

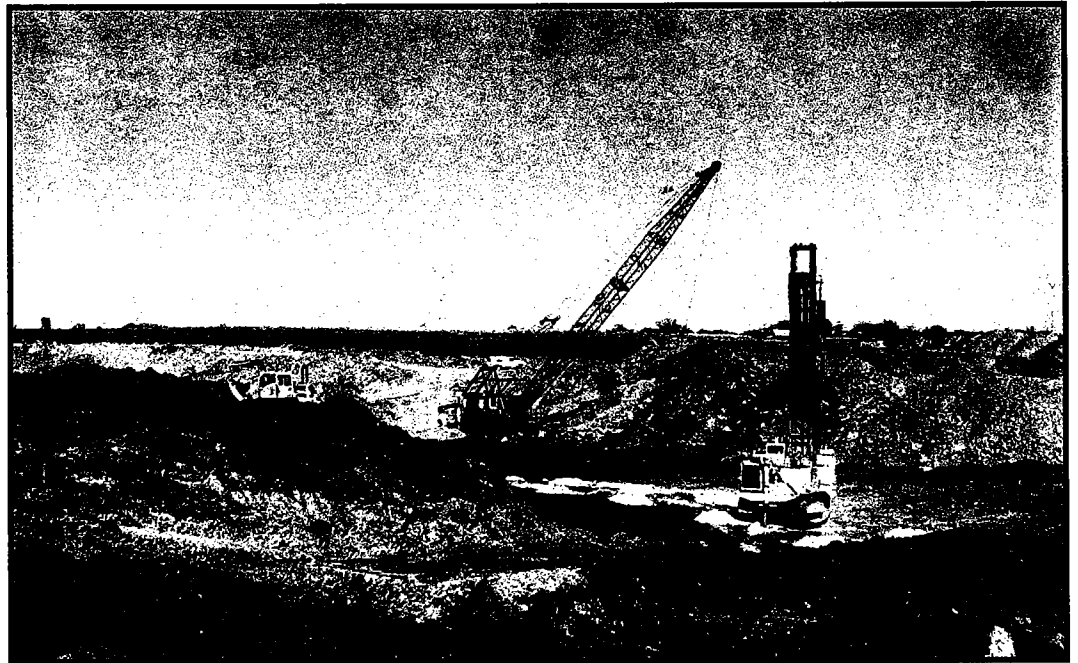


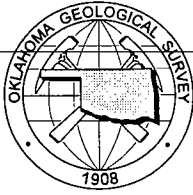
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Coal Geology of Muskogee County, Oklahoma

LeRoy A. Hemish





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Oklahoma Geological Survey
Charles J. Mankin, *Director*

The University of Oklahoma
Norman, Oklahoma

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SPECIAL PUBLICATION SERIES

The Oklahoma Geological Survey's Special Publication series is designed to bring timely geologic information to the public quickly and economically. Review and editing of this material has been minimized in order to expedite publication. For the most part, maps and cross sections were author prepared and drafted.

Front Cover

View of the Pollyanna No. 5 Mine, where the Secor coal was being mined in 1988. The mine, in sec. 34, T. 15 N., R. 17 E., was operated by P&K Coal Co., Ltd. At left a bulldozer is pushing aside the unconsolidated surface material; at right a shot-hole rig is drilling a blast hole in consolidated overburden; and in the center a dragline is removing rock overburden that has been blasted. Since removal of profitable coal, the mine has been closed and the area reclaimed.

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Coal Geology of Muskogee County, Oklahoma

*LeRoy A. Hemish*¹

ABSTRACT. — Muskogee County is located in the east-central part of the coal belt of eastern Oklahoma. Coal-bearing strata of Desmoinesian (Middle Pennsylvanian) age underlie ~500 mi² in the western two-thirds of the county. Remaining resources of coal in the area total 95,557,000 tons (all tonnage figures are in short tons), and reserves total 11,141,000 tons.

Tonnage figures for estimated resources and reserves show a significant increase for Muskogee County, resulting from new data, detailed mapping, and new exploratory work. Ten coal beds in Muskogee County have commercial potential: Hartshorne coal, with reserves of 59,000 tons; Keefeton coal, 624,000 tons; Stigler coal, 3,006,000 tons; Spaniard coal, 60,000 tons; Rowe coal, 751,000 tons; Secor coal, 815,000 tons; Peters Chapel coal, 3,192,000 tons; Wainwright coal, 1,823,000 tons; Tebo coal, 794,000 tons; and Croweburg coal, 17,000 tons.

Coals of the area are predominantly of high-volatile A bituminous (hvAb) rank. The Hartshorne, Keefeton, and Secor coals have much lower sulfur content than the others, averaging ~1.1%. The combined average sulfur content of all the other coals is ~5.0%.

In the late 1980s and early 1990s, one mine operator was producing coal from the Secor bed in Muskogee County. Another operator was mining the Keefeton coal until the mine was closed in 1993. Surface-mining methods were used in both operations. At the time of this writing (1994) no coal is being produced in Muskogee County.

INTRODUCTION

This is the fifth in a series of coal reports published by the Oklahoma Geological Survey (OGS), county by county. Figure 1 shows the status of the county studies. Their purpose is to determine the location, amount, and chemical character of the coal deposits, as well as the geologic character of the coal beds and associated strata.

In the past, the coal geology of Muskogee County has been poorly understood, the reasons being lack of detailed studies focusing on the coals, confusion regarding the stratigraphy of the Boggy Formation, and the structural complexity of the area. New extensive field investigations by the writer, core-drilling by the OGS, and acquisition of abundant new data (mostly from coal companies) have contributed to the establishment of a reliable framework upon which this report was built. Clarification of stratigraphic relations in the study area was similarly achieved.

The location of Muskogee County is shown in Figure 2. Coal beds that have commercial potential are present only in the western two-thirds of the county, within the coal belt of eastern Oklahoma.

The area under consideration comprises ~500 mi². The city of Muskogee lies in the northeastern part of

the study area, at the confluence of the Arkansas, Neosho, and Verdigris Rivers. Smaller towns are scattered throughout the county. Within the coal belt they include (from north to south) Haskell, Taft, Boynton, Wainwright, Keefeton, Oktaha, Warner, and Porum.

Three geomorphic provinces are included in the study area. The Claremore Cuesta Plains extend over most of the area, with the exception of small areas in the extreme northwestern, south-central, and southern parts, which are included in the Eastern Sandstone Cuesta Plains. The southeastern part of the study area is in the Arkansas Hill and Valley Belt (Curtis and Ham, 1972, p. 3). Topographically, the Claremore Cuesta Plains are characterized by resistant sandstones and limestones that dip gently westward, forming cuestas between broad shale plains. The Eastern Sandstone Cuesta Plains are characterized by steep-sided, sandstone-capped hills standing >300 ft above the surrounding plains. The Arkansas Hill and Valley Belt contains broad, gently rolling plains and valleys with scattered hills 100–300 ft high capped by Pennsylvanian sandstones.

Muskogee is the largest city in the county, with a population (in 1994) of ~68,000. Major highways serving the area include Interstate Highway 40; U.S. Highways 62, 64, and 69; and State Highways 2, 16, 71, 72, and 104. Two major railroads serve the area—

¹Oklahoma Geological Survey.

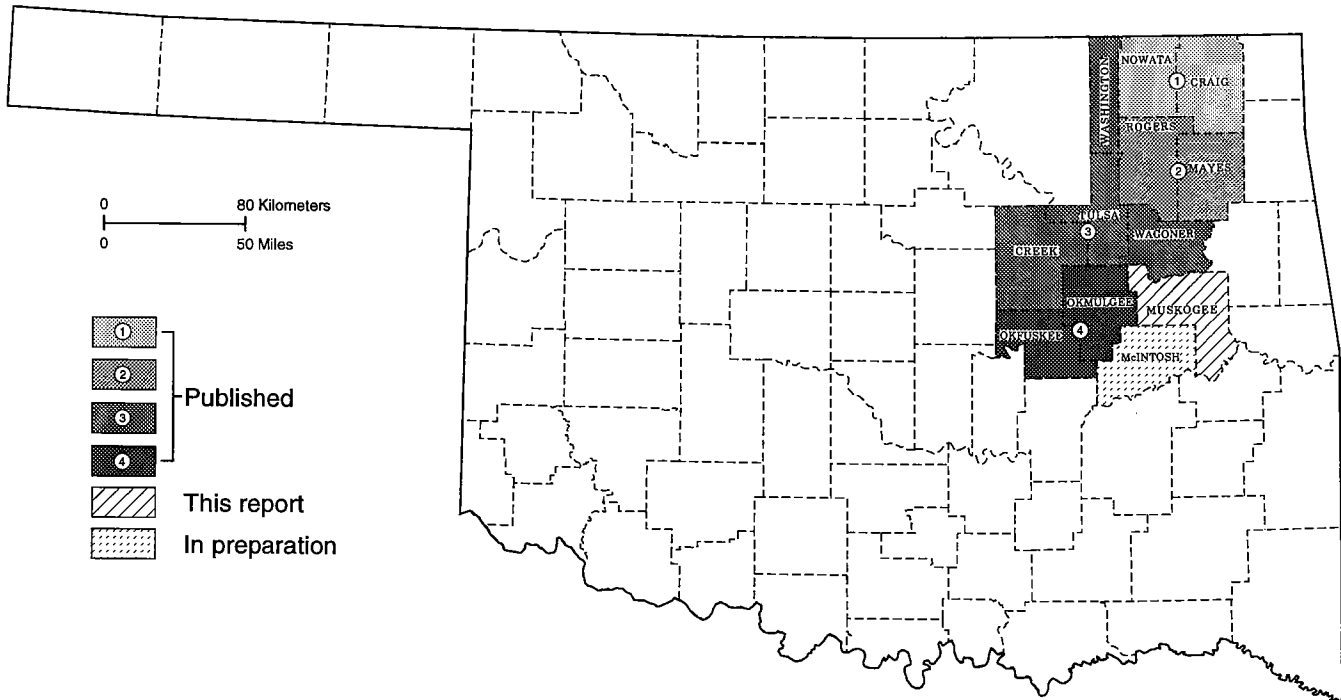


Figure 1. Status of county coal studies in Oklahoma. Reports completed are (1) Coal geology of Craig County and eastern Nowata County, Oklahoma (Hemish, 1986a); (2) Coal geology of Rogers County and western Mayes County, Oklahoma (Hemish, 1989); (3) Coal geology of Tulsa, Wagoner, Creek, and Washington Counties, Oklahoma (Hemish, 1990a); and (4) Coal geology of Okmulgee County and eastern Okfuskee County, Oklahoma (Hemish, 1994).

the Missouri-Kansas-Texas and the Missouri-Pacific. The Port of Muskogee is situated on the McClellan-Kerr Arkansas River Navigation System, which links the area to the Gulf of Mexico.

Plates 1A and 2A show locations of datum points used in the study, outcrop boundaries of coal beds, thickness of coal beds, mined-out areas, and thickness of overburden. These maps were prepared for the 10 coal beds for which resources and reserves were tabulated. Coal beds that are areally insignificant or too thin to have economic importance are discussed briefly, and their outcrop boundaries are shown where feasible. Plate 1B is a generalized columnar section, showing the coal-bearing strata of Muskogee County; Plate 2B is a structure-contour map of the top of the Secor coal bed in northwestern Muskogee County. Three cross sections (Pl. 3) show the succession of coals and associated strata throughout the study area.

Detailed information on estimated original, mined, and remaining coal resources and reserves are tabulated in Appendix 1 according to coal thickness, overburden thickness, and category of reliability.

Summary information on resources and reserves is presented in Table 1 according to township and coal thickness, and in Table 2 according to coal bed. (All tonnage figures in this report are in short tons.)

To be considered economically extractable, a high-sulfur coal (sulfur content $\geq 3.0\%$) must have a stripping ratio $\leq 30:1$. In this study, no deductions from reserves were made for reasons such as adverse geo-

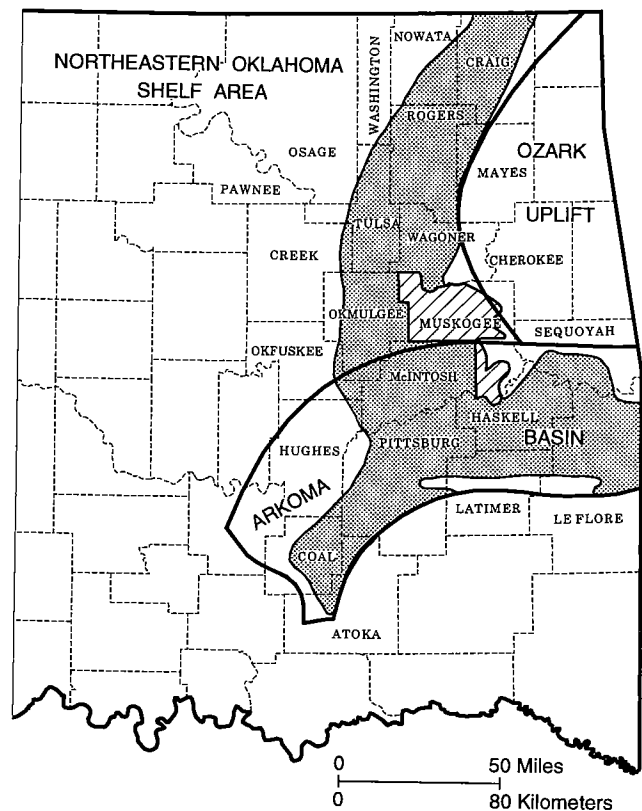


Figure 2. Index map of eastern Oklahoma showing the commercial coal belt (shaded), the northeastern Oklahoma shelf, and the Arkoma basin. A pattern of diagonal lines marks the study area.

TABLE 1. -- COAL RESOURCES AND RESERVES IN MUSKOGEE COUNTY ACCORDING TO TOWNSHIP AND COAL THICKNESS*
(thousands of short tons)

Township, Range	Remaining Resources												Total Remaining Resources		Mined or Lost in Mining ¹		Original Resources		Reserves	
	0.8 - 1.2 ft		1.2 - 2.4 ft		2.4 - 3.5 ft		> 3.5 ft		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons		
	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons		
T10N, R19E	216	383	10,199	29,485				10,415	29,868	333	1,080	10,748	30,948	422	998					
T10N, R20E	118	198	46	163				164	361	48	173	212	534	9	25					
T11N, R19E	281	485	4,604	13,385				4,885	13,870	438	1,461	5,323	15,331	533	1,083					
T11N, R20E	904	1,423	241	776				1,145	2,199	618	1,993	1,763	4,192	210	251					
T12N, R19E	628	925	1,715	4,623				2,343	5,548	142	328	2,485	5,876	74	133					
T12N, R20E	635	942						635	942	428	617	1,063	1,559	84	105					
T13N, R15E	110	161	9	8				119	169	1	1	120	170	79	98					
T13N, R16E	2,223	3,993	211	454				2,434	4,447	11	20	2,445	4,467	705	1,025					
T13N, R17E	842	1,558	893	2,410				1,735	3,968	50	146	1,785	4,114	612	1,222					
T13N, R18E	962	1,650	934	3,043				1,896	4,693	7	11	1,903	4,704	960	2,110					
T13N, R19E	1,140	1,926						1,140	1,926	10	18	1,150	1,944	422	555					
T14N, R15E	308	444						308	444	7	8	315	452	219	252					
T14N, R16E	18	26						18	26			18	26	18	20					
T14N, R17E	2,060	3,710	1,233	2,964				3,293	6,674	14	20	3,307	6,694	318	434					
T14N, R18E	545	821						545	821	14	20	559	841	308	368					
T15N, R16E	222	382						222	382			222	382	1	1					
T15N, R17E	5,924	10,701	2,090	5,082				8,014	15,783	892	1,729	8,906	17,512	1,295	2,031					
T15N, R18E	878	1,686	698	1,629				1,576	3,315	9	15	1,585	3,330	270	413					
T16N, R15E			42	121				42	121			42	121	12	17					
TOTAL	18,014	31,414	22,915	64,143				40,929	95,557	3,022	7,640	43,951	103,197	6,551	11,141					

* See Appendix 1 for details.

TABLE 2. — COAL RESOURCES AND RESERVES IN MUSKOGEE COUNTY ACCORDING TO COAL BED*
(thousands of short tons)

Coal	Total remaining resources		Mined or lost in mining		Original resources		Reserves	
	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons
Croweburg	42	121			42	121	12	17
Tebo	1,067	1,841	19	29	1,086	1,870	598	794
Wainwright	3,436	6,932	50	146	3,486	7,078	1,035	1,823
Peters Chapel	5,598	11,654	42	66	5,640	11,720	1,659	3,192
Secor	7,046	14,582	840	1,637	7,886	16,219	503	815
Rowe	2,237	4,453	51	86	2,288	4,539	53	751
Spaniard	81	146	1	1	82	147	42	60
Stigler	18,883	51,954	1,570	5,028	20,453	56,982	1,612	3,006
Keefton	2,410	3,661	446	642	2,856	4,303	513	624
Hartshorne	<u>129</u>	<u>213</u>	<u>3</u>	<u>5</u>	<u>132</u>	<u>218</u>	<u>44</u>	<u>59</u>
<i>Total</i>	40,929	95,557	3,022	7,640	43,951	103,197	6,071	11,141

*See Appendix 1 for details.

ernmental regulations and policies, land-use conflicts, poor accessibility, or adverse geologic and engineering conditions. Reserves and recoverable reserves are used in the same sense. If the coal is >100 ft deep, it is considered recoverable only by underground mining. The minimum thickness considered for underground mining is 1.2 ft.

Previous Investigations

The earliest investigation of coal in Muskogee County was by Drake (1897) who made a reconnaissance of the coalfields of the Indian Territory. Shannon and others (1926) included Muskogee County in a report on coal in Oklahoma. The U.S. Bureau of Mines (1928) reported analyses of mine samples of coal from the study area, and Moose and Searle (1929) made a chemical study of coal from the Porum area in southern Muskogee County. Wilson and Newell (1937) presented the most comprehensive information available in their time for the coal beds of Muskogee County in their report on the geology of the Muskogee-Porum District. Trumbull (1957) estimated the coal resources of Oklahoma, including information from Muskogee County. He noted (p. 332) that "The oldest coal bed known in Oklahoma is the topmost bed of the Bloyd shale, just below the base of the Atoka Formation."

More recently, Friedman (1974) investigated and reported on coals of Oklahoma, updating figures for the resources and reserves of Muskogee County. Oakes (1977) mapped the geology of Muskogee County and wrote briefly about some of the coal beds

in the area. Friedman (1982, pl. 2) mapped potentially strippable coal beds in Muskogee County by assimilating the information available.

Hemish (1986b) wrote about the stratigraphic position of coal beds in the Boggy Formation in northwestern Muskogee County. Later Hemish (1987) presented a compendium of coal nomenclature recognized by the OGS for the northeastern Oklahoma shelf area. Hemish (1988a) reported on OGS core-drilling (including 28 holes in Muskogee County) to gather information about the coal beds throughout Oklahoma. Hemish (1988b) also wrote about the coal stratigraphy of the Boggy Formation in the shelf-to-basin transition area (including Wagoner, Muskogee, McIntosh, Haskell, and Pittsburg Counties). A report on an active strip mine in the Secor coal west of the city of Muskogee was made by Hemish (1988c). Another report on core-drilling (including three holes in Muskogee County) and lithostratigraphy in the northeastern Oklahoma shelf area was written by Hemish (1990b). Hemish (1990c) also reported on occurrences of the Secor coal and associated strata in the Beland-Crekola area of Muskogee County.

Information on coal from numerous University of Oklahoma student theses was assimilated by Oakes (1977) in his report on the geology of Muskogee County.

Acknowledgments

The present author is grateful to individual landowners and to various coal companies, who provided access to their properties and furnished information

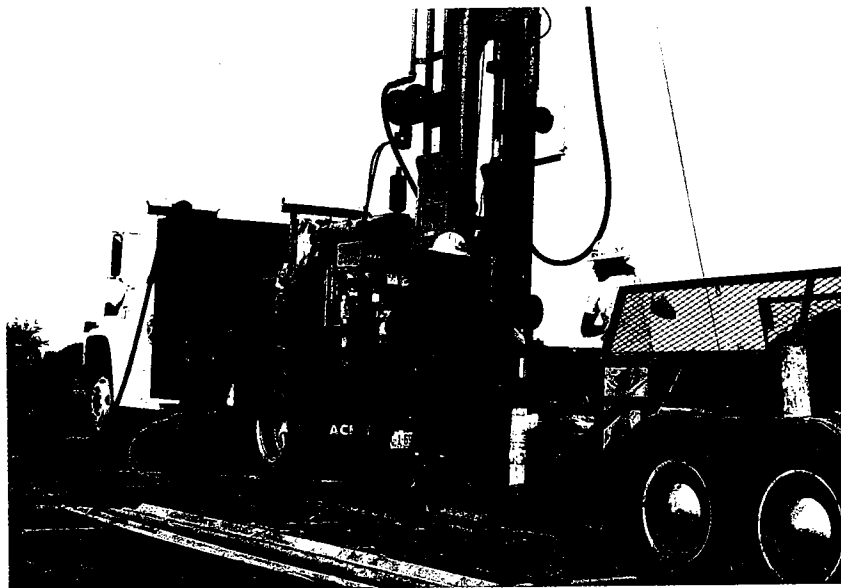


Figure 3. The Oklahoma Geological Survey's drill rig and crew coring for coal in Muskogee County. A 10-ft length of NX core lies in a tray in left foreground.

regarding coal beds discussed in this report. Appreciation is also expressed to Dale Dalton, James Dycus, and Harvey Geizer for sharing their data on the geology and coal beds of Muskogee County.

Thanks are extended to Christie Cooper, OGS editor, and her staff, for editing the material for this report, and for guiding it through to publication. Thanks are also extended to T. Wayne Furr, OGS manager of cartography, and his staff, for assistance and advice about drafting the plates and preparing the illustrations.

METHODS OF INVESTIGATION

Sources of Information

Data for compiling the maps, cross sections, and coal resources and reserve estimates were obtained from >650 drill and core logs provided mostly by coal companies, from 31 OGS core-hole logs (Appendix 2), from 121 sections measured by the author in active and abandoned strip pits and on outcrops (Appendix 2), and from numerous sections measured during previous geological studies in the area.

Analytical data for the various coal beds were compiled from information from 276 analyses provided by coal companies or other industry-related sources, from the U.S. Bureau of Mines, the U.S. Geological Survey, and the OGS (Appendix 3, Table A3-1). In addition, data from 61 samples collected by the author for this investigation and analyzed by the OGS Analytical Chemistry Laboratory are presented in Appendix 3, Table A3-2.

Procedures

Field mapping in Muskogee County began in late 1982, and by 1984 was nearly complete. However,

various core-drilling investigations (Figs. 3, 4), mapping of newly mined areas, and sampling of coal beds continued through 1994. Information was plotted on 7.5'-quadrangle topographic maps. The general practice was to traverse all roads by vehicle, and then if necessary to traverse important areas on foot. Outcrop boundaries of the various coals were field-checked, but exposures were difficult to find because of surficial materials and dense vegetation over most of the area (see Hemish, 1980). Around the city of Muskogee, urban expansion has obliterated outcrops. Slumped material and ponded water have covered most exposures of coal beds in abandoned strip mines, and abandoned underground mines are inaccessible. As no mine maps of old underground mines were found, the extent of those mines is unknown.

The term "outcrop" is used broadly in this report to describe the areal border of a coal bed, whether exposed at the surface or concealed beneath unconsolidated surficial materials. Accuracy of mapping coal boundaries depends on the amount of surface cover, the nature of the topography, and the number and distribution of exposures and drill holes. Structural complications, erosional cutouts, and areas of lenticular or discontinuous coal also hinder mapping. For some areas, additional drill information will modify the outcrop boundaries shown on the maps. These boundary lines generally indicate where coal can be found at strippable depths.



Figure 4. The author measures a core recovered from the Secor coal in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 4, T. 13 N., R. 18 E., Muskogee County. (See core-hole log 11, Appendix 2, for detailed description.)

Mined Areas

Areas mined by surface methods were mapped by use of aerial photographs or by visual estimation in the field. In the past, underground mining was practiced on a small scale in the hills between Taft and Muskogee, and also near the Canadian River, southwest of Porum. Only the entrances to these long-abandoned underground mines were plotted on the coal maps (Pls. 1A, 2A).

Thickness of Coals

Isopach lines on the maps (Pls. 1A, 2A) indicate thicknesses of the various coal beds. The isopach interval for this study was set at 0.2 ft, an interval allowing for fairly precise calculations in areas where coal-bed thickness averages <2 ft.

Overburden Categories

The term "overburden" includes all consolidated or unconsolidated lithologic material that overlies useful geologic deposits such as coal. Thickness of overburden is shown on the maps (Pls. 1A, 2A) by isopach lines that divide the overburden into three categories: 0–40, 40–100, and >100 ft. One hundred feet represents the maximum depth at which coal reserves are considered strippable in the study area. (Future economic and technological factors may change this limitation.)

Procedures for Calculating Resources and Reserves

Polygons delineating the various categories of coal resources were constructed by superimposing coal-thickness lines on a work map (scale 1:24,000) for each coal. Shown on the map are lines of outcrop, mined-out areas, and overburden-thickness lines (all color-coded). Circles were drawn around each datum point, defining categories of reliability. A circle with radius 0.25 mi defines an area of measured resources; a circle whose radius segment extends from 0.25 to 0.75 mi defines an area of indicated resources; and a circle whose radius segment extends from 0.75 to 2 mi defines an area of inferred resources (Friedman, 1974, p. 14). Areas for each category of reliability were also color-coded, so that polygons to be measured would be readily distinguishable. (Acreage of each polygon was measured with a planimeter.)

Coal tonnage was then calculated from the number of acres, the average thickness of the coal to the nearest tenth of a foot, and the factor 1,800—that last being the average weight in tons of an acre-foot of bituminous coal in the ground (Friedman, 1974, p. 17). Calculations and totals were rounded to the nearest 1,000 tons.

Original work maps, charts, tables, and records of calculations are kept on open file at the Oklahoma Geological Survey in Norman and are available for public examination.

Definitions

Coal resources comprise maximum estimates of original and remaining coal resources that are identified or presumed to exist within a coalfield and are based on interpretation of geologic data (Friedman, 1974, p. 13). In this study, resource figures were not calculated for coal beds less than 0.8 ft thick (considered the minimum minable thickness), regardless of depth. At depths >100 ft, no resource figures were calculated for beds <1.2 ft thick.

These definitions are paraphrased from Friedman (1974, p. 13–14):

Original coal resources. These are determined from coal-datum points and include all coal (in all categories of reliability) in beds before mining. New coal data can be used in updating estimates of original resources.

Remaining coal resources. These include all coal (in all categories of reliability) now present in beds, excluding coal that has been mined or lost in mining. These estimates require periodic updating owing to coal production and new coal data. In areas of no mining, remaining resources equal original resources. Remaining resources are updated by subtracting the amount of coal mined (or lost in mining) from the estimates of original resources.

Reserves. (In this report, reserves include only the part of remaining resources that could be extracted profitably.) Reserves are calculated from estimates of maximum recoverable resources, using 50% recovery for underground mining and 80% recovery for surface mining. Estimates of remaining resources may change owing to additional coal data or coal production, and thus the recoverable reserves may change; each requires periodic updating.

GEOLOGY

Structure

Muskogee County lies at the western edge of the Ozark uplift. Within the county ~400 mi² of the commercial coal belt of the state is in the shelf area, which is one of two major structural provinces dividing the coal-bearing region of northeastern Oklahoma. About 100 mi² of the coal belt in Muskogee County is in the Arkoma basin, the other structural province (Fig. 2). The regional dip of the surface rocks is generally westward at ~1°. However, the structure of Muskogee County is dominated by folds and faults that trend southwestward (Oakes, 1977); on the flanks of the folds, dips are generally 3°–4°.

Folds and faults—many previously mapped by Wilson and Newell (1937) and Oakes (1977)—are shown in Plates 1A,B and 2A,B. Most geologists who have worked in the area have agreed about the trend and general character of the folds and faults, but not about their exact mapping. The reader is referred to Oakes (1977, p. 41–44) for a detailed discussion of the structure of Muskogee County. Only major features will be mentioned here.

Wilson (in Wilson and Newell, 1937) mapped a fault extending northeastward across sec. 14, T. 15 N., R. 17 E., and named it the Pecan Creek fault. Subsequently Oakes (1977) extended it into the northern part of sec. 4, T. 14 N., R. 17 E., and linked it to a fault that extends through secs. 7, 8, and 13, T. 14 N., R. 17 E. The Pecan Creek fault is downthrown on the northwest side.

The Muskogee fault bisects the north-central part of Muskogee County, extending southwestward from the east line of sec. 12, T. 15 N., R. 20 E., to the northwest corner of sec. 22, T. 13 N., R. 15 E. The present writer found evidence (see measured section 22, Appendix 2) for extending the Muskogee fault southwestward into Okmulgee County, beyond sec. 18, T. 14 N., R. 17 E., the last point mapped by Oakes (1977). In this area the fault is downthrown on the north, and the maximum throw is 250–300 ft (Huffman, 1958); however, field evidence found by the present writer suggests that in most areas the stratigraphic displacement is only about 30–40 ft.

Other major named faults that impact coal outcrop-boundaries include the Keefeton fault (the spelling “Keefeton” is from Oakes [1977]) and the Dirty Creek fault, in the south-central part of the county (Pls. 1A, 2A). Throw on the Keefeton fault is ~300 ft, downthrown on the north. The Dirty Creek fault has a throw of ~50 ft, also downthrown on the north (Oakes, 1977).

Two major faults flank the Warner uplift (Pls. 1A, 2A). They are the North fault of the Warner uplift, which is downthrown on the north and has a maximum displacement of ~500 ft; and the South fault of the Warner uplift, which is downthrown on the south and in places has a throw of 300–400 ft (Gregware, 1958). The Warner uplift is a broad horst extending from McIntosh County on the west into Muskogee County, and continuing eastward into Sequoyah and Cherokee Counties.

The Porum syncline (Pls. 1A, 2A) lies along the south side of the Warner uplift. It is an asymmetric fold having a dip of less than 2° on the southeast flank and ~12° on the northwest flank. The outcrop boundaries of the Keefeton, Stigler, and Rowe coal beds are defined by the configuration of the Porum syncline (Pls. 1A, 2A).

The Rattlesnake Mountains syncline lies along the north side of the Warner uplift. Its axis parallels that of the North fault of the Warner uplift. It enters Muskogee County from McIntosh County on the west, and probably extends across the Arkansas River into eastern Muskogee County (Pls. 1A, 2A). The Rattlesnake Mountains syncline is asymmetrical, its north limb having the steeper dips.

A southwestward-trending anticline was mapped by Wilson (see Wilson and Newell, 1937) in secs. 17 and 19, T. 15 N., R. 17 E.; he named it the Taft anticline. Subsequently Campbell (1957) extended its axis into sec. 35, T. 15 N., R. 16 E. Information from recent close-spaced drilling indicates that the axis of

the anticline bends to the north near the middle of sec. 17, T. 15 N., R. 17 E. Modifications of the original mapping are shown in Plates 1A, 2A, and 2B. The Taft anticline is an important structure because of its effect on the minability of the Secor and Peters Chapel coal in the Taft area.

Smaller and previously unmapped and unnamed folds and faults that affect the minability of the Secor and Peters Chapel coals are shown in the structure-contour map drawn on the top of the Secor coal bed in northwestern Muskogee County (Pl. 2B). Hemish (1990c) has investigated the coal beds in the Beland-Crekola area in T. 14 N., R. 17 E., and compiled a structure-contour map drawn on the Secor coal (fig. 2, p. 202–203). For the folds and faults on his map, see Plates 1A and 2A of the present report.

Other unnamed structures, too numerous for discussion here, are found throughout Muskogee County (Pls. 1A, 2A).

Rose diagrams (Fig. 5) were constructed from 32 measurements of cleat orientations made with a Brunton compass in the study area (Appendix 4). Cleat is defined as a vertical joint or system of joints along which coal has fractured naturally (McCulloch and others, 1974, p. 2). Face cleat is the major well-defined joint in a coal bed; butt cleat is a poorly defined joint, commonly at right angles to the face cleat. According to McCulloch and others (1974, p. 1), “face cleats were formed as extension fractures during structural deformation, and butt cleats, as release fractures during erosion and uplift.” Their studies indicated that “face cleat maintains a perpendicular orientation to the shifting axial trend of local structures.” As the rose diagrams in Figure 5 show, the face cleat in Muskogee County strikes generally NW, and the butt cleat strikes NE. These trends suggest that the cleat structure was produced by tectonic forces associated with the Ouachita overthrust belt, as well as with those of the Ozark uplift; the latter has a NE-trending axis.

Stratigraphy and Coal Resources

The commercial coal beds in Muskogee County are in strata of Desmoinesian (Pennsylvanian) age. These rocks consist mostly of sandstone, siltstone, and shale; limestone and coal beds constitute a minor percentage of the whole. The most important coal beds are in the Krebs Group, which comprises the Hartshorne, McAlester, Savanna, and Boggy Formations. Less-important coal beds are in the Senora Formation of the overlying Cabaniss Group (Pl. 1B).

Some commercially insignificant coal beds, older than Desmoinesian age, are present in Muskogee County.

One of the oldest coals in Oklahoma was observed by Moore (1947, p. 40) in a “new highway cut between Muskogee and Camp Gruber.” It is located in the NE¼ sec. 20, T. 15 N., R. 20 E., on the south side of State Highway 10 (Pl. 2A). The thickness of the coal

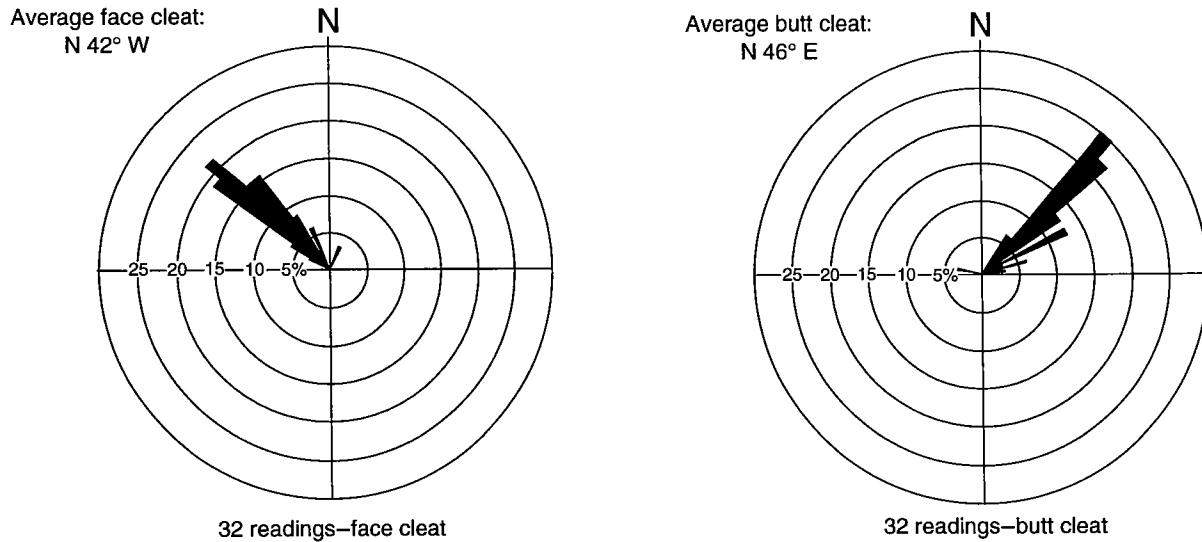


Figure 5. Rose diagrams of cleat orientations in the coal beds of Muskogee County. The number of readings for each azimuth shown is given as percent of total.

was measured by Moore (1947, p. 41) at 0.8 ft. It lies at the top of the Bloyd Formation (Morrowan) just below the basal sandstone of the Atoka Formation.

One thin (0.6 ft) coal in a thick shale unit at the top of the Atoka Formation was mapped—but not named—by Wilson and Newell (1937, pl. 1), and observed by the present writer in sec. 15, T. 14 N., R. 19 E. (measured section 76, Appendix 2). Because the coals in the Bloyd and Atoka Formations are insignificant, these stratigraphic units are not shown in Plate 1B.

Outcrop boundaries of 13 coal beds are shown in Plates 1A and 2A. All but four of the coal beds have been named previously (Hemish, 1987). Most have been correlated with coal beds mapped in counties to the north, or in some cases with coal beds mapped in the Arkoma basin, to the south. Although reserves are estimated for 10 coals, only these have realistic economic potential: Keefton, Stigler, Rowe, Secor, Peters Chapel, Wainwright, and Tebo. The Hartshorne, Spaniard, and Croweburg coals are not considered good prospects for mining. The Hartshorne is thick enough to be minable locally, and has been strip-mined on a small scale in secs. 35–36, T. 12 N., R. 20 E. (Pl. 2A). However, judging by available data, stripable acreage is quite limited.

The Tamaha coal is not known to be of minable thickness; however, a small strip pit was discovered in sec. 17, T. 13 N., R. 19 E., in the stratigraphic position of the Tamaha, so about a mile of outcrop boundary of the coal is shown in Plate 1A. Two outcrops of the Tamaha coal were described in this same area (measured sections 32 and 50, Appendix 2).

The Spaniard coal was observed in several outcrops across Muskogee County. However, it is known to be of minable thickness only in the NE $\frac{1}{4}$ sec. 13, T. 15 N., R. 17 E., and the NW $\frac{1}{4}$ sec. 18, T. 15 N., R. 18 E.

“Good coal” 13 in. thick has been reported in an active strip pit in that area by investigators for the State Mineral Survey, WPA Project 65-65-538 (Oklahoma Geological Survey, 1936–37, sheet 1011). Elsewhere, measured thicknesses of the Spaniard coal range from 0.1 to 0.6 ft (measured sections 4, 8, 26, 31, 46, 117, Appendix 2).

The Weir-Pittsburg coal crops out intermittently in northwestern Muskogee County (Pl. 1A). Outcrops of the coal were observed in several places (measured sections 81, 83, 84, 85, Appendix 2), but its thickness does not exceed 0.6 ft at any exposure. Numerous old and small abandoned strip pits were mapped along the outcrop boundary (Pl. 1A), but the coal was no longer exposed at any of the sites. By today’s standards it is probably not thick enough to mine.

The Mineral coal and the Croweburg coal are present only in the extreme northwestern corner of Muskogee County, in sec. 19, T. 16 N., R. 15 E. (Pl. 1A). Although the Mineral coal is 1.0 ft thick in a small pit ~1.2 mi to the north in Wagoner County (Lowry, 1955), the bed thins southwestward, and ~2 mi from the Muskogee-Okmulgee county line it is only 0.2 ft thick (Hemish, 1994). Core-drilling by the OGS in Muskogee County revealed only a trace of coal tentatively identified as the Mineral (core-hole log 31, Appendix 2).

Projected thickness for the Croweburg coal, based on measurements in Wagoner County (Hemish, 1990a) and Okmulgee County (Hemish, 1994) is 1.4 ft in Muskogee County. However, the outcrop boundary of the coal is in the steep escarpment of Conchartry Mountain, so conditions for mining are extremely unfavorable.

(For stratigraphic relationships of the coal beds discussed in the next section, see Plate 1B.)

The Hartshorne coal is the oldest of the Des-

moinesian coals. Where the Hartshorne sandstone is present, the coal occurs a few inches to a few feet above the sandstone. Oakes (1977, p. 15) believed that the single coal bed in Muskogee County represented "both the Upper and Lower Hartshorne coals of the Arkoma basin." The top of the coal marks the boundary between the Hartshorne Formation and the overlying McAlester Formation. Although the outcrop boundary line of the coal could not be mapped continuously across the study area, it is probably present below the surface: 0.6 ft of the Hartshorne coal has been cored just south of the Arkansas River in sec. 11, T. 15 N., R. 18 E. (core-hole log 30, Appendix 2).

A previously unnamed coal was observed near the middle of the McCurtain Shale Member of the McAlester Formation. Here the bed is named the Brushy Mountain coal from an exposure in a shale pit along a winding road on the southeast side of Brushy Mountain in the NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27, T. 14 N., R. 19 E. The coal bed is only 0.2 ft thick, so is not economic. It is overlain by 2 ft of dark gray, hard, brittle shale containing ferruginous concretions, which is in turn overlain by a similar silty shale section 18 ft thick. The coal bed is underlain by 0.2 ft of silty, sandy underclay, in its turn underlain by a rather distinctive light greenish gray, very fine grained sandstone containing well-preserved plant fossils including rootlets nearly 0.5 in. in diameter (measured section 77, Appendix 2; Pl. 1A). Other occurrences of the Brushy Mountain coal are in sec. 7, T. 15 N., R. 19 E.; in the bluff along the Arkansas River just west of the Missouri-Kansas-Texas Railroad bridge, where it is 0.4 ft thick (measured section 120, Appendix 2; Pl. 1A); and in sec. 11, T. 15 N., R. 18 E.—where the coal is only 0.1 ft thick (core-hole log 30, Appendix 2; Pl. 1A).

The most recently mined coal in Muskogee County generally occurs in a thin shale interval underlying a sandstone bed near the top of the Warner Sandstone Member of the McAlester Formation. Here it is named the Keefeton coal from outcrops in the hills a mile or two southwest of the village of Keefeton (spelling of the coal name is from the U.S. Geological Survey 1974 Keefeton 7.5 Minute Series Quadrangle map), where numerous small abandoned wagon pits provide evidence of past mining. (The Keefeton coal was most recently mined in sec. 33, T. 12 N., R. 20 E.)

The type section of the Keefeton coal is in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 13 N., R. 18 E., Muskogee County. The coal bed is well exposed in a low bluff along an intermittent stream where it occurs in a shale interval between the lower and upper units of the Warner Sandstone (measured section 39, Appendix 2; Pl. 1A). The Keefeton coal is quite persistent; its outcrop boundary extends intermittently from the Porum area on the south to the Arkansas River on the north. However, the maximum thickness of the coal is only ~1.0 ft (in an area ~5 mi southeast of Warner, and in the Keefeton area) (Pl. 1A).

The next younger coal occurs just above the Cameron Sandstone in the McAlester Formation. In this report the coal is called "Stigler" although Friedman (1974, p. 29) stated that the McAlester coal (which was named earlier than the Stigler) and the Stigler coal were correlative. (Use of the name "Stigler" for the coal bed mined in large areas east and north of the town of Stigler has been widespread in both speech and print, so it cannot be abandoned.)

The Stigler coal bed has a maximum thickness of 2.0 ft in the Porum area of Muskogee County, where it has been extensively strip-mined as evidenced by numerous unreclaimed open-pit mines. An entrance to a small abandoned underground mine was observed also in the hills south of Porum near the Canadian River (Pl. 2A). The Stigler is ~1.5 ft thick in the area northwest of Warner, but it thins northward to ~1.0 ft in the Spaniard Creek vicinity, and to ~0.5 ft along the Arkansas River north of Muskogee (Pl. 2A). The coal has been extensively strip-mined northwest of Warner, and to a lesser extent along its outcrop boundary in the Spaniard Creek vicinity.

A thin (0.3 ft) coal interpreted as the Stigler Rider coal, 1.3 ft above the Stigler coal, was cored in sec. 22, T. 10 N., R. 19 E., in extreme southern Muskogee County (core-hole log 3, Appendix 2). It probably pinches out a short distance to the north.

The Tamaha coal (discussed earlier) is another insignificant bed that occurs in the McAlester Formation just above the Tamaha Sandstone. Another thin (0.1–0.4 ft) coal bed, stratigraphically higher, was first noted by Wilson and Newell (1937). It is one of several beds of varying lithology that occur within the Keota Sandstone Member in the upper part of the McAlester Formation. Here the name "Keota coal bed" is adopted for this coal, which crops out intermittently, mostly in the central and northern part of the study area (measured sections 5, 45, 48, 65, 67, 115, 116, Appendix 2; Pl. 1A).

The Spaniard coal (discussed earlier) occurs at or just below the top of the McAlester Formation. It is recognized by its association with the overlying Spaniard Limestone. The base of the Spaniard Limestone marks the contact between the McAlester Formation and the overlying Savanna Formation. Another insignificant coal, the Tullahassee—named by Hemish (1990a) just north of the Arkansas River in Wagoner County—occurs at the top of the Spaniard Limestone. In the present study it was observed at only two places, both just south of the Arkansas in secs. 7 and 18, T. 15 N., R. 18 E.; there it is only 0.1 ft thick (measured sections 111, 119, Appendix 2; Pl. 1A).

The Sam Creek coal is a thin (0.2 ft) bed first recognized by Wilson and Newell (1937, p. 48–49). They stated that "In T. 13 N., and to the southward, coal and underclay occur sporadically beneath the upper [Sam Creek] limestone . . ." The Sam Creek coal was observed by the present writer in only one outcrop, in sec. 22, T. 10 N., R. 19 E., south of Porum (measured section 4, Appendix 2; Pl. 1A).

A thin (0.2 ft) unnamed coal crops out in the flanks of Hi Early Mountain, west of Porum, about 12 to 14 ft below the Rowe coal (measured sections 2, 3, Appendix 2; Pl. 2A). The Rowe coal itself, generally about 0.8 to 1.0 ft thick across most of Muskogee County, has fair economic potential. It is as much as 1.4 ft thick in a small area just west of Muskogee, where it was mined in the 1970s (Pl. 2A). Many other small abandoned strip pits occur along the outcrop boundary of the Rowe. The Rowe coal is near the middle of the Savanna Formation, and can be recognized by its association with the overlying Doneley Limestone and an unnamed black shale (Pl. 1B).

In northern Muskogee County are traces of a coal believed to be equivalent to the Drywood coal mapped by Hemish (1990a) in Wagoner County; it occurs in a similar stratigraphic position, just below the Bluejacket Sandstone of the Boggy Formation (measured section 96, Appendix 2; Pl. 1A). The Drywood was not observed elsewhere in the study area.

Four coals are present within a rather short stratigraphic interval between the top of the Bluejacket Sandstone and the Inola Limestone: the Secor, Secor Rider, Peters Chapel, and Bluejacket. Prior to a report by Hemish (1986b) much confusion existed about the sequence of rocks in this interval in Muskogee County. General agreement prevailed in mapping the Bluejacket Sandstone, which is the surface equivalent of the Bartlesville sand of subsurface nomenclature. However, Oakes (1977), in his report on the geology of Muskogee County, mapped only two coal beds in the interval from the top of the Bluejacket Sandstone to the base of the Inola Limestone. One he called the Secor; the other is an unnamed coal just below the Inola Limestone (now called the Bluejacket coal). Part of the confusion resulted from failure to recognize that in addition to the Crekola Sandstone, which occurs just under the Bluejacket coal (Pl. 1B), a second unnamed sandstone occurs stratigraphically lower, but still above the Secor coal. The Peters Chapel coal (named by Hemish, 1986b, p. 177) occurs between the lower unnamed sandstone and the Crekola Sandstone. Because only one coal bed was believed to lie between the Bluejacket Sandstone (below) and the Crekola Sandstone (above), the Peters Chapel coal was often confused with the Secor coal and mistakenly mapped as such (Wilson, 1935; Wilson and Newell, 1937; Stewart, 1949; Bell, 1959; Oakes, 1977). To further complicate matters, it appears that Oakes (1977, pl. 1) mismapped the unnamed sandstone between the Bluejacket Sandstone and the Crekola

Sandstone, in some places calling it the Crekola. Oakes' errors in mapping were revealed by core-drilling, exposures in active strip mines, and new field mapping. Without drilling data, correct geological mapping is virtually impossible in structurally complex areas such as Muskogee County, where sandstone channels may be stacked (see Pl. 1B and Hemish, 1990b, fig. 4), and coals may be absent due to nondeposition.

