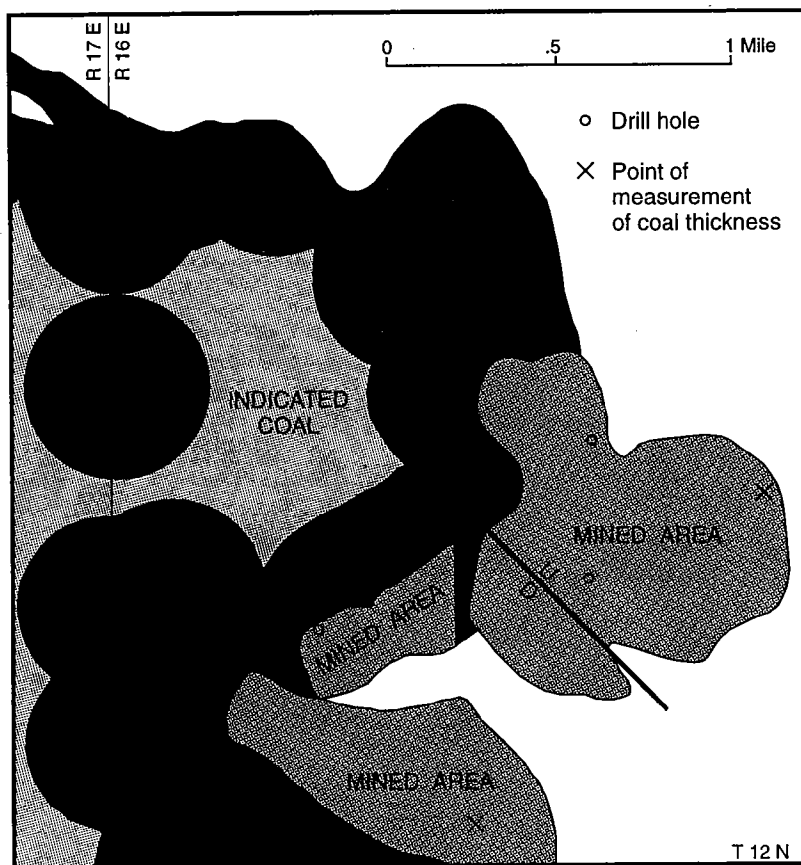


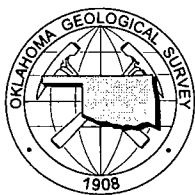
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Coal Geology of McIntosh County, Oklahoma

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

Excerpt from map used to calculate resources and reserves for the Secor coal bed in eastern McIntosh County. Determination of measured and indicated category of reliability areas, and mined areas, are made from points of measurement, mine boundaries, and drill-hole data.

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Coal Geology of McIntosh County, Oklahoma

*LeRoy A. Hemish*¹

ABSTRACT. — McIntosh County is located in the east-central part of the coal belt of eastern Oklahoma, and almost the entire county is underlain by coal-bearing strata of Desmoinesian (Middle Pennsylvanian) age. For lack of data about coal depth and thickness, resource potential is unknown for ~75% of the county—mostly in its western and southern parts. Structural complexity further inhibits evaluation of resources.

Remaining resources of coal in the county total 36,319,000 short tons, and reserves total 5,437,000 tons. Eight coal beds have commercial potential: Stigler coal with reserves of 457,000 tons; Rowe coal—144,000 tons; Lower Witteville coal—368,000 tons; Secor coal—2,119,000 tons; Peters Chapel coal—1,003,000 tons; Wainwright coal—95,000 tons; Mineral coal—42,000 tons; and Croweburg coal—1,209,000 tons.

The coals rank predominantly as high-volatile A bituminous (hvAb). The Secor coal has the least sulfur, averaging ~2.5%. However, its sulfur varies areally, and is as high as 7.8%. The combined average sulfur content of all the other coals is 4.5%.

In the late 1980s and early 1990s, one operator was producing coal from the Secor bed, using surface methods. At the time of this publication (1998), no coal was being produced in McIntosh County.

INTRODUCTION

This is the sixth 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, whose purpose is to determine the location, amount, and chemical character of the coal deposits, as well as the geology of the coal beds and associated strata.

As Figure 2 shows, McIntosh County is in east-central Oklahoma. Except for limited acreages in the extreme western part of the study area, the coal beds with the most commercial potential lie in the north-eastern one-fourth of the county (Pls. 1, 2A).

Plate 1 shows McIntosh County, whose area is ~750 mi². Eufaula, the county seat (population 2,652 in 1995), is at the junction of State Highway 9 and U.S. Highway 69. Just east of Eufaula is Eufaula Lake, which forms the southern boundary of the county and isolates its northeastern third. Three major streams enter the county from the west and flow into Eufaula Lake: the Canadian River, the North Canadian River, and Deep Fork—a tributary of the Canadian River.

Checotah, at the junction of U.S. Highway 266, U.S. Highway 69, and Interstate Highway 40 (population 3,290), is the county's largest city. No other town in the county has more than about 100 residents. The only major railroad serving the area is the Missouri-

Kansas-Texas; it runs north-south through Checotah and Eufaula, and links the region with McAlester on the south and the McClellan-Kerr Arkansas River Navigation System at Muskogee to the north.

Two geomorphic provinces extend through McIntosh County: the Claremore Cuesta Plains and the Eastern Sandstone Cuesta Plains (Curtis and Ham, 1972, p. 3). Topographically, the provinces are similar, being characterized by resistant sandstone-capped hills that dip gently westward and form cuestas between broad shale plains.

Almost all of McIntosh County is underlain by coal-bearing strata of Desmoinesian (Middle Pennsylvanian) age, an exception being an area of ~8 mi² on the Warner uplift, near the eastern border.

In 1982–84, the present writer did extensive field work in the county, a period almost coinciding with the two years of the highest coal production ever reported there. Through cooperation by the various coal-mining companies, the OGS acquired a great deal of new drilling data, and collected fresh coal samples from active mines for analysis by the OGS Chemistry Laboratory. Thus a better understanding of the coal geology of McIntosh County was attained; it is presented in this report.

Detailed information about estimated original, mined, and remaining coal resources and reserves are tabulated in Appendix 1, arranged by coal thickness, overburden thickness, and category of reliability.

Two maps (Pls. 1, 2A) show datum points used in the study, outcrop boundaries of coal beds, thickness

¹Oklahoma Geological Survey.

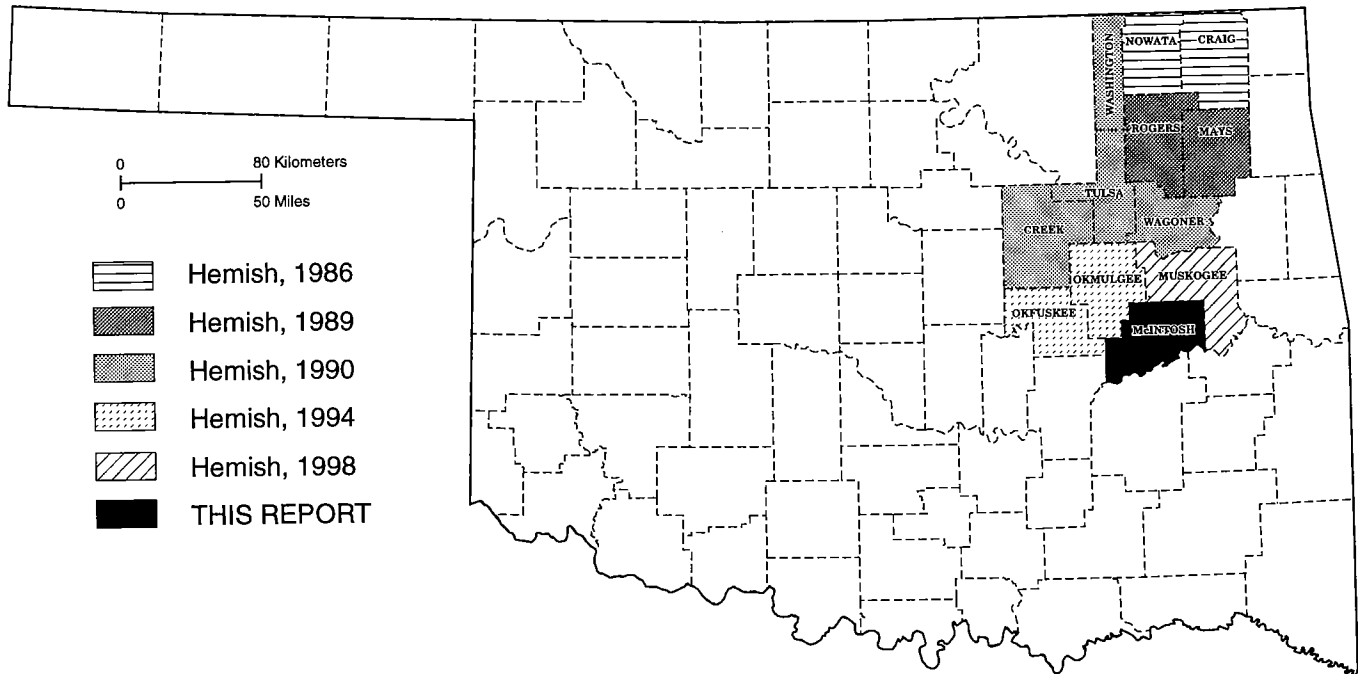


Figure 1. Status of county coal studies in Oklahoma. Reports completed: (1) Coal geology of Craig County and eastern Nowata County, Oklahoma (Hemish, 1986a); (2) Coal geology of Rogers County and western Mayes County, Oklahoma (Hemish, 1989); (3) Coal geology of Tulsa, Wagoner, Creek, and Washington Counties, Oklahoma (Hemish, 1990); (4) Coal geology of Okmulgee County and eastern Okfuskee County, Oklahoma (Hemish, 1994a); (5) Coal geology of Muskogee County, Oklahoma (Hemish, 1998).

of coal beds, mined-out areas, and thickness of overburden. These maps were prepared for the eight 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 where feasible their outcrop boundaries are shown. Figure 3, a generalized columnar section, shows the coal-bearing strata. Plate 2B is a structure-contour map drawn on the Secor coal, and two cross sections (Pl. 2C, A-A' and B-B' show the stratigraphic succession of the coal beds and associated strata in the lower part of the Boggy Formation in the Checotah-Onapa area.

Summaries of resources and reserves appear in Table 1, arranged by township and coal thickness, and in Table 2 by 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 $\leq 20:1$, and a low-sulfur coal (sulfur content $\leq 1.0\%$) must have a stripping ratio $\leq 30:1$ (Friedman, 1974). No deductions from reserves were made here for reasons such as adverse governmental 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, but the minimum thickness for underground mining is 1.2 ft (Friedman, 1974).

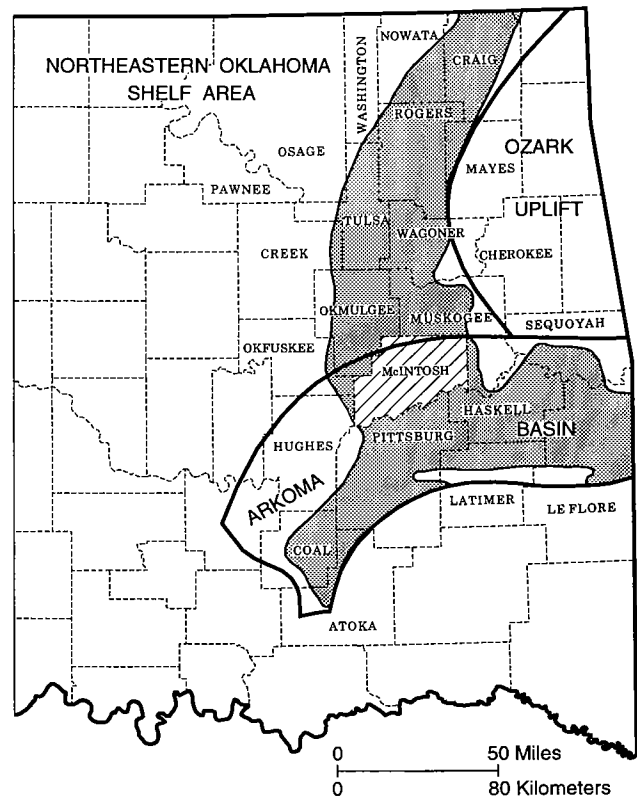


Figure 2. Map of Oklahoma showing the commercial coal belt (shaded), the area of this report (ruled), and major structural provinces in the coalfield area.

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

Township, range	Remaining Resources										Mined or lost in mining		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						
T10N, R13E	—	—	696	3,011	—	—	—	—	696	3,011	—	—	696	3,011	349	1,209
T10N, R17E	297	631	—	—	—	—	—	—	297	631	—	—	297	631	—	—
T10N, R18E	267	567	—	—	—	—	—	—	267	567	4	8	271	575	—	—
T11N, R16E	1,445	2,096	39	134	15	66	—	—	1,499	2,296	41	62	1,540	2,358	251	325
T11N, R17E	2,706	4,412	933	2,279	—	—	—	—	3,639	6,691	622	1,018	4,261	7,709	437	727
T11N, R18E	317	593	269	783	—	—	—	—	586	1,376	150	365	736	1,741	67	113
T12N, R14E	45	83	—	—	—	—	—	—	45	83	—	—	45	83	29	42
T12N, R16E	185	332	48	111	—	—	—	—	233	443	1	1	234	444	39	56
T12N, R17E	1,438	2,594	2,068	5,974	38	177	—	—	3,544	8,745	333	650	3,877	9,395	744	1,641
T12N, R18E	881	1,579	3,945	10,897	—	—	—	—	4,826	12,476	841	3,140	5,667	15,616	604	1,324
TOTAL	7,581	12,887	7,998	23,189	53	243	—	—	15,632	36,319	1,992	5,244	17,624	41,563	2,520	5,437

*See Appendix 1 for details.

TABLE 2. — COAL RESOURCES AND RESERVES IN McINTOSH 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	696	3,011	—	—	696	3,011	349	1,209
Mineral	45	83	—	—	45	83	29	42
Wainwright	284	535	1	1	285	536	66	95
Peters Chapel	763	2,033	1	3	764	2,036	415	1,003
Secor	7,641	16,857	1,765	4,703	9,406	21,560	1,120	2,119
Lower Witteville	939	1,691	62	235	1,001	1,926	194	368
Rowe	709	1,558	—	—	709	1,558	87	144
Stigler	4,555	10,551	163	302	4,718	10,853	260	457
<i>TOTAL</i>	15,632	36,319	1,992	5,244	17,624	41,563	2,520	5,437

*See Appendix 1 for details.

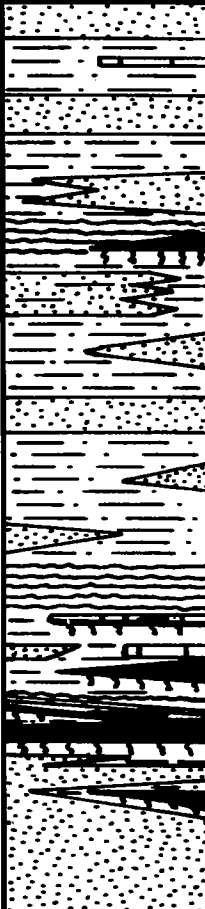
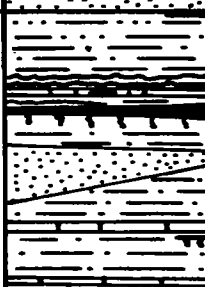
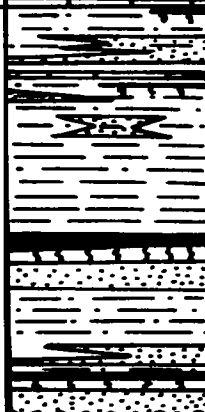
SYSTEM	SERIES	GROUP	FORMATION	LITHOLOGY	MEMBER OR UNIT
PENNSYLVANIAN	DESMOINESIAN	Krebs	Boggy		Wainwright coal Bluejacket coal Peters Chapel coal Secor Rider coal Secor coal Lower Witteville coal
			Savanna		Drywood coal Rowe coal Sam Creek Coal
			McAlester		Spaniard coal Keota coal Stigler coal Keifton coal

Figure 3 (above and facing page). Generalized columnar section of the coal-bearing strata of McIntosh County.

Figure 3 (continued).

Previous Investigations

The first report on coal in McIntosh County was by Drake (1897), after his reconnaissance of the coal fields of the Indian Territory. Shannon and others (1926) noted that a strip pit had been in operation for about four years near Texanna, but was abandoned in 1910. Coal there was said to be 18 in. thick; the bed, not identified then, was probably the Secor (Pl. 1). Mention also was made of coal found near Fawn (defunct since 1916; once 8 mi southeast of Chetopa), and of 5–18 in. of coal strip mined near Rentiesville. Wilson and Newell (1937, Pl. 1) mapped three coal beds in the county.

Trumbull (1957) estimated remaining reserves (“remaining resources” in present-day terminology) of 5.61 million tons for the Secor coal in McIntosh County, but mentioned no other beds. Oakes and others (1967, p. 47–48) included a section on coal, but said that “McIntosh County has little workable coal” and that most beds “are of academic interest only.” Reports of findings of coal by students mapping in the county were summarized, and for the present report some of their locations were relocated but many could not be found. Oakes and others (1967, p. 47) indicated that the coal geology of the county was poorly understood, saying that “the name ‘Secor’ is commonly applied to one or possibly several coal seams that lie at various distances, from a few feet to 100 feet or more, above the Bluejacket Sandstone.”

More recently, Friedman (1974) investigated and reported on coals of Oklahoma, and updated the resources and reserves of McIntosh County. As part of a presentation covering the coal belt of Oklahoma, Friedman (1982, pl. 2) mapped potentially strippable coal beds in McIntosh County by assimilating information gathered earlier.

Hemish (1987) presented a compendium of coal nomenclature recognized by the OGS for the northern part of the Oklahoma coal belt. In the next year, Hemish (1988a) reported on OGS core drilling in 1983–86 (including 30 holes in McIntosh County). Separately, Hemish (1988b) wrote about the coal stratigraphy of the Boggy Formation in the shelf-to-basin transition area (including Wagoner, Muskogee, McIntosh, Haskell, and Pittsburg Counties). In the same year Hemish (1988c) reported on the coalescence of the Secor and Secor Rider coal beds in the Shady Grove Creek area of northeastern McIntosh County—a report providing critical information about the coal-bearing strata in the area of the county with greatest potential for development of coal reserves.

Acknowledgments

The author is grateful to individual landowners and to various coal companies for providing access to their properties and furnishing information about coal beds. Appreciation is also expressed to W. H. Burnett, of Checotah, mining engineer and operator,

who spent many hours sharing his recollections, as well as his mine-plan maps from the early days in McIntosh County. (According to Mr. Burdett, the abandoned strip mines in sec. 5, T. 11 N., R. 18 E., and secs. 29, 31, and 32, T. 12 N., R. 18 E.—shown on the Warner 7.5' Quadrangle Map—were operated 1952–1955 by the Leavel Coal Company, and 1955–1961 by the Magic City Coal Company. In 1955, he said, Secor coal from the Leavel Mine sold for \$5.00 a ton.)

Appreciation is also expressed to Dale Dalton, James Dycus, R. Vance Hall, and Kay Kay and Associates for sharing their data on geology and coal beds. Thanks are extended to Christie Cooper, OGS managing editor, to Wendell Cochran, consulting technical editor, and to T. Wayne Furr, OGS manager of cartography, and his staff for their assistance and advice during preparation of the manuscript.

METHODS OF INVESTIGATION

Sources of Information

Data for compiling the maps, cross sections, and coal resources and reserves were obtained from >300 drill and core logs provided mostly by coal companies; from 31 OGS core-hole logs (Appendix 2); from 41 sections measured by the writer in active and abandoned strip pits, and on outcrops (Appendix 2); and from numerous sections measured by other workers during previous geologic studies in the area.

Analytical data for the coals of McIntosh County are included in Appendix 3. The data for the various coal beds were compiled from information from 98 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 (Table A3-1). In addition, data from 65 samples collected by the writer and analyzed by the OGS Chemistry Laboratory are presented in Table A3-2.

Procedures

Field mapping in McIntosh County began in April 1982 and by 1984 was mostly complete. The general practice was to traverse all roads by vehicle, and then as necessary to continue on foot throughout any area important to the investigation. Outcrop boundaries of the various coals were checked in the field, although exposures were difficult to find due to cover by surficial materials and dense vegetation in much of the area. Slumped material and ponded water largely cover most exposures of coal beds in abandoned strip mines, and abandoned underground mines are inaccessible. No maps of underground mines could be located, so the extent of those mines is unknown. Eu-faula Lake has flooded some outcrop locations reported in the literature, and reduced the potential for mining coal, but the impact is not great.

In this report, the term *outcrop* is used broadly to describe the areal border of a coal bed, whether it is exposed at the surface or concealed beneath uncon-

solidated 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 in which the coal is lenticular or lacks persistence also hinder mapping. Additional drill information will modify some outcrop boundaries shown on the maps. Generally, boundary lines shown on Plates 1 and 2A indicate where coal can be found at strippable depths.

In January 1988, a section was measured and the Secor coal sampled in the Inter-Chem #2 Mine, in sec. 6, T. 11 N., R. 18 E. (Appendix 2, Measured Section 29). OGS core-drilling projects were carried on from 1983 to 1986, during which time the writer described 2,738.7 ft of core (Appendix 2). (Figure 4 shows the OGS drill rig near Onapa.) In 1973, a 118.5-ft hole was drilled by the Cullum Core Drilling Company for the OGS; descriptions of the lithology from that borehole are included in Appendix 2 (Core-Hole Log 30).

All data points, outcrop boundaries of the various coal beds, and the extent of mined-out areas were plotted on 7.5'-quadrangle topographic maps, and the information transferred to green-line maps at the publication scale of 1 in. = 1 mi.

Mined Areas

Areas mined by surface methods were mapped through use of aerial photographs or by sight in the field. Large-scale maps of mined areas were provided by the Turner Brothers Coal Company, so the extent of its operation is well known.

In the past, underground mining was practiced on a small scale in the hills ~2 mi northwest of Onapa

(Pl. 1), as evidenced by an abandoned drift mine and two openings to abandoned shaft mines in dense woods. Other abandoned underground mines may be present in this area, where the Secor coal is known to be at least 2.5 ft thick (Appendix 2, Measured Section 9, Core-Hole Log 8).

Thickness of Coals

Isopach lines on the maps (Pls. 1, 2A) indicate thickness of various coal beds. The isopach interval for this study was set at 0.2 ft; this interval permits reasonably precise calculations in areas such as the one considered here, where coal-bed thickness averages <2 ft.

Overburden Categories

"Overburden" includes all consolidated or unconsolidated lithologic material overlying useful geologic deposits such as coal. Thickness of overburden is shown on the maps (Pls. 1, 2A) by isopach lines that divide the overburden into three categories: 0–40, 40–100, and >100 ft. In Oklahoma, the maximum depth at which coal reserves are considered strippable in Oklahoma is 100 ft, a figure based on observation of strip mines in which that depth was the limit for mining a single coal bed (Friedman, 1974, p. 15). Future economic and technological factors may change that number, but no predictions are made here.

Calculation of 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. Included on the map were 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 radius segment of 0.25 to 0.75 mi defines an area of indicated resources; and a radius segment 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 could be readily distinguished), and the acreage in each polygon was measured with a planimeter.

Coal tonnage was then calculated by multiplying the number of acres by the average thickness of the coal (to the nearest tenth of a foot), and that by the factor 1,800, which is 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.



Figure 4. The Oklahoma Geological Survey's drill rig and crew raising the mast before coring the Secor and Secor Rider coals in the SW¼NW¼SW¼SW¼ sec. 19, T. 11 N., R. 17 E. (see Appendix 2, Core-Hole Log 17).

Original work maps, charts, tables, and records of calculations are kept on open file at the Oklahoma Geological Survey in Norman, 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 the use of geologic judgment and 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 to be the minimum thickness minable), regardless of depth. At depths >100 ft, no resource figures were calculated for beds <1.2 ft thick.

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

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

Remaining coal resources 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 coal mined (or lost in mining), from the estimates of original resources.

Reserves, in this report, 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. Because of variations in coal thickness and depth within polygons used to estimate reserves on the work maps, some departures from the 80% recovery limit can be found in Appendix 1. 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

McIntosh County lies at the northern edge of the Arkoma basin, just southwest of the Ozark uplift (Fig. 2). In the eastern part of the county, the surface structure is dominated by several westward-trending folds and faults (Pls. 1; 2A,B). Rocks that crop out in the western part of the county generally dip ~1° toward the west. The major structural features shown on Plates 1 and 2A,B are taken from Oakes and others (1967, pl. 1) with some modifications. Several previously unmapped features discovered as a result of close-spaced drilling, field mapping, and coal mining activity are shown in Plates 1 and 2A,B.

Because of a general lack of minable coal in the western part of McIntosh County, the structural fea-

tures mapped by Oakes and others (1967, pl. 1), such as the Hanna syncline, are of little importance to the present study. However, the faults mapped in secs. 3 and 10, T. 12 N., R. 14 E., do affect the Mineral coal bed. Core drilling by the OGS in the area (Appendix 2, Core-Hole Logs 20, 21) shows that the coal has been eroded away on the upthrown side of a newly mapped fault in the same area that extends southward into sec. 15, T. 12 N., R. 14 E. (Pl. 1). The complex structure in the three sections containing coal inhibits large-scale mining and severely limits projection of Mineral coal resources (Table 2). The numerous northeast-trending faults in this area are an extension of the Seneca fault zone mapped by Hemish (1988d) in Okmulgee County.

Major folds previously mapped in the eastern part of McIntosh County include the Porum syncline, the Warner uplift, and the Rattlesnake Mountains syncline. Two major faults are the north and south faults of the Warner uplift (Pls. 1; 2A,B). These features, which trend roughly east-west, probably resulted from the same forces that produced the folds and faults of the Ouachita Mountains to the south (Oakes and others, 1967, p. 44).

The axis of the Porum syncline extends southwestward across southern McIntosh County. The syncline affects the outcrop boundary of only one coal bed having economic possibilities, the Secor. Webb (1957, 1960) found an outcrop of the Secor coal in the north bank of the Canadian River in the SE¼NW¼NE¼ SE¼ sec. 22, T. 10 N., R. 18 E. (now inundated by Eufaula Lake). This 18-in.-thick outcrop of coal is located on Plate 1, as well as a highly tentative projection of the outcrop boundary of the Secor bed across the axis of the Porum syncline.

On the north flank of an unnamed anticline, which lies between the Porum syncline and the south fault of the Warner uplift in southeastern McIntosh County, the present writer found a small, long-abandoned strip pit. Shannon and others (1926, p. 54) have said that a coal bed ~18 in. thick was mined at a depth of 10 ft at this location, near Texanna (Pl. 1), for four years, then abandoned in 1910. Probably the coal was the Secor. OGS core drilling to a depth of 140 ft just west of the old pit, but higher (Appendix 2, Core-Hole Log 6) did not penetrate the bed, indicating a fault. On this basis, mapping of the south fault of the Warner uplift was extended southwestward through the alluvium-filled valley at the foot of Texanna Mountain (Pl. 1). Core drilling ~1 mi southwest of Texanna—just off the nose of the unnamed anticline—penetrated a 0.4-ft-thick coal at 59 ft, which is interpreted as the Secor bed (Appendix 2, Core-Hole Log 3). Because of thinness of the coal observed in the core, and also proximity to Eufaula Lake, uncertainty of the outcrop boundary, general lack of data, and structural complexity in the area, reserves and resources for the Secor in the Texanna area have not been estimated.

