickness observed is 60 feet. The Englevale channel is known to trench all of the following formations: Fort Scott, Excello, Mulky, Lagonda, and Bevier. No Englevale Sandstone was seen below the uppermost bed of the Verdigris Limestone. Especially good exposures where the profile of the Englevale trench cutting the Fort Scott Limestone may be observed or traced are:

NE¼ sec. 23, T. 26 S., R. 25 E., west highwall, pit
NE cor. sec. 27, T. 26 S., R. 25 E., pit
SE¼ sec. 33, T. 26 S., R. 25 E., north highwall, pit
SW¼ sec. 9, T. 27 S., R. 25 E., west highwall, pit
SE¼ sec. 25, T. 27 S., R. 24 E., east bluff, West Fork of Dry Wood Creek

All but the last are in Bourbon County.

The direction of flow of the stream that deposited the Englevale Sandstone is interpreted to have been in general southward. This belief is supported by the fact that all cross-bedding except that 2 miles west of Cato in Crawford County dips in general southward, by the orientation of the petrified wood fragments found in the sandstone, by the decrease in sand grain size from north to south, and by the pattern of the river system. It is believed that for at least part of the time in its history, the river west of Cato in Crawford County flowed northwestward, as indicated by the cross-bedding of the sandstone in that direction. Whether the stream initially flowed southward in Crawford County towards Arma and later was captured by headward erosion of a pirate stream farther west or whether the original stream flowed southward in Bourbon County and then west in Crawford County and its westward extension was later tapped by a stream working by headward erosion from the south or general vicinity of Arma is not yet established. It seems reason-

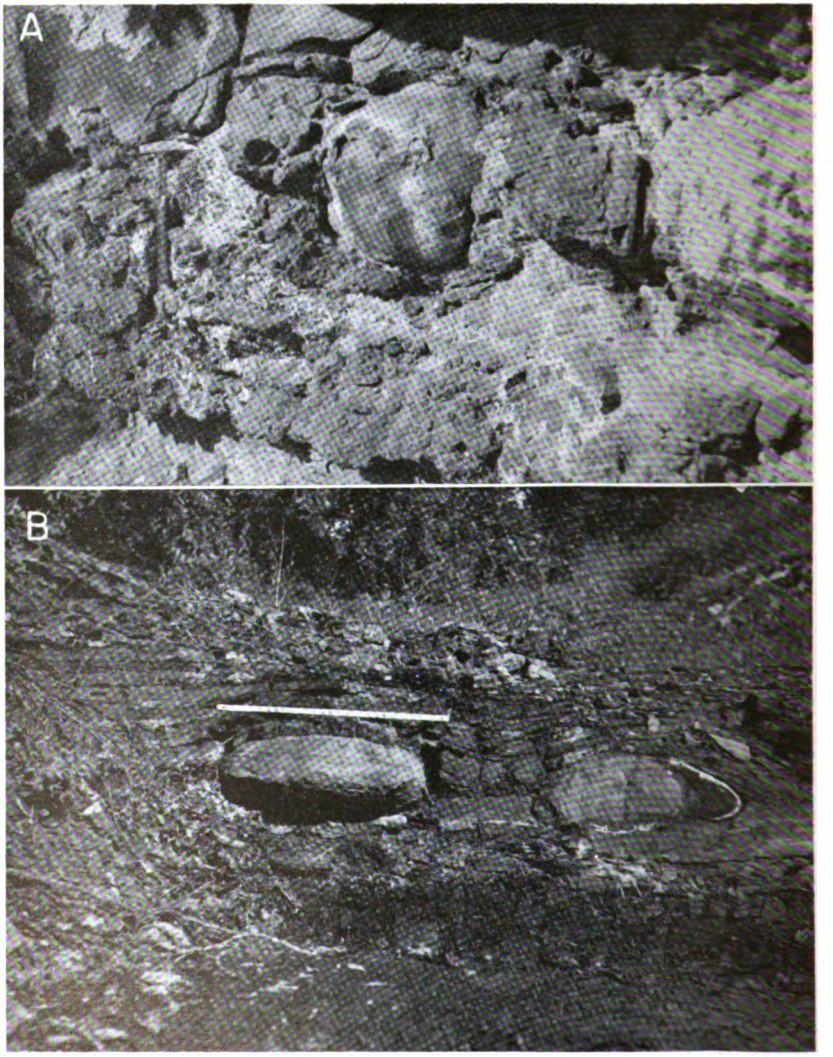

PLATE 6.—**A**, Detail of conglomerate in basal part of Englevale channel sandstone. Note large Excello Shale concretions to right of hammer. Locality same as Plate 5B. **B**, Typical limestone concretions in Excello Shale; folding rule exposed, 2 feet. Concretions contain pyrite, which oxidizes white as seen on concretion to right. Mulky coal, 7 inches thick, about 6 inches beneath concretions. Pit in NE cor. sec. 34, T. 27 S., R. 24 E., Crawford County, Kansas.

ably certain, however, that stream piracy was involved in the history of the Englevale stream in Crawford County. A map showing the general course of the stream that deposited the Englevale Sandstone in Bourbon and Crawford Counties, Kansas, is presented in Figure 3.