Of the four coals known in the lower part of the Boggy Formation in Muskogee County, only the Secor and Peters Chapel are locally of minable thickness. The Secor coal occurs almost immediately above the Bluejacket Sandstone. It is generally underlain by a few feet of shale and siltstone. Thickness of the Secor ranges from a trace to as much as 1.6 ft in a small area northeast of Taft (Pl. 1A), the average being ~0.8 ft. Because of its superior quality, the Secor coal has been extensively surface-mined in recent years, in the area between Taft and Muskogee (Fig. 6; Pl. 1A)

Where present, the Secor Rider occurs from 1 to 3 ft above the Secor coal. The coal is not economic in Muskogee County, being thin and of poor quality. It is generally overlain by a thin, fossiliferous, impure limestone—a useful marker bed.

The Peters Chapel coal is the next stratigraphically higher coal above the Secor Rider. It occurs between an unnamed channel sandstone and the Crekola Sandstone (Pl. 1B). Thickness of the Peters Chapel ranges from 0.2 to 2.0 ft (Pl. 2A), but, like the Secor coal, its average thickness is <1 ft. Abundant evidence shows that the Peters Chapel coal was mined in the distant past, as can be seen by the numerous small strip pits and openings to underground



Figure 6. Photograph of the 1-ft-thick bed of Secor coal in the Pollyanna No. 5 Mine, January 1988. The overburden in this part of the mine consists mostly of silty shale, siltstone, and sandstone. This coal has an ash content of only 2.0% and a sulfur content of only 0.5%. Heat value is 14,530 Btu/lb (Hemish, 1988c).

mines (particularly in the Peters Chapel area—west of Muskogee—from which the coal takes its name) (Pl. 2A).

The Bluejacket coal (unnamed coal of Oakes [1977]) is the stratigraphically highest of the four coal beds in the lower part of the Boggy Formation. It is identified by its close association with the overlying Inola Limestone. Its thickness ranges from a trace to 0.7 ft (core-hole log 25, Appendix 2); it has no economic value.

One economically important coal occurs in the upper part of the Boggy Formation. It has been produced for more than 50 years around the town of Wainwright, so it is here named the Wainwright coal. The bed has been mined south of Wainwright as recently as the 1970s, and exploration drilling by coal companies has been going on until recent years. The Wainwright coal is up to 2.4 ft thick (Pl. 1A), and several hundred acres are surface-minable between Wainwright and the Muskogee-McIntosh county line. The coal thins northward, and is only 0.4–0.6 ft thick west and southwest of Taft (measured sections 56, 87, 88, Appendix 2; Pl. 1A).

The next stratigraphically higher coal bed in the study area is the Weir-Pittsburg (discussed earlier). Its base marks the boundary between the Boggy Formation (Krebs Group) and the Senora Formation (Cabaniss Group). The Weir-Pittsburg coal apparently pinches out in southwestern Muskogee County, somewhere between the towns of Boynton and Council Hill. It was not mapped south of the Muskogee Fault (Pl. 1A). In this area the base of the Stuart Shale marks the boundary between the Krebs Group and the overlying Cabaniss Group.

An economically insignificant coal, informally called the RC bed by Hemish (1989), is present locally in the lower part of the Senora Formation in western Muskogee County. It was observed in one core hole (core-hole log 17, Appendix 2), where it is only 0.1 ft thick, and in one outcrop (measured section 53, Appendix 2), where it occurs as lenses up to 0.6 ft thick within an unnamed sandstone unit.

The next stratigraphically higher coal, the Tebo, lies ~21 ft above the RC coal. In the Boynton area of western Muskogee County it has economic potential, but southwest of Haskell it is too thin to mine (Pl. 2A). At some time in the past, the Tebo was mined along its outcrop boundary in several small strip pits near Boynton, and as recently as the late 1970s in a modern stripping operation south of Boynton. The Tebo is readily identified in the field by its association with the overlying Tiawah Limestone and an unnamed black shale unit.

The Mineral and Croweburg coal beds (discussed earlier) are the youngest coals in Muskogee County. They occur in the upper part of the Senora Formation, stratigraphically between the Chelsea Sandstone Member and the Calvin Sandstone (Pl. 1B).

Cross sections A–A', B–B', and C–C' (Pl. 3), show the relationships of the various coal beds discussed above.

COAL QUALITY

Coals of Muskogee County are predominantly of high-volatile A bituminous (hvAb) in rank (Appendix 3). Rank was determined by standard procedures of the American Society for Testing and Materials (ASTM, 1987, p. 225–228). Average values for the various analytical properties of each coal are listed in Appendix 3, based on data from 276 analytical reports (Appendix 3, Table A3-1). During the investigation, 61 channel samples of coal were collected in the study area by the present writer. Fifteen of the samples were collected in active strip mines, 26 from core holes, and 20 from abandoned strip mines or outcrops. Analyses of samples that showed evidence of weathering were not used for classification by rank. Analysis was by chemists in the Analytical Chemistry Laboratory of the Oklahoma Geological Survey.

The average overall moisture content of all coals in Muskogee County is low, averaging 3.8% on 276 samples (Appendix 3, Table A3-1). Of the seven coals listed previously that are considered to have the most economic potential, the Secor coal has the highest quality; analyses of 143 samples show that it is a low-ash (4.2%), low-sulfur (0.9%) coal, and that its heat value is 13,526 Btu/lb. The Keefton coal is also a good quality coal; analyses of 38 samples show that it is a low-ash (6.9%), medium-sulfur (1.7%) coal, with a heat value of 14,016 Btu/lb. The five other coals are all medium-ash, high-sulfur coals: Rowe—8.6% ash, 3.3% sulfur (7 samples); Stigler—10.4% ash, 4.4% sulfur (22 samples); Wainwright—11.8% ash, 3.9% sulfur (14 samples); Peters Chapel—13.1% ash, 6.5% sulfur (44 samples); Tebo—13.8% ash, 6.5% sulfur (4 samples). All the above data are from analyses made as received.

According to Friedman (1974, p. 23), ~20% of the sulfur in some of the high-sulfur coals can be removed by coal-washing plants in Oklahoma. Most of the sulfur is contained in pyrite, which is much denser than coal and tends to sink during washing.

COAL ECONOMICS

Production

The earliest reported production of coal from Muskogee County was in 1919 (U.S. Geological Survey, 1900–31), but the production was combined with that of Rogers and Wagoner Counties, so exact tonnage is unknown. Undoubtedly, small-scale mining was carried on earlier, but no records exist. Annual reports of production continued through 1933, but always in combination with adjacent counties. Production figures for 1934 onward are available for coal mined in Muskogee County, exclusive of combined production, and except for 1940–41 when reported production was combined with Wagoner County (U.S. Bureau of Mines, 1934–48).

No production of coal was reported in Muskogee County during 1960–61, 1985, or 1993–94. Figure 7

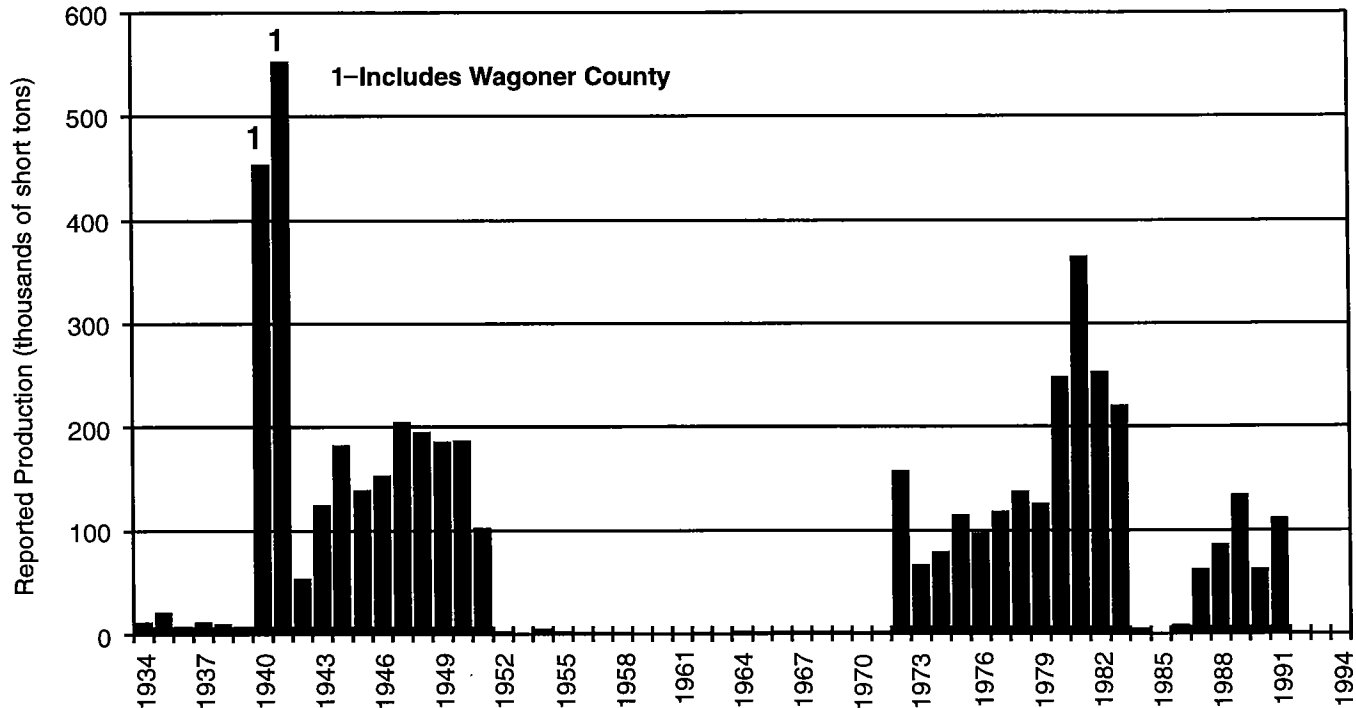


Figure 7. Histogram illustrating reported production of coal in Muskogee County, 1934–94. (Data for 1934–48 from USBM, Minerals Yearbooks; for 1949–94 from Annual Report of the Chief Mine Inspector, Oklahoma Department of Mines.)

shows coal production data in the county from 1934 to 1994.

Rapid expansion in the coal industry occurred during and after World War II, and in 1947 more than 200,000 tons of coal was produced in Muskogee County. Production declined in the 1950s and remained low until the 1970s, when there was another upturn in the industry. Production peaked in 1981, when 363,653 tons was reported mined, mostly from the Secor and Stigler coal beds. In the mid-1980s production again declined, but a brief upturn in production occurred in 1989–91, when the high-quality Keefton and Secor beds were being mined. By 1993, mining in Muskogee County had ceased.

Resources and Reserves

Data on the resources and reserves of the coals described in this report are shown in Tables 1 and 2, and in Appendix 1. Original resources, remaining resources, coal mined or lost in mining, and reserves are tabulated by coal beds for the county. Grand totals for the county as a whole are also listed.

Remaining resources for the county total 95,557,000 short tons, of which 11,141,000 short tons are reserves.

The Stigler coal bed has the most remaining resources, with 51,954,000 short tons, and the second most reserves, with 3,006,000 short tons. The greatest tonnage is in the Porum area (T. 10 N., R. 19 E., Appendix 1) with 29,485,000 short tons still in the ground; of that, 936,000 short tons are reserves.

The Secor coal bed also has potential for exploitation, particularly in the Taft area (T. 15 N., R. 17 E., Appendix 1), where 9,971,000 short tons remain; of that, 669,000 short tons are reserves. Major drawbacks to mining the Secor are thinness of bed, uneven distribution of overburden, and uncertainty about factors such as structural complications. However, the superior quality of the coal (and consequently higher price) permits removal of greater thicknesses of overburden. Likewise, a market is ensured for a low-sulfur, low-ash, high-Btu coal such as the Secor.

The high-sulfur, high-ash Peters Chapel coal has the most reserves in Muskogee County, 3,192,000 short tons (Table 2). Most of the acreage underlain by the Peters Chapel reserves is in T. 14 and 15 N., R. 17 E. (Appendix 1), coinciding in part with the area where the stratigraphically lower (about 45–50 ft) Secor coal has abundant resources. With higher prices for coal and better marketing, both coal beds may some day be mined in a single operation.

REFERENCES CITED

- American Society for Testing and Materials, 1987, Gaseous fuels; coal and coke, *in* Annual book of ASTM standards; petroleum products, lubricants, and fossil fuels: American Society for Testing and Materials, v. 05.05, 561 p.
- Bell, Walton, 1959, Surface geology of the Muskogee area, Muskogee County, Oklahoma: University of Oklahoma unpublished M.S. thesis, 113 p.
- Campbell, D. J., 1957, Geology of the Jamesville area, Muskogee and Okmulgee Counties, Oklahoma: University of Oklahoma unpublished M.S. thesis, 91 p.
- Curtis, N. M., Jr.; and Ham, W. E., 1972, Geomorphic provinces of Oklahoma, *in* Johnson, K.S.; and others, Geology and earth resources of Oklahoma—an atlas of maps and cross sections: Oklahoma Geological Survey Educational Publication 1, 8 p.
- Drake, N. F., 1897, A geological reconnaissance of the coal fields of the Indian Territory: American Philosophical Society Proceedings, v. 36, p. 326–419.
- Friedman, S. A., 1974, An investigation of the coal reserves in the Ozarks section of Oklahoma and their potential uses; final report to the Ozarks Regional Commission: Oklahoma Geological Survey Special Publication 74-2, 117 p.
- _____, 1982, Map showing potentially strippable coal beds in eastern Oklahoma: Oklahoma Geological Survey Map GM-23, 4 sheets, scale 1:125,000.
- Gregware, William, 1958, Surface geology of the McLain area, Muskogee County, Oklahoma: University of Oklahoma unpublished M.S. thesis, 101 p.
- Hemish, L. A., 1980, Observations and interpretations concerning Quaternary geomorphic history of northeastern Oklahoma: Oklahoma Geology Notes, v. 40, p. 79–94.
- _____, 1986a, Coal geology of Craig County and eastern Nowata County, Oklahoma: Oklahoma Geological Survey Bulletin 140, 131 p.
- _____, 1986b, Stratigraphy of the lower part of the Boggy Formation (Desmoinesian) in northwestern Muskogee and southwestern Wagoner Counties, Oklahoma: Oklahoma Geology Notes, v. 46, p. 168–187.
- _____, 1987, Names of coal beds in the northeastern Oklahoma shelf area: Oklahoma Geology Notes, v. 47, p. 96–113.
- _____, 1988a, Report of core-drilling by the Oklahoma Geological Survey in Pennsylvanian-age rocks of the northeastern Oklahoma coal belt, 1983–86: Oklahoma Geological Survey Special Publication 88-2, 174 p.
- _____, 1988b, Coal geology of the lower Boggy Formation in the shelf-to-basin transition area, eastern Oklahoma, *in* Johnson, K. S. (ed.), Shelf-to-basin geology and resources of Pennsylvanian strata in the Arkoma basin and frontal Ouachita Mountains of Oklahoma: Oklahoma Geological Survey Guidebook 25, p. 7–19.
- _____, 1988c, Secor coal in Pollyanna No. 5 strip mine, west of Muskogee, *in* Johnson, K. S. (ed.), Shelf-to-basin geology and resources of Pennsylvanian strata in the Arkoma basin and frontal Ouachita Mountains of Oklahoma: Oklahoma Geological Survey Guidebook 25, p. 69–72.
- _____, 1989, Coal geology of Rogers County and western Mayes County, Oklahoma: Oklahoma Geological Survey Bulletin 144, 118 p.
- _____, 1990a, Coal geology of Tulsa, Wagoner, Creek, and Washington Counties, Oklahoma: Oklahoma Geological Survey Map GM-33, 5 sheets, scale 1:63,360, accompanying text with appendixes.
- _____, 1990b, Lithostratigraphy and core-drilling, upper Atoka Formation through lower Senora Formation (Pennsylvanian), northeastern Oklahoma shelf area: Oklahoma Geological Survey Special Publication 90-2, 54 p.
- _____, 1990c, The Secor coal and associated strata in the Beland-Crekola area, Muskogee County, Oklahoma: Oklahoma Geology Notes, v. 50, p. 196–217.
- _____, 1994, Coal geology of Okmulgee County and eastern Okfuskee County, Oklahoma: Oklahoma Geological Survey Special Publication 94-3, 86 p.
- Huffman, G. G.; and others, 1958, Geology of the flanks of the Ozark uplift, northeastern Oklahoma: Oklahoma Geological Survey Bulletin 77, 281 p.
- Lowry, J. C. A., Jr., 1955, Geology of the Concharly and Conjada Mountain areas of Tulsa, Wagoner, Muskogee, and Okmulgee Counties, Oklahoma: University of Tulsa unpublished M.S. thesis, 105 p.
- McCulloch, C. M.; Deul, Maurice; and Jeran, P. W., 1974, Cleat in bituminous coalbeds: U.S. Bureau of Mines Report of Investigations 7910, 25 p.
- Moore, C. A., 1947, The Morrow series of northeastern Oklahoma: Oklahoma Geological Survey Bulletin 66, 151 p.
- Moose, J. E.; and Searle, V. C., 1929, A chemical study of Oklahoma coals: Oklahoma Geological Survey Bulletin 51, 112 p.
- Oakes, M. C., 1977, Geology and mineral resources (exclusive of petroleum) of Muskogee County, Oklahoma: Oklahoma Geological Survey Bulletin 122, 78 p.
- Oklahoma Department of Mines, 1949–93, Annual reports: Oklahoma Department of Mines, Oklahoma City.
- Oklahoma Geological Survey, 1936–37, State Mineral Survey, WPA Project 65-65-538.
- Shannon, C. W.; and others, 1926, Coal in Oklahoma [revised and edited by C. L. Cooper]: Oklahoma Geological Survey Bulletin 4, 110 p.
- Stewart, Francis, Jr., 1949, A map of portions of Muskogee and McIntosh Counties, Oklahoma, with special reference to the Inola limestone and Secor coal: University of Oklahoma unpublished M.S. thesis, 81 p.
- Trumbull, J. V. A., 1957, Coal resources of Oklahoma: U.S. Geological Survey Bulletin 1042-J, p. 307–382.
- U.S. Bureau of Mines, 1928, Analyses of Oklahoma coals: U.S. Bureau of Mines Technical Paper 411, 62 p.
- _____, 1934–48, Minerals Yearbooks.
- U.S. Geological Survey, 1900–31, Mineral resources of the United States.
- Wilson, C. W., Jr., 1935, Age and correlation of Pennsylvanian surface formations and of oil and gas sands of Muskogee County, Oklahoma: American Association of Petroleum Geologists Bulletin, v. 19, p. 503–520.
- Wilson, C. W., Jr.; and Newell, N. D., 1937, Geology of the Muskogee-Forum district, Muskogee and McIntosh Counties, Oklahoma: Oklahoma Geological Survey Bulletin 57, 184 p.

APPENDIXES

Appendix 1: Coal Resources and Reserves by Township and Range and by Coal Bed

(thousands of short tons)

Coal	Category of Reliability and Depth (ft)	Remaining Resources												Mined or Lost in Mining ¹		Original Resources		Reserves							
		0.8 - 1.2 ft			1.2 - 2.4 ft			2.4 - 3.5 ft			> 3.5 ft			Total Remaining Resources		Acres	Tons	Acres	Tons	Acres	Tons				
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons												
T10N, R19E, MUSKOGEE COUNTY																									
ROWE	<u>Measured</u>																								
	0-20	23	41	69	197	102	313	102	313	69	197	331	1,077	400	1,274	25	44	2	3	100	178	23	33		
	20-40	22	39	129	359	101	316	101	316	129	359	2	3	129	359	14	25			14	25	14	20		
	40-100	53	95	712	2,348	774	2,592	774	2,592	712	2,348			712	2,348	15	26			15	26	15	26		
	> 100			282	837	1,716	5,371	1,716	5,371	282	837			282	837	29	53			29	53	29	53		
	<u>Total</u>	98	175	1,192	3,741	2,693	8,592	2,693	8,592	1,192	3,741	331	1,077	2,693	8,592	100	178			100	178	100	178	23	33
	<u>Indicated</u>																								
	0-20	14	25	102	313	102	313	102	313	102	313			102	313	14	25			14	25	14	25	14	20
	20-40	15	26	101	316	101	316	101	316	101	316			101	316	15	26			15	26	15	26	15	26
	40-100	29	53	774	2,592	774	2,592	774	2,592	774	2,592			774	2,592	29	53			29	53	29	53	29	53
> 100			282	837	1,716	5,371	1,716	5,371	282	837			282	837											
<u>Total</u>	58	104	1,192	3,741	2,693	8,592	2,693	8,592	1,192	3,741	331	1,077	2,693	8,592	58	104			58	104	58	104	14	20	
<u>Inferred</u>																									
0-20	6	12	6	12	6	12	6	12	6	12			6	12	6	12			6	12	6	12	6	9	
20-40	6	11	6	11	6	11	6	11	6	11			6	11	6	11			6	11	6	11	6	9	
40-100	12	22	12	22	12	22	12	22	12	22			12	22	12	22			12	22	12	22	12	9	
> 100																									
<u>Total</u>	24	45	24	45	24	45	24	45	24	45	2	3	24	45	24	45			24	45	24	45	6	9	
Grand Total	180	324	180	324	180	324	180	324	180	324	3	3	182	327	182	327			182	327	182	327	43	62	
STIGLER																									
STIGLER	<u>Measured</u>																								
	0-20			69	197	102	313	102	313	69	197			400	1,274					400	1,274	69	158		
	20-40			129	359	101	316	101	316	129	359			129	359			129	359	129	359	69	165		
	40-100			712	2,348	774	2,592	774	2,592	712	2,348			712	2,348			712	2,348	712	2,348	69	165		
	> 100			282	837	1,716	5,371	1,716	5,371	282	837			282	837			282	837	282	837	69	165		
	<u>Total</u>			1,192	3,741	2,693	8,592	2,693	8,592	1,192	3,741			1,523	4,818			1,523	4,818	1,523	4,818	138	323		
	<u>Indicated</u>																								
	0-20			102	313	102	313	102	313	102	313			102	313			102	313	102	313	102	250		
	20-40			101	316	101	316	101	316	101	316			101	316			101	316	101	316	77	197		
	40-100			774	2,592	774	2,592	774	2,592	774	2,592			774	2,592			774	2,592	774	2,592	77	197		
> 100			1,716	5,371	1,716	5,371	1,716	5,371	1,716	5,371			1,716	5,371			1,716	5,371	1,716	5,371	77	197			
<u>Total</u>			2,693	8,592	2,693	8,592	2,693	8,592	2,693	8,592			2,693	8,592			2,693	8,592	2,693	8,592	179	447			
<u>Inferred</u>																									
0-20			32	109	32	109	32	109	32	109			32	109			32	109	32	109	32	87			
20-40			35	117	35	117	35	117	35	117			35	117			35	117	35	117	30	79			
40-100			275	932	275	932	275	932	275	932			275	932			275	932	275	932	30	79			
> 100			5,972	15,994	5,972	15,994	5,972	15,994	5,972	15,994			5,972	15,994			5,972	15,994	5,972	15,994	62	166			
<u>Total</u>			6,314	17,152	6,314	17,152	6,314	17,152	6,314	17,152	331	1,077	6,314	17,152	331	1,077	6,314	17,152	6,314	17,152	379	936			
Grand Total			10,199	29,485	10,199	29,485	10,199	29,485	10,199	29,485	1,077	3,354	10,530	30,562	1,077	3,354	10,530	30,562	10,530	30,562	379	936			

KEEFTON

<u>Measured</u>									
0-20									
20-40									
40-100	35	57	35	57	35	57	35	57	57
> 100									
<u>Total</u>	35	57	35	57	35	57	35	57	57
<u>Indicated</u>									
0-20									
20-40									
40-100	1	2	1	2	1	2	1	2	2
> 100									
<u>Total</u>	1	2	1	2	1	2	1	2	2
<u>Inferred</u>									
0-20									
20-40									
40-100									
> 100									
<u>Total</u>									
<u>Grand Total</u>	36	59	36	59	36	59	36	59	59
Combined Grand Totals	216	383	10,199	29,485	10,415	29,868	333	1,080	10,748
									30,948
									422
									998

T10N, R20E, MUSKOGEE COUNTY

STIGLER

<u>Measured</u>															
0-20															
20-40															
40-100	9	31	9	31	48	173	48	173	48	31	173	48	173	9	25
> 100	37	132	37	132	37	132	37	132	37	37	132	37	132	9	25
<u>Total</u>	46	163	46	163	46	163	46	163	46	94	336	94	336	9	25
<u>Indicated</u>															
0-20															
20-40															
40-100															
> 100															
<u>Total</u>															
<u>Inferred</u>															
0-20															
20-40															
40-100															
> 100															
<u>Total</u>															
<u>Grand Total</u>	46	163	46	163	46	163	46	163	46	94	336	94	336	9	25

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

Coal	Category of Reliability and Depth (ft)	Remaining Resources						Total Remaining Resources			Mined or Lost in Mining ¹			Original Resources			Reserves			
		0.8 - 1.2 ft		1.2 - 2.4 ft		2.4 - 3.5 ft		> 3.5 ft		Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons											
T10N, R20E, MUSKOGEE COUNTY (continued)																				
KEEFTON																				
	<u>Measured</u>																			
	0-20																			
	20-40	21	33							21	33							21	33	
	40-100	52	93							52	93							52	93	
	> 100																			
	<i>Total</i>	73	126							73	126							73	126	
	<u>Indicated</u>																			
	0-20																			
	20-40	29	45							29	45							29	45	
	40-100	16	27							16	27							16	27	
	> 100																			
	<i>Total</i>	45	72							45	72							45	72	
	<u>Inferred</u>																			
	0-20																			
	20-40																			
	40-100																			
	> 100																			
	<i>Total</i>																			
	<i>Grand Total</i>	118	198							118	198							118	198	
	Combined Grand Totals	118	198	46	163					164	361	48	173	212	534	9	25			
T11N, R19E, MUSKOGEE COUNTY																				
ROWE																				
	<u>Measured</u>																			
	0-20																			
	20-40	14	23							14	23	1	1	15	24	14	19			
	40-100	13	22							13	22			13	22					
	> 100	25	42							25	42			25	42					
	<i>Total</i>	52	87							52	87			53	88	14	19			
	<u>Indicated</u>																			
	0-20																			
	20-40	9	17							9	17			9	17	9	13			
	40-100	8	13							8	13			8	13					
	> 100	18	31							18	31			18	31					
	<i>Total</i>	35	61							35	61			35	61	9	13			
	<u>Inferred</u>																			
	0-20																			
	20-40																			
	40-100																			
	> 100																			
	<i>Total</i>																			
	<i>Grand Total</i>	87	148							87	148	1	1	88	149	23	32			

Appendix 1: Resources and Reserves

T12N, R19E, MUSKOGEE COUNTY

ROWE

<u>Measured</u>	9	16	9	16	1	1	10	17	9	13
0-20										
20-40	7	13	7	13			7	13		
40-100	30	54	30	54			30	54		
> 100										
Total	46	83	46	83			47	84	9	13
<u>Indicated</u>	5	8	5	8	8	5	5	8	4	6
0-20										
20-40	5	9	5	9			5	9		
40-100	10	16	10	16			10	16		
> 100										
Total	20	33	20	33			20	33	4	6
<u>Inferred</u>	1	2	1	2	2	1	1	2	1	2
0-20										
20-40	1	1	1	1			1	1		
40-100										
> 100										
Total	2	3	2	3			2	3	1	2
Grand Total	68	119	68	119	1	1	69	120	14	21

STIGLER

<u>Measured</u>	6	16	6	16	126	306	132	322	6	13
0-20										
20-40	61	157	61	157			61	157		
40-100	383	1,034	383	1,034			383	1,034		
> 100										
Total	450	1,207	450	1,207			576	1,513	13	58
<u>Indicated</u>	129	350	129	350	496	1,338	129	350		
0-20										
20-40										
40-100										
> 100										
Total	625	1,688	625	1,688			625	1,688		
<u>Inferred</u>	640	1,728	640	1,728	126	306	640	1,728	13	58
0-20										
20-40										
40-100										
> 100										
Total	640	1,728	640	1,728	126	306	640	1,728	13	58
Grand Total	1,715	4,623	1,715	4,623	126	306	1,841	4,929	13	58

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

HARTSHORNE												
<u>Measured</u>												
0-20	31	52										
20-40	41	67										
40-100	30	51										
> 100												
Total	102	170										
<u>Indicated</u>												
0-20	8	13										
20-40	3	4										
40-100	4	6										
> 100												
Total	15	23										
<u>Inferred</u>												
0-20	5	8										
20-40	3	5										
40-100	4	7										
> 100												
Total	12	20										
Grand Total	129	213										
Combined Grand Totals	635	942										

TI3N, R15E, MUSKOGEE COUNTY

TEBO												
<u>Measured</u>												
0-20	54	80	8	5								
20-40	25	36										
40-100												
> 100												
Total	79	116	8	5								
<u>Indicated</u>												
0-20	17	25	1	3								
20-40	14	20										
40-100												
> 100												
Total	31	45	1	3								
<u>Inferred</u>												
0-20												
20-40												
40-100												
> 100												
Total	110	161	9	8								
Grand Total	110	161	9	8								

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

Coal	Category of Reliability and Depth (ft)	Remaining Resources										Mined or Lost in Mining ¹		Original Resources		Reserves			
		0.8 - 1.2 ft		1.2 - 2.4 ft		2.4 - 3.5 ft		> 3.5 ft		Total Remaining Resources		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons
TEBO																			
T13N, R16E, MUSKOGEE COUNTY																			
	<u>Measured</u>																		
	0-20	175	314	28	60					203	374	11	20	214	394	203	304		
	20-40	125	225	50	107					175	332			175	332				
	40-100	52	104	78	168					130	272			130	272				
	>100																		
	<i>Total</i>	352	643	156	335					508	978			519	998	203	304		
	<u>Indicated</u>																		
	0-20	53	94	26	55					79	149			79	149	79	120		
	20-40	6	11	19	42					25	53			25	53				
	40-100			10	22					10	22			10	22				
	>100																		
	<i>Total</i>	59	105	55	119					114	224			114	224	79	120		
	<u>Inferred</u>																		
	0-20																		
	20-40																		
	40-100																		
	>100																		
	<i>Total</i>																		
	Grand Total	411	748	211	454					622	1,202	11	20	633	1,222	282	424		
WAINWRIGHT																			
	<u>Measured</u>																		
	0-20	89	151							89	151			89	151	89	121		
	20-40	101	177							101	177			101	177				
	40-100	76	136							76	136			76	136				
	>100																		
	<i>Total</i>	266	464							266	464			266	464	89	121		
	<u>Indicated</u>																		
	0-20	174	312							174	312			174	312	174	250		
	20-40	233	420							233	420			233	420				
	40-100	172	309							172	309			172	309				
	>100																		
	<i>Total</i>	579	1,041							579	1,041			579	1,041	174	250		
	<u>Inferred</u>																		
	0-20	160	288							160	288			160	288	160	230		
	20-40	362	651							362	651			362	651				
	40-100	445	801							445	801			445	801				
	>100																		
	<i>Total</i>	967	1,740							967	1,740			967	1,740	160	230		
	Grand Total	1,812	3,245							1,812	3,245			1,812	3,245	423	601		
	Combined Grand Totals	2,223	3,993	211	454					2,434	4,447	11	20	2,445	4,467	705	1,025		

Appendix 1: Resources and Reserves

T13N, R17E, MUSKOGEE COUNTY

WAINWRIGHT

Measured												
0-20	98	196	203	570	301	766	50	146	351	912	301	613
20-40	125	234	243	684	368	918			368	918	122	289
40-100	60	116	242	648	302	764			302	764		
> 100												
Total	283	546	688	1,902	971	2,448			1,021	2,594	423	902
Indicated												
0-20	78	143	42	97	120	240			120	240	120	192
20-40	75	134	24	58	99	192			99	192	5	12
40-100	142	260	28	72	170	332			170	332		
> 100												
Total	295	537	94	227	389	764			389	764	125	204
Inferred												
0-20	64	116			64	116			64	116	64	116
20-40	78	140			78	140			78	140		
40-100	122	219			122	219			122	219		
> 100												
Total	264	475			264	475			264	475	64	116
Grand Total	842	1,558	782	2,129	1,624	3,687	50	146	1,674	3,833	612	1,222

PETERS CHAPEL

Measured												
0-20												
20-40												
40-100												
> 100												
Total												
Indicated												
0-20												
20-40												
40-100												
> 100												
Total												
Inferred												
0-20												
20-40												
40-100												
> 100												
Total												
Grand Total												
Combined Grand Totals	842	1,558	893	2,410	1,735	3,968	50	146	1,785	4,114	612	1,222

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

Coal	Category of Reliability and Depth (ft)	Remaining Resources										Mined or Lost in Mining ¹			Original Resources			Reserves					
		0.8 - 1.2 ft		1.2 - 2.4 ft		2.4 - 3.5 ft		> 3.5 ft		Total Remaining Resources		Acres		Tons		Acres		Tons		Acres		Tons	
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons		
T13N, R18E, MUSKOGEE COUNTY																							
PETERS CHAPEL																							
	<u>Measured</u>																						
	0-20	5	10	85	303					90	313			90	313			90	313			90	251
	20-40	24	42	53	147					77	189			77	189			77	189			29	68
	40-100			47	154					47	154			47	154			47	154				
	>100			45	129					45	129			45	129			45	129				
	Total	29	52	230	733					259	785			259	785			259	785			119	319
	<u>Indicated</u>																						
	0-20	37	67	296	1,060					333	1,127			333	1,127			333	1,127			333	902
	20-40	39	70	72	193					111	263			111	263			111	263			34	78
	40-100	12	22	36	126					48	148			48	148			48	148				
	>100			201	580					201	580			201	580			201	580				
	Total	88	159	605	1,959					693	2,118			693	2,118			693	2,118			367	980
	<u>Inferred</u>																						
	0-20			83	300					83	300			83	300			83	300			83	300
	20-40																						
	40-100			16	51					16	51			16	51			16	51				
	>100																						
	Total	117	211	934	3,043					1,051	3,254			1,051	3,254			1,051	3,254			569	1,599
	Grand Total	117	211	934	3,043					1,051	3,254			1,051	3,254			1,051	3,254			569	1,599
SECOR																							
	<u>Measured</u>																						
	0-20	10	19							10	19			10	19			10	19			10	15
	20-40	86	155							86	155			86	155			86	155				
	40-100	20	36							20	36			20	36			20	36				
	>100																						
	Total	116	210							116	210			116	210			116	210			10	15
	<u>Indicated</u>																						
	0-20	11	21							11	21			11	21			11	21				
	20-40																						
	40-100																						
	>100																						
	Total	11	21							11	21			11	21			11	21			10	15
	<u>Inferred</u>																						
	0-20																						
	20-40																						
	40-100																						
	>100																						
	Total																						
	Grand Total	127	231							127	231			127	231			127	231			10	15

ROWE										
<u>Measured</u>										
0-20	70	105	70	105	2	3	72	108	70	84
20-40										
40-100										
> 100										
<u>Total</u>	70	105	70	105			72	108	70	84
<u>Indicated</u>										
0-20										
20-40										
40-100										
> 100										
<u>Total</u>										
<u>Inferred</u>										
0-20										
20-40										
40-100										
> 100										
<u>Total</u>										
<u>Grand Total</u>	70	105	70	105	2	3	72	108	70	84
STIGLER										
<u>Measured</u>										
0-20	83	142	83	142	2	3	85	145	83	114
20-40	76	130	76	130			76	130		
40-100	48	81	48	81			48	81		
> 100										
<u>Total</u>	207	353	207	353			209	356	83	114
<u>Indicated</u>										
0-20	60	101	60	101			60	101	60	80
20-40	75	139	75	139			75	139		
40-100	109	186	109	186			109	186		
> 100										
<u>Total</u>	244	426	244	426			244	426	60	80
<u>Inferred</u>										
0-20	6	10	6	10			6	10	6	8
20-40	9	16	9	16			9	16		
40-100	20	35	20	35			20	35		
> 100										
<u>Total</u>	35	61	35	61			35	61	6	8
<u>Grand Total</u>	486	840	486	840	2	3	488	843	149	202
KEEFTON										
<u>Measured</u>										
0-20	162	263	162	263	1	2	163	265	162	210
20-40										
40-100										
> 100										
<u>Total</u>	162	263	162	263			163	265	162	210

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

Coal	Category of Reliability and Depth (ft)	Remaining Resources						Total Remaining Resources			Mined or Lost in Mining ¹			Original Resources			Reserves		
		0.8 - 1.2 ft		1.2 - 2.4 ft		2.4 - 3.5 ft		> 3.5 ft		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons										
T13N, R18E, MUSKOGEE COUNTY (continued)																			
<u>Indicated</u>																			
0-20																			
20-40																			
40-100																			
> 100																			
<u>Total</u>																			
<u>Inferred</u>																			
0-20																			
20-40																			
40-100																			
> 100																			
<u>Total</u>																			
Grand Total		162	263			162	263	1	2	163	265	162	210						
Combined Grand Totals		962	1,650	934	3,043	1,896	4,693	7	11	1,903	4,704	960	2,110						

T13N, R19E, MUSKOGEE COUNTY																			
<u>Measured</u>																			
0-20																			
20-40																			
40-100																			
> 100																			
<u>Total</u>																			
<u>Indicated</u>																			
0-20																			
20-40																			
40-100																			
> 100																			
<u>Total</u>																			
Grand Total		640	1,075			640	1,075	9	16	326	571	130	177						
Combined Grand Totals		1,302	2,725	1,878	6,086	3,736	9,768	16	27	2,229	5,272	1,090	1,394						
T13N, R19E, MUSKOGEE COUNTY																			
<u>Measured</u>																			
0-20																			
20-40																			
40-100																			
> 100																			
<u>Total</u>																			
<u>Inferred</u>																			
0-20																			
20-40																			
40-100																			
> 100																			
<u>Total</u>																			
Grand Total		142	234			142	234	9	16	142	234	53	71						
Combined Grand Totals		1,099	1,864	1,099	1,864	1,099	1,864	9	16	1,108	1,880	389	517						

STIGLER

KEEFTON												
<u>Measured</u>	0-20	33	47									38
	20-40	5	7									7
	40-100	3	8									8
	> 100											
	<u>Total</u>	41	62									
<u>Indicated</u>	0-20			33	47	1	2	34	49	33		
	20-40			5	7			5	7			
	40-100			3	8			3	8			
	> 100											
<u>Total</u>	41	62	41	62	42	64	42	64	33			38
<u>Inferred</u>	0-20											
	20-40											
	40-100											
	> 100											
	<u>Total</u>											
<u>Total</u>	41	62	41	62	42	64	42	64	33			38
Grand Total	41	62	41	62	42	64	42	64	33			38
Combined Grand Totals	1,140	1,926	1,140	1,926	1,150	1,944	1,150	1,944	422			555

T14N, R15E, MUSKOGEE COUNTY

TEBO												
<u>Measured</u>	0-20	131	189									151
	20-40	12	17									17
	40-100											
	> 100											
	<u>Total</u>	143	206									
<u>Indicated</u>	0-20	88	127									101
	20-40	77	111									
	40-100											
	> 100											
<u>Total</u>	165	238										101
<u>Inferred</u>	0-20											
	20-40											
	40-100											
	> 100											
	<u>Total</u>											
<u>Total</u>	165	238	165	238	165	238	165	238	88			101
Grand Total	308	444	308	444	315	452	315	452	219			252

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

Coal	Category of Reliability and Depth (ft)	Remaining Resources										Mined or Lost in Mining ¹			Original Resources			Reserves			
		0.8 - 1.2 ft		1.2 - 2.4 ft		2.4 - 3.5 ft		> 3.5 ft		Total Remaining Resources		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons		
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons										
T14N, R16E, MUSKOGEE COUNTY																					
	<u>Measured</u>	18	26					18	26					18	26	18	26	18	20		
	0-20																				
	20-40																				
	40-100																				
	> 100																				
	<i>Total</i>	18	26					18	26					18	26	18	26	18	20		
	<u>Indicated</u>																				
	0-20																				
	20-40																				
	40-100																				
	> 100																				
	<i>Total</i>																				
	<u>Inferred</u>																				
	0-20																				
	20-40																				
	40-100																				
	> 100																				
	<i>Total</i>																				
	Grand Total	18	26					18	26					18	26	18	26	18	20		

T14N, R17E, MUSKOGEE COUNTY																					
	<u>Measured</u>	118	196					118	196			2	2	120	198	118	156				
	0-20																				
	20-40																				
	40-100																				
	> 100																				
	<i>Total</i>	409	738					409	738					411	740	118	156				
	<u>Indicated</u>	30	51					30	51					30	51	30	41				
	0-20																				
	20-40																				
	40-100																				
	> 100																				
	<i>Total</i>	790	1,447					790	1,447					790	1,447	30	41				
	<u>Inferred</u>	4	5					4	5					4	5	4	4				
	0-20																				
	20-40																				
	40-100																				
	> 100																				
	<i>Total</i>	116	195					116	195					116	195	4	4				
	Grand Total	1,315	2,380					1,315	2,380			2	2	1,317	2,382	152	201				

PETERS CHAPEL

SECOR												
	87	154	2	5	89	159	3	5	92	164	89	127
<u>Measured</u>	136	230	9	19	145	249			145	249	2	3
0-20	196	368	51	124	247	492			247	492		
20-40			1	3	1	3			1	3		
40-100												
>100	419	752	63	151	482	903			485	908	91	130
Total												
<u>Indicated</u>	4	8			4	8			4	8		
0-20	12	21	3	7	15	28			15	28	1	1
20-40	168	303	65	164	233	467			233	467		
40-100			697	1,694	697	1,694			697	1,694		
>100	184	332	765	1,865	949	2,197			949	2,197	1	1
Total												
<u>Inferred</u>												
0-20												
20-40	50	89	405	948	50	89			50	89		
40-100					405	948			405	948		
>100												
Total	50	89	405	948	455	1,037			455	1,037		
Grand Total	653	1,173	1,233	2,964	1,886	4,137	3	5	1,889	4,142	92	131
ROWE												
<u>Measured</u>	8	12			8	12	8	11	16	23	6	7
0-20												
20-40												
40-100												
>100												
Total	8	12			8	12	8	11	16	23	6	7
<u>Indicated</u>												
0-20												
20-40												
40-100												
>100												
Total												
Grand Total	8	12			8	12	8	11	16	23	6	7

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

SECOR	<u>Measured</u>													
	0-20												1	
	20-40	16	29									16	29	
	40-100	8	14									8	14	
	> 100													
	Total	24	43									25	44	
	<u>Indicated</u>													
	0-20													
	20-40													
	40-100													
> 100														
Total														
Grand Total	24	43									1	25	44	
ROWE	<u>Measured</u>													
	0-20	118	170											
	20-40													
	40-100													
	> 100													
	Total	118	170									126	182	
	<u>Indicated</u>													
	0-20													
	20-40													
	40-100													
> 100														
Total														
Grand Total	118	170									8	12	126	
STIGLER	<u>Measured</u>													
	0-20	61	92											
	20-40	80	122											
	40-100	9	13											
	> 100													
	Total	150	227									152	230	
	<u>Indicated</u>													
	0-20													
	20-40													
	40-100													
> 100														
Total														
Grand Total	118	170									8	12	126	

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

Coal	Category of Reliability and Depth (ft)	Remaining Resources						Mined or Lost in Mining ¹			Original Resources			Reserves						
		0.8 - 1.2 ft		1.2 - 2.4 ft		2.4 - 3.5 ft		> 3.5 ft		Total Remaining Resources		Acres		Tons		Acres		Tons		
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	
T14N, R18E, MUSKOGEE COUNTY (continued)																				
STIGLER (continued)																				
	<u>Indicated</u>																			
	0-20	46	77					46	77					46	77			46	62	
	20-40	61	93					61	93					61	93			61	93	
	40-100	13	19					13	19					13	19			13	19	
	> 100																			
	<u>Total</u>	120	189					120	189					120	189			120	189	
	<u>Inferred</u>																			
	0-20																			
	20-40																			
	40-100																			
	> 100																			
	<u>Total</u>																			
	Grand Total	270	416					270	416					270	416	3	272	419	107	136
KEEFTON																				
	<u>Measured</u>																			
	0-20	9	13					9	13					9	13			9	11	
	20-40	19	28					19	28					19	28			19	28	
	40-100																			
	> 100																			
	<u>Total</u>	28	41					28	41					28	41			28	41	
	<u>Indicated</u>																			
	0-20																			
	20-40																			
	40-100																			
	> 100																			
	<u>Total</u>																			
	Grand Total	28	41					28	41					28	41			28	41	
Combined Grand Totals		545	821					545	821	14	20	559	841	308	368					

T15N, R16E, MUSKOGEE COUNTY

PETERS CHAPEL

<u>Measured</u>									
0-20	1	2	1	2	1	2	1	1	1
20-40	37	70	37	70	37	70	37	70	
40-100	61	110	61	110	61	110	61	110	
> 100									
<u>Total</u>	99	182	99	182	99	182	99	182	1
<u>Indicated</u>									
0-20									
20-40									
40-100									
> 100									
<u>Total</u>									
<u>Inferred</u>									
0-20									
20-40									
40-100									
> 100									
<u>Total</u>									
Grand Total	99	182	99	182	99	182	99	182	1

SECOR

<u>Measured</u>									
0-20									
20-40									
40-100	100	163	100	163	100	163	100	163	
> 100									
<u>Total</u>	100	163	100	163	100	163	100	163	
<u>Indicated</u>									
0-20									
20-40									
40-100	23	37	23	37	23	37	23	37	
> 100									
<u>Total</u>	23	37	23	37	23	37	23	37	
<u>Inferred</u>									
0-20									
20-40									
40-100									
> 100									
<u>Total</u>									
Grand Total	123	200	123	200	123	200	123	200	
Combined Grand Totals	222	382	222	382	222	382	222	382	1

1 Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

ROWE												
<u>Measured</u>	10	19	12	30	43	90	22	49	21	41	43	39
0-20	24	49	32	76	56	125	9	125	56	87	125	17
20-40	87	150			87	150		150			87	150
40-100												
> 100												
<u>Total</u>	121	218	44	106	186	365	31	324	165	186	365	56
<u>Indicated</u>												
0-20												
20-40	32	50	14	32	46	82		82	46	46	82	
40-100												
> 100												
<u>Total</u>	32	50	14	32	46	82		82	46	46	82	
<u>Inferred</u>												
0-20												
20-40												
40-100												
> 100												
<u>Total</u>												
Total	153	268	58	138	232	447	31	406	211	232	447	56
Grand Total	5,924	10,701	2,090	5,082	8,906	17,512	1,295	15,783	8,014	8,906	17,512	2,031

T15N, R18E, MUSKOGEE COUNTY

ROWE												
<u>Measured</u>	51	88	18	41	77	143	69	129	8	14	77	104
0-20	95	169	20	46	115	215	115	215	59	59	115	8
20-40	49	81	10	23	441	945	18	104	18	18	441	40
40-100					134	314		40			134	
> 100												
<u>Total</u>	195	338	56	150	261	488	269	488	261	269	488	112
<u>Indicated</u>												
0-20	97	188	14	31	97	188	97	188	114	97	188	151
20-40	100	197		31	114	228	13	228	441	114	228	21
40-100	290	589	151	356	441	945	134	314	134	441	945	
> 100												
<u>Total</u>	487	974	299	701	786	1,675	786	1,675	786	786	1,675	172
<u>Inferred</u>												
0-20	37	71		50	37	71	37	71	47	37	71	57
20-40	25	50	22	50	47	100	7	100	152	47	100	12
40-100	53	107	99	231	152	338	212	497	212	152	338	
> 100												
<u>Total</u>	115	228	333	778	448	1,006	448	1,006	448	448	1,006	69
Total	797	1,540	698	1,629	1,495	3,169	8	3,169	1,495	1,503	3,183	353

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

Coal	Category of Reliability and Depth (ft)	Remaining Resources						Mined or Lost in Mining ¹			Original Resources			Reserves				
		0.8 - 1.2 ft		1.2 - 2.4 ft		2.4 - 3.5 ft		> 3.5 ft		Total Remaining Resources			Acres			Tons		
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	
T15N, R18E, MUSKOGEE COUNTY (continued)																		
SPANIARD	<u>Measured</u>																	
	0-20	42	75					42	75	1	1	43	76	42	60			
	20-40	31	56					31	56			31	56					
	40-100	8	15					8	15			8	15					
	> 100																	
	<u>Total</u>	81	146					81	146			82	147	42	60			
	<u>Indicated</u>																	
	0-20																	
	20-40																	
	40-100																	
> 100																		
<u>Total</u>																		
<u>Inferred</u>																		
0-20																		
20-40																		
40-100																		
> 100																		
<u>Total</u>																		
<u>Grand Total</u>	81	146					81	146	1	1	82	147	42	60				
<u>Combined Grand Totals</u>	878	1,686	698	1,629			1,576	3,315	9	15	1,585	3,330	270	413				
T16N, R15E, MUSKOGEE COUNTY																		
CROWEBURG	<u>Measured</u>																	
	0-20																	
	20-40																	
	40-100																	
	> 100																	
	<u>Total</u>																	
	<u>Indicated</u>																	
	0-20																	
	20-40																	
	40-100																	
> 100																		
<u>Total</u>																		
<u>Inferred</u>																		
0-20																		
20-40																		
40-100																		
> 100																		
<u>Total</u>																		
<u>Grand Total</u>	42	121	42	121			42	121	42	121	42	121	12	17	12	17		

¹ Coal mined or lost in mining is not categorized by depth, thickness, or category of reliability. Data have been placed arbitrarily on the line for measured resources, 0-20 ft depth.