The Warner uplift is a raised block between faults

on its north and south (Wilson and Newell, 1937, p. 83). The uplift is nearly 7 mi wide where it enters McIntosh County from the east, mostly along the east line of T. 11 N., R. 18 E. (Pls. 1; 2A,B). It is discernible as far southwest as the east side of R. 16 E. (Oakes and others, 1967). The axis of a previously unmapped, westward-plunging anticline located on the Warner uplift is defined by the outcrop boundary of the Stigler coal in secs. 35 and 36, T. 11 N., R. 17 E., and secs. 31 and 32, T. 11 N., R. 18 E. Close-spaced drilling shows that this secondary structural feature is truncated at the foot of the Bluejacket Sandstone escarpment by a southwestward-trending branch fault of the north fault of the Warner uplift (Pls. 1; 2A,B). The fault is upthrown to the east; the amount of throw is unknown.

Minable Stigler coal occurs in a structurally complex area of <1 mi², bounded by faults on two sides and running along the boundary between T. 11 and 12 N., R. 18 E. Along the north-bounding fault, the coal is downthrown, probably ~300 ft, which is the maximum estimated throw on the north fault of the Warner uplift in McIntosh County (Oakes and others, 1967).

The north fault of the Warner uplift—described by Wilson and Newell (1937, p. 78)—enters McIntosh County near the E¼ corner sec. 25, T. 12 N., R. 18 E., and extends southwestward to the N¼ corner sec. 23, T. 11 N., R. 17 E. Wilson did not believe that the fault was discernible farther southwest. However, recent exploration drilling for coal, and opening of coal strip pits in the area, show that the fault extends westward to the northeast edge of sec. 21, T. 11 N., R. 17 E., where it bends to the northwest and extends into sec. 11, T. 11 N., R. 16 E. (Pls. 1; 2A,B).

Field measurements on the attitude of the rocks, recent strip mining, and close-spaced drilling in the vicinity of Onapa (Pls. 1; 2A,B) show that the axis of a major syncline (Onapa syncline—a new name) trends east-west through the town. Strike and dip measurements on outcropping rocks in secs. 21, 22, and 28, T. 11 N., R. 17 E., indicate that the axis of the syncline bends to the northeast in this area, which is apparently devoid of minable coal.

Oakes and others (1967, p. 45) stated that “The Secor coal which is present in both the Porum and Rattlesnake Mountain synclines seems to be absent from the [Warner] uplift, indicating that the uplift probably stood too high to support coal marshes in Secor time.” They further hypothesized that thinner coals younger than the Secor were present on the uplift because of environmentally favorable conditions that prevailed at that time. Plate 1 shows that the thin coals referred to by Oakes and others (1967) are the Secor, the Secor Rider, and the Bluejacket coal beds, and that the Secor is indeed present on the uplift, where it is preserved in the Onapa syncline. Whether the Secor was ever deposited farther to the east on the Warner uplift is a moot point. The coal may have been deposited, then removed by erosion

after uplifting of the Warner block. Discounting the throw on the north fault of the Warner uplift, there appears to be no lack of continuity of the outcrop boundary of the Secor coal (Pl. 1).

Two folds that approximately parallel the axis of the Rattlesnake Mountains syncline were revealed by coal exploration drilling in an area about 4–5 mi east of Checotah. A fault mapped by Oakes and others (1967) was extended northeastward from sec. 35, T. 12 N., R. 17 E., to the southwest corner of sec. 18, T. 12 N., R. 18 E., based on core drilling (Pls. 1; 2A,B).

Two faults were mapped in secs. 14, 22, 23, and 26, T. 12 N., R. 17 E.—again, based on core drilling and field observations. Absence of the Secor coal in parts of these sections, and the presence of a thick sandstone in the area, interpreted as the Bluejacket Sandstone, suggests that an upthrown block lies between the two faults.

Another two faults have been revealed by coal mining in secs. 16 and 21, T. 12 N., R. 17 E. Drilling, strike and dip measurements on rock exposures, topography, and drainage patterns indicate that several structures are present in the northeastern part of T. 12 N., Rs. 16 and 17 E. (Pls. 1; 2A,B). In this area the Secor coal appears to have no commercial value.

The Wainwright coal was identified in an outcrop and penetrated in a core-hole just south of the Muskogee County line in sec. 1, T. 12 N., R. 16 E. (Appendix 2, Measured Section 31; Core-Hole Log 22). The coal cannot be traced south of the bluffs along a southeastward-trending tributary of Elk Creek, in T. 12 N., Rs. 16 and 17 E. Absence of coal, the escarpment on one side of the stream, and the straight course of the stream suggest a fault (Pls. 1; 2A,B).

Cleat orientations were measured with a Brunton compass on 26 exposures of coal (Appendix 4). Rose diagrams (Fig. 5) show that the average face-cleat direction is N. 45° W., and the average butt-cleat direction is N. 47° E.

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, and butt cleat is the 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 indicate that “face cleat maintains a perpendicular orientation to the shifting axial trend of local structures.” As the rose diagrams show, the face cleat strikes NW generally, and the butt cleat strikes NE. These trends suggest that the cleat structure was produced by tectonic forces associated with the Ozark uplift, which has a NE-trending axis. Tectonic forces that produced the east-west-trending folds and faults associated with the Ouachita overthrust belt to the south probably also influenced cleat structure in the coals of McIntosh County.

Stratigraphy and Coal Resources

The coal beds in McIntosh 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. Other coal beds are in the Stuart and Senora Formations of the overlying Cabaniss Group (Fig. 3).

The Hartshorne Formation contains two commercial coal beds in the Arkoma basin to the south. However, the Hartshorne Formation is not mappable at the surface in McIntosh County (Oakes and others, 1967).

The oldest coal bed known in the county is the Keifton coal, present in the upper part of the Warner Sandstone Member of the McAlester Formation (Fig. 3). Its outcrop boundary has been projected into the extreme northeastern part of McIntosh County from adjacent Muskogee County (Hemish, 1998) (Pl. 1). Although the Keifton coal was not observed in outcrop in the map area, based on data from Muskogee County (Hemish, 1998), it is assumed that the coal lacks the thickness or extent required for commercial value.

The Stigler coal is the oldest of eight coals in McIntosh County that have commercial potential. The others (from oldest to youngest) are Rowe, Lower Witteville, Secor, Peters Chapel, Wainwright, Mineral, and Croweburg (Fig. 3). Other coals in the county are too thin to have economic value—the Keota, Spaniard, Sam Creek, Drywood, Secor Rider, Bluejacket, an unnamed coal in the Stuart Formation, and the Tebo coal (Fig. 3).

The name “Stigler” is used in this report for the coal that occurs just above the Cameron Sandstone Member of the McAlester Formation. Friedman (1974, p. 29) stated that the McAlester coal and the

Stigler coal are correlative. Although “McAlester” preempts “Stigler,” the latter name has been used widely for the coal mined east and north of the town of Stigler—used so widely that it cannot be abandoned.

The Stigler coal is minable, and has been mined in the past, in three distinct areas in McIntosh County—one area mostly within secs. 25, 26, 35, and 36, T. 11 N., R. 17 E.; a second area in secs. 2 and 3, T. 11 N., R. 18 E., and sec. 35, T. 12 N., R. 18 E.; and a third in secs. 2, 3, 10, 11, and 12, T. 12 N., R. 18 E. (Pl. 2A). The thickest coal is in sec. 36, T. 11 N., R. 17 E., where it is as much as 1.6 ft thick and was being mined in the early 1980s. The most remaining reserves are also in this area (Appendix 1). In the study area, the McAlester Formation contains no other commercial coals.

The Rowe coal of the Savanna Formation is the next stratigraphically higher coal bed that has some economic possibilities, but only in a limited area in extreme northeastern McIntosh County (Pl. 2A). The Rowe generally crops out midway up slope in the Bluejacket Sandstone escarpment. Its outcrop boundary is discontinuous and broken by faults, particularly the north fault and the south fault of the Warner uplift (Pl. 2A).

The next stratigraphically higher economic coal is in the Bluejacket Sandstone Member of the Boggy Formation. Here it is called the Lower Witteville coal on the basis of correlation with the Lower Witteville coal at its type locality in Le Flore County (Hemish, 1994b). The Lower Witteville coal is one of several coal beds in the Boggy Formation that have mistakenly been called “Secor” in the past (Oakes and others, 1967, p. 47). The Lower Witteville crops out on the flanks of two synclines, where locally it is thick enough to mine. The bed has not been mined on the flanks of the Onapa syncline, where it is about 0.8–1.0 thick; however, it was mined as recently as the mid-1980s in the Rattlesnake Mountains syncline (Pl. 2A), where it is locally 2.2 ft thick. The coal was sampled for analysis twice, and sections were measured in the mine operated by Woodside Construction Company during 1985–86 (Appendix 2, Measured Sections 40, 41; Appendix 3, Table A3-2). The Lower Witteville coal thins northward and apparently pinches out north of Rentiesville, just south of the Muskogee County line, where it was observed in a stream bank in the NW¼ sec. 3, T. 12 N., R. 17 E. (Appendix 2, Measured Section 34). Figure 6 shows an outcrop of the Lower Witteville coal in the town of Rentiesville in the area where it thins northward (Appendix 2, Measured Section 35).

The Secor coal is the oldest in a sequence of four coal beds in a 100-ft-thick interval just above the Bluejacket

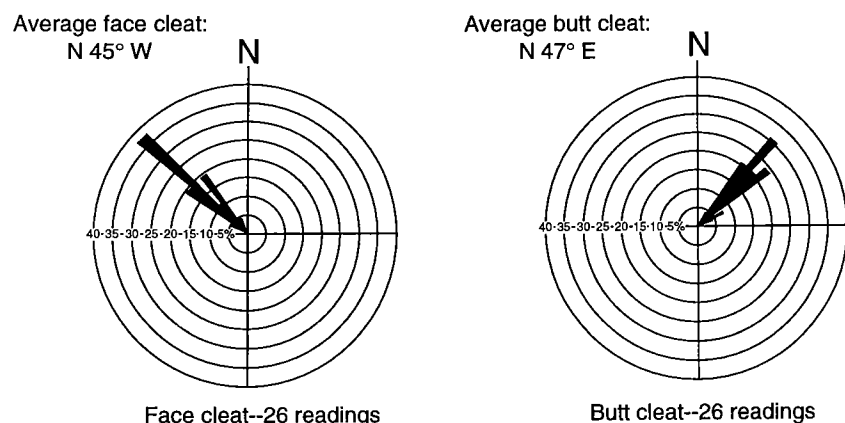


Figure 5. Rose diagrams of cleat orientations in the coal beds of McIntosh County. Number of readings for each azimuth shown are given as percent of total (see Appendix 4).



Figure 6. Outcrop of the 3-in.-thick Lower Witteville coal bed in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 15, T. 12 N., R. 17 E., McIntosh County (see Appendix 2, Measured Section 35). Trenching tool is 1.7 ft long.

Sandstone. Like the Lower Witteville, it crops out on the flanks of the Onapa syncline and the Rattlesnake Mountains syncline (Pls. 1, 2B). The coal bed attains a maximum thickness of 2.5 ft in a small area just south of the north fault of the Warner uplift ~2 mi northwest of the town of Onapa, where it was mined underground at an unknown time in the past. Old strip-mine records show that the Secor coal, mined in the area ~5 mi east of Checotah, had a similar thickness. Hemish (1988c) showed that the Secor and the overlying Secor Rider bed coalesce in this area, thus explaining the above-average thickness of the coal. Coalescence of the two coal beds in the area of unusual thickness northwest of Onapa could not be confirmed. However, the Secor Rider coal is not present in an OGS core hole in that same area (Appendix 2, Core-Hole Log 8). The Secor Rider is apparently present elsewhere throughout the Onapa area (Appendix 2, Measured Sections 6, 10, 11, 12, 13, 14, 15, 16, 17, 18; Core-Hole Log 17) where the Secor coal is <1.0 ft thick.

The Secor Rider coal generally occurs about 15–20 ft above the Secor coal where the two do not coalesce (Appendix 2). It has no economic value because its maximum thickness is not known to exceed 0.7 ft, and it is a high-ash, high-sulfur coal (Appendix 3). It is generally overlain closely by an unnamed thin marine limestone (Pl. 2C).

A locally thick coal bed cropping out south and east of Checotah occurs ~50 ft above the Secor Rider coal and ~14 ft below the Inola Limestone. This bed is correlated with the Peters Chapel coal, named by Hemish (1986b, p. 77) in Muskogee County. The Peters Chapel was cored in the SE $\frac{1}{4}$ sec. 8, T. 11 N., R. 17 E., where it is 2.2 ft thick (Appendix 2, Core-Hole Log 14). However, coal-company logs indicate that within 0.5 mi to the south the coal thins to 0.2 ft (Pl.

2A). In the NE $\frac{1}{4}$ sec. 3, T. 11 N., R. 17 E., it was cored and its thickness found to be 1.8 ft (Appendix 2, Core-Hole Log 10). Coal-company logs show that the Peters Chapel is 2.8 ft thick on the downthrown side of a fault in sec. 35, T. 12 N., R. 17 E. (Pl. 2A). Abandoned small mines are found along the outcrop boundary of the Peters Chapel coal east and south of Checotah (Pl. 2A), but the coal has not been mined in recent times, probably because its content of ash and sulfur is high (Appendix 3).

The youngest of the sequence of four coals between the top of the Bluejacket Sandstone and the Inola Limestone is the Bluejacket coal. It lies just under the limestone, but does not exceed 0.2 ft in thickness (Appendix 2, Measured Sections 20, 21, 22; Core-Hole Logs 7, 10, 13, 24) and so it has no economic value.

Cross sections A–A' and B–B' (Pl. 2C) show the relationships of five coal beds in eastern McIntosh County and in the lower part of the Boggy Formation. New data acquired during the present study should correct some stratigraphic misconceptions of the past.

The outcrop belt of one other coal in the Boggy Formation extends from the Wainwright area of Muskogee County (Hemish, 1998) into sec. 1, T. 12 N., R. 16 E., and sec. 6, T. 12 N., R. 17 E. (Pl. 1). The coal is the Wainwright, and locally it is thick enough to mine. Small abandoned strip pits attest to past mining (Pl. 1), and observations of the bed in outcrops in the area show it to be at least 0.8 ft thick (Appendix 2, Measured Section 31). However, a core sample (Appendix 2, Core-Hole Log 22) shows that <1 mi to the west the coal is 1.3 ft thick.

The Stuart Formation of the Cabaniss Group overlies the Boggy Formation in McIntosh County (Fig. 3). It contains at least one unnamed coal bed that may have limited economic potential. Two abandoned strip mines were located by the present writer along a stream in sec. 8, T. 9 N., R. 15 E. (Pl. 1), but the coal could not be found in outcrop, so its thickness is unknown.

A coal interpreted as the Tebo coal of the Senora Formation crops out in T. 12 N., R. 15 E., east of Hitchita (Pl. 1). A few feet above the coal is a black, fossiliferous limestone interpreted as the Tiawah Limestone (Fig. 3). The Tebo does not exceed 0.5 ft in thickness where observed by the writer (Appendix 2, Measured Section 30). However, Andrews (1957, p. 25) reported finding a coal bed 7.5 in. thick in the southeastern part of sec. 23, T. 10 N., R. 14 E., that may correlate with the Tebo. According to local residents, coal there has been mined for household use, but a search of the area found neither pits nor coal.

A coal bed correlated with the Mineral (Eram) coal (Hemish, 1994a, pl. 2) was cored in sec. 10, T. 12 N., R. 14 E. (Appendix 2, Core-Hole Log 21). This coal is in the Senora Formation (Fig. 3). Structural complexities in the area limit the potential for mining, even though the coal is 1 ft thick. Close-spaced exploration drilling is needed to determine the true extent of the bed.

The youngest commercial coal in the county is also in the Senora Formation. The coal is the Croweburg (Henryetta) bed (Fig. 3), mapped by Hemish (1994a, pl. 1) in Okmulgee County to the north and Okfuskee County to the west. The Croweburg occurs in only a small part of the extreme western part of McIntosh County, in T. 10 N., R. 13 E. (Pl. 1). Core holes were drilled by OGS in sec. 7, T. 10 N., R. 13 E. (Appendix 2, Core-Hole Logs 1, 2). The coal bed splits into three layers in Core-Hole 1: the lowest layer is 1.3 ft thick, and is separated from the middle layer by 0.2 ft of carbonaceous shale; the middle layer is impure, and only 0.3 ft thick; the 1.1-ft-thick uppermost layer is separated from the middle layer by 1.2 ft of underclay.

In Core-Hole 2, crop-line coal was drilled, so true thickness could not be determined. About 1 ft of smutty, weathered coal was deduced from cuttings. The potential for surface mining the cumulative 2.4 ft (neglecting the middle layer) of Croweburg coal seems feasible from the Okfuskee County line on the west to the Okmulgee County line on the north.

COAL QUALITY

Coals of McIntosh County rank predominantly as high-volatile A bituminous (hvAb) (Appendix 3). Rank was determined by standard procedures of the American Society for Testing and Materials (ASTM, 1987, p. 225–228), with analysis by the Chemistry Laboratory of the OGS. Average values for the various analytical properties of each coal are listed in Appendix 3, based on data from 98 analytical reports (Table A3-1). During the investigation, the present writer collected 65 samples of coal: 24 in active strip mines, 30 from core holes, and 11 from stockpiles of

active strip mines, abandoned strip mines, test pits, cutbanks, shale pits, and road cuts (Appendix 3, Table A3-2). Analyses of samples that showed evidence of weathering were not used in classification by rank.

The average overall moisture content of all coals analyzed in McIntosh County is low, averaging 3.4% on 98 samples (Appendix 3, Table A3-1). Of the eight coals listed previously that are considered to have the most economic potential (and those sampled five or more times), the Secor coal has the highest quality. Averaged analyses of 56 samples show that it is a medium-ash (10.1%), medium-sulfur (2.5%) coal, with heat value of 12,987 Btu/lb. Analytical values of the other coals (average of five or more samples) are as follows: Stigler coal—8.8% ash, 3.9% sulfur, heat value, 12,907 Btu/lb (11 samples); Lower Witteville coal—10.8% ash, 3.3% sulfur, heat value, 13,155 Btu/lb (10 samples); Peters Chapel coal—16.2% ash, 6.6% sulfur, heat value, 12,331 Btu/lb (5 samples). Analytical properties of other coals are given in Appendix 3. 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 in pyrite, which is much denser than coal and tends to sink during washing.

COAL ECONOMICS

Production

The earliest reported production of coal from McIntosh County was in 1934 (U.S. Bureau of Mines, 1932–48), but the production was combined with Wagoner County, so exact tonnage is unknown. Rec-

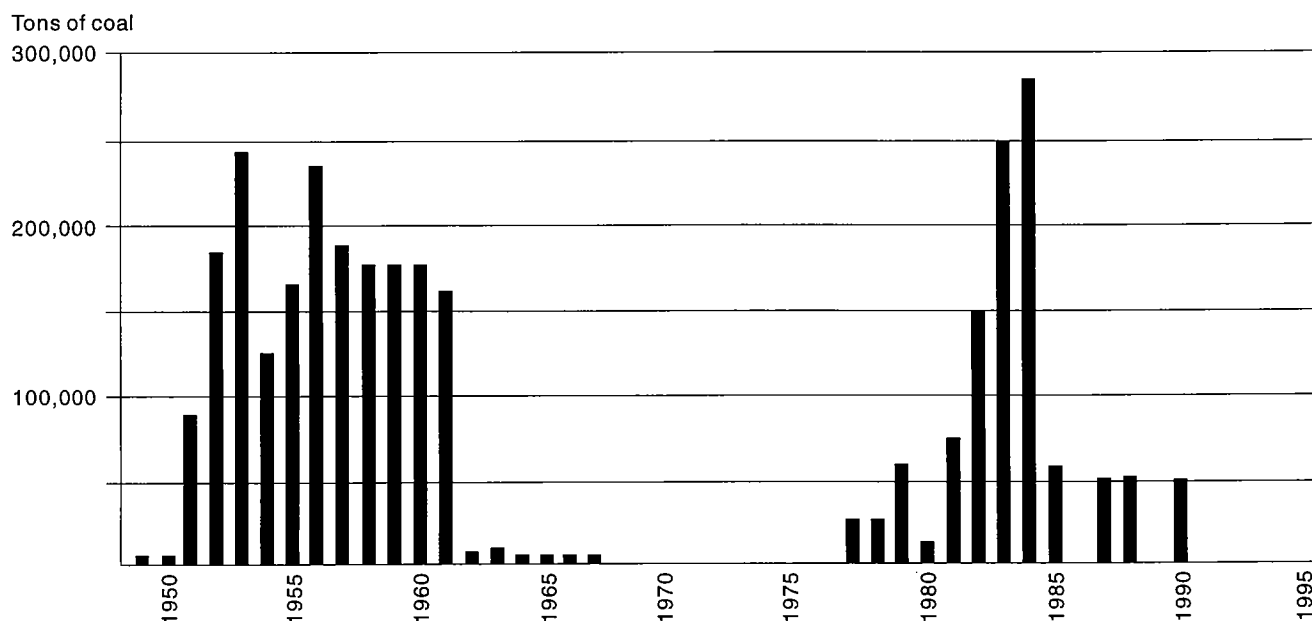


Figure 7. Histogram illustrating reported production of coal in McIntosh County, 1949–95. (Data from *Annual Report of the Chief Mine Inspector*, Oklahoma Department of Mines.)

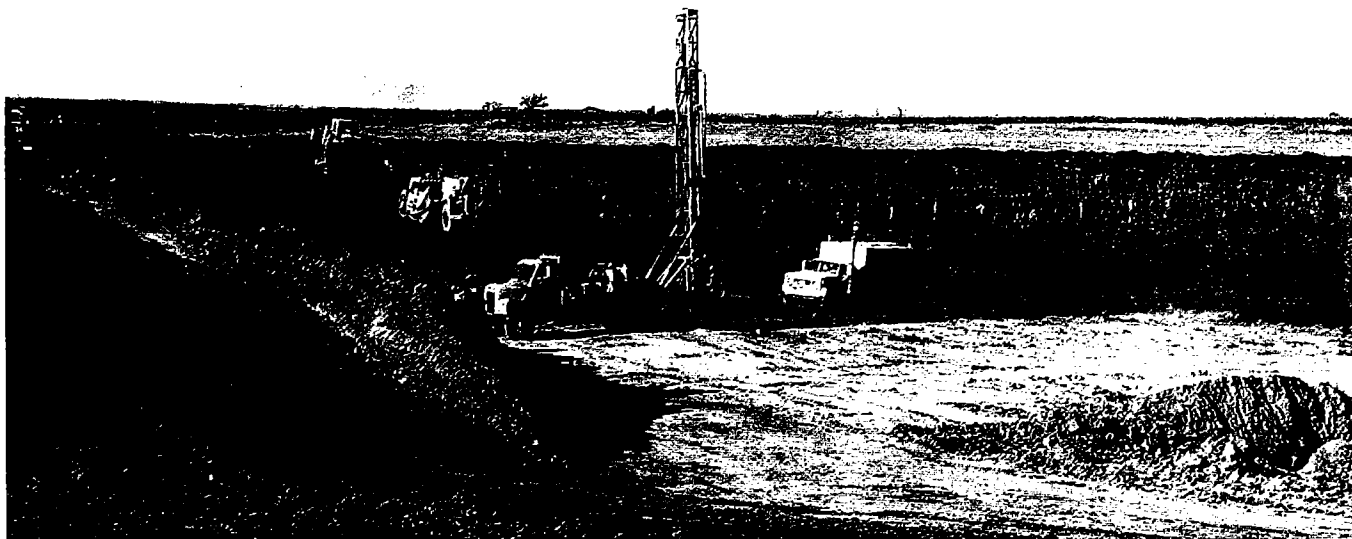


Figure 8. The Inter-Chem #2 Mine in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 6, T. 11 N., R. 18 E., McIntosh County, in January 1988. Coal was being produced from the 1.0-ft-thick Secor coal bed (see Appendix 2, Measured Section 29).

ords were not kept for small-scale mining earlier than 1934. After 1934, no coal production was reported until 1942, when 1,573 tons was mined (U.S. Bureau of Mines, 1932–48). No further production of coal was reported for McIntosh County until 1949, when 1,424 tons was mined (Oklahoma Department of Mines (1949–95). Figure 7 shows coal production in the county from 1949 to 1995, as reported by the Oklahoma Department of Mines (1949–95). The longest extended period of noteworthy coal production in the county from 1952 to 1961, when the Leavel Coal Company and the Magic City Coal Company were mining the Secor coal about 5 mi east of Checotah. During that period the average annual production was 178,429 tons. However, the all-time peak production came in 1983 with 244,974 tons and in 1984 with 283,364 tons. That coal came from the Stigler and Secor coal beds.

The most recent production of coal from McIntosh County was in 1990, when 46,692 tons of Secor coal was mined by Inter-Chem Coal Company. Figure 8 shows the Inter-Chem #2 Mine as it appeared in January 1988. At publication time for this report there were no active coal mines in McIntosh County.

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 36,319,000 tons, of which 5,437,000 tons are reserves.

The Secor coal bed has the most remaining resources, with 16,857,000 tons, and reserves, with 2,119,000 tons. The greatest tonnage is in T. 12 N., R. 17 E., where 7,364,000 tons are still in the ground, of which 832,000 tons are reserves. T. 12 N., R. 18 E. has 4,091,000 tons of Secor coal still in the ground, of which 750,000 tons are reserves (Appendix 1).

The Stigler coal bed also has potential for exploitation, particularly in T. 11 N., R. 17 E., where 6,691,000 tons remain, of which 727,000 tons are reserves (Appendix 1).

With higher prices for coal and increased demand, particularly for medium- and high-sulfur coal, the mining industry could once again become important to the economy of McIntosh County.

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.
- Andrews, R. E., Jr., 1957, *Geology of the Raiford area, McIntosh County, Oklahoma*: University of Oklahoma unpublished M.S. thesis, 56 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, p. 3
- 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.
- Hemish, L. A., 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, Coalescence of the Secor and Secor Rider coal beds in the Shady Grove Creek area, northeastern McIntosh County, Oklahoma, with interpretations concerning depositional environments: Oklahoma Geology Notes, v. 48, p. 100–119.
- _____. 1988d, A stratigraphic and structural study of the Eram coal and associated strata in eastern Okmulgee County and western Muskogee County, Oklahoma: Oklahoma Geological Survey Map GM-30, 1 sheet with text, scale 1:31,680.
- _____. 1989, Coal geology of Rogers County and western Mayes County, Oklahoma: Oklahoma Geological Survey Bulletin 144, 118 p.
- _____. 1990, Coal geology of Tulsa, Wagoner, Creek, and Washington Counties, Oklahoma: Oklahoma Geological Survey Map GM-33, 3 sheets, scale 1:63,360, accompanying text.
- _____. 1994a, Coal geology of Okmulgee County and eastern Okfuskee County, Oklahoma: Oklahoma Geological Survey Special Publication 94-3, 86 p.
- _____. 1994b, Correlation of the Lower Witteville coal bed in the Arkoma basin, eastern Oklahoma: Oklahoma Geology Notes, v. 54, p. 4–28.
- _____. 1998, Coal geology of Muskogee County, Oklahoma: Oklahoma Geological Survey Special Publication 98-2, 111 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.
- Oakes, M. C.; and others, 1967, Geology and mineral resources of McIntosh County, *part 1 of* Geology and petroleum of McIntosh County, Oklahoma: Oklahoma Geological Survey Bulletin 111, p. 1–40, 68–85.
- Oklahoma Department of Mines, 1949–94, Annual reports: Oklahoma Department of Mines, Oklahoma City.
- Shannon, C. W.; and others, 1926, Coal in Oklahoma [revised and edited by C. L. Cooper]: Oklahoma Geological Survey Bulletin 4, 110 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, 1932–48, Minerals Yearbooks.
- Webb, F. S., 1957, Surface geology of the Eufaula-Texanna area, McIntosh and Pittsburg Counties, Oklahoma: University of Oklahoma unpublished M.S. thesis, 60 p.
- _____. 1960, Surface geology of the Eufaula-Texanna area, McIntosh and Pittsburg Counties, Oklahoma: Oklahoma City Geological Society, Shale Shaker, v. 10, no. 8, p. 2–14; also in Shale Shaker Digest, v. 3, p. 273–284.
- Wilson, C. W., Jr.; and Newell, N. D., 1937, Geology of the Muskogee-Porum district, Muskogee and McIntosh Counties, Oklahoma: Oklahoma Geological Survey Bulletin 57, 184 p.