From field observations, the Englevale Sandstone in Bourbon and Crawford Counties, Kansas, is definitely known to be younger than Fort Scott Limestone and older than middle Labette Shale.

Excello Formation, Cherokee Group

The Excello Formation is the uppermost formation of the Cherokee Group and of the Cabaniss Subgroup as now classified. The Excello underlies directly the Blackjack Creek Limestone member of the Marmaton Group or in places the Englevale Sandstone member of the Labette Shale, a channel sandstone of still younger age. The formation is black fissile to blocky shale characterized by abundant small subspherical phosphatic concretions, some of which have coprolitic nuclei (Howe, 1956, p. 89). Near the base of the formation, large subspherical limestone concretions, some as much as 2 feet in diameter (Pl. 6B), are common. They are composed of hard, dense, blackish limestone, have pyritic rinds, and contain an ammonite tentatively assigned to *Eoasianites* cf. *E. globulosus* (Meek and Worthen). According to Howe (1956, p. 88), fossils in the Excello Shale include conodonts and *Orbiculoidea missouriensis*. Silicified tree stumps have been found in the base of the Excello Shale (Pierce and Courtier, 1937a, p. 78) at several places. In an abandoned strip pit in the NE¼ sec. 10, T. 29 S., R. 25 E., south of Mulberry in Crawford County several such tree stumps, 30 inches in height and 20 to 24 inches in diameter, were lying scattered about on the floor of the pit. The thickness of the Excello Shale ranges from 10 to 68 inches. The minimum thickness of 10 inches was measured in the NE¼ sec. 23, T. 26 S., R. 25 E., at a place where the Blackjack Creek and overlying rocks have been removed by erosion and have been replaced by a channel sandstone.

Mulky Formation, Cherokee Group

The Mulky Formation, which underlies the Excello, consists in descending order of the Mulky coal seam, an underclay, the

Breezy Hill Limestone and, in northern Oklahoma, the Kinnison Shale. Exposures or outcrops of the Mulky Formation in the Mulky coal mining area of Bourbon County and northern Crawford County are limited to the Mulky coal seam. The underclay and the Breezy Hill Limestone member are not seen in the strip pit mines but only in a few places where the topography is relatively rough, as in the Breezy Hill area 2 to 3 miles east of Arma in Crawford County. Consequently, for mapping the Mulky coal the seldom seen underclay and Breezy Hill Limestone are not important. According to Howe (1956, p. 87), the gray underclay is commonly silty, particularly in its upper part, and plastic to limonitic in its lower part. Fossil root impressions and other plant material are common in this unit, which ranges in thickness from a feather edge to 11 feet. The maximum thickness observed by Howe was in the SW¼ SW¼ sec. 16, T. 31 S., R. 23 E., Cherokee County. At most places, however, the underclay is not more than 4 feet thick and at many places is less than 2 feet thick.

Breezy Hill Limestone member.—The Breezy Hill Limestone underlies the Mulky coal underclay. Although seldom seen in the area where the Mulky coal has been mined, the limestone needs to be noted because of its nearness to the Mulky coal. The limestone is whitish to light gray, silty, and crumbly. Its thickness averages 20 inches, but is known to range from a feather edge to 8 feet. The rock is irregularly bedded and nodular, being made up of angular to rounded fragments of dense gray limestone in a matrix of light-gray, friable, sandy, impure limestone; it weathers to a coarse rubble (Howe, 1956, p. 85). Locally in Cherokee and Labette Counties the Breezy Hill Limestone is composed almost entirely of fusulinid tests imbedded in a matrix of calcareous sand and silt (Howe, 1956, p. 85). This phase was not observed in the area where the Mulky coal has been mined.

According to Pierce and Courtier (1937a, p. 33), on the west side of Breezy Hill about 2 miles southwest of Mulberry in Crawford County the Breezy Hill Limestone consists of 1 to 2 feet of impure limestone, whereas in the eastern part of the same hill the limestone attains a maximum thickness of 8 feet and is similar in appearance to the Blackjack Creek Limestone of the Fort Scott Limestone formation.

MULKY COAL

Name.—The Mulky coal is named after the town of Mulky, Lafayette County, Missouri, where it is mined. Originally, the Mulky coal was known in Kansas as the Osage and also the Fort Scott coal. Other names applied to the coal include: Fort Scott Red, Red, Rusty, Bunker Hill, Mound, Hilltop, and Sunshine. Hinds (1912, p. 16) thought the Mulky coal of Kansas to be stratigraphically the equivalent of the Lexington coal of Missouri and the Mystic coal of Appanoose and Wayne Counties, Iowa. The Lexington coal of Missouri is now known, however, to occur in the Labette, which is stratigraphically higher than the Cherokee, in which the Mulky coal occurs. Greene and Pond (1926, p. 54) later correlated the Mulky coal of Kansas with the Mulky coal of Lafayette and Saline Counties and the Macon City coal of Macon County, Missouri.

Geographic distribution.—The Mulky coal is coextensive with the outcrop of the Blackjack Creek Limestone in southeastern Bourbon County and in northeastern Crawford County north of Mulberry and Arma and generally westward for a distance of several miles on U. S. Highway 69 (Pl. 1). Between Arma and Girard, which is 7 miles west of U. S. Highway 69 and 2 miles south of Arma, the coal is discontinuous (Pierce and Courtier, 1937a, p. 78). In general the coal is absent south and west of Arma. At places, however, its horizon is indicated by a black smut or featheredge of black carbonaceous matter.