APPENDIX 2: Measured Sections and Core-Hole Logs

Measured Section 1

NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T. 10 N., R. 19 E., Muskogee County. Measured in highwall of active strip mine operated by Carbonex Coal Co., by LeRoy A. Hemish. Field notebook designation MM-75-82-H. (Estimated elevation at top of section, 571 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Shale, light orange brown, clayey, weathered	11.0
Shale, dark gray; contains dark gray ironstone concretions with brown exterior bands about 1–2 in. thick; unit is uniform in appearance throughout the interval	20.0
Coal, black, minor white calcite on cleat surfaces, very hard; includes a thin strip of pyritic coal at top of seam and thin pyritic nodules randomly distributed throughout (Stigler coal)	1.9
Underclay, medium gray, slickensided, shaly; contains abundant black carbonized plant fragments; includes finely disseminated pyrite (total thickness not known)	<u>1.0</u>
Total	33.9

Measured Section 2

SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ and NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 4, T. 10 N., R. 19 E., Muskogee County. Measured on southeast-facing slope of Hensley Mountain southwest from old strip mine, by LeRoy A. Hemish. Field notebook designation MM-99-82-H. (Estimated elevation at top of section, 960 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, yellowish brown, fine-grained, massive, noncalcareous; fills channels in underlying sediment; weathers to large blocks littering slope of mountain (Blue-jacket Sandstone)	20.0
Savanna Formation:	
Shale, dark grayish brown, silty; weathers to small flakes on the outcrop; interlaminated with siltstone in lower part of unit; contains some brown clay ironstone stringers just above contact with underlying unit	165.0
Shale, very dark gray to black, fissile, brittle; contains dark gray phosphatic nodules; includes several layers of dark purplish brown to reddish brown ironstone concretions as much as 2 in. thick, some of which contain fossil brachiopods and pelecypods	35.0
Limestone, very dark gray, weathers red and dark pink, shaly, crumbly; very fossiliferous, with brachiopods predominant and crinoids abundant (Doneley Limestone)	0.7
Coal, black (Rowe coal)	1.0
Underclay, light gray with red mottling	3.0
Shale, olive gray with orange mottling; contains some reddish brown clay ironstone stringers	10.0
Limestone, dark gray, shaly, carbonaceous, fossiliferous	0.5
Shale, dark gray, calcareous, soft	0.1
Coal, black, soft, weathered (unnamed coal)	0.2
Underclay, yellowish gray	0.5
Shale, olive gray and rusty brown; silty in lower part of exposure; base covered	<u>3.0</u>
Total	239.0

Measured Section 3

N $\frac{1}{2}$ N $\frac{1}{2}$ SE $\frac{1}{2}$ NE $\frac{1}{4}$ sec. 9, T. 10 N., R. 19 E., Muskogee County. Measured on slope of Hi Early Mountain southeast across valley from Tater Hill, by LeRoy A. Hemish. Field notebook designation MM-76-82-H. (Estimated elevation at top of section, 970 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, yellowish brown, fine-grained, massive, cross-bedded, weathers to huge blocks littering slopes below bluffs (Bluejacket Sandstone)	56.0
Savanna Formation:	
Shale, gray brown, silty, flaky	120.0
Shale, very dark gray to black, fissile; contains small, rounded phosphatic nodules; includes several layers of reddish brown clay ironstone concretions 1–3 in. thick	46.0
Limestone, very dark gray, impure, carbonaceous, fossiliferous	0.7
Coal, black, weathered (Rowe coal)	1.0
Shale, olive gray; contains thin stringers of reddish brown clay ironstone	12.0
Coal, black, soft, weathered (unnamed coal)	0.2
Underclay, light gray with orange mottling	0.8
Sandstone, greenish gray, very fine grained, thin-bedded, shaly, ripple-marked in part; bioturbated; includes abundant fossil tracks, trails, and burrows on stratification surfaces; noncalcareous; forms resistant ledge along valley side	4.0

Appendix 2: Measured Sections and Core-Hole Logs

Shale, greenish gray, very silty; includes some 1-in.-thick reddish brown clay ironstone concretions (base covered)	<u>12.0</u>
Total	252.7

Measured Section 4

SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ and SW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 22, T. 10 N., R. 19 E., Muskogee County. Measured in gully adjacent to creek south of blacktop road and in creek bank downstream, by LeRoy A. Hemish. Field notebook designation MM-98-82-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Shale, grayish brown, contains abundant stringers of brown and orange clay ironstone	10.0
Limestone, grayish brown, silty, sandy, impure; very fossiliferous, with brachiopods and crinoids abundant; flaggy (Sam Creek Limestone)	0.7
Shale, grayish brown, soft	0.6
Shale, black with yellowish gray and orange bands, very carbonaceous, coaly in part	0.9
Coal, black with reddish brown iron oxide deposits on cleat surfaces (Sam Creek coal)	0.2
Underclay, dark gray with orange mottling, shaly; contains stringers of coal and carbonaceous shale	1.7
Shale, dark gray with brown staining, silty, fissile; contains rounded ironstone concretions (to water level in creek)	5.0
Covered interval	19.0
Limestone, brown, impure, silty, very fossiliferous, thickness variable (Spaniard Limestone)	0.4
McAlester Formation:	
Coal, black, soft, weathered (Spaniard coal)	0.1
Underclay, gray; contains black carbonized plant fragments	<u>0.4</u>
Total	39.0

Measured Section 5

NW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 22, T. 10 N., R. 19 E., Muskogee County. Measured in creek bank, by LeRoy A. Hemish. Field notebook designation MM-2-84-H. (Estimated elevation at top of section, 554 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, greenish gray with light brown staining, very fine grained, noncalcareous, micaceous, thin-bedded and wavy-bedded, bioturbated; shaly in lower 6 in. with abundant dark reddish brown iron oxide staining (Keota Sandstone)	6.0
Shale, medium gray with grayish orange streaks	0.7
Coal, black, bright, soft, weathered (Keota coal)	0.1
Shale, medium dark gray with dark reddish brown staining, very silty, hard (base covered)	<u>0.2</u>
Total	7.0

Measured Section 6

NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 35, T. 10 N., R. 19 E., Muskogee County. Measured in small gully below abandoned strip mines, by LeRoy A. Hemish. Field notebook designation MM-79-82-H. (Estimated elevation at top of section, 530 ft.)

	<i>Thickness (ft)</i>
Spoils from abandoned strip pit	2.0
KREBS GROUP	
McAlester Formation:	
Coal, black, hard, finely cleated (Stigler coal)	1.3
Underclay, light gray with orange mottling	0.9
Shale, grayish brown, purplish black staining on cleat surfaces, fissile, micaceous (to stream bed)	<u>12.0</u>
Total	16.2

Measured Section 7

E $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 11, T. 11 N., R. 19 E., Muskogee County. Measured in road ditch on south slope of steep hill, by LeRoy A. Hemish. Field notebook designation MM-74-82-H. (Estimated elevation at top of section, 600 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, yellowish brown with orange staining, very fine grained, thin-bedded, micaceous, noncalcareous (upper Warner Sandstone)	7.0

Shale, light grayish brown with orange and dark brown streaks, silty, flaky; contains thin stringers of clay ironstone	9.0
Coal, black, soft, weathered (Keefton coal)	0.6
Underclay, light gray, weathers pinkish gray; contains black, carbonized plant fragments	3.0
Siltstone, orange brown with dark pink and black mottling, shaly	3.4
Sandstone, light yellowish brown to reddish brown, fine-grained, noncalcareous, medium-bedded, well-indurated, cross-bedded, ripple-marked; contains ferruginous concretions (lower Warner Sandstone)	<u>30.0</u>
Total	53.0

Measured Section 8

NE¼NW¼NW¼SE¼ sec. 27, T. 11 N., R. 19 E., Muskogee County. Measured in cutbank of South Fork Creek, by LeRoy A. Hemish. Field notebook designation MM-80-82-H. (Estimated elevation at top of section, 550 ft.)

	<i>Thickness (ft)</i>
Silt, brown, clayey, gravelly (alluvium)	3.0
KREBS GROUP	
Savanna Formation:	
Ironstone, black with reddish brown rind, very hard	0.1
Shale, black, platy, brittle	1.7
Limestone, very dark gray, purplish brown and well-indurated in upper 1 in.; shaly in lower part; very fossiliferous, with brachiopod species predominant (Spaniard Limestone)	0.4
McAlester Formation:	
Coal, black with reddish brown iron oxide staining on cleats (Spaniard coal)	0.1
Underclay, medium gray; contains carbonized plant fragments	0.5
Shale, greenish gray with reddish brown and orange mottling; silty, flaky, ferruginous in part	1.0
Sandstone, greenish gray, weathers light brown to rusty brown; very fine grained, thin-bedded; contains small ferruginous concretions (Keota Sandstone)	<u>5.2</u>
Total	12.0

Measured Section 9

NW¼NW¼NW¼NW¼ sec. 33, T. 11 N., R. 19 E., Muskogee County. Measured in road cut east side of gravel road, by LeRoy A. Hemish. Field notebook designation MM-81-82-H. (Estimated elevation at top of section, 640 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Shale, olive gray, weathers orange brown, flaky	5.0
Ironstone, reddish brown and orange, weathers to angular fragments on the outcrop	0.1
Shale, black, hard, brittle; contains small, black phosphatic nodules	0.9
Shale, dark olive gray; contains abundant stringers of small orange brown clay ironstone concretions	2.3
Hartshorne Formation:	
Coal, black, soft, weathered (Hartshorne coal)	0.1
Underclay, light gray with orange streaks	1.0
Shale, medium brown, blocky	0.7
Shale, olive brown, silty, hard; contains a few small, brown clay ironstone concretions (well-exposed on west side of road; base covered)	<u>10.0</u>
Total	20.1

Measured Section 10

NE¼SW¼SW¼NW¼ sec. 4, T. 11 N., R. 20 E., Muskogee County. Measured at bend in tributary stream of South Fork Creek, by LeRoy A. Hemish. Field notebook designation MM-95-82-H. (Estimated elevation at top of section, 490 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, light grayish brown, weathers rusty brown, very fine grained, noncalcareous, micaceous; occurs as weathered, resistant remnants at top of knoll (upper Warner Sandstone)	1.0
Sandstone, light gray with orange mottling, very fine grained, thin-bedded, noncalcareous, micaceous (upper Warner Sandstone)	3.0
Siltstone, dark grayish, brown, very thin bedded, shaly, micaceous; includes black, carbonaceous grains; grades into underlying unit	2.0
Shale, very dark grayish brown, silty; includes some dark gray, well-indurated siltstone layers ~1 in. thick	10.0

Appendix 2: Measured Sections and Core-Hole Logs

Coal, black; impure and shaly in upper 1 in.; also somewhat impure in lower 0.5 in. (Keefton coal)	0.9
Sandstone, dark gray, fine-grained, massive, noncalcareous; surface of bed exposed in stream bed; total thickness unknown (lower Warner Sandstone)	<u>0.1</u>
Total	17.0

Measured Section 11

NW¼SE¼SE¼NW¼ sec. 4, T. 11 N., R. 20 E., Muskogee County. Measured in bank of small stream adjacent to old abandoned strip pits, by LeRoy A. Hemish. Field notebook designation MM-94-82-H. (Estimated elevation at top of section, 482 ft.)

	<i>Thickness (ft)</i>
Spoils from old, abandoned strip pits	4.0
Gravel, dark brownish gray with reddish brown streaks; composed of small angular to subrounded clasts of shale, sandstone, and coal	1.0
KREBS GROUP	
McAlester Formation:	
Coal, black, very hard, finely cleated (Keefton coal)	0.8
Shale, black, carbonaceous	0.1
Underclay, light gray with orange streaks (base covered by water in stream bed)	<u>0.1</u>
Total	6.0

Measured Section 12

NE¼SE¼SE¼NE¼ sec. 10, T. 11 N., R. 20 E., Muskogee County. Measured in low road cut west side of gravel road ~100 yd south from Sulfur Creek, by LeRoy A. Hemish. Field notebook designation MM-93-82-H. (Estimated elevation at top of section, 514 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Shale, orange brown, silty, weathered; contains brown, clay ironstone concretions ~1.5 in. thick and 3 in. in diameter	2.0
Hartshorne Formation:	
Coal, black, weathered and soft; thickness varies along outcrop according to degree of weathering (Hartshorne coal)	0.5
Underclay, light yellowish gray with orange streaks; contains thin clay ironstone stringers	2.0
Sandstone, olive gray with orange and reddish brown mottling, very fine grained, thin-bedded, noncalcareous; includes abundant fossil plant impressions and some casts of <i>Stigmara</i> (base of unit covered)	<u>1.5</u>
Total	6.0

Measured Section 13

SW¼NW¼NE¼NE¼ sec. 20, T. 11 N., R. 20 E., Muskogee County. Measured in stream bank adjacent to small, abandoned strip mine, by LeRoy A. Hemish. Field notebook designation MM-97-82-H. (Estimated elevation at top of section, 525 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, grayish brown to orange brown, very fine grained, thin-bedded, shaly, noncalcareous, micaceous; sandstone float on grassy knoll above outcrop indicates unit is at least 6 ft thicker than measured (upper Warner Sandstone)	2.0
Shale, olive brown, weathered; contains small discoidal dark brown clay ironstone concretions	5.5
Shale, black with red iron oxide deposits on stratification surfaces, very carbonaceous, fissile	0.7
Coal, black with orange and red iron oxide deposits on cleat surfaces; soft, weathered (Keefton coal)	0.8
Underclay, dark gray, carbonaceous	0.9
Shale, very dark gray with orange streaks, carbonaceous, fissile; contains abundant black, carbonized plant compressions; includes discoidal pyritic nodules as much as 7 in. in diameter that contain well-preserved seed fern leaves (base covered)	<u>1.5</u>
Total	11.4

Measured Section 14

NE¼SE¼NE¼NE¼ sec. 5, T. 12 N., R. 19 E., Muskogee County. Measured in ditch west side of U.S. Highway 64 near base of escarpment, by LeRoy A. Hemish. Field notebook designation MM-70-82-H. (Estimated elevation at top of section, 520 ft.)

	<i>Thickness (ft)</i>
Silt, brown, clayey, gravelly (colluvium)	5.0

KREBS GROUP

McAlester Formation:	
Shale, brown to brownish gray, silty	2.0
Sandstone, light brown, very fine grained, thin-bedded, cross-laminated, noncalcareous, micaceous, shaly in part	0.4
Shale, brownish gray, silty and sandy in part, fissile; contains thin, brown clay ironstone concretions	3.6
Hartshorne Formation:	
Coal, black, soft, weathered; intricately interlaminated with light gray carbonaceous sandstone containing fragmentary leaf compressions (Hartshorne coal)	0.2
Underclay, light gray with reddish brown mottling; contains abundant black, carbonized plant compressions	0.7
Sandstone, olive brown, very fine grained, irregular-bedded, micaceous; contains fossil plant fragments	2.1
Shale, light grayish brown with dark brown mottling, blocky, silty; base covered	1.2
Total	15.2

Measured Section 15

NE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 6, T. 12 N., R. 19 E., Muskogee County. Measured in highwall of active strip mine operated by MYLU Coal Co., Inc., by LeRoy A. Hemish. Field notebook designation MM-4-84-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, orange brown, clayey, very weathered, soft and friable, dark grayish brown and silty in upper 6 in.	2.0
Sandstone, yellowish brown to orange brown, thin- to medium-bedded, very fine grained; wavyly interlaminated with shaly siltstone in part, micaceous; contains comminuted plant fragments on stratification surfaces	10.0
Sandstone, medium gray with light gray laminae, very fine grained, silty, shaly, micaceous, wavy-bedded; includes abundant black comminuted plant material on stratification surfaces; grades into underlying unit	3.0
Shale, medium gray; includes abundant laminae of very fine grained, light gray sandstone and siltstone, micaceous; includes abundant black comminuted plant material on stratification surfaces	2.0
Coal, black, finely cleated, very friable; includes abundant reddish orange iron oxide deposits on cleat surfaces; surface of the coal bed is very irregular, with folds having axes extending east-west across the pit and closure of 3-4 ft. The folds appear to be compressional and are aligned parallel to the Ouachita Mountains overthrust belt (Keefton coal)	0.8
Underclay, medium light gray, carbonaceous in upper part	1.2
Total	19.0

Measured Section 16

SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 6, T. 12 N., R. 19 E., Muskogee County. Measured in highwall of strip pit operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-69-82-H. (Estimated elevation at top of section, 594 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, yellowish brown, fine-grained, well-indurated, grains rounded; thin- to medium-bedded with some thick, cross-bedded, channel-filling lenses, noncalcareous; weathered in upper 5 ft	16.0
Sandstone, light yellow brown, very fine grained, very thin bedded, noncalcareous, shaly, micaceous	0.7
Shale, medium gray, weathers yellowish gray with reddish brown and orange streaks, silty; contains thin stringers of hard, ferruginous siltstone; includes abundant black, carbonized plant fragments on stratification surfaces	2.0
Shale, black, soft, highly carbonaceous	0.5
Coal, black with reddish brown iron oxide coating on cleat surfaces (Keefton coal)	0.8
Underclay, very dark gray to dark gray, carbonaceous in upper part	1.0
Total	21.0

Measured Section 17

E $\frac{1}{2}$ W $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 19, T. 12 N., R. 19 E., Muskogee County. Measured from top of mountain down ravine to north section line fence above stock pond, by LeRoy A. Hemish. Field notebook designation MM-77-82-H. (Estimated elevation at top of section, 830 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, yellowish brown to reddish brown, fine-grained, massive, cross-bedded, noncalcareous; basal contact sharp and disconformable (Bluejacket Sandstone)	20.0

Appendix 2: Measured Sections and Core-Hole Logs

Savanna Formation:

Sandstone and siltstone, brownish gray, very thin bedded, shaly, noncalcareous, fissile; weathers to angular fragments on the outcrop slope	9.0
Shale, grayish brown, silty, flaky	98.0
Shale, black, brittle, fissile; contains several layers of dark purplish brown ironstone concretions 1-3 in. thick, mostly in upper part of unit	49.0
Limestone, dark gray, impure, shaly, carbonaceous in part; very fossiliferous, with crinoids and brachiopods abundant; feels hackly, weathers brownish gray with pinkish tones (Doneley Limestone)	0.8
Clay, orange brown, highly calcareous, ferruginous; contains fossil fragments	0.1
Coal, black with iron oxide deposits on cleat surfaces, soft, weathered (Rowe coal)	1.0
Underclay, light gray with maroon mottling	2.2
Shale, light gray with orange mottling, weathered	1.9
Covered interval	5.0
Sandstone, greenish gray, noncalcareous, very fine grained, impure, shaly; weathers to small flakes on the outcrop	2.0
Shale, olive gray; includes abundant brown and orange clay ironstone concretions that weather into angular flakes on the outcrop (base covered)	4.0
Total	193.0

Measured Section 18

NE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 19, T. 12 N., R. 19 E., Muskogee County. Measured in side of small gully on the northeast side of Rattlesnake Mountain, by LeRoy A. Hemish. Field notebook designation MM-78-82-H. (Estimated elevation at top of section, 655 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Shale, black, brittle, fissile (total thickness unknown; upper contact covered by alluvium) .	10.0
Limestone, dark gray, weathers brownish gray, impure, shaly, very fossiliferous (Doneley Limestone)	0.7
Coal, black, soft, weathered (Rowe coal)	0.9
Underclay, light gray with orange mottling, plastic (base covered)	1.4
Total	13.0

Measured Section 19

SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, T. 12 N., R. 20 E., Muskogee County. Measured in small gully at horseshoe bend in tributary of South Fork Creek, by LeRoy A. Hemish. Field notebook designation MM-96-82-H. (Estimated elevation at top of section, 474 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Shale, dark grayish brown, silty, platy; weathered in upper 3 ft; contains discoidal, brown clay ironstone concretions ~1 in. thick and 1-4 in. in diameter	5.0
Shale, dark gray to black, very carbonaceous; coaly in lower part	0.3
Coal, black with reddish brown iron oxide deposits on cleat surfaces, soft, weathered (Keefon coal)	0.8
Underclay, light gray with brownish tint; contains crosscutting streaks of coal as much as 1 in. thick	1.4
Sandstone, dark gray with reddish brown mottling, very fine grained, thin-bedded, non-calcareous, ripple-marked; contains rounded ferruginous concretions at contact with overlying unit; includes abundant burrows and trails (base of unit covered) (lower Warner Sandstone)	3.0
Total	10.5

Measured Section 20

SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 35, T. 12 N., R. 20 E., Muskogee County. Measured in bank of creek ~100 yd northwest from steel bridge over Dirty Creek, by LeRoy A. Hemish. Field notebook designation MM-92-82-H. (Estimated elevation at top of section, 485 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Shale, very dark gray with reddish brown staining, black in lower few feet; fissile, brittle, silty; includes medium brown and dark brown ironstone concretions ~2 in. thick and 6 in. in diameter	20.0
Hartshorne Formation:	
Coal, black, finely cleated (Hartshorne coal)	0.8
Underclay, light gray with yellow and orange streaks, blocky, very silty and sandy, hard; contains abundant black carbonized plant compressions as well as fossil plant impressions; grades into underlying unit	2.0
Sandstone, dark olive gray with dark reddish brown and orange mottling, fine-grained, irregularly thin bedded, micaceous, bioturbated; surface weathers rough and knobby; contains <i>Stigmara</i> and other plant fossils (Hartshorne sandstone)	1.1

Sandstone, dark grayish brown, very fine grained, thin-bedded, shaly, noncalcareous, ripple-marked (to water level in creek)	<u>1.5</u>
Total	25.4

Measured Section 21

SW¼NW¼SE¼NE¼ sec. 12, T. 13 N., R. 15 E., Muskogee County. Measured in cutbank of Cloud Creek, by LeRoy A. Hemish. Field notebook designation MM-14-82-H. (Estimated elevation at top of section, 630 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Shale, black, stained reddish brown on joint surfaces, brittle, fissile, jointed	5.5
Shale, medium gray with reddish brown iron oxide staining, weathers yellowish gray	2.4
Coal, black with reddish brown and yellow staining on cleat surfaces (Tebo coal)	0.8
Underclay, light yellowish gray to whitish gray, plastic	3.0
Limestone, dark gray, weathers reddish orange, finely crystalline, impure, silty, nodular; fossiliferous, brachiopods abundant; also occurs locally as irregular, lumpy masses scattered about in overlying unit	<u>0.1</u>
Total	11.8

Measured Section 22

NW¼SW¼NW¼ sec. 14, T. 13 N., R. 15 E., Muskogee County. Measured in northwest fork of Cloud Creek from the bridge north of oil storage tanks downstream to Muskogee fault, by LeRoy A. Hemish. Field notebook designation MM-16-82-H. (Estimated elevation at top of section, 660 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Shale, black, brittle, fissile, very carbonaceous; includes black phosphatic nodules	5.0
Ironstone, black, weathers brown, dense, hard	0.1
Shale, very dark gray to black (to water to creek)	<u>2.9</u>
Total	8.0

NOTE: Adjacent to the exposure, a covered area separates the very dark gray shale from a brownish gray, light yellowish brown weathering silty shale which crops out at approximately the same elevation; downstream the yellowish brown weathering shale becomes very silty and sandy, and grades into sandstone. This unit appears to be upthrown in relation to the very dark gray shale, indicating that the Muskogee fault can be extended into the area, and that the Tebo coal is faulted out on the upthrown side.

Measured Section 23

SE¼SW¼SE¼NW¼ sec. 7, T. 13 N., R. 16 E., Muskogee County. Measured in highwall of unreclaimed strip pit, by LeRoy A. Hemish. Field notebook designation MM-11-82-H. (Estimated elevation at top of section, 648 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Shale, orange brown with light gray mottling, weathered; contains fragments of orange, weathered clay ironstone	7.0
Shale, dark orange brown to grayish brown with purplish black staining on stratification surfaces	3.0
Shale, very dark gray to black, brittle, fissile; includes phosphatic nodules	3.0
Limestone, dark brown, impure, silty, thin-bedded; fossiliferous, small brachiopods most abundant (Tiawah Limestone)	0.2
Shale, black, brittle, fissile	1.4
Ironstone, reddish brown, very calcareous; occurs as concentrically banded, large nodules embedded in black shale	0.2
Shale, black, brittle, fissile; includes gypsiferous stringers	2.2
Covered by water in strip pit	<u>11.8</u>
Total	28.8

NOTE: Coal company records indicate 12 in. of coal (Tebo coal) at base of interval.

Measured Section 24

SE¼SW¼NE¼SW¼ sec. 18, T. 13 N., R. 17 E., Muskogee County. Measured in cutbank of Anderson Creek adjacent to small, abandoned strip pit, by LeRoy A. Hemish. Field notebook designation MM-52-82-H. (Estimated elevation at top of section, 612 ft.)

	<i>Thickness (ft)</i>
Disturbed ground (spoils from adjacent strip pit)	11.0
KREBS GROUP	
Boggy Formation:	

Appendix 2: Measured Sections and Core-Hole Logs

Shale, black with yellow and reddish brown staining, fissile; very carbonaceous	0.5
Coal, black with reddish brown and yellow iron oxide staining on cleat surfaces (Wainwright coal)	1.1
Underclay, olive gray and brown; contains abundant, well-preserved carbonized plant compressions	0.5
Sandstone, light brown, very fine grained, very thin bedded, micaceous, noncalcareous, ripple-marked; contains ironstone concretions 1 in. in diameter; contains <i>Stigmaria</i> ≤5 ft in length as well as other plant fossils (total thickness not observed)	<u>3.0</u>
Total	16.1

Measured Section 25

NE¼NE¼NW¼SE¼ sec. 31, T. 13 N., R. 17 E., Muskogee County. Measured in cutbank of Wayside Creek, by LeRoy A. Hemish. Field notebook designation MM-58-82-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
Silt, light brown, sandy (alluvium associated with Wayside Creek).....	4.5
Clay, buff with orange mottling, silty, gravelly; includes ferruginous masses of weathered clay ironstone	1.5
KREBS GROUP	
Boggy Formation:	
Shale, light grayish brown, fissile; contains discoidal clay ironstone concretions ~0.5-in. thick and 3 in. in diameter; includes abundant black, carbonized fossil plant fragments on stratification surfaces	2.0
Shale, black, carbonaceous, weathers dark grayish brown	0.8
Shale, black, very carbonaceous; coaly in part	0.2
Coal, black, reddish brown staining on cleat surfaces (Wainwright coal)	0.5
Shale, black, very carbonaceous	0.1
Coal, black, reddish brown iron oxide and yellow pyrite on cleat surfaces (Wainwright coal)	0.7
Underclay, dark gray with reddish brown staining, hard; includes black carbonized plant fragments	0.4
Sandstone, gray, weathers grayish brown, very fine grained, massive; surface is irregular and knobby; contains ironstone concretions	1.0
Siltstone, grayish brown, stained reddish brown in part by iron oxides; shaly, fissile; contains reddish brown clay ironstone concretions about hen's egg size	1.5
Sandstone, light gray to reddish brown, fine- to very fine grained, thin-bedded, noncalcareous, micaceous, ripple-marked, cross-laminated, jointed	2.6
Siltstone, medium gray with light reddish brown staining; micaceous, fissile; contains black, carbonized flecks of comminuted materials; grades into underlying unit	2.2
Shale, dark grayish brown, very silty, micaceous, fissile; contains black flecks of carbonaceous material (base covered)	<u>3.0</u>
Total	21.0

Measured Section 26

SE¼SE¼SW¼SE¼ sec. 2, T. 13 N., R. 18 E., Muskogee County. Measured in stream bank ~25 yd east from concrete bridge on Highway 64, by LeRoy A. Hemish. Field notebook designation MM-100-82-H. (Estimated elevation at top of section, 543 ft.)

	<i>Thickness (ft)</i>
Silt, dark brown, clayey, contains scattered clasts of gravel (alluvial soil)	1.0
KREBS GROUP	
Savanna Formation:	
Shale, olive gray with dark brown and orange mottling	3.0
Limestone, dark grayish brown, weathers yellowish brown, silty, massive, impure; very fossiliferous, contains abundant brachiopods, crinoids, and horn corals (Spaniard Limestone)	2.1
McAlester Formation:	
Shale, olive gray with reddish brown, orange, and dark gray bands, clayey	1.3
Coal, black, soft, weathered (Spaniard coal)	0.3
Underclay, light yellowish gray with orange mottling, plastic	1.7
Sandstone, dark greenish brown with reddish brown mottling, fine-grained, irregularly thin bedded, noncalcareous, ferruginous in part; contains burrows and trails (Keota Sandstone)	1.0
Shale, dark grayish brown with orange mottling, sandy, fissile (base covered by water in creek)	<u>1.2</u>
Total	11.6

Measured Section 27

NW¼NW¼NE¼NE¼ sec. 6, T. 13 N., R. 18 E., Muskogee County. Measured in road ditch south side of gravel road in hill slope west of Butler Creek, by LeRoy A. Hemish. Field notebook designation MM-50-82-H. (Estimated elevation at top of section, 595 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, light brown with olive brown tones, fine-grained, micaceous, weakly calcareous; forms resistant cap on hill	0.4

Covered interval	8.0
Sandstone, light grayish brown, very fine grained, thin-bedded, noncalcareous, bioturbated; includes black, carbonized plant material; ferruginous in part	3.1
Siltstone, light gray, weathers light grayish brown, very thin bedded; includes black, carbonized plant fragments	0.5
Shale, very dark gray to brownish black, fissile, jointed, carbonaceous in part	5.0
Shale, black, very carbonaceous, fissile	1.4
Shale, purplish brown with yellow spots, clayey	0.3
Coal, black, soft, weathered (Secor coal)	0.6
Underclay, light gray with orange mottling; contains black, carbonized plant fragments	0.8
Shale, very dark grayish brown, silty (base covered)	<u>0.9</u>
Total	21.0

Measured Section 28

NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 7, T. 13 N., R. 18 E., Muskogee County. Measured in road cut at NE corner of sec. 7, T. 13 N., R. 18 E., and south along bank of Butler Creek to just below stock pond by LeRoy A. Hemish. Field notebook designation MM-6-85-H. (Surface elevation, estimated from topographic map, 565 ft.)

	<i>Thickness (ft)</i>
Conglomerate, brownish orange, weathers reddish brown, ferruginous; composed mostly of flat, subrounded clasts of sandstone and ironstone, imbricated; well indurated	0.6
Gravel and clay, yellowish orange with black and reddish brown mottling; contains abundant subrounded light yellowish brown clay ironstone concretions that are extensively fractured	1.1
KREBS GROUP	
Boggy Formation:	
Underclay, medium light gray with reddish brown mottling, slickensided; grades into underlying unit	2.0
Shale, medium dark gray, soft, contains irregular-shaped reddish brown ironstone concretions ~4 in. thick, 6 in. wide, and 12 in. long	1.3
Shale, black, brittle, contains black phosphatic nodules stained brown on stratification surfaces	5.5
Limestone, dark gray, weathers brownish gray, impure, silty, fossiliferous, crinoids abundant, hard; forms ledge along creek bank (Inola Limestone)	1.0
Shale, medium gray	1.7
Shale, black, platy, very carbonaceous	0.6
Coal, black, moderately friable (Bluejacket coal)	0.2
Underclay, medium light gray with orange mottling (to water in creek)	<u>1.2</u>
Total	15.2

Measured Section 29

SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 8, T. 13 N., R. 18 E., Muskogee County. Measured in bank of south-flowing creek directly southeast from stockpond, by LeRoy A. Hemish. Field notebook designation MM-64-82-H. (Estimated elevation at top of section, 575 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, black, weathers very dark gray and brown; contains spheroidal and oblate dark brown and purplish brown ironstone concretions	5.0
Limestone, very dark gray, weathers dark grayish brown, very thin bedded, impure, sandy, very fossiliferous; breaks into large, angular slabs (Inola Limestone)	0.6
Coal, black, soft, interlaminated with black, carbonaceous shale (Bluejacket coal)	0.1
Underclay, medium gray with orange streaks	0.8
Shale, medium gray with orange mottling	1.5
Sandstone, olive gray to reddish brown, very fine grained, shaly, irregularly thin bedded, noncalcareous; weathers to a lumpy-textured surface (to stream bed)	<u>4.0</u>
Total	12.0

Measured Section 30

SE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9, T. 13 N., R. 18 E., Muskogee County. Measured in eroded bluff at curve in stream directly north of ranch shed, by LeRoy A. Hemish. Field notebook designation MM-65-82-H. (Estimated elevation at top of section, 600 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, reddish brown, fine-grained, thin-bedded in part, noncalcareous, ferruginous; contains fossil plant impressions	6.5
Siltstone, reddish brown, shaly, very thin bedded	1.5
Shale, medium gray, silty	9.0
Coal, black, soft, weathered (Secor coal)	0.7
Underclay, light yellowish brown	0.5
Shale, dark gray, weathers grayish brown; contains thin, reddish brown stringers of clay ironstone (to water in creek)	<u>8.8</u>
Total	27.0

Appendix 2: Measured Sections and Core-Hole Logs

Measured Section 31

NW¼SE¼SE¼NE¼ sec. 13, T. 13 N., R. 18 E., Muskogee County. Measured along Spaniard Creek, by LeRoy A. Hemish. Field notebook designation MM-67-82-H. (Estimated elevation at top of section, 510 ft.)

	Thickness (ft)
KREBS GROUP	
Savanna Formation:	
Shale, gray with orange brown mottling	1.7
Shale, black, fissile; contains small, rounded phosphatic nodules	0.4
Shale, dark gray, weathers reddish brown, very calcareous; contains fossil hash	0.2
Limestone, dark gray with red weathered rind, fossiliferous (Spaniard Limestone)	0.2
McAlester Formation:	
Shale, light gray, very calcareous, very fossiliferous with brachiopods most abundant	0.3
Coal, black, weathered (Spaniard coal)	0.3
Underclay, light gray with orange streaks	0.9
Shale, gray, weathers grayish brown, silty; contains small, brown ironstone concretions	12.0
Siltstone, olive gray with reddish brown and orange mottling, irregularly very thin bedded, noncalcareous, shaly in part	8.0
Sandstone, gray, weathers brownish gray, very fine grained, thin-bedded, ripple-marked, noncalcareous; interbedded with siltstone in lower part of unit	10.5
Shale, dark gray with purplish brown staining, very silty, fissile (base covered)	6.5
Total	41.0

Measured Section 32

E½E½NE¼SE¼ sec. 13, T. 13 N., R. 18 E., Muskogee County. Measured in pasture directly west of gravel road from bluff above Spaniard Creek south to top of hill, by LeRoy A. Hemish. Field notebook designation MM-71-82-H. (Estimated elevation at top of section, 512 ft.)

	Thickness (ft)
KREBS GROUP	
McAlester Formation:	
Shale, medium dark gray, silty, weathers moderate yellowish brown, noncalcareous; contains scattered moderate brown discoidal ironstone concretions as much as 8 in. thick ...	5.5
Ironstone, moderate brown, dense, weakly calcareous in part; contains abundant well-preserved brachiopods; occurs as discontinuous lenses in a layer of medium dark gray, calcareous, fossiliferous shale	0.3
Shale, medium dark gray, calcareous, very fossiliferous, brachiopods abundant; grades downward into shaly limestone	0.5
Limestone, dusky yellowish brown and shaly in upper 3 in.; grayish brown to moderate brown with purplish tones in lower 9 in.; very fossiliferous, brachiopods, abundant; ferruginous, silty and very weathered in lower 2 in.	1.0
Coal, black with reddish brown staining, friable, weathered (Tamaha coal)	0.1
Underclay, medium light gray, weathers grayish orange, noncalcareous; contains rare carbonaceous streaks and some sandstone-replaced <i>Stigmara</i> ~8 in. long; grades into underlying shale unit	1.0
Shale, medium light gray and pale yellowish brown, finely jointed, noncalcareous; becomes silty downward	1.4
Siltstone, medium light gray to light greenish gray, thin-bedded, shaly in part; noncalcareous, but includes some sandy calcareous lenses; trace fossils common; includes some very fine grained sandstone in places; contains rare, large ironstone concretions ~4 in. thick and 18 in. in diameter (Tamaha Sandstone)	3.7
Shale, medium gray, weathers purplish brown, brittle, fissile; contains discontinuous layers of weakly calcareous dark brown ironstone concretions as much as 4 in. thick	38.0
Shale, purplish brown with yellow streaks, carbonaceous	0.5
Coal, black with reddish brown iron oxide coating on cleat surfaces (Stigler coal)	1.1
Underclay, light gray with orange streaks	1.2
Sandstone, light yellowish brown, very fine grained noncalcareous; weathers to gravelly rubble on the outcrop (Cameron Sandstone)	4.2
Shale, brownish gray, flaky, poorly exposed	50.0
Covered interval	78.0
Sandstone, yellowish brown to orange gray, very fine grained, thin-bedded, noncalcareous, micaceous, silty, shaly	2.0
Sandstone, reddish brown, fine-grained, thick-bedded, noncalcareous, well-indurated, ferruginous; contains limonite-cemented, contorted concretions (Warner Sandstone)	33.0
Total	221.5

NOTE: Beds in the area dip N. 16° W. at 14°.

Measured Section 33

NW¼NW¼NW¼SW¼ sec. 13, T. 13 N., R. 18 E., Muskogee County. Measured in ditch east side of gravel road from base of slope to top of hill, by LeRoy A. Hemish. Field notebook designation MM-102-82-H. (Estimated elevation at top of section, 550 ft.)

	Thickness (ft)
KREBS GROUP	
McAlester Formation:	

Sandstone, reddish brown, very fine grained, thin-bedded, noncalcareous, micaceous; contains ferruginous boxwork concretions (upper Warner Sandstone)	4.0
Shale, light yellowish gray with orange bands, very weathered, silty in part	3.5
Shale, purplish brown, contains stringers of coal	0.6
Coal, black, soft, very weathered (Keefton coal)	0.7
Underclay, light gray to purplish gray with orange streaks, soft	1.2
Shale, medium grayish brown with orange streaks, weathered	3.0
Sandstone, reddish brown, fine-grained, thick-bedded, noncalcareous; contains ferruginous concretions and cavities from weathered-out concretions; poorly exposed (lower Warner Sandstone)	<u>12.0</u>
Total	25.0

NOTE: Section is poorly exposed and must be uncovered by excavating washed-in material from road ditch. The coal crops out 65 yd north from driveway to brick house east side of road. Beds dip N. 25° E. at 16°.

Measured Section 34

NE¼NE¼SW¼NW¼ sec. 14, T. 13 N., R. 18 E., Muskogee County. Measured in stream bank west side of old abandoned strip mine, by LeRoy A. Hemish. Field notebook designation MM-101-82-H. (Estimated elevation at top of section, 560 ft.)

	<i>Thickness (ft)</i>
Silt, orange brown, dark brown at surface, clayey, gravelly (alluvium)	6.0
KREBS GROUP	
McAlester Formation:	
Shale, grayish brown with orange mottling, very weathered	0.2
Coal, black with orange iron oxide deposits on cleat surfaces (Stigler coal)	0.9
Underclay, light gray with orange and dark gray streaks; includes coalified roots and thin lenses of carbonaceous shale	1.3
Shale, dark olive brown, silty; contains discoidal brown clay ironstone concretions ~0.5 in. thick and 4 in. in diameter (base covered)	<u>4.0</u>
Total	12.4

Measured Section 35

NW¼NW¼NW¼ sec. 20, T. 13 N., R. 18 E., Muskogee County. Measured in escarpment, gullies, and adjacent to old, small coal pit, by LeRoy A. Hemish. Field notebook designation MM-104-82-H. (Estimated elevation at top of section, 735 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Sandstone, yellowish brown, fine-grained, massive, cross-bedded; forms a 10- to 15-ft-high bluff at base of unit near top of escarpment (Bluejacket Sandstone)	40.0
Covered interval, slope littered with massive blocks of sandstone	65.0
Shale, dark gray to black, weathers grayish brown, fissile; includes layers of brown ironstone concretions	30.0
Limestone, dark gray, weathers rusty grayish brown; very fossiliferous, coquinoïdal (Doneley Limestone)	0.2
Coal, black with reddish brown iron oxide deposits on cleat surfaces (Rowe coal)	0.6
Underclay, light yellowish gray with orange mottling	0.2
Covered interval	2.0
Sandstone, greenish gray, very fine grained, very thin bedded, noncalcareous, shaly; weathers to small, thin, yellowish green flakes on the outcrop	0.5
Shale, olive gray, includes discoidal concretions and thin stringers of brown clay ironstone	10.0
Limestone, pinkish brown, impure, silty; very fossiliferous, brachiopods abundant, feels hackly (Sam Creek Limestone)	0.5
Shale, yellowish gray with orange spots, clayey (to covered area)	<u>3.0</u>
Total	152.0

Measured Section 36

NE¼NW¼SW¼NW¼ sec. 20, T. 13 N., R. 18 E., Muskogee County. Measured in ravine from gravel road eastward down slope, by LeRoy A. Hemish. Field notebook designation MM-105-82-H. (Estimated elevation at top of section, 580 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Shale, grayish brown, fissile, weathers to small flakes on the outcrop	8.0
Limestone, brownish gray to grayish purple, weathers grayish orange pink; very dark red and ferruginous in lower 1 in.; impure, silty; very fossiliferous, brachiopods abundant (Spaniard Limestone Member)	1.3
McAlester Formation:	
Shale, yellowish gray with orange mottling, calcareous, weathered	1.0
Covered interval	1.7

Appendix 2: Measured Sections and Core-Hole Logs

Sandstone, greenish gray to grayish brown, very fine grained, thin- to medium-bedded, hard, noncalcareous, ripple-marked in part; contains abundant burrows and trails (top of Keota Sandstone Member)	4.0
Shale, moderate yellowish brown with orange streaks, weathered, poorly exposed	11.0
Limestone, dark gray, impure, carbonaceous, very fossiliferous	0.5
Coal, black, soft, weathered (Keota coal)	0.3
Underclay, light brownish gray	0.2
Shale, grayish brown, silty (base covered)	<u>12.0</u>
Total	40.0

Measured Section 37

SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 13 N., R. 18 E., Muskogee County. Measured in road cut north side of gravel road from top of low hill westward to bridge, by LeRoy A. Hemish. Field notebook designation MM-73-82-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, yellowish brown, weathers reddish brown, fine-grained, noncalcareous, cross-bedded, flaggy (upper Warner Sandstone)	7.0
Shale, light gray, weathers grayish orange pink; contains thin stringers of clay ironstone ..	3.4
Coal, black with purplish brown staining on cleat surfaces, soft, weathered; includes a $\frac{1}{16}$ -in.-thick sandstone stringer 5 in. from base of bed (Keefton coal)	0.8
Sandstone, light grayish brown and orange, with dark purplish brown and black bands, very fine grained; interbedded with coal and carbonaceous shale stringers	0.2
Underclay, light gray with orange mottling, carbonaceous in upper part; contains abundant purplish brown and black carbonized plant fragments; grades into underlying unit	1.3
Siltstone, grayish brown to orange brown, very shaly, soft, weathered (base covered)	0.5
Covered to bridge level	<u>2.8</u>
Total	16.0

Measured Section 38

SW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 13 N., R. 18 E., Muskogee County. Measured in cutbank of south-westward-flowing intermittent stream and above on valley slope, by LeRoy A. Hemish. Field notebook designation MM-63-82-H. (Estimated elevation at top of section, 600 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, reddish brown to reddish orange, fine-grained, cross-bedded, noncalcareous, massive, ferruginous; occurs as large weathered slabs at top of outcrop and as float on slopes (upper Warner Sandstone)	8.0
Sandstone, light yellowish brown, very fine grained, shaly, very thin bedded, micaceous; includes black, carbonized, macerated plant fragments on stratification surfaces; grades downward into siltstone	2.0
Siltstone, light yellowish brown with orange bands, very thin bedded, noncalcareous; includes black, carbonized plant fragments on stratification surfaces	0.5
Shale, light brownish gray to purplish brown at base of unit, silty, noncalcareous; contains abundant well-preserved fossil plant fragments such as seed fern leaves	2.0
Shale, black, highly carbonaceous; contains very thin stringers of bright coal	0.4
Coal, black, impure, shaly, soft (Keefton coal)	0.6
Underclay, light brownish gray (total thickness not determined)	<u>0.5</u>
Total	14.0

NOTE: From 100 to 300 yd upstream, the dry creek bed is littered with excellent specimens of *Stigmaria* ~3 in. in diameter and 1 ft in length.

Measured Section 39

NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 13 N., R. 18 E., Muskogee County. Measured in low bluff along intermittent stream, by LeRoy A. Hemish. Field notebook designation MM-66-82-H. (Estimated elevation at top of section, 552 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, light orange brown, very fine grained, thin-bedded to very thin bedded, cross-laminated, micaceous, noncalcareous, silty and shaly in lower 2 ft (upper Warner Sandstone)	4.0
Siltstone, light yellowish brown, noncalcareous, laminated	0.4
Shale, light yellowish brown with orange bands, silty; contains small, discoidal ironstone concretions ~0.75 in. thick	0.7
Shale, dark purplish brown, very carbonaceous, contains thin stringers of coal	0.3
Coal, black with purplish brown staining on cleat surfaces, weathered (Keefton coal)	0.7
Underclay, medium gray; contains black, carbonized plant remains	0.3

Sandstone, light brownish gray, very fine grained, micaceous, massive; includes abundant black, comminuted plant material; thins laterally along the outcrop to <0.5 in. and locally fills channel cut into underlying strata	0.4
Shale, medium gray, weathers grayish brown with orange streaks; contains small limonitic nodules and discontinuous stringers of well-indurated siltstone	6.5
Sandstone, reddish brown, fine-grained, noncalcareous (lower Warner Sandstone)	<u>0.7</u>
Total	14.0

Measured Section 40

NW¼NW¼NW¼SE¼ sec. 35, T. 13 N., R. 18 E., Muskogee County. Measured in bank of creek adjacent to small abandoned coal pit and directly east of Rock Grove Cemetery, by LeRoy A. Hemish. Field notebook designation MM-72-82-H. (Estimated elevation at top of section, 540 ft.)