APPENDIXES

(Thousands of short tons)

[illegible]

T10N, R18E, MCINTOSH COUNTY

STIGLER

<u>Measured</u>									
0-20								4	8
20-40								4	8
40-100								4	8
> 100								4	8
<u>Total</u>								4	8
<u>Indicated</u>									
0-20									
20-40									
40-100	92	196			92	196		92	196
> 100									
<u>Total</u>	92	196			92	196		92	196
<u>Inferred</u>									
0-20									
20-40									
40-100	175	371			175	371		175	371
> 100									
<u>Total</u>	175	371			175	371		175	371
<u>Grand Total</u>	267	567			267	567	4	8	575

T11N, R16E, MCINTOSH COUNTY

SECOR

<u>Measured</u>																			
0-20	173	254	16	53	3	12	12	192	319	41	62	233	381	192	257				
20-40	194	288	23	81	12	54	54	229	423			229	423						
40-100	302	434						302	434			302	434						
> 100																			
<u>Total</u>	669	976	39	134	15	66	66	723	1,176			764	1,238	192	257				
<u>Indicated</u>																			
0-20	54	78						54	78			54	78	54	62				
20-40	97	141						97	141			97	141						
40-100	533	768						533	768			533	768						
> 100																			
<u>Total</u>	684	987						684	987			684	987	54	62				
<u>Inferred</u>																			
0-20	2	3						2	3			2	3	2	2				
20-40	39	56						39	56			39	56						
40-100	37	54						37	54			37	54						
> 100																			
<u>Total</u>	78	113						78	113			78	113	2	2				
<u>Grand Total</u>	1,431	2,076	39	134	15	66	66	1,485	2,276	41	62	1,526	2,338	248	321				

¹Coal 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		
										Total Remaining Resources								
		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		
TT1N, R17E, MCINTOSH COUNTY (continued.)																		
	<u>Measured</u>																	
	0-20	11	24	63	149						74	173	21	53	95	226	74	139
	20-40	26	55	125	307						151	362			151	362	50	99
	40-100	59	123	223	530						282	653			282	653		
	>100			118	277						118	277			118	277		
	<u>Total</u>	96	202	529	1,263						625	1,465			646	1,518	124	238
	<u>Indicated</u>																	
	0-20	2	5	21	51						23	56			23	56	23	45
	20-40	5	11	13	33						18	44			18	44		
	40-100	175	368	54	125						229	493			229	493		
	>100			148	351						148	351			148	351		
	<u>Total</u>	182	384	236	560						418	944			418	944	23	45
	<u>Inferred</u>																	
	0-20																	
	20-40																	
	40-100	26	54								26	54			26	54		
	>100																	
	<u>Total</u>	26	54								26	54			26	54		
	<u>Grand Total</u>	304	640	765	1,823						1,069	2,463	21	53	1,090	2,516	147	283
	<u>Combined Grand Totals</u>	2,706	4,412	933	2,279						3,639	6,691	622	1,018	4,261	7,709	437	727
TT1N, R18E, MCINTOSH COUNTY																		
	<u>Measured</u>																	
	0-20			7	20						7	20	145	355	152	375	7	16
	20-40			8	24						8	24			8	24	5	11
	40-100	102	183	159	515						261	698			261	698		
	>100																	
	<u>Total</u>	102	183	174	559						276	742			421	1,097	12	27
	<u>Indicated</u>																	
	0-20																	
	20-40																	
	40-100	53	95	21	52						74	147			74	147		
	>100																	
	<u>Total</u>	53	95	21	52						74	147			74	147		
	<u>Inferred</u>																	
	0-20																	
	20-40																	
	40-100																	
	>100																	
	<u>Total</u>																	
	<u>Grand Total</u>	155	278	195	611						350	889	145	355	495	1,244	12	27

STIGLER														

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		
T12N, R16E, MCINTOSH COUNTY																					
WAINWRIGHT	Measured																				
	0-20	19	33									19	33	1	1	20	34	15	21		
	20-40	40	76	10	23							50	99			50	99	3	5		
	40-100	24	48	23	54							47	102			47	102				
	> 100																				
	Total	83	157	33	77							116	234			117	235	18	26		
	Indicated																				
	0-20	23	39									23	39			23	39	18	25		
	20-40	23	37	11	26							34	63			34	63	3	5		
	40-100	56	99	4	8							60	107			60	107				
	> 100																				
	Total	102	175	15	34							117	209			117	209	21	30		
	Inferred																				
	0-20																				
	20-40																				
	40-100																				
	> 100																				
	Total																				
	Grand Total	185	332	48	111							233	443	1	1	234	444	39	56		

T12N, R17E, MCINTOSH COUNTY																
WAINWRIGHT																
	<u>Measured</u>															
	0-20															
	20-40															
	40-100															
	>100															
	<u>Total</u>															
	<u>Indicated</u>															
	0-20	27	49								27	49		27	49	39
	20-40	16	29								16	29		16	29	
	40-100	8	14								8	14		8	14	
	>100															
	<u>Total</u>	51	92								51	92		51	92	39
	<u>Inferred</u>															
	0-20															
	20-40															
	40-100															
	>100															
	<u>Total</u>															
	Grand Total	51	92								51	92		51	92	39

PETERS CHAPEL											
<u>Measured</u>	0-20	6	24	10	46	16	70	16	70	16	56
	20-40	47	154	21	99	68	253	68	253	59	179
	40-100			7	32	7	32	7	32	3	13
	>100										
	Total	53	178	38	177	91	355	91	355	78	248
<u>Indicated</u>	0-20	40	78			78	189	78	189	78	151
	20-40	19	31	162	541	181	572	181	572	134	362
	40-100	27	42	30	101	57	143	57	143		
	>100										
	Total	86	151	230	753	316	904	316	904	212	513
<u>Inferred</u>	0-20	7	11			7	11	7	11	7	9
	20-40	9	15			9	15	9	15	15	
	40-100	3	4			3	4	3	4	4	
	>100										
	Total	19	30			19	30	19	30	7	9
Grand Total		105	181	283	931	426	1,289	426	1,289	297	770
SECOR											
<u>Measured</u>	0-20	149	268	98	306	247	574	580	1,224	247	459
	20-40	181	325	122	390	303	715	303	715	95	244
	40-100	699	1,274	529	1,363	1,228	2,637	1,228	2,637		
	>100			203	514	203	514	203	514		
	Total	1,029	1,867	952	2,573	1,981	4,440	2,314	5,090	342	703
<u>Indicated</u>	0-20	52	94	20	51	72	145	72	145	72	116
	20-40	36	65	16	40	52	105	52	105	6	13
	40-100	165	295	309	973	474	1,268	474	1,268		
	>100			488	1,406	488	1,406	488	1,406		
	Total	253	454	833	2,470	1,086	2,924	1,086	2,924	78	129
<u>Inferred</u>	0-20										
	20-40										
	40-100										
	>100										
	Total										
Grand Total		1,282	2,321	1,785	5,043	3,067	7,364	333	8,014	420	832
Combined Grand Totals		1,438	2,594	2,068	5,974	3,544	8,745	333	9,395	744	1,641

'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			Total Remaining Resources			Total Remaining Resources		
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	
T12N, R18E, MCINTOSH COUNTY																		
SECOR	Measured																	
	0-20			162	526					162	526	646	2,674	808	3,200	162	421	
	20-40			150	495					150	495			150	495	122	325	
	40-100	107	183	562	1,957					669	2,140			669	2,140			
	> 100																	
	Total	107	183	874	2,978					981	3,161			1,627	5,835	284	746	
	Indicated																	
	0-20																	
	20-40			1	5					1	5			1	5	1	4	
	40-100			257	925					257	925			257	925			
> 100																		
Total			258	930					258	930			258	930	1	4		
Inferred																		
0-20																		
20-40																		
40-100																		
> 100																		
Total																		
Grand Total	107	183	1,132	3,908					1,239	4,091	646	2,674	1,885	6,765	285	750		
LOWER WITTEVILLE																		
	Measured																	
	0-20			36	118					36	118	62	235	98	353	36	94	
	20-40																	
	40-100																	
	> 100																	
	Total			36	118					36	118			98	353	36	94	
	Indicated																	
	0-20	16	32	56	131					72	163			72	163	72	157	
	20-40	3	6							3	6			3	6			
	40-100																	
> 100																		
Total	19	38	56	131					75	169			75	169	72	157		
Inferred																		
0-20	66	113							66	113			66	113	66	91		
20-40	15	24							15	24			15	24				
40-100																		
> 100																		
Total	81	137							81	137			81	137	66	91		
Grand Total	100	175	92	249					192	424	62	235	254	659	174	342		

APPENDIX 2: Measured Sections and Core-Hole Logs

Measured Sections

Measured Section 1

NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 10 N., R. 18 E., McIntosh County, Oklahoma. Measured in slope of Texanna Mountain from top of ridge to floor of active shale pit under power wires, by LeRoy A. Hemish. Field notebook designation MM-4-86-H. (Estimated elevation at top of section, 860 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, grayish orange to moderate red, very fine grained, cross-bedded, medium-bedded, noncalcareous (Bluejacket Sandstone)	10.0
Sandstone, pale yellowish brown, interstratified with shale, very thin bedded, flaky, ripple-marked, noncalcareous, upper 30 ft poorly exposed (Bluejacket Sandstone)	51.0
Savanna Formation:	
Shale, moderate yellowish brown, silty, weathered, poorly exposed	84.0
Shale, olive gray, brittle	12.0
Shale, black, brittle, flaky; includes dark yellowish orange and moderate brown ironstone concretions as much as 2 in. thick and 2 ft in diameter that are blackish red on freshly broken surfaces	13.0
Limestone, dark gray, impure, silty, weathers light brown; contains abundant fossil hash; weathers to soft shaly clay in places on the outcrop	0.5
Coal, black with moderate reddish brown iron-oxide deposits on cleat surfaces, moderately friable (Rowe coal)	0.5
Underclay, light gray with grayish yellow and light brown secondary deposits on fracture surfaces; contains black carbonized plant fragments, blocky fracture	2.5
Shale, light olive gray, blocky	1.5
Sandstone, yellowish gray, very fine grained, massive, hard, ripple-marked on surface of exposure, base covered	1.0
<i>Total</i>	176.0

Measured Section 2

NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ and W $\frac{1}{2}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 7, T. 10 N., R. 18 E., McIntosh County. Measured in gully on southeastern end of Texanna Mountain, by LeRoy A. Hemish. Field notebook designation MM-27-83-H. (Estimated elevation at top of section, 910 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, brown to reddish brown, fine-grained, cross-bedded, massive; weathers to large blocks that litter underlying slope (Bluejacket Sandstone)	40.0
Savanna Formation:	
Shale, brownish gray, silty; poorly exposed, outcrop largely covered by colluvium	112.0
Shale, black, fissile; contains reddish brown layers of ironstone about 1–2 in. thick; poorly exposed	9.0
Shale, light grayish brown, very weathered	0.7
Coal, black, soft, very weathered (Rowe coal)	0.5
Underclay, purplish gray, mottled pink and light gray on fresh surface, weathered	1.8
Sandstone, grayish brown and reddish brown, very fine grained, irregularly wavy bedded, hard; bioturbated, with abundant trails and burrows (covered to base of slope)	5.0
<i>Total</i>	169.0

Measured Section 3

SW¼SW¼NW¼NE¼ sec. 11, T. 10 N., R. 18 E., McIntosh County. Measured in gully and shale pit on northeastern end of Black Haw Mountain, by LeRoy A. Hemish. Field notebook designation MM-28-83-H. (Estimated elevation at top of section, 665 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Shale, black, brittle, fissile; contains layers of reddish brown ironstone about 1–2 in. thick; upper part covered by colluvium	7.0
Limestone, dark gray, weathers dark grayish brown, irregular-bedded, impure, silty, feels hackly; very fossiliferous, brachiopods abundant, pinkish purple stain on fossils (Don- eley Limestone)	0.7
Coal, black, soft, weathered (Rowe coal)	0.7
Underclay, very dark gray, to black with reddish brown spots and streaks	0.5
Covered interval	0.5
Shale, light grayish brown; contains thin, orange brown stringers of clay ironstone	1.5
Sandstone, light grayish brown; to dark brown; very fine grained, thin-bedded; grades downward to fissile shaly siltstone	1.2
Siltstone, light olive tan with orange and brown staining, very thin bedded, shaly	7.8
Sandstone, brown to orange brown with dark brown staining, very fine grained, irregu- larly thin bedded; contains abundant trails, burrows, and some poorly preserved bra- chiopod shells; resistant, forms ledge in gully	3.5
Shale, light olive gray with brown staining, silty; poorly exposed in upper part	20.0
Shale, black, brittle, fissile	0.9
Shale, light olive gray	1.4
Limestone, brown to purplish brown, impure; contains some shaly limestone in part; very fossiliferous, brachiopods, bryozoans, and large crinoid columns abundant (Sam Creek Limestone)	0.8
Shale, light olive gray	0.8
Shale, very dark gray to black; contains a ¼-in. thick seam of weathered coal; laterally discontinuous	0.1
Underclay, light gray with orange brown staining	1.2
Sandstone, light olive brown with reddish brown marking, very fine grained, irregular- bedded, contains scattered brachiopods; includes abundant ironstone concretions ~0.5 in. in diameter and 2–3 in. in length that are probably burrow fillings; grades laterally into siltstone and well-indurated shaly siltstone	1.5
Shale, dark gray with brown staining, fissile	13.0
Shale, dark gray with purplish brown staining, fissile, brittle, silty, hard	7.8
<i>Total</i>	71.0

Measured Section 4

NW¼NW¼NW¼NE¼ sec. 12, T. 10 N., R. 18 E., McIntosh County. Measured in shale pit, by LeRoy A. Hemish. Field notebook designation MM-26-83-H. (Estimated elevation at top of section, 615 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Savanna Formation:	
Sandstone, brown to orange brown, very fine grained, irregular-bedded, micaceous, bio- turbated; contains dark reddish brown ironstone concretions	2.8
Shale, light gray with reddish brown staining, weathers olive brown, micaceous, very silty; contains abundant reddish brown to orange ironstone concretions occurring in layers and as nodules	19.2
Limestone, light gray, pinkish in bottom 1 in. impure, silty; very fossiliferous with abun- dant well-preserved brachiopods and crinoid columns (Sam Creek Limestone)	1.0
Shale, black, stained reddish brown, soft, fissile, very carbonaceous; includes thin string- ers (½ in.) of bright coal in upper 4 in. (Sam Creek coal)	0.8
Underclay, light gray with yellow streaks	0.8
Sandstone, light brown with dark brown staining, very fine grained, massive; trails, tracks, and burrows abundant on sole of bed; thins laterally	1.8

Shale, light gray with reddish gray staining	0.6
Shale, brownish gray, soft; contains discontinuous layers of reddish brown ironstone concretions throughout unit	2.7
Shale, black, brittle,	0.2
Shale, very dark gray to brownish gray, fissile, silty; contains lenses and stringers of hard, fine-grained, brown siltstone and some layers of black shale	5.2
Shale, very dark gray, weathers purplish brown, brittle, hard, silty, fissile, micaceous (base covered)	<u>1.9</u>
<i>Total</i>	37.0

Measured Section 5

NE¼NE¼SE¼SW¼ sec. 25, T. 10 N., R. 18 E., McIntosh County. Measured in bluffs north of the power station directly under the middle set of electric power lines at Eufaula Dam, by LeRoy A. Hemish. Field notebook designation MM-25-83-H. (Estimated elevation at top of section, 700 ft.)

*Thickness
(ft)*

KREBS GROUP

Boggy Formation:

Sandstone, light brown with dark brown staining, very fine to fine-grained, cross-bedded, noncalcareous, well-jointed; contains pebbles of ironstone and black, fine, interlaminated particles of coal near base of unit; fills channels in underlying sediment; basal contact sharp (Bluejacket Sandstone)	28.0
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Savanna Formation:

Coal, black, bright, finely cleated, very friable; occurs only locally; grades laterally into coaly, coarse-grained siltstone (Drywood coal)	0.1
Siltstone, brown with black streaks, coarse-grained, interlaminated with coal particles; includes several water-worn ironstone pebbles; wedges out laterally	0.2
Shale, dark gray, weathers dark brownish gray, very silty, brittle, micaceous, interlaminated with light gray siltstone	10.5
Shale, dark gray, hard, silty; contains large ovate, reddish brown, shaly concretions as much as 10 in. thick and 2 ft in diameter (base covered)	<u>62.0</u>
<i>Total</i>	100.8

Measured Section 6

SE¼SW¼SW¼SE¼ sec. 13, T. 11 N., R. 16 E., McIntosh County. Measured in highwall of active strip pit operated by Blevins-Vogt Coal Co., by LeRoy A. Hemish. Field notebook designation MM-3-83-H. (Estimated elevation at top of section, 665 ft.)

*Thickness
(ft)*

KREBS GROUP

Boggy Formation:

Sandstone, brown, weathers dark reddish tan, fine- to very fine grained, thin- to medium-bedded, noncalcareous, micaceous, cross-laminated	1.2
Shale, purplish brown, clayey, very weathered	4.0
Shale, grayish brown with orange and yellow banding, very silty, includes some brown carbonaceous shale stringers	3.0
Coal, black with purplish brown iron-oxide deposits on cleat surfaces, bituminous, soft, weathered (Secor Rider coal)	0.4
Underclay, light gray with orange streaks; contains brown and black carbonized plant compressions, slickensided	0.1
Shale, light gray, silty; contains abundant well-preserved plant compressions, seed ferns numerous	13.5
Coal, black with some reddish brown iron-oxide staining on cleat surfaces, bituminous (Secor coal)	0.8
Underclay, dark gray, hard, contains carbonized plant fragments, coaly in upper few inches (total thickness unknown)	<u>0.9</u>
<i>Total</i>	24.8

Measured Section 7

SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 13, T. 11 N., R. 16 E., McIntosh County. Measured in road cut north of gravel road ~100 yd west of Deep Fork Church, by LeRoy A. Hemish. Field notebook designation MM-21-83-H. (Estimated elevation at top of section, 640 ft.)

	<i>Thickness (ft)</i>
Silt, light grayish brown, contains angular blocks of reddish brown sandstone (soil and colluvium)	0.8
KREBS GROUP	
Boggy Formation:	
Shale, buff with reddish brown staining on stratification surfaces, very dark gray where freshly exposed, very weathered	9.3
Coal, black, soft, weathered (Secor coal)	0.8
Underclay, light grayish brown; contains black, carbonized plant fragments	1.0
Shale grayish brown, weathered, poorly exposed (base covered)	<u>0.7</u>
<i>Total</i>	12.6

Measured Section 8

SW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 11 N., R. 16 E., McIntosh County. Measured at northeast edge of abandoned strip mine by LeRoy A. Hemish. Field notebook designation MM-3-85-H. (Surface elevation, estimated topographic map, 700 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, dark reddish brown, very fine grained, weathered	1.0
Covered (oxidized clay with sandstone float)	2.0
Shale, orange gray brown, weathered	6.0
Shale, black with light brown iron-oxide staining on stratification surfaces, hard, brittle, very silty, bioturbated in part; includes stringers of well-indurated orange brown siltstone	10.0
Covered to coal (see Measured Section 9)	<u>10.0</u>
<i>Total</i>	29.0

Measured Section 9

SW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 11 N., R. 16 E., McIntosh County. Measured in side of recently excavated test pit adjacent to old, abandoned coal mine, by LeRoy A. Hemish. Field notebook designation MM-29-83-H. (Estimated elevation at top of section, 700 ft.)

	<i>Thickness (ft)</i>
Silt, brown, sandy; contains angular clasts of reddish brown sandstone ranging from pebble to boulder size (soil)	1.0
KREBS GROUP	
Boggy Formation:	
Shale, light orange gray, very weathered; includes thin, silty stringers of orange clay ironstone that weather to flakes on the exposure	4.0
Sandstone, light tan, very fine grained, very thin bedded, silty; interbedded with pinkish tan shale	4.0
Shale, light grayish brown	0.2
Shale, dark grayish brown; contains black, carbonized plant fragments on stratification surfaces	2.0
Sandstone, light brown with dark brown and reddish brown staining, very fine grained, thin-bedded, well-indurated, ripple-marked	1.8
Shale, light gray, interlaminated with very fine grained siltstone; contains black, carbonized plant fragments on stratification planes	0.2

Coal, black, yellow and orange brown iron-oxide deposits on cleat surfaces, moderately friable; includes at 0.75-in. bony coal parting 5 in. from top of bed and a 0.5 in. bony coal parting 8 in. from bottom of bed (Secor coal)	2.5
Shale, black, clayey, very carbonaceous; contains thin (1/16-in.-thick) layers of bright, hard coal (base covered)	<u>0.6</u>
<i>Total</i>	16.3

Measured Section 10

SW¼SE¼SE¼ sec. 14, T. 11 N., R. 16 E., McIntosh County, Oklahoma. Measured in side of entrance to small, old, abandoned slope mine, by LeRoy A. Hemish. Field notebook designation MM-3-86-H. (Estimated elevation at top of section, 620 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, medium dark gray, weathers yellowish gray, very fine grained, shaly in part, very thin bedded, noncalcareous, ripple-marked, fissile	12.0
Shale, black, fissile, silty	0.5
Coal, black with reddish brown iron-oxide staining on cleat surfaces, moderately weathered (Secor Rider coal)	0.5
Underclay, grayish brown with yellow streaks	0.5
Shale, black, fissile (covered by spoils to stream level)	<u>1.0</u>
<i>Total</i>	14.5

Measured Section 11

SW¼SE¼NE¼SE¼ sec. 24, T. 11 N., R. 16 E., McIntosh County, Oklahoma. Measured in highwall of active strip mine operated by Blevins-Vogt Coal Co., by LeRoy A. Hemish. Field notebook designation MM-20-83-H. (Estimated elevation at top of section, 670 ft.)

	<i>Thickness (ft)</i>
Silt, grayish brown, unbedded, gravelly; contains organic material (soil)	1.0
Clay, yellowish brown with orange mottlings; contains pisolites of limonite and angular clasts of reddish brown sandstone up to boulder size (colluvium)	7.0
KREBS GROUP	
Boggy Formation:	
Shale, grayish brown, streaked with orange; contains zones of reddish brown ironstone concretions with individual concretions as much as 5 in. thick and 18 in. in diameter	8.0
Shale, black, fissile, brittle; selenite crystals on stratification surfaces; brachiopods abundant	3.5
Siltstone, medium gray, wavy-bedded, shaly	0.2
Shale, very dark gray to black, very silty; contains thin laminae of coal in lower part	0.1
Coal, black, peacock coal in part, very friable; contains pyrite and gypsum on cleat surfaces (Secor Rider coal)	0.5
Underclay, dark gray, contains black carbonized plant fragments	0.3
Siltstone, medium gray, irregular-bedded	5.0
Siltstone, light gray and dark gray, coarse-grained, laminated	9.2
Shale, dark gray, hard	0.5
Coal, black, bright, moderately friable; pyritic lens near base of unit (Secor coal)	<u>0.8</u>
<i>Total</i>	36.1

Measured Section 12

NW¼NE¼SE¼NE¼ sec. 24, T. 11 N., R. 16 E., McIntosh County, Oklahoma. Measured in slightly eroded slope of hill, by LeRoy A. Hemish. Field notebook designation MM-5-86-H. (Estimated elevation at top of section, 664 ft.)

KREBS GROUP**Boggy Formation:**

Shale, dark yellowish brown to moderate yellowish brown, weathered, clayey, contains nodules and concretionary layers of dark yellowish orange and dark reddish brown clay ironstone	2.2
Coal, black, smutty, soft, very weathered (Secor Rider coal)	0.5
Underclay, dusky yellowish brown with dark yellowish orange mottling, blocky fracture; contains abundant black carbonized plant material that appears to be rootlet remains ..	<u>1.8</u>
<i>Total</i>	4.5

Measured Section 13

SE¼SW¼NE¼SE¼ sec. 24, T. 11 N., R. 16 E., McIntosh County. Measured in highwall of active strip pit operated by Blevins-Vogt Coal Co., by LeRoy A. Hemish. Field notebook designation MM-15-83-H. (Estimated elevation at top of section, 657 ft.)

Silt, brown, clayey, unbedded; contains angular fragments of reddish brown sandstone up to cobble size (alluvium and colluvium)	0.6
KREBS GROUP	
Boggy Formation:	
Shale, buff with reddish orange mottling, clayey, very weathered, bedding obscured	0.6
Ironstone, purplish black and reddish brown, weathers yellowish brown; occurs as discontinuous broken concretions as much as 1 ft in diameter	0.3
Shale, yellowish gray to light gray in bottom part of unit; contains reddish iron-oxide deposits on stratification surfaces and along joints	3.3
Shale, black, stained brown and yellow in places, carbonaceous, fissile; contains scattered marine fossils	1.0
Shale, light yellowish gray, silty, fractured; contains abundant brown, carbonized plant fragments	0.9
Coal, black, bituminous, closely spaced cleating (Secor Rider coal)	0.5
Underclay, light gray with orange streaks, contains coalified plant roots; grades into underlying unit	0.4
Shale, light gray with orange mottling (base covered)	0.8
Partially covered interval; contains laminated gray, very fine grained silty sandstone in part	13.6
Coal, black, bituminous (Secor coal)	<u>0.8</u>
<i>Total</i>	22.8

Measured Section 14

NE¼SE¼SW¼NW¼ sec. 24, T. 11 N., R. 16 E., McIntosh County. Measured in low bluff along west side of bay extending north from Lake Eufaula, by LeRoy A. Hemish. Field notebook designation MM-22-83-H. (Estimated elevation at top of section, 605 ft.)

Silt, light brown, sandy, contains organic material (soil)	0.8
Clay, orange brown, gravelly; contains angular, flat, reddish brown sandstone clasts up to cobble size (alluvium)	2.0
KREBS GROUP	
Boggy Formation:	
Shale, very light gray with orange and black mottling, very weathered	0.9
Coal, black with reddish brown staining on cleat surfaces, weathered (Secor Rider coal)	0.3
Underclay, very light gray with orange mottling, highly weathered, grades into underlying unit	1.1
Shale, light gray with orange mottling; base covered by beach gravel	<u>1.2</u>
<i>Total</i>	6.3

Measured Section 15

NE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 24, T. 11 N., R. 16 E., McIntosh County. Measured in low bluff along east side of bay extending north from Lake Eufaula, by LeRoy A. Hemish. Field notebook designation MM-23-83-H. (Estimated elevation at top of section, 610 ft.)