Stratigraphic position.—The Mulky coal is 32 to 60 inches below the Blackjack Creek Limestone member of the Fort Scott Limestone and directly below the Excello Shale (Fig. 4, 5). As now defined (Searight and others, 1953; Howe, 1956, p. 84, 87) the Mulky coal is the uppermost unit of the Mulky Formation, Cabaniss Subgroup.

Thickness.—Where seen in outcrops the Mulky coal ranges in thickness from a featheredge to 22 inches. The coal thickens northward from Arma and Mulberry in Crawford County to Fort Scott in Bourbon County. Where mined at Breezy Hill southwest of Mulberry, Crawford County, the Mulky coal has a maximum thickness of 12 inches. At most places in the southern part of the mining area in northeastern Crawford County the Mulky coal is 7 to 8 inches thick. Around Fort Scott in Bour-

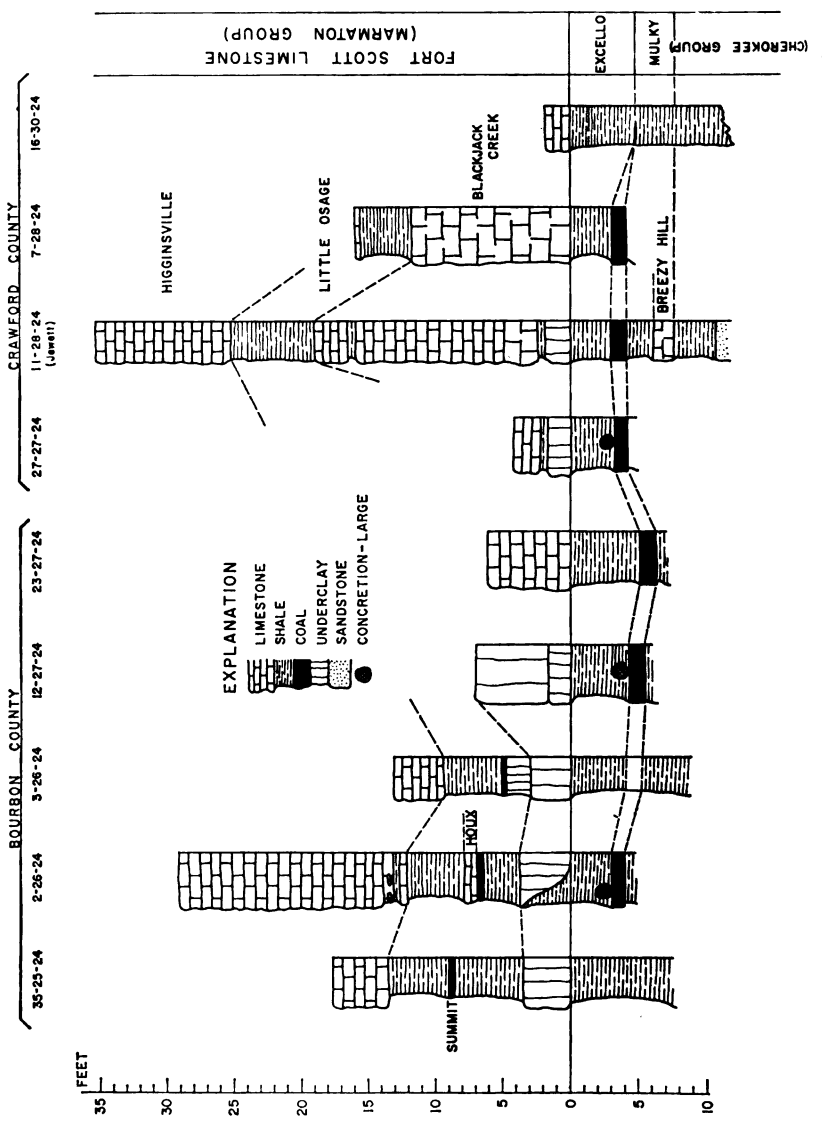

Fig. 4.—Stratigraphic sections showing position and thickness of Mulky coal and its relation to adjacent rocks in R. 24 E., Bourbon and Crawford Counties, Kansas.

bon County the coal is 13 to 19 inches thick, and northeast of Hammond in Bourbon County the coal measures 22 inches thick.

Contact rock.—The rock overlying the Mulky coal is the black, blocky to fissile, phosphatic-nodule-bearing shale of the Excello. Almost everywhere that the coal has been mined, large black spherical concretions of dense limestone rest directly on the coal or lie a short distance above it (Pl. 4A).

At several places, as at the north end of the outlier in the NE¼ sec. 23, T. 26 S., R. 25 E., in the NE corner sec. 27, T. 26 S., R. 25 E., in the SE¼ sec. 33, T. 26 S., R. 25 E., in the NE corner SW¼ sec. 5, T. 27 S., R. 25 E., in the NE corner NW¼ sec. 8, T. 27 S., R. 25 E., and in the NW¼ and SW¼ sec. 9, T. 27 S., R.