	<i>Thickness (ft)</i>
Silt, brown, sandy (soil)	1.5
Sand, grayish brown to reddish brown, fine-grained, unbedded, contains some gravel (alluvium)	2.0
Gravel, reddish brown, contains cobble-size angular clasts of sandstone (alluvium)	1.5
KREBS GROUP	
McAlester Formation:	
Coal, black with reddish brown iron oxide deposits on cleat surfaces (Keefton coal)	0.7
Underclay, light yellowish gray streaked with orange, becomes light gray in lower 6 in.; contains carbonized plant fragments	<u>1.3</u>
Total	7.0

NOTE: At top of ridge, above the floodplain of the creek, a reddish brown to yellowish brown, fine-grained, medium-bedded, noncalcareous sandstone crops out. This sandstone (upper Warner) overlies the coal bed by only a few feet.

Measured Section 41

SW¼NE¼NW¼NW¼ sec. 3, T. 13 N., R. 19 E., Muskogee County. Measured in cutbank of overflow channel at southeast corner of stockpond dam, by LeRoy A. Hemish. Field notebook designation MM-1-85-H. (Estimated elevation at top of section, 648 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Shale, grayish orange with light brown and dark reddish brown mottling, silty, interbedded with stringers of siltstone and very fine grained sandstone, micaceous, noncalcareous, highly weathered	4.0
Coal, black, soft, weathered (Keefton coal)	0.7
Underclay, grayish orange pink, soft; contains black coalified plant material	<u>1.4</u>
Total	6.1

Measured Section 42

SW¼SW¼NW¼ sec. 4, T. 13 N., R. 19 E., Muskogee County. Measured in road cut, east side of gravel road from top of hill to covered area, by LeRoy A. Hemish. Field notebook designation MM-86-82-H. (Estimated elevation at top of section, 600 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, reddish brown, fine-grained, thin- to medium-bedded, noncalcareous, ferruginous, well-indurated; contains small ferruginous concretions (upper Warner Sandstone)	3.0
Sandstone, light yellowish gray with red and black mottling, very fine grained, very thin bedded, noncalcareous, micaceous, silty, shaly	5.5
Shale, grayish brown with reddish brown and black staining, silty; contains very thin stringers of orange brown clay ironstone	3.2
Shale, purplish brown, carbonaceous, flaky	0.7
Coal, black, reddish brown iron oxide staining on cleat surfaces (Keefton coal)	0.8
Underclay, purplish brown with orange streaks; contains black carbonized plant fragments	0.9
Shale, yellowish brown with reddish brown streaks, silty; contains sandy, ferruginous concretions ~3 in. in diameter	0.2
Sandstone, gray with reddish brown staining; mostly very fine grained, but fine-grained in lower part; mostly thin bedded, but massive in lower part, noncalcareous; cross-bedded near base of unit; includes ferruginous concretions (lower Warner Sandstone) (base covered)	<u>9.7</u>
Total	24.0

Appendix 2: Measured Sections and Core-Hole Logs

Measured Section 43

NW¼NE¼NW¼SW¼ sec. 4, T. 13 N., R. 19 E., Muskogee County. Measured in highwall of active strip pit operated by Black Mountain Energy, Inc., by LeRoy A. Hemish. Field notebook designation MM-1-84-H. (Estimated elevation at top of section, 582 ft.)

	<i>Thickness (ft)</i>
Sand, dark yellowish brown, silty; contains organic matter (soil)	1.6
KREBS GROUP	
McAlester Formation:	
Sandstone, dark yellowish orange with moderate reddish orange mottling, very fine grained; extensively broken and weathered; includes clay between broken pieces	1.2
Sandstone, moderate brown, very fine grained, massive, well-indurated, noncalcareous	0.6
Shale, very pale orange with light brown and brownish black mottling, extensively fractured and weathered	4.9
Sandstone, moderate brown, very fine grained, massive, well-indurated, noncalcareous	2.2
Shale, pale yellowish brown with dusky brown bands, silty, sandy, interbedded with very fine grained, yellowish gray sandstone	2.5
Shale, dark gray to medium gray, silty; includes black carbonized plant fragments on stratification surfaces	4.9
Shale, brownish black, very carbonaceous, soft, fissile, pyritic	0.8
Coal, black, bright, moderately friable (Keefton coal)	0.7
Underclay, medium dark gray, slickensides common	<u>0.9</u>
Total	20.3

Measured Section 44

SW¼NE¼SW¼SE¼ sec. 4, T. 13 N., R. 19 E., Muskogee County. Measured in stream bank adjacent to old, abandoned coal pit directly east from bridge on Muskogee Turnpike by LeRoy A. Hemish. Field notebook designation MM-88-82-H. (Estimated elevation at top of section, 554 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, brown, weathers reddish brown, fine-grained, thin-bedded, cross-bedded, noncalcareous, ferruginous, micaceous; fills channels in underlying sediment (upper Warner Sandstone)	5.0
Sandstone and siltstone, light yellowish gray, very thin bedded, noncalcareous, shaly; contains thin stringers of brown clay ironstone (thickness of unit variable)	7.0
Shale, medium gray, weathers grayish brown with reddish brown streaks, silty; includes thin stringers of brown clay ironstone	3.5
Shale, dark purplish black, very carbonaceous	0.4
Coal, black with reddish brown iron oxide staining on cleat surfaces (Keefton coal)	0.7
Underclay, light gray with orange streaks; includes abundant black carbonized plant fragments	1.1
Shale, medium gray, weathers yellowish gray with reddish brown streaks; contains irregularly rounded ironstone concretions about 1-2 in. in diameter	1.0
Sandstone, greenish gray with dark brown spots, fine-grained, thin-bedded, ripple-marked, micaceous, bioturbated; contains small ferruginous concretions; to water in creek (lower Warner Sandstone)	<u>2.0</u>
Total	20.7

Measured Section 45

SE¼SW¼SW¼SW¼ sec. 6, T. 13 N., R. 19 E., Muskogee County. Measured in road cut north side of gravel road, by LeRoy A. Hemish. Field notebook designation MM-7-83-H. (Estimated elevation at top of section, 588 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, greenish gray, weathers brown, very fine grained, thin-bedded, noncalcareous; contains ferruginous concretions; occurs as weathered remnants at base of covered unit; thickness greater than exposure indicates (Keota Sandstone)	1.0
Shale, grayish brown, olive gray where less weathered; contains thin strata of orange clay ironstone concretions	12.0
Ironstone, dark reddish brown and orange; sparsely fossiliferous; occurs as a concretionary bed	0.3
Shale, light grayish brown	1.5
Shale, dark gray and brown, carbonaceous, ferruginous	0.1
Coal, black with orange iron oxide deposits on cleat surfaces, banded, bituminous (Keota coal)	0.3
Underclay, light gray with orange banding	0.6
Shale, bluish gray with orange mottling, blocky fracture (base covered)	<u>4.2</u>
Total	20.0

Measured Section 46

SE¼SE¼NE¼SW¼ sec. 7, T. 13 N., R. 19 E., Muskogee County. Measured in cutbank of tributary of Spaniard Creek, by LeRoy A. Hemish. Field notebook designation MM-6-83-H. (Estimated elevation at top of section, 528 ft.)

	<i>Thickness (ft)</i>
Silt, brown, clayey, unbedded (soil).....	1.2
KREBS GROUP	
McAlester Formation:	
Shale, grayish brown with orange bands.....	1.4
Coal, brown with black and orange banding, impure; includes interbedded carbonaceous shale and clay shale (Spaniard coal)	0.2
Underclay, light grayish brown with orange streaks.....	1.8
Shale, grayish brown with orange and reddish brown streaks, silty, blocky fracture	0.4
Sandstone, greenish gray, weathers rusty brown and olive brown, very fine grained, non-calcareous, extensively ripple marked on surface of unit; contains <i>Stigmara</i> molds; hard, forms floor of creek; total thickness not exposed (Keota Sandstone).....	<u>1.0</u>
Total	6.0

Measured Section 47

SW¼NW¼SW¼SW¼ sec. 11, T. 13 N., R. 19 E., Muskogee County. Measured in bluffs west side of Webbers Falls Reservoir, by LeRoy A. Hemish. Field notebook designation MM-89-82-H. (Estimated elevation at top of section, 570 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Shale, yellowish brown, interbedded with thin layers of very fine grained sandstone.....	12.0
Sandstone, greenish gray to yellowish brown with reddish brown staining, fine-grained, thick-bedded in upper part to thin-bedded, silty and shaly in lower 4 ft, noncalcareous, cross-bedded in part (upper Warner Sandstone)	12.5
Shale, grayish-brown with orange mottling	0.9
Shale, purplish brown, carbonaceous	0.2
Coal, black with reddish brown iron oxide staining on cleat surfaces (Keefton coal)	0.8
Underclay, light gray; contains some black coalified plant material at contact with underlying unit	0.7
Sandstone, light gray, fine-grained, unbedded, shaly, weakly consolidated	0.7
Sandstone, greenish gray, fine-grained, thin- to medium-bedded, noncalcareous, cross-laminated in some sets; includes a 10-in.-thick bed containing assorted soft-sediment structures such as rolls and highly contorted strata; forms a sheer wall midway in bluffs; base covered by slumped material (lower Warner Sandstone).....	<u>15.0</u>
Total	42.8

Measured Section 48

NW¼NW¼NW¼NW¼ sec. 16, T. 13 N., R. 19 E., Muskogee County. Measured in road cut east side of gravel road from top of hill south to covered area, by LeRoy A. Hemish. Field notebook designation MM-103-82-H. (Estimated elevation at top of section, 530 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, dark brown, very fine grained, thin- to medium-bedded, very hard, noncalcareous; contains abundant burrows and trails (Keota Sandstone)	1.5
Shale, olive gray, weathers to small, orange brown flakes on the outcrop	8.5
Shale, dark gray with reddish brown staining, very silty, fissile; includes thin, discoidal, orange brown clay ironstone concretions as much as 10 in. in diameter in lower part of unit	5.0
Shale, light grayish brown with orange staining; includes ironstone concretions about 3-4 in. in diameter	0.5
Coal, black, soft, highly weathered (Keota coal)	0.2
Underclay, light gray with orange mottling (base covered).....	<u>1.3</u>
Total	17.0

Measured Section 49

SW¼SW¼NW¼NW¼ sec. 16, T. 13 N., R. 19 E., Muskogee County. Measured in road cut east side of gravel road ~½ mi north from bridge over Spaniard Creek, by LeRoy A. Hemish. Field notebook designation MM-90-82-H. (Estimated elevation at top of section, 520 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, greenish gray to dark brown, very fine grained, thin-bedded, noncalcareous, ripple-marked, bioturbated; trails and burrows abundant; weathers to small, blocky fragments on the outcrop	0.5
Shale, orange brown, silty; interbedded with thin hard layers of siltstone and very fine grained sandstone; includes a hard, 1-in.-thick bed of very fine grained sandstone containing abundant burrows and trails ~1 ft from base of unit	7.0

Appendix 2: Measured Sections and Core-Hole Logs

Shale, very dark gray, weathers rusty grayish brown, noncalcareous, brittle, flaky	6.5
Shale, very dark gray, very silty, weakly calcareous; contains abundant, well-preserved fossil brachiopods and pelecypods	0.2
Shale, greenish gray with dark reddish brown streaks, noncalcareous	0.4
Shale, black, silty, highly calcareous, carbonaceous; contains well-preserved fossil brachiopod and pelecypod valves	0.1
Coal and carbonaceous shale, black, soft, weathered; coal bed is ~0.5 in. thick (unnamed coal)	0.1
Underclay, light grayish brown with orange streaks	0.7
Shale, olive gray with orange streaks; contains abundant stringers of orange brown clay ironstone	1.3
Shale, medium gray, weathers dark brownish gray, very silty; contains hard stringers and nodules of very fine grained sandstone and siltstone (base covered)	<u>12.0</u>
Total	28.8

Measured Section 50

SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 13 N., R. 19 E., Muskogee County. Measured in bank of small tributary of Spaniard Creek ~100 yd southwest from old abandoned strip pit, by LeRoy A. Hemish. Field notebook designation MM-91-82-H. (Estimated elevation at top of section, 500 ft.)

	<i>Thickness (ft)</i>
Silt, dark brown, organic (alluvial soil)	2.0
Clay, light gray with orange streaks; contains angular fragments of shale and sandstone ...	1.0
KREBS GROUP	
McAlester Formation:	
Coal, black, weathered (Tamaha coal). This coalbed occurs stratigraphically a few feet above the Tamaha Sandstone	0.3
Underclay, light gray, plastic (to water level in stream)	<u>0.7</u>
Total	4.0

Measured Section 51

SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, T. 14 N., R. 15 E., Muskogee County. Measured in cutbank of Cane Creek, by LeRoy A. Hemish. Field notebook designation MM-13-82-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Shale, black, brittle, fissile	1.0
Limestone, very dark gray, weathers brown, dense, hard, jointed, impure, silty; highly fossiliferous, with fusulinids and brachiopods abundant; forms ledge around hill slope (Tiawah Limestone)	0.7
Shale, black, hard, fissile	13.0
Shale, light gray with yellowish orange streaks, stained by reddish brown iron oxides in lower part; clayey	2.5
Coal, black, stained red by iron oxides on cleat surfaces (Tebo coal)	0.7
Underclay, light olive gray with orange mottling, plastic	2.4
Shale, medium gray, weathers light gray, fissile; stained by reddish brown iron oxides	8.0
Shale, very dark gray, fissile; interbedded with dark brown discoidal ironstone concretions ~1 in. thick and as much as 2 ft in diameter that occur in layers from 2 in. to 1 ft apart (to water level)	<u>3.5</u>
Total	31.8

NOTE: At the base of the black shale unit underlying the Tiawah Limestone, a pod-like lens of dark gray to blackish purple, yellowish gray weathering limestone is present at one place along the outcrop. The pod is ~1 ft thick at its maximum in its center. From the center it tapers in both directions for ~7 ft on each side where it pinches out. The shale bedding is parallel to the wing-like extensions but butts up against the thick central part, which is ~4 ft in diameter. The pod is fractured and seems to be unbedded. Veinlets of shaly coal 0.25 in. thick and black, bright, finely cleated coal fill the fractures in places. This material, which is highly pyritic in spots, seems to partially surround the mass. Gypsum crystals are also present in profusion. The mass is underlain by light gray plastic underclay that has coaly veins extending downward into it for about one foot. The unit appears to be a fossilized tree stump in situ.

Measured Section 52

SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, T. 14 N., R. 15 E., Muskogee County. Measured in east-facing slope of small ravine overlooking Cane Creek, by LeRoy A. Hemish. Field notebook designation MM-5-82-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
Clay, orange red, sandy, oxidized; contains angular pebbles and cobbles of buff to reddish brown sandstone (soil zone)	1.5
CABANISS GROUP	
Senora Formation:	
Shale, black, brittle, weathers gray and orange	5.5
Coal, black, soft, weathered (Tebo coal)	0.8

Underclay, light gray with orange spots	1.5
Shale, olive gray; includes silty, orange clay ironstone stringers that weather to small flakes on the outcrop (base covered)	<u>8.2</u>
Total	17.5

Measured Section 53

SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, T. 14 N., R. 15 E., Muskogee County. Measured in bluff on south side of Cane Creek, by LeRoy A. Hemish. Field notebook designation MM-4-82-H. (Estimated elevation at top of section, 588 ft.)

	<i>Thickness (ft)</i>
Clay, light yellowish brown, sandy; contains angular pebbles and cobbles of yellowish gray to reddish brown sandstone (soil zone)	3.0
CABANISS GROUP	
Senora Formation:	
Coal, black, soft, weathered (Tebo coal)	0.8
Underclay, yellowish gray with orange streaks	1.5
Shale, grayish brown; includes scattered, 1- to 2-in.-thick, discoidal, brown sideritic concretions as much as 14 in. in diameter in lower 2 ft of unit; grades into underlying unit	14.0
Shale, very dark gray to purplish black, hard, brittle, fissile; contains stringers and lenses of reddish orange sideritic concretions 1-4 in. thick	6.0
Sandstone and coal, reddish black to purplish brown; thickness varies along outcrop from <1 ft to >4 ft where sandstone contains no coal. Maximum thickness of coal observed was 7 in. (RC coal); sandstone is intricately interbedded with coal and coalified plant fossils, and contains abundant large, well-preserved impressions of <i>Calamites</i> and <i>Stigmaria</i> ; some fossil specimens observed on bedding surfaces measured 3 x 2 ft; contact with underlying unit sharp and unconformable	2.0
Siltstone, bluish gray with yellow and orange streaks; very thin bedded; contains minor faults with inclusions of black, sandy, coaly material (to water in Cane Creek)	<u>4.5</u>
Total	31.8

Measured Section 54

NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 13, T. 14 N., R. 15 E., Muskogee County. Measured in slope at northwest edge of old, abandoned, shallow strip pit located just northeast of Lee Cemetery, by LeRoy A. Hemish. Field notebook designation MM-3-82-H. (Estimated elevation at top of section, 600 ft.)

	<i>Thickness (ft)</i>
Spoils from abandoned strip mine (consists predominantly of flakes of black shale with grayish brown shale and scattered black phosphatic nodules)	1.5
CABANISS GROUP	
Senora Formation:	
Shale, light gray with orange mottling; flakes of fissile, orange clay ironstone with lieegang rings litter the surface of knoll adjacent to outcrop	0.5
Coal, black, soft, weathered (Tebo coal)	0.6
Underclay, purplish gray and orange (base covered)	<u>1.4</u>
Total	4.0

Measured Section 55

SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 14, T. 14 N., R. 15 E., Muskogee County. Measured in recently excavated cut in road ditch directly southwest from bridge over Cane Creek, from driveway to abandoned farm site down slope to water level, by LeRoy A. Hemish. Field notebook designation MM-1-81-H. (Estimated elevation at top of section, 585 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Limestone, black, weathers medium brown, impure, silty, highly fossiliferous; shaly and flaky on upper surface—otherwise dense and massive; forms ledge around hill slope (top of Tiawah Limestone)	0.6
Shale, black; includes thin stringers of orange clay ironstone	3.2
Limestone, black with orange brown surface band, thin-bedded, brittle, sparsely fossiliferous	0.2
Shale, black, brittle, breaks into small flakes on outcrop	3.8
Limestone, black; occurs as flat, rounded masses with soft brown noncalcareous surface bands; jointed, sparsely fossiliferous	0.1
Shale, black, brittle, weathers reddish brown, jointed	4.5
Shale, medium gray, silty; streaked with orange iron oxides along fractures and on stratification surfaces, giving the outcrop a yellowish gray hue	1.8
Coal, black, stained reddish brown on cleat surfaces (Tebo coal)	0.6
Underclay, light gray to yellowish gray with light reddish brown streaks	2.0
Shale, light brownish gray with reddish brown mottling	1.1
Shale, medium gray, silty, fissile; extensively cut by vertical dikes that contain silty brownish gray shale as well as well-indurated nodules and irregular-shaped masses of black, partly ferruginous, calcareous, very fine grained sandstone (to water level)	<u>7.5</u>
Total	25.4

Appendix 2: Measured Sections and Core-Hole Logs

Measured Section 56

SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, T. 14 N., R. 16 E., Muskogee County. Measured in cutbank of stream adjacent to small, old, abandoned strip pit, by LeRoy A. Hemish. Field notebook designation MM-30-82-H. (Estimated elevation at top of section, 588 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, black, brittle, fissile, jointed; stained reddish brown by iron oxides on joint surfaces and bedding planes	4.0
Shale, black, highly carbonaceous, soft	0.1
Coal, black with reddish brown iron oxide staining on cleat surfaces (Wainwright coal)	0.5
Underclay, light gray	0.1
Sandstone, grayish brown, very fine grained; contains marine fossils, predominantly brachiopods, as well as black carbonized plant fragments; sandstone has lumpy, nodular appearance, is stained rusty brown in part, noncalcareous; in some places the coal rests directly on the irregular surface of the sandstone	0.3
Underclay, light gray with orange streaks, impure; contains high proportion of very fine grained sandstone and siltstone	<u>1.3</u>
Total	6.3

Measured Section 57

SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 30, T. 14 N., R. 16 E., Muskogee County. Measured in west highwall of abandoned shale pit, by LeRoy A. Hemish. Field notebook designation MM-10-82-H. (Estimated elevation at top of section, 655 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Sandstone, light gray, weathers light brown, very fine grained, noncalcareous, irregularly thin bedded; dikes of orange brown sandstone extend >10 ft downward from base of unit in carrot-shaped wedges into top of underlying shale unit; stratification in dikes is at right angles to stratification in shale	4.0
Shale, light gray in upper part to dark gray in lower part, weathers brownish gray, highly silty; includes large oblate concretions as much as 3 ft in diameter and 1 ft thick (to water level in old quarry)	<u>16.0</u>
Total	20.0

NOTE: Owner of property reported a total thickness of ~36 ft of shale was quarried at this location.

Measured Section 58

NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 3, T. 14 N., R. 17 E., Muskogee County. Measured in cutbank of Pecan Creek ~100 yd east from bridge, by LeRoy A. Hemish. Field notebook designation MM-44-82-H. (Estimated elevation at top of section, 555 ft.)

	<i>Thickness (ft)</i>
Clay, dark brownish gray, very silty, gravelly in part; composed largely of reworked, weathered shale flakes (alluvium associated with Pecan Creek)	5.5
KREBS GROUP	
Boggy Formation:	
Limestone, very dark gray to black, impure, carbonaceous, hard; highly fossiliferous, crinoid columns abundant; forms ledge in cutbank of creek (Inola Limestone)	0.8
Coal, black, very shaly; contains white stringers of gypsum (Bluejacket coal)	0.1
Underclay, dark gray to medium gray with orange mottling, gypsiferous (to stream bed)	<u>0.8</u>
Total	7.2

Measured Section 59

SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 8, T. 14 N., R. 17 E., Muskogee County. Measured in eroded hill slope east side of Pecan Creek and northeast from curve in road, by LeRoy A. Hemish. Field notebook designation MM-45-82-H. (Estimated elevation at top of section, 580 ft.)

	<i>Thickness (ft)</i>
Clay, brown, silty, gravelly (alluvium associated with Pecan Creek)	2.0
KREBS GROUP	
Boggy Formation:	
Shale, dark gray with orange spots, includes orange brown stringers of clay ironstone	1.2
Shale, black, brittle, weathers to small flakes on the outcrop	1.8
Shale, brownish gray with some orange weathered flakes on the outcrop	0.9
Ironstone, purplish brown with rusty brown surface band; contains sparsely distributed small brachiopod valves	0.2
Shale, gray, weathers light brownish gray	2.4
Ironstone, reddish brown and orange	0.1
Shale, gray, weathers light brownish gray	2.4
Shale, black, brittle, weathers to small flakes on the outcrop	0.9
Ironstone, dark reddish brown, very dense; includes sparsely distributed, poorly preserved marine fossils; conchoidal fractures on weathered surfaces	0.3

Shale, black, brittle; contains scattered oblate ironstone concretions as much as 10 in. in diameter and 3 in. thick (base covered by alluvium and pond water)	<u>8.0</u>
Total	20.2

NOTE: Wilson and Newell (1937, p. 173), at approximately the same location as this section, reported 1.0 ft of the Inola Limestone, 0.3 ft of gray shale, and 0.5 ft of coal (Bluejacket coal) exposed in the creek bed in the NE¼ sec. 17, T. 14 N., R. 17 E.

Measured Section 60

NW¼NE¼NE¼NE¼ sec. 12, T. 14 N., R. 17 E., Muskogee County. Measured in cutbank of stream near old, abandoned strip pits, by LeRoy A. Hemish. Field notebook designation MM-47-82-H. (Estimated elevation at top of section, 595 ft.)

	<i>Thickness (ft)</i>
Silt, dark grayish brown, clayey; contains ships of coal from adjacent spoil piles	2.8
Disturbed ground (spoils from adjacent strip mine), predominantly gray shale and coal chips	0.6
KREBS GROUP	
Savanna Formation:	
Coal, black with reddish brown iron oxide staining on cleat surfaces (Rowe coal)	0.8
Underclay, gray with orange mottling; includes black, carbonized plant fragments, slickensided (base covered)	<u>1.2</u>
Total	5.4

Measured Section 61

SW¼NW¼NE¼NE¼ sec. 16, T. 14 N., R. 17 E., Muskogee County. Measured in cutbank of stream, by LeRoy A. Hemish. Field notebook designation MM-59-82-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
Silt, dark grayish brown, sandy, gravelly (alluvium)	3.0
KREBS GROUP	
Boggy Formation:	
Coal, black moderately weathered (Secor coal)	0.8
Underclay, dark gray, weathers light gray with orange streaks; contains abundant black carbonized plant material; locally, at the top of the unit, lenses 1 ft wide and 3–6 in. thick of very fine grained sandstone containing carbonized roots directly underlie the coal bed	1.2
Shale, dark gray (base covered)	<u>1.0</u>
Total	6.0

Measured Section 62

NW¼SE¼NE¼NE¼ sec. 16, T. 14 N., R. 17 E., Muskogee County. Measured in dry creek bed in branch of Pecan Creek, by LeRoy A. Hemish. Field notebook designation MM-3-90-H. (Estimated elevation at top of section, 588 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, black, fissile, calcareous, fossiliferous, brachiopods abundant	1.1
Coal, black, moderately friable, well-exposed in bench across creek bed (Secor coal)	<u>0.8</u>
Total	1.9

Measured Section 63

NE¼NE¼SE¼SE¼ sec. 16, T. 14 N., R. 17 E., Muskogee County. Measured on eroded point of hill in pasture southeast from large pond, by LeRoy A. Hemish. Field notebook designation MM-2-90-H. (Estimated elevation at top of section, 686 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone and soil, grayish orange; sandstone is broken and weathered, very fine grained, friable, noncalcareous; conglomeratic in part, with abundant clay galls; irregular-bedded	2.0
Coal, black, smutty, very soft, weathered; true thickness probably greater (Secor coal)	0.4
Underclay, soft, grayish brown with purplish hue	0.6
Shale, clayey, light yellowish gray, noncalcareous, weathered	<u>5.5</u>
Total	8.5

Appendix 2: Measured Sections and Core-Hole Logs

Measured Section 64

NE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 17, T. 14 N., R. 17 E., Muskogee County. Measured in ditch just southeast of Texas and Pacific Railroad grade by LeRoy A. Hemish. Field notebook designation MM-1-90-H. (Estimated elevation at top of section, 588 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, grayish orange, very fine grained, medium to thin bedded, micaceous, noncalcareous, wavy-laminated in lower 2 ft	
(Crekola Sandstone)	4.5
Shale, yellowish brown, clayey, weathered	1.2
Coal, black, soft, weathered; includes a 2-in.-thick bright orange to brownish orange clay parting 1 in. from top of unit (Peters Chapel coal)	0.8
Underclay, light grayish orange to dark brown	0.4
Shale, light gray, clayey; includes numerous crumbly grayish orange clay ironstone layers about 0.25–0.5 in. thick	<u>2.5</u>
Total	9.4

Measured Section 65

NE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, T. 14 N., R. 18 E., Muskogee County. Measured in cutbank of Coody Creek directly northwest from railroad tracks, by LeRoy A. Hemish. Field notebook designation MM-55-82-H. (Estimated elevation at top of section, 540 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Siltstone, olive brown, very thin bedded, shaly, micaceous, noncalcareous, fissile	2.4
Sandstone, olive brown to orange brown, very fine grained, medium bedded, ripple-marked, bioturbated; noncalcareous in upper part of unit, grading downward through weakly calcareous, to highly calcareous in lower 6 in.; very fossiliferous in lower part, with brachiopods predominant, and well-preserved bryozoans common (Keota Sandstone)	2.0
Shale, very dark gray, weathers brownish gray; contains abundant orange brown calcareous clay ironstone concretions as much as 10 in. in diameter and 3 in. thick; shale and concretions are fossiliferous in lower 1 ft	5.0
Limestone, medium gray to very dark gray, includes a 2-in.-thick purplish brown layer at top of unit, black and highly carbonaceous in lower 2 in.; very fossiliferous, with well-preserved brachiopod valves abundant, coquinoïdal in part	0.8
Coal, black with light reddish brown staining on cleat surfaces (Keota coal)	0.4
Underclay, light gray (to water in creek)	<u>0.8</u>
Total	11.4

Measured Section 66

SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, T. 14 N., R. 18 E., Muskogee County. Measured in cut in southeast corner of excavated area south of farm pond, by LeRoy A. Hemish. Field notebook designation MM-43-82-H. (Estimated elevation at top of section, 560 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Shale, medium gray with bright reddish brown iron oxide staining	2.0
Shale, black, brittle, jointed; weathers to small flakes on the outcrop	3.0
Limestone, dark gray, weathers rusty brownish gray, impure, shaly, highly fossiliferous, coquinoïdal, feels hackly (Doneley Limestone)	0.4
Shale, black, highly carbonaceous, stained rusty orange at base of unit	0.8
Coal, black with reddish brown iron oxide coating on cleat surfaces (Rowe coal)	0.7
Underclay, light gray, slickensided; contains black, carbonized plant fragments	0.9
Shale, gray with orange staining; includes zone of discontinuous, rounded, ferruginous, purplish brown, oolitic limestone masses as much as 6 in. thick and 10 in. long; strata containing the oolitic limestone weathers light brown (base covered)	<u>4.2</u>
Total	12.0

Measured Section 67

SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 11, T. 14 N., R. 18 E., Muskogee County. Measured in recently bulldozed hillslope and adjacent to cement drainage structure, by LeRoy A. Hemish. Field notebook designation MM-85-82-H. (Estimated elevation at top of section, 570 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, light olive brown with dark brown mottling, very fine grained, thin-bedded, noncalcareous, micaceous, bioturbated; includes some poorly preserved marine fossils; weathers to small, blocky fragments on the outcrop (Keota Sandstone)	2.0

Shale, yellowish brown, silty; contains abundant dark brown discoidal clay ironstone concretion as much as 6 in. in diameter	2.0
Ironstone, dark brown and orange; contains abundant marine fossils; occurs as continuous zone of rounded concretions	0.1
Limestone, reddish brown, orange, and gray, very highly weathered and crumbly, shaly, ferruginous in part; marine fossils abundant	0.3
Coal, black, soft, weathered (Keota coal)	0.3
Underclay, orange and light gray	0.4
Shale, light gray; includes a thin, orange layer of clay ironstone at top of unit that weathers to flakes on the outcrop; other discontinuous layers of clay ironstone scattered throughout the interval	1.4
Sandstone, olive brown with reddish brown staining, very fine grained, irregularly thin bedded, noncalcareous, ferruginous in part	1.4
Limestone, dark grayish brown to reddish brown, impure, sandy, silty; very fossiliferous with several species of brachiopods abundant	0.4
Shale, medium gray, weathers orange gray, flaky; contains abundant stringers of orange clay ironstone	6.0
Coal, black, soft, highly weathered (Tamaha coal)	0.1
Underclay, light gray with orange streaks; contains black, coalified plant material	1.6
Shale, medium gray, silty; contains orange clay ironstone stringers	3.0
Sandstone, olive gray with reddish brown staining, very fine grained, very thin bedded, noncalcareous, silty, shaly (Tamaha Sandstone) (base covered)	<u>5.0</u>
Total	24.0

Measured Section 68

NW¼NW¼NW¼NW¼ sec. 12, T. 14 N., R. 18 E., Muskogee County. Measured in road cut south side of Peak Boulevard, by LeRoy A. Hemish. Field notebook designation MM-60-82-H. (Estimated elevation at top of section, 560 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, tan to light grayish brown, stained black and reddish brown in places, very fine grained, very thin bedded, cross-bedded, noncalcareous, micaceous, silty, shaly in part (upper Warner Sandstone)	10.5
Shale, medium gray	0.4
Coal, black, reddish brown iron oxide staining on cleat surfaces, hard, bright; includes a 0.5-in.-thick coaly shale parting ~1.5 in. from top of coal (Keefton coal)	0.8
Underclay, medium gray, contains carbonized plant material	1.2
Sandstone, gray with purplish brown mottling, weathers orange brown; very fine grained, thin-bedded, cross-laminated, micaceous; bedding contorted at contact with underlying unit from soft-sediment slumping (lower Warner Sandstone)	6.1
Siltstone, medium gray, noncalcareous, micaceous, laminated, fissile (base covered)	<u>8.0</u>
Total	27.0

Measured Section 69

SW¼SW¼SE¼NW¼ sec. 12, T. 14 N., R. 18 E., Muskogee County. Measured near head of small ravine, by LeRoy A. Hemish. Field notebook designation MM-84-82-H. (Estimated elevation at top of section, 572 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, orange tan, weathers rusty brown, fine-grained, medium-bedded, noncalcareous, well-indurated; contains small ferruginous concretions (upper Warner Sandstone)	5.0
Covered interval	3.0
Shale, light yellowish gray with orange streaks, dark orange in lower 10 in., weathered	1.5
Coal, black, purplish brown iron oxide staining on cleat surfaces, weathered (Keefton coal)	0.8
Underclay, light purplish gray with orange mottling; contains black, carbonized plant fragments	1.3
Shale, grayish brown with orange mottling, silty (base covered)	<u>0.5</u>
Total	12.1

Measured Section 70

NE¼NE¼SE¼SE¼ sec. 14, T. 14 N., R. 18 E., and SW¼SW¼NW¼SW¼ sec. 13, T. 14 N., R. 18 E., Muskogee County. Measured in road cut, in pasture west side of blacktop road, and in pasture east side of road from top of hill to bed of Sam Creek, by LeRoy A. Hemish. Field notebook designation MM-61-82-H. (Estimated elevation at top of section, 565 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	

Appendix 2: Measured Sections and Core-Hole Logs

Sandstone, brown to olive brown with dark brown staining, very fine grained, medium- to thin-bedded, ripple-marked; contains ironstone concretions 1-2 in. in diameter (upper Warner Sandstone).....	6.0
Shale, gray, weathers light gray and orange brown, contains discoidal clay ironstone concretions; mostly covered	8.0
Coal, black with reddish orange iron oxide deposits on cleat surfaces, soft, weathered; includes a 0.75-in.-thick carbonaceous shale parting 3 in. from top of unit (Keefton coal)	0.7
Underclay, light gray with orange mottling, includes black, carbonized plant fragments	1.0
Shale, medium gray with orange brown mottling; includes thin, orange siltstone stringers that weather to resistant flakes on the outcrop	2.0
Siltstone, tan, laminated, micaceous; includes thin lenses of very fine grained sandstone ...	4.0
Shale, black, brittle; includes 1- to 2-in.-thick irregular masses of reddish brown, fossiliferous limestone and ironstone (to creek bed)	<u>10.0</u>
Total	31.7

Measured Section 71

NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 18, T. 14 N., R. 18 E., Muskogee County. Measured in road cut west side of gravel road from top of high hill to northeast corner of section, by LeRoy A. Hemish. Field notebook designation MM-56-82-H. (Estimated elevation at top of section, 742 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, dark reddish brown to yellowish brown, fine- to medium-grained, cross-bedded, noncalcareous, ferruginous; includes iron oxide concretions and fossil plant molds	6.0
Shale, light yellowish brown, noncalcareous; interlaminated with siltstone and sandstone; contains black, carbonized plant fragments on stratification surfaces; overlying sandstone fills channels at top of unit	1.1
Coal, black, soft, highly weathered (Secor coal)	0.4
Underclay, light gray with orange staining; contains abundant carbonized plant fragments	3.0
Shale, yellowish brown, silty; includes thin stringers of well-indurated, ferruginous siltstone	0.5
Siltstone, buff, very thin bedded, noncalcareous, micaceous; grades downward to very fine grained sandstone	12.0
Sandstone, light yellowish brown, noncalcareous, micaceous; interbedded with siltstone and shale; the coarser-grained, well-indurated intervals form resistant benches at three places in road bed north from crest of hill (Bluejacket Sandstone)	<u>37.0</u>
Total	60.0

Measured Section 72

NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 19, T. 14 N., R. 18 E., Muskogee County. Measured in road cut east side of Highway 69, by LeRoy A. Hemish. Field notebook designation MM-48-82-H. (Estimated elevation at top of section, 630 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, reddish brown, ferruginous, very fine grained, thin-bedded, noncalcareous; contains small-scale ripple-drift cross-laminations; weathers to small- and medium-sized flakes on the outcrop; poorly exposed	8.0
Covered interval	5.5
Shale, very dark gray to black, brittle, fissile, carbonaceous	0.2
Coal, black with peacock coloration (Peters Chapel coal)	0.8
Underclay, medium gray with dark olive brown mottling; contains carbonized plant compressions	1.3
Shale, medium gray; contains irregular-shaped reddish brown nodules of clay ironstone about 1-2 in. in diameter that weather out and litter the outcrop (to bottom of ditch)	<u>3.2</u>
Total	19.0

Measured Section 73

NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 24, T. 14 N., R. 18 E., Muskogee County. Measured in cutbank of north-flowing, small stream north of stockpond, by LeRoy A. Hemish. Field notebook designation MM-62-82-H. (Estimated elevation at top of section, 560 ft.)

	<i>Thickness (ft)</i>
Silt, light brown (alluvial soil)	3.0
Clay, light yellowish gray with orange mottling, gravelly; includes clasts of sandstone, shale, and coal	1.5
KREBS GROUP	
McAlester Formation:	
Coal, black, soft, weathered (Stigler coal)	0.6
Underclay, light gray with light orange mottling, plastic	1.1

Shale, light gray and light orange brown; includes thin, indurated stringers of orange, shaly siltstone (base covered by gravel in stream bed)	0.5
Total	6.7

Measured Section 74

NW¼NW¼SW¼NW¼ sec. 26, T. 14 N., R. 18 E., Muskogee County. Measured northeastward along dry stream bed from bridge on Highway 64, by LeRoy A. Hemish. Field notebook designation MM-53-82-H. (Estimated elevation at top of section, 589 ft.)

	<i>Thickness (ft)</i>
Silt, yellowish gray, sandy, unconsolidated, unbedded	0.5
Clay, yellowish brown, silty, sandy; contains abundant, rounded, pea-size ironstone fragments	3.0
KREBS GROUP	
Savanna Formation:	
Shale, medium gray to dark gray with reddish brown staining, silty, fissile; weathers to small flakes on the outcrop	3.0
Ironstone, dark purplish black with brown surface band; contains sparsely distributed calcareous marine fossils	0.1
Shale, black, brittle, fissile, jointed	1.2
Shale, light grayish brown with orange and yellow streaks; includes black carbonaceous shale stringers; resembles underclay	0.9
Shale, very dark gray with reddish brown bands	0.9
Shale, black carbonaceous, hard, brittle	0.1
Covered interval (probably black shale, as above)	0.5
Shale, black, brittle, fissile, highly carbonaceous	0.5
Shale, medium gray and reddish brown, oxidized just above contact with underlying unit	0.8
Coal, black, bright, with some iron oxide staining on cleat surfaces (Rowe coal)	0.6
Underclay, light gray with orange staining; includes some black carbonized plant fragments	2.2
Siltstone, yellowish gray with orange staining, irregularly very thin bedded, shaly, micaceous; contains brown ovate clay ironstone concretions as much as 3 in. in diameter	3.5
Limestone, brown, dense, massive; highly fossiliferous, with brachiopods predominant (Sam Creek Limestone)	0.4
Total	18.2

Measured Section 75

SW¼SW¼SE¼SE¼ sec. 31, T. 14 N., R. 18 E., Muskogee County. Measured in bluffs along west side of Butler Creek adjacent to old, abandoned contour mine, by LeRoy A. Hemish. Field notebook designation MM-49-82-H. (Estimated elevation at top of section, 592 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, buff to reddish brown, fine-grained, thin-bedded, noncalcareous, micaceous	3.0
Covered interval	7.0
Shale, dark grayish brown with orange mottling, highly weathered	0.3
Coal, black, soft, highly weathered (Secor coal)	0.6
Underclay, light grayish brown, stained orange and reddish brown; contains carbonized plant fragments	0.9
Shale, very dark gray with purplish brown staining, silty; includes stringers of brown clay ironstone as well as hard, purplish brown concretions as much as 8 in. in diameter and 1 in. thick	14.0
Covered interval (to creek bed)	7.2
Total	33.0

Measured Section 76

E½SE¼NE¼ and E½NE¼NE¼SE¼ sec. 15, T. 14 N., R. 19 E., Muskogee County. Measured along west side of road from top of hill to near bottom of small valley, by LeRoy A. Hemish. Field notebook designation MM-87-82-H. (Estimated elevation at top of section, 670 ft.)

	<i>Thickness (ft)</i>
ATOKAN SERIES	
Atoka Formation:	
Sandstone, greenish gray to light brown, fine-grained, thin- to medium-bedded, noncalcareous, ripple-marked in part; includes a shaly, carbonaceous stringer near base of unit that contains some coalified plant material	50.0
Shale, brownish gray; includes abundant flat, clay ironstone concretions about 0.25–0.5 in. thick	3.8
Coal, black, soft, weathered (unnamed coal)	0.6
Underclay, light gray with orange streaks, plastic (base covered).	1.0
Total	55.4

NOTE: Other outcrops in the vicinity indicate that a thick, grayish brown, silty shale interval underlies the section described above.

Appendix 2: Measured Sections and Core-Hole Logs

Measured Section 77

NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27, T. 14 N., R. 19 E., Muskogee County. Measured in shale pit and road cut, by LeRoy A. Hemish. Field notebook designation MM-7-84-H. (Estimated elevation at top of section, 620 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
<i>McCurtain Shale Member:</i>	
Shale, dark gray with brown to purplish brown staining; silty, hard, brittle, noncalcareous; contains abundant shaly concretions as much as 6 in. thick and 2 ft in diameter	18.0
Shale, dark gray with weathered light gray and orange brown layers; hard and brittle where unweathered; soft and clayey where weathered; contains abundant purplish brown shaly, ferruginous concretions ~2 in. thick and 2-4 in. in diameter	2.0
Coal, black, soft, very highly weathered; some red iron oxide deposits on cleat surfaces (Brushy Mountain coal)	0.2
Underclay, yellowish brown with purple staining, silty, and sandy	0.2
Sandstone, light greenish gray with orange brown staining on fracture surfaces, very fine grained, well-indurated, bedding mostly obscured; contains black carbonized plant fragments and abundant well-preserved plant fossils including rootlets ~ $\frac{3}{8}$ in. in diameter; base of unit covered	<u>2.0</u>
Total	22.4

Measured Section 78

SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 31, T. 14 N., R. 19 E., Muskogee County. Measured in road cut east side of entrance to driveway and in driveway ditch of farmhouse on high hill north of gravel road, by LeRoy A. Hemish. Field notebook designation MM-57-82-H. (Estimated elevation at top of section, 610 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, olive brown to light brown, very fine grained, silty, micaceous, noncalcareous, ferruginous in part, cross-laminated	9.0
Shale, medium gray with reddish orange spots; weathers to crumbly pieces on the outcrop; includes some brownish gray fissile intervals of siltstone and highly silty shale	19.0
Coal, black with reddish orange mottling, soft, very highly weathered (Stigler coal)	0.7
Underclay, light gray with orange mottling	1.5
Shale, light gray to light yellowish brown, oxidized reddish brown in part, fissile, silty; includes large brown, discoidal, silty ironstone concretions (base covered)	<u>14.8</u>
Total	45.0

Measured Section 79

SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 4, T. 15 N., R. 15 E., Muskogee County. Measured in cutbank of stream on downthrown side of fault, by LeRoy A. Hemish. Field notebook designation MM-1-82-H. (Estimated elevation at top of section, 620 ft.)

	<i>Thickness (ft)</i>
Silt, brown, organic (topsoil)	1.0
Gravel, orange brown, clayey; contains abundant subangular to subrounded clasts of light yellowish brown very fine grained sandstone up to small cobble size; unit is highly oxidized	5.0
CABANISS GROUP	
Senora Formation:	
Limestone, very dark gray to grayish brown where partly weathered; orange brown where highly weathered; impure, sandy, highly fossiliferous, coquinoidal, well-indurated; forms resistant ledge in cutbank of stream (Tiawah Limestone)	0.3
Shale, gray to grayish brown with orange streaks	1.0
Ironstone, reddish brown, well-indurated (about 0.5-0.75 in. thick)	0.1
Shale, light grayish brown with orange oxidized bands	1.0
Shale, black, hard, platy	3.1
Coal, black, oxidized (Tebo coal)	0.4
Underclay, light whitish gray with orange mottling	3.1
Sandstone, light gray, silty, noncalcareous, very fine grained, very thin bedded	1.0
Sandstone, light yellowish brown, fine-grained, noncalcareous, thin-bedded, ripple-marked (to water level in stream)	<u>2.0</u>
Total	18.0

Measured Section 80

NE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 22, T. 15 N., R. 15 E., Muskogee County. Measured in cutbank of south fork of Salt Creek, by LeRoy A. Hemish. Field notebook designation MM-12-82-H. (Estimated elevation at top of section, 580 ft.)

	<i>Thickness (ft)</i>
Silt, grayish brown, includes organic material (soil)	0.8

Silt, yellowish brown, contains roots and rootlets	2.0
Gravel, very dark gray with orange specks; composed predominantly of black shale clasts and ironstone fragments	4.0
CABANISS GROUP	
Senora Formation:	
Shale, black, fissile; orange iron oxide staining on stratification surfaces	0.5
Limestone, black, weathers brown, impure, silty, dense, hard, jointed; highly fossiliferous, shell hash abundant; forms resistant ledge in creek bed (Tiawah Limestone)	<u>1.0</u>
Total	8.3

Measured Section 81

SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 24, T. 15 N., R. 15 E., Muskogee County. Measured in cutbank of stream ~100 ft north from concrete bridge on section line road, by LeRoy A. Hemish. Field notebook designation MM-9-82-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
Silt, dark grayish brown; contains organic material (soil)	1.2
Clay, light gray with blackish red and orange brown mottling; includes abundant particles of soft, weathered coal (alluvium)	4.5
CABANISS GROUP	
Senora Formation:	
Shale, black, brittle, fissile; contains abundant small, rounded phosphatic nodules	1.2
Coal, black, banded, hard; contains abundant compressed, pyritized brachiopod fossils in upper 0.25 in. of bed (Weir-Pittsburg coal)	0.5
KREBS GROUP	
Boggy Formation:	
Underclay, light gray with yellow streaks, plastic (base covered in stream bed)	<u>1.0</u>
Total	8.4

NOTE: Anticlinal structure brings coal bed to surface at this site; downstream at lower elevation the coal dips below the water level in the creek.

Measured Section 82

W $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, T. 15 N., R. 15 E., and E $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 19, T. 15 N., R. 15 E., Muskogee County. Measured from top of hill NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, along road north to creek bed directly below curve in road SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 19, by LeRoy A. Hemish. Field notebook designation MM-2-82-H. (Estimated elevation at top of section, 702 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Sandstone, dark reddish brown, fine-grained, noncalcareous, ferruginous, medium-bedded; contains flecks of black carbonized plant material (Chelsea Sandstone)	5.0
Sandstone, light reddish brown to light yellowish brown, very fine grained, silty, noncalcareous, micaceous, very thin bedded, interbedded with grayish brown silty shale; black carbonized plant material on stratification surfaces; grades into shale downward	47.0
Sandstone, buff, fine-grained, poorly exposed; forms topographic bench at Midway corner ..	10.0
Shale, orange to grayish brown, highly weathered; poorly exposed in road ditch	12.0
Covered interval	8.0
Limestone, very dark gray, weathers brown, dense, hard, highly fossiliferous, coquinoideal; crops out in cutbank of stream adjacent to west side of road across from farm site in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 15 N., R. 15 E. (Tiawah Limestone)	0.6
Shale, gray to grayish brown streaked with orange, includes thin layer of reddish brown, banded clay ironstone at contact with overlying unit	1.2
Shale, black, brittle, fissile; contains phosphatic nodules; jointed, with purplish brown staining on joint surfaces; in places includes zones of brownish black, discoidal ironstone concretions as much as 1 ft in diameter	5.8
Coal, black with reddish orange iron oxide staining on cleat surfaces (Tebo coal)	0.5
Underclay, light whitish gray with orange mottling, medium gray in upper 10 in.; lower 2 ft contain discontinuous, irregular-shaped masses of reddish brown to grayish brown limestone 1-8 in. in diameter; coloration in lower part of unit is highly irregular, with areas of whitish gray hues alternating with sizeable areas of bluish gray hues	4.5
Shale, medium gray with some orange iron oxide staining, clayey (base covered by water)	<u>2.0</u>
Total	96.6

Measured Section 83

SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 6, T. 15 N., R. 16 E., Muskogee County. Measured in bluffs on west side of Coal Creek, by LeRoy A. Hemish. Field notebook designation MM-8-82-H. (Estimated elevation at top of section, 585 ft.)