	<i>Thickness (ft)</i>
Silt, light yellowish brown, sandy, clayey; contains large, angular clasts of reddish brown sandstone to boulder size (alluvium)	2.5
KREBS GROUP	
Boggy Formation:	
Shale, orange brown, very weathered; contains zones of reddish brown clay ironstone concretions, some 4 in. thick and 2 ft in diameter	3.0
Shale, black, fissile, brittle; contains brachiopod fossils	4.0
Siltstone, light gray with brown streaks, shaly; contains black, carbonized plant fragments	0.3
Shale, very dark gray with purplish brown staining; contains black, carbonized plant fragments	0.1
Coal, black with reddish brown staining on cleat surfaces, weathered (Secor Rider coal)	0.5
Underclay, very light gray with orange mottling; contains black, carbonized plant fragments	0.8
Shale, light gray with brown and purple staining, weathered, very silty, irregular-bedded; base covered by beach gravels	<u>3.0</u>
<i>Total</i>	14.2

Measured Section 16

NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, T. 11 N., R. 16 E., McIntosh County. Measured along east shore of Onapa Lake on point at narrow part of lake, by LeRoy A. Hemish. Field notebook designation MM-30-83-H. (Estimated elevation at top of section, 633 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, very dark gray to black, fissile; contains prominent layers of orange and purplish black ironstone 1–2 in. thick that weather out to resistant blocks on the outcrop	7.0
Shale, light yellowish gray; contains layers of siltstone that weather to angular blocky fragments	1.3
Coal, black, soft, weathered (Secor Rider coal)	0.4
Underclay, light gray with orange streaks	0.8
Shale, medium gray	3.0
Sandstone, light gray with orange mottling, very fine grained, very thin bedded, shaly, bioturbated in part; weathers to small flakes on the outcrop	<u>7.5</u>
<i>Total</i>	20.0

Measured Section 17

SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, T. 11 N., R. 16 E., McIntosh County. Measured at head of northeastward-extending arm of Onapa Lake, by LeRoy A. Hemish. Field notebook designation MM-31-83-H. (Estimated elevation at top of section, 680 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, dark reddish brown, fine-grained, medium-bedded, noncalcareous	3.0
Covered interval	20.0
Shale, very dark gray to black, weathers brownish gray, flaky; includes layers of reddish orange ironstone about 1–2 in. thick near base of unit	13.0
Siltstone, light gray with orange staining, shaly; contains black carbonized plant fragments	1.0

Coal, black, reddish orange iron-oxide staining on cleat surfaces (Secor Rider coal)	0.4
Underclay, grayish brown with orange mottling	0.6
Shale, medium gray to dark gray with orange mottling	5.5
Sandstone, light yellowish gray, very fine grained, very thin bedded, silty; weathers to angular flakes (to water level)	<u>1.0</u>
<i>Total</i>	44.5

Measured Section 18

NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 25, T. 11 N., R. 16 E., McIntosh County. Measured along trail northeastward from point on Lake Onapa, by LeRoy A. Hemish. Field notebook designation MM-32-83-H. (Estimated elevation at top of section, 652 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, medium to dark gray with orange mottling; contains abundant stringers of orange brown clay ironstone that weather to flakes on the outcrop	21.0
Shale, very dark gray to black, fissile, brittle; includes prominent dark reddish brown ironstone layers 1–2 in. thick at about 1-ft intervals	5.0
Siltstone, light yellowish gray, unbedded, shaly; contains well-preserved plant fossils such as <i>Stigmara</i> , as well as black, carbonized plant fragments; weathers to angular fragments on the outcrop	1.0
Coal, black with reddish brown iron-oxide staining (Secor Rider coal)	0.4
Underclay, medium gray with orange mottling; fossil rootlets and other plant fragments abundant (to water level)	<u>0.6</u>
<i>Total</i>	28.0

Measured Section 19

NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 11 N., R. 16 E., McIntosh County. Measured in low bluff along north-facing shore of cove extending eastward from Deep Fork River channel, by LeRoy A. Hemish. Field notebook designation MM-24-83-H. (Estimated elevation at top of section, 603 ft.)

	<i>Thickness (ft)</i>
Silt, light yellowish brown, sandy, unbedded; contains angular clasts of reddish brown and brown sandstone up to boulder size	1.5
KREBS GROUP	
Boggy Formation:	
Shale, light brownish gray, weathered; contains oblate clay ironstone concretions 1 in. thick and as much as 3 in. in diameter; weathers to small flakes on the outcrop	6.0
Shale, black, weathers dark purplish brown with black streaks, fissile	0.3
Coal, black, very weathered, extremely friable (Lower Witteville coal)	0.8
Underclay, dark brown to light brownish gray; contains abundant black, carbonized plant fragments	0.4
Shale, medium gray, silty; contains black, carbonized plant fragments	0.8
Siltstone, brownish gray with streaks of brown; hard, micaceous; base covered by beach gravel	<u>3.2</u>
<i>Total</i>	13.0

Measured Section 20

SE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, T. 11 N., R. 17 E., McIntosh County. Measured in bank and bed of small west-flowing tributary of Elk Creek by LeRoy A. Hemish. Field notebook designation MM-5-85-H. (Surface elevation, estimated from topographic map, 605 ft.)

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

Shale, black, stained dark reddish brown on stratification planes, hard, brittle, jointed; contains black phosphatic nodules	5.0
Covered	2.0
Limestone, dark gray, weathers dark yellowish brown, impure, silty, hard, very fossilif- erous; contains abundant brachiopod valves and crinoid stems (Inola Limestone)	0.8
Clay, grayish brown, soft	0.2
Coal, black, soft, weathered (Bluejacket coal)	0.1
Underclay, brownish gray with dark yellowish orange mottling	2.5
Sandstone, dark reddish brown, very fine grained, shaly, thin- to medium-bedded, noncal- careous (total thickness not known). (Note: A small abandoned coal pit is present in the interval stratigraphically just below the sandstone at this location. The coal bed is not exposed, so the thickness of the interval could not be determined)	<u>1.4</u>
<i>Total</i>	12.0

Measured Section 21

NE¼NE¼SE¼SE¼ sec. 3, T. 11 N., R. 17 E., McIntosh County. Measured in bank of small intermit-
tent stream by LeRoy A. Hemish. Field notebook designation MM-4-85-H. (Surface elevation, esti-
mated from topographic map, 609 ft.)

	<i>Thickness (ft)</i>
Silt, dusky brown, sandy; contains organic material (soil)	2.0
KREBS GROUP	
Boggy Formation:	
Limestone, dark gray, impure, silty, weathers dark yellowish brown; very fossiliferous, crinoid fragments abundant; forms resistant ledge in stream bed (Inola Limestone)	0.4
Clay, grayish brown with dark reddish brown mottling, soft	0.2
Coal, black, soft, weathered (Bluejacket coal)	0.1
Underclay, dark yellowish orange, oxidized, soft	0.4
Underclay, light gray with dark yellowish orange mottling, soft, plastic	<u>0.9</u>
<i>Total</i>	4.0

Measured Section 22

NE¼NW¼NE¼NW¼SE¼ sec. 8, T. 11 N., R. 17 E., McIntosh County. Measured in dry bed of Elk
Creek ~90 ft west from location of OGS Core Hole C MM 20, by LeRoy A. Hemish. Field notebook
designation MM-2-85-H. (Estimated elevation at top of section, 620 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Limestone, dark gray, weathers grayish brown, very fine grained, impure, silty, hard, very fossiliferous, brachiopods and crinoids abundant (Inola Limestone)	0.5
Shale, olive gray with dusky yellowish brown and dark yellowish orange mottling, soft, clayey, noncalcareous	0.2
Coal, black, soft, weathered, moderate reddish brown iron-oxide deposits on cleat surfaces (Bluejacket coal)	0.2
Underclay, brownish black with grayish red mottling, shaly	0.5
Sandstone, moderate yellowish brown, very fine grained, well indurated, noncalcareous (base covered)	<u>0.6</u>
<i>Total</i>	2.0

Measured Section 23

SW¼SW¼NE¼NW¼ sec. 14, T. 11 N., R. 17 E., McIntosh County. Measured in highwall of active strip
mine operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-18-83-H.
(Estimated elevation at top of section, 642 ft.)

	<i>Thickness (ft)</i>
Clay, grayish brown, weathered, some gravel at surface	7.0
KREBS GROUP	
Boggy Formation:	
Shale, dark gray with brown streaks, weathered, irregular-bedded, noncalcareous, very friable; contains thin beds of brown siltstone	10.5
Shale, dark gray, very hard, some wavy bedding	29.0
Limestone, light gray, very fine grained, nonfossiliferous	0.3
Siltstone, dark gray, very hard, wavy-bedded	2.9
Coal, black, bright, calcite on cleat surfaces; pyrite occurs as veinlets and crusts on both cleat and bedding surfaces (Secor Rider coal)	0.6
Coal, black, impure, shaly	0.1
Underclay, medium gray, slickensided; contains sparsely distributed plant fragments	0.5
Siltstone, dark gray, includes abundant black, carbonized plant fragments	5.0
Shale, medium gray with some iron-oxide staining, hard, silty, massive, brittle	12.0
Coal, black, bright, moderately friable; contains white calcite on cleat surfaces (Secor coal)	0.8
Shale, very dark gray, hard, highly carbonaceous; includes very thin laminae of bright coal (base covered)	<u>0.1</u>
<i>Total</i>	68.8

Measured Section 24

NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 14, T. 11 N., R. 17 E., McIntosh County. Measured in highwall of active strip mine operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-16-83-H. (Estimated elevation at top of section, 660 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Clay, yellowish brown, appears to be weathered shale	10.0
Shale, brownish gray with much orange staining, weathered; appears to be same unit as dark gray to black shale below underlying ironstone layer	2.0
Ironstone, purplish black and orange brown	0.2
Shale, very dark gray to black with some orange iron-oxide staining	1.7
Ironstone, purplish black and orange brown; occurs as continuous layer	0.3
Shale, very dark gray to black	3.5
Ironstone, purplish black and brownish orange; occurs as somewhat discontinuous concretions as much as 2 ft in diameter	0.3
Shale, very dark gray to black	1.0
Ironstone, purplish black and brownish orange; occurs as discontinuous discoidal concretions as much as 2 ft in diameter	0.3
Shale, very dark gray with streaks of orange brown iron oxides, hard	3.5
Coal, black, pyritic in part and impure in upper 1 in. (Secor Rider coal)	0.7
Underclay, light gray, shaly	0.8
Shale, medium gray interlaminated with siltstone, hard, very uniform	19.2
Coal, black, bright, bituminous (Secor coal)	0.8
Shale, very dark gray, carbonaceous, well-indurated	<u>0.1</u>
<i>Total</i>	44.4

Measured Section 25

NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 15, T. 11 N., R. 17 E., McIntosh County. Measured in highwall of active strip mine operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-19-83-H. (Estimated elevation at top of section, 665 ft.)

	<i>Thickness (ft)</i>
Clay, light yellowish brown with orange mottling; contains weathered clasts of ironstone and reddish brown sandstone as much as 10 in. in diameter and 6 in. thick	3.0

KREBS GROUP

Boggy Formation:

Shale, light yellowish brown, very weathered; contains abundant layers of reddish brown clay ironstone 1–2 in. thick	6.0
Shale, light gray with brownish streaks	4.0
Limestone, very dark gray, impure, silty; very fossiliferous, with small brachiopods pre-dominant, fossil hash in upper 0.5 in.	0.3
Shale, black, fissile, brittle; contains abundant well-preserved calcareous brachiopods	0.5
Siltstone, dark gray, wavy-bedded, very hard	0.3
Coal, black, bright, banded; pyrite veins, crusts, and thin bands abundant (Secor Rider coal)	0.5
Underclay, medium gray, unbedded, feels soapy; contains sparse black carbonized plant fragments	0.6
Siltstone, medium gray, wavy-bedded, hard; contains abundant black carbonized plant fragments	5.0
Siltstone, light gray with dark gray bands, coarse-grained, cross-laminated, noncalcareous, hard	11.0
Coal, black, bright, hard; minor calcite and pyrite on cleat surfaces (Secor coal)	0.6
Shale, very dark gray to black, very carbonaceous, contains abundant black, carbonized plant fragments (base covered)	0.2
<i>Total</i>	32.0

Measured Section 26

N $\frac{1}{2}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 25 and E $\frac{1}{2}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 26, T. 11 N., R. 17 E., McIntosh County. Measured in shale pits west and east of road and along southeast-flowing small stream, by LeRoy A. Hemish. Field notebook designation MM-4-83-H. (Estimated elevation at top of section, 770 ft.)

*Thickness
(ft)*

KREBS GROUP

Boggy Formation:

Sandstone, light orange brown to yellowish brown, fine-grained, massive to medium-bedded, micaceous, conglomeratic in places at base of unit; contact with underlying unit sharp and disconformable (Bluejacket Sandstone)	4.0
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Savanna Formation:

Siltstone, light brown with dark brown staining on weathered surfaces, dark grayish brown in lower 10 ft of unit, micaceous, shaly; includes 1- to 2-in.-thick lenses of very fine grained sandstone; intricately cross-laminated with sandstone and shale strata	34.0
Shale, very dark gray, orange brown along oxidized fracture margins, very silty, brittle, flaky; contains some small clay ironstone concretions in lower part of unit	40.0
Ironstone, purplish red with orange rind, sparsely fossiliferous	0.2
Shale, black, brittle, flaky; contains small, rounded phosphatic nodules	1.2
Ironstone, very dark gray on freshly broken surface, dark purplish red on weathered surface, sparsely fossiliferous	0.3
Shale, very dark gray, weathers grayish brown, flaky, brittle	7.0
Limestone, dark purplish gray, impure, silty; fossiliferous, brachiopods moderately abundant; poorly exposed in stream bank (Doneley Limestone)	0.1
Shale, dark gray, very silty, blocky fracture; appears to be weathered and leached portion of overlying unit	0.6
Coal, black, very soft, weathered (Rowe coal)	0.4
Underclay, light gray with orange streaks	2.2
Shale, yellowish brown with orange streaks (base covered)	0.5
Covered interval	5.5
Sandstone, brown to olive brown, weathers reddish brown, very fine grained, medium-bedded to massive, cross-laminated, noncalcareous; rectangular-jointed; surface weathers irregularly, with small pits and swirls in places; hard, forms ledge in stream bed	1.0
Shale, light grayish brown, concretionary	5.0
Limestone, dark gray, weathers grayish brown, impure, silty, hard, resistant; very fossiliferous, with brachiopods most abundant, coquinoideal (Sam Creek Limestone)	0.1

Clay, creamy gray with orange staining, plastic (base covered)	<u>0.4</u>
<i>Total</i>	102.5

Measured Section 27

NW¼NW¼NW¼SW¼ sec. 36, T. 11 N., R. 17 E., McIntosh County. Measured in active strip mine operated by Westhoff, Inc., by LeRoy A. Hemish. Field notebook designation MM-10-83-H. (Estimated elevation at top of section, 612 ft.)

	<i>Thickness (ft)</i>
Sand, pinkish brown, very fine grained, silty	1.0
Clay, yellowish brown, silty, sandy, oxidized	11.0
Gravel, yellowish brown to dark reddish brown, very clayey; contains rounded, flat pebbles and cobbles as much as 4 in. in diameter	2.0
KREBS GROUP	
McAlester Formation:	
Shale, medium gray with some orange streaks; contains brown, discoidal clay ironstone concretions about 0.5 in. thick	4.5
Coal, black, bright, bituminous; minor pyrite on cleat surfaces; includes some 0.25-in.-thick, randomly distributed pyritic lenses in lower 10 in.; cleat closely spaced (Stigler coal)	1.5
Underclay, medium gray, slickensided; contains finely disseminated pyrite in upper 2 in.	<u>1.2</u>
<i>Total</i>	21.2

Measured Section 28

SW¼SW¼NE¼SW¼ sec. 36, T. 11 N., R. 17 E., McIntosh County. Measured in highwall of active strip mine operated by Westhoff, Inc., by LeRoy A. Hemish. Field notebook designation MM-6-84-H. (Estimated elevation at top of section, 612 ft.)

	<i>Thickness (ft)</i>
Silt, brown, well-sorted, unbedded; contains organic matter	1.2
Clay, yellowish brown with orange mottling; contains angular fragments of reddish brown ironstone, compact, unbedded	3.0
KREBS GROUP	
McAlester Formation:	
Shale, grayish brown with orange bands, silty, brittle; breaks into sharp-edged, angular blocks ~1 in. thick; medium gray in lower 5 ft with small brachiopod fossils	14.0
Coal, black, finely cleated, moderately friable, minor white calcite and pyrite on cleat surfaces (Stigler coal)	1.2
Underclay, light gray with orange streaks, plastic	<u>2.2</u>
<i>Total</i>	21.6

Measured Section 29

SW¼SE¼NE¼SW¼ sec. 6, T. 11 N., R. 18 E., McIntosh County. Measured in highwall of active strip pit operated by Inter-Chem Coal Co., by LeRoy A. Hemish. Field notebook designation MM-1-88-H. (Estimated elevation at top of section, 668 ft.)

	<i>Thickness (ft)</i>
Silt, dusky brown, sandy, contains organic material (topsoil)	1.0
Clay, moderate brown to moderate yellowish brown with very light gray and black streaks; contains pebbles of sandstone and ironstone	8.0
KREBS GROUP	
Boggy Formation:	

Shale, olive gray, brittle; contains dark yellowish orange ironstone concretions, noncalcareous, slightly weathered, stained grayish orange on joint surfaces	10.0
Shale, grayish black, flaky, jointed; contains dark reddish brown ironstone concretions, noncalcareous	21.1
Shale, medium dark gray, noncalcareous; includes a 4-in.-thick light brownish gray layer of discoidal ironstone concretions at top of unit, a 3-in.-thick layer 16 in. below, and a 6-in.-thick layer at base of unit. All concretions contain veins filled with brown calcite	3.8
Shale, dark gray to grayish black, silty, carbonaceous, weakly calcareous; contains rare fossil brachiopods	3.6
Sandstone, medium light gray, very fine grained, very silty, noncalcareous	0.4
Coal, black, bright, moderately friable, fine-cleated, contains pyrite on cleat surfaces (Secor Rider coal)	0.5
Underclay, medium dark gray, carbonaceous, slickensided; contains some coalified plant material; becomes silty in lower part and contains abundant black carbonized plant fragments as well as casts of <i>Stigmaria</i>	1.4
Shale, medium gray, silty, noncalcareous; contains abundant well-preserved, black carbonized plant compressions	16.6
Coal, black, bright, moderately friable, minor pyrite on cleat surfaces (Secor coal)	1.0
Underclay, medium gray, very hard, silty; only top of unit observed	<u>0.1</u>
<i>Total</i>	67.5

Measured Section 30

SE¼ sec. 10 and SW¼ sec. 11, T. 12 N., R. 15 E., McIntosh County. Measured in road ditch from SE corner sec. 10 to creek at base of hill, then downstream to the cutbank where stream bends north in NW¼SW¼SW¼SW¼ sec. 11, by LeRoy A. Hemish. Field notebook designation MM-15-82-H. (Estimated elevation at top of section, 655 ft.)

	<i>Thickness (ft)</i>
CABANISS GROUP	
Senora Formation:	
Ironstone, dark orange brown, very fractured; forms resistant cap on small hill northwest of road intersection	0.1
Shale, reddish brown, stained by iron oxide, very weathered	3.5
Ironstone, dark orange brown, very fractured	0.1
Shale, dark olive brown, silty, fissile; contains black carbonaceous material on stratification surfaces	3.3
Shale, black, brittle, fissile, very carbonaceous; includes scattered phosphatic nodules and discoidal, black, dense, noncalcareous concretions 3–4 in. in diameter and ~0.5 in. thick	13.0
Limestone, black, weathers medium brown, micritic, dense, hard, massive; includes sparse poorly preserved brachiopod fossils as well as a few well-preserved plant fossils such as <i>Calamites</i> ; well-jointed; brown outer band splits off in concentric layers that extend through the joints	0.2
Shale, black, brittle, fissile, jointed	6.0
Covered interval	3.8
Shale, medium gray with orange mottling and streaks	2.0
Shale, dark gray with reddish brown iron-oxide staining on stratification surfaces and joints; fissile	1.5
Shale, grayish brown with orange mottling, clayey, weathered	1.0
Coal, black with reddish brown iron-oxide staining on cleat surfaces (Tebo coal)	0.5
Underclay, yellowish gray, silty; contains coalified plant material, grades downward into underlying unit	1.0
Sandstone, light greenish gray, stained orange in part, very fine grained, silty, weakly calcareous, thin-bedded; at contact with overlying unit, includes a 6-in.-thick zone of well-indurated, orange brown to greenish gray, calcareous, sandy, irregular-shaped nodules as much as 3 in. in diameter	1.0
Shale, olive gray, weathers yellowish orange, silty (base covered)	<u>3.0</u>
<i>Total</i>	40.0

Measured Section 31

CNW¼ sec. 1, T. 12 N., R. 16 E., McIntosh County. Measured along small south-flowing stream, by LeRoy A. Hemish. Field notebook designation MM-8-83-H. (Estimated elevation at top of section, 610 ft.)

	<i>Thickness (ft)</i>
Silt, dark brown, clayey, organic (soil)	2.0
KREBS GROUP	
Boggy Formation:	
Shale, medium gray, weathers to small, gray brown flakes on the outcrop	5.5
Shale, black, fissile, brittle; includes some 1-in.-thick orange clay ironstone concretionary beds	2.5
Covered interval	1.0
Coal, black, bituminous; cleat spacing ~1 in.; well-exposed in creek bed; total thickness may be greater than measured as upper surface is in contact with alluvial material (Wainwright coal)	0.8
Underclay, light gray with orange streaks, lower part shaly	0.9
Sandstone, rusty brown, very fine grained, irregularly thin bedded, noncalcareous, micaceous; forms resistant ledge in stream bed	0.2
Sandstone and siltstone, grayish brown, very fine grained, very thin bedded, shaly, noncalcareous, micaceous, cross-laminated, ripple-marked; in places, well-indurated sandstone lenses fill small channels within the unit (base covered)	<u>8.0</u>
<i>Total</i>	20.9

Measured Section 32

NW¼SW¼SW¼ sec. 3, T. 12 N., R. 17 E., McIntosh County. Measured in northwest end of water-filled borrow pit used in construction of U.S. Highway 69, by LeRoy A. Hemish. Field notebook designation MM-9-83-H. (Estimated elevation at top of section, 580 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Shale, black, fissile; weathers to small flakes on the outcrop; includes several dark purplish black concretionary beds of sparsely fossiliferous ironstone about 1–2 in. thick, vertically spaced at 2- to 3-ft intervals	14.0
Shale, very dark gray, carbonaceous, very calcareous; very fossiliferous, with brachiopods most abundant; weathers to litter of soft flakes and brachiopod fragments on the outcrop	0.6
Underclay, light gray with minor orange streaks, soft; includes a 0.5-in.-thick bed of soft, black, impure coal (Secor Rider coal) 6 in. below base of overlying calcareous shale	1.0
Shale, light to medium gray with orange mottling; contains abundant red, ferruginous nodules and concretions about 1–2 in. in diameter; also contains some scattered brown, discoidal clay ironstone concretions ~6 in. in diameter	3.0
Shale, black with yellow staining on joint surfaces, very carbonaceous, coaly shale in part; hard, brittle; smells of sulfur when struck (Secor coal interval)	1.1
Underclay, brownish gray and reddish brown, ferruginous in part, oxidized	1.0
Shale, dark gray with abundant reddish brown staining; contains scattered concretionary beds of dark purplish brown, very fine grained sandstone; grades into underlying unit ..	2.3
Siltstone, very dark gray and purplish brown, very shaly, soft; includes scattered pods of hard, reddish brown, very fine grained sandstone; very carbonaceous, brownish black near base of unit	14.0
Sandstone, light gray with dark brown and pinkish brown staining, very fine grained, thin-bedded, noncalcareous, bioturbated in part; contains black flecks of carbonaceous material; total thickness not exposed (Bluejacket Sandstone)	<u>5.0</u>
<i>Total</i>	42.0

Measured Section 33

NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T. 12 N., R. 17 E., McIntosh County. Measured in bank of small stream from ~100 yd south of farm pond east to underpass beneath U.S. Highway 69, by LeRoy A. Hemish. Field notebook designation MM-11-83-H. (Estimated elevation at top of section, 565 ft.)

	<i>Thickness (ft)</i>
Silt, brown with reddish brown mottling, clayey, gravelly; contains abundant broken fragments of coal at contact with underlying unit	3.0
KREBS GROUP	
Boggy Formation:	
Coal, black with purplish brown coloration on stratification surfaces, bituminous; breaks easily into thin flakes, impure in part; total thickness may be greater if top has been eroded (Secor coal)	0.8
Underclay, dark gray with maroon staining, shaly, ferruginous in part (base covered)	0.5
Covered interval	2.2
Sandstone, light yellowish brown to reddish brown and pink, very fine grained, thin bedded, shaly in upper part, ripple-marked; contains some reddish brown ferruginous concretions (Bluejacket Sandstone)	<u>8.5</u>
<i>Total</i>	15.0

Measured Section 34

NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T. 12 N., R. 17 E., McIntosh County. Measured in stream bank on south side of creek ~50 yd east of trail, by LeRoy A. Hemish. Field notebook designation MM-2-86-H. (Surface elevation, estimated from topographic map, 565 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, pale yellowish brown to grayish orange, very fine grained, noncalcareous, rippled-marked, thin- to medium-bedded, silty and shaly in part, micaceous (Bluejacket Sandstone)	10.0
Shale, moderate yellowish brown, silty; contains moderate reddish brown concretions as much as 4 in. in diameter; includes thin siltstone layers	4.0
Coal, black, highly weathered, soft; bed is moderate brown, very carbonaceous shale in exposures laterally along the outcrop (Lower Witteville coal)	0.1
Underclay, pale brown to moderate brown, carbonaceous	0.2
Shale, brownish gray to grayish orange pink, clayey; contains abundant, well-preserved, black carbonized plant compressions; weathered (base covered)	<u>4.0</u>
<i>Total</i>	18.3

Measured Section 35

NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 15, T. 12 N., R. 17 E., McIntosh County. Measured in road ditch south side of blacktop road just north of church, by LeRoy A. Hemish. Field notebook designation MM-1-86-H. (Surface elevation, estimated from topographic map, 610 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, grayish orange to dark yellowish orange, very fine grained, thick-bedded, noncalcareous (Bluejacket Sandstone)	6.0
Shale, pale yellowish brown to moderate yellowish brown, weathered, silty; includes abundant thin stringers of dark yellowish orange well-indurated siltstone that weather to flakes on the outcrop; contains ironstone concretions ~1 in. thick and 1–3 in. in diameter	7.0

Shale, moderate brown, clayey, soft	0.1
Coal, black, soft, weathered (Lower Witteville coal)	0.3
Underclay, pale brown with dark yellowish orange bands, carbonaceous; includes a 0.5-in.-thick, discontinuous layer of coal near base of unit	0.6
Shale, pale yellowish orange with pale brown streaks, clayey; includes carbonaceous material; contains black carbonized plant compressions	1.5
Coal, black soft, weathered (unnamed coal)	0.1
Underclay, pale brown to moderate brown	0.3
Shale, light olive gray, clayey	5.1
Sandstone, pale yellowish brown, very fine grained, noncalcareous, ripple-marked, thin-bedded in upper part, becomes medium-bedded lower in unit; total thickness unknown (Bluejacket Sandstone)	<u>9.0</u>
<i>Total</i>	30.0

Measured Section 36

SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 12 N., R. 17 E., McIntosh County. Measured in active strip pit operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-5-83-H. (Estimated elevation at top of section, 572 ft.)