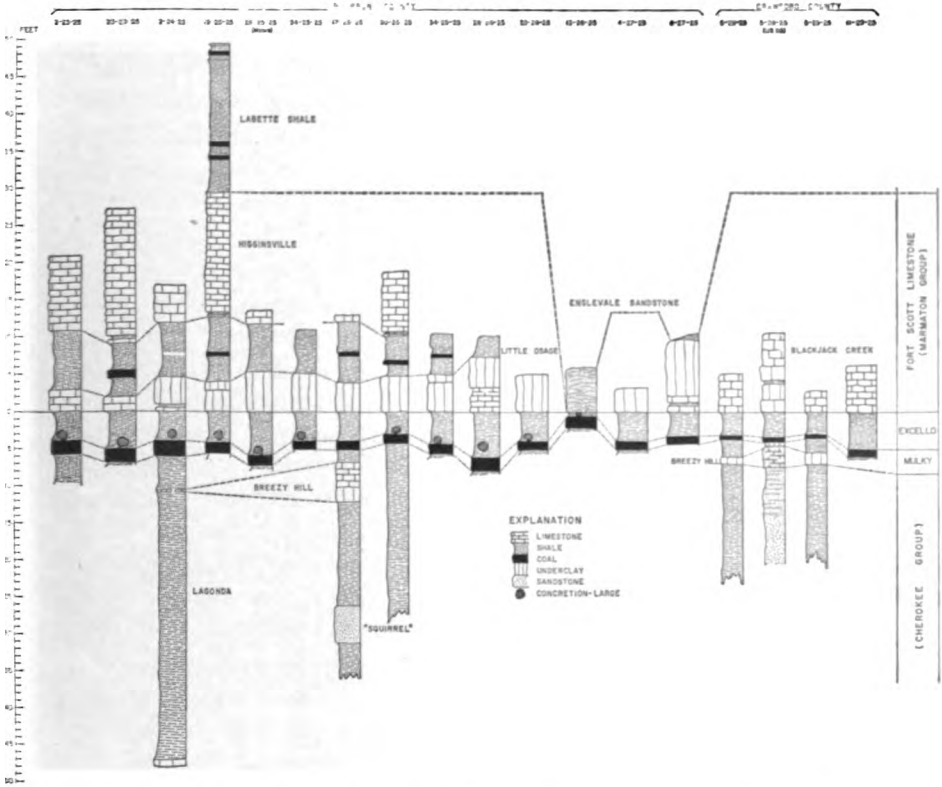

FIG. 5.—Stratigraphic sections showing position and thickness of Mulky coal and its relation to adjacent rocks in R. 25 E., Bourbon and Crawford Counties, Kansas.

TABLE 3.—*Proximate analyses, sulfur content, and heating value of Mulky coal, Bourbon County, Kansas.* (Analyses by State Geological Survey of Kansas.)

Sample no.	Mine	Location	Analyses, percent					Heating value, Btu	
			Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Moisture free	Moisture and ash free
1		NW¼ 34-25-25	1.47	35.00	53.55	9.98	3.73	13,073	14,763
2	Fort Scott Hydraulic Cement Co.	NW 19-25-25	1.10	31.19	43.47	24.24	5.78	10,731	14,375
3	Pelett	NE¼ 33-26-25	1.00	36.29	52.48	10.23	5.95	13,046	14,696

25 E., all in Bourbon County, and in the Englevale area in Crawford County, the coal is overlain directly by the Englevale Sandstone or a few inches of Excello Shale.

Physical and chemical characteristics.—The Mulky coal is classified as bituminous coal of high volatile A to B rank. The unweathered coal is jet black, bright, shiny, brittle, and moderately hard, and occurs as a single bed or seam. In general, the coal is free of clay, shale, or dirt impurities. Close inspection reveals that the coal is laminated or finely stratified. A few thin vertical cracks filled with coal and calcite containing traces of pyrite traverse the seam. Where mined the coal ranges from 7 to 22 inches in thickness. In strip mining, seldom is more than 10 feet of overburden removed. The depth to the coal is dependent upon the dip of the strata, which in Bourbon and Cherokee Counties varies from place to place in amount and also in direction. The prevailing regional dip is to the northwest, but there are many deviations in the direction.

Proximate analyses presented in Table 3 show that the Mulky coal compares very favorably with other Kansas coals in Btu content and in the low percentage of ash.

Mining methods.—Although the Mulky coal has been mined for many years, being probably the first commercially mined coal seam in the state, a relatively small quantity of coal has actually been mined. The small tonnage mined is explained by the fact that the coal seam is thin (less than 2 feet) and the overburden, except for 3 to 5 feet of soft Excello Shale, consists of resistant, massive Blackjack Creek Limestone commonly 3 to 5 feet thick. Furthermore, at the time the Mulky coal was first mined, mining machinery capable of removing the overburden had not been developed. After the discovery of thicker and lower coal beds farther south, mining of the thin Mulky coal was almost abandoned in favor of the more profitable, thicker coals of southern Bourbon County and Crawford and Cherokee Counties.