	<i>Thickness (ft)</i>
Sand, reddish brown, silty (alluvium associated with the Arkansas River)	12.0
CABANISS GROUP	
Senora Formation:	

Appendix 2: Measured Sections and Core-Hole Logs

Sandstone, reddish brown, very fine grained, ferruginous, noncalcareous, hard; weathers to resistant, flat, angular clasts on outcrop	2.0
Shale, grayish brown with orange mottling, clayey	2.0
Limestone and ironstone, dark reddish brown, very hard, nonfossiliferous; occurs as discontinuous lenses; poorly exposed	0.1
Shale, light gray with orange streaks, becomes dark gray downward	2.5
Shale, black, brittle, hard; contains small, rounded and flattened phosphatic nodules	3.8
Coal, black with reddish brown iron oxide staining on cleat surfaces, hard (Weir-Pittsburg coal)	0.6
KREBS GROUP	
Boggy Formation:	
Underclay, very light gray with orange mottling	3.2
Limestone, gray, weathers to light brown to dark purplish brown, hard, impure, sandy; contains marine fossils, brachiopods predominant	0.3
Shale, light greenish gray, clayey	0.8
Sandstone, light greenish gray, very fine grained, noncalcareous, very thin bedded	3.0
Sandstone, light grayish brown, very fine grained, noncalcareous; thick-bedded to very thin bedded and shaly; ripple-marked, blocky fracture (covered to water level in Coal Creek)	<u>6.2</u>
Total	36.5

Measured Section 84

NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 6, T. 15 N., R. 16 E., Muskogee County. Measured in small abandoned strip pit and in gully above Coal Creek, by LeRoy A. Hemish. Field notebook designation MM-7-82-H. (Estimated elevation at top of section, 584 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Sandstone, orange red, very fine grained, noncalcareous, ferruginous; occurs mostly as angular, pebble- to cobble-size fragments in weathered, silty soil zone	2.5
Shale, very dark gray, clayey	3.5
Shale, black, brittle, fissile; contains abundant small, rounded and flattened grayish black phosphatic nodules	2.0
Coal, black, hard (Weir-Pittsburg coal)	0.5
KREBS GROUP	
Boggy Formation:	
Underclay, very light gray with orange mottling	3.5
Sandstone, buff, very fine grained, highly calcareous, cross-bedded; contains scattered brachiopods	0.8
Shale, yellowish brown with orange mottling, calcareous	0.6
Limestone, dark purplish brown, impure, sandy; highly fossiliferous, brachiopods predominant	0.2
Shale, light yellowish gray	2.0
Sandstone, light yellowish gray to grayish brown, very fine grained, noncalcareous; thin-bedded and shaly in upper part to thick-bedded in lower part; includes ripple marks, sole marks, flow rolls and other soft-sediment deformation structures; contact with underlying unit sharp	8.4
Shale, medium gray to olive gray, weathers grayish brown, silty, fissile (covered to creek)	<u>15.0</u>
Total	39.0

Measured Section 85

NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 6, T. 15 N., R. 16 E., Muskogee County. Measured in small gully in bluff west side of Coal Creek, by LeRoy A. Hemish. Field notebook designation MM-6-82-H. (Estimated elevation at top of section, 590 ft.)

	<i>Thickness (ft)</i>
Sand, light grayish brown, very fine grained, silty, noncalcareous, unconsolidated (high terrace deposits associated with the Arkansas River)	8.0
CABANISS GROUP	
Senora Formation:	
Shale, black, brittle, fissile; contains abundant brownish black, rounded, irregular-shaped, flattened phosphatic nodules ≤ 1 in. in diameter	4.0
Coal, black, banded (Weir-Pittsburg coal)	0.6
KREBS GROUP	
Boggy Formation:	
Underclay, light gray with orange streaks, weathers very light gray	3.0
Limestone, medium gray, weathers light brown to dark purplish brown, finely crystalline, impure, sandy, hard; thickness variable along outcrop; contains marine fossils, fusulids abundant, contact with underlying unit sharp and disconformable	0.6
Shale, grayish brown, stained reddish brown in part, silty; includes carbonaceous material on stratification surfaces	1.8
Sandstone, light yellowish gray with greenish hue, very fine grained, noncalcareous; thick-bedded with alternating thin-bedded shaly units; ripple-marked; includes flow rolls and other sedimentary structures indicating soft-sediment deformation; forms resistant bluff along Coal Creek; covered to water level	<u>9.0</u>
Total	27.0

Measured Section 86

SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 13, T. 15 N., R. 16 E., Muskogee County. Measured in shallow ravine just north of intersection of two power lines, by LeRoy A. Hemish. Field notebook designation MM-29-82-H. (Estimated elevation at top of section, 580 ft.)

	<i>Thickness (ft)</i>
Sand, brown, silty, gravelly, contains organic material (topsoil)	1.4
KREBS GROUP	
Boggy Formation:	
Shale, black, fissile, weathers to small flakes on the outcrop	2.0
Ironstone, dark purplish black, weathers reddish brown, dense, hard; sparsely fossiliferous, with scattered brachiopods valves unevenly distributed; weakly calcareous in part	0.2
Shale, black, fissile; weathers to small flakes on the outcrop	2.0
Ironstone, black to purple with orange surface band hard, dense; very sparsely fossiliferous	0.2
Shale, very dark gray, weathers dark grayish brown, stained orange and reddish brown by iron oxide on stratification surfaces, clayey	7.0
Shale, black, stained reddish brown on stratification surfaces, fissile; weathers to small flakes on outcrop	4.2
Limestone, maroon and purplish brown, impure, sandy, silty, coquinoidal, dense, hard; feels hackly; contains well-preserved fossil burrows from $\frac{1}{8}$ to $\frac{1}{4}$ in. in diameter, as well as pelecypod casts 3-4 in. long and 1 in. in diameter (Inola Limestone)	0.5
Shale, medium gray; contains thin stringers of weakly calcareous, iron oxide cemented sandstone	0.1
Underclay, light yellowish gray with orange streaks and mottling, includes discontinuous 0.25-in.-thick stringers of soft, weathered coal in upper 2 in. (Bluejacket coal)	2.3
Sandstone, reddish brown, very fine grained, hard, medium- to thick-bedded, cross-bedded in part, noncalcareous; forms bluff along flood plain of Arkansas River	<u>6.0</u>
Total	25.9

Measured Section 87

E $\frac{1}{2}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 15 N., R. 16 E., Muskogee County. Measured in cutbank of north-flowing tributary of the Arkansas River, by LeRoy A. Hemish. Field notebook designation MM-18-82-H. (Estimated elevation at top of section, 560 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, black, brittle, fissile, well-jointed; contains small, irregular-shaped phosphatic nodules in lower part of unit; also includes discontinuous black to reddish brown and purplish black ironstone and limestone lenses ranging from 0.5 to 2 in. thick	16.0
Shale, black, highly, carbonaceous	1.0
Coal, black with reddish brown and yellow staining on cleat surfaces (Wainwright coal)	0.4
Underclay, light yellowish gray, grades into underlying unit	0.8
Sandstone, light yellowish gray with orange mottling, very fine grained, friable, unbedded	1.7
Sandstone, light greenish gray and reddish brown, very fine grained, micaceous, noncalcareous, nodular in upper part to thin-bedded in lower part; strongly bioturbated in upper part	6.5
Shale, light olive gray, micaceous, highly silty, fissile, noncalcareous; includes lenses of reddish brown clay ironstone (to water in stream)	<u>3.5</u>
Total	29.0

Measured Section 88

W $\frac{1}{2}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 26, T. 15 N., R. 16 E., Muskogee County. Measured in cutbank of tributary stream of the Arkansas River from bridge on blacktop to point just east of right-angle bend in stream, by LeRoy A. Hemish. Field notebook designation MM-17-82-H. (Estimated elevation at top of section, 562 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, light gray, weathers yellowish gray, silty, fissile	9.0
Shale, black, fissile; includes several 0.5- to 1-in.-thick lenses and stringers of reddish brown ironstone and limestone; sparsely fossiliferous	8.5
Ironstone, reddish brown, weakly calcareous	0.2
Shale, black, brittle, fissile	1.0
Ironstone, reddish brown, weakly calcareous	0.1
Shale, black, brittle, fissile	2.2
Limestone, very dark gray, weathers brown, dense, hard, micritic; sparsely fossiliferous	0.3
Shale, black, brittle, well-jointed; joint sets strike N.11°W. and N.80°E.; includes small spheroidal and discoidal phosphatic nodules	7.0
Shale, very dark gray, highly carbonaceous	0.5

Appendix 2: Measured Sections and Core-Hole Logs

Coal, black, banded; at contact with overlying black shale, includes a well-indurated, 0.25-in.-thick layer containing abundant pyrite and pyritized brachiopod valves; thickness of coal varies along the outcrop, thinning locally to 2 in. where irregular surfaces of the underlying sandstone unit protrude upward (Wainwright coal)	0.5
Underclay, light gray; occurs only locally in depressions at top of irregular surface of underlying sandstone unit; maximum thickness observed, 10 in.	0.2
Sandstone, yellowish brown to reddish brown with olive green hue, well-indurated, very fine grained, noncalcareous, unbedded; surface is lumpy and very irregular; contains a few brachiopod valves as well as carbonized plant compressions	0.6
Sandstone, light gray with orange mottling, very clayey, very fine grained, noncalcareous, weakly indurated, unbedded; has the appearance and consistency of underclay	<u>0.4</u>
Total	30.5

Measured Section 89

SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 8, T. 15 N., R. 17 E., Muskogee County. Measured in ravine west from abandoned farm site, by LeRoy A. Hemish. Field notebook designation MM-28-82-H. (Estimated elevation at top of section, 570 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Ironstone, dark brownish black, dense, hard; contains sparsely distributed fossil brachiopods	0.1
Shale, black, partially oxidized, weathers to small flakes on the outcrop	2.0
Ironstone, dark brownish black, weathers reddish brown, weakly calcareous, dense, hard; sparsely fossiliferous, brachiopods predominant	0.1
Shale, black, brittle, fissile; includes small, rounded phosphatic nodules in lower part	14.2
Limestone, dark grayish brown, weathers brown, very impure and sandy, wavy thin bedded, coquinoidal in part; contains fossil burrows (unnamed limestone)	0.7
Underclay, yellowish brown	2.0
Shale, yellowish brown to olive gray, silty	2.0
Siltstone, yellowish gray, noncalcareous, micaceous, very thin bedded; grades downward into underlying unit	1.5
Sandstone, yellowish gray, silty, very fine grained, thin-bedded, micaceous, noncalcareous	4.5
Sandstone, yellowish gray to reddish brown, very fine grained, noncalcareous, ripple-marked, thick-bedded, well-indurated; forms ledge adjacent to stream bottom; base covered	<u>3.5</u>
Total	30.6

Measured Section 90

NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 9, T. 15 N., R. 17 E., Muskogee County. Measured in small gully northeast from abandoned farm site, by LeRoy A. Hemish. Field notebook designation MM-27-82-H. (Estimated elevation at top of section, 558 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, black, weathers dark brownish gray, clayey	1.0
Ironstone, dark brownish black, weathers dark brown, dense, hard; contains unevenly and sparsely distributed fossil brachiopods	0.2
Shale, black, includes much reddish brown iron oxide material; weathers to small, thin flakes; contains sparsely distributed fossil brachiopods	2.2
Ironstone, dark brownish black, weathers brown to reddish brown, dense, hard; some drusy calcite on fracture surfaces; sparsely fossiliferous, contains a few pelecypod and brachiopod shells	0.4
Shale, black, brittle, fissile; weathers to small flakes on the outcrop, poorly exposed in lower 1 ft	14.2
Limestone, purplish brown, impure, silty, hard, dense, bioturbated; contains abundant fossil hash consisting of crinoid, brachiopod, and pelecypod fragments; also contains well-preserved fossil burrows ~0.25 in. in diameter; to alluvial valley fill (unnamed limestone)	<u>0.4</u>
Total	18.4

Measured Section 91

NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 10, T. 15 N., R. 17 E., Muskogee County. Measured in highwall of active strip mine operated by Alpine Construction Co., by LeRoy A. Hemish. Field notebook designation MM-22-82-H. (Estimated elevation at top of section, 593 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, light yellowish gray, weathered	6.0

Sandstone, light gray, very fine grained, noncalcareous, small-scale cross-laminated; includes abundant black carbonized plant fragments and yellowish gray flat pebbles of claystone	15.0
Siltstone, medium gray; contains excellent assemblage of black carbonized plant compressions	0.8
Shale, gray, silty; contains black carbonized plant fragments	1.0
Shale, black, highly carbonaceous	0.1
Coal, black, banded; locally includes pyrite veinlets and crusts on cleat surfaces; peacock coal (Secor coal)	1.1
Underclay, dark gray, silty, hard; contains abundant black carbonaceous plant fragments	<u>1.0</u>
Total	25.0

Measured Section 92

SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 10, T. 15 N., R. 17 E., Muskogee County. Measured in highwall of active strip pit operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-24-82-H. (Estimated elevation at top of section, 621 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, dark reddish brown to light yellowish brown, ferruginous, micaceous, very fine to fine-grained, noncalcareous; massive to thin-bedded in lower part and stained by purplish black manganese dioxide (Crekola Sandstone)	10.0
Shale, orange brown, weathered, dark gray where unweathered, silty	8.0
Shale, black, highly carbonaceous	0.2
Coal, black, reddish brown iron oxide staining on cleat surfaces; banded (Peters Chapel coal)	0.8
Underclay, light gray with orange staining; includes black, carbonized plant fragments	0.9
Shale, very dark gray, pyritic in part; includes gray, noncalcareous nodules <1 in. in diameter	6.2
Shale, black, stained reddish brown on joint surfaces, blocky	8.0
Ironstone, black with maroon and reddish brown surface band ~0.75 in. thick, drusy calcite on fracture surfaces, dense, hard, sparsely fossiliferous	0.2
Shale, black with reddish brown banding, fissile, jointed, gypsiferous	2.6
Ironstone, black with blackish brown surface band ~1.25 in. thick, dense, hard, sparsely fossiliferous	0.3
Shale, black with reddish brown banding, fissile, jointed, gypsiferous	0.8
Ironstone purplish brown to hematite red, highly fractured, selenite crystals on fracture surfaces	0.1
Shale, black with bright yellow banding, yellow material probably jarosite; carbonaceous, gypsiferous	2.0
Shale, very dark gray, highly calcareous, unbedded; includes abundant well-preserved marine fossils; selenite crystals fill fracture cavities; at top of unit a 0.5-in.-thick colorless and white layer of selenite crystals and powdery gypsum fills or partially fills a continuous, horizontal solution cavity	0.5
Limestone, very dark gray to dark purplish black, impure, muddy, hard; contains abundant fossil marine fauna, brachiopods predominant (unnamed limestone)	0.5
Shale, very dark gray, highly calcareous, unbedded, gypsiferous, includes abundant marine fossils	0.5
Coal, black, with reddish brown iron oxide staining on cleat surfaces (Secor Rider coal)	0.1
Underclay, very dark gray with orange iron oxide staining in upper 3 in.; medium gray with black, carbonized plant fragments in lower part; highly carbonaceous	2.0
Sandstone, light gray with brown streaks along joints and fractures, very fine grained, massive to thin-bedded, noncalcareous; includes small-scale cross-bedding in part	13.0
Shale, medium gray, silty, hard; contains well-preserved, black, carbonized plant compressions, with ferns abundant	4.5
Coal, black, banded; peacock coal in part; breaks apart easily; includes scattered occurrences of pyrite in veinlets and as crust on cleat surfaces (Secor coal)	0.8
Underclay, dark gray, silty; contains very thin coaly streaks and carbonized plant material; pyritic in part (total thickness undetermined)	<u>0.8</u>
Total	62.8

Measured Section 93

NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, T. 15 N., R. 17 E., Muskogee County. Measured in ravine adjacent to old, small, abandoned mine, by LeRoy A. Hemish. Field notebook designation MM-2-83-H. (Estimated elevation at top of section, 595 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, yellowish brown, weathers reddish brown, fine-grained, thick- to medium-bedded, thin-bedded and cross-laminated in lower 12 in., noncalcareous; basal contact sharp; forms resistant ledge at head of ravine; top covered by sandy soil (Crekola Sandstone)	7.0
Shale, light gray with orange streaks	2.0
Shale, very dark gray, flaky; contains some stringers of orange clay ironstone	2.0

Appendix 2: Measured Sections and Core-Hole Logs

Shale, black, with purplish brown stains on stratification surfaces, fissile	1.9
Shale, light gray with orange streaks, clayey	0.3
Shale, black, soft, coaly	0.1
Coal, black, with reddish brown staining on cleat surfaces, bituminous (Peters Chapel coal)	0.9
Underclay, light gray and orange; contains carbonized plant fragments	1.1
Shale, bluish gray with orange and purple mottling, silty; weathers to roughly rounded, flattened nodules about 1-2 in. in diameter in some places	1.5
Shale, very dark gray to black, fissile; contains discoidal, highly oxidized orange red ferruginous concretions -6 in. in diameter and 1-2 in. thick (base covered)	<u>1.7</u>
Total	18.5

Measured Section 94

NW¼NW¼NW¼SW¼ sec. 11, T. 15 N., R. 17 E., Muskogee County. Measured in road ditch from near top of hill at entrance to Turner Brothers, Inc. strip mine down slope to terrace deposits associated with the Arkansas River, by LeRoy A. Hemish. Field notebook designation MM-26-82-H. (Estimated elevation at top of section, 610 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, dark reddish brown to light yellowish brown, very fine grained, ferruginous, thick-bedded, well-indurated, noncalcareous (Crekola Sandstone)	9.5
Shale, yellowish brown with orange mottling; highly weathered; includes some dark gray unweathered bands; black carbonized plant fragments on stratification surfaces; includes some reddish brown, banded clay ironstone concretions	11.0
Shale, light grayish brown and yellow, clayey	0.2
Coal, black, soft, very highly weathered; thickness questionable owing to extent of weathering of bed (Peters Chapel coal)	0.4
Underclay, light purplish brown in upper part and light whitish gray with orange mottling in lower part, highly weathered	1.2
Shale, very dark gray to black; includes abundant clay ironstone concretions that weather to orange fragments on the outcrop, poorly exposed in lower part	<u>18.0</u>
Total	40.3

Measured Section 95

E½NW¼NE¼NE¼ sec. 13, T. 15 N., R. 17 E., Muskogee County. Measured on north slope of high, isolated hill southeast of Pecan Creek, by LeRoy A. Hemish. Field notebook designation MM-34-82-H. (Estimated elevation at top of section, 652 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, yellowish brown to pinkish red, fine-grained, micaceous, cross-bedded, noncalcareous, massive to thick-bedded; includes cavities surrounded by surface bands of ironstone concretions	9.0
Savanna Formation:	
Covered interval	27.5
Sandstone, light yellowish brown to orange brown, very fine grained, flat-bedded, noncalcareous, medium- to thin-bedded, breaks into flagstones; forms bench on hill slope, has been quarried on northwest side of hill	2.5
Shale, brownish gray, silty; interbedded with thin, moderately well indurated beds of siltstone	5.5
Shale, medium gray, weathers grayish brown with orange mottling	4.0
Shale, very dark gray, weathers to dark brownish gray and orange flakes on the outcrop; contains reddish brown ironstone concretions as much as 2 in. thick, interbedded with black, brittle shale in the upper part of the unit	20.0
Ironstone, dark purplish brown to orange, dense, hard, highly calcareous locally, sparsely fossiliferous	0.1
Shale, very dark gray, weathers to dark brownish gray flakes on the outcrop, fissile	25.0
Limestone, dark brown, wavy thin bedded, impure, sandy, coquinoidal, porous; highly fossiliferous; contains abundant brachiopod shells; unit exposed on southwest side of hill, appears to be absent on north side of hill	0.2
Shale, very dark gray, weathers to dark brown flakes on the outcrop, fissile (to water level in Pecan Creek)	<u>60.0</u>
Total	153.8

Measured Section 96

N½SW¼SE¼NE¼ and E½NW¼SE¼NE¼ sec. 13, T. 15 N., R. 17 E., Muskogee County. Measured in hillslope, by LeRoy A. Hemish. Field notebook designation MM-35-82-H. (Estimated elevation at top of section, 670 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	

Sandstone, light yellowish brown to pinkish brown, fine-grained, thick-bedded, cross-bedded, micaceous, noncalcareous; basal contact disconformable (Bluejacket Sandstone)	10.0
Savanna Formation:	
Shale, yellowish brown to brown with orange mottling	1.1
Sandstone, dark brown, carbonaceous, very fine grained, micaceous, weakly indurated; interlaminated with very thin streaks of coal (Drywood coal)	0.1
Shale, and siltstone, interlaminated, light brown; includes black, carbonized plant fragments on stratification surfaces; weathers to angular fragments on the outcrop; includes minor thin beds of very fine grained sandstone	13.5
Shale, olive gray, weathers to yellowish gray; includes several prominent layers of dark reddish brown ironstone concretions that form minor benches on the outcrop and weather to angular fragments	30.5
Shale, medium gray, weathers grayish brown with orange mottling, clayey; includes scattered bright orange ironstone concretions with purplish brown surface bands	6.0
Ironstone, very dark brownish black, hard, dense	0.1
Shale, black, brittle, very hard	0.5
Shale, dark gray, weathers to brownish gray flakes on the outcrop, fissile	38.0
Limestone, dark brown, coquinoideal, impure, sandy, porous, feels hackly; brachiopods abundant (crops out ~30 ft north of pond)	0.1
Shale, dark gray, fissile; includes several 0.5-in.-thick, dark gray, rusty brown weathering stringers of very fine grained sandstone and siltstone in about the middle of the interval	<u>34.3</u>
Total	134.2

Measured Section 97

NW¼SE¼NW¼NE¼ sec. 14, T. 15 N., R. 17 E., Muskogee County. Measured at edge of old, small, abandoned coal mine and shale pit, by LeRoy A. Hemish. Field notebook designation MM-25-82-H. (Estimated elevation at top of section, 552 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, orange brown, very fine grained, ferruginous, thick-bedded, noncalcareous, ripple-marked at base; forms resistant ledge jutting out 4 ft beyond underlying unit	1.9
Siltstone, yellowish brown and yellowish gray, shaly, laminated to thin-bedded, noncalcareous	6.1
Shale, dark gray with orange brown streaks, silty; includes black, carbonaceous plant fragments on stratification surface	6.5
Shale, black, highly carbonaceous	0.2
Coal, black, reddish brown iron oxide staining on cleat surfaces, bituminous (Peters Chapel coal)	0.9
Underclay, light gray with orange streaks and mottling; includes thin coal streaks and black, carbonized plant compressions	<u>1.0</u>
Total	16.6

Measured Section 98

SE¼NE¼SE¼SE¼NE¼ sec. 15, T. 15 N., R. 17 E., Muskogee County. Measured in ditch west side of blacktop road, by LeRoy A. Hemish. Field notebook designation MM-1-83-H. (Estimated elevation at top of section, 553 ft.)

	<i>Thickness (ft)</i>
Silt, dark grayish brown, clayey, sandy (soil)	5.0
KREBS GROUP	
Boggy Formation:	
Limestone, grayish brown, weathers yellowish brown, impure, silty; fossiliferous, brachiopod fragments abundant; forms resistant ledge in ditch (Inola Limestone)	0.5
Clay, yellowish brown; contains thin, dark grayish brown streaks of carbonaceous shale and coal; includes a 0.5-in.-thick bed of soft coal at base of unit (Bluejacket coal)	0.2
Underclay, light gray with orange streaks	<u>1.0</u>
Total	6.7

Measured Section 99

NW¼NW¼ sec. 16, T. 15 N., R. 17 E., Muskogee County. Measured along stream, by LeRoy A. Hemish. Field notebook designation MM-23-82-H. (Estimated elevation at top of section, 558 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, black, brittle, fissile, jointed	1.0
Ironstone, black, weathers brown, dense, hard	0.1
Shale, black, brittle, fissile, jointed; includes phosphatic nodules	0.9
Limestone, dark purplish gray, impure, sandy, wavy thin bedded; highly fossiliferous, coquinoideal in part, hard, resistant (Inola Limestone)	0.5
Covered interval	2.0

Appendix 2: Measured Sections and Core-Hole Logs

Sandstone, brown, ferruginous, fine-grained, medium- to thin-bedded, noncalcareous, ripple-drift cross-laminated; includes black, carbonaceous plant material; base covered	<u>10.0</u>
Total	14.5

Measured Section 100

NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 15 N., R. 17 E., Muskogee County. Measured in northwest-facing bluff along Arkansas River valley ~100 ft northeast from oil well, by LeRoy A. Hemish. Field notebook designation MM-21-82-H. (Estimated elevation at top of section, 560 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Limestone, very dark grayish brown, weathers orange brown and maroon, impure, silty, feels raspy on surface; very highly fossiliferous, coquinoïdal, fossils have distinctive maroon color, brachiopods predominant; thickness ranges from 0.5 to 1 in.	0.1
Coal, black, soft, highly weathered (Secor Rider coal)	0.2
Underclay, brownish gray with orange mottling; grades into underlying shale	1.5
Shale, light gray with orange banding, weathers whitish gray, clayey; includes thin stringers of clay ironstone that weather to flakes on the outcrop	2.0
Shale, olive gray, stained by red to reddish brown iron oxides, silty, hard; breaks into sharp-edged chips on the outcrop	7.0
Siltstone, yellowish brown, thin-bedded, shaly, noncalcareous; includes 3-4 in. ovoid clay ironstone concretions; grades into underlying unit	8.0
Sandstone, yellowish brown to brown, very fine grained, thin-bedded to massive, noncalcareous, small-scale cross-laminated	1.5
Sandstone, light yellowish brown, very fine grained, thin-bedded, micaceous, very shaly; base covered	<u>1.4</u>
Total	21.7

Measured Section 101

NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 15 N., R. 17 E., Muskogee County. Measured in highwall of active strip mine operated by Richard's Coal Co., by LeRoy A. Hemish. Field notebook designation MM-3-84-H. (Estimated elevation at top of section, 574 ft.)

	<i>Thickness (ft)</i>
Clay, yellowish brown to orange; contains angular cobble-size clasts of reddish brown sandstone in upper part of unit and gravel-size clasts of ironstone and brown chert scattered throughout	4.0
KREBS GROUP	
Boggy Formation:	
Shale, yellowish brown, highly weathered; contains discoidal ironstone concretions as much as 1 ft in diameter	2.0
Shale, black, fissile, stained reddish orange on fracture surfaces	5.0
Shale, black, interbedded with several 1- to 2-in. layers of reddish brown to black ironstone	5.0
Limestone, grayish black, hard, dense, impure, silty and shaly; contains abundant fossil shell fragments	1.0
Coal, black, very friable (Secor Rider coal)	0.2
Underclay, light gray with orange streaks, soft	1.5
Shale, medium gray	7.0
Sandstone, light olive gray, silty, very fine grained, thin- to medium-bedded; stained brown on joint surfaces	11.0
Shale, and siltstone, interlaminated, dark gray alternating with light gray; micaceous; includes abundant well-preserved plant compressions on stratification surfaces	5.8
Coal, black, bright, moderately friable, minor white calcite on cleat surface (Secor coal)	1.1
Underclay, dark gray, silty; contains carbonized plant remains	<u>0.4</u>
Total	44.0

Measured Section 102

NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 17, T. 15 N., R. 17 E., Muskogee County. Measured in side of small, old abandoned strip mine, by LeRoy A. Hemish. Field notebook designation MM-20-82-H. (Estimated elevation at top of section, 606 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, reddish brown, very fine grained, ripple-drift cross-laminated, well-indurated, top eroded (Crekola Sandstone)	0.9
Shale, medium gray, silty, includes thin laminae of orange ferruginous siltstone that weather to flakes on the outcrop	6.0
Coal, black; yellow and reddish brown staining on cleat surfaces (Peters Chapel coal)	0.8
Underclay, purplish gray with orange streaks, silty; contains abundant carbonized plant fragments	0.1

Siltstone, light gray with orange mottling, very fine grained sandstone in part; includes abundant black carbonized plant fragments	0.5
Shale, medium gray; includes numerous stringers of resistant, orange brown clay ironstone that weather to flakes on the outcrop (base covered)	<u>5.2</u>
Total	13.5

Measured Section 103

SE¼SE¼SW¼SW¼ sec. 17, T. 15 N., R. 17 E., Muskogee County. Measured in road cut on north side of gravel road, by LeRoy A. Hemish. Field notebook designation MM-19-82-H. (Estimated elevation at top of section, 592 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, orange brown, very fine grained, noncalcareous, micaceous, medium-bedded to thin-bedded, small-scale cross-laminated; forms resistant ledge near crest of hill	3.7
Shale, light gray, weathers buff, silty, fissile (Crekola Sandstone)	0.4
Sandstone, as above	0.5
Shale, medium gray with orange bands, silty, fissile, micaceous, noncalcareous; includes thin strata of hard, ferruginous siltstone and fine-grained sandstone	7.5
Coal, black, soft, weathered (Peters Chapel coal)	0.8
Underclay, light grayish brown with orange streaks; includes abundant black carbonized plant compressions	1.0
Shale, medium gray with orange streaks, weathers yellowish gray, silty; includes thin stringers of clay ironstone that weather to small flakes on outcrop (base covered)	<u>6.0</u>
Total	19.9

Measured Section 104

NW¼NW¼NW¼SW¼ sec. 23, T. 15 N., R. 17 E., Muskogee County. Measured in low bluff of Pecan Creek, by LeRoy A. Hemish. Field notebook designation MM-31-82-H. (Estimated elevation at top of section, 570 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, reddish brown, ferruginous, very fine grained, noncalcareous, medium- to thick-bedded, cross-bedded in part; small-scale ripple-drift cross-laminated; well-indurated; locally contains brachiopod and pelecypod casts 1–2 in. in diameter	26.0
Sandstone, light yellowish brown, micaceous, noncalcareous, very shaly; cross-laminated, fissile; includes abundant black carbonaceous plant material on stratification surfaces ..	4.0
Covered interval (shale fragments and chips of peacock coal in spoils from old, abandoned drift mine indicate the presence of shale beds and the Secor coal)	10.5
Sandstone, light yellowish brown, fine- to very fine grained, micaceous, noncalcareous, massive, well-indurated; dips southwest; base covered by water in Pecan Creek (Blue-jacket Sandstone)	<u>3.5</u>
Total	44.0

Measured Section 105

NE¼NW¼NE¼SW¼ sec. 28, T. 15 N., R. 17 E., Muskogee County. Measured in highwall of active strip mine operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-17-83-H. (Estimated elevation at top of section, 581 ft.)

	<i>Thickness (ft)</i>
Clay, orange brown, silty, gravelly in part, very weathered (alluvium)	18.0
KREBS GROUP	
Boggy Formation:	
Shale, very dark gray, silty, very calcareous; contains black phosphatic nodules and marine shells, brachiopods abundant	1.5
Coal, black, reddish brown iron oxide-stained calcite on cleat surfaces, banded, friable (Peters Chapel coal)	0.8
Siltstone, very dark gray to black, hard, very shaly, carbonaceous; contains abundant purplish black, irregular-shaped ironstone nodules about 1–3 in. in diameter	3.7
Shale, very dark gray, brittle, noncalcareous, fissile; contains abundant 0.5-in.-thick layers of purplish brown ironstone (base covered)	<u>25.0</u>
Total	49.0

Measured Section 106

SW¼NE¼SE¼SW¼ sec. 28, T. 15 N., R. 17 E., Muskogee County. Measured in highwall of active strip pit operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-13-83-H. (Estimated elevation at top of section, 583 ft.)

	<i>Thickness (ft)</i>
Silt, brown, clayey, gravelly, contains some organic material (soil)	1.0
KREBS GROUP	
Boggy Formation:	

Appendix 2: Measured Sections and Core-Hole Logs

Sandstone, light brown, fine-grained, massive, oxidized	4.4
Sandstone, light gray with dark gray bands, very fine grained, noncalcareous, hard, cross-laminated, massive; fills large channel in shale beds	19.8
Coal, black, bright, bituminous, with white kaolinite and pyrite on cleat surfaces and stratification planes (Secor coal)	0.8
Siltstone, very dark gray, well-indurated; includes abundant black, carbonized plant fragments (total thickness unknown)	<u>0.2</u>
Total	26.2

Measured Section 107

NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 28, T. 15 N., R. 17 E., Muskogee County. Measured in highwall of active strip pit operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-14-83-H. (Estimated elevation at top of section, 580 ft.)

	<i>Thickness (ft)</i>
Clay, brown, silty, gravelly (soil)	1.2
Clay, orange brown with very dark gray, red and white mottling, pisolitic, very weathered; contains selenite crystals and fragments of ironstone concretions	2.0
KREBS GROUP	
Boggy Formation:	
Shale, dark gray and brown with orange banding, very weathered, clayey	4.0
Shale, black, carbonaceous	0.8
Coal, black, shows effects of incipient weathering, bituminous (Peters Chapel coal)	0.8
Underclay, dark olive gray with orange bands; contains minor sandstone streaks	1.3
Shale, medium to dark gray	<u>7.0</u>
Total	17.1

NOTE: Approximately 40 ft of medium and dark gray shaly rocks were exposed in the highwall of the mine below the rocks described above. Because of the steepness of the highwall and resultant hazardous conditions, these strata could not be examined at close range. The underlying Secor coal was not uncovered, but the mine superintendent reported that an interval ~60 ft separates the Peters Chapel coal from the Secor coal. The Secor coal was reported to be 10 in. thick in this pit.

Measured Section 108

NW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 15 N., R. 17 E., Muskogee County. Measured in highwall of strip mine operated by P & K Coal Co., Ltd., by LeRoy A. Hemish. Field notebook designation MM-2-88-H. (Estimated elevation at top of section, 560 ft.)

	<i>Thickness (ft)</i>
Silt, dusky brown, unconsolidated; contains organic material (topsoil)	1.3
Clay, dark yellowish brown to light brown with moderate reddish brown and blackish red mottling, pisolitic, sticky, gravelly, weathered	2.7
KREBS GROUP	
Boggy Formation:	
Shale, brownish black with light brown iron oxide staining on stratification surfaces, noncalcareous; includes brachiopod fossils on some bedding planes; contains some dark yellowish orange ironstone concretions	4.0
Shale, grayish black, noncalcareous, brittle; includes trace fossils and rare brachiopod valves on stratification surfaces; contains scattered layers of brownish gray ironstone 1-2 in. thick	7.0
Limestone, medium dark gray, silty, fossiliferous; contains fossil hash and brachiopods	0.2
Shale, black, carbonaceous, pyritic	0.2
Coal, black, bright, moderately friable, cleats closely spaced (Secor Rider coal)	0.2
Shale, black, coaly, very carbonaceous	0.7
Underclay, medium dark gray; contains some very thin laminae of bright coal	0.5
Shale, medium light gray, very silty, noncalcareous; shaly siltstone interlaminated with very fine grained sandstone in part; contains abundant well-preserved black carbonized plant compressions	22.3
Coal, black, bright, moderately friable; contains minor pyrite on cleat surfaces (Secor coal)	1.0
Underclay, medium dark gray; contains abundant black carbonized plant compressions, slickensided	<u>1.3</u>
Total	41.4

NOTE: Beds dip S.40°E. at 4°.

Measured Section 109

NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 35, T. 15 N., R. 17 E., Muskogee County. Measured in cutbank of stream adjacent to abandoned strip pit, by LeRoy A. Hemish. Field notebook designation MM-46-82-H. (Estimated elevation at top of section, 568 ft.)

	<i>Thickness (ft)</i>
Disturbed ground (spoils from abandoned strip pit)	5.0
KREBS GROUP	
Boggy Formation:	
Shale, grayish brown with abundant orange and maroon mottling, very weathered	0.7

Coal, black (Peters Chapel coal)	1.0
Underclay, purplish gray with orange mottling; includes abundant black, carbonized plant fragments	1.0
Shale, light grayish brown with orange banding; includes abundant thin stringers of clay ironstone that weather to resistant flakes on the outcrop	1.8
Shale, medium gray, clayey (base covered)	<u>1.5</u>
Total	11.0

Measured Section 110

SE¼SE¼SE¼NW¼ sec. 7, T. 15 N., R. 18 E., Muskogee County. Measured on flanks of Fern Mountain, east of Pecan Creek, by LeRoy A. Hemish. Field notebook designation MM-36-82-H. (Estimated elevation at top of section, 710 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, reddish brown, ferruginous, fine-grained, cross-bedded, massive; includes zones of ironstone pebbles that in places weather out, leaving cavities	9.0
Shale, yellowish brown, silty, highly weathered	2.0
Coal, black, soft, powdery, very weathered (Secor coal)	0.3
Underclay, light yellowish gray	0.7
Shale, light yellowish brown, silty, very weathered	6.0
Sandstone, buff to rusty brown, fine-grained, micaceous, noncalcareous, thin-bedded to massive, ripple-marked, cross-bedded; highly resistant, forms sheer wall with some ledges over-hanging underlying unit by 10–15 ft; total thickness well exposed laterally for hundreds of feet; basal contact sharp and disconformable; fills channels cut into underlying unit (Bluejacket Sandstone)	48.0
Savanna Formation:	
Siltstone, medium gray with light gray laminae, shaly, micaceous; intricately cross-laminated; includes abundant black, carbonized plant fragments; grades into underlying unit; includes thin laminae of very fine grained sandstone	4.0
Shale, medium gray, weathers grayish brown, silty	11.0
Covered interval	35.0
Shale, medium gray, weathers grayish brown with orange mottling; includes reddish brown ironstone concretions	3.0
Shale, black, brittle, hard	0.4
Shale, dark gray, weathers grayish brown (covered to Pecan Creek)	<u>10.6</u>
Total	130.0

Measured Section 111

SW¼SE¼SE¼SW¼ sec. 7, T. 15 N., R. 18 E., Muskogee County. Measured in cutbank of tributary of Pecan Creek, by LeRoy A. Hemish. Field notebook designation MM-38-82-H. (Estimated elevation at top of section, 530 ft.)

	<i>Thickness (ft)</i>
Silt, light brown, clayey, sandy, unbedded (alluvium associated with tributary system)	10.0
KREBS GROUP	
Savanna Formation:	
Shale, brown with medium gray mottling on unoxidized surfaces, very weathered, noncalcareous	2.0
Ironstone, orange with reddish brown surface band	0.1
Shale, very dark gray, purplish brown on weathered surfaces, carbonaceous, breaks into small flakes on the outcrop	1.2
Coal, black, impure, shaly in part (Tallahassee coal)	0.1
Underclay, purplish brown	0.1
Shale, reddish brown and black with yellowish gray mottling, weathered, brittle, highly carbonaceous; contains abundant ferruginous material	0.8
Limestone, purplish gray, weathers brownish gray, impure, silty, hard, wavy thin bedded, very fossiliferous; weathered and eroded surfaces are irregular, knobby, and hackly; to water level (Spaniard Limestone)	<u>2.7</u>
Total	17.0

Measured Section 112

SW¼SE¼SE¼SE¼ sec. 9, T. 15 N., R. 18 E., Muskogee County. Measured in road ditch and in cutbank of a small north-flowing stream north side of blacktop road near bridge, by LeRoy A. Hemish. Field notebook designation MM-42-82-H. (Estimated elevation at top of section, 565 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, olive brown with maroon mottling, very fine grained, micaceous, thin-bedded, noncalcareous, shaly in part, highly weathered in upper part (Tamaha Sandstone)	5.5
Shale, grayish brown, silty; contains reddish brown ironstone concretions that weather to fragments littering the outcrop	5.0

Appendix 2: Measured Sections and Core-Hole Logs

Ironstone, brown; contains fossil brachiopod valves; occurs as a continuous layer of concretions	0.2
Shale, brown, highly weathered	1.4
Coal, black with purple staining on fracture surfaces, weathered (Stigler coal)	0.3
Underclay, light gray with orange mottling	1.0
Shale, light yellowish gray with much orange mottling, very weathered; contains abundant thin clay ironstone stringers that break into flakes littering the outcrop	2.0
Sandstone, olive brown with reddish brown mottling, very fine grained, irregular-bedded, well-indurated; weakly calcareous in part; contains fossil marine shells replaced by calcite	2.1
Siltstone, light yellowish gray, shaly in lower part, noncalcareous, very thin bedded; contains brown ironstone concretions as much as 5 in. in diameter and 2 in. thick	1.5
Limestone, light yellowish gray with reddish brown mottling, very shaly, weakly indurated; contains abundant well-preserved brachiopod valves	0.2
Shale, medium gray, contains layers of reddish brown ironstone concretions as much as 10 in. in diameter and 1.5 in. thick (to creek bed)	2.5
Total	21.7

Measured Section 113

SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 10, T. 15 N., R. 18 E., Muskogee County. Measured in small gully and low bluff along south side of Arkansas River flood plain, by LeRoy A. Hemish. Field notebook designation MM-41-82-H. (Estimated elevation at top of section, 534 ft.)

	<i>Thickness (ft)</i>
Silt, light grayish brown, unbedded	3.0
KREBS GROUP	
McAlester Formation:	
Shale, grayish brown with orange streaks and spots, weathered	0.8
Shale, medium gray with orange mottling	0.3
Coal, black, soft, weathered (Keefton coal)	0.3
Underclay, light gray with orange mottling	0.6
Shale, light grayish brown	1.0
Sandstone, light grayish brownish yellow with thin reddish brown bands, very fine grained, noncalcareous, micaceous, well-indurated, thin- to medium-bedded, ripple-marked; becomes very thin bedded, gray, and highly silty and shaly near base of unit; base covered by colluvium (Warner Sandstone)	9.5
Total	15.5

Measured Section 114

NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 10, T. 15 N., R. 18 E., Muskogee County. Measured in road cut east of black top road, by LeRoy A. Hemish. Field notebook designation MM-82-82-H. (Estimated elevation at top of section, 550 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, olive brown, weathers orange brown, very fine grained, silty, noncalcareous, irregularly thin bedded, bioturbated; trails and burrows abundant; breaks into small, blocky fragments on the outcrop (Tamaha Sandstone)	3.0
Shale, medium gray with orange mottling, weathers light reddish brown; includes a zone of 2-in.-thick dark reddish brown clay ironstone concretions that contain well-preserved limonitic brachiopods	6.5
Coal, black, soft, very weathered (Stigler coal)	0.3
Underclay, light yellowish gray with orange streaks	1.2
Shale, light bluish gray with bright orange streaks; clayey; contains abundant stringers of clay ironstone that weather to small fragments on the outcrop	2.0
Sandstone, light olive brown with orange and dark brown mottling; very fine grained, thin-bedded, noncalcareous	1.2
Shale, light grayish brown, silty (base covered)	1.8
Total	16.0

Measured Section 115

SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, T. 15 N., R. 18 E., Muskogee County. Measured in road cut east side of blacktop road from top of knoll north toward bridge, by LeRoy A. Hemish. Field notebook designation MM-39-82-H. (Estimated elevation at top of section, 566 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, orange brown, very fine grained, silty, very thin bedded, noncalcareous, bioturbated, burrows abundant; weathers to flakes on the outcrop; grades into underlying unit (Keota Sandstone)	3.0
Siltstone, yellowish brown shaly, micaceous, noncalcareous, bioturbated, very thin bedded; contains reddish orange ironstone concretions as much as 8 in. in diameter and 2 in. thick	5.8

Shale, light gray, very calcareous, contains abundant brachiopods	1.0
Shale, black with grayish brown and orange banding; highly carbonaceous; includes thin stringers of coal	0.1
Coal, black; thickness varies from 4 in. to almost 6 in. laterally where overlying unit grades into coal (Keota coal)	0.4
Underclay, light gray, contains black, carbonized plant fragments	1.0
Shale, medium gray, contains thin stringers of clay ironstone (base of unit covered)	1.7
Total	13.0

Measured Section 116

NE¼SE¼SE¼NE¼ sec. 17, T. 15 N., R. 18 E., Muskogee County. Measured from top of knoll northeast of stockpond down eroded gully below pond to creek bed northwest of pond, by LeRoy A. Hemish. Field notebook designation MM-40-82-H. (Estimated elevation at top of section, 564 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, orange brown, very fine grained, silty, micaceous, contains fossil burrows; weathers to flakes on the outcrop; grades into underlying unit (Keota Sandstone)	2.0
Siltstone, light grayish brown, shaly, very thin bedded, micaceous, noncalcareous	6.0
Limestone, medium gray, shaly; very fossiliferous, with brachiopods abundant	0.5
Coal, black, weathered (Keota coal)	0.4
Underclay, very light gray, contains black carbonized plant fragments	0.9
Shale, grayish brown; contains abundant thin stringers of orange clay ironstone that weather to fragments on the outcrop	2.6
Limestone, purplish brown, very fossiliferous; weathered surface feels hackly	0.5
Shale, grayish brown; contains several discontinuous layers of brown clay ironstone concretions in lower 5 ft of unit	18.0
Sandstone, light grayish brown, silty, very fine grained; forms resistant floor in bed of creek (Tamaha Sandstone)	6.0
Total	36.9

Measured Section 117

NW¼NE¼SE¼NW¼ sec. 18, T. 15 N., R. 18 E., Muskogee County. Measured in cutbank of tributary of Pecan Creek, by LeRoy A. Hemish. Field notebook designation MM-32-82-H. (Estimated elevation at top of section, 555 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Shale, yellowish brown, very silty; contains abundant orange brown ironstone concretions that weather to flakes on the outcrop	7.0
Sandstone, light yellowish brown, silty, very fine grained, micaceous, noncalcareous, irregularly thin bedded; contains discoidal brown concretions as much as 8 in. in diameter and 0.5 in. thick	2.0
Shale, olive gray, silty, stained brown by iron oxides in part	1.5
Limestone, grayish brown, weathers brown to light yellowish brown, impure, very sandy in part, hard; characterized by abundant fossil horn corals 0.5–1 in. in diameter and as much as 4 in. in length that weather out in relief on the outcrop; also contains abundant brachiopods (Spaniard Limestone)	0.7
Shale, light gray with orange to chocolate brown bands; silty, very calcareous	0.5
Limestone, as above	0.2
Shale, olive gray to gray, calcareous; includes small, reddish brown ironstone concretions	1.8
Limestone, dark gray, sandy; occurs as discontinuous 3 × 4 in. pods	0.2
McAlester Formation:	
Shale, very dark gray, extensively streaked with reddish brown iron oxide	0.3
Coal, black; not exposed, revealed by excavation in bed of dry stream (Spaniard coal)	0.6
Underclay, light gray, plastic (total thickness unknown)	0.2
Total	15.0

Measured Section 118

SE¼SE¼SW¼NW¼ sec. 18, T. 15 N., R. 18 E., Muskogee County. Measured in cutbank of stream ~50 ft north from high line wires, by LeRoy A. Hemish. Field notebook designation MM-33-82-H. (Estimated elevation at top of section, 582 ft.)