	<i>Thickness (ft)</i>
Silt, brown, sandy, clayey (alluvial soil)	3.5
Clay, light gray with orange brown mottling; contains brownish black carbonized plant fragments (alluvium)	13.5
Gravel, dark gray and orange brown, silty, clayey; poorly sorted, includes rounded pebbles of ironstone as well as flat, black and gray shale pebbles; contact with underlying unit unconformable	1.4
KREBS GROUP	
Boggy Formation:	
Shale, gray with minor orange streaks, silty	1.0
Claystone, medium gray, noncalcareous, very dense and hard	0.3
Shale, light gray, silty	11.3
Coal, black, banded, bituminous; minor pyrite and kaolinite on cleat surfaces (Secor coal) ..	0.9
Underclay, very dark gray, carbonaceous, hard; contains coaly stringers in upper part	<u>0.8</u>
<i>Total</i>	32.7

Measured Section 37

NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 12 N., R. 17 E., McIntosh County. Measured in active strip pit operated by Turner Brothers, Inc., by LeRoy A. Hemish. Field notebook designation MM-51-82-H. (Estimated elevation at top of section, 578 ft.)

	<i>Thickness (ft)</i>
Sand, tan, very fine grained, silty (alluvium)	5.0
KREBS GROUP	
Boggy Formation:	
Clay, brown with reddish brown and black mottling, pisolitic, ferruginous in part	1.0
Shale, light brown, very silty, weathered	6.5
Siltstone, medium gray, micaceous, noncalcareous, laminated; contains well-preserved fossil plant compressions on stratification surfaces	6.0
Coal, black with peacock coloration, white kaolinite on cleat surfaces (Secor coal)	0.5
Sandstone, light gray, very fine grained, noncalcareous, cross-bedded, well-indurated; includes stringers of coal and abundant, large, coalified plant compressions	0.5
Coal, black, hard (Secor coal)	0.7
Underclay, light gray, contains plant compressions (total thickness unknown)	<u>0.8</u>
<i>Total</i>	21.0

Measured Section 38

NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 26, T. 12 N., R. 17 E., McIntosh County. Measured in old, abandoned strip pits just south of fence along gravel road, by LeRoy A. Hemish. Field notebook designation MM-12-83-H. (Estimated elevation at top of section, 630 ft.)

	<i>Thickness (ft)</i>
KREBS GROUP	
Boggy Formation:	
Sandstone, light brown with salmon tones and liesegang banding, weathers rusty brown, very fine grained, massive to thin-bedded, noncalcareous, ripple-marked	5.5
Shale, light brown with reddish orange mottling; contains some siltstone stringers	2.0
Sandstone, greenish gray, weathers pinkish gray with rusty brown mottling, very fine grained, cross-laminated, hard, noncalcareous; contains abundant large-scale plant impressions as well as sparsely distributed brachiopod fossils; thickness variable	0.5
Clay, light chocolate brown	0.1
Coal, brownish black with red streaks, impure, soft, very weathered (unnamed coal)	0.2
Underclay, light chocolate brown with orange mottling, contains some bright reddish orange iron-oxide deposits	0.6
Coal, black, with some reddish brown and yellow iron-oxide deposits on cleat surfaces, bituminous (Secor coal)	2.0
Shale, black, very carbonaceous; contains thin laminae of bright, hard coal in upper 12 in.	4.1
Covered interval	<u>5.0</u>
<i>Total</i>	20.0

Measured Section 39

SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 3, T. 12 N., R. 18 E., McIntosh County. Measured in fresh bulldozer cut adjacent to abandoned strip mine and on southeast bank of meander loop in Dirty Creek, by LeRoy A. Hemish. Field notebook designation MM-68-82-H. (Estimated elevation at top of section, 522 ft.)

	<i>Thickness (ft)</i>
Silt, brown, clayey, gravelly; contains subangular to angular clasts of sandstone and ironstone; orange brown in lower 6 in. of unit	1.5
KREBS GROUP	
McAlester Formation:	
Shale, yellowish gray to light brown with orange mottling, soft, weathered; contains brown, discoidal clay ironstone concretions	5.5
Shale, purplish brown and yellow, carbonaceous	0.2
Coal, black, hard, finely cleated (Stigler coal)	0.8
Underclay, light gray with orange and brown streaks; contains coalified plant roots	0.8
Shale, medium gray with orange iron-oxide deposits on fracture surfaces	4.2
Sandstone, light gray with orange brown streaks and mottling, very fine grained, thin-bedded, noncalcareous, micaceous, ripple-marked, shaly in upper part, weathers dark reddish brown; well-exposed in bed of Dirty Creek; base covered (Cameron Sandstone) ..	<u>4.0</u>
<i>Total</i>	17.0

Measured Section 40

SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 12 N., R. 18 E., McIntosh County. Measured in highwall of active strip mine operated by Woodside Construction Co., by LeRoy A. Hemish. Field notebook designation MM-5-84-H. (Estimated elevation at top of section, 716 ft.)

	<i>Thickness (ft)</i>
Silt, dark grayish brown; contains abundant organic material	1.0
Clay, yellowish brown with orange mottling; contains small, soft, white, calcium carbonate nodules, and abundant dark brownish black ironstone fragments in lower 3 ft; becomes gray with orange mottling in lower 4 ft	7.0

KREBS GROUP

Boggy Formation:

Ironstone, dark brown; orange brown on exterior; broken and weathered	0.3
Shale, light olive gray; clayey, blocky fracture; contains 1-in. stringers of brown clay ironstone	6.0
Shale, black with reddish orange iron-oxide deposits on stratification surfaces, carbonaceous	2.5
Shale, medium gray, clayey	1.2
Coal, black, peacock coloring on cleat surfaces; contains lenses and layers of pyrite 0.25 in. thick in upper 12 in.; includes a 0.25-in. band of brownish black very carbonaceous clay in the middle of the unit (Lower Witteville coal)	2.2
Shale, brownish black, hard, very carbonaceous; includes some coal stringers	1.0
Underclay, light gray with orange streaks	<u>0.8</u>
<i>Total</i>	22.0

Measured Section 41

SW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 12 N., R. 18 E., McIntosh County. Measured in highwall of active strip mine operated by Woodside Construction Co. Inc., by LeRoy A. Hemish. Field notebook designation MM-33-83-H. (Estimated elevation at top of section, 706 ft.)

	<i>Thickness (ft)</i>
Silt, dark grayish brown; contains organic matter (topsoil)	1.0
Clay, dark yellowish orange, weathered, silty	1.0
Clay, light grayish brown with rusty orange and dark gray mottling, weathered; contains root casts in upper part and weathered ironstone fragments in lower part	5.4

KREBS GROUP

Boggy Formation:

Shale, light grayish brown to light gray with orange mottling; bedding obscured by weathering; marked by a continuous 2-in.-thick zone of weathered fragments of clay ironstone at top of unit	1.7
Shale, black with thin yellow bands, weathered dark brown in upper 6 in., very carbonaceous; contains some thin stringers of bright coal ranging from $\frac{1}{64}$ to $\frac{1}{16}$ in. thick in lower 3 in.	0.9
Underclay, bright orange with reddish brown streaks, contains thin layers of black carbonaceous clay material	0.2
Shale, medium gray, clayey	1.2
Coal, black, bright, moderately friable; contains layers of pyrite 0.25 in. thick and lenses 1–2 in. thick in upper 3 in.; includes a 0.25-in.-thick band of brownish black carbonaceous clay 14 in. from top of unit (Lower Witteville coal)	1.9
Shale, brownish black, hard, very carbonaceous, coaly	1.1
Underclay, light gray, sticky (total thickness unknown)	<u>0.6</u>
<i>Total</i>	15.0

Core-Hole Logs

Core-Hole Log 1

NW¼SW¼SW¼NW¼SW¼ sec. 7, T. 10 N., R. 13 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-2. (Surface elevation, estimated from topographic map, 755 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, grayish brown; contains organic matter; includes angular cobbles of moderate brown sandstone	0.0	1.0
Clay, grayish brown, gravelly; includes abundant clasts of moderate reddish brown ironstones	1.0	3.0
CABANISS GROUP		
Senora Formation		
Shale, yellowish gray to light olive gray, clayey; ironstone concretion at 9 ft, weathered; less weathered in bottom 6 in.	4.0	5.0
Siltstone, pale brown, well-indurated, interbedded with grayish brown shale	9.0	1.0
Shale, light olive gray with yellowish gray bands, silty; includes layers of moderate reddish orange ironstone concretions	10.0	4.0
Shale, olive gray with some thin, very dark gray streaks	14.0	2.0
Shale, medium gray, clayey; contains moderate reddish brown ironstone concretions	16.0	3.9
Ironstone, moderate red, hard	19.9	0.1
Shale, olive gray to pale brown; includes some orange bands and light gray stringers of silty sandstone	20.0	1.2
Shale, pale yellowish brown to grayish brown, clayey; contains some moderate reddish orange streaks along fractures, and a 1-in.-thick layer of moderate reddish orange ironstone ~1 ft from bottom of unit	21.2	3.8
Shale, dark gray to grayish black, noncalcareous; contains a grayish orange siderite concretion 8 in. from top of unit	25.0	1.0
Shale, medium gray with dark gray to grayish black bands up to 2 in. thick, noncalcareous	26.0	2.0
Shale, grayish black, includes some minor medium gray bands	28.0	1.0
Shale, medium gray with dark gray bands	29.0	1.2
Shale, grayish black	30.2	1.5
Shale, dark gray, silty; includes some thin, hard siderite layers	31.7	2.3
Shale, grayish black	34.0	4.0
Limestone, medium to light gray, dense, hard, micritic; very sparsely fossiliferous; contains shell fragments and crinoid segments	38.0	0.2
Shale, black, soft, highly carbonaceous	38.2	1.0
Shale, very dark gray, weakly calcareous; sparsely fossiliferous; contains scattered brachiopods	39.2	8.1
Limestone, medium gray, dense, hard, micritic; sparry calcite fills fractures; contains a few small marine fossils	47.3	0.4
Shale, very dark gray to grayish black, weakly calcareous; sparsely fossiliferous, contains scattered brachiopods; small brachiopods abundant in bottom 6 in.	47.7	6.3
Coal, black, bright; includes white calcite on cleat surfaces (Croweburg coal)	54.0	1.1
Underclay, light gray; includes some dark gray carbonaceous bands in lower 6 in.	55.1	1.2
Coal, black, impure in upper 2 in.; includes thin brownish black shale laminae (Croweburg coal)	56.3	0.3
Shale, grayish black, highly carbonaceous	56.6	0.2
Coal, black, bright; includes white calcite on cleat surfaces, pyritic in upper part (Croweburg coal)	56.8	1.3
Underclay, brownish black, contains abundant carbonaceous material	58.1	0.9
<i>Total Depth</i>		59.0

Core-Hole Log 2

NW¼SE¼SW¼SW¼SW¼ sec. 7, T. 10 N., R. 13 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-1. (Surface elevation, estimated from topographic map, 742 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, moderate brown, sandy; contains abundant organic material (soil)	0.0	0.5
Gravel, grayish brown, poorly sorted; clasts range from silt size to cobble size; angular fragments of light brown and dark reddish brown sandstone abundant ...	0.5	3.5
Sand, moderate yellowish brown, very fine	4.0	2.5
Clay, moderate yellowish brown with dark yellowish orange mottling; contains fragments of weathered clay ironstone concretions	6.5	1.5
CABANISS GROUP		
Senora Formation		
Shale, light olive gray, clayey; contains abundant layers of dark yellowish orange ironstone	8.0	0.7
Ironstone, dark yellowish orange, clayey, weathered	8.7	0.2
Shale, light to medium gray with black streaks; contains carbonized plant frag- ments	8.9	1.1
Coal, brownish black, soft, highly weathered (thickness estimated from cuttings) (Croweburg coal)	10.0	1.0
Underclay, light gray; contains black carbonized plant fragments	11.0	2.0
Shale, light gray, clayey; includes some minor black plant fragments	13.0	2.0
Shale, yellowish gray with dark yellowish orange and pale purple streaks and bands, clayey	15.0	<u>3.0</u>
<i>Total Depth</i>		18.0

Note: Core was not recovered from the coal and underclay intervals. Log is from cuttings.

Core-Hole Log 3

SW¼NE¼NE¼NE¼SE¼ sec. 13, T. 10 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at southwest corner of farm pond just north of building site 230 ft FEL and 2,360 ft FSL. Field notebook designation C-MM-29. (Surface elevation, estimated from topographic map, 616 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, silty, very fine grained, unbedded; contains organic material (soil)	0.0	2.0
Sand, moderate yellowish brown, silty, very fine grained, oxidized	2.0	2.0
Sand, grayish orange, fine grained, unconsolidated, oxidized	4.0	4.0
Sand, pale yellowish brown to very pale orange, very fine grained, silty, uncon- solidated; stained moderate reddish brown from 18.3 to 18.6 ft; includes moderate reddish orange mottles from 18.6 to 19.0 ft	8.0	11.0
Sand, grayish orange with abundant moderate reddish orange mottling, highly clayey, very fine to fine-grained	19.0	10.0
Silt, dark greenish gray, sandy, clayey	29.0	1.0
Sand, dark greenish gray, fine- to very fine grained, clayey; includes some gravel ...	30.0	8.0
Gravel, dark greenish gray, sandy, clayey; contains angular to subangular clasts of very fine grained sandstone up to coarse gravel in size	38.0	6.0
KREBS GROUP		
Boggy Formation		
Siltstone, medium dark gray with light gray laminae, shaly; contains thin laminae of very fine grained sandstone; includes black carbonized plant fragments on stratification surfaces; burrowed in places	44.0	5.3
Shale, medium dark gray, silty, noncalcareous; contains black carbonized plant compressions on stratification planes; includes some light brownish gray sideritic concretions 0.5–1 in. thick	49.3	9.7
Coal, black, bright, friable (Secor? coal)	59.0	0.4
No cuttings or core	59.4	4.6
Sandstone, medium dark gray with medium light gray bands and laminae, very fine grained; shaly, noncalcareous, bioturbated, bedding convoluted, cross- laminated in part; scour-and-fill features common; black macerated plant material abundant on stratification surfaces	64.0	30.2
Sandstone, medium gray, fine-grained; cross-bedded; contains some black coalified plant material	94.2	3.8

Sandstone, medium dark gray with medium light gray bands and laminae, very fine grained, shaly, cross-laminated, noncalcareous; scour-and-fill features common; black macerated plant material abundant on stratification surfaces	98.0	2.3
Sandstone, medium gray, fine-grained; cross-bedded, noncalcareous; contains some black coalified plant material	100.3	<u>14.7</u>
<i>Total Depth</i>		115.0

Core-Hole Log 4

SW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 13, T. 10 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture south of farmhouse 210 ft FEL and 1,760 ft FSL. Field notebook designation C-MM-30. (Surface elevation, estimated from topographic map, 623 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate yellowish brown, very fine, unbedded; contains organic material in upper 1 ft (soil)	0.0	3.0
Sand, light brown, very fine	3.0	4.8
Sand, grayish orange, very fine	7.8	<u>16.2</u>
(Hole abandoned owing to excessive caving of unconsolidated sand.)		
<i>Total Depth</i>		24.0

Core-Hole Log 5

NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 24, T. 10 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled at northeast edge of farm pond 420 ft FWL and 1,740 ft FNL. Field notebook designation C-MM-35. (Surface elevation, estimated from topographic map, 631 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate brown, very fine grained, silty; contains organic material	0.0	2.0
Sand, pale reddish brown, fine- to medium-grained, subrounded to rounded; becomes moderate reddish brown at 10 ft, oxidized; consists predominately of quartz	2.0	26.0
Sand, medium gray, silty, unoxidized, unconsolidated	28.0	7.0
Clay, pale brown with some grayish orange tones, silty, sandy	35.0	0.5
Peat, dusky brown, fibrous, mixed with black shaly gravel; poor recovery	35.5	4.0
Gravel, dark yellowish brown; fine-grained, sandy; poorly sorted; contains a high percentage of subangular black shale flakes and rounded quartz grains; poor recovery	39.5	10.5
Clay, olive gray with pale reddish brown bands, silty	50.0	12.0
Sand and gravel, dark yellowish brown, coarse, clayey; contains clasts of oxidized fine-grained sandstone; some may be cobble to boulder size; includes coarse sand-size, well-rounded clasts of colorless quartz and minor light red clasts of feldspar	62.0	13.0
KREBS GROUP		
Boggy Formation		
Shale, dark gray to grayish black, hard	75.0	<u>5.0</u>
<i>Total Depth</i>		80.0

Core-Hole Log 6

SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 7, T. 10 N., R. 18 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in farmyard just north of blacktop road at west edge of Texanna. Field notebook designation C-MM-34. (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	0.5

Sand, moderate yellowish brown, very fine grained, silty; contains limonite-cemented, medium-size gravel particles	0.5	1.5
Sand, grayish orange, very fine grained, silty, clayey, oxidized	2.0	6.5
Sand, dark yellowish orange to grayish orange, very fine grained, mottled; contains a high percentage of silt and clay; includes abundant brownish black pea-size concretions	8.5	7.0
Gravel, moderate brown, coarse; poorly sorted; includes very fine sand, silt, and clay	15.5	1.7
KREBS GROUP		
Savanna Formation		
Shale, dark yellowish brown, with light brown and dusky brown bands, highly weathered	17.2	3.8
Shale, light olive gray with minor light brown streaks, partly weathered; includes some hard, blackish red ironstone concretions	21.0	5.0
Shale, olive gray to medium dark gray; minor iron-oxide staining on fracture surfaces	26.0	1.0
Shale, dark gray, silty, hard; contains some minor pyrite; includes sparse grayish brown sideritic concretions ~1 in. thick	27.0	23.5
Coal, black (unnamed)	50.5	0.1
Shale, medium dark gray, silty, slickensided	50.6	10.7
Shale, dark gray, silty; noncalcareous; contains sparse fossil marine shells	61.3	3.0
Sandstone, very light gray with medium dark gray bands, very fine grained, calcareous, shaly; includes some bioturbation features in upper part, cross-bedded; slump structures abundant	64.3	1.6
Siltstone, medium dark gray with minor thin light gray bands, noncalcareous; sparsely interlaminated with very fine grained sandstone	65.9	4.1
Shale, medium dark gray, silty, noncalcareous	70.0	6.5
Limestone, medium dark gray, impure, very silty and shaly; contains abundant brachiopod shell fragments (Sam Creek Limestone)	76.5	3.5
Siltstone, medium gray, unbedded; contains sparse fossil shell fragments in upper part, as well as black carbonized plant fragments; noncalcareous, sandy	80.0	1.9
Shale, medium dark gray, silty, slickensided, noncalcareous	81.9	33.5
Shale, medium light gray, noncalcareous, bedding greatly disturbed, bioturbation features abundant	115.4	0.6
Shale, medium gray, silty, noncalcareous; includes minor streaks of very fine grained sandstone	116.0	3.3
Sandstone, medium dark gray, very fine grained, silty, calcareous, contains brachiopod shells and shell fragments	119.3	0.7
Limestone, medium dark gray, impure, highly silty and shaly, brachiopod shells abundant (Spaniard Limestone)	120.0	0.2
McAlester Formation		
Shale, medium gray, noncalcareous, silty	120.2	9.3
Sandstone, medium gray, very fine grained, silty, shaly, bedding disturbed; includes abundant fossil shells and shell fragments; grades into underlying unit	129.5	0.9
Sandstone and shale interstratified, medium dark gray with light gray bands, extensively bioturbated, noncalcareous (Keota Sandstone)	130.4	9.6
<i>Total Depth</i>		140.0

Core-Hole Log 7

SW¼SW¼SE¼NE¼NE¼ sec. 12, T. 11 N., R. 16 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled at east edge of farm pond 575 ft FEL and 1,100 ft FNL. Field notebook designation C-MM-19. (Surface elevation, estimated from topographic map, 698 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, grayish orange, very fine grained, silty; contains organic material (soil)	0.0	2.0
Sand, moderate brown, very fine grained, silty, unconsolidated, oxidized	2.0	5.0
Sand, moderate yellowish brown, very fine grained, silty, clayey; contains gravel-size clasts of weathered dusky yellowish brown sandstone, unconsolidated	7.0	3.0
KREBS GROUP		
Boggy Formation		
Sandstone, light brown to very pale orange with medium dark gray bands, very fine grained, shaly, noncalcareous, cross-bedded, micaceous, weathered	10.0	1.3

Sandstone, light gray with dark gray bands, very fine grained, shaly, wavy-laminated, fractured, oxidized along fracture surfaces, micaceous, noncalcareous	11.3	2.7
Siltstone, medium dark gray, shaly, noncalcareous, micaceous	14.0	2.0
Sandstone, very light gray with dark gray laminae, noncalcareous, very fine grained, silty, cross-laminated, micaceous	16.0	5.5
Siltstone, medium dark gray, shaly, micaceous, noncalcareous; includes a few laminae of light gray, very fine grained sandstone; cross-laminated in part	21.5	72.7
Shale, medium dark gray, noncalcareous	94.2	15.8
Shale, dark gray, noncalcareous; includes some light brownish gray sideritic concretions 0.25–1.5 in. thick; contains sparse calcareous brachiopod fossils in lower part	110.0	21.6
Shale, grayish black, noncalcareous, includes some light brownish gray sideritic concretions 0.5–1 in. thick as well as a sideritic concretion 4 in. thick at 179 ft; contains sparse calcareous brachiopod fossils and white calcite deposits on fracture surfaces; slickensided in part	131.6	59.4
Shale, black, noncalcareous; contains sparse calcareous brachiopod fossils and white calcite veinlets occurring as fracture fillings	191.0	2.2
Limestone, medium dark gray, impure, silty, shaly; highly fossiliferous, brachiopod shell fragments abundant; interfingered with underlying unit in lower 1 in. (Inola Limestone)	193.2	0.7
Coal, black, bright, moderately friable, white calcite on cleat surfaces (Bluejacket coal)	193.9	0.1
Underclay, medium light gray, highly silty and sandy, contains sparse black carbonized plant fragments; slickensided; grades into underlying unit	194.0	3.0
Shale, medium dark gray, sandy, silty; stratification obscure; includes a few thin sideritic concretions	197.0	8.7
Sandstone, light gray and medium dark gray, shaly, very fine grained, noncalcareous, cross-bedded and wavy-laminated, micaceous	205.7	4.1
Shale, dark gray, noncalcareous	209.8	5.7
Sandstone, very light gray with some medium dark gray bands and laminae, shaly, very fine grained, noncalcareous, cross-laminated	215.5	7.6
Siltstone, dark gray, highly shaly, noncalcareous; grades into underlying unit	223.1	3.9
Shale, dark gray, silty, noncalcareous; includes sparse calcareous brachiopod fossils.	227.0	5.0
Shale grayish black, noncalcareous, includes some light grayish brown pyritic, sideritic concretions 1–2 in. thick; contains sparse white calcareous brachiopod fossils; slickensided in part; includes a 0.06-in.-thick layer of bright, black, pyritic coal at 254.6 ft	232.0	28.0
<i>Total Depth</i>		260.0

Core-Hole Log 8

SW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 11 N., R. 16 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled on crown of hill just south of abandoned building site. Field notebook designation C-MM-37. (Surface elevation, estimated from topographic map, 700 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate brown, silty; contains abundant organic material	0.0	1.0
KREBS GROUP		
Boggy Formation		
Sandstone, dark yellowish orange, clayey, very fine grained, highly weathered, soft .	1.0	5.5
Shale, grayish orange pink to dark yellowish orange, highly silty and sandy, interbedded with 1-in.-thick layers of very fine grained indurated sandstone, highly weathered; includes some moderate red ironstone concretions ~1 in. thick; iron-oxide deposits abundant on stratification surfaces; grades into underlying unit	6.5	2.5
Shale, grayish orange pink, silty; includes dark yellowish orange bands of weathered clay ironstone about 0.5–1.5 in. thick; noncalcareous, weathered	9.0	3.7
Shale, dusky brown with dark yellowish orange bands; includes black carbonized plant fragments and abundant iron-oxide deposits on stratification surfaces; becomes brownish black with depth	12.7	13.3
Shale, grayish black with medium gray bands, noncalcareous; interlaminated with fine-grained siltstone; cross-laminated and wavy-bedded in part	26.0	6.5
Shale, medium gray, clayey	32.5	1.0

Coal, black, bright, friable; includes three pyrite layers 0.06–0.75 in. thick; becomes increasingly impure with depth (Secor coal)	33.5	2.5
Shale, black to brownish black, highly carbonaceous; includes numerous coal bands 0.06–0.75 in. thick; contains thin pyritic layers in upper part and small pyrite nodules in lower 1 ft	36.0	8.0
Shale, medium gray, noncalcareous; includes sparse grayish black carbonaceous stringers	44.0	2.1
Sandstone, medium light gray, very fine grained, interlaminated with shale	46.1	0.4
Shale, medium gray	46.5	2.5
Sandstone, medium dark gray, very fine grained, shaly, cross-bedded	49.0	0.4
Mudstone, dark gray, silty, contains almond-size, siltstone-filled burrows in lower 1 ft	49.4	1.5
Sandstone and shale, medium dark gray, interbedded and interlaminated, slumped, cross-bedded, burrowed in part; contains sparse pyritic nodules, fractured and slickensided	50.9	6.1
Sandstone, medium dark gray, very fine grained, highly silty and shaly, unbedded to obscurely bedded, noncalcareous	57.0	3.6
Siltstone, medium dark gray, shaly, includes some very fine grained sand clasts, burrowed; interbedded with shale in parts; contains some pyrite nodules; becomes sandy with depth	60.6	5.4
Sandstone, medium dark gray and light gray, very fine grained, shaly; bedding highly contorted; slump features abundant from 66 to 69 ft; includes large abundant burrow features in bottom 6 ft	66.0	10.3
Sandstone, medium light gray, fine- to medium-grained, noncalcareous, micaceous, cross-bedded; contains abundant black macerated plant material; conglomeratic in upper 18 in.; includes numerous stringers and inclusions of coal (Bluejacket Sandstone)	76.3	<u>3.7</u>
<i>Total Depth</i>		80.0

Core-Hole Log 9

NE¼NW¼NE¼SW¼ sec. 13, T. 11 N., R. 16 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture directly south from large overhead iron gate 2,200 ft FWL and 2,570 ft FSL. Field notebook designation C-MM-36. (Surface elevation, estimated from topographic map, 700 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate brown, silty; contains abundant organic material	0.0	1.5
Sand, light brown to dark yellowish orange, highly clayey	1.5	1.5
KREBS GROUP		
Boggy Formation		
Sandstone, grayish orange, very fine grained, friable, highly weathered, clayey	3.0	1.8
Sandstone, moderate reddish brown to dark yellowish orange, very fine grained, cross-laminated; includes some clayey shale bands; noncalcareous, highly weathered	4.8	10.2
Shale, dark yellowish brown with light brown mottling, clayey, noncalcareous	15.0	4.7
Shale, dusky yellowish brown with moderate yellowish brown bands, noncalcareous; includes some light brown sideritic concretions ~0.75 in. in diameter	19.7	2.5
Shale, medium dark gray to dark gray, silty, noncalcareous; includes some light brown iron-oxide staining along fractures and partings in upper 2 ft	22.2	8.8
Sandstone, dark gray with light gray streaks, silty and shaly, noncalcareous, cross-bedded in part, bedding contorted in places; fills small channel in underlying unit	31.0	5.7
Shale, dark gray, silty, noncalcareous; contains two 1-in.-thick sandstone layers in bottom 1 ft	36.7	6.1
Sandstone, medium light gray with thin black bands, fine-grained, micaceous, noncalcareous, cross-bedded; contains abundant black carbonized plant materials	42.8	2.8
Shale and siltstone, interlaminated, medium gray	45.6	4.4
Sandstone, medium gray with light gray bands, very fine grained, shaly, cross-bedded, noncalcareous; slump features, small scour features, and cross-laminae common; includes light brownish gray sideritic concretions 0.5–2 in. thick at irregular intervals from a few inches to several feet apart; contains black carbonized plant fragments on stratification surfaces	50.0	59.5