Drift or slope mines.—All Mulky coal mines follow the irregular escarpment of the Fort Scott Limestone. The coal was extracted either by drifting or strip-mining methods. Hundreds of drift or slope mines puncture the escarpment of the Blackjack Creek Limestone in the valley of Marmaton River from Fort Scott eastward to the Kansas-Missouri line. These mines were tunnels dug in the coal bed at right angles to the line of out-

crop. The tunnel mouth or entry was usually just large enough for a person to enter the mine. Most of these mines extended into the hillside only a short distance, probably no more than 300 feet for most. Mine entries are spaced at various distances, some less than 100 feet apart, others several hundred feet. Usually where one drift or slope mine was seen, several others were found close by. In the early days there was no system in mining the Mulky coal seam. "Each man mines under any system most convenient whereby he can produce the most coal. They drift under the hill until such time as it becomes impossible for them to mine any longer for want of air, as they have no system of ventilation in the majority of drifts. Having no boss or superintendent, the mining laws are disregarded and when requested to comply with the laws they abandon many of the drifts and commence operation in some other convenient place. The greater number of the mines are operated only in autumn and winter and employ from 1 to 6 miners, who lease the mines from the owners of the land at 1 cent per bushel royalty. There are many farmers who strip coal in winter and haul the same to Fort Scott. They keep no record of the amount produced. The selling price of strip coal if delivered is from 7 to 10 cents per bushel in summer and from 8 to 12 cents in the winter. The average stripping in the Fort Scott coal pits is 10 feet. The thickness of vein in stripbanks coal runs from 12 to 20 inches. The coal is of good quality, and is known as the 'Fort Scott red coal'. Mining around Fort Scott is conducted in a very careless manner. The owners of the land permit anyone who is willing to pay the royalty to go and dig for a few months in the winter. Having no regular system, they try to produce all the coal possible, and take very little precautions as to safety. Many of the so-called operators have little, if any, experience in mining" (Gallagher, 1894. p. 2). "Most of the coal mined is sold in Fort Scott for domestic purposes at an average price of 7 cents per bushel. Those who employ miners pay 4½ cents per bushel for all coal mined" (Gallagher, 1895, p. 9). Royalty paid to the landowner was 1 cent per bushel for all coal mined. All of the drift or slope mines are now abandoned and are full of water, caved in, or clogged with rocky debris. Some of the larger underground mines, especially those within the city limits of Fort Scott and in the vicinity (Fig. 6), were better developed than the average "gopher hole" type of the inexperienced farmer or lease miner. Although

definite and accurate information is not available concerning the better Mulky coal mines, older citizens of Fort Scott acquainted with the former mining activity report that some of the mines extended for considerable distances from the mine portal and had many rooms from which the coal was mined. The system employed was the room and pillar method. Because of the nature and antiquity of the mining, it was impossible to locate all drift or slope mines that must have existed or even to estimate the number of mines. Many of the drift or slope mines, however, can be spotted by their openings, partly clogged portals or entries,

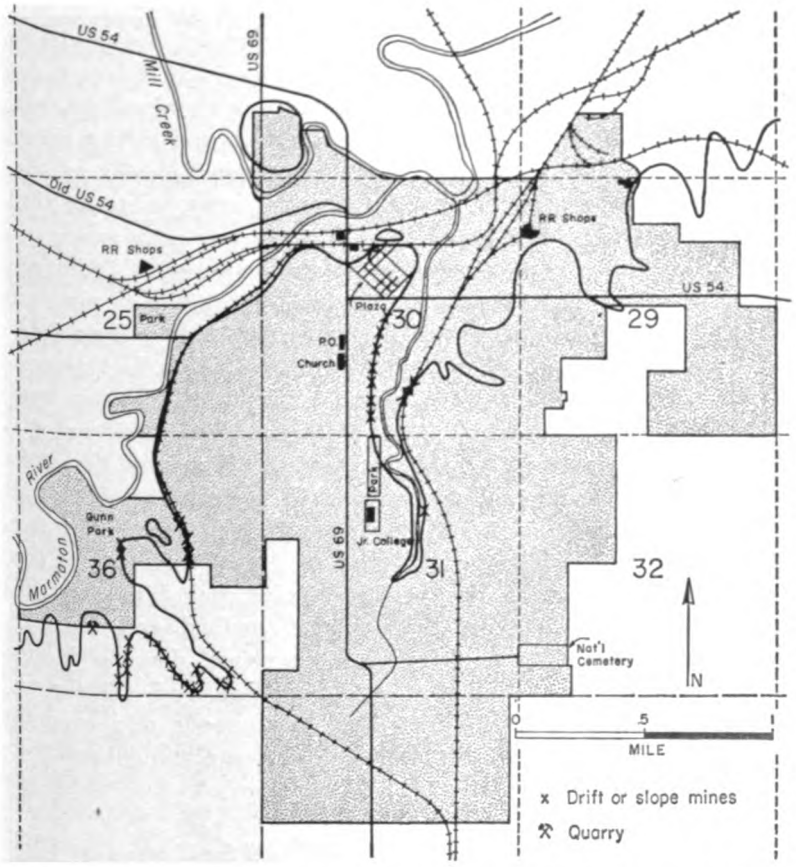

FIG. 6.—Fort Scott, Bourbon County, Kansas, showing trace of Mulky coal and location of some drift mines. Mulky coal was mined here in 1854 and before.

trenches, mine debris, and other surface indications. Known slope or drift mines are shown on Plate 1.