	<i>Thickness (ft)</i>
Silt, brown, sandy; contains organic matter (soil zone)	3.0
KREBS GROUP	
Savanna Formation:	
Shale, dark gray, weathers grayish brown, noncalcareous	1.4
Limestone, very dark gray with brown mottling, sandy, impure, carbonaceous locally; very fossiliferous, with brachiopods abundant, most shells fragmented; part of thickness includes interbedded, highly calcareous, fossiliferous, very dark gray shale (Doneley Limestone)	0.5

Appendix 2: Measured Sections and Core-Hole Logs

Coal, black, soft, weathered (Rowe coal)	0.8
Underclay, light purplish gray stained orange by iron oxides	0.7
Shale, medium gray, stained orange and yellow on fracture surfaces by iron oxides, blocky, noncalcareous	2.4
Shale, light gray with yellowish hue, some orange staining, silty; not as fractured as overlying unit	1.2
Sandstone, light gray to olive gray, weathers grayish brown and orange, stained dark brownish black by manganese oxides in part; very fine grained, silty, shaly, micaceous, very thin bedded, fissile; ripple-marked where exposed in stream bed; contains hema- tite red ironstone concretions as much as 6 in. in diameter which are oolitic on broken interior surfaces and contain ooids of white calcite in places (base covered)	<u>2.5</u>
Total	12.5

Measured Section 119

NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 18, T. 15 N., R. 18 E., Muskogee County. Measured in cutbank of north-
west-flowing tributary of Pecan Creek, by LeRoy A. Hemish. Field notebook designation MM-37-82-H.
(Estimated elevation at top of section, 530 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Shale, dark gray, weathers light brownish gray, noncalcareous	3.0
Limestone, dark grayish brown with brown surface band; contains scattered, small brachiopod fossils	0.2
Shale, very dark gray with purplish brown staining on oxidized surfaces, carbonaceous	1.0
Coal, black with reddish brown staining; impure and shaly in part (Tullahassee coal)	0.1
Siltstone, rusty brown, very limonitic, porous; occurs as weathered layer between coal and underlying limestone	0.1
Limestone, purplish gray, weathers brownish gray, hard; wavy thin bedded, surface irregular, knobby and hackly, with numerous reddish brown fossils standing out in relief; very fossiliferous, fossil hash abundant, contains large horn corals in places (Spaniard Limestone)	0.8
McAlester Formation:	
Shale, very light gray with orange mottling, highly calcareous; becomes silty and sandy in lower part (base covered)	<u>2.0</u>
Total	7.2

Measured Section 120

NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 7, T. 15 N., R. 19 E., Muskogee County. Measured in bluff south of the
Arkansas River just west of Missouri-Kansas-Texas Railroad bridge, by LeRoy A. Hemish. Field
notebook designation MM-54-82-H. (Estimated elevation at top of section, 529 ft.)

	<i>Thickness (ft)</i>
Silt, light orange brown, includes very fine grained sand	18.0
KREBS GROUP	
McAlester Formation:	
Sandstone, dark greenish gray with reddish brown and orange mottling, very fine grained, thin-bedded, silty, shaly in lower part, noncalcareous, ripple-marked; strongly bioturbated; contains scattered poorly preserved pelecypod fossils; includes a 3-in.-thick rusty brown ferruginous layer ~1.5 ft from base of unit; fills channels is underlying unit; basal contact sharp (Warner Sandstone)	5.5
Shale, very dark gray, noncalcareous; contains numerous stringers and discoidal con- cretions of dark brown ironstone ≤ 2 in. thick (top of McCurtain Shale)	8.0
Coal, black, soft, weathered; includes white gypsum crystals on outcrop face (Brushy Mountain coal)	0.4
Underclay, light gray with light yellowish green hue	0.9
Shale, very dark gray with dark reddish brown staining, silty; includes abundant irreg- ular-shaped dark grayish brown clay ironstone concretions about 3-4 in. in diameter (to water level)	<u>7.0</u>
Total	39.8

Measured Section 121

W $\frac{1}{2}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ and NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 21, T. 15 N., R. 19 E., Muskogee County. Mea-
sured in stream gorge from just west of west section line downstream, by LeRoy A. Hemish. Field
notebook designation MM-83-82-H. (Estimated elevation at top of section, 506 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
McAlester Formation:	
Sandstone, reddish brown, fine-grained, cross-bedded, ripple-marked, noncalcareous, well-indurated (Warner Sandstone)	3.0
Sandstone, medium gray, weathers dark olive brown, very thin bedded, platy, noncal- careous, shaly in part, ripple-marked; contains some marine fossil fragments as well as burrows and trails (Warner Sandstone)	6.0

Siltstone, dark olive gray, very thin bedded, sandy, fissile; contains abundant plant compressions (top of McCurtain Shale)	8.0
Shale, very dark grayish brown, fissile, noncalcareous	12.0
Coal, black with reddish brown iron oxide staining on cleat surfaces (Brushy Mountain coal)	0.4
Shale, black, coaly	0.1
Underclay, light gray with orange brown streaks; contains black, carbonized plant fragments	1.8
Sandstone, bluish gray, very fine grained, shaly, noncalcareous, nodular	0.2
Shale, olive gray, weathers orange to rusty brown, silty; includes irregularly distributed lenses of dark reddish brown, fine-grained, noncalcareous, well-indurated sandstone, as well as dark reddish brown, rounded clay ironstone concretions as much as 6 in. in diameter (base covered)	<u>4.0</u>
Total	35.5

CORE-HOLE LOG 1

NW¼NW¼SW¼SW¼NW¼ sec. 5, T. 10 N., R. 19 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at north edge of farm pond 66 ft FWL and 2076 ft FNL. Field notebook designation C-MM-32. Surface elevation, estimated from topographic map, 626 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Clay, dark yellowish brown, silty; contains organic material	0.0	2.0
Clay, dark yellowish orange, sandy, gravelly, oxidized	2.0	5.0
KREBS GROUP		
Savanna Formation:		
Shale, yellowish gray and grayish orange, clayey, weathered	7.0	3.2
Shale, yellowish gray to dark yellowish brown with dark yellowish orange bands, partly weathered	10.2	4.8
Shale, dark gray, silty, noncalcareous, grades into underlying unit	15.0	2.0
Siltstone, medium dark gray, contains abundant very fine grained sandstone, noncalcareous, bioturbated	17.0	13.0
Siltstone, medium dark gray, shaly, noncalcareous	30.0	4.5
Shale, dark gray, silty	34.5	19.7
Shale, black, pyritic	54.2	1.0
Shale, dark gray, noncalcareous	55.2	<u>12.8</u>
Total Depth		68.0

CORE-HOLE LOG 2

NE¼SW¼NW¼SW¼NE¼ sec 6, T. 10 N., R. 19 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled on east side of small farm pond directly east of farm house. Field notebook designation C-MM-33. Surface elevation, estimated from topographic map, 620 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, very fine grained, silty, contains organic material ..	0.0	2.0
Sand, grayish orange, very fine grained, silty, noncalcareous; includes some fine gravel	2.0	5.0
Sand, moderate yellowish brown, very fine grained, noncalcareous, unconsolidated; gravelly in bottom 1 ft	7.0	7.0
KREBS GROUP		
McAlester Formation:		
Shale, dusky yellowish brown with light brown bands, partly weathered	14.0	2.0
Shale, dark gray, silty, noncalcareous, very uniform in character	16.0	37.5
Shale, dark gray, silty, noncalcareous, contains sparse fossil shells	53.5	6.0
Limestone, dark gray, impure, shaly, pyritic; contains abundant fossils consisting of brachiopod shells and fossil hash	59.5	<u>0.5</u>
Total Depth		60.0

Appendix 2: Measured Sections and Core-Hole Logs

CORE-HOLE LOG 3

NW¼NE¼SE¼SW¼NE¼ sec 22, T. 10 N., R. 19 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Hole drilled in pasture northwest of buildings 40 ft directly east from pond. Field notebook designation C-MM-8. Surface elevation, estimated from topographic map, 570 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, silty; contains organic material	0.0	1.0
KREBS GROUP		
McAlester Formation:		
Shale, dark gray with moderate reddish brown iron-oxide deposits on stratification surfaces, silty; includes some moderate reddish brown ironstone concretions	1.0	12.5
Shale, medium light gray, calcareous	13.5	2.3
Sandstone, medium light gray, very fine grained, noncalcareous	15.8	0.8
Shale, medium dark gray, silty, fissile; includes some hard, thin, light gray sandstone layers at 23.5 and 24.5 ft	16.6	12.4
Shale, dark gray, silty, fissile, pyritic; includes black carbonized plant fragments on stratification surfaces	29.0	15.8
Shale, dark gray, silty, fissile, interbedded with thin stringers of light-gray, very fine grained sandstone and siltstone; includes some minor pyrite	44.8	9.7
Sandstone, medium gray with black flecks, very fine grained, well-indurated, interbedded with dark gray, silty shale and siltstone, noncalcareous (Keota Sandstone)	54.5	3.5
Sandstone, medium gray with very light gray bands, very fine grained, silty, bedding contorted, bioturbation features abundant, noncalcareous (Keota Sandstone)	58.0	1.3
Siltstone, medium gray with minor light gray stringers of very fine grained sandstone, thin bedded, shaly	59.3	0.7
Shale, dark gray with light gray streaks, sandy, silty, bioturbated	60.0	2.3
Shale, dark gray, silty; contains scattered calcareous fossil brachiopod shell fragments	62.3	2.0
Sandstone, light gray, very fine grained, highly calcareous, shaly	64.3	0.1
Shale, medium dark gray with brownish gray sandstone-filled burrows, silty; grades into underlying unit	64.4	1.0
Sandstone, medium light gray, to light gray, very fine grained, silty, highly bioturbated, noncalcareous	65.4	1.5
Shale, medium gray with light gray streaks, silty, sandy	66.9	0.4
Shale, dark gray	67.3	0.2
Siltstone, medium dark gray, sandy, becomes shaly downward, bioturbated, noncalcareous	67.5	3.7
Shale, medium dark gray, silty, intricately interbedded with light gray, very fine grained sandstone, noncalcareous; wavy-bedded, cross-bedded; bioturbation and flow features common in the sandstone; unit consists of ~5% sandstone in upper part and >10% sandstone in lower part	71.2	6.3
Shale, medium dark gray, silty; includes some very thin stringers of very fine grained sandstone; extensively bioturbated, with very fine grained sandstone fillings in burrows; includes a 3/16-in.-thick grayish black carbonaceous shale layer at 88.3 ft	77.5	14.5
Shale, dark gray, silty; contains minor very fine grained sandstone laminae and burrow fillings in upper 6 ft of unit	92.0	8.0
Shale, dark gray, silty, hard; includes some minor pyrite and layers of brownish gray, silty ironstone	100.0	26.0
Shale, dark gray, silty, includes thin laminae of very fine grained sandstone; bioturbated in part; grades into underlying unit	126.0	2.7
Siltstone, dark gray, shaly, includes abundant very fine grained sandstone in thin laminae and burrow fillings, hard; contains some black carbonized plant compressions	128.7	5.1
Shale, dark gray, silty, hard; includes thin laminae of very fine grained sandstone and siltstone; bioturbated in part; contains black carbonized plant material and layers of brownish gray, silty ironstone up to 2 in. thick; includes scattered brachiopod fossils from 165 to 168 ft	133.8	55.0
Coal, black, bright, moderately friable; contains thin lenses of pyrite and white calcite on cleat surfaces (Tamaha coal)	188.8	0.3
Underclay, medium gray to medium dark gray; silty in lower part; contains black coalified plant roots and white calcite veinlets; slickensides common; grades into underlying unit	189.1	1.1

Shale, dark gray with very light gray laminae of very fine grained sandstone, highly silty; bioturbation, scour, and soft-sediment deformation features abundant	190.2	4.4
Siltstone, dark gray with very light gray laminae of very fine grained sandstone, shaly in part, micaceous; bioturbation, scour, and soft-sediment deformation features abundant; grades into underlying unit	194.6	9.2
Shale, dark gray, silty; includes minor very thin laminae of very fine grained sandstone	203.8	11.0
Sandstone, medium dark gray, very fine grained, silty and shaly, very thin-bedded; basal contact sharp and disconformable (Tamaha Sandstone)	214.8	0.2
Shale, dark gray, silty, hard; includes thin laminae of very fine grained light gray sandstone and siltstone; extensively bioturbated; contains layers of brownish gray, silty ironstone up to 1 in. thick	215.0	9.4
Shale, dark gray, silty, hard; contains brownish gray, silty ironstone lenses up to 1.75 in. thick; includes minor bioturbation features; grades into underlying unit	224.4	16.6
Shale, dark gray, less silty and softer than overlying unit	241.0	29.0
Shale, dark gray; contains small, sparsely distributed calcareous brachiopod fossils	270.0	0.8
Shale, black, highly calcareous, fossiliferous; contains a high concentration of white fossil hash consisting mostly of brachiopod shells in lower 1 in.	270.8	0.5
Shale, dark gray, silty; contains abundant carbonized plant material	271.3	0.2
Coal, black, bright; includes a 0.25-in.-thick carbonaceous shale parting 1 in. from top of unit (Stigler Rider coal)	271.5	0.3
Underclay, medium dark gray, shaly; contains abundant black carbonized plant fragments and minor coal streaks in lower part of unit	271.8	1.3
Coal, black, bright, finely cleated (Stigler coal)	273.1	1.8
Underclay, medium dark gray, contains black carbonized plant fragments; slickenside surfaces common	274.9	<u>2.1</u>
Total Depth		277.0

CORE-HOLE LOG 4

NE¼NE¼NW¼SW¼ sec 7, T. 11 N., R. 20 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at northwest edge of stock pond 2400 ft FSL and 575 ft FWL. Field notebook designation C-MM-31. Surface elevation, estimated from topographic map, 515 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, moderate brown, sandy, contains abundant organic material	0.0	2.0
Clay, moderate yellowish brown, sandy, weathered	2.0	1.5
KREBS GROUP		
McAlester Formation:		
Shale, brownish black with abundant dark yellowish orange streaks, noncalcareous; includes dark reddish brown iron-oxide deposits on stratification surfaces; weathered in part	3.5	4.5
Shale, brownish black to dark gray with minor dark yellowish orange banding, noncalcareous	8.0	2.3
Shale, medium dark gray to dark gray, noncalcareous; includes a few light brownish gray sideritic concretions up to 1 in. thick; also includes a few 0.5- to 1-in.-thick bands of calcareous fossil shell fragments	10.3	9.7
Shale, dark gray, noncalcareous; includes a few light brownish gray sideritic concretions up to 3 in. thick; contains small, thin lenses of pyrite	20.0	20.7
Shale, black, contains sparse calcareous fossil shell fragments	40.7	0.1
Sandstone, light gray, interbedded with dark gray shale, very fine grained, noncalcareous, wavy bedded, bioturbated in part	40.8	19.2
Shale, black, coaly, slickensided	60.0	0.2
Coal, black, bright, moderately friable (Keefton coal)	60.2	0.5
Underclay, dark gray, contains compressed plant fragments and rootlet casts . . .	60.7	0.7
Shale, medium dark gray, interlaminated with very fine grained sandstone; grades into underlying unit	61.4	0.7
Sandstone, light gray, very fine grained, noncalcareous; interbedded with dark gray shale	62.1	0.8
Sandstone, medium light gray, fine- to medium-grained, noncalcareous, cross-bedded; includes minor shale clasts (Warner Sandstone)	62.9	<u>7.1</u>
Total Depth		70.0

CORE-HOLE LOG 5

SW¼SE¼SW¼SW¼ sec 16, T. 12 N., R. 19 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture just east of farm pond 200 ft FSL and 1,000 ft FWL. Field notebook designation C-MM-59. Surface elevation, estimated from topographic map, 578 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, pale yellowish brown; contains organic matter	0.0	0.5
Gravel, dark yellowish brown, fine-grained, silty; contains organic matter	0.5	1.5
Clay, moderate yellowish brown, sandy, silty, noncalcareous; contains rare gravel clasts; weathered	2.0	4.0
DESMOINESIAN SERIES		
KREBS GROUP		
McAlester Formation:		
Shale, pale yellowish brown and dark reddish brown, clayey, noncalcareous, weathered	6.0	4.8
Shale, dusky yellowish brown, noncalcareous; contains oxidized, moderate reddish brown and dark yellowish orange ironstone concretions	10.8	0.5
Shale, grayish black, noncalcareous; contains pyrite lenses and pyrite-filled burrows; includes some light brownish gray, sideritic concretions up to 1 in. thick, and rare white, calcareous fossil shells in lower 6 in.	11.3	20.1
Limestone, medium dark gray, impure, silty, fine grained, hard; contains abundant fossil hash; includes some grayish black, calcareous, slickensided shale and light brownish gray, calcareous concretions in middle 0.3 ft	31.4	0.9
Shale, medium dark gray, very calcareous, burrowed	32.3	0.5
Sandstone, very light gray, very fine grained, calcareous; interbedded with noncalcareous, medium dark gray silty shale; burrowed, wavy-bedded or cross-laminated in places; includes a 0.3-ft-thick, sandy, yellowish gray limestone concretion from 33.3 to 33.6 ft (upper Warner Sandstone)	32.8	3.2
Shale, medium dark gray, noncalcareous, silty; includes scattered streaks of very light gray sandstone, and interbedded units of wavy-bedded sandstone and shale up to 0.3 ft thick	36.0	3.9
Shale, medium dark gray, noncalcareous, burrowed; contains scattered streaks of very light gray sandstone, and light brownish gray, sideritic concretions from 0.25 to 1 in. thick	39.9	7.9
Coal, black, bright, moderately friable; includes minor pyrite crusts on bedding surfaces (Keefton coal)	47.8	0.7
Underclay, medium light gray, carbonaceous in upper part	48.5	2.0
Shale, medium dark gray, silty, noncalcareous, burrowed; contains streaks of light gray, very fine grained sandstone	50.5	1.8
Sandstone, light gray with medium dark gray streaks, very fine grained, noncalcareous, micaceous, rippled; includes some contorted beds; contains shale clasts and black, comminuted plant debris on stratification surfaces (Warner Sandstone)	52.3	7.7
Sandstone, medium light gray, fine- to medium-grained, quartzose, noncalcareous, massive to cross-bedded; contains black, comminuted plant debris on bedding planes; including some yellowish gray shale pebbles and coal streaks in lower 3 ft (Warner Sandstone)	60.0	13.0
Ironstone, yellowish gray; shows indistinct relict bedding planes (top unit of McCurtain Shale)	73.0	0.3
Shale, medium dark gray to dark gray, interbedded with white, very fine grained sandstone, micaceous, flaser bedded, rippled, burrowed in part; includes sparse, black, comminuted plant debris on stratification surfaces; grades into underlying unit	73.3	7.3
Shale, dark-gray with white streaks of very fine grained sandstone, noncalcareous, burrowed, flat-bedded; contains numerous bands of light brownish gray, sideritic concretions up to 1 in. thick	80.6	9.4
Shale, dark gray with numerous light brownish gray, sideritic bands, noncalcareous, silty; contains rare burrows and sparse streaks of white sandstone from 90.0 to 95.0 ft; includes black, carbonized plant compressions and plant debris on some bedding planes	90.0	9.2
Sandstone, medium dark gray, very fine grained, shaly, noncalcareous, extensively bioturbated; lower contact very irregular	99.2	0.5
Shale, dark gray with numerous light brownish gray, sideritic bands, noncalcareous, silty; contains black comminuted plant debris on some bedding planes; includes rare pyrite-filled burrows	99.7	10.2

Coal, black, bright, moderately friable, minor white calcite on cleat surfaces, and rare pyrite crusts on bedding planes (Brushy Mountain coal)	109.9	0.3
Underclay, grayish black, very carbonaceous, slickensided; plant compressions abundant; silty in lower part; grades into underlying unit	110.2	0.2
Sandstone, medium gray, silty, very fine grained, noncalcareous, churned; contains streaks of black, comminuted plant debris	110.4	3.3
Siltstone, medium gray, noncalcareous; burrowed; contains streaks of light gray, very fine grained sandstone; becomes darker gray and shaly in lower 3 ft	113.7	4.0
Shale, medium dark gray, silty, noncalcareous; becomes dark gray at about 119 ft	117.7	2.3
Shale, grayish black, very silty, hard, noncalcareous; contains abundant streaks of white, very fine grained sandstone; burrowed; includes rare, light brownish gray, sideritic concretions up to 1 in. thick and black, comminuted plant debris on bedding planes; proportion of silt-sized grains and sandstone streaks decreases gradually downward; sandstone streaks sparse below 129 ft; pyrite occurs in small lenses and crusts; white calcite occurs on some parting surfaces	120.0	30.0
Shale, black, hard, brittle, noncalcareous; contains sparse calcareous and pyritized fossil shells, pyrite-filled burrows and light brownish gray, sideritic concretions up to 2 in. thick; includes some white calcite in fractures in concretions, and on some parting surfaces	150.0	22.9
Limestone, black, impure, shaly, carbonaceous, extensively burrowed; contains white fossil shells; sandy in lower 0.1 ft (basal unit of McCurtain Shale) . . .	172.9	0.2
Hartshorne Formation:		
Sandstone, light gray with greenish gray tint, very fine grained; noncalcareous, burrowed extensively in upper 1 ft; rooted in upper 1.5 ft; mostly flat-bedded, with some low-angle cross-laminated layers; contains some light brownish gray, sideritic concretions about 1 in. thick; grades downward into sandy siltstone	173.1	6.9
Siltstone, medium dark gray with very light gray sandstone streaks, coarse-grained, noncalcareous, micaceous; mostly flat-bedded, grain size decreases downward; grades into underlying unit	180.0	8.0
ATOKAN SERIES		
Atoka Formation:		
Shale, grayish black to black, silty, hard, noncalcareous; contains scattered white, calcareous marine fossils, and light brownish gray sideritic concretions up to 2.5 in. thick; includes rare pyrite in small lenses and burrows	188.0	19.3
Limestone, grayish black, very shaly, carbonaceous; contains abundant fossil fragments concentrated in layers; thin streaks of same unit occur in upper 6 in. of underlying unit	207.3	0.2
Shale, medium gray to medium dark gray, noncalcareous; contains thin streaks of very light gray sandstone and siltstone	207.5	<u>2.5</u>
Total Depth		210.0

CORE-HOLE LOG 6

SW ¼ NE ¼ NE ¼ SE ¼ SE ¼ sec 14, T. 13 N., R. 16 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at northeast end of pond 350 ft FEL and 1100 ft FSL. Field notebook designation C-MM-48. Surface elevation, estimated from topographic map, 666 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate-brown, silty, contains organic material	0.0	1.8
Clay, moderate yellowish brown, sandy; contains some gravel-size clasts of oxidized, very fine grained sandstone	1.8	3.2
KREBS GROUP		
Boggy Formation:		
Sandstone, moderate yellowish brown, very fine grained, clayey, highly weathered	5.0	2.5
Shale, moderate yellowish brown, clayey, weathered	7.5	0.3
Sandstone, dusky yellow with dark yellowish orange and dusky brown bands, wavy-bedded and cross-laminated, very fine grained, shaly, weathered	7.8	0.5
Shale, pale yellowish brown with dark yellowish orange bands, sandy; contains abundant 0.5- to 1-in.-thick layers of clay ironstone	8.3	4.1

Appendix 2: Measured Sections and Core-Hole Logs

Shale, grayish black, and sandstone, light gray, interstratified, wavy-laminated, bioturbated, micaceous; contains black comminuted plant fragments; includes a 0.25-in.-thick lens of smutty coal at base of unit	12.4	1.8
Shale, olive gray to medium gray, silty, micaceous, contains black carbonized plant compressions and light brown layers of iron oxide	14.2	0.9
Sandstone, moderate brown with moderate yellowish brown laminae, very fine grained, shaly, noncalcareous, cross-laminated, weathered	15.1	0.2
Shale, pale yellowish brown, clayey, weathered	15.3	0.2
Sandstone, grayish orange to dark yellowish orange; becomes medium light gray with grayish brown bands at ~18 ft, fine-grained, micaceous, noncalcareous, cross-bedded, contains black comminuted plant material on stratification surfaces	15.5	10.5
Sandstone, medium gray with light gray and grayish black bands, very fine grained, shaly in part, micaceous, cross-bedded, noncalcareous, bioturbated in part, abundant black comminuted plant material on stratification surfaces; includes some layers of fine-grained sandstone	26.0	12.6
Siltstone, medium dark gray, sparsely interlaminated with light gray, very fine grained sandstone, noncalcareous, micaceous, bioturbated	38.6	3.5
Sandstone, medium gray with light gray and dark gray bands, fine- to very fine grained, shaly in part, micaceous, wavy-bedded, noncalcareous, bioturbated in part, abundant black comminuted plant fragments on stratification surfaces . .	42.1	<u>17.9</u>
Total Depth		60.0

CORE-HOLE LOG 7

NE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec 25, T. 13 N., R. 16 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in hay meadow at north edge of farm pond 400 ft FSL and 1600 ft FEL. Field notebook designation C-MM-16. Surface elevation, estimated from topographic map, 617 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, dark yellowish orange, sandy, unbedded; contains organic material (soil) . .	0.0	3.0
Clay, moderate yellowish brown, silty, sandy; contains some fine gravel-size clasts of dusky brown clay ironstone, soft, weathered	3.0	4.0
KREBS GROUP		
Boggy Formation:		
Shale, dusky yellowish brown, clayey; moderate brown staining on stratification surfaces	7.0	3.0
Shale, dark gray with minor brownish gray streaks	10.0	2.4
Shale, black, hard, brittle, fractured	12.4	1.8
Shale, dark gray, calcareous, silty; includes sparse fossil shell parts; contains some light brownish gray sideritic concretions	14.2	11.2
Shale, grayish black, carbonaceous; black and highly carbonaceous in lower 1 in.	25.4	0.6
Coal, black, bright, moderately friable, white calcite and pyrite on cleat surfaces (Wainwright coal)	26.0	0.8
Underclay, medium gray, shaly, contains black carbonized plant fragments	26.8	0.7
Sandstone, medium light gray with black streaks, very fine grained, wavy-laminated, micaceous, noncalcareous; contains abundant black comminuted plant material on stratification surfaces	27.5	2.5
Sandstone and shale, interbedded, light gray and medium dark gray, noncalcareous, micaceous, wavy-laminated in part, bioturbated in places, thin-bedded; contains abundant black comminuted plant material on stratification surfaces	30.0	8.0
Siltstone, medium dark gray; highly shaly, noncalcareous; includes some thin lenses and stringers of light gray, very fine grained sandstone, wavy-laminated in part	38.0	5.5
Sandstone, medium dark gray with light gray bands, shaly, very fine grained, cross-laminated and cross-bedded, noncalcareous; abundant black comminuted plant material on stratification surfaces; grades into underlying unit	43.5	46.5
Siltstone, medium dark gray; contains some light gray, very fine grained sandstone laminae in upper part, noncalcareous, shaly; includes some light brownish gray sideritic concretions about 0.5-1 in. thick in lower part	90.0	2.0
Shale, dark gray, noncalcareous, silty; includes some light brownish gray sideritic concretions ~0.5 in. thick	92.0	2.3
Siltstone, medium dark gray, shaly; includes some laminae of light gray, very fine grained sandstone	94.3	2.4

Sandstone, medium dark gray with light gray bands, very fine grained, shaly, bioturbated in part, wavy-laminated, noncalcareous, micaceous	96.7	2.1
Siltstone, medium dark gray, shaly; includes some laminae of light gray, very fine grained sandstone; noncalcareous	98.8	4.1
Shale, medium dark gray with dark gray bands, silty, noncalcareous	102.9	3.1
Shale, dark gray to grayish black, noncalcareous; includes some sideritic concretionary layers 1/16 to 1 in. thick	106.0	15.7
Shale, grayish black to black, noncalcareous, hard, brittle; contains sparse white calcareous and pyritized brachiopod shell fragments; includes sideritic concretion layers 1.5-2 in. thick from 122 to 129 ft, 140 to 142 ft, and at 149.5 ft; number of calcareous fossil shells increases markedly in lower 3 ft	121.7	30.5
Coal, black, moderately friable, includes white calcite along stratification surfaces and a 1/8-in.-thick pyritic layer at top of bed (Bluejacket[?] coal)	152.2	0.2
Shale, dark gray, soft, noncalcareous	152.4	0.3
Limestone, dark gray; very light gray in part where fossil hash is abundant; highly impure, shaly; fossils broken and unidentifiable (Inola Limestone)	152.7	1.0
Shale, dark gray with very light gray contorted layers composed of fossil hash, highly calcareous	153.7	1.3
Shale, grayish black, noncalcareous; contains white calcareous shell fragments and 1- to 2-in.-thick sideritic concretions	155.0	<u>3.0</u>
Total Depth		158.0

CORE-HOLE LOG 8

SE 1/4 SE 1/4 NE 1/4 NE 1/4 SE 1/4 sec 35, T. 13 N., R. 16 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at northeast end of farm pond 60 ft FEL and 2000 ft FSL. Field notebook designation C-MM-47. Surface elevation, estimated from topographic map, 637 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, very fine grained, silty, contains organic material	0.0	1.5
Sand, pale yellowish brown, clayey, contains spheroidal limonite concretions ~1/32 in. in diameter	1.5	1.5
Clay, moderate yellowish brown, sandy, contains particles of limonite concretions and some gravel clasts	3.0	5.2

KREBS GROUP

Boggy Formation:

Shale, moderate yellowish brown with dusky brown and dark yellowish orange bands, silty, weathered	8.2	5.5
Sandstone, dark gray with minor light gray laminae, very fine grained, shaly, noncalcareous, sparsely bioturbated	13.7	<u>16.3</u>
Total Depth		30.0

CORE-HOLE LOG 9

SW 1/4 SE 1/4 NE 1/4 NE 1/4 NE 1/4 sec 36, T. 13 N., R. 16 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture 540 ft FNL and 210 ft FEL. Field notebook designation C-MM-17. Surface elevation, estimated from topographic map, 611 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, pale yellowish brown, very fine grained, silty, unconsolidated; contains organic matter (soil)	0.0	2.0
Sand, light brown to dark yellowish orange, very fine grained, silty, oxidized, unconsolidated	2.0	3.0

KREBS GROUP

Boggy Formation:

Shale, dark yellowish brown to dusky yellowish brown	5.0	3.0
Shale, dark gray to grayish black, calcareous; contains sparse white calcitic fossil shell fragments	8.0	2.5

Appendix 2: Measured Sections and Core-Hole Logs

Shale, dark gray to grayish black, noncalcareous; includes several 0.5- to 1-in.-thick, light brownish gray sideritic concretions	10.5	9.2
Shale, medium dark gray, soft, noncalcareous	19.7	0.3
Coal, black, bright, moderately friable; contains small lenses and veins of pyrite (Wainwright coal)	20.0	0.8
Underclay, medium gray, shaly; contains coal laminae, black carbonized plant fragments and some pyritic deposits	20.8	0.6
Siltstone, medium dark gray, highly shaly	21.4	1.4
Sandstone, medium dark gray with light gray bands, very fine grained, shaly, wavy laminated, bioturbated in part, noncalcareous	22.8	<u>5.2</u>
Total Depth		28.0

CORE-HOLE LOG 10

NW¼NE¼SW¼NE¼SE¼ sec 36, T. 13 N., R. 16 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at south edge of farm pond 1000 ft FEL and 1900 ft FSL. Field notebook designation C-MM-49. Surface elevation, estimated from topographic map, 617 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, grayish brown, sandy, mottled dark reddish brown, contains organic material	0.0	1.5
Silt, dark yellowish brown, clayey; contains some dark reddish orange oxidized streaks	1.5	5.5
Clay, grayish orange to dark yellowish orange; contains gravel-size iron-oxide concretions	7.0	2.0
Gravel, moderate brown, clayey; clasts are predominantly subrounded sandstone and clay ironstone	9.0	1.9
KREBS GROUP		
Boggy Formation:		
Shale, moderate yellowish brown, clayey; becomes dark yellowish brown at ~11.5 ft, weathered	10.9	3.9
Shale, brownish black, silty, noncalcareous	14.8	2.0
Siltstone, medium dark gray, shaly, noncalcareous; includes minor pyrite crusts on bedding surfaces and in burrow fillings; contains some sparsely distributed laminae of light gray sandstone; also contains some laminae of black macerated plant fragments from 43 to 43.5 ft; grades into underlying unit . . .	16.8	30.2
Shale, medium dark gray, silty, hard, noncalcareous, bioturbated; contains thin brownish gray calcite crusts on some stratification surfaces; also contains some pyrite-filled burrows and calcareous brachiopod valves; grades into underlying unit	47.0	24.0
Shale, dark gray to grayish black, hard, silty, noncalcareous; contains some pyrite-filled burrows up to 1.5 in. long, white calcareous brachiopod shell fragments, and abundant light brownish gray sideritic concretions ¼ to 2.5 in. thick	71.0	15.0
Shale, black, noncalcareous, carbonaceous, slickensided	86.0	7.0
Shale, dark gray to grayish black, hard, silty; contains white calcite-filled laminae and white calcitic brachiopod shells; burrowed in part; includes light gray and light brownish gray sideritic concretions ¼ to 2.5 in. thick	93.0	10.6
Coal, black, bright, moderately friable; includes white calcite and pyrite on cleat surfaces (Wainwright coal)	103.6	1.0
Shale, medium dark gray, silty, noncalcareous; includes a 0.75-in.-thick black and grayish black, coaly, pyritic layer at top of unit	104.6	0.2
Sandstone, medium dark gray with light gray laminae, noncalcareous, very fine grained, shaly, bioturbated, bedding contorted and faulted	104.8	0.4
Sandstone, medium light gray, fine-grained, massive, micaceous, noncalcareous; contains thin streaks of black comminuted plant fragments	105.2	3.8
Sandstone, medium light gray with dark gray bands, very fine to fine-grained, shaly, cross-laminated, bioturbated, micaceous, noncalcareous	109.0	<u>1.0</u>
Total Depth		110.0

CORE-HOLE LOG 11

NE¼NE¼NE¼SE¼NE¼ sec 4, T. 13 N., R. 18 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled 1370 ft FNL and 50 ft FEL. Field notebook designation C-MM-7. Surface elevation, estimated from topographic map, 611 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, grayish brown, very fine grained, silty; contains organic material	0.0	1.6
Sand, moderate reddish brown, very fine grained, silty, clayey	1.6	0.9
Sand, moderate yellowish brown, very fine grained, clayey; contains brownish black fragments of iron-oxide concretions	2.5	8.0
KREBS GROUP		
Boggy Formation:		
Shale, very light gray with dark yellowish orange streaks	10.5	0.5
Shale, light olive gray with dark yellowish orange streaks; becomes olive gray in lower 10 in. of unit	11.0	3.0
Sandstone, light olive gray with light brown and grayish black bands, very fine grained, micaceous, cross-laminated, wavy-bedded; bedding distorted in part; abundant black carbonized plant debris on stratification surfaces	14.0	1.6
Sandstone, light gray with grayish black bands, micaceous, very fine grained, cross-laminated, wavy-bedded; bedding highly distorted in part; includes abundant black carbonized plant debris on stratification surfaces	15.6	18.2
Shale, medium gray, silty; includes coalified plant material on stratification surfaces	33.8	0.2
Coal, black bright, friable; minor pyrite on cleat surfaces (Secor coal)	34.0	0.6
Siltstone, medium gray, shaly; includes a 0.25-in.-thick layer of grayish black, highly carbonaceous shale at top of unit as well as black carbonized plant fragments distributed throughout	34.6	0.3
Underclay, medium gray, silty; contains black carbonized plant fragments; slickensides common	34.9	1.3
Shale, medium gray, silty; contains black carbonized plant fragments	36.2	2.5
Sandstone, medium light gray with dark gray bands, fine- to very fine grained, micaceous, cross-stratified; black comminuted plant debris abundant on stratification surfaces (Bluejacket Sandstone)	38.7	<u>1.3</u>
Total Depth		40.0

CORE-HOLE LOG 12

SW¼NE¼NW¼SE¼NE¼ sec 4, T. 13 N., R. 18 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled 20 ft from east edge of stock pond. Field notebook designation C-MM-6. Surface elevation, estimated from topographic map, 610 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, grayish brown, very fine grained, silty; contains organic material	0.0	1.5
Sand, moderate reddish brown, very fine grained, silty	1.6	1.0
Sand, moderate yellowish brown, very fine grained, clayey	2.6	1.5
Sand, pale yellowish orange, highly clayey	4.1	3.0
Sand, grayish orange, highly clayey; includes brownish black iron-oxide particles	7.1	1.4
Clay, dark yellowish orange with very pale orange mottling, sandy; contains subangular to subrounded clasts of very fine grained, light brown sandstone and brownish black iron-oxide concretions	8.5	2.6
KREBS GROUP		
Boggy Formation:		
Sandstone, yellowish gray with dark reddish brown and moderate brown bands, fine- to very fine grained, noncalcareous, cross-bedded, micaceous; includes abundant black carbonized plant debris on stratification surfaces	11.1	3.0
Sandstone, light gray with dark gray bands, fine- to very fine grained, cross- bedded, micaceous, noncalcareous; includes abundant black macerated plant debris on stratification surfaces	14.1	<u>14.0</u>
Total Depth		28.1

Appendix 2: Measured Sections and Core-Hole Logs

CORE-HOLE LOG 13

SE¼NW¼SE¼NE¼NW¼ sec 7, T. 13 N., R. 18 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at north edge of farm pond 2220 ft FWL and 890 ft FNL. Field notebook designation C-MM-51. Surface elevation, estimated from topographic map, 566 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, grayish orange, sandy, clayey; contains organic material	0.0	1.0
Sand, dark yellowish orange, clayey, very fine grained	1.0	2.0
Clay, moderate yellowish brown; contains gravel-size clasts of clay ironstone . . .	3.0	1.3
KREBS GROUP		
Boggy Formation:		
Shale, dark yellowish brown, weathered	4.3	0.7
Shale, medium dark gray with light brown and dark reddish brown layers; contains oxidized clay ironstone concretions	5.0	4.0
Shale, black, brittle; contains dark reddish brown sideritic concretions	9.0	9.0
Shale, dark gray to grayish black with some olive gray bands	18.0	10.0
Limestone, dark gray, impure, shaly	28.0	0.4
Shale, grayish black to black, hard; includes sideritic concretions 1-2 in. thick; contains calcite in veins, and pyrite-filled burrows, as well as white calcareous brachiopod shells in lower 2 ft of unit	28.4	5.6
Limestone, dark gray; impure, silty, very fossiliferous; fossil hash abundant; bioturbated at contact with underlying unit; includes a thin stringer of grayish black, carbonaceous, silty shale at base of unit (Inola Limestone)	34.0	1.0
Underclay, medium light gray, blocky fracture; includes some brownish gray carbonaceous stringers and a 1-in.-thick sandy interval ~1.5 ft from top of unit	35.0	2.5
Sandstone, medium gray, very fine grained, calcareous in upper 4 in., bioturbated; includes black macerated plant fragments; shaly in part; medium dark gray with medium light gray bands and cross-bedded below 44 ft	37.5	11.5
Siltstone, dark gray, shaly; contains pyrite-filled burrows several inches long; also contains some well-preserved, black plant compressions and stringers of very fine grained sandstone	49.0	7.5
Sandstone, medium dark gray and medium light gray, very fine grained, shaly, cross-bedded, bioturbated; contains abundant black comminuted plant fragments (Crekola Sandstone)	56.5	3.5
Shale, black, hard, brittle; includes light brownish gray sideritic concretions up to 2 in. thick; contains white calcareous fossil shell fragments from 60.8 to 61.2 ft	60.0	3.7
Limestone, medium light gray, impure, sandy, bioturbated; interbedded with 0.25- to 0.5-in.-thick coal stringers	63.7	0.2
Coal, black, moderately friable; contains some minor pyrite (Peters Chapel coal)	63.9	0.2
Limestone, medium light gray, impure, shaly, sandy, coaly, bioturbated	64.1	0.3
Shale, medium dark gray, silty, sandy, bioturbated; includes light brownish gray sideritic concretions ~2 in. thick; grades into underlying unit	64.4	2.1
Shale, dark gray, hard, silty, noncalcareous; includes numerous light brownish gray sideritic concretions ½ to 2 in. thick; contains rare fossil shells and thin veins of white calcite along fracture fillings	66.5	41.5
Shale, grayish black, noncalcareous, slickensided; includes light brownish gray sideritic concretions up to 2.5 in. thick; contains white calcareous fossil shells and shell fragments, with abundant occurrences from 110.2 to 110.6 ft and from 111.8 to 111.9 ft	108.0	4.3
Limestone, grayish black, impure, very shaly; contains abundant white fossil shell fragments	112.3	0.1
Shale, grayish black, calcareous, carbonaceous; contains abundant fossil brachiopods	112.4	0.3
Limestone, grayish black, impure, shaly; contains abundant fossil shell fragments	112.7	0.1
Coal, black, moderately friable, white calcite on cleat surfaces (Secor rider coal)	112.8	0.1
Shale, medium dark gray, slickensided	119.9	0.6
Coal, black, very impure, shaly; white calcite on cleat surfaces	113.5	0.3
Shale, grayish black, coaly; contains abundant thin stringers of bright, hard coal .	113.8	0.3
Shale, dark gray to grayish black; contains coalified plant material and a few thin stringers of bright, hard coal	114.1	1.8
Coal, black, bright, moderately friable; includes white calcite on cleat surfaces and pyrite masses up to 0.5 in. thick (Secor coal)	115.9	0.3
Shale, dark gray, coaly, slickensided, noncalcareous	116.2	0.4

Siltstone, medium dark gray; noncalcareous; includes abundant black carbonized plant compressions on stratification surfaces	116.6	1.0
Sandstone, medium gray and light gray, very fine grained, shaly, noncalcareous, micaceous, even-bedded to cross-bedded; thick-bedded in part; contains comminuted plant fragments; bioturbated in part; includes soft-sediment deformation features in places; grades into underlying unit (Bluejacket Sandstone)	117.6	17.4
Siltstone, medium gray, noncalcareous; contains some thin laminae of very fine grained sandstone	135.0	<u>1.0</u>
Total Depth		136.0

CORE-HOLE LOG 14

NW¼SW¼NW¼NW¼NE¼ sec 18, T. 13 N., R. 18 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled 12 ft south from the south edge of stock pond. Field notebook designation C-MM-5. Surface elevation, estimated from topographic map, 567 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, dark yellowish brown, sandy; contains organic material (soil)	0.0	1.4
Gravel, moderate yellowish brown, fine to medium, sandy, clayey; clasts predominantly subrounded to subangular ironstone and very fine grained sandstone	1.4	1.6
KREBS GROUP		
Boggy Formation:		
Shale, grayish black; contains very dark red ironstone concretions	3.0	1.0
Shale, light olive gray, clayey; includes a moderate reddish brown ironstone concretion at 7.0 ft	4.0	4.0
Shale, light olive gray with moderate brown and brownish black deposits on stratification surfaces, jointed	8.0	3.0
Shale, grayish black, brittle, includes streaks of soft, grayish orange clay from 15.0 to 15.5 ft; some interbedded dark gray shale in upper part of unit	11.0	5.3
Ironstone, medium gray with some moderate brown staining, hard	16.3	0.2
Shale, dark gray	16.5	0.3
Limestone, medium light gray, very fine grained, hard, nonfossiliferous	16.8	0.4
Shale, dark gray; contains some minor pyrite crusts on stratification planes and joint surfaces; thin calcite deposits occasionally occur on bedding planes; includes sparsely distributed pyritic and calcareous brachiopod shells and shell fragments; weakly calcareous	17.2	29.3
Siltstone, medium dark gray, highly shaly	46.5	0.2
Shale, dark gray; contains scattered pyritized brachiopod shells and sandy pyritic lenses up to 0.5 in. thick and 1 in. long; weakly calcareous	46.7	7.8
Limestone, light brownish gray, dense, hard, nonfossiliferous	54.5	0.2
Shale, dark gray, noncalcareous, includes some thin calcite crusts on stratification surfaces; contains 3-in.-thick, light brownish gray limestone layers at 56.5 and 60 ft	54.7	10.3
Limestone, light brownish gray, very hard, nonfossiliferous	65.0	0.4
Shale, dark gray, noncalcareous	65.4	12.8
Shale, dark gray, highly calcareous; contains calcareous and pyritic brachiopod shells	78.2	1.6
Limestone, medium gray, impure, shaly; includes abundant fossil brachiopod shells and fragments	79.8	0.2
Limestone, dark gray, highly shaly, fossil brachiopod shells sparsely distributed	80.0	0.8
Limestone, medium gray, hard, very highly fossiliferous, brachiopods abundant, shaly in part (Inola Limestone)	80.8	3.1
Shale, dark gray, hard, very highly calcareous; includes some 1- to 2-in.-thick bands of shaly, highly fossiliferous limestone as well as several horizontal and diagonal veinlets of white calcite	83.9	4.8
Limestone, light gray with dark gray matrix, hard, pyritic at base; very highly fossiliferous; brachiopod shells and fossil hash abundant	88.7	0.2
Coal, black, bright, banded, moderately friable, pyritic at top (unnamed coal)	88.9	0.3
Shale, grayish black, hard, pyritic, noncalcareous	89.2	0.7
Coal, black, shaly, highly pyritic (Peters Chapel coal)	89.9	0.6
Coal, black, bright, moderately friable (Peters Chapel coal)	90.5	1.4
Shale, brownish black, highly carbonaceous; contains thin stringers of irregularly spaced bright coal throughout unit	91.9	7.4

Appendix 2: Measured Sections and Core-Hole Logs

Sandstone, medium gray, very fine grained, impure, silty and shaly	99.3	0.5
Shale, medium dark gray to dark gray with light gray and light brownish gray bands; interbedded at regular intervals with very fine grained sandstone and siltstone layers 1/64 to 1.5 in. thick that are cross-laminated, contorted in part and bioturbated in places; noncalcareous	99.8	11.5
Shale, medium dark gray, noncalcareous	111.3	5.5
Shale, dark gray with light brownish gray bands; interbedded at irregular intervals with very fine grained sandstone and siltstone layers 1/64 to 1 in. thick that are cross-laminated and bioturbated in places; noncalcareous; includes some hard light olive gray ironstone concretions occurring as layers ~0.5 in. thick and as spheroidal masses up to 8 in. in diameter	116.8	9.2
Shale, medium dark gray, highly silty; contains some pyrite nodules up to 2 in. long and 0.5 in. thick; includes abundant coalified plant compressions; grades into underlying unit	126.0	3.0
Siltstone, medium dark gray; includes a minor amount of very fine grained sandstone; bioturbated; contains abundant coalified plant compressions	129.0	3.7
Shale, dark gray, very highly silty, carbonaceous; contains abundant, very thin stringers of coal; coaly shale from 135.7 to 136.0 ft (Secor coal interval?)	132.7	3.3
Siltstone, medium dark gray, shaly, interlaminated with minor, very fine grained sandstone; grades into underlying unit	136.0	2.0
Sandstone, medium gray with light gray bands, very fine grained, shaly, interlaminated with siltstone, wavy-bedded, bioturbated, noncalcareous, micaceous; contains black carbonized, comminuted plant debris on stratification surfaces (Bluejacket Sandstone)	138.0	15.6
Shale, grayish black, hard, brittle, noncalcareous	153.6	1.0
Sandstone, medium gray with light gray bands, very fine grained, bioturbated, noncalcareous, micaceous; includes abundant black carbonized plant debris on stratification surfaces; wavy-bedded to even-bedded; siltstone in part (Bluejacket Sandstone)	154.6	<u>15.4</u>
Total Depth		170.0