Mudstone, medium dark gray, slickensided, noncalcareous, bioturbated, contains sand-filled burrows in lower 2 in.	109.5	0.5
Sandstone, medium light gray, micaceous, fine- to medium-grained, bioturbated in upper part, noncalcareous, cross-bedded; contains black macerated plant material on stratification surfaces; contact with overlying and underlying units sharp (Bluejacket Sandstone)	110.0	2.5
Sandstone, medium dark gray with light gray bands, very fine grained, shaly, cross-bedded	112.5	1.8
Sandstone, medium light gray to light gray with medium dark gray bands, fine- to very fine grained, noncalcareous, cross-bedded; interlaminated with shale in part	114.3	2.3
Sandstone, medium light gray, fine- to medium-grained, noncalcareous, cross-bedded, micaceous; includes abundant black carbonaceous macerated plant material and coal stringers between 118 and 119 ft and minor amounts throughout; includes numerous dark gray shaly bands from paper-thin to ~1 in. thick below 124 ft (Bluejacket Sandstone)	116.6	<u>13.4</u>
<i>Total Depth</i>		130.0

Core-Hole Log 10

SW¼NE¼NE¼NW¼NE¼ sec. 3, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture just northwest from old abandoned strip pit 230 ft FNL and 1,400 ft FEL. Field notebook designation C-MM-39. (Surface elevation, estimated from topographic map, 603 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
Sand, moderate yellowish brown, clayey, fine-grained	1.8	1.2
Sand, light brown, clayey, very fine to fine-grained	3.0	1.5
Clay, pale yellowish brown; highly sandy, weathered shale in lower part	4.5	1.5
KREBS GROUP		
Boggy Formation		
Shale, brownish gray with moderate reddish orange mottling; includes a 1-in.-thick layer of oxidized clay ironstone at base of unit	6.0	0.7
Shale, medium dark gray with moderate reddish orange oxidized clay ironstone deposits on some stratification surfaces	6.7	2.9
Shale, black, brittle, noncalcareous, moderate reddish brown iron-oxide deposits on fracture surfaces; fossiliferous in lower 3 in.	9.6	2.7
Limestone, dark gray, impure, silty, highly fossiliferous, brachiopods and crinoids abundant (Inola Limestone)	12.3	1.0
Coal, black, friable, white calcite on cleat surfaces (Bluejacket coal)	13.3	0.1
Underclay, medium light gray, hard, blocky fracture, sandy; includes some minor grayish black carbonaceous layers	13.4	2.0
Limestone, medium dark gray with dark gray bands, impure, silty, shaly; calcareous shale in part; fossiliferous in some parts, broken shell fragments abundant....	15.4	4.6
Shale and limestone, interbedded, dark gray with medium light gray bands; limestone layers are fossiliferous	20.0	4.0
Coal, black, impure, shaly, white calcite on cleat surfaces (unnamed coal)	24.0	0.1
Limestone, medium light gray, impure, shaly and silty; contains streaks of black carbonaceous shale; contains unidentifiable marine fossils; wavy-bedded	24.1	0.4
Shale, medium dark gray with medium light gray bands, noncalcareous; includes some wavy-bedded, very fine grained sandstone laminae	24.5	0.5
Shale, medium dark gray, noncalcareous	25.0	0.7
Coal, black, bright, moderately friable; contains some pyrite and black carbonaceous shale laminae (Peters Chapel coal)	25.7	1.8
Shale, black, coaly; contains abundant layers of hard, bright coal and pyrite	27.5	2.2
Underclay, medium dark gray; contains abundant disseminated pyrite and black carbonized plant fragments	29.7	0.8
Shale, medium dark gray to dark gray, silty, noncalcareous; interlaminated with very fine grained sandstone in part, bioturbated in places, fractured	30.5	<u>14.5</u>
<i>Total Depth</i>		45.0

Core-Hole Log 11

SE¼NW¼SW¼NW¼NE¼ sec. 3, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture just west of old, small coal pit along bluff of Elk Creek 810 ft FNL and 2,430 ft FEL. Field notebook designation C-MM-27. (Surface elevation, estimated from topographic map, 615 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown to grayish brown, silty, contains organic material (soil) .	0.0	2.0
Clay, dark yellowish brown, sandy	2.0	6.0
KREBS GROUP		
Boggy Formation		
Shale, pale yellowish orange to dusky yellowish brown, banded, weathered	8.0	3.0
Sandstone, moderate reddish brown to moderate brown, very fine grained, indurated, noncalcareous, contains laminae of black macerated plant material, shaly in part; becomes light gray with dark gray bands at ~14 ft	11.0	6.0
Shale, black, soft, coaly	17.0	0.2
Underclay, dark gray; includes abundant black carbonized plant material on stratification surfaces	17.2	0.3
Shale, medium dark gray	17.5	0.3
Sandstone, medium dark gray with medium gray bands, interbedded with shale, very fine grained, noncalcareous, wavy-laminated	17.8	1.2
Shale, dark gray to grayish black, highly carbonaceous	19.0	0.4
Coal, black, impure, contains several layers of pyrite up to 0.5 in. thick (Peters Chapel coal)	19.4	0.5
Pyrite, metallic yellowish black	19.9	0.1
Coal, black, bright, moderately friable (Peters Chapel coal)	20.0	1.0
Coal, black, impure, includes a 0.5-in.-thick pyrite layer at top (Peters Chapel coal) .	21.0	1.1
Shale, grayish black, very highly carbonaceous; contains some thin layers of coal and pyrite	22.1	1.2
Underclay, medium dark gray; contains black carbonized plant fragments	23.3	1.3
Shale, medium dark gray, includes light brownish gray sideritic concretions	24.6	0.4
Shale, black, highly carbonaceous, coaly	25.0	<u>1.5</u>
<i>Total Depth</i>		26.5

Core-Hole Log 12

NW¼NW¼NW¼SW¼NE¼ sec. 3, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture on northwest side of farm pond 2,560 ft FEL and 1,370 ft FNL. Field notebook designation C-MM-26. (Surface elevation, estimated from topographic map, 618 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown, silty, unbedded; contains organic material (soil)	0.0	2.0
KREBS GROUP		
Boggy Formation		
Sandstone, moderate yellowish brown to moderate brown, clayey, soft, weathered	2.0	4.0
Shale, dark yellowish brown to grayish brown to dusky yellowish brown with light brown bands, weathered; includes clay ironstone concretions 0.5–1 in. thick	6.0	11.5
Sandstone, dusky yellowish brown, very fine grained, noncalcareous, wavy-laminated, shaly; includes black macerated plant material on stratification surfaces; becomes medium light gray with dark gray bands at ~22 ft	17.5	10.5
Shale, medium dark gray	28.0	3.0
Shale, grayish black, brittle, noncalcareous, fractured; includes light brownish gray sideritic concretions 0.5–1 in. in diameter	31.0	7.0
Shale, dark gray, noncalcareous, fractured, slickensided; includes some light brownish gray sideritic concretions 0.25–1 in. thick	38.0	16.0
Shale, grayish black, hard, brittle, noncalcareous; includes light brownish gray sideritic concretions ~0.5 in. thick	54.0	11.0
Limestone, light brownish gray, impure, silty, very hard; contains sand-filled fractures and burrows	65.0	0.2

Shale, black; contains some rare pyritized brachiopod shells	65.2	1.0
Shale, medium dark gray, highly silty, slickensided; contains black carbonized plant fragments	66.2	0.7
Shale, black, highly carbonaceous, coaly in lower half, flaky	66.9	0.5
Coal, black, impure, moderately friable; contains minor pyrite on stratification surfaces (Secor Rider coal)	67.4	0.4
Underclay, dark gray, slickensided; contains thin stringer of coal	67.8	0.5
Shale, medium dark gray, silty; contains abundant black carbonized plant material	68.3	1.5
Siltstone, medium dark gray, shaly, noncalcareous, grades into underlying unit	69.8	1.2
Sandstone, medium gray with light gray laminae, very fine grained, shaly, noncalcareous, cross-laminated, includes black carbonized plant fragments; bioturbated in part, silty in lower 1 ft	71.0	11.3
Shale, dark gray, silty, contains well-preserved black carbonized plant compressions	82.3	1.7
Coal, black, bright, friable, minor pyrite on cleat surfaces (Secor coal)	84.0	0.5
Underclay, dark gray; contains abundant black carbonized plant fragments	84.5	0.5
Shale, medium dark gray, silty; includes abundant black carbonized plant fragments	85.0	0.5
Sandstone, medium gray with light gray bands and laminae, very fine grained, noncalcareous, shaly, cross-bedded, extensively bioturbated, wavy-laminated; includes light brownish gray sideritic concretions 0.5–1.5 in. thick; becomes light gray with medium dark gray bands and laminae, and less shaly below 108 ft; contains rare black carbonized plant fragments in lower 10 ft	85.5	34.0
Siltstone, medium dark gray, shaly, noncalcareous; contains some thin laminae of very fine grained sandstone; includes some light brownish gray sideritic concretions 1–1.5 in. thick in upper and lower 1 ft of unit; contains well-preserved black carbonized plant compressions	119.5	6.5
Coal, black, bright, friable (Lower Witteville coal)	126.0	0.3
Underclay, medium dark gray, shaly, slickensided	126.3	0.2
Siltstone, medium dark gray, noncalcareous, shaly; contains black carbonized plant compressions and light brownish gray sandstone-filled burrows	126.5	3.5
Sandstone, medium dark gray with light gray bands and laminae, very fine grained, shaly, wavy-laminated, cross-bedded, bioturbated; contains black macerated plant material on stratification surfaces, noncalcareous; becomes predominantly light gray and fine-grained from 150 to 163 ft	130.0	<u>33.0</u>
<i>Total Depth</i>		163.0

Core-Hole Log 13

SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 3, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture just north of small westward-flowing intermittent stream 300 ft FEL and 1,380 ft FSL. Field notebook designation C-MM-38. (Surface elevation, estimated from topographic map, 612 ft).

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, pale yellowish brown, clayey; contains organic matter	0.0	1.0
Clay, dark yellowish brown, soft; contains brownish black and dark reddish brown gravel-size clasts of weathered clay ironstone	1.0	6.0
KREBS GROUP		
Boggy Formation		
Shale, grayish orange and light olive gray, weathered; contains dark yellowish orange iron-oxide layers	7.0	4.5
Limestone, medium dark gray, highly weathered, impure, silty and sandy, fossiliferous, contains brachiopods and crinoids; weathers dark yellowish orange; crops out in creek bed 100 ft southeast from drill hole (Inola Limestone)	11.5	0.5
Coal, brownish black, smutty, highly weathered (Bluejacket coal)	12.0	0.1
Shale, medium gray with dark yellowish orange bands, silty, partly weathered	12.1	1.4
Shale, medium gray, silty; includes some grayish black bands ~0.5 in. thick	13.5	5.9
Sandstone, medium gray, very fine grained, silty, noncalcareous, cross-bedded, fractured	19.4	0.3

Shale, medium gray, silty	19.7	2.7
Siltstone, dark gray, pyritic	22.4	0.2
Shale, dark gray to grayish black, carbonaceous; contains well-preserved fossil plant impressions, predominantly seed-fern leaves; includes some burrows in bottom 18 in. and brownish gray sideritic concretions in bottom 6 in.; contact with underlying unit sharp	22.6	2.8
Sandstone, light gray with black streaks and bands, fine- to very fine grained, shaly, pritic, noncalcareous; includes some black carbonaceous shale laminae, some in bands up to 3 in. thick; also contains coalified plant fragments; grades into underlying unit	25.4	9.5
Siltstone, black with light gray streaks, highly carbonaceous and shaly; includes some laminae of very fine grained sandstone; wavy-bedded and cross-bedded in part	34.9	2.9
Shale, grayish black, highly silty, pyritic, slickensided	37.8	2.2
Shale, dark gray to grayish black with light brownish gray bands, silty; contains abundant sideritic concretionary layers 0.25–2 in. thick; includes scattered calcareous marine shells and shell fragments from 48 to 52 ft; also includes pyrite-filled burrows, small pyritized shells and pyrite laminae from 52 to 54 ft; white calcite veins fill fractures in places; slickensided	40.0	59.3
Limestone, grayish black, impure, shaly; contains abundant fossil shell fragments ...	99.3	0.1
Shale, black, weakly calcareous; contains fossil brachiopods	99.4	0.3
Limestone, grayish black, impure, shaly; contains abundant fossil shell fragments ...	99.7	0.3
Underclay, medium light gray, silty, bioturbated; contains black carbonized plant fragments	100.0	1.9
Shale, grayish black, contains sparse pyritized and calcareous shell fragments; weakly calcareous; abundant fossils from 106.5 to 107 ft; includes sparse, well-preserved plant fossils	101.9	6.4
Shale, grayish black with light gray bands; includes a few 0.06-in.-thick coal stringers and wavy-bedded calcareous sandstone beds 0.25–0.5 in. thick; pyritic in part	108.3	1.0
Limestone, grayish black with light gray laminae, impure, shaly; contains abundant fossil hash	109.3	0.2
Shale, grayish black; contains sparse calcareous shell fragments	109.5	0.3
Coal, black, moderately friable; contains pyritic nodules ~0.75 in. thick; includes a 1-in.-thick slickensided, brownish black shale parting 3 in. from top of unit (Secor coal)	109.8	0.4
Shale, brownish black, hard, silty, includes sparse pyritized fossil shells; contains a 0.75-in.-thick layer of highly shaly, fossiliferous, black limestone 2 in. from top of unit	110.2	0.9
Shale, black, soft, flaky, noncalcareous	111.1	0.8
Sandstone; very light gray with medium light gray bands, very fine grained, non-calcareous, cross-bedded, micaceous, intricately interlaminated with shale; contains sandstone-filled burrows, brecciated shaly sandstone clasts, truncated beds, and highly contorted slump features; includes black macerated plant material on stratification surfaces; becomes finer grained in lower 6 ft	111.9	45.8
Coal, black, bright, moderately friable; white calcite on cleat surfaces; contains some pyrite veins and small nodules (Lower Witteville coal)	157.7	0.6
Shale, grayish black, coaly, slickensided, includes abundant black carbonized plant compressions; grades into underlying unit	158.3	0.3
Siltstone, medium dark gray, shaly, noncalcareous; includes some light brownish gray sideritic concretions ~1 in. thick and well-preserved black carbonized plant fossils; grades into underlying unit	158.6	1.4
Sandstone, medium gray, very fine grained, highly silty and shaly, even-bedded, noncalcareous; includes several layers of light brownish gray sideritic concretions 0.5–1 in. thick; contains well-preserved, black carbonized plant fossils; seed-fern leaves abundant (Bluejacket Sandstone)	160.0	<u>10.0</u>
<i>Total Depth</i>		170.0

Core-Hole Log 14

NE¼NW¼NE¼NW¼SE¼ sec. 8, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled just south of Elk Creek 2,580 ft FSL and 1,700 ft FEL. Field notebook designation C-MM-20. (Surface elevation, estimated from topographic map, 626 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, grayish brown to brownish black, sandy, unbedded; contains abundant organic material (soil)	0.0	3.0
Silt, dark yellowish brown to brownish gray, sandy, unconsolidated	3.0	3.0
Silt, dark yellowish brown, clayey; contains some gravel-size clasts of sandstone and ironstone	6.0	2.0
KREBS GROUP		
Boggy Formation		
Sandstone, medium dark gray with medium light gray bands and streaks, very fine grained; siltstone in large part, noncalcareous, wavy-laminated and cross-laminated; includes some dark gray silty shale layers ~0.5 in. thick that are carbonaceous and pyritic; black carbonized plant fragments abundant in places on stratification surfaces; grayish black and highly carbonaceous from 20.5 to 21.0 ft	8.0	22.0
Coal, black, bright, moderately friable, pyritic; includes pyrite layers from laminae to 0.5 in. thick (Peters Chapel coal)	30.0	2.2
Shale, black, very highly carbonaceous; includes abundant thin stringers of coal, and pyrite layers up to 0.5 in. thick	32.2	1.0
Shale, black, carbonaceous; includes sparse thin stringers of coal	33.2	2.1
Shale, dark gray to medium gray, noncalcareous; includes light brownish gray sideritic concretions 0.125–1.5 in. thick	35.3	10.7
Siltstone, medium dark gray; includes abundant grains of very fine sand, noncalcareous, well-indurated	46.0	1.0
Shale, dark gray, silty, noncalcareous; includes light brownish gray sideritic concretions 0.5–1 in. thick	47.0	13.3
Conglomerate, medium light gray, massive; contains rounded shale pebbles, coal streaks, and fragments of coal up to 1 in. long and 0.5 in. thick, matrix is coarse-grained sandstone	60.3	1.3
Sandstone, medium light gray, medium- to coarse-grained, massive, noncalcareous; contains streaks, fragments, and lenses of coal up to 0.75 in. thick; includes some brownish gray mottling and what appears to be transported chunks of peat; where visible, bedding is greatly disturbed and contorted	61.6	15.2
Coal, black, bright; contact with overlying unit irregular; sandstone and coal interfinger in part (Secor Rider coal)	76.8	0.2
Underclay, medium gray, slickensided	77.0	0.3
Shale, medium gray, silty, grades into underlying unit; contains black carbonized plant fragments	77.3	2.0
Siltstone, medium gray; includes some thin laminae of very fine grained light gray sandstone; grades into underlying unit, noncalcareous	79.3	2.7
Sandstone, medium gray, very fine grained, siltstone in part, laminated, noncalcareous; contains black carbonized plant fragments; becomes medium dark gray and shaly at 85 ft	82.0	13.0
Shale, dark gray, carbonaceous; contains thin coal stringers in bottom 6 in. of unit ...	95.0	1.0
Coal, black, bright, moderately friable; minor pyrite crusts on stratification surfaces (Secor coal)	96.0	0.8
Shale, dark gray, silty; black carbonized plant fragments abundant on stratification surfaces; grades into underlying unit	96.8	1.2
Siltstone, medium dark gray, shaly; black carbonized plant fragments abundant on stratification surfaces; grades into underlying unit	98.0	1.0
Sandstone, medium dark gray with light gray laminae, very fine grained, silty, shaly, noncalcareous, micaceous; cross-laminated and wavy-bedded; black macerated plant material abundant; includes an 8-in.-thick, massive, fine-grained, light gray layer at 105 ft; contains sparse light brownish gray sideritic concretions about 1–2 in. thick	99.0	<u>41.0</u>
<i>Total Depth</i>		140.0

Core-Hole Log 15

NE¼SE¼NW¼SW¼NW¼ sec. 19, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture just east of new Highway 69, 1,350 ft FNL and 420 ft FWL. Field notebook designation C-MM-24. (Surface elevation, estimated from topographic map, 678 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, pale yellowish brown, very fine grained, unconsolidated; contains organic material (soil)	0.0	2.0
Silt, moderate yellowish brown, clayey; contains weathered fragments of dusky brown ironstone concretions	2.0	6.0
KREBS GROUP		
Boggy Formation		
Shale, dark yellowish brown, clayey, weathered	8.0	3.5
Shale, grayish orange with moderate reddish orange bands; contains dusky brown ironstone concretions; weathered; becomes dark yellowish brown below 13 ft	11.5	3.5
Sandstone, medium dark gray with light gray laminae, some moderate brown streaks in upper 2 ft, very fine grained, noncalcareous, well-indurated	15.0	10.1
Siltstone, medium gray, shaly; black carbonized plant material on stratification surfaces	25.1	1.1
Shale, medium dark gray; grayish black and highly carbonaceous in lower 1 in.	26.2	0.4
Coal, black, bright, moderately friable, includes minor pyrite and white calcite on cleat surfaces (Lower Witteville coal)	26.6	0.8
Underclay, dark gray to medium gray; includes abundant black carbonized plant fragments	27.4	0.6
Sandstone, medium light gray with medium dark gray bands, very fine grained, shaly, noncalcareous, wavy laminated and cross laminated in part; black carbonized plant fragments abundant on stratification surfaces	28.0	<u>20.0</u>
<i>Total Depth</i>		48.0

Core-Hole Log 16

NE¼NE¼NE¼SW¼ sec. 19, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture 1,040 ft FSL and 1,100 ft FWL. Field notebook designation C-MM-23. (Surface elevation, estimated from topographic map, 675 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, pale brown, very fine grained, silty, unbedded; contains organic material (soil)	0.0	2.0
Sand, light brown, very fine grained, silty; contains gravel-size particles of moderate reddish brown sandstone	2.0	3.0
KREBS GROUP		
Boggy Formation		
Sandstone, grayish orange to moderate yellowish brown, highly shaly, very fine grained, soft, weathered	5.0	3.5
Sandstone, grayish orange to pale yellowish brown with light brown and dusky red bands, shaly, very fine grained, cross-laminated in part, contains ironstone concretions 0.5–1 in. thick, noncalcareous, weakly indurated, weathered	8.5	6.1
Shale, dark yellowish brown with light brown bands, silty in upper 1 ft	14.6	4.4
Siltstone, pale yellowish brown to brownish gray with light brown bands, shaly; black macerated plant material on stratification surfaces; grades into underlying unit	19.0	3.0
Sandstone, medium gray with light brown bands in upper part, shaly, very fine grained, laminated in part, noncalcareous	22.0	<u>13.0</u>
<i>Total Depth</i>		35.0

Core-Hole Log 17

SW¼NW¼SW¼SW¼SW¼ sec. 19, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture 75 ft FWL and 564 ft FSL. Field notebook designation C-MM-25. (Surface elevation, estimated from topographic map, 688 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark yellowish brown with light brown streaks, silty, unbedded; contains organic material (soil)	0.0	1.5
KREBS GROUP		
Boggy Formation		
Sandstone, moderate reddish orange, very fine grained, noncalcareous, well-indurated	1.5	4.5
Shale, olive gray, clayey; stained light brown on stratification surfaces	6.0	5.0
Shale, grayish black with light brown to moderate reddish orange bands; includes oxidized sideritic concretions 0.5–1 in. thick	11.0	14.6
Shale, black, noncalcareous	25.6	0.2
Limestone, grayish black, impure, shaly, hard; contains abundant broken fossil shell fragments	25.8	0.2
Shale, black, brittle, noncalcareous; contains sparse pyritized and calcareous brachiopod shells; highly carbonaceous at contact with underlying unit	26.0	0.9
Shale, medium gray, clayey	26.9	0.3
Coal, black, friable, pyrite and light gray calcite on cleat surfaces (Secor Rider coal) .	27.2	0.3
Underclay, medium light gray, gypsiferous, slickensided; contains black carbonized plant fragments	27.5	0.8
Siltstone, medium gray, gypsiferous; contains black carbonized plant fragments; grades into underlying unit	28.3	0.7
Sandstone, medium light gray with very light gray laminae, shaly, very fine grained, noncalcareous, cross-laminated and wavy-bedded	29.0	10.2
Siltstone, medium gray, sandy in upper part, shaly in lower part, noncalcareous, includes some light brownish gray sideritic concretions; pyritic in places	39.2	3.6
Shale, medium dark gray, silty, carbonaceous in part; contains black carbonized plant fragments	42.8	0.8
Coal, black, bright, friable; includes some pyrite on stratification surfaces (Secor coal)	43.6	0.8
Underclay, medium dark gray; includes abundant black carbonized plant fragments	44.4	0.4
Siltstone, medium gray, shaly, noncalcareous; black carbonized plant fragments abundant	44.8	0.7
Sandstone, medium light gray with medium dark gray bands, shaly, very fine grained, noncalcareous, wavy-laminated and cross-laminated; micaceous; includes black macerated plant material on stratification surfaces	45.5	<u>10.5</u>
<i>Total Depth</i>		56.0

Core-Hole Log 18

NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 19, T. 11 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled just west of farm pond situated on west side of old Highway 69 in Onapa 1,000 ft FWL and 500 ft FSL. Field notebook designation C-MM-22. (Surface elevation, estimated from topographic map, 666 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, pale yellowish brown with light brown mottling, unconsolidated; contains organic material (soil)	0.0	1.8
Clay, grayish orange, sandy, soft, weathered	1.8	3.2
Sand, moderate yellowish brown, soft, clayey; contains gravel size clasts of dark reddish brown sandstone, highly weathered	5.0	5.0
Clay, dark yellowish orange, pisolitic, highly weathered	10.0	1.0
KREBS GROUP		
Boggy Formation		
Sandstone, pale yellowish brown with dark yellowish orange bands, very fine grained, fractured; contains abundant black carbonized plant fragments on stratification surface; wavy-laminated and cross-bedded in part	11.0	4.5
Sandstone, medium light gray with medium dark gray bands, shaly; very fine grained, wavy-bedded and cross-laminated, bedding contorted in places, non-calcareous; black macerated plant material abundant on stratification surfaces; grades into underlying unit	15.5	22.5

Siltstone, medium gray, shaly; contains abundant black macerated plant material on stratification surfaces; includes some light brownish gray sideritic concretions about 1–1.5 in. thick, and sparse laminae of very fine grained light gray sandstone	38.0	13.5
Shale, medium dark gray, black and coaly in lower 0.5 in. of unit	51.5	0.2
Coal, black, bright, moderately friable; minor white calcite and pyrite on cleat surfaces and stratification planes (Lower Witteville coal)	51.7	1.0
Sandstone, medium gray, fine-grained; contains abundant black macerated plant fragments	52.7	0.1
Underclay, dark gray; contains black carbonized plant fragments and coal streaks ...	52.8	0.6
Siltstone, medium gray, shaly; laminated and bioturbated in part; grades into underlying unit	53.4	1.0
Sandstone, medium light gray, fine-grained, noncalcareous, massive; includes some black macerated plant material	54.4	<u>0.6</u>
<i>Total Depth</i>		55.0

Core-Hole Log 19

NW¼NE¼NW¼NE¼NW¼ sec. 18, T. 11 N., R. 18 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at north end of farm pond 1,700 ft FWL and 60 ft FNL. Field notebook designation C-MM-28. (Surface elevation, estimated from topographic map, 638 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Clay, brownish gray, sandy; contains organic matter (soil)	0.0	2.5
Clay, pale yellowish brown, silty, sandy, oxidized	2.5	5.5
Sand, grayish orange; very fine grained, with ~20% coarse-grained material; clayey, oxidized	8.0	5.0
KREBS GROUP		
McAlester Formation		
Sandstone, pale yellowish brown with grayish orange bands, very fine grained; interbedded with shale and clay ironstone concretions; light brownish gray with grayish black bands below 16 ft	13.0	5.0
Shale, grayish black with light brownish gray bands, interbedded with very fine grained sandstone laminae and layers up to 1.75 in. thick; includes some light brownish gray sideritic concretions	18.0	5.2
Sandstone, medium light gray with dark gray bands, shaly, very fine grained, wavy-laminated and cross-bedded, noncalcareous; contains abundant black macerated plant material on stratification surfaces	23.2	<u>16.8</u>
<i>Total Depth</i>		40.0

Core-Hole Log 20

SW¼NW¼SE¼SW¼SE¼ sec. 10, T. 12 N., R. 14 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-3. (Surface elevation, estimated from topographic map, 684 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, grayish brown; contains abundant organic material (soil)	0.0	1.8
Clay, moderate yellowish brown, color changes to dusky yellow at 8 ft, silty; mottled with moderate reddish orange spots in upper 2 ft	1.8	8.2
CABANISS GROUP		
Senora Formation		
Shale, yellowish gray, moderately weathered, clayey; includes some moderate reddish brown ironstone concretions	10.0	3.0
Shale, medium to light gray, clayey; includes numerous bands of moderate reddish orange and dusky red ironstone concretions	13.0	7.0
Shale, olive gray to medium gray with moderate yellowish brown clay-ironstone concretions 0.5–1 in. thick	20.0	10.5