Strip mines.—All Mulky strip pit mines are within ¼ mile of the edge of the Fort Scott Limestone escarpment. From Fort Scott in Bourbon County southward to the vicinity of Arma in Crawford County there are relatively few places along the escarpment where the Mulky coal has not been mined by the stripping method. The length of the escarpment face totals roughly 90 miles, 40 miles in Bourbon County and 50 in Crawford County. With few exceptions, as in the Breezy Hill area south of Mulberry in Crawford County and in sec. 28, T. 28. S., R. 25 E., also in Crawford County, and at several places in Bourbon County, all strip pit mines are very narrow, most being less than 100 feet wide. The narrowness of the strip mines is best explained by the fact that the Mulky coal was mined at a very early date, before modern mining machinery and power shovels were available, and also the mines were worked chiefly by inexperienced persons, many of them farmers, who had only slight knowledge of mining and whose horse-drawn equipment and hand tools were unable to cope with the heavy overburden confronting them. The overburden at most strip pits is not more than 10 feet thick, but at least half consists of the massive Blackjack Creek Limestone. Perhaps the most amazing fact concerning the stripping of the Mulky coal in Crawford County is the thinness of the seam mined (7 to 8 inches). The mining of such thin coal was justified by (1) the general absence of timber for fuel in the early days of settlement, (2) the quality of the coal, (3) its abundance, (4) its easy accessibility for mining short distances into the hillsides, (5) the good roof for slope or drift mines provided by the massive Blackjack Creek Limestone, (6) the fact that thicker coal seams in Crawford and Cherokee Counties had not been discovered or, when developed later, yielded coal that was expensive to purchase, and (7) the fact that the coal was well adapted to local needs and gave the owners, mainly farmers and leasers, added employment and compensation during the fall and winter months when work was normally slack on the farms.

In the early days of mining, the coal sold for 7 cents per 80-lb. bushel or $1.75 per ton and as much as $3.00 per ton delivered during the summer months. In 1906 the same coal commanded a price averaging $5.00 per ton at the mine site, and the same price

prevailed in 1958 where the coal was still being mined. All coal sold was and is classified as mine-run or untreated coal. Except for local farm use, mining of the Mulky coal has virtually ceased, that fuel having been supplanted by imported and treated coal and by such other fuels as oil, natural gas, and liquefied petroleum gases. Also, because of the thinness of the coal and the heavy overburden, the Mulky coal cannot compete succesfully with thicker, more easily mined coal of other nearby areas.

Production.—Production data on the Mulky coal are very incomplete. Almost every coal mine inspector registered complaint in his reports; for example, "It is very difficult to gather the coal statistics of this county [Bourbon], as the coal is produced from strip pits and drifts in and around Fort Scott. Many farmers open a strip pit to get coal for their own use, and then haul and trade the balance off to anyone who will buy it at Fort Scott; and then some man will come along, and drift from the strip pit into the hill and produce a little coal, and sell it to a teamster who will haul it to Fort Scott, and stand around the city scales until they find buyers. The miner pays one cent per bushel royalty for this privilege, and keeps no record of his coal, and in this way about 100 or more mines are producing coal. . . . Many who mine coal one month are doing something else the next, and making it almost impossible to make a record of them" (McGrath, 1898, p. 67). Statistical records of Mulky coal production were further complicated later as coals other than the Mulky were mined. None of the records differentiate between coals, and because the reported locations of the coal mines are very general it is impossible, for many mines, to know what coal was actually mined and reported. Inasmuch as published reports of production data relative to the Mulky coal are unreliable, the quantity of Mulky coal mined was computed upon the basis of the mapped areal extent of the mined coal as shown on Plate 1, the known or observed thickness of the coal, and a specific gravity of 1.32, equivalent to a weight of 1,800 tons per acre-foot of coal, the standard used by the U. S. Geological Survey, Fuels Branch (Averitt and Berryhill, 1950, p. 13; Averitt, Berryhill, and Taylor, 1953, p. 23). Tonnage of coal mined by underground methods (drift or slope mines) can be estimated only roughly. Because the strip mines follow more or less continuously the Fort Scott Limestone escarpment, it is impractical to define coal mining

districts, hence production data are tabulated by township and range. Total mined Mulky coal, computed and estimated, amounts to 3,582,630 tons, 2,415,360 tons from Bourbon County and 1,167,270 tons from Crawford County. Most of the Mulky coal mined in Bourbon County came from T. 26 S., R. 25 E., whereas the greatest amount of coal mined in Crawford County was obtained in T. 28 S., R. 25 E., where the average thickness of the coal is only 8 inches. Computed and estimated coal production in Bourbon and Crawford Counties by township and range is presented in Table 4. The tabulated tonnage of Mulky coal represents a minimum, as undoubtedly numerous drift or slope mines were in existence as early as 1860 but all traces of them are now lost. Such mines within the city limits of Fort Scott are now for the most part forgotten and unknown to the present population of the city, as is indicated by the uncovering in the summer of 1956 of an unrecorded caved-in drift mine several hundred feet east of the Missouri Pacific Railroad depot during excavation of rock at the site of a loading platform.