CORE-HOLE LOG 15

SW¼SW¼NW¼NE¼NW¼ sec 29, T. 13 N., R. 18 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled at south edge of farm pond directly east of driveway 560 ft FNL and 1400 ft FWL. Field notebook designation C-MM-50. Surface elevation, estimated from topographic map, 540 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, very fine, silty, contains organic material	0.0	1.0
Sand, pale yellowish brown, very fine, silty	1.0	1.0
Sand, dark yellowish orange, very fine, clayey, oxidized	2.0	2.5
Sand and gravel, light brown, clayey, weathered	4.5	2.5
Clay, grayish orange, sandy, gravelly	7.0	2.0
KREBS GROUP		
McAlester Formation:		
Shale, pale yellowish brown with dark yellowish orange bands, clayey, weathered	9.0	1.5
Shale, dark yellowish brown to brownish gray, partly weathered	10.5	1.5
Shale, dark gray; contains abundant siltstone-filled burrows and thin siltstone lenses, fractured; includes some white calcite along fracture surfaces; contains light brownish gray sideritic concretions ~0.5 in. thick	12.0	18.0
Siltstone and shale, interbedded, medium dark gray and medium light gray; includes some stringers of very fine grained sandstone; extensively burrowed, fractured, slickensided; includes white calcite occurring in vertical veins up to 1/8 in. thick	30.0	7.5
Shale, dark gray with medium light gray siltstone laminae, bioturbated, fractured; includes light brownish gray sideritic concretions up to 1.5 in. thick; contains white calcite in vertical veins	37.5	5.0
Siltstone, medium light gray, shaly; wavy-bedded, extensively bioturbated; noncalcareous; includes some contorted thin strata of very fine grained sandstone	42.5	0.7
Shale, dark gray, noncalcareous, fractured, slickensided; includes light brownish gray sideritic concretions up to 2.5 in. thick	43.2	10.1

Coal, black, moderately friable, very impure, shaly (unnamed coal)	53.3	0.1
Underclay, medium light gray, bioturbated, slickensided, silty in part; includes some brownish black carbonaceous streaks; grades into underlying shale unit	53.3	0.1
Shale, medium gray, silty, bioturbated	56.2	1.8
Shale, dark gray, silty; contains fossil plant-leaf compressions in upper 1 ft; includes pyritized and calcareous brachiopod fossils, bioturbation features and sideritic concretions up to 1 in. thick, and white calcite occurring as fracture fillings	58.0	4.0
Shale, dark gray, silty; includes bioturbation features and light brownish gray sideritic concretions 1/8 to 2 in. thick; contains sparsely distributed calcareous brachiopod shells and minor pyrite; slickensided; grayish black in bottom 5 ft	62.0	39.7
Sandstone, medium light gray with dark gray bands, very fine grained, shaly, massive to wavy-laminated in part, noncalcareous, bioturbated; includes streaks of coal and black comminuted plant material; cross-bedded in places	101.7	7.9
Siltstone, medium dark gray, sandy, noncalcareous; includes thin streaks of coal in lower 2 in.	109.6	0.5
Shale, dark gray, very silty, noncalcareous; includes abundant light brownish gray sideritic concretions 1/8 to 1 in. in diameter; contains some thin laminae of very fine grained sandstone; slickensided	110.1	7.4
Shale, black, noncalcareous, carbonaceous; contains abundant plant compressions and thin stringers of coal; coaly shale in bottom 8 in. of unit	117.5	3.8
Shale, dark gray, silty, slickensided; contains black carbonized plant compressions; grades into underlying unit	121.3	1.5
Siltstone, medium dark gray, noncalcareous, bioturbated; contains thin, wavy laminae of light gray, very fine grained sandstone; includes some black carbonized plant compressions; grades into underlying unit	122.8	3.2
Sandstone, medium dark gray with very light gray laminae, very fine grained, even-bedded, shaly, extensively bioturbated; below 132 ft becomes light gray with medium dark gray bands (Warner Sandstone)	126.0	<u>34.0</u>
Total Depth		160.0

CORE-HOLE LOG 16

NE 1/4 NW 1/4 NW 1/4 NW 1/4 sec 3, T. 13 N., R. 19 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture north of building site 270 ft FWL and 115 ft FNL. Field notebook designation C-MM-15. Surface elevation, estimated from topographic map, 658 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate yellowish brown, very fine grained, silty, unbedded; contains organic material (soil)	0.0	2.5
KREBS GROUP		
McAlester Formation:		
Sandstone, moderate reddish brown to dark yellowish orange, very fine to fine-grained, noncalcareous, well indurated; includes some soft shaly layers (Warner Sandstone)	2.5	5.5
Sandstone, grayish orange to very pale orange with light brown bands, very fine to fine-grained, micaceous, noncalcareous, cross-bedded; includes some shaly layers and some ferruginous concretions ~1.5 in. long and 0.25 in. thick (Warner Sandstone)	8.0	5.8
Shale, grayish orange and dark yellowish orange, banded, micaceous, interbedded with very fine grained sandstone, silty; includes some light brown concretionary layers	13.8	2.7
Shale, medium gray with dark gray bands, silty	16.5	0.8
Shale, black, highly carbonaceous; includes laminae of bright coal	17.3	0.2
Coal, black, bright, moderately friable, moderate reddish brown iron-oxide deposits on cleat surfaces (Keefon coal)	17.5	0.7
Underclay, light gray; contains black carbonized plant fragments	18.2	<u>0.3</u>
Total Depth		18.5

Appendix 2: Measured Sections and Core-Hole Logs

CORE-HOLE LOG 17

SW¼SE¼NW¼NE¼ sec 26, T. 14 N., R. 15 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at north edge of pond 1660 ft FEL and 1200 ft FNL. Field notebook designation C-MM-58. Surface elevation, estimated from topographic map, 625 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, dark yellowish brown, well-sorted; contains organic matter	0.0	2.0
Sand, moderate yellowish brown, gravelly; contains abundant clay in matrix; includes clasts of oxidized, moderate reddish brown clay ironstone and blackish red-stained sandstone; weathered	2.0	8.0
CABANISS GROUP		
Senora Formation:		
Shale, dark yellowish brown to olive gray with olive black streaks, noncalcareous, weathered, contains bands of moderate reddish brown ironstone; becomes grayish black with moderate reddish brown bands below 11 ft	10.0	2.8
Shale, black, calcareous; contains scattered, white fossil shells and shell fragments	12.8	4.0
Shale, grayish black, noncalcareous	16.8	2.4
Limestone, medium dark gray, hard, impure, silty; contains abundant fossil hash (Tiawah Limestone)	19.2	0.4
Shale, grayish black, noncalcareous	19.6	0.3
Limestone, medium dark gray, hard, impure, silty; contains abundant fossil hash Shale, black, calcareous; contains scattered white fossil shells and light brownish gray, sideritic concretions up to 2.5 in. thick; includes some pyrite-filled burrows	19.9	0.1
Shale, black, noncalcareous; contains rare fossil shells; calcareous from 29.5 to 29.8 ft	20.0	6.5
Shale, grayish black, noncalcareous	26.5	3.5
Coal, black, moderately friable; contains white calcite on cleats and thin layers of pyrite on bedding surfaces (Tebo coal)	30.0	1.4
Underclay, medium light gray; contains rare, black, carbonized plant fragments; feels soapy; grades into underlying unit	31.4	0.6
Shale, medium light gray, soft, clayey, noncalcareous	32.0	5.3
Shale, medium gray, noncalcareous; contains disseminated pyrite; grades into underlying unit	37.3	1.4
Shale, medium dark gray, noncalcareous; contains light brownish gray, sideritic concretions up to 1.5 in. thick; becomes dark gray to grayish black in lower 2 ft; includes white calcite on fracture surfaces in lower 2 in.; contact with underlying unit sharp	38.7	4.3
Coal, black, hard; contains disseminated pyrite and white calcite on cleat surfaces (RC coal)	43.0	10.4
Sandstone, very light gray, very fine grained, noncalcareous, rooted, churned; contains black, carbonized plant fragments and abundant disseminated pyrite; grades downward into coarse siltstone	53.4	0.1
Siltstone, medium gray, sandy, noncalcareous, micaceous; contains light brownish gray, sideritic concretions up to 1.5 in. thick; indistinctly rippled	53.5	3.5
Shale, dark gray, hard, brittle, silty, noncalcareous; contains white, calcareous fossil brachiopods from 58.6 to 62.3 ft; includes rare, yellowish gray, calcareous and sideritic concretions up to 1 in. thick, as well as pyrite-filled burrows and lenses	57.0	1.6
Shale, medium dark gray, noncalcareous, silty; contains rare pyrite-filled burrows; includes white calcite in fracture-fillings from 100.0 to 103.0 ft	58.6	41.4
Shale, dark gray to grayish black, silty, noncalcareous; contains rare pyritized brachiopods	100.0	6.0
Ironstone, light brownish gray; contains white, calcareous fossil shells at contact with underlying unit	106.0	5.1
Shale, dark gray with light brownish gray bands, noncalcareous, silty; contains scattered, pyrite-filled burrows and rare, small, light brownish gray, sideritic concretions, as well as rare, calcareous fossil brachiopod shells	111.1	0.3
Ironstone, yellowish gray, weakly calcareous; contains scattered, white, calcareous fossil shell fragments	111.4	53.2
Shale, grayish black; noncalcareous, except in upper 1 in. of unit; contains rare pyritized brachiopod fossils and pyrite-filled burrows	164.6	0.3
Ironstone, light brownish gray, weakly calcareous; contains rare, white, calcareous fossil shell fragments	164.9	5.8
	170.7	0.2

Shale, medium dark gray with light brownish gray bands, noncalcareous; contains sideritic layers and rare pyrite-filled burrows	170.9	3.9
Sandstone, very light gray with medium dark gray bands, very fine grained, micaceous, shaly, noncalcareous, thin-bedded, rippled, burrowed, cross-laminated; contains some contorted beds, scour features, and dewatering features; includes black, comminuted plant debris on stratification planes . . .	174.8	7.9
Sandstone, medium dark gray with sparse white streaks, silty, micaceous, noncalcareous; contains flat beds, contorted beds, wavy beds, scour features, and load features	182.7	7.9
Sandstone, medium dark gray and very light gray, very fine grained, shaly, micaceous, thin-bedded, noncalcareous, rippled, cross-bedded, flat-bedded; contains rare burrows and black, comminuted plant debris on bedding planes .	190.6	6.4
Siltstone, medium gray with very light gray sandstone streaks, flat-bedded, noncalcareous, micaceous, grades into underlying unit	197.0	4.0
Shale, medium gray, silty, hard, noncalcareous; includes some dark gray bands and light brownish gray, sideritic concretions up to 1 in. thick	201.0	5.5
Shale, grayish black, noncalcareous; contains several yellowish gray sideritic bands from 0.25 to 0.75 in. thick; includes rare fossil brachiopods	206.5	<u>9.5</u>
Total Depth		216.0

CORE-HOLE LOG 18

SW¼NW¼NW¼SW¼ sec 4, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-11. Surface elevation, estimated from topographic map, 572 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, pale yellowish brown, sandy, unbedded; contains organic matter (soil)	0.0	2.0
Gravel, light brown, fine-grained, clayey	2.0	0.3
Clay, moderate yellowish brown, soft, weathered	2.3	9.7
KREBS GROUP		
Boggy Formation:		
Shale, medium dark gray with dark yellowish orange mottling, weathered	12.0	1.4
Shale, dusky yellowish brown with moderate brown and black bands; includes some moderate yellowish brown ironstone concretions ~1 in. thick	13.4	1.6
Shale, black, fissile; includes light brown ironstone concretions	15.0	4.0
Shale, dark gray to grayish black, soft	19.0	6.8
Shale, black, brittle; contains pyritic stringers and white calcite veinlets	25.8	3.6
Limestone, dark gray, impure, silty, fossiliferous; brachiopod and pelecypod shell fragments abundant (Inola Limestone)	29.4	0.9
Coal, black; interfingers with limestone in upper part and grades into carbonaceous shale in lower part (Bluejacket coal)	30.3	0.1
Underclay, medium gray, sandy; contains black coalified plant roots; grades into underlying unit	30.4	1.6
Shale, medium gray, sandy, soft	32.0	0.7
Sandstone, very light gray with medium gray bands, very fine grained, shaly, noncalcareous; grades into underlying unit	32.7	3.7
Siltstone, light gray, interbedded with medium gray shale, noncalcareous	36.4	1.6
Shale, medium dark gray with medium light gray bands, silty, noncalcareous . . .	38.0	2.2
Shale, dark gray with medium gray bands, noncalcareous, sparsely fossiliferous .	40.2	3.3
Shale, black, hard, fossiliferous, calcareous	43.5	2.3
Limestone, dark gray, impure, silty, shaly, fossiliferous; contains broken shell fragments	45.8	0.2
Coal, black, bright, moderately friable; white calcite on cleat surfaces (Peters Chapel coal)	46.0	0.9
Shale, dark gray, silty, noncalcareous	46.9	3.1
Shale, grayish black to black, hard, brittle; includes numerous pinkish gray sideritic concretionary layers 0.5-2.5 in. thick; contains sparsely distributed calcareous fossil brachiopod shells in upper half	50.0	17.2
Sandstone, medium light gray, very fine to fine-grained, noncalcareous, wavy-laminated and cross-bedded, well-indurated; contains a few poorly preserved fossil shells in upper 3 ft; includes abundant layers of medium gray shale, and laminae containing black comminuted fragments in lower 22 ft	67.2	<u>30.8</u>
Total Depth		98.0

Appendix 2: Measured Sections and Core-Hole Logs

CORE-HOLE LOG 19

NW¼NW¼NE¼SW¼ sec 14, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-12. Surface elevation, estimated from topographic map, 710 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, unbedded, very fine grained, silty; contains organic material	0.0	1.8
KREBS GROUP		
Boggy Formation:		
Sandstone, light brown, fine- to very fine grained, soft, weathered, unconsolidated, noncalcareous	1.8	2.7
Sandstone, dark yellowish orange, fine- to very fine grained, noncalcareous, weathered; includes some hard layers	4.5	3.5
Sandstone, grayish orange with moderate brown banding, fine- to very fine grained, noncalcareous; includes some grayish orange to medium gray shale layers about 0.5-1 in. thick	8.0	15.5
Sandstone, yellowish gray with medium dark gray shale layers up to 0.25 in. thick, fine- to very fine grained, cross-laminated, micaceous, noncalcareous; becomes medium light gray at 27.5 ft; includes abundant laminae of black comminuted plant material (Bluejacket Sandstone)	23.5	14.5
Savanna Formation:		
Shale, dark-gray silty, noncalcareous, uniform in character	38.0	<u>25.0</u>
Total Depth		63.0

CORE-HOLE LOG 20

NE¼NW¼SW¼NE¼NE¼ sec 15, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture about 100 ft southwest from pole shed 700 ft FNL and 1100 ft FEL. Field notebook designation C-MM-54. Surface elevation, estimated from topographic map, 642 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, very fine grained, silty, contains organic material	0.0	0.5
KREBS GROUP		
Boggy Formation:		
Sandstone, moderate brown, ferruginous, very fine grained, weathered	0.5	0.5
Sandstone, light brown, fine- to very fine grained, ferruginous, weathered	1.0	3.2
Sandstone, moderate reddish brown with grayish orange and dark yellowish orange bands, very fine grained, silty, clayey; wavy-laminated and cross-laminated (Crekola Sandstone)	4.2	4.8
Siltstone, pale yellowish brown, shaly, sandy	9.0	1.2
Shale, dusky yellowish brown with dark yellowish orange and dark gray bands, clayey	10.2	2.8
Shale, grayish black with dark yellowish orange bands; includes thin layers of clay ironstone	13.0	3.6
Shale, black, carbonaceous	16.6	0.4
Coal, black, moderately friable; dark reddish brown iron oxide deposits on cleat surfaces; includes some pyritic laminae (Peters Chapel coal)	17.0	0.6
Shale, medium gray to medium dark gray, silty, noncalcareous, bioturbated; contains some pyritic burrows and 0.5- to 1-in.-thick, light brownish gray sideritic concretions	17.6	18.5
Shale, dark gray, calcareous; contains some sparsely distributed, white, fossil brachiopod shells	36.1	1.9
Shale, grayish black to black, noncalcareous; includes some hard, dense, pyritic, sideritic concretions 0.5-3 in. thick	38.0	7.5
Shale, black, very calcareous, carbonaceous; contains small pyrite-filled burrows and marine shell fragments	45.5	0.4

Limestone, medium dark gray, hard, impure, silty; contains abundant fossil shell fragments	45.9	0.2
Coal, black, impure, interlaminated with carbonaceous shale; contains disseminated pyrite (Secor Rider coal)	46.1	0.2
Shale, grayish black, very carbonaceous, pyritic, bioturbated in lower part	46.3	0.1
Underclay, medium light gray, bioturbated, kaolinitic	46.4	0.2
Siltstone, medium gray, hard, bioturbated, unbedded	46.6	0.2
Shale, black, silty, hard, carbonaceous, bioturbated	46.8	0.3
Coal, black, impure and shaly in upper 0.5 in.; contains numerous pyrite lenses ~0.25 in. thick and 0.75 in. long (Secor coal)	47.1	0.2
Shale, dark gray, slickensided; includes a 1/8-in.-thick layer of black, bright coal at base of unit	47.3	0.4
Underclay, medium light gray; includes abundant black carbonized plant compressions and disseminated pyrite	47.7	0.7
Shale, medium light gray, noncalcareous, silty, bioturbated; grades into underlying unit	48.4	1.6
Siltstone, medium gray, shaly, noncalcareous, laminated, bioturbated; includes some thin laminae of light gray, very fine grained sandstone; grades into underlying unit	50.0	3.3
Sandstone, medium gray and light gray, very fine grained, silty, shaly, noncalcareous, laminated, microfaulted in places, bioturbated; contains black comminuted plant fragments; includes numerous soft-sediment deformation features (Bluejacket Sandstone)	53.3	5.7
Sandstone, medium dark gray with light gray laminae, very silty and shaly, very fine grained, even-bedded, noncalcareous; includes black comminuted plant fragments on some stratification surfaces (Bluejacket Sandstone)	59.0	<u>7.0</u>
Total Depth		66.0

CORE-HOLE LOG 21

SW 1/4 NE 1/4 SE 1/4 NE 1/4 SW 1/4 sec 15, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at crest of hill directly west of corral 1740 ft FSL and 2570 ft FWL. Field notebook designation C-MM-56. Surface elevation, estimated from topographic map, 710 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate yellowish brown, very fine grained, silty, contains organic material	0.0	1.0
KREBS GROUP		
Boggy Formation:		
Sandstone, dark reddish brown, very fine grained, indurated, ferruginous, weathered	1.0	2.5
Sandstone, moderate orange pink, very fine grained, very clayey, soft, weathered	3.5	6.0
Sandstone, grayish orange with dark yellowish orange bands, fine- to very fine grained, cross-bedded; contains iron-oxide deposits on parting surfaces	9.5	3.3
Sandstone, light olive gray, fine- to very fine grained, noncalcareous; includes a 2-in.-thick shaly layer from 14.5 to 14.7 ft; contains thin wisps of medium dark gray shaly siltstone; massive, with some interbeds of laminated, shaly sandstone; contains black comminuted plant fragments	12.8	7.2
Sandstone, medium light gray to light olive gray with dark gray bands, very fine grained, shaly, noncalcareous, cross-bedded, wavy-laminated in part; contains black comminuted plant fragments on stratification surfaces; includes soft-sediment deformation features and broken, disrupted beds in places (Bluejacket Sandstone)	20.0	<u>18.0</u>
Total Depth		38.0

Appendix 2: Measured Sections and Core-Hole Logs

CORE-HOLE LOG 22

SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec 15, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in a hay meadow 190 ft FWL and 560 ft FSL. Field notebook designation C-MM-55. Surface elevation, estimated from topographic map, 710 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, very fine grained, silty, unconsolidated, contains organic material	0.0	1.5
KREBS GROUP		
Boggy Formation:		
Sandstone, moderate reddish orange to light brown, very fine grained, well-sorted, well-rounded, friable, weathered, noncalcareous (Crekola Sandstone)	1.5	2.5
Sandstone, grayish orange to dark yellowish orange with moderate reddish brown flecks, very fine grained, well-sorted, well-rounded, moderately friable, weathered, noncalcareous	4.0	4.0
Sandstone, light brown to grayish orange with moderate reddish brown bands and black streaks, very fine to fine-grained, noncalcareous, cross-bedded; contains some clayey shale layers and thin coal laminae as well as black comminuted plant material	8.0	8.3
Sandstone, medium gray, fine- to medium-grained, noncalcareous; cross-bedded; contains abundant laminae of black coal; includes some sparsely distributed medium dark gray clay-shale layers up to $\frac{1}{8}$ in. thick	16.3	4.4
Sandstone, medium dark gray with medium gray bands, very fine grained, shaly, noncalcareous, wavy, laminated	20.7	0.8
Shale, brownish gray to olive black, clayey, very carbonaceous; contains black carbonized plant material	21.5	1.0
Coal, black, bright, moderately friable; contains minor pyritic laminae (Secor coal)	22.5	0.7
Underclay, light gray, kaolinitic, bioturbated, contains black carbonized plant fragments	23.2	5.8
Sandstone, medium dark gray with light gray bands, very silty and shaly, very fine grained, cross-bedded and cross-laminated, micaceous, noncalcareous, bioturbated in places	29.0	7.4
Sandstone, light olive gray with medium dark gray bands, very fine to fine-grained, shaly in part, noncalcareous, bioturbated in part, cross-bedded; contains some shaly laminated beds interbedded with thicker massive beds; massive, with thin wisps of medium dark gray shaly siltstone from 48 to 57 ft and from 62.5 to 77.0 ft; includes some black comminuted plant fragments in places	36.4	40.6
Conglomerate, light brownish gray; contains numerous rounded shale pebbles up to 1 in. long and 0.25 in. thick; contact with overlying and underlying units sharp	77.0	0.1
Sandstone, dark gray with light gray bands, very fine grained, shaly, noncalcareous, extensively bioturbated, cross-laminated; includes abundant black comminuted plant material on stratification surfaces	77.1	<u>9.9</u>
Total Depth		87.0

CORE-HOLE LOG 23

SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec 16, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture directly north of farm pond 120 ft FWL and 2200 ft FNL. Field notebook designation C-MM-53. Surface elevation, estimated from topographic map, 605 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, silty, contains organic material	0.0	0.5
KREBS GROUP		
Boggy Formation:		
Sandstone, grayish orange, very fine grained, noncalcareous, micaceous, ripple-marked, oxidized; crops out sporadically near drill site	0.5	5.5

Sandstone, medium light gray with light brown flecks, very fine grained, well-indurated	6.0	2.0
Sandstone, medium light gray with medium dark gray bands, very fine grained, shaly, noncalcareous, cross-laminated, cross-bedded, wavy-bedded in part; contains black comminuted plant fragments on stratification surfaces; includes some scour-and-fill features and soft-sediment deformation features	8.0	21.3
Siltstone, medium dark gray, shaly, noncalcareous, even- to wavy-laminated; includes minor streaks and small lenses of light gray, very fine grained sandstone	29.3	4.7
Sandstone, light olive gray; predominantly fine- to medium-grained and massive, but includes some interbeds of medium dark gray and very light gray, cross-laminated, shaly, very fine grained sandstone; noncalcareous; bioturbated in part; contains some black comminuted plant material; contact with overlying unit sharp (Bluejacket Sandstone)	34.0	<u>24.0</u>
Total Depth		58.0

CORE-HOLE LOG 24

SW¼NW¼NE¼NW¼SW¼ sec 17, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in hay meadow just west of shallow ravine 860 ft FWL and 2380 ft FSL. Field notebook designation C-MM-57. Surface elevation, estimated from topographic map, 573 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, dusky brown, contains organic material	0.0	3.0
Silt, moderate brown, clayey, sandy, gravelly at base of unit; gravel contains abundant clasts of hard, black, brittle shale	3.0	1.0
KREBS GROUP		
Boggy Formation:		
Limestone, medium dark gray, hard, impure, silty, highly fossiliferous, crinoid columnals abundant; weathers brownish gray (Inola Limestone)	4.0	0.5
Clay, grayish brown to dark yellowish brown, calcareous	4.5	0.4
Clay, brownish black, soft, smutty, highly weathered (Bluejacket coal)	4.9	0.1
Underclay, light gray with dark yellowish orange mottling, kaolinitic, calcareous; contains black carbonized plant fragments	5.0	1.5
Sandstone, dark reddish brown to medium light gray, very fine grained, micaceous, noncalcareous, massive	6.5	5.0
Sandstone, dark yellowish orange, very fine grained, shaly, soft, oxidized, friable	11.5	0.5
Sandstone, light gray with medium gray bands, very fine-grained, silty, shaly, laminated, noncalcareous (Crekola Sandstone)	12.0	4.5
Shale, dark gray, silty, becomes grayish black around 19.5 ft, noncalcareous; contains sparsely distributed brachiopod fossils; includes rare light brownish gray sideritic concretions up to 1 in. thick	16.5	6.0
Limestone, grayish black, impure, shaly, carbonaceous; contains abundant brachiopod fossils	22.5	0.1
Coal, black, bright, moderately friable; contains minor pyrite and light gray calcite on cleavage surfaces (Peters Chapel coal)	22.6	0.8
Underclay, medium dark gray, bioturbated; contains black carbonized plant fossils	23.4	0.9
Shale, medium dark gray, silty, bioturbated; contains numerous pyrite-filled burrows	24.3	5.7
Shale, dark gray to grayish black, contains pyrite-filled burrows, noncalcareous; includes light brownish gray sideritic concretions 0.5-3 in. thick, generally spaced in vertical intervals 8-18 in. apart	30.0	16.8
Shale, black, noncalcareous	46.8	1.0
Shale, black, very highly calcareous, fossil marine shells abundant	47.8	0.6
Limestone, dark gray, hard, impure, highly fossiliferous, fossil marine shells and shell fragments abundant	48.4	0.2
Siltstone, grayish black, hard, carbonaceous; grades into underlying unit	48.6	0.1
Coal, black, moderately friable, impure and silty in upper 0.5 in. (Secor Rider coal)	48.7	0.2
Underclay, medium gray, carbonaceous in upper 1 in., slickensided, bioturbated, kaolinitic	48.9	0.8
Siltstone, medium light gray, shaly, contains black carbonized plant fragments, bioturbated, noncalcareous	49.7	2.5

Appendix 2: Measured Sections and Core-Hole Logs

Coal, black, bright, moderately friable (Secor coal)	52.2	0.2
Shale, grayish black, very carbonaceous; contains coal stringers up to 0.25 in. thick in upper 3 in. of unit	52.4	0.6
Underclay, medium light gray, slickensided, bedding disturbed; contains black carbonized plant fossils and minor pyrite	53.0	1.5
Shale, medium gray, silty, contains well-preserved plant fossils; grades into underlying unit	54.5	1.0
Siltstone, medium gray, shaly, noncalcareous, laminated; includes some thin stringers of light gray, very fine grained sandstone; grades into underlying unit	55.5	3.5
Sandstone, medium gray with light gray laminae, shaly, noncalcareous, even-bedded to cross-bedded below 62 ft; soft-sediment deformation features common; bioturbated in places (Bluejacket Sandstone)	59.0	<u>11.0</u>
Total Depth		70.0

CORE-HOLE LOG 25

SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec 18, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-10. Surface elevation, estimated from topographic map, 580 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, pale yellowish brown, sandy, unbedded; contains organic material (soil) . . .	0.0	2.0
Gravel, dusky brown, highly silty; gravel fraction predominantly fragments of ironstone concretions	2.0	0.5
Clay, grayish brown, highly silty and sandy	2.5	3.5
Clay, dark yellowish brown, sandy, soft, weathered	6.0	6.7
KREBS GROUP		
Boggy Formation:		
Shale, black, laminated, soft and grayish brown in upper 6 in.	12.7	8.3
Limestone, medium dark gray, impure, shaly, highly fossiliferous, brachiopods most abundant (Inola Limestone)	21.0	0.8
Coal, black, bright, moderately friable (Bluejacket coal)	21.8	0.7
Shale, grayish black, very highly carbonaceous	22.5	0.1
Underclay, medium gray; includes some black carbonized plant fragments	22.6	0.9
Sandstone, very light gray to medium light gray, very fine grained, cross-bedded and wavy-laminated, well-indurated	23.5	2.0
Sandstone, grayish black, highly carbonaceous, very fine grained	25.5	0.1
Shale, medium dark gray, slickensided; contains a few medium light gray sideritic concretions ~1 in. thick; fractured	25.6	<u>7.4</u>
Total Depth		33.0

CORE-HOLE LOG 26

SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec 18, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-10A. Surface elevation, estimated from topographic map, 580 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, pale yellowish brown, sandy, unbedded; contains organic material	0.0	2.0
Gravel, dusky brown, highly silty; gravel fraction predominantly fragments of ironstone concretions	2.0	0.5
Clay, grayish brown, highly silty and sandy	2.5	3.5
Clay, dark yellowish brown, sandy, soft, weathered	6.0	7.3
KREBS GROUP		
Boggy Formation		
Shale, black, laminated; soft and grayish brown in upper 6 in.	13.3	3.5
Limestone, medium dark gray, impure, shaly, highly fossiliferous, brachiopods most abundant; most shaly in lower part	16.8	0.9
Shale, medium gray, clayey; contains black carbonized root fragments	17.7	1.0

Sandstone, very light gray to medium light gray, very fine grained, massive, calcareous	18.7	0.4
Shale, medium dark gray with dark gray bands	19.1	0.4
Sandstone, medium gray with dark gray bands, very fine grained, laminated; includes some layers of black comminuted plant material	19.5	0.1
Shale, dark gray, soft, slickensided	19.6	0.7
Limestone, medium dark gray; hard, shaly; contains a few fossil shell fragments	20.3	0.2
Shale, dark gray to grayish black	20.5	1.5
Limestone, medium dark gray, impure, shaly, laminated, highly fossiliferous, brachiopods most abundant; highly shaly in lower 8 in.; black and carbonaceous in lower 2 in. (Inola Limestone)	22.0	1.3
Coal, black, bright, moderately friable; includes some pyritic laminae; white calcite on cleat surfaces (Bluejacket coal)	23.3	0.6
Sandstone, dark gray, carbonaceous, silty, shaly, fine-grained, noncalcareous, bedding disturbed	23.9	0.4
Shale, medium dark gray, silty	24.3	5.7
Shale, grayish black, slickensided; includes layers of medium light gray sideritic concretions 0.5-2 in. thick	30.0	10.4
Siltstone, medium light gray, shaly, laminated; includes some very fine grained sandstone	40.4	2.6
Coal, black, bright, very friable (Peters Chapel coal)	43.0	1.2
Shale, black, carbonaceous; interlaminated with thin layers of bright coal	44.2	0.2
Shale, dark gray, slickensided; contains black carbonized plant compressions	44.4	0.5
Sandstone, light gray, fine grained; wavy-laminated, with black streaks of comminuted plant fragments in upper 3 in.; massive in lower 5 in.	44.9	0.7
Shale, dark gray, soft	45.6	0.1
Siltstone, medium gray, shaly, noncalcareous; grades into underlying unit	45.7	3.6
Sandstone, medium light gray, silty, shaly, very fine grained, cross-laminated	49.3	1.7
Sandstone, medium dark gray with light gray bands, shaly, very fine grained, wavy-laminated, cross-laminated in part, noncalcareous; includes minor bioturbation; microfaulted in part; well indurated; becomes predominantly light gray below 55 ft; grain size increases downward and shale laminae occur less frequently; includes abundant black comminuted plant material on stratification surfaces	51.0	<u>38.0</u>
Total Depth		89.0

CORE-HOLE LOG 27

NE¼NW¼NW¼SE¼SW¼ sec 21, T. 14 N., R. 17 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in hay meadow at west edge of pond 1550 ft FWL and 1180 ft FSL. Field notebook designation C-MM-52. Surface elevation, estimated from topographic map, 630 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, pale yellowish brown, sandy; contains organic material	0.0	2.0
Silt, dusky yellowish brown, sandy	2.0	2.0
KREBS GROUP		
Boggy Formation:		
Shale, moderate brown to moderate yellowish brown, soft, clayey; contains weathered particles of dark reddish brown clay ironstone	4.0	4.5
Shale, grayish orange, pale yellowish brown and light gray; weathered; contains abundant stringers of dark yellowish orange and moderate reddish brown clay ironstone	8.5	7.5
Shale, medium dark gray; contains several 0.25- to 0.5-in.-thick, moderate reddish brown and very dark red clay ironstone layers	16.0	4.0
Shale, grayish black, fractured, slickensided	20.0	7.5
Ironstone, medium light gray with light brownish gray bands, very hard; includes calcite occurring as fracture fillings, particularly in brecciated bands	27.5	0.4
Shale, black, brittle, slickensided	27.9	0.5
Limestone, medium gray, impure, silty, very fossiliferous; fossil shell fragments predominant (Inola Limestone)	28.4	0.6
Coal, black, impure and shaly in upper and lower 0.5 in., pyritic (Bluejacket coal)	29.0	0.2
Underclay, medium dark gray; bioturbated, slickensided, kaolinitic; contains pyrite-filled burrows	29.2	0.6

Appendix 2: Measured Sections and Core-Hole Logs

Sandstone, medium light gray, very fine grained, silty, clayey, bioturbated, kaolinitic; contains black carbonized plant fragments; bedding disturbed and obscure	29.8	2.2
Underclay, medium light gray, silty, bioturbated, kaolinitic	32.0	1.5
Shale, medium dark gray with black streaks; carbonaceous in upper 6 in.; noncalcareous; contains black carbonized plant fossils on stratification surfaces; slickensided	33.5	3.3
Sandstone, medium light gray with light gray bands, very fine grained, very silty, thinly laminated, noncalcareous, bioturbated, contains rare pyrite-filled burrows; cross-laminated and cross-bedded, fines upward; becomes medium dark gray with medium light gray bands at ~50 ft; includes some sparsely distributed, black carbonized plant fragments	36.8	37.2
Shale, brownish black with light brownish gray bands, hard, laminated, noncalcareous	74.0	0.4
Coal, black, moderately friable; includes some thin shaly and pyritic laminae in upper 1 in. of unit (Secor coal)	74.4	0.4
Shale, dark gray; contains some thin black layers of coalified plant material in upper 3 in.; extensively bioturbated; becomes silty downward and grades into underlying unit	74.8	2.0
Siltstone, medium gray, shaly, grades into underlying unit	76.8	1.2
Sandstone, medium gray, very fine grained, silty, shaly, noncalcareous; contains some black, well-preserved plant fossils; thinly laminated	78.0	<u>2.0</u>
Total Depth		80.0

CORE-HOLE LOG 28

SW¼NE¼NE¼NW¼ sec 32, T. 14 N., R. 18 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-14. Surface elevation, estimated from topographic map, 602 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, grayish brown, silty, unbedded, contains organic material (soil)	0.0	2.0
Sand, moderate reddish brown, fine grained, unconsolidated	2.0	2.0
Clay, moderate yellowish brown, gravelly; gravel clasts consist predominantly of very dusky red ironstone; possibly highly weathered shale in part	4.0	4.0
KREBS GROUP		
Boggy Formation:		
Shale, very pale orange to dark yellowish orange, soft, weathered; includes light brown ironstone concretions	8.0	0.8
Sandstone, dusky yellow to grayish orange, shaly, micaceous, very fine grained, soft, oxidized, contains black carbonized plant fragments; includes a well-indurated, dark reddish brown to dusky brown 1-ft-thick layer of well-sorted sandstone at bottom of unit (Crekola Sandstone)	8.8	5.2
Shale, dark gray to black; includes some light brownish gray sideritic concretions	14.0	7.9
Shale, black, coaly, highly pyritic	21.9	0.1
Coal, black, bright, moderately friable; includes minor small pyritic lenses (Peters Chapel coal)	22.0	0.5
Shale, dark gray, noncalcareous	22.5	<u>2.5</u>
Total Depth		25.0

CORE-HOLE LOG 29

SW¼NW¼NW¼NW¼ sec 32, T. 14 N., R. 18 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-13. Surface elevation, estimated from topographic map, 587 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate brown, silty, unbedded; contains organic matter	0.0	2.0
Sand, moderate reddish brown to grayish orange, highly clayey, weathered	2.0	3.0

KREBS GROUP

Boggy Formation:

Shale, black, brittle	5.0	1.0
Limestone, medium gray, hard, impure; contains abundant fossil hash (Inola Limestone)	6.0	0.8
Underclay, very pale orange to pale yellowish orange, soft, weathered; contains black coaly streaks	6.8	1.1
Shale, dark yellowish orange to grayish orange, soft, weathered; becomes silty downward	7.9	1.8
Sandstone, very light gray with medium dark gray bands, shaly, very fine grained, bioturbated in part, wavy-laminated; includes abundant black macerated plant material on stratification surfaces below 15 ft (Crekola Sandstone)	9.7	6.3
Shale, black with light gray bands, fissile, carbonaceous; includes wavy-laminated stringers of siltstone and very fine grained sandstone	16.0	7.4
Shale, black, coaly, pyritic	23.4	0.1
Coal, black, moderately friable (Peters Chapel coal)	23.5	0.8
Shale, dark gray, noncalcareous, sparsely fossiliferous	24.3	5.7
Shale, grayish black, noncalcareous, includes scattered light brownish gray sideritic concretions up to 1.5 in. thick; pyritic in places	30.0	28.6
Underclay, brownish gray, sandy; contains black carbonized plant compressions and streaks of black carbonaceous shale, brecciated in upper half	58.6	0.3
Sandstone, medium light gray, silty, very fine grained, noncalcareous, bedding obscure; contains inclusions of black carbonaceous shale (Bluejacket Sandstone)	58.9	<u>1.1</u>
Total Depth		60.0

CORE-HOLE LOG 30

SW¼SW¼SW¼NW¼ sec 11, T. 15 N., R. 18 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled at edge of driveway 2600 ft FNL and 45 ft FWL. Field notebook designation C-MM-60. Surface elevation, estimated from topographic map, 542 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
DESMOINESIAN SERIES		
KREBS GROUP		
McAlester Formation:		
Shale, pale yellowish brown to moderate yellowish brown, soft, clayey, noncalcareous; contains stringers of moderate reddish brown clay ironstone	0.0	4.5
Shale, moderate reddish orange, soft, clayey, noncalcareous, ferruginous	4.5	0.1
Shale, blackish red with pale yellowish orange and light brown staining, carbonaceous; contains thin layers of coal	4.6	0.1
Coal, black, bright, very friable; moderate reddish brown iron-oxide staining on cleat surfaces (Keefton coal)	4.7	0.4
Underclay, medium light gray to medium gray, micaceous; contains streaks of dark yellowish orange iron oxide and abundant black, carbonized plant fragments	5.1	0.4
Sandstone, yellowish gray with brownish gray streaks, very fine grained, micaceous, noncalcareous; wavy-bedded in part, cross-laminated in part; extensively burrowed from 15 to 19 ft; includes abundant black, comminuted plant debris on stratification surfaces; becomes very light gray with medium dark gray streaks in lower 7 ft of unit; stained by dark yellowish orange iron oxides on fracture surfaces in lower 2 ft; interbedded with shale in lower 0.5 ft (Warner Sandstone)	5.5	15.8
Shale, medium dark gray to dark gray, noncalcareous; contains rare medium gray, sideritic concretions; includes white, calcareous fossil shells from 25.3 to 25.7 ft (top unit of McCurtain Shale)	21.3	6.2
Coal, black, bright, moderately friable; contains pyrite on stratification surfaces (unnamed coal)	27.5	0.1
Underclay, medium gray; blocky fracture; contains black, carbonized plant compressions; includes a 1-in.-thick, dark gray, very carbonaceous zone at top of unit	27.6	1.4
Sandstone, medium dark gray, very silty and shaly, noncalcareous, very fine grained, thin-bedded, burrowed in upper part	29.0	0.9

Appendix 2: Measured Sections and Core-Hole Logs

Shale, medium gray, silty, noncalcareous; blocky fracture	29.9	0.6
Coal, black, bright, moderately friable, 0.5 in. thick (Brushy Mountain coal) . . .	30.5	0.1
Underclay, medium gray, blocky fracture, slickensided	30.6	2.8
Sandstone, medium dark gray, very fine grained, noncalcareous, very silty, massive to obscurely cross-bedded; grades into underlying unit	33.4	1.4
Shale, grayish black, hard, silty, noncalcareous, slickensided; contains rare pyrite-filled burrows and lenses; includes fractured, light brownish gray, sideritic concretions up to 3 in. thick, with white calcite in veinlets filling fractures	34.8	33.7
Shale, grayish black, silty, hard, noncalcareous; contains thin, wavy layers and burrows filled with very light gray, very fine grained sandstone, most abundant from 69.8 to 70.3 ft and 74.5 to 75.9 ft; includes pyrite-filled burrows, light brownish gray, sideritic concretions up to 2 in. thick, and rare fossil brachiopods	68.5	8.2
Shale, grayish black, noncalcareous to weakly calcareous in lower half of unit; contains abundant disseminated pyrite and pyrite in burrows; includes white calcite in crusts on bedding planes (basal unit of McCurtain Shale)	76.7	2.5
Hartshorne Formation:		
Coal, black, bright, moderately friable; includes pyrite in thin laminae concentrated in upper 0.1 ft (Hartshorne coal)	79.2	0.6
Underclay, medium gray, silty, carbonaceous, slickensided	79.8	0.5
Sandstone, light gray with medium gray streaks, very fine grained, micaceous, noncalcareous, rooted in upper part, rippled, cross-laminated, convolute- bedded, burrowed, microfaulted and massive in various places; contains black, comminuted plant debris on some stratification surfaces; grades into underlying unit	80.3	9.5
Siltstone, medium dark gray with light gray, very fine grained sandstone streaks, micaceous, noncalcareous, mostly flat-bedded; contains rare burrows; grades into underlying unit	89.8	9.7
ATOKAN SERIES		
Atoka Formation:		
Shale, medium gray with light brownish gray sideritic bands, silty, noncalcareous; contains broken, white, calcareous fossil shells in lower 1 in. . .	99.5	3.3
Shale, medium light gray, very silty; blocky fracture; crumbly, noncalcareous; contains irregularly shaped pieces of medium dark gray shale; churned in part; includes some dark gray, sandstone-filled burrows; slickensided	102.8	5.2
Shale, grayish black with light brownish gray, sideritic bands, noncalcareous; contains thin pyrite lenses and rare pyrite-filled burrows; includes thin calcite crusts on parting surfaces and abundant black, comminuted plant debris on stratification planes; sideritic bands absent below 120 ft; contains rare, white, calcareous shell fragments below 138 ft	108.0	34.0
Shale, black, noncalcareous; contains light brownish gray, sideritic concretions up to 1 in. thick; fossiliferous; white, calcareous fossil shells concentrated in 0.5-in. layer above a 0.25-in.-thick coal bed at base of unit	142.0	0.5
Sandstone, medium gray, very fine grained, silty, noncalcareous, churned; contains coal spars and some calcite in crusts on fracture surfaces	142.5	1.5
Underclay, medium gray; blocky fracture; shaly	144.0	0.5
Shale, medium dark gray to dark gray, silty, noncalcareous, burrowed	144.5	4.5
Shale, grayish black, noncalcareous; contains rare pyrite-filled burrows and light gray streaks of very fine grained sandstone	149.0	<u>1.0</u>
Total Depth		150.0

CORE-HOLE LOG 31

SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec 19, T. 16 N., R. 15 E., Muskogee County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-4. Surface elevation, estimated from topographic map, 707 ft.

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, pale yellowish brown, very fine grained, silty; contains gravel-size clasts of grayish orange sandstone and organic material	0.0	1.0
Sand, moderate yellowish brown, fine- to very fine grained, clayey; contains brownish black and grayish orange gravel-size clasts of sandstone	1.0	6.5

Appendix 2: Measured Sections and Core-Hole Logs

Clay, pale yellowish brown to light brownish gray with light brown and blackish red mottling, sandy, gravelly, unbedded; contains subangular clasts of dark reddish brown and grayish orange, very fine grained sandstone and ironstone; highly gravelly in lower 2.5 ft	7.5	11.5
CABANISS GROUP		
Senora Formation:		
Shale, dark yellowish brown, weathered, silty; contains thin laminae of very fine grained sandstone	19.0	5.0
Siltstone, medium dark gray with light olive gray bands, shaly, even-bedded to cross-laminated with some contorted bedding, noncalcareous, micaceous; includes numerous laminae of very fine grained sandstone; contains abundant black comminuted plant debris below 33 ft and minor coal streaks from 34.2 to 34.5 ft (Mineral coal interval?)	24.0	13.6
Sandstone, light olive gray, very fine to fine-grained, massive, noncalcareous, micaceous; includes abundant black comminuted plant debris (Chelsea Sandstone)	37.6	<u>2.4</u>
Total Depth		40.0

Appendix 3: Analyses of Coals

In Table A3-1, the analyses are grouped first by township and range, progressing from south to north and west to east, respectively. Within each township block, coal analyses are listed according to the age of the data report, from oldest to youngest. Coal beds are arranged alphabetically by name within the age group. Averages of the data from two or more analyses were computed only if: (1) samples of the coal were collected in the same township; (2) data were reported in the same year; (3) analyses were performed

on coal samples from the same coal bed; (4) analyses were reported under identical conditions, such as "as received basis" or "moisture free basis"; and (5) analyses were done in the same laboratory.

Table A3-2 contains data from individual samples of coal collected and analyzed by OGS personnel. Listing of analyses is alphabetical, by names of coal beds. Location of sample sites can be obtained by referring to the map numbers (see footnote a, Table A3-2).