Shale, medium gray to dark gray; includes black carbonaceous plant fragments on stratification surfaces; contains several hard, medium light gray siderite layers 0.5–1 in. thick	30.5	4.5
Shale, grayish black, silty; interbedded with light gray, very fine grained, even-bedded sandstone layers ~1 in. thick irregularly spaced throughout the unit	35.0	<u>5.5</u>
<i>Total Depth</i>		40.5

Core-Hole Log 21

SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, T. 12 N., R. 14 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-9. (Surface elevation, estimated from topographic map, 681 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, pale yellowish brown, sandy; contains abundant organic material (soil)	0.0	1.5
Sand, moderate brown, silty, well-rounded	1.5	1.5
CABANISS GROUP		
Senora Formation		
Shale, moderate brown; contains black and dark reddish brown gravel-size particles of weathered clay ironstone	3.0	3.0
Shale, dark yellowish brown, contains brownish black fragments of ironstone	6.0	4.0
Shale, pale yellowish brown, clayey, soft, weathered	10.0	3.0
Shale, light olive gray to olive gray; contains dark reddish brown ironstone concretions ~1 in. in diameter and layers of ironstone ~0.5 in. thick	13.0	9.0
Shale, brownish gray, sandy, very highly calcareous, weakly indurated, feels gritty ..	22.0	0.6
Shale, brownish gray; sandy; noncalcareous, highly gypsiferous; contains some poorly preserved fossil shells; feels gritty	22.6	0.4
Coal, black, moderately friable; light brown and white gypsum on stratification surfaces (Mineral [Eram] coal)	23.0	1.0
Underclay, dark gray, slickensided; contains abundant black carbonized plant fragments	24.0	2.3
Shale, medium dark gray with medium gray bands, silty; contains some small lenses of pyrite and abundant black carbonized plant fossils	26.3	<u>9.7</u>
<i>Total Depth</i>		36.0

Core-Hole Log 22

NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, T. 12 N., R. 16 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture 40 ft FNL and 2,600 ft FEL. Field notebook designation C-MM-46. (Surface elevation, estimated from topographic map, 622 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	1.0
Clay, dark yellowish brown, gravelly; contains rounded clasts of very fine grained ferruginous sandstone	1.0	7.5
KREBS GROUP		
Boggy Formation		
Shale, dusky yellow to light olive gray with light brown bands, silty, noncalcareous; contains weathered clay-ironstone concretions occurring in layers ~0.5 in. thick ...	8.5	3.4
Shale, dusky yellowish brown, silty, hard, fractured; contains light brown layers of clay-ironstone concretions 0.125 to 0.5 in. thick; includes white calcite deposits on some stratification surfaces and in fractures	11.9	4.1
Siltstone, medium dark gray, shaly; contains small spheroidal pyrite masses ~0.125 in. in diameter, and minor calcite on stratification surfaces; includes sparse laminae of very fine grained sandstone as well as some small bioturbation features	16.0	30.2
Sandstone, medium gray and light gray, very fine grained, shaly, micaceous, noncalcareous, bedding highly contorted; soft-sediment slump features abundant	46.2	0.7
Siltstone, medium dark gray, shaly, includes sparse laminae of very fine grained sandstone, bioturbated	46.9	4.1

Shale, medium dark gray, silty, noncalcareous; includes sparse laminae of very fine grained sandstone; contains some partially pyritized burrow fillings in upper 10 ft and calcareous brachiopod fossils in lower 3.5 ft of unit	51.0	20.5
Shale, dark gray to grayish black, contains abundant pyrite-filled burrows ~0.375 in. thick and up to 2 in. long; includes calcareous brachiopod fossils and white calcite on stratification surfaces in lower 5 in. of unit	71.5	1.9
Shale, grayish black, contains abundant white calcareous brachiopod shells; includes several light brownish gray sideritic concretions 0.5–2.5 in. thick	73.4	5.6
Shale, grayish black to black, hard; contains minor white calcite along fracture surfaces; includes some light brownish gray sideritic concretions 0.5–1 in. thick; fossil brachiopod shells sparsely distributed from 90 to 92 ft; highly carbonaceous and coaly with pyrite crusts in bottom 1 in. of unit	79.0	15.0
Coal, black, bright, moderately friable; contains white calcite veinlets and pyritic laminae; includes a 0.5-in.-thick, dark gray shale parting 4 in. above bottom of unit (Wainwright coal)	94.0	1.3
Underclay, dark gray, burrowed, slickensided	95.3	0.3
Sandstone, medium gray and light gray, very fine grained; wavy-bedded, shaly and bioturbated in upper 2 in.; fine-grained and massive in lower part with black macerated plant fragments abundant	95.6	<u>0.6</u>
<i>Total Depth</i>		96.2

Core-Hole Log 23

SW¼NE¼NE¼SE¼SE¼ sec. 11, T. 12 N., R. 16 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at west edge of small farm pond 156 ft FEL and 1,140 ft FSL. Field notebook designation C-MM-45. (Surface elevation, estimated from topographic map, 700 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate reddish brown, silty, unconsolidated contains organic materials	0.0	1.5
KREBS GROUP		
Boggy Formation		
Sandstone, dark yellowish orange and moderate reddish brown, very fine grained, clayey, highly broken and weathered	1.5	2.5
Sandstone, moderate yellowish brown, very fine grained, well-indurated	4.0	4.5
Sandstone, pale yellowish brown with moderate brown bands; very fine grained, shaly, noncalcareous, cross-laminated, partly weathered	8.5	3.0
Sandstone, light gray and medium dark gray, interlaminated with shale, very fine grained, noncalcareous, cross-laminated, bioturbated; contains abundant black macerated plant fragments on stratification surfaces	11.5	10.5
Sandstone, medium dark gray with sparse light gray laminations, very fine grained, noncalcareous, cross-laminated; contains abundant black macerated plant fragments on stratification surfaces; grades into underlying unit	22.0	10.0
Siltstone, medium dark gray, shaly, micaceous, noncalcareous, includes sparse laminae of light gray, very fine grained sandstone; grades into underlying unit	32.0	5.0
Shale, medium dark gray, noncalcareous, silty; contains light brownish gray sideritic concretions ~0.5 in. thick; minor pyrite on stratification surfaces; includes some medium dark gray siltstone containing sparse laminae of light gray, very fine grained sandstone; slickensided in places	37.0	47.5
Shale, black; includes some light brownish gray sideritic concretions ~0.5 in. thick ...	84.5	2.5
Shale, black, calcareous, hard, brittle; includes sparse white calcite laminae and fossil shells; contains some minor pyrite and pyritized brachiopod shells; includes light brownish gray sideritic concretions ~1 in. thick that are pyritic in part; slickensided	87.0	12.2
Shale, medium dark gray, soft, noncalcareous, bioturbated; contains some pyrite-filled burrows and pyritized shells in upper 6 in. of unit	99.2	0.8
Shale, grayish black, fractured, noncalcareous; contains light brownish gray sideritic concretions up to 2 in. thick; includes white calcite on fracture surfaces, in fossil shells, and in sideritic concretions	100.0	9.7
Shale, black to grayish black, noncalcareous, hard, brittle, contains sparse veinlets of white calcite; includes abundant light brownish gray sideritic concretions about 0.125 to 1 in. thick; fractured, slickensided	109.7	21.0

Shale, black, noncalcareous; contains abundant discontinuous laminae of pyrite and some small pyritized brachiopod shells	130.7	0.3
Shale, medium gray with medium light gray and light brownish gray bands, laminated, noncalcareous; contains some pyritized brachiopods and sideritic concretions 0.125 to 0.5 in. thick	131.0	9.0
Shale, dark gray to grayish black, hard, noncalcareous, includes some light brownish gray silty laminae, bioturbated in part, slickensided; contains sparsely distributed brachiopod fossils and rare pyritized burrows; pyrite-filled burrows abundant from 154.7 to 155 ft and from 157.5 to 158 ft	140.0	18.0
Shale, medium gray to medium dark gray, hard, silty, obscurely cross-laminated, noncalcareous; bioturbated; includes rare pyrite-filled burrows; contains light gray sideritic concretions up to 2 in. thick	158.0	20.5
Shale, black to dark gray, hard, brittle, weakly calcareous; contains some small pyritized burrows and medium gray sideritic concretions up to 2 in. thick	178.5	3.8
Sandstone, medium dark gray and light gray, very fine grained, shaly, noncalcareous, cross-laminated to wavy-laminated in part; soft-sediment deformation features common; bioturbated in places; contains abundant black carbonized plant fragments	182.3	<u>7.7</u>
<i>Total Depth</i>		190.0

Core-Hole Log 24

NW¼NE¼SW¼SW¼NW¼ sec. 16, T. 12 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled at east edge of small pond on hill south of old barn 400 ft FWL and 2,400 ft FNL. Field notebook designation C-MM-18. (Surface elevation, estimated from topographic map, 583 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, dark yellowish brown, clayey, unbedded; contains organic material (soil)	0.0	2.0
Clay, light brown, highly sandy, soft; contains some subangular coarse gravel consisting predominantly of sandstone	2.0	3.0
KREBS GROUP		
Boggy Formation		
Shale, dark yellowish brown; contains fragments of moderate reddish brown ironstone, weathered	5.0	1.5
Shale, medium dark gray to dark gray with dark yellowish brown mottling; contains fragments of moderate reddish brown ironstone, partially weathered	6.5	1.5
Shale, grayish black with light brown to moderate reddish brown staining on stratification surfaces	8.0	6.0
Shale, grayish black to black, hard, brittle; contains sparse white calcitic fossil shell fragments and some light brownish gray sideritic concretions 1 in. thick	14.0	19.0
Limestone, medium gray to medium dark gray, impure, shaly, highly fossiliferous, brachiopod shell fragments abundant (Inola Limestone)	33.0	1.1
Coal, black, bright, moderately friable; pyrite and white calcite on cleat surfaces; includes a highly carbonaceous, coaly, calcareous shale in upper 0.5 in. of unit (Bluejacket coal)	34.1	0.2
Underclay, very light gray, bedding obscure or absent, feels soapy; grades into underlying unit	34.3	2.5
Shale, medium gray, sandy, bedding obscure	36.8	1.2
Sandstone, medium gray, massive, very hard; very fine grained; contains disseminated pyrite	38.0	0.2
Shale, dark gray to grayish black, brittle; includes some 0.5- to 2-in.-thick light brownish gray sideritic concretionary layers; calcareous from 50.5 to 52 ft, with sparse white fossil shell fragments included; contains some pyrite nodules as much as 1 in. in diameter	38.2	45.8
Shale, black, includes some 0.5- to 2.5-in.-thick sideritic concretions; contains sparse, white calcareous fossil shell fragments in lower 1 ft of unit	84.0	3.3
Limestone, dark gray, impure, shaly; contains abundant fossil hash	87.3	0.2
Shale, black to grayish black, noncalcareous; white calcite deposits included in veinlets; silty in lower 1 in.	87.5	0.3
Shale, medium dark gray, silty, noncalcareous, slickensided; grades into underlying unit	87.8	0.7

Siltstone, medium light gray, shaly, noncalcareous; contains abundant black carbonized plant fossils in lower part	88.5	1.1
Sandstone, light gray, medium gray in part, silty, very fine grained; contains abundant black carbonized plant fossils; micaceous, noncalcareous, wavy-laminated in part, bedding contorted in places; cross-bedded; plant fossils well preserved in bottom 2 ft of unit, seed-fern leaves abundant	89.6	15.4
Siltstone, medium gray, shaly; contains well-preserved, black carbonized plant fossils and streaks of coal	105.0	0.5
Shale, black, coaly	105.5	0.1
Coal, black, bright, very friable; includes some pyrite and minor white calcite on cleat surfaces (Secor coal)	105.6	0.8
Shale, dark gray, silty in lower part; contains coal streaks and abundant black carbonized plant material	106.4	0.5
Sandstone, medium gray to dark gray with light gray bands, very fine grained, silty, shaly, micaceous, wavy-laminated, noncalcareous, bedding contorted in part; contains black carbonized plant fragments, cross-bedded in places; includes some light brownish gray concretions up to 1 in. in diameter; contains massive beds of fine-grained sandstone 18–24 in. thick	106.9	<u>43.1</u>
<i>Total Depth</i>		150.0

Core-Hole Log 25

SW¼NE¼NE¼SE¼SW¼ sec. 23, T. 12 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in meadow at high point on bluff overlooking tributary of Elk Creek 2,400 ft FWL and 1,040 ft FSL. Field notebook designation C-MM-44. (Surface elevation, estimated from topographic map, 642 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dark reddish brown, very fine grained, silty; contains organic material	0.0	0.8
KREBS GROUP		
Boggy Formation		
Sandstone, moderate reddish brown, clayey, very fine grained, weathered	0.8	2.2
Sandstone, dark yellowish orange to grayish orange to pale yellowish brown, very fine grained, clayey, well-indurated	3.0	6.0
Sandstone, pale yellowish brown streaked with moderate reddish orange, very fine grained, interbedded with very pale orange to grayish orange clay, weathered	9.0	1.4
Sandstone, moderate reddish brown, fine- to medium-grained, noncalcareous, cross-bedded, oxidized	10.4	4.1
Shale, grayish orange to medium gray, soft, clayey	14.5	3.2
Shale, black with light brown bands; iron-oxide deposits on stratification surfaces and in fractures	17.7	4.0
Shale, dark gray to grayish black; includes some light brownish gray sideritic concretions up to 2 in. thick; contains minor pyrite; fractured, slickensided	21.7	38.3
Shale, dark gray, noncalcareous; includes some medium light gray sideritic concretions up to 1.5 in. thick; slickensided	60.0	9.0
Limestone, medium dark gray, impure, silty, fossiliferous, broken shell fragments abundant	69.0	0.1
Shale, dark gray, silty; includes thin layers of white calcite on some stratification surfaces	69.1	0.1
Siltstone, medium dark gray, shaly, noncalcareous, contains well-preserved black carbonized plant fossils on stratification surfaces; includes light brownish gray sideritic concretions up to 1 in. thick, slickensided	69.2	10.0
Sandstone, light gray with medium gray bands, very fine grained, shaly, micaceous, noncalcareous, cross-laminated, contains black macerated plant fragments	79.2	0.8
Sandstone, medium gray with sparse light gray bands and laminae, very fine grained, shaly, micaceous, noncalcareous, wavy-laminated; contains sparse black carbonized plant fossils	80.0	4.2
Sandstone, light gray and medium gray, shaly, very fine grained, micaceous, noncalcareous, cross-laminated in part; includes sedimentary slump features; contains black macerated plant fragments	84.2	3.8
Sandstone, medium gray with light gray laminae, very fine grained, micaceous, noncalcareous, uniformly stratified; includes a few bioturbation features; contains sparse black carbonized plant fragments; grades into underlying unit	88.0	17.2

Shale, dark gray, sandy, silty, noncalcareous; contains light brownish gray siderite-filled burrows and sideritic concretions up to 1.5 in. thick; slickensided; includes sparse black carbonized plant compressions	105.2	5.7
Sandstone, light gray with dark gray bands and laminae, very fine to fine-grained, noncalcareous; micaceous, bedding contorted, cross-bedded in part; includes abundant black macerated plant fragments (Bluejacket Sandstone)	110.9	<u>4.1</u>
<i>Total Depth</i>		115.0

Core-Hole Log 26

NW¼SE¼NW¼NW¼ sec. 25, T. 12 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at northwest corner of farm pond 450 ft FNL and 465 ft FWL. Field notebook designation C-MM-41. (Surface elevation, estimated from topographic map, 661 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, pale brown, very fine grained, clayey	1.5	1.0
Clay, moderate orange pink to moderate reddish brown, sandy; contains gravel-size clasts of sandstone	2.5	4.0
KREBS GROUP		
Boggy Formation		
Sandstone, moderate reddish brown, very fine grained, shaly, bioturbated; oxidized; becomes grayish orange at 11 ft	6.5	6.0
Shale, grayish black to dark gray with moderate yellowish brown ironstone concretionary bands; color of bands changes to light brownish gray below 20 ft; some pyrite crusts on stratification surfaces; fractured, slickensided; includes rare limestone nodules about 1–1.5 in. in diameter; contains white calcite veinlets and possible shell fragments from 21 to 22.6 ft; 1- to 2-in.-thick sideritic concretions abundant below 25 ft	12.5	59.5
Shale, grayish black to black; contains scattered, well-preserved white fossil shells and shell fragments	72.0	3.8
Limestone, dark gray, impure, shaly, highly fossiliferous, brachiopods abundant	75.8	0.2
Shale, black; includes white calcite on some stratification surfaces	76.0	0.4
Coal, black, moderately friable; white calcite on stratification surfaces (Secor Rider coal)	76.4	0.1
Underclay, medium light gray, silty, extensively burrowed; contains black carbonaceous material	76.5	0.4
Shale, medium gray, wavy-bedded, burrowed	76.9	0.8
Shale, black; contains pyrite-filled burrows, pyritized and calcareous brachiopods; white calcite on some stratification surfaces; calcareous below 83 ft; silty in part	77.7	15.8
Shale, grayish black, silty, hard, burrowed; contains numerous thin strata filled with very fine grained, light gray calcareous sandstone; pyrite abundant	93.5	7.6
Coal, black, bright, moderately friable; contains thin lenses and laminae of pyrite; calcite on cleat surfaces (Secor coal)	101.1	0.5
Shale, grayish black, coaly	101.6	0.2
Shale, medium gray, silty at base of unit	101.8	0.2
Siltstone, medium light gray, shaly, wavyly interlaminated with very fine grained sandstone, noncalcareous; contains some filled burrows; slump structures abundant	102.0	2.9
Sandstone, light gray, fine-grained, micaceous, noncalcareous; includes abundant black macerated plant material on stratification surfaces; wavy-laminated in part	104.9	4.4
Siltstone, light brownish gray, sandy, shaly, hard, noncalcareous	109.3	0.3
Sandstone, fine- to medium-grained, micaceous, noncalcareous; black macerated plant material abundant on stratification surfaces; wavy-laminated in part; includes rare light brownish gray sideritic concretions 0.5–0.75 in. thick (Bluejacket Sandstone)	109.6	1.3
Sandstone, medium dark gray with light gray wavy bands, very fine grained, shaly, noncalcareous, micaceous; includes abundant black macerated plant material and some bioturbation features; fine- to very fine grained and light gray with medium dark gray shaly bands below 126.7 ft	110.9	<u>49.1</u>
<i>Total Depth</i>		160.0

Core-Hole Log 27

NW¼SW¼SE¼NW¼NW¼ sec. 26, T. 12 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in pasture at southeast corner of farm pond 1,080 ft FNL and 600 ft FWL. Field notebook designation C-MM-21. (Surface elevation, estimated from topographic map, 620 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Silt, grayish brown with light brown mottling, sandy, unbedded, contains organic matter (soil)	0.0	2.0
Silt, dusky yellowish brown, unbedded	2.0	2.0
Sand, moderate yellowish brown, silty, clayey, very fine grained; contains gravel-size clasts of light brown to dark reddish brown weathered sandstone	4.0	4.0
KREBS GROUP		
Boggy Formation		
Sandstone, dark reddish brown, very fine grained, well-indurated	8.0	0.2
Shale, pale yellowish orange, soft, clayey, weathered	8.2	2.8
Shale, light gray with dark yellowish orange streaks; includes some weathered stringers of light brown clay ironstone	11.0	1.1
Shale, dusky brown with dark reddish brown and dusky red bands; includes several layers of weathered ironstone ~0.5 in. thick; becomes predominantly grayish black in bottom 18 in.	12.1	4.3
Sandstone, dusky yellowish brown to pale yellowish brown with some medium light gray layers, very fine grained, micaceous, noncalcareous, wavy-bedded and cross-laminated, well-indurated	16.4	2.1
Shale, brownish black to grayish black with light brown bands containing bluish white selenite crystals	18.5	1.0
Sandstone, very light gray with moderate reddish brown and dark gray streaks, very fine grained, micaceous, cross-laminated and wavy-bedded in part, bioturbated in places; abundant black macerated plant material on stratification surfaces	19.5	4.0
Siltstone, medium dark gray, grades into underlying unit	23.5	1.2
Shale, medium gray, silty	24.7	0.9
Sandstone, medium gray, very fine grained, silty, shaly, micaceous, some pyrite on stratification surfaces; wavy-laminated in upper 6 in.; includes stringers of light gray sandstone throughout; contains sparse, well-preserved fossil plant material such as seed-fern leaves	25.6	12.7
Shale, dark gray, noncalcareous, includes well-preserved fossil plant compressions; becomes silty in lower 2 ft and grades into underlying unit	38.3	4.7
Siltstone, dark gray, shaly; includes some laminae of very fine grained sandstone	43.0	0.8
Sandstone, medium light gray with medium gray laminae, very fine grained, noncalcareous, wavy-laminated	43.8	0.6
Sandstone, medium dark gray, silty, shaly, very fine grained, noncalcareous; includes some thin stringers of coal in lower part; contains well-preserved plant compressions; bioturbated in places	44.4	7.7
Sandstone, medium light gray, massive, fractured, very fine to fine-grained, noncalcareous; contact with underlying unit irregular; sand-filled burrows extend downward 2–3 in. into unit below	52.1	0.4
Shale, dark gray, slickensided, noncalcareous; includes sparsely distributed light brownish gray sideritic concretions ~1 in. thick; becomes grayish black at 68 ft; includes sparse, white, calcareous brachiopod shells in lower 3 ft of unit	52.5	23.9
Siltstone, medium dark gray, shaly; bedding disturbed at contact with overlying unit	76.4	0.3
Sandstone, medium dark gray, silty, shaly, very fine grained, massive, noncalcareous	76.7	0.3
Siltstone, medium dark gray, shaly, bioturbated; grades into underlying unit	77.0	0.3
Shale, grayish black, noncalcareous	77.3	1.0
Sandstone, medium dark gray, very fine grained, silty, shaly; contains well-preserved fossil plant compressions on stratification surfaces; includes some light brownish gray sideritic concretions about 0.5–1.5 in. thick; slickensided along fractures	78.3	22.2
Sandstone, very light gray with dark gray streaks and bands, fine-grained, noncalcareous; bedding highly contorted; scour-and-fill features abundant	100.5	2.3
Sandstone, medium dark gray, very fine grained, noncalcareous, laminated; includes some very thin coal stringers	102.8	1.4
Sandstone, very light gray with medium dark gray laminae and bands, very fine grained, shaly, noncalcareous, wavy-laminated	104.2	4.3

Sandstone, medium dark gray with sparse, very light gray laminae, very fine grained, silty, shaly, noncalcareous; includes well-preserved plant compressions on stratification surfaces; contains minor coal streaks and macerated plant material in places	108.5	<u>26.5</u>
<i>Total Depth</i>		135.0

Core-Hole Log 28

SW¼NE¼NW¼NW¼NE¼ sec. 26, T. 12 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-42. (Surface elevation, estimated from topographic map, 633 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, moderate brown, silty; contains organic material	0.0	0.5
KREBS GROUP		
Boggy Formation		
Sandstone, grayish orange to dark reddish brown, very fine grained; contains hard iron-oxide cemented concretions; includes some clayey layers, ripple-marked; contains abundant plant impressions	0.5	5.5
Coal, black, very impure and shaly, soft, smutty	6.0	0.2
Shale, grayish orange pink and moderate reddish orange, weathered	6.2	1.0
Coal, black, very friable, impure, shaly, pyritic, iron oxide on cleat surfaces (Secor coal)	7.2	2.0
Shale, black, coaly; contains abundant plant compressions, pyritic	9.2	4.8
Underclay, medium light gray, silty, slickensided	14.0	3.0
Shale, medium light gray, silty, fractured, slickensided	17.0	13.0
Sandstone, medium dark gray and medium light gray, very fine grained, shaly, noncalcareous; bedding highly contorted; slump and plume features abundant; includes some medium dark gray, slickensided, silty shale layers up to 3 in. thick (Bluejacket Sandstone)	30.0	7.3
Shale, medium dark gray, highly silty, noncalcareous; slickensided; contains some very fine grained sand clasts	37.3	2.8
Sandstone, medium dark gray and medium light gray, very fine grained, silty, shaly, noncalcareous, cross-bedded in part; contains scour-and-fill, slump, and microfault features; includes slickensided medium dark gray shale beds up to 2 in. thick	40.1	9.7
Siltstone, medium dark gray, shaly, noncalcareous; includes abundant light brownish gray silty shale-filled burrows, slickensided; contains some minor laminae of very fine grained sandstone	49.8	9.1
Sandstone, medium dark gray and light gray, very fine grained, shaly, noncalcareous, slump features common, bedding contorted in places, fractured	58.9	11.1
Siltstone, medium dark gray, shaly, noncalcareous, slickensided, fractured; bioturbated in places; contains some very fine grained sand clasts	70.0	<u>10.0</u>
<i>Total Depth</i>		80.0

Core-Hole Log 29

NE¼SE¼SW¼NW¼NE¼ sec. 26, T. 12 N., R. 17 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Field notebook designation C-MM-43. (Surface elevation, estimated from topographic map, 637 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, pale yellowish brown, silty; contains organic material	0.0	1.5
Gravel, moderate yellowish brown, clayey; contains rounded sandstone clasts up to coarse gravel size	1.5	6.5
Clay, moderate yellowish brown, sandy, soft	8.0	2.0
Sand, moderate brown, clayey, soft, very fine grained	10.0	1.0
KREBS GROUP		
Boggy Formation		
Coal, black, very soft, smutty, weathered (Secor Rider coal)	11.0	0.1

Underclay, dusky yellowish brown; contains black carbonized plant fragments	11.1	0.2
Shale, dark yellowish brown to dark gray, silty; contains dark yellowish orange iron-oxide deposits on stratification surfaces in upper part, weathered	11.3	1.7
Sandstone, medium dark gray and medium light gray, very fine grained, wavy-bedded, interlaminated with shale, bioturbated in part; slump features common ..	13.0	4.7
Coal, black, very shaly, soft, fissile; contains minor pyrite	17.7	0.1
Underclay, medium gray; contains black carbonized plant fragments; includes some minor veinlets of white calcite	17.8	0.3
Sandstone, medium dark gray and medium light gray, very fine grained, interlaminated with shale, noncalcareous, wavy-bedded and cross-laminated; bioturbated in part; contains abundant black carbonized plant material	18.1	4.1
Shale, dark gray and highly carbonaceous in upper part, medium gray in lower part	22.2	0.9
Sandstone, medium dark gray with black coal streaks and medium gray shale laminae, very fine grained	23.1	0.2
Shale, medium gray; includes a 0.25-in.-thick coal stringer at top of unit	23.3	0.3
Sandstone, medium dark gray and medium light gray with black streaks, very fine grained, shaly, coaly; bedding highly contorted	23.6	1.0
Coal, black, moderately friable, includes a 0.75-in.-thick pyrite nodule	24.6	0.2
Sandstone, medium dark gray with medium light gray bands, highly carbonaceous, very fine grained, bedding contorted	24.8	0.2
Coal, black, bright, moderately friable; peacock coal; contains some pyrite laminae (Secor coal)	25.0	1.5
Shale, black, highly carbonaceous, coaly in upper part; contains coal layers up to 0.25 in. thick, pyritic	26.5	<u>3.5</u>
<i>Total Depth</i>		30.0

Core-Hole Log 30

SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 12 N., R. 18 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by Robert O. Fay. Drilled 635 ft south and 10 ft east of NW corner of SW $\frac{1}{4}$ of sec. 30. Field notebook designation OGS Coal Borehole 8. Rockbit drill 0–85 ft; cored 85–118.5 ft. (Surface elevation, estimated from topographic map, 659 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Clay, brown and gray, in part soil	0.0	10.0
Clay, brown, overlies bedrock unconformably	10.0	4.5
KREBS GROUP		
Boggy Formation		
Shale, brown	14.5	8.5
Shale, gray; water at 28 ft (set 4 in. casing to 30 ft)	23.0	10.3
Sandstone, gray	33.3	0.2
Shale, gray, contains siderite nodules from 46 to 81 ft	33.5	47.5
Shale, dark gray, contains siderite nodules	81.0	3.9
Coal, black, banded, bituminous; includes gray shale parting from 86.75 to 86.9 ft (Secor coal)	84.9	2.1
Underclay, medium gray, nonbedded, noncalcareous, contains rootlets	87.0	1.0
Shale, medium dark gray, interlaminated with sandstone, bioturbated, slump structure, disturbed bedding	88.0	7.2
Sandstone, light gray, fine-grained, clayey, slightly micaceous, contains shale laminae, contains 3 sideritic bands and some indistinct slump structures	95.2	12.6
Shale, medium dark gray, interlaminated with gray sandstone laminae	107.8	10.2
Sandstone, light gray, fine-grained, clayey	118.0	<u>0.5</u>
<i>Total Depth</i>		118.5

Core-Hole Log 31

SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, T. 12 N., R. 18 E., McIntosh County. Well cored by Oklahoma Geological Survey; lithologic descriptions by LeRoy A. Hemish. Drilled in farmyard 312 ft FWL and 2,080 ft FSL. Field notebook designation C-MM-40. (Surface elevation, estimated from topographic map, 661 ft.)