Reserves.—Coal reserves in the United States are classified as measured, indicated, and inferred (Averitt and Berryhill, 1950, p. 11; Averitt, Berryhill, and Taylor, 1953, p. 11). Measured coal reserves include any minable coal within a radius of ½

TABLE 4.—*Computed and estimated total Mulky coal production, Bourbon and Crawford Counties, Kansas.*

Location			Thickness of coal, inches	Computed area, acres	Estimated production, tons		
County	Township	Range			Surface mines	Underground mines	Total
Bourbon County	23	25	22	53.5	176,550		
	25	25	16	139.3	334,320		
	25	24	14	10.4	11,400		
	26	24	14	?	?		
	26	25	14	494.1	1,037,610		
	27	25	10	331.6	497,400		
	27	24	13	166.4	324,480		
	Total Bourbon County			1,195.3	2,381,760	33,600	2,415,360
Crawford County	27	24	9	190.8	257,580		
	27	25	12	10.0	18,000		
	28	25	8	516.8	620,160		
	28	24	9	147.4	189,990		
	29	25	12	453.0	81,540		
	Total Crawford County			1,318.0	1,167,270		1,167,270
	Total Mulky coal production			2,513.3	3,549,030	33,600	3,582,630

TABLE 5.—*Measured and indicated Mulky coal reserves, Bourbon and Crawford Counties, Kansas, by township and range. (As of December 31, 1957.)*

Township	Range	Thickness of coal, inches	Reserves			
			Measured		Indicated	
			Acres	Tons	Acres	Tons
23	25	20	168	504,000	888	2,664,000
		22	590	1,447,000	4,975	16,417,500
		Total	758	1,951,000	5,863	19,081,500
24	25	18	398	804,600	3,041	8,210,700
		22	1,493	4,926,900	5,327	17,579,100
		Total	1,791	5,731,500	8,368	25,789,800
25	25	14	4,187	8,792,700	1,858	3,901,800
		16	1,120	2,688,000	1,080	2,592,000
		17	320	816,000	1,950	4,972,500
		18	1,184	3,196,800	1,250	3,375,000
		Total	6,811	15,493,500	6,138	14,841,400
25	24	14	676	1,419,600	4,555	9,565,500
26	24	14	1,840	3,864,000	8,918	18,727,800
26	25	12	21	37,800	7,243	13,037,400
		14	2,897	6,083,700	5,465	11,476,500
		15	1,971	4,434,750	935	2,103,750
		Total	4,889	10,556,250	13,643	26,617,650
27	25	12	1,354	2,377,200	435	783,000
27	24	12	2,156	3,880,800	3,613	6,503,400
		14	518	1,087,800	2,146	4,506,600
		Total	2,674	4,968,600	5,759	11,010,000
Total Bourbon County			20,793	46,361,650	53,679	126,416,550
29*	25	12	366	658,800		
Grand total				74,838 acres		173,437,000 tons

* Crawford County; all other reserves are in Bourbon County.

mile from a known thickness of coal at an outcrop, in a dug well, or in a mine. Indicated coal is coal believed to be present in an area whose limits are defined by a maximum radius of 2 miles and a minimum radius of ½ mile from a known thickness of coal at an outcrop or in a drill hole, deep well, or mine. Inferred coal is coal believed to exist more than 2 miles (but not more than 10 miles) from coal at an outcrop or in a drill hole, deep well, or mine. The inferred coal reserves are those that are believed, on the basis of broad geologic information and regional stratigraphic projection, to underlie a given area (Schoewe, 1946, p. 40; Abernathy, Jewett, and Schoewe, 1947, p. 13). According to the procedure of the U. S. Geological Survey, the minimum thickness of coal considered in computing bituminous coal reserves is 14

inches (Averitt and Berryhill, 1950, p. 9). As much of the coal mined in Kansas came from seams 1 foot thick, however, the State Geological Survey of Kansas has adopted a minimum thickness of 12 inches (Schoewe, 1955, p. 76, 78). On this basis, Crawford County is virtually without any Mulky coal reserves. The only area in Crawford County that is underlain by measured reserves of Mulky coal is in the Breezy Hill community in sec. 1, 2, 10, and 11, T. 29 S., R. 25 E., south and southwest of Mulberry, where an area of approximately 366 acres is underlain by 12 inches of Mulky coal still unmined. Of the 658,000 tons of measured Mulky coal reserves in this area, 474,100 tons may be classified as recoverable coal. Mulky coal reserves are almost limited to Bourbon County. Because of the linear, widespread, continuous distribution of the Mulky coal mines it is not practical to classify them and their reserve areas into coal-mining districts. For this report, therefore, coal reserves are grouped by township and range. The total area of 74,472 acres (116.3 square miles) of Mulky coal reserve lands in Bourbon County comprises 20,793 acres (32.49 square miles) of measured coal reserve land and 53,674 acres (83.86 square miles) of indicated coal reserve land. Measured Mulky coal reserves are 46,361,650 tons and indicated coal reserves are 126,416,550 tons, a total of 172,778,200 tons of Mulky coal reserves. Most of the measured Mulky coal reserves in Bourbon County are in T. 25 and 26 S., R. 25 E., where 4,186 acres and 2,897 acres respectively are underlain by