TABLE A3-1. — AVERAGE ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA

Township/ Range	Coal bed and rank ^a	Sample condition ^b	Proximate Analysis (%)					Sulfur (%)	Btu/lb	Free swelling index	Number of analyses (whole seam)	Data source ^d	Year reported
			Moisture ^c	Volatile matter	Fixed carbon	Ash ^e							
<u>T10N, R19E</u>	Stigler —	1	5.8	27.9	63.8	2.5	0.4	12,049	—	2	USBM	1971	
		2	N/A	29.6	67.7	2.7	0.4	12,790					
		3	N/A	30.4	69.6	N/A	—	13,147					
	Stigler —	1	1.9	29.1	57.6	11.4	5.3	13,294	—	3	Company	1980	
		2	N/A	29.7	58.7	11.6	5.4	13,556					
		3	N/A	33.6	66.4	N/A	—	15,330					
	Stigler hvAb	1	1.4	28.0	58.3	12.3	5.1	13,269	8½	1	OGS	1983	
		2	N/A	28.4	59.1	12.5	5.2	13,457					
		3	N/A	32.4	67.6	N/A	—	15,375					
	Stigler hvAb	1	1.0	29.1	61.8	8.1	1.6	14,066	9	1	OGS	1984	
		2	N/A	29.4	62.4	8.2	1.6	14,208					
		3	N/A	32.0	68.0	N/A	—	15,474					
	Tamaha hvAb	1	1.3	28.1	53.0	17.6	8.2	12,242	7	1	OGS	1984	
		2	N/A	28.5	53.7	17.8	8.3	12,407					
		3	N/A	34.5	65.5	N/A	—	15,101					
<u>T11N, R19E</u>	Stigler —	1	1.5	31.3	56.2	11.0	3.8	13,535	—	1	Company	1978	
		2	N/A	31.7	57.1	11.2	3.9	13,743					
		3	N/A	35.7	64.3	N/A	—	15,479					
<u>T11N, R20E</u>	Stigler hvAb	1	0.2	29.7	59.1	11.0	5.1	13,392	—	1	OGS	1976	
		2	N/A	29.8	59.2	11.0	5.1	13,419					
		3	N/A	33.5	66.5	N/A	—	15,078					
	Stigler hvAb	1	1.0	30.0	59.3	9.7	4.7	13,372	8½	3	OGS	1977	
		2	N/A	30.3	59.9	9.8	4.8	13,502					
		3	N/A	33.6	66.4	N/A	—	14,972					
	Stigler hvAb	1	1.1	29.0	58.2	11.7	5.0	13,324	—	4	Penn. State	1978	
		2	N/A	29.3	58.9	11.8	5.1	13,477					
		3	N/A	33.3	66.7	N/A	5.7	15,269					
	Stigler —	1	1.4	29.6	59.0	10.0	3.6	12,600	—	1	Company	1978	
		2	N/A	30.0	59.9	10.1	3.6	12,774					
		3	N/A	33.4	66.6	N/A	—	14,213					
	Stigler hvAb	1	1.1	30.0	59.9	9.0	4.8	13,783	9	1	OGS	1979	
		2	N/A	30.3	60.6	9.1	4.9	13,941					
		3	N/A	33.3	66.7	N/A	—	15,338					
	Stigler —	1	2.7	27.6	49.3	20.4	5.5	11,665	—	1	Company	1979	
		2	N/A	28.4	50.6	21.0	5.6	11,988					
		3	N/A	35.9	64.1	N/A	—	15,175					
	Keefton hvAb	1	5.0	27.3	59.0	8.7	3.9	13,294	7½	1	OGS	1986	
		2	N/A	28.8	62.1	9.1	4.1	13,991					
		3	N/A	31.6	68.4	N/A	—	15,398					
<u>T12N, R19E</u>	Keefton —	1	1.5	28.5	59.7	10.3	1.2	13,837	6½	1	Company	1977	
		2	N/A	28.9	60.6	10.5	1.3	14,054					
		3	N/A	32.3	67.7	N/A	—	15,695					
	Stigler —	1	1.6	31.6	55.5	11.3	4.5	13,000	—	1	Company	1977	
		2	N/A	32.1	56.5	11.4	4.6	13,211					
		3	N/A	36.3	63.7	N/A	—	14,915					
	Keefton —	1	1.7	34.8	57.5	6.0	0.7	14,003	—	2	Company	1980	
		2	N/A	35.4	58.5	6.1	0.7	14,248					
		3	N/A	37.7	63.3	N/A	—	15,175					

TABLE A3-1 (Continued). — AVERAGE ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA

Township/ Range	Coal bed and rank ^a	Sample condition ^b	Proximate Analysis (%)					Sulfur (%)	Btu/lb	Free swelling index	Number of analyses (whole seam)	Data source ^d	Year reported
			Moisture ^c	Volatile matter	Fixed carbon	Ash ^c							
	Keefton —	1	3.4	33.4	58.1	5.1	0.5	13,311	—	1	Company	1980	
		2	N/A	34.5	60.2	5.3	0.6	13,778					
		3	N/A	36.5	63.5	N/A	—	14,544					
	Keefton hvAb	1	1.2	32.0	54.3	12.5	1.4	13,162	8½	1	OGS	1983	
		2	N/A	32.4	55.0	12.6	1.4	13,322					
		3	N/A	37.0	63.0	N/A	—	15,242					
	Keefton hvAb	1	1.6	35.4	51.1	11.9	2.9	13,174	8	1	OGS	1984	
		2	N/A	35.9	52.0	12.1	2.9	13,388					
		3	N/A	40.9	59.1	N/A	—	15,223					
<u>T12N, R20E</u>	Keefton —	1	1.5	32.0	60.5	6.0	1.1	14,238	6	6	Company	1980	
		2	N/A	32.5	61.4	6.1	1.1	14,455					
		3	N/A	34.6	65.4	N/A	—	15,389					
	Hartshorne Mvb	1	1.6	26.0	69.8	2.6	0.9	14,863	8½	1	OGS	1983	
		2	N/A	26.4	71.0	2.6	0.9	15,105					
		3	N/A	27.1	72.9	N/A	—	15,508					
<u>T13N, R15E</u>	Tebo —	1	2.0	35.4	44.0	18.6	10.4	11,294	7	1	OGS	1982	
		2	N/A	36.1	44.9	19.0	10.6	11,529					
		3	N/A	44.6	55.4	N/A	—	14,230					
<u>T13N, R16E</u>	Tebo —	1	0.3	36.0	50.0	13.7	4.4	12,851	4	1	Company	1980	
		2	N/A	36.1	50.1	13.8	4.5	12,894					
		3	N/A	41.8	58.2	N/A	—	14,951					
	Wainwright —	1	3.5	35.1	51.8	9.6	4.4	13,084	—	3	Company	1981	
		2	N/A	36.3	53.7	10.0	4.6	13,556					
		3	N/A	40.3	59.7	N/A	—	15,061					
	Tebo hvAb	1	2.2	39.0	45.8	13.0	5.6	12,426	7½	1	OGS	1982	
		2	N/A	39.8	46.9	13.3	5.7	12,705					
		3	N/A	45.9	54.1	N/A	—	14,647					
	Wainwright hvAb	1	1.9	34.4	49.1	14.6	5.0	12,345	7½	2	OGS	1985	
		2	N/A	35.0	50.1	14.9	5.1	12,581					
		3	N/A	41.2	58.8	N/A	—	14,786					
	Wainwright hvAb	1	2.0	30.9	42.9	24.2	3.7	10,730	5½	1	OGS	1986	
		2	N/A	31.5	43.8	24.7	3.8	10,949					
		3	N/A	41.9	58.1	N/A	—	14,544					
<u>T13N, R17E</u>	Wainwright —	1	1.9	35.6	56.3	6.2	2.4	13,844	6	1	Company	1976	
		2	N/A	36.3	57.4	6.3	2.5	14,115					
		3	N/A	38.7	61.3	N/A	—	15,057					
	Wainwright —	1	1.0	33.8	56.1	9.1	3.5	13,338	—	2	Company	1976	
		2	N/A	34.1	56.7	9.2	3.5	13,475					
		3	N/A	37.6	62.4	N/A	—	14,846					
	Wainwright —	1	3.3	37.1	52.8	6.8	1.9	13,507	—	1	Company	1981	
		2	N/A	38.3	54.7	7.0	2.0	13,964					
		3	N/A	41.2	58.8	N/A	—	15,015					
	Wainwright hvAb	1	2.1	32.8	54.5	10.6	2.8	13,023	7½	2	OGS	1983	
		2	N/A	33.5	55.7	10.8	2.9	13,303					
		3	N/A	37.6	62.4	N/A	—	14,922					
<u>T13N, R18E</u>	Keefton —	1	1.9	32.7	54.1	11.3	5.6	13,189	7	3	Company	1982	
		2	N/A	33.3	55.2	11.5	5.8	13,449					
		3	N/A	37.7	62.3	N/A	—	15,203					
	Keefton —	1	3.2	32.4	57.6	6.8	0.5	13,159	1	1	OGS	1983	
		2	N/A	33.5	59.5	7.0	0.5	13,594					
		3	N/A	36.0	64.0	N/A	—	14,617					
	Peters Chapel hvAb	1	2.0	29.3	41.9	26.8	10.8	10,355	5½	1	OGS	1984	
		2	N/A	29.9	42.8	27.3	11.0	10,566					
		3	N/A	41.2	58.8	N/A	—	14,544					
	Secor hvAb	1	3.0	33.8	57.5	5.7	0.7	13,899	8½	1	OGS	1984	
		2	N/A	34.8	59.3	5.9	0.7	14,332					
		3	N/A	37.0	63.0	N/A	—	15,229					
	unnamed coal hvAb	1	0.9	30.4	44.9	23.8	5.6	11,394	6½	1	OGS	1984	
		2	N/A	30.7	45.3	24.0	5.6	11,496					
		3	N/A	40.4	59.6	N/A	—	15,126					
	Peters Chapel hvAb	1	1.6	33.2	38.9	26.3	2.3	10,901	5½	1	OGS	1986	
		2	N/A	33.7	39.5	26.8	2.4	11,075					
		3	N/A	46.0	54.0	N/A	—	15,122					

TABLE A3-1 (Continued). — AVERAGE ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA

Township/ Range	Coal bed and rank ^a	Sample condition ^b	Proximate Analysis (%)						Free swelling index	Number of analyses (whole seam)	Data source ^d	Year reported
			Moisture ^c	Volatile matter	Fixed carbon	Ash ^e	Sulfur (%)	Btu/lb				
<u>T13N, R19E</u>	Secor hvAb	1	0.9	31.0	40.2	27.9	8.1	10,435	6½	1	OGS	1986
		2	N/A	31.3	40.5	28.1	8.1	10,533				
		3	N/A	43.5	56.5	N/A	—	14,656				
	Keefton —	1	2.9	33.5	57.7	5.9	1.4	14,252	—	18	Company	1981
		2	N/A	34.5	59.4	6.1	1.5	14,674				
		3	N/A	36.7	63.3	N/A	—	15,628				
	Stigler —	1	3.2	32.6	53.7	10.5	5.5	13,246	—	2	Company	1981
		2	N/A	33.7	55.5	10.8	5.7	13,689				
		3	N/A	37.8	62.2	N/A	—	15,339				
Keefton hvAb	1	0.9	36.2	58.8	4.1	1.1	14,872	8	1	OGS	1984	
	2	N/A	36.5	59.4	4.1	1.2	15,010					
	3	N/A	38.1	61.9	N/A	—	15,652					
Keefton hvAb	1	1.6	35.8	56.4	6.1	1.9	14,350	7½	1	OGS	1985	
	2	N/A	36.4	57.4	6.2	1.9	14,581					
	3	N/A	38.9	61.1	N/A	—	15,553					
<u>T14N, R15E</u>	Tebo hvAb	1	3.5	37.8	48.8	9.9	5.7	12,701	6½	1	OGS	1982
2		N/A	39.2	50.6	10.2	5.9	13,160					
3		N/A	43.7	56.3	N/A	—	14,655					
<u>T14N, R16E</u>	Wainwright —	1	2.3	37.9	45.8	14.0	3.8	12,361	7	1	OGS	1983
2		N/A	38.8	46.8	14.4	3.9	12,647					
3		N/A	45.3	54.7	N/A	—	14,766					
<u>T14N, R17E</u>	Secor —	1	2.5	33.2	53.6	10.7	0.9	12,544	—	1	Company	1982
2		N/A	34.1	54.9	11.0	0.9	12,865					
3		N/A	38.3	61.7	N/A	—	14,456					
Keefton hvAb	1	3.7	34.0	50.3	12.0	3.9	12,002	—	2	Company	1983	
	2	N/A	35.3	52.2	12.5	4.0	12,466					
	3	N/A	40.3	59.7	N/A	—	14,236					
<u>T14N, R17E</u>	Secor —	1	4.9	36.5	51.4	7.2	1.8	13,111	—	6	Company	1983
2		N/A	38.3	54.1	7.6	1.9	13,750					
3		N/A	41.5	58.5	N/A	—	14,875					
Keefton hvAb	1	2.5	38.9	53.5	5.1	1.2	14,026	7	3	Company	1983	
	2	N/A	39.9	54.9	5.2	1.2	14,387					
	3	N/A	42.2	57.8	N/A	—	15,177					
Bluejacket hvAb	1	1.3	36.9	46.9	15.0	7.2	12,498	7½	1	OGS	1985	
	2	N/A	37.3	47.5	15.2	7.3	12,660					
	3	N/A	44.0	56.0	N/A	—	14,924					
Keefton hvAb	1	1.1	37.9	48.5	12.5	5.4	12,975	7½	2	OGS	1985	
	2	N/A	38.3	49.0	12.7	5.5	13,122					
	3	N/A	43.8	56.2	N/A	—	15,028					
Keefton hvAb	1	1.6	38.1	46.8	13.5	6.5	12,702	8	2	OGS	1986	
	2	N/A	38.7	47.6	13.7	6.6	12,916					
	3	N/A	44.9	55.1	N/A	—	14,976					
Keefton hvAb	1	2.3	32.0	45.5	20.2	3.6	11,436	6	3	OGS	1986	
	2	N/A	32.8	46.6	20.6	3.7	11,703					
	3	N/A	41.6	58.4	N/A	—	14,644					
Keefton hvAb	1	1.3	36.5	44.1	18.1	6.8	11,971	7	1	OGS	1986	
	2	N/A	37.0	44.7	18.3	6.9	12,128					
	3	N/A	45.3	54.7	N/A	—	14,843					
<u>T14N, R18E</u>	Peters Chapel —	1	1.7	36.0	49.3	13.0	7.8	12,972	—	3	Company	1982
2		N/A	38.6	50.1	13.2	7.9	13,197					
3		N/A	42.2	57.8	N/A	—	15,209					
Keefton —	1	1.6	31.6	59.4	7.4	0.9	13,904	8½	1	OGS	1983	
	2	N/A	32.2	60.3	7.5	0.9	14,130					
	3	N/A	34.8	65.2	N/A	—	15,276					
Keefton hvAb	1	1.6	35.7	53.6	9.1	6.2	13,375	8½	1	OGS	1983	
	2	N/A	36.3	54.4	9.3	6.3	13,598					
	3	N/A	40.0	60.0	N/A	—	14,987					
Keefton hvAb	1	3.2	34.4	52.3	10.1	8.0	12,828	—	1	Company	1983	
	2	N/A	35.5	54.1	10.4	8.3	13,259					
	3	N/A	39.7	60.3	N/A	—	14,803					
Keefton hvAb	1	1.1	36.0	55.3	7.6	3.3	13,979	8½	2	OGS	1983	
	2	N/A	36.3	56.0	7.7	3.3	14,136					
	3	N/A	39.3	60.7	N/A	—	15,311					

TABLE A3-1 (Continued). — AVERAGE ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA

Township/ Range	Coal bed and rank ^a	Sample condition ^b	Proximate Analysis (%)					Sulfur (%)	Btu/lb	Free swelling index	Number of analyses (whole seam)	Data source ^d	Year reported
			Moisture ^c	Volatile matter	Fixed carbon	Ash ^c							
	Peters Chapel	1	3.4	33.7	49.8	13.1	6.8	12,656	—	2	Company	1984	
	—	2	N/A	34.9	51.6	13.5	7.1	13,097					
	—	3	N/A	40.3	59.7	N/A	—	15,143					
	Peters Chapel hvAb	1	3.3	35.6	46.1	15.0	6.6	12,468	7	2	OGS	1985	
	—	2	N/A	36.8	47.7	15.5	6.8	12,884					
	—	3	N/A	43.5	56.5	N/A	—	15,239					
<u>T15N, R15E</u>	Weir- Pittsburg	1	4.3	35.7	51.2	8.8	3.2	12,890	—	1	Company	1977	
	—	2	N/A	37.3	53.5	9.2	3.4	13,466					
	—	3	N/A	41.0	59.0	N/A	—	14,837					
	Weir- Pittsburg	1	2.0	38.2	47.1	12.7	7.6		6½	1	OGS	1982	
	—	2	N/A	39.0	48.0	13.0	7.8						
	—	3	N/A	44.8	55.2	N/A	—						
<u>T15N, R16E</u>	Wainwright	1	1.7	38.5	42.9	16.9	6.4	11,891	7	1	OGS	1982	
	—	2	N/A	39.2	43.6	17.2	6.5	12,102					
	—	3	N/A	47.3	52.7	N/A	—	14,616					
	Weir- Pittsburg	1	5.4	36.5	53.6	4.5	1.2	12,430	½	1	OGS	1982	
	—	2	N/A	38.6	56.6	4.8	1.3	13,133					
	—	3	N/A	40.5	59.5	N/A	—	13,789					
<u>T15N, R17E</u>	Peters Chapel	1	2.7	37.7	45.5	14.1	5.9	12,272	—	11	Company	1978	
	—	2	N/A	38.8	46.8	14.4	6.1	12,603					
	—	3	N/A	45.3	54.7	N/A	—	14,734					
	Peters Chapel	1	3.2	38.5	48.8	9.5	5.3	13,256	—	1	Company	1979	
	—	2	N/A	39.7	50.4	9.9	5.5	13,697					
	—	3	N/A	44.1	55.9	N/A	—	15,197					
	Peters Chapel	1	2.5	37.7	45.5	14.3	6.0	12,270	—	2	Company	1979	
	—	2	N/A	38.7	46.7	14.6	6.2	12,591					
	—	3	N/A	45.3	54.7	N/A	—	14,748					
	Peters Chapel	1	1.9	37.6	46.5	14.0	7.6	12,761	—	6	Company	1979	
	—	2	N/A	38.3	47.5	14.2	7.7	12,989					
	—	3	N/A	44.7	55.3	N/A	—	15,120					
	Rowe	1	3.6	37.9	49.7	8.8	4.4	13,413	6	1	Company	1979	
	—	2	N/A	39.3	51.5	9.2	4.5	13,910					
	—	3	N/A	43.3	56.7	N/A	—	15,313					
	Secor	1	4.5	34.1	57.7	3.7	1.0	13,526	7½	6	Company	1979	
	—	2	N/A	35.7	60.4	3.9	1.1	14,163					
	—	3	N/A	37.1	62.9	N/A	—	14,734					
	Secor	1	2.4	35.1	59.2	3.3	0.6	14,249	—	1	Company	1979	
	—	2	N/A	35.9	60.7	3.4	0.7	14,604					
	—	3	N/A	37.2	62.8	N/A	—	15,117					
	Secor	1	5.6	34.1	56.5	3.8	0.6	13,396	—	28	Company	1979	
	—	2	N/A	36.1	59.9	4.0	0.6	14,191					
	—	3	N/A	37.6	62.4	N/A	—	14,786					
	Secor	1	4.9	33.8	57.5	3.8	0.6	13,396	—	22	Company	1979	
	—	2	N/A	35.5	60.5	4.0	0.6	14,086					
	—	3	N/A	37.0	63.0	N/A	—	14,673					
	Rowe	1	3.5	—	—	9.2	3.8	13,283	—	3	Company	1979	
	—	2	N/A	—	—	9.6	4.0	13,767					
	—	3	N/A	—	—	N/A	—	15,225					
	Secor hvAb	1	3.6	32.4	61.4	2.6	0.6	14,248	8	1	OGS	1980	
	—	2	N/A	33.6	63.7	2.7	0.6	14,774					
	—	3	N/A	34.5	65.5	N/A	—	15,181					
	Secor	1	3.9	33.9	59.5	2.7	1.3	14,221	—	1	Company	1980	
	—	2	N/A	35.3	61.9	2.8	1.3	14,798					
	—	3	N/A	36.3	63.7	N/A	—	15,224					
	Secor	1	2.5	36.5	59.1	1.9	0.6	14,701	—	1	Company	1980	
	—	2	N/A	37.5	60.6	1.9	0.6	15,074					
	—	3	N/A	38.2	61.8	N/A	—	15,371					
	Secor	1	3.8	33.9	59.5	2.8	0.9	14,221	—	2	Company	1980	
	—	2	N/A	35.2	61.9	2.9	1.0	14,790					
	—	3	N/A	36.3	63.7	N/A	—	15,231					
	Secor	1	2.4	36.4	58.7	2.5	0.6	14,520	8	1	Company	1980	
	—	2	N/A	37.3	60.2	2.5	0.6	14,872					
	—	3	N/A	38.3	61.7	N/A	—	15,256					

TABLE A3-1 (Continued). — AVERAGE ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA

Township/ Range	Coal bed and rank ^a	Sample condition ^b	Proximate Analysis (%)				Sulfur (%)	Btu/lb	Free swelling index	Number of analyses (whole seam)	Data source ^d	Year reported
			Moisture ^c	Volatile matter	Fixed carbon	Ash ^c						
Peters Chapel —	—	1	1.2	40.8	49.8	8.2	5.2	13,762	—	1	Company	1981
		2	N/A	41.3	50.4	8.3	5.3	13,921				
		3	N/A	45.0	55.0	N/A	—	15,184				
Peters Chapel —	—	1	3.1	39.0	49.7	8.2	5.6	13,493	—	1	Company	1981
		2	N/A	40.2	51.3	8.5	5.8	13,928				
		3	N/A	43.9	56.1	N/A	—	15,706				
Secor —	—	1	3.8	34.1	60.6	1.5	0.5	14,474	—	1	Company	1981
		2	N/A	35.4	63.0	1.6	0.5	15,047				
		3	N/A	36.0	64.0	N/A	—	15,292				
Secor —	—	1	1.9	35.6	60.0	2.5	0.5	14,450	—	3	Company	1981
		2	N/A	36.3	61.2	2.5	0.5	14,730				
		3	N/A	37.2	62.8	N/A	—	15,115				
Secor —	—	1	3.9	33.8	59.5	2.8	0.9	14,221	—	2	Company	1981
		2	N/A	35.2	61.9	2.9	1.0	14,793				
		3	N/A	36.3	63.7	N/A	—	15,234				
Peters Chapel —	—	1	6.1	34.8	48.3	10.8	6.8	11,095	6½	2	OGS	1982
		2	N/A	37.0	51.7	11.3	7.1	11,833				
		3	N/A	41.8	58.2	N/A	—	13,389				
Secor hvAb	—	1	2.0	35.2	60.6	3.2	0.5	14,552	8	2	OGS	1982
		2	N/A	35.9	61.9	3.2	0.6	14,849				
		3	N/A	36.8	63.2	N/A	—	15,177				
Secor —	—	1	3.9	35.0	57.5	3.6	0.6	14,078	—	2	Company	1982
		2	N/A	35.5	59.8	3.7	0.6	14,635				
		3	N/A	37.9	62.1	N/A	—	15,199				
Secor Rider hvBb	—	1	4.4	35.6	41.6	18.4	2.4	10,796	1	1	OGS	1982
		2	N/A	37.2	43.5	19.3	2.5	11,293				
		3	N/A	46.1	53.9	N/A	—	13,990				
Peters Chapel —	—	1	15.6	31.6	48.5	4.3	0.9	10,316	½	2	OGS	1983
		2	N/A	37.4	57.4	5.2	1.0	12,196				
		3	N/A	39.4	60.6	N/A	—	12,850				
Peters Chapel hvAb	—	1	1.0	39.2	49.1	10.7	6.2	13,159	7½	1	OGS	1983
		2	N/A	39.6	49.6	10.8	6.3	13,296				
		3	N/A	44.4	55.6	N/A	—	14,910				
Rowe —	—	1	12.7	31.0	47.9	8.4	0.7	9,836	—	1	OGS	1983
		2	N/A	35.5	54.9	9.6	0.8	11,263				
		3	N/A	39.3	60.7	N/A	—	12,464				
Secor hvAb	—	1	2.1	40.9	50.2	6.8	3.2	13,745	7	1	OGS	1983
		2	N/A	41.8	51.2	7.0	3.3	14,043				
		3	N/A	45.0	55.0	N/A	—	15,100				
Secor —	—	1	7.3	34.4	54.8	3.5	0.8	13,062	—	27	Company	1983
		2	N/A	37.1	59.1	3.8	0.9	14,091				
		3	N/A	38.6	61.4	N/A	—	14,643				
Secor hvAb	—	1	3.8	34.6	59.4	2.2	0.6	14,284	7½	1	OGS	1984
		2	N/A	36.0	61.7	2.3	0.6	14,851				
		3	N/A	36.8	63.2	N/A	—	15,202				
Secor —	—	1	4.3	34.3	57.7	3.7	0.9	13,923	—	18	Company	1984
		2	N/A	35.8	60.3	3.9	1.0	14,549				
		3	N/A	37.3	62.7	N/A	—	15,134				
Secor hvAb	—	1	2.9	36.4	58.6	2.0	0.5	14,530	8	1	OGS	1988
		2	N/A	37.5	60.4	2.0	0.5	14,969				
		3	N/A	38.3	61.7	N/A	—	15,280				
Secor Rider hvAb	—	1	2.9	40.2	45.7	11.2	3.9	13,026	7½	1	OGS	1988
		2	N/A	41.4	47.0	11.6	4.0	13,414				
		3	N/A	46.8	53.2	N/A	—	15,171				
<u>T15N, R18E</u> —	Keota	1	4.2	34.3	52.8	8.7	1.6	12,621	2	1	OGS	1983
		2	N/A	35.8	55.2	9.0	1.7	13,170				
		3	N/A	39.3	60.7	N/A	—	14,480				

^ahvAb, high-volatile A bituminous; hvBb, high-volatile B bituminous; hvCb, high-volatile C bituminous; — not classified.

^b1 = as received; 2 = moisture-free; 3 = moisture- and ash-free.

^cN/A, not applicable.

^dCompany, coal company or other industry-related source; OGS, Oklahoma Geological Survey.

TABLE A3-2. — ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA
(Samples collected by LeRoy Hemish and tested by the Oklahoma Geological Survey Chemistry Laboratory.)

Sample number	Map number ^a (Pl. 1,2)	Coal bed and rank ^b	Sample condition ^c	Proximate Analyses (%)						Free swelling index	Year sampled	Type of sample site ^d
				Moisture	Volatile matter	Fixed carbon	Ash	Sulfur (%)	Btu/lb			
85C13H	CH 25, Pls. 1a,2a	Bluejacket hvAb	1	1.3	36.9	46.9	15.0	7.2	12,498	7½	1985	Core
			2	N/A	37.3	47.5	15.2	7.3	12,660			
			3	N/A	44.0	56.0	N/A		14,924			
82C39H	MS 20, Pl. 2b	Hartshorne mvb	1	1.6	26.0	69.8	2.6	0.9	14,863	8½	1982	Cb
			2	N/A	26.4	71.0	2.6	0.9	15,105			
			3	N/A	27.1	72.9	N/A		15,508			
82C32H	MS 68, Pl. 1a	Keefton hvAb	1	1.6	31.6	59.4	7.4	0.9	13,904	8½	1982	RC
			2	N/A	32.2	60.3	7.5	0.9	14,130			
			3	N/A	34.8	65.2	N/A		15,276			
82C35H	MS 16, Pl. 1b	Keefton hvAb	1	1.2	32.0	54.3	12.5	1.4	13,162	8½	1982	AcSM
			2	N/A	32.4	55.0	12.6	1.4	13,322			
			3	N/A	37.0	63.0	N/A		15,242			
82C36H	MS 40, Pl. 1a	Keefton —	1	3.2	32.4	57.6	6.8	0.5	13,159	1	1982	Cb
			2	N/A	33.5	59.5	7.0	0.5	13,594			
			3	N/A	36.0	64.0	N/A		14,617			
84C3H	MS 43 Pl. 1a	Keefton hvAb	1	0.9	36.2	58.8	4.1	1.1	14,872	8	1984	AcSM
			2	N/A	36.5	59.4	4.1	1.2	15,010			
			3	N/A	38.1	61.9	N/A		15,652			
84C80H	MS 15, Pl. 1b	Keefton hvAb	1	1.6	35.4	51.1	11.9	2.9	13,174	8	1984	AcSM
			2	N/A	35.9	52.0	12.1	2.9	13,388			
			3	N/A	40.9	59.1	N/A		15,223			
85C18H	CH 16, Pl. 1a	Keefton hvAb	1	1.6	35.8	56.4	6.1	1.9	14,350	7½	1985	Core
			2	N/A	36.4	57.4	6.2	1.9	14,581			
			3	N/A	38.9	61.1	N/A		15,553			
86C1H	CH 4, Pl. 1b	Keefton hvAb	1	5.0	27.3	59.0	8.7	3.9	13,294	7½	1986	Core
			2	N/A	28.8	62.1	9.1	4.1	13,991			
			3	N/A	31.6	68.4	N/A		15,398			
82C18H	MS 115, Pl. 1a	Keota —	1	4.2	34.3	52.8	8.7	1.6	12,621	2	1982	RC
			2	N/A	35.8	55.2	9.0	1.7	13,170			
			3	N/A	39.3	60.7	N/A		14,480			
82C9H	MS 92, Pl. 2a	Peters Chapel —	1	9.4	34.5	51.8	4.3	1.3	11,041	0	1982	AcSM
			2	N/A	38.0	57.2	4.8	1.4	12,183			
			3	N/A	39.9	60.1	N/A		12,792			
82C12H	MS 97, Pl. 2a	Peters Chapel hvAb	1	2.9	35.0	44.7	17.4	12.4	11,148	6½	1982	AbSM
			2	N/A	36.0	46.1	17.9	12.8	11,482			
			3	N/A	43.8	56.2	N/A		13,985			
82C23H	MS 109, Pl. 2a	Peters Chapel —	1	18.0	30.3	47.2	4.5	0.7	9,327	0	1982	Cb
			2	N/A	36.9	57.6	5.5	0.9	11,367			
			3	N/A	39.0	61.0	N/A		12,027			
82C25H	MS 72, Pl. 2a	Peters Chapel —	1	1.6	35.7	53.6	9.1	6.2	13,375	8½	1982	RC
			2	N/A	36.3	54.4	9.3	6.3	13,598			
			3	N/A	40.0	60.0	N/A		14,987			
83C22H	MS 105, Pl. 2a	Peters Chapel —	1	13.2	32.9	49.8	4.1	1.0	11,305	½	1983	AcSM
			2	N/A	37.9	57.3	4.8	1.2	13,024			
			3	N/A	39.8	60.2	N/A		13,673			
83C34H	MS 107, Pl. 2a	Peters Chapel hvAb	1	1.0	39.2	49.1	10.7	6.2	13,159	7½	1983	AcSM
			2	N/A	39.6	49.6	10.8	6.3	13,296			
			3	N/A	44.4	55.6	N/A		14,910			

TABLE A3-2 (Continued). — ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA

Sample number	Map number ^a (Pl. 1,2)	Coal bed and rank ^b	Sample condition ^c	Proximate Analyses (%)					Sulfur (%)	Free swelling index	Year sampled	Type of sample site ^d
				Moisture	Volatile matter	Fixed carbon	Ash	Btu/lb				
84C5H (Upper 7 in. of split sample)	CH 14, Pl. 2a	Peters Chapel hvAb	1	1.8	25.8	33.2	39.2	15.9	7,915	3	1984	Core
			2	N/A	26.3	33.8	39.9	16.2	8,063			
			3	N/A	43.7	56.3	N/A		13,416			
84C6H (Middle 8.5 in. of split sample)	CH 14, Pl. 2a	Peters Chapel hvAb	1	1.6	32.7	47.8	17.9	9.1	12,101	7	1984	Core
			2	N/A	33.2	48.6	18.2	9.2	12,297			
			3	N/A	40.6	59.4	N/A		15,033			
84C7H (Lower 8.5 in. of split sample)	CH 14, Pl. 2a	Peters Chapel hvAb	1	2.6	28.6	43.4	25.4	8.5	10,620	6½	1984	Core
			2	N/A	29.4	44.5	26.1	8.7	10,906			
			3	N/A	39.7	60.3	N/A		14,758			
85C14H	CH 265, Pl. 2a	Peters Chapel hvAb	1	1.0	36.3	49.3	13.4	5.7	12,872	7½	1985	Core
			2	N/A	36.7	49.8	13.6	5.8	13,002			
			3	N/A	42.4	57.6	N/A		15,042			
85C15H	CH 18, Pl. 2a	Peters Chapel hvAb	1	1.2	39.4	47.7	11.7	5.1	13,007	7½	1985	Core
			2	N/A	39.9	48.3	11.8	5.2	13,241			
			3	N/A	45.2	54.8	N/A		15,013			
85C16H	CH 29, Pl. 2a	Peters Chapel hvAb	1	3.2	33.3	42.7	20.8	7.4	11,464	6½	1985	Core
			2	N/A	34.4	44.1	21.4	7.6	11,842			
			3	N/A	43.8	56.2	N/A		15,072			
85C17H	CH 28, Pl. 2a	Peters Chapel hvAb	1	3.3	37.8	49.6	9.3	5.7	13,471	7	1985	Core
			2	N/A	39.1	51.3	9.6	5.9	13,926			
			3	N/A	43.2	56.8	N/A		15,405			
86C17H	CH 13, Pl. 2a	Peters Chapel hvAb	1	1.6	33.2	38.9	26.3	2.3	10,901	5½	1986	Core
			2	N/A	33.7	39.5	26.8	2.4	11,075			
			3	N/A	46.0	54.0	N/A		15,122			
86C20H	CH 20, Pl. 2a	Peters Chapel hvAb	1	2.0	37.8	47.8	12.4	6.9	12,940	8	1986	Core
			2	N/A	38.5	48.8	12.6	7.1	13,203			
			3	N/A	44.2	55.8	N/A		15,112			
86C22H	CH 24, Pl. 2a	Peters Chapel hvAb	1	1.3	38.3	45.7	14.7	6.1	12,463	8	1986	Core
			2	N/A	38.8	46.3	14.9	6.2	12,628			
			3	N/A	45.6	54.4	N/A		14,840			
82C19H	MS 66, Pl. 2a	Rowe hvAb	1	1.2	36.5	55.5	6.8	2.6	14,131	9	1982	CST
			2	N/A	36.9	56.2	6.9	2.6	14,304			
			3	N/A	39.6	60.4	N/A		15,358			
82C24H	MS 60, Pl. 2a	Rowe —	1	12.7	31.0	47.9	8.4	0.7	9,836	0	1982	Cb
			2	N/A	35.5	54.9	9.6	0.8	11,263			
			3	N/A	39.3	60.7	N/A		12,464			
82C29H	MS 74, Pl. 2a	Rowe —	1	1.0	35.4	55.2	8.4	4.0	13,827	8	1982	DCB
			2	N/A	35.7	55.8	8.5	4.0	13,967			
			3	N/A	39.0	61.0	N/A		15,264			
82C8H	MS 91, Pl. 1a	Secor hvAb	1	2.0	35.8	60.0	2.2	0.5	14,590	8	1982	AcSM
			2	N/A	36.5	61.3	2.2	0.5	14,888			
			3	N/A	37.3	62.7	N/A		15,227			
82C11H	MS 92, Pl. 1a	Secor hvAb	1	2.0	34.7	61.2	2.1	0.6	14,514	7½	1982	AcSM
			2	N/A	35.4	62.5	2.1	0.6	14,809			
			3	N/A	36.2	63.8	N/A		15,127			
83C21H	MS 106, Pl. 1a	Secor hvAb	1	2.1	40.9	50.2	6.8	3.2	13,745	7	1983	AcSM
			2	N/A	41.8	51.2	7.0	3.3	14,043			
			3	N/A	45.0	55.0	N/A		15,100			
84C8H	CH 11, Pl. 1a	Secor hvAb	1	3.0	33.8	57.5	5.7	0.7	13,899	8½	1984	Core
			2	N/A	34.8	59.3	5.9	0.7	14,332			
			3	N/A	37.0	63.0	N/A		15,229			

TABLE A3-2 (Continued). — ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA

Sample number	Map number ^a (Pl. 1,2)	Coal bed and rank ^b	Sample condition ^c	Proximate Analyses (%)					Free swelling index	Year sampled	Type of sample site ^d	
				Moisture	Volatile matter	Fixed carbon	Ash	Sulfur (%)				Btu/lb
84C79H	MS 101, Pl. 1a	Secor hvAb	1	3.8	34.6	59.4	2.2	0.6	14,284	7½	1984	AcSM
			2	N/A	36.0	61.7	2.3	0.6	14,851			
			3	N/A	36.8	63.2	N/A		15,202			
86C18H	CH 13, Pl. 1a	Secor hvAb	1	0.9	31.0	40.2	27.9	8.1	10,435	6½	1986	Core
			2	N/A	31.3	40.5	28.1	8.1	10,533			
			3	N/A	43.5	56.5	N/A		14,646			
86C19H	CH 27, Pl. 1a	Secor hvAb	1	3.5	31.0	47.2	18.3	3.1	11,454	8	1986	Core
			2	N/A	32.2	48.9	18.9	3.2	11,874			
			3	N/A	39.6	60.4	N/A		14,650			
86C21H	CH 22, Pl. 1a	Secor hvAb	1	1.7	38.5	56.5	3.3	0.8	14,538	8	1986	Core
			2	N/A	39.2	57.5	3.3	0.9	14,788			
			3	N/A	40.5	59.5	N/A		15,296			
86C24H	CH 24, Pl. 1a	Secor hvAb	1	1.6	26.5	32.9	39.0	7.0	8,315	1½	1986	Core
			2	N/A	26.9	33.5	39.6	7.1	8,448			
			3	N/A	44.6	55.4	N/A		13,986			
88C5H	MS 108, Pl. 1a	Secor hvAb	1	2.9	36.4	58.6	2.0	0.5	14,530	8	1988	AcSM
			2	N/A	37.5	60.4	2.0	0.5	14,969			
			3	N/A	38.3	61.7	N/A		15,280			
82C10H	MS 92, Pls. 1a,2a	Secor Rider hvBb	1	4.4	35.6	41.6	18.4	2.4	10,796	1	1982	AcSM
			2	N/A	37.2	43.5	19.3	2.5	11,293			
			3	N/A	46.1	53.9	N/A		13,990			
86C23H	CH 24, Pls. 1a,2a	Secor Rider hvAb	1	1.3	36.5	44.1	18.1	6.8	11,971	7	1986	Core
			2	N/A	37.0	44.7	18.3	6.9	12,128			
			3	N/A	45.3	54.7	N/A		14,843			
88C4H	MS 108, Pl. 1a	Secor Rider hvAb	1	2.9	40.2	45.7	11.2	3.9	13,026	7½	1988	AcSM
			2	N/A	41.4	47.0	11.6	4.0	13,414			
			3	N/A	46.8	53.2	N/A		15,171			
82C37H (Upper 12 in. of split sample)	MS 1, Pl. 2b	Stigler hvAb	1	1.0	27.9	55.0	16.1	4.6	12,685	8	1982	AcSM
			2	N/A	28.2	55.6	16.2	4.6	12,813			
			3	N/A	33.7	66.3	N/A		15,290			
82C38H (Lower 11 in. of split sample)	MS 1, Pl. 2b	Stigler hvAb	1	1.9	28.1	61.9	8.1	5.7	13,907	9	1982	AcSM
			2	N/A	28.6	63.2	8.2	5.8	14,176			
			3	N/A	31.2	68.8	N/A		15,442			
84C10H (Upper 11 in. of split sample)	CH 3, Pl. 2b	Stigler hvAb	1	1.0	29.1	60.7	9.2	1.9	13,892	8½	1984	Core
			2	N/A	29.4	61.3	9.2	1.9	14,030			
			3	N/A	32.4	67.6	N/A		15,460			
84C11H (Lower 11 in. of split sample)	CH 3, Pl. 2b	Stigler hvAb	1	0.9	29.2	62.8	7.1	1.4	14,240	9	1984	Core
			2	N/A	29.5	63.3	7.2	1.4	14,371			
			3	N/A	31.7	68.3	N/A		15,488			
84C9H	CH 3, Pl. 2b	Tamaha hvAb	1	1.3	28.1	53.0	17.6	8.2	12,242	7	1984	Core
			2	N/A	28.5	53.7	17.8	8.3	12,407			
			3	N/A	34.5	65.5	N/A		15,101			
81C15H	MS 55, Pl. 2a	Tebo hvAb	1	3.5	37.8	48.8	9.9	5.7	12,701	6½	1981	RC
			2	N/A	39.2	50.6	10.2	5.9	13,160			
			3	N/A	43.7	56.3	N/A		14,655			
82C5H	MS 23, Pl. 2a	Tebo hvAb	1	2.2	39.0	45.8	13.0	5.6	12,426	7½	1982	Stp
			2	N/A	39.8	46.9	13.3	5.7	12,705			
			3	N/A	45.9	54.1	N/A		14,647			
82C6H	MS 21, Pl. 2a	Tebo —	1	2.0	35.4	44.0	18.6	10.4	11,294	7	1982	Cb
			2	N/A	36.1	44.9	19.0	10.6	11,529			
			3	N/A	44.6	55.4	N/A		14,230			

TABLE A3-2 (Continued). — ANALYSES OF COALS IN MUSKOGEE COUNTY, OKLAHOMA

Sample number	Map number ^a (Pl. 1,2)	Coal bed and rank ^b	Sample condition ^c	Proximate Analyses (%)					Sulfur (%)	Free swelling index	Year sampled	Type of sample site ^d
				Moisture	Volatile matter	Fixed carbon	Ash	Btu/lb				
82C7H	MS 88, Pl. 1a	Wainwright —	1	1.7	38.5	42.9	16.9	6.4	11,891	7	1982	Cb
			2	N/A	39.2	43.6	17.2	6.5	12,102			
			3	N/A	47.3	52.7	N/A		14,616			
82C17H	MS 56, Pl. 1a	Wainwright —	1	2.3	37.9	45.8	14.0	3.8	12,361	7	1982	Cb
			2	N/A	38.8	46.8	14.4	3.9	12,647			
			3	N/A	45.3	54.7	N/A		14,766			
82C28H	MS 24, Pl. 1a	Wainwright —	1	2.4	32.2	55.6	9.8	1.1	13,123	7	1982	Cb
			2	N/A	33.0	57.0	10.0	1.1	13,446			
			3	N/A	36.6	63.4	N/A		14,940			
82C30H (sample of upper 6 in. bench of 15 in. coal bed)	MS 25, Pl. 1a	Wainwright —	1	1.8	35.4	56.3	6.5	3.3	13,823	8	1982	Cb
			2	N/A	36.1	57.3	6.6	3.4	14,076			
			3	N/A	38.7	61.3	N/A		15,071			
82C31H (sample of lower 8 in. bench of 15 in. coal bed)	MS 25, Pl. 1a	Wainwright —	1	1.9	31.9	51.1	15.1	5.5	12,279	7½	1982	Cb
			2	N/A	32.5	52.1	15.4	5.6	12,517			
			3	N/A	38.4	61.6	N/A		14,796			
85C19H	CH 7, Pl. 1a	Wainwright hvAb	1	2.1	34.6	48.1	15.1	4.5	12,167	7½	1985	Core
			2	N/A	35.4	49.2	15.5	4.6	12,426			
			3	N/A	41.8	58.2	N/A		14,701			
85C20H	CH 9, Pl. 1a	Wainwright hvAb	1	1.7	34.1	50.1	14.1	5.4	12,522	7½	1985	Core
			2	N/A	34.7	51.0	14.4	5.5	12,736			
			3	N/A	40.5	59.5	N/A		14,871			
86C16H	CH 10, Pl. 1a	Wainwright hvAb	1	2.0	30.9	42.9	24.2	3.7	10,730	5½	1986	Core
			2	N/A	31.5	43.8	24.7	3.8	10,949			
			3	N/A	41.9	58.1	N/A		14,544			
82C3H	MS 85, Pl. 1a	Weir-Pittsburg —	1	5.4	36.5	53.6	4.5	1.2	12,430	½	1982	SO
			2	N/A	38.6	56.6	4.8	1.3	13,133			
			3	N/A	40.5	59.5	N/A		13,789			
82C4H	MS 81, Pl. 1a	Weir-Pittsburg	1	2.0	38.2	47.1	12.7	7.6	12,493	6½	1982	Cb
			2	N/A	39.0	48.0	13.0	7.8	12,743			
			3	N/A	44.8	55.2	N/A		14,640			
84C4H	CH 14, Pls. 1a,2a	unnamed hvAb	1	0.9	30.4	44.9	23.8	5.6	11,394	6½	1984	Core
			2	N/A	30.7	45.3	24.0	5.6	11,496			
			3	N/A	40.4	59.6	N/A		15,126			

^aData point number on map (sample site) corresponds to measured-section (MS) number or core-hole (CH) number, Appendix 2.

^bhvAb, high-volatile A bituminous; hvBb, high-volatile B bituminous; mvb, medium-volatile bituminous; -- not classified.

^c1 = as received; 2 = moisture-free; 3 = moisture- and ash-free.

^dAbSM, abandoned strip mine; AcSM, active strip mine; Cb, cutbank of stream; Core, core hole; CST, construction site trench; DCB, dry creek bed; RC, road cut; SO, slope outcrop; Stp, stockpile.

Appendix 4: Cleat Orientations in Coals Sampled in Muskogee County, Oklahoma

Coal	Face cleat	Butt cleat	Degrees of separation	Location
Hartshorne	N. 33° W.	N. 64° E.	97	SW¼SE¼SE¼NE¼ sec. 35, T12N, R20E
Keefton	N. 45° W.	N. 43° E.	88	SE¼NW¼SE¼SE¼ sec. 6, T12N, R19E
	N. 51° W.	N. 38° E.	89	NE¼NW¼SW¼SE¼ sec. 6, T12N, R19E
	N. 22° E.	N. 65° W.	87	NW¼NE¼NW¼SW¼ sec. 4, T13N, R19E
	N. 51° W.	N. 42° E.	93	NW¼NW¼NW¼SE¼ sec. 35, T13N, R18E
	N. 38° W.	N. 51° E.	89	NW¼NW¼NW¼NW¼ sec. 12, T14N, R18E
Keota	N. 36° W.	N. 46° E.	82	SW¼SW¼SW¼NW¼ sec. 16, T15N, R18E
Peters Chapel	N. 52° W.	N. 71° E.	123	NW¼NW¼NE¼SE¼ sec. 19, T14N, R18E
	N. 40° W.	N. 60° E.	100	SE¼SW¼SW¼NE¼ sec. 10, T15N, R17E
	N. 48° W.	N. 40° E.	88	NW¼SE¼NW¼NE¼ sec. 14, T15N, R17E
	N. 50° W.	N. 45° E.	95	NE¼NW¼NE¼SW¼ sec. 28, T15N, R17E
	N. 48° W.	N. 50° E.	98	NE¼NE¼SW¼SW¼ sec. 28, T15N, R17E
	N. 56° W.	N. 30° E.	86	NE¼NE¼SE¼NW¼ sec. 35, T15N, R17E
Rowe	N. 33° W.	N. 65° E.	98	NW¼NE¼NE¼NE¼ sec. 12, T14N, R17E
	N. 38° W.	N. 45° E.	83	SW¼NW¼NE¼SE¼ sec. 10, T14N, R18E
	N. 43° W.	N. 47° E.	90	NW¼NW¼SW¼NW¼ sec. 26, T14N, R18E
Secor	N. 49° W.	N. 44° E.	93	NW¼SE¼SE¼NW¼ sec. 10, T15N, R17E
	N. 35° W.	N. 63° E.	98	SE¼SW¼SW¼NE¼ sec. 10, T15N, R17E
	N. 43° W.	N. 42° E.	85	NE¼SE¼NW¼NW¼ sec. 17, T15N, R17E
	N. 57° W.	N. 42° E.	99	SW¼NE¼SE¼SW¼ sec. 28, T15N, R17E
	N. 48° W.	N. 43° E.	91	NW¼SE¼NE¼SW¼ sec. 34, T15N, R17E
Secor Rider	N. 46° W.	N. 50° E.	96	SE¼SW¼SW¼NE¼ sec. 10, T15N, R17E
	N. 54° W.	N. 48° E.	102	NW¼SE¼NE¼SW¼ sec. 34, T15N, R17E
Stigler	N. 44° W.	N. 49° E.	93	NW¼SE¼NW¼SE¼ sec. 1, T10N, R19E
Tebo	N. 33° W.	N. 60° E.	93	SW¼NW¼SE¼NE¼ sec. 12, T13N, R15E
	N. 22° W.	N. 71° E.	93	SE¼NE¼NE¼SE¼ sec. 14, T14N, R15E
Wainwright	N. 50° W.	N. 39° E.	89	SE¼SW¼NE¼SW¼ sec. 18, T13N, R17E
	N. 45° W.	N. 40° E.	85	NE¼NE¼NW¼SE¼ sec. 31, T13N, R17E
	N. 21° W.	N. 82° E.	103	SW¼SW¼NE¼NE¼ sec. 3, T14N, R16E
	N. 60° W.	N. 32° E.	92	SW¼NW¼NE¼NW¼ sec. 26, T15N, R16E
Weir-Pittsburg	N. 44° W.	N. 45° E.	89	SW¼SE¼SE¼SE¼ sec. 24, T15N, R15E
	N. 38° W.	N. 53° E.	91	NE¼NW¼NW¼NE¼ sec. 6, T15N, R16E

*Separation is defined as the angular difference between the average face-cleat and butt-cleat directions. Ideal separation is 90°.