TABLE 6.—*Summary of measured and indicated Mulky coal reserves, Bourbon and Crawford Counties, Kansas, by coal thickness. (As of December 31, 1957.)*

Thickness of coal, inches	Reserves			
	Measured		Indicated	
	Acres	Tons	Acres	Tons
22	2,083	6,373,900	10,302	33,996,600
20	168	504,000	888	2,664,000
18	1,482	4,001,400	4,291	11,585,000
17	320	816,000	1,950	4,972,500
16	1,120	2,688,000	1,080	2,592,000
15	1,971	4,434,750	935	2,103,750
14	10,118	21,247,800	22,942	48,178,200
12	3,531	6,295,800	11,291	20,323,800
Total Bourbon County	20,793	46,361,650	53,679	126,416,550
12*	366	658,800	—	—
Grand total	21,159	47,020,450	53,679	126,416,550

* Crawford County; all other reserves are in Bourbon County.

14 inches of coal, and T. 24 S., R. 25 E., where coal 22 inches thick underlies 1,493 acres. Most of the indicated Mulky coal reserves are in T. 26 S., R. 24 E., where 14-inch coal underlies 8,918 acres, and T. 23 and 24 S., R. 25 E., where 22 inches of coal underlies 4,975 and 5,326 acres respectively. Measured and indicated Mulky coal reserves are listed by township and range in Table 5. Table 6 is a summary of measured and indicated Mulky coal reserves arranged by thickness of the coal. Data are too sparse to warrant consideration of inferred coal reserves.

Recoverable coal.—The coal reserves listed in Table 5 are original reserves or coal in the ground. In order to be classified as recoverable coal, the coal must be salable. Experience in the Kansas strip-mining industry indicates a normal recovery of 75 percent of the original coal. Recoverable shaft-mined coal is computed on a 50 percent recovery basis. Estimates of recoverable coal in the report apply only to measured coal reserves. These amount to 35,265,338 tons for the Mulky coal as of January 1, 1957 (Table 7). It should be pointed out that although all Mulky coal included in the estimates of reserves is within the depth limits permitted for strippable coal, it is overlain in most

TABLE 7.—*Estimated recoverable measured reserves of Mulky coal in Bourbon and Crawford Counties, Kansas, by township and range and by coal thickness. (As of January 1, 1957.)*

County	Location		Thickness of coal, inches	Recoverable coal, tons
	Township	Range		
Bourbon	23	25	20	378,000
			22	1,085,250
	24	25	18	603,450
			22	3,695,175
	25	25	14	6,594,525
			16	2,016,000
			17	612,000
			18	2,397,600
	25	24	14	1,064,700
	26	24	14	2,898,000
	26	25	12	27,500
			14	4,562,775
			15	3,326,063
	27	25	12	1,782,900
	27	24	12	2,910,600
			14	815,850
	Total Bourbon County			34,771,238
Crawford	29	25	12	494,100
	Total			35,265,338

places by the entire Fort Scott Limestone (including the Higginsville Limestone member), which were fully developed is 15 to 20 feet thick. Such a thickness of hard rock that is not easily removable, coupled with the thinness of the Mulky coal, may preclude the mining of the coal under present economic conditions, although the coal is within reach of the shovel. Furthermore, it should be pointed out that some of the easily obtainable coal may be "dead", "rotten", impure, or partly altered, that is, coal that for one reason or another cannot be sold, hence not "recoverable" coal. Obviously, estimates of recoverable coal must change from time to time, depending upon annual production, economic conditions, and advances in coal technology, factors that one cannot forsee or predict for the future.

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Plate 1

Map of Bourbon and Crawford Counties, Kansas

Showing location of Mulky coal mines, reserve coal areas, and trace of the basal Fort Scott limestone

By Walter H. Schoewe
1959

EXPLANATION

- Mulky coal strip pits
- X Drift or slope mines
- Trace of Mulky coal and base of Fort Scott Ls.
- U.S. and State highways
- Reserves:
  - Measured
  - Indicated

0 1 2 3 miles
Scale

N

8°

KANSAS
Area shown

R.25E.

T. 23 S.
T. 24 S.
T. 25 S.
T. 26 S.
T. 27 S.
T. 28 S.
T. 29 S.

Fulton
Little Osage R.
Hammond
SAN FRANCISCO RR
ST LOUIS
MO. PAC R R
M.K.T. RR
FORT SCOTT
MISSOURI PACIFIC RR
Marmaton River
Rock Creek Lake
TEXAS RAILROAD
KANSAS MO.
Elm Creek Lake
Garland
MISSOURI
Arcadia
MISSOURI PACIFIC RAILROAD
ST. L. S. F. RY.
RAILWAY
SAN FRANCISCO
ST. LOUIS
Mulberry
Arma
Croweburg
Franklin
Girard
Crawford County Lake No.2

BOURBON COUNTY
CRAWFORD COUNTY

Mulky coal, although formerly mined in Crawford County, averages less than 12 inches thick, hence no reserves

Only reserves of Mulky coal in Crawford County are in Arma-Mulberry District

No minable Mulky coal south and west of Franklin