	<i>Depth to unit top (ft)</i>	<i>Thickness of unit (ft)</i>
Sand, dusky yellowish brown, very fine, silty; contains abundant organic material ...	0.0	1.0
Clay, moderate brown to dark yellowish orange, sandy; contains subangular clasts of grayish orange sandstone up to coarse gravel size	1.0	7.6
KREBS GROUP		
Boggy Formation		
Shale, moderate yellowish brown, interbedded with very fine grained silty sand- stone, weathered	8.6	1.1
Sandstone, light gray with medium dark gray bands, very fine grained, shaly, wavy-bedded, noncalcareous, micaceous, black macerated plant material on stratification surfaces; contains sedimentary slump features; cross-laminated in part	9.7	32.0
Shale, dark gray to grayish black, highly carbonaceous; includes abundant stringers of bright, hard coal in lower 2 in. of unit	41.7	0.4
Coal, black, friable; pyrite on cleat surfaces, impure; contains thin shale partings (Lower Witteville coal)	42.1	0.5
Shale, black, carbonaceous; includes abundant thin stringers of bright hard coal	42.6	0.8
Shale, dark gray, silty, burrowed in lower part	43.4	1.0
Siltstone, medium dark gray with light gray laminae of very fine grained sandstone, wavy-bedded, shaly, noncalcareous	44.4	0.8
Sandstone, light gray with medium gray shale laminae, very fine grained, mica- ceous, wavy-bedded, bioturbated in upper part; bedding contorted in part; black macerated plant material abundant on stratification surfaces; cross- bedded	45.2	<u>52.8</u>
<i>Total Depth</i>		98.0

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 McINTOSH 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, R13E</u>	Croweburg hvAb	1	3.2	34.1	37.4	25.3	5.2	10,073	3½	1	OGS	1983	
		2	N/A	35.2	38.7	26.1	5.3	10,406					
		3	N/A	47.7	52.3	N/A	—	14,088					
<u>T10N, R18E</u>	Rowe —	1	3.7	32.5	58.0	5.9	1.0	13,393	3	1	OGS	1986	
		2	N/A	33.7	60.2	6.1	1.0	13,903					
		3	N/A	36.0	64.0	N/A	—	14,803					
<u>T11N, R16E</u>	Secor hvAb	1	1.5	35.1	59.1	4.3	1.0	14,415	8	3	OGS	1983	
		2	N/A	35.7	60.0	4.3	1.0	14,632					
		3	N/A	37.3	62.7	N/A	—	15,289					
	Secor hvBb	1	6.6	31.0	50.5	11.9	1.6	12,082	2½	1	OGS	1983	
		2	N/A	33.2	54.1	12.7	1.7	12,936					
		3	N/A	38.0	62.0	N/A	—	14,824					
	Secor Rider hvAb	1	0.9	34.7	47.5	16.9	9.1	12,328	7	1	OGS	1983	
		2	N/A	35.1	47.9	17.0	9.2	12,441					
		3	N/A	42.2	57.8	N/A	—	14,997					
	Secor Rider —	1	10.0	26.8	41.6	21.6	2.3	9,058	½	2	OGS	1983	
		2	N/A	30.4	47.2	22.4	2.4	10,230					
		3	N/A	39.2	60.7	N/A	—	13,333					
	Secor hvAb	1	1.6	31.3	46.5	20.6	7.8	11,374	7	1	OGS	1986	
		2	N/A	31.8	47.3	20.9	7.9	11,559					
		3	N/A	40.2	59.8	N/A	—	14,620					
<u>T11N, R17E</u>	Lower Witteville —	1	2.2	35.6	55.9	6.3	3.7	13,905	—	1	Company	1981	
		2	N/A	36.5	57.1	6.4	3.8	14,219					
		3	N/A	38.9	61.1	N/A	—	15,194					
	Peters Chapel	1	4.5	31.8	44.3	19.4	6.8	11,566	—	2	Company	1981	
		2	N/A	33.2	46.3	20.5	7.2	12,081					
		3	N/A	41.7	58.3	N/A	—	15,150					
	Secor —	1	5.6	31.2	57.8	5.4	0.6	13,178	7½	2	Company	1981	
		2	N/A	33.0	61.3	5.7	0.6	13,944					
		3	N/A	35.0	65.0	N/A	—	14,788					
	Stigler —	1	1.7	33.1	57.0	8.2	3.9	13,079	5½	6	Company	1981	
		2	N/A	33.7	58.0	8.3	3.9	13,305					
		3	N/A	36.8	63.2	N/A	—	14,499					
	Lower Witteville	1	4.2	33.4	58.0	4.4	2.2	13,935	8	3	Company	1982	
		2	N/A	34.9	60.5	4.6	2.3	14,537					
		3	N/A	36.6	63.4	N/A	—	15,239					
	Secor —	1	2.8	32.9	58.2	6.1	0.7	14,004	8	2	Company	1982	
		2	N/A	33.8	59.9	6.3	0.7	14,412					
		3	N/A	36.1	63.9	N/A	—	15,385					
	Secor Rider —	1	2.9	35.7	57.1	4.2	2.3	14,215	8	1	Company	1982	
		2	N/A	36.8	58.9	4.3	2.4	14,644					
		3	N/A	38.5	61.5	N/A	—	15,306					
	Rowe —	1	3.2	33.6	57.5	5.7	1.4	13,984	8	1	OGS	1983	
		2	N/A	34.7	59.4	5.9	1.4	14,443					
		3	N/A	36.9	63.1	N/A	—	15,344					
	Secor hvAb	1	1.1	33.9	59.7	5.3	1.2	14,295	8½	3	OGS	1983	
		2	N/A	34.3	60.3	5.4	1.2	14,457					
		3	N/A	36.3	63.7	N/A	—	15,292					
	Secor Rider hvAb	1	0.6	32.5	46.9	20.0	11.1	11,793	7	3	OGS	1983	
		2	N/A	32.7	47.2	20.1	11.1	11,868					
		3	N/A	40.9	59.1	N/A	—	14,860					

TABLE A3-1 (Continued). — AVERAGE ANALYSES OF COALS IN McINTOSH 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							
T11N, R18E	Stigler hvAb	1	1.0	32.6	58.5	7.9	4.9	14,044	8½	1	OGS	1983	
		2	N/A	32.9	59.1	8.0	5.0	14,186					
		3	N/A	35.8	64.2	N/A	—	15,416					
	Stigler hvAb	1	3.0	31.9	54.5	10.6	5.6	13,348	7½	1	OGS	1984	
		2	N/A	32.9	56.2	10.9	5.7	13,762					
		3	N/A	36.9	63.1	N/A	—	15,456					
	Lower Witteville hvAb	1	1.5	35.6	56.0	6.9	3.0	13,950	8	2	OGS	1985	
		2	N/A	36.2	56.8	7.0	3.1	14,164					
		3	N/A	39.0	61.0	N/A	—	15,228					
	Peters Chapel hvAb	1	1.8	34.9	51.0	12.3	5.5	13,183	7	2	OGS	1985	
		2	N/A	35.5	52.0	12.5	5.6	13,432					
		3	N/A	40.6	59.4	N/A	—	15,345					
	Secor hvAb	1	1.8	33.7	58.3	6.2	0.9	14,103	8	3	OGS	1985	
		2	N/A	34.3	59.4	6.3	1.0	14,363					
		3	N/A	36.6	63.4	N/A	—	15,326					
	Secor Rider hvAb	1	1.2	32.3	40.9	25.6	8.0	10,892	5	2	OGS	1985	
		2	N/A	32.7	41.4	25.9	8.1	11,029					
		3	N/A	44.1	55.9	N/A	—	14,879					
	Lower Witteville hvAb	1	1.3	36.0	56.5	6.3	3.3	13,969	8½	1	OGS	1986	
		2	N/A	36.5	57.2	6.4	3.3	14,149					
		3	N/A	39.9	61.1	N/A	—	15,111					
	Peters Chapel hvAb	1	1.4	32.1	49.1	17.4	8.3	12,157	7½	1	OGS	1986	
		2	N/A	32.6	49.8	17.6	8.4	12,330					
		3	N/A	39.5	60.5	N/A	—	14,972					
	Secor hvAb	1	1.6	31.1	47.3	20.1	6.3	11,633	7	1	OGS	1986	
		2	N/A	31.6	48.0	20.4	6.4	11,823					
		3	N/A	39.7	60.3	N/A	—	14,852					
	T11N, R18E	Secor —	1	1.7	33.4	57.7	7.2	2.2	13,977	7½	1	Company	1983
			2	N/A	34.0	58.6	7.4	2.3	14,216				
			3	N/A	36.6	63.4	N/A	—	15,351				
	T11N, R18E	Secor hvAb	1	2.4	33.9	60.4	3.4	0.5	14,569	8½	1	OGS	1988
			2	N/A	34.7	61.8	3.4	0.5	14,922				
			3	N/A	36.0	64.0	N/A	—	15,452				
	T11N, R18E	Secor Rider hvAb	1	3.1	31.9	46.2	18.8	8.2	11,595	7½	1	OGS	1988
			2	N/A	32.9	47.7	19.4	8.5	11,967				
			3	N/A	40.8	59.2	N/A	—	14,848				
	T12N, R14E	Mineral hvCb	1	14.2	36.8	37.6	11.3	2.3	9,454	0	1	OGS	1985
			2	N/A	43.0	43.8	13.2	2.7	11,024				
			3	N/A	49.4	50.6	N/A	—	12,703				
	T12N, R16E	Wainwright hvAb	1	2.0	30.5	42.9	24.6	2.5	10,761	6	1	OGS	1986
			2	N/A	31.1	43.8	25.1	2.6	10,981				
			3	N/A	41.6	58.4	N/A	—	14,661				
	T12N, R17E	Secor —	1	4.5	31.5	56.9	7.1	1.2	13,299	7	6	Company	1978
			2	N/A	33.1	59.5	7.4	1.3	13,920				
			3	N/A	35.7	64.3	N/A	—	14,815				
	T12N, R17E	Secor —	1	4.1	28.8	60.2	6.9	0.9	13,441	—	5	Company	1978
		2	N/A	30.1	62.7	7.2	1.0	13,960					
		3	N/A	32.4	67.6	N/A	—	15,056					
T12N, R17E	Secor —	1	9.5	34.8	48.4	7.3	0.5	11,308	—	1	Company	1979	
		2	N/A	38.5	53.6	7.9	0.6	12,454					
		3	N/A	41.9	58.1	N/A	—	13,608					
T12N, R17E	Secor hvAb	1	1.5	34.2	60.3	4.0	0.9	14,508	8½	1	OGS	1982	
		2	N/A	34.7	61.2	4.1	0.9	14,729					
		3	N/A	36.2	63.8	N/A	—	15,352					
T12N, R17E	Secor hvAb	1	1.6	34.0	59.3	5.1	0.6	14,282	8	1	OGS	1983	
		2	N/A	34.6	60.3	5.1	0.6	14,514					
		3	N/A	36.5	63.5	N/A	—	15,294					
T12N, R17E	Secor —	1	5.5	27.5	49.1	17.9	1.0	10,575	½	2	OGS	1983	
		2	N/A	29.2	52.1	18.7	1.1	11,215					
		3	N/A	36.0	64.0	N/A	—	13,839					
T12N, R17E	Bluejacket hvAb	1	1.5	29.2	29.9	39.5	3.4	8,590	2½	1	OGS	1985	
		2	N/A	29.6	30.3	40.1	3.5	8,718					
		3	N/A	49.4	50.6	N/A	—	14,551					
T12N, R17E	Secor hvAb	1	1.5	34.7	55.7	8.1	1.3	13,684	8	1	OGS	1985	
		2	N/A	35.2	56.6	8.2	1.3	13,898					
		3	N/A	38.4	61.6	N/A	—	15,144					

TABLE A3-1 (Continued). — AVERAGE ANALYSES OF COALS IN McINTOSH 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							
T12N, R18E	Secor hvAb	1	1.2	32.8	52.0	14.0	5.7	12,725	8	2	OGS	1986	
		2	N/A	33.2	52.7	14.1	5.8	12,887					
		3	N/A	38.7	61.3	N/A	—	15,010					
	Secor —	1	1.8	—	—	21.6	4.0	11,686	—	2	Company	1986	
		2	N/A	—	—	22.0	4.1	11,904					
		3	N/A	—	—	N/A	—	15,246					
	Secor —	1	3.0	33.0	56.0	8.0	1.0	13,500	9	1	Company	—	
		2	N/A	34.0	57.8	8.2	1.0	13,917					
		3	N/A	37.0	63.0	N/A	—	15,160					
	Secor hvAb	1	1.0	35.2	51.8	12.0	6.2	12,709	—	1	OGS	1975	
		2	N/A	35.6	52.3	12.1	6.3	12,837					
		3	N/A	40.5	59.5	N/A	—	14,608					
	Secor —	1	5.1	31.3	57.7	5.9	1.9	13,153	—	2	Company	1976	
		2	N/A	33.0	60.8	6.2	2.0	13,861					
		3	N/A	35.2	64.8	N/A	—	14,776					
	Stigler —	1	1.7	34.3	51.8	12.2	4.0	13,029	—	1	Company	1978	
		2	N/A	34.9	52.7	12.4	4.0	13,247					
		3	N/A	39.8	60.2	N/A	—	15,122					
	Stigler —	1	0.7	33.3	52.0	14.0	4.2	12,865	7	1	OGS	1982	
		2	N/A	33.5	52.4	14.1	4.2	12,956					
		3	N/A	39.0	61.0	N/A	—	15,083					
	Stigler —	1	13.5	30.5	52.7	3.3	0.6	10,613	—	1	OGS	1982	
		2	N/A	35.3	60.8	3.9	0.7	12,269					
		3	N/A	36.7	63.3	N/A	—	12,767					
	Lower Witteville hvAb	1	1.0	34.0	54.0	11.0	5.2	13,403	7½	1	OGS	1983	
		2	N/A	34.3	54.6	11.1	5.3	13,538					
		3	N/A	38.6	61.4	N/A	—	15,231					
	Secor —	1	2.7	29.4	50.7	17.2	5.4	11,331	—	8	Company	1983	
		2	N/A	30.3	52.0	17.7	5.6	11,620					
		3	N/A	37.0	63.0	N/A	—	14,128					
	Lower Witteville hvAb	1	3.1	33.3	53.7	9.9	5.6	13,292	7	1	OGS	1984	
		2	N/A	34.4	55.4	10.2	5.7	13,820					
		3	N/A	38.3	61.7	N/A	—	15,278					
	Lower Witteville hvAb	1	1.7	21.9	29.0	47.4	2.6	7,280	4½	1	OGS	1986	
		2	N/A	22.3	29.5	48.2	2.6	7,406					
		3	N/A	43.0	57.0	N/A	—	14,292					
	Secor —	1	1.8	—	—	10.7	4.1	13,389	—	5	Company	1986	
		2	N/A	—	—	10.8	4.2	13,632					
		3	N/A	—	—	N/A	—	15,285					

^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 McINTOSH 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 (%)					Sulfur (%)	Btu/lb	Free swelling index	Year sampled	Type of sample site ^d
				Moisture	Volatile matter	Fixed carbon	Ash						
85C21H	24, Pl. 2A	Bluejacket hvAb	1	1.5	29.2	29.9	39.5	3.4	8,590	2½	1985	Core	
			2	N/A	29.6	30.3	40.1	3.5	8,718				
			3	N/A	49.4	50.6	N/A		14,551				
83C51H (Upper 13.5 in. of split sample)	1, Pl. 1A	Croweburg hvAb	1	2.4	40.0	42.7	14.9	4.8	11,994	7	1983	Core	
			2	N/A	41.0	43.8	15.2	5.0	12,292				
			3	N/A	48.4	51.6	N/A		14,503				
83C52H (Middle 3 in. of split sample)	1, Pl. 1A	Croweburg hvBb	1	4.9	23.4	27.4	44.3	4.5	6,749	½	1983	Core	
			2	N/A	24.6	28.8	46.6		7,098				
			3	N/A	46.1	53.9	N/A		13,290				
83C53H (Upper 7.5 in. of lower 15 in. of split sample)	1, Pl. 1A	Croweburg hvBb	1	2.9	34.3	39.6	23.2	4.8	10,306	5	1983	Core	
			2	N/A	35.3	40.8	23.9	5.0	10,610				
			3	N/A	46.4	53.6	N/A		13,946				
83C54H (Lower 7.5 in. of lower 15 in. of split sample)	1, Pl. 1A	Croweburg hvBb	1	4.1	27.5	29.6	38.8	6.4	7,716	1	1983	Core	
			2	N/A	28.7	30.8	40.5	6.7	8,048				
			3	N/A	48.2	51.8	N/A		13,529				
83C62H (Upper 7 in. of split sample)	41, Pl. 2A	Lower Witteville hvAb	1	0.9	32.7	52.0	14.3	8.8	12,728	7½	1983	AcSM	
			2	N/A	33.1	52.5	14.4	8.9	12,863				
			3	N/A	38.6	61.4	N/A		15,034				
83C63H (Middle 7 in. of split sample)	41, Pl. 2A	Lower Witteville hvAb	1	1.1	34.0	57.3	7.6	4.2	13,992	8	1983	AcSM	
			2	N/A	34.3	58.0	7.7	4.3	14,151				
			3	N/A	37.2	62.8	N/A		15,331				
83C64H (Lower 9 in. of split sample)	41, Pl. 2A	Lower Witteville hvAb	1	0.9	34.8	53.1	11.2	3.3	13,504	7	1983	AcSM	
			2	N/A	35.1	53.6	11.3	3.3	13,633				
			3	N/A	39.6	60.4	N/A		15,369				
84C81H (Upper 13 in. of split sample)	40, Pl. 2A	Lower Witteville hvAb	1	3.3	32.0	55.2	9.5	6.5	13,299	7½	1984	AcSM	
			2	N/A	33.1	57.1	9.8	6.7	13,755				
			3	N/A	36.7	63.3	N/A		15,248				
84C82H (Lower 13 in. of split sample)	40, Pl. 2A	Lower Witteville hvAb	1	2.9	34.6	52.1	10.4	4.6	13,285	7	1984	AcSM	
			2	N/A	35.7	53.6	10.7	4.7	13,685				
			3	N/A	39.9	60.1	N/A		15,324				
85C26H	18, Pl. 2A	Lower Witteville hvAb	1	1.3	35.9	54.1	8.7	3.3	13,606	7½	1985	Core	
			2	N/A	36.4	54.8	8.8	3.3	13,790				
			3	N/A	39.9	60.1	N/A		15,117				
85C27H	15, Pl. 2A	Lower Witteville hvAb	1	1.7	35.4	57.8	5.1	2.8	14,295	8	1985	Core	
			2	N/A	36.0	58.8	5.2	2.9	14,539				
			3	N/A	38.0	62.0	N/A		15,340				
86C7H	13, Pl. 2A	Lower Witteville hvAb	1	1.3	36.0	56.5	6.3	3.3	13,969	8½	1986	Core	
			2	N/A	36.5	57.2	6.4	3.3	14,149				
			3	N/A	39.9	61.1	N/A		15,111				
86C10H	31, Pl. 2A	Lower Witteville hvAb	1	1.7	21.9	29.0	47.4	2.6	7,280	4½	1986	Core	
			2	N/A	22.3	29.5	48.2	2.6	7,406				
			3	N/A	43.0	57.0			14,292				
85C12H	21, Pl. 1A	Mineral (Eram) hvCb	1	14.2	36.8	37.6	11.3	2.3	9,454	0	1985	Core	
			2	N/A	43.0	43.8	13.2	2.7	11,024				
			3	N/A	49.4	50.6	N/A		12,703				
85C23H (Upper 13 in. of split sample)	14, Pl. 2A	Peters Chapel hvAb	1	0.6	33.5	47.1	18.8	7.7	12,209	7	1985	Core	
			2	N/A	33.7	47.4	18.9	7.8	12,289				
			3	N/A	41.6	58.4	N/A		15,160				
85C24H (Lower 13 in. of split sample)	14, Pl. 2A	Peters Chapel hvAb	1	0.9	36.9	53.0	9.2	4.3	13,898	7½	1985	Core	
			2	N/A	37.2	53.5	9.3	4.4	14,018				
			3	N/A	41.0	59.0	N/A		15,456				

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

Sample number	Map number ^a (Pl. 1,2)	Coal bed and rank ^b	Sample condition ^c	Proximate Analyses (%)					Sulfur (%)	Btu/lb	Free swelling index	Year sampled	Type of sample site ^d
				Moisture	Volatile matter	Fixed carbon	Ash						
85C32H	11, Pl. 2A	Peters Chapel hvAb	1	2.9	34.6	52.0	10.5	5.0	13,312	7	1985	Core	
			2	N/A	35.6	53.5	10.9	5.2	13,711				
			3	N/A	40.0	60.0	N/A		15,382				
86C8H (Upper 11 in. of split sample)	10, Pl. 2A	Peters Chapel hvAb	1	0.9	29.9	44.6	24.6	11.2	10,988	6½	1986	Core	
			2	N/A	30.2	45.0	24.8	11.3	11,087				
			3	N/A	40.1	59.9	N/A		14,741				
86C9H (Lower 11 in. of split sample)	10, Pl. 2A	Peters Chapel hvAb	1	1.9	34.2	53.6	10.3	5.3	13,326	8½	1986	Core	
			2	N/A	34.8	54.7	10.5	5.4	13,580				
			3	N/A	39.0	61.0	N/A		15,172				
83C41H	26, Pl. 2A	Rowe —	1	3.2	33.6	57.5	5.7	1.4	13,984	8	1983	Cb	
			2	N/A	34.7	59.4	5.9	1.4	14,443				
			3	N/A	36.9	63.1	N/A		15,344				
86C2H	1, Pl. 2A	Rowe —	1	3.7	32.5	58.0	5.9	1.0	13,393	3	1986	SP	
			2	N/A	33.7	60.2	6.1	1.0	13,903				
			3	N/A	36.0	64.0	N/A		14,803				
82C26H (Upper 6 in. of split sample)	37, Pl. 1A	Secor hvAb	1	1.4	34.0	59.2	5.4	0.8	14,285	8	1982	AcSM	
			2	N/A	34.5	60.1	5.4	0.8	14,488				
			3	N/A	36.5	63.5	N/A		15,315				
82C27H (Lower 8 in. of split sample)	37, Pl. 1A	Secor hvAb	1	1.5	34.4	61.0	3.1	0.9	14,667	8½	1982	AcSM	
			2	N/A	35.0	61.8	3.2	0.9	14,890				
			3	N/A	36.2	63.8	N/A		15,382				
83C2H	6, Pl. 1A	Secor hvAb	1	1.4	34.4	57.2	7.0	1.5	13,967	7½	1983	AcSM	
			2	N/A	35.0	57.9	7.1	1.5	14,165				
			3	N/A	37.7	62.3	N/A		15,248				
83C3H	36, Pl. 1A	Secor hvAb	1	1.6	34.0	59.3	5.1	0.6	14,282	8	1983	AcSM	
			2	N/A	34.6	60.3	5.1	0.6	14,514				
			3	N/A	36.5	63.5	N/A		15,294				
83C6H	33, Pl. 1A	Secor —	1	3.0	25.8	44.4	26.8	0.6	9,955	½	1983	Cb	
			2	N/A	26.6	45.8	27.6	0.6	10,263				
			3	N/A	36.7	63.3	N/A		14,175				
83C7H (Upper 12 in. of split sample)	38, Pl. 1A	Secor —	1	9.8	29.8	55.3	5.1	1.4	11,234	0	1983	AbSM	
			2	N/A	33.1	61.2	5.7	1.5	12,454				
			3	N/A	35.1	64.9	N/A		13,207				
83C8H (Lower 12 in. of split sample)	38, Pl. 1A	Secor —	1	6.2	28.7	52.0	13.1	1.5	11,155	½	1983	AbSM	
			2	N/A	30.6	55.4	14.0	1.6	11,892				
			3	N/A	35.6	64.4	N/A		13,8281				
83C24H	13, Pl. 1A	Secor —	1	1.8	35.2	59.2	3.8	0.8	14,479	8½	1983	SpAcSM	
			2	N/A	35.9	60.3	3.8	0.8	14,746				
			3	N/A	37.3	62.7	N/A		15,333				
83C26H	24, Pl. 1A	Secor hvAb	1	1.5	34.6	61.0	2.9	0.7	14,745	8	1983	AcSM	
			2	N/A	35.2	61.8	3.0	0.7	14,967				
			3	N/A	36.3	63.7	N/A		15,426				
83C36H	23, Pl. 1A	Secor hvAb	1	1.0	33.6	59.5	5.9	0.6	14,210	8½	1983	AcSM	
			2	N/A	33.9	60.1	6.0	0.6	14,356				
			3	N/A	36.1	63.9	N/A		15,266				
83C38H	25, Pl. 1A	Secor hvAb	1	0.8	33.5	58.5	7.2	2.3	13,931	8½	1983	AcSM	
			2	N/A	33.8	59.0	7.2	2.3	14,048				
			3	N/A	36.4	63.6	N/A		15,184				
83C40H	11, Pl. 1A	Secor hvAb	1	1.2	35.8	61.0	2.0	0.6	14,800	8½	1983	AcSM	
			2	N/A	36.2	61.8	2.0	0.7	14,984				
			3	N/A	37.0	63.0	N/A		15,287				
83C42H (Upper 10 in. of split sample)	9, Pl. 1A	Secor hvBb	1	4.7	32.7	54.1	8.5	1.5	12,133	1½	1983	TP	
			2	N/A	34.4	56.7	8.9	1.6	12,735				
			3	N/A	37.7	62.3	N/A		13,978				

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

Sample number	Map number ^a (Pl. 1,2)	Coal bed and rank ^b	Sample condition ^c	Proximate Analyses (%)				Sulfur (%)	Btu/lb	Free swelling index	Year sampled	Type of sample site ^d
				Moisture	Volatile matter	Fixed carbon	Ash					
83C43H (Middle 10 in. of split sample)	9, Pl. 1A	Secor hvAb	1	6.6	30.5	49.6	13.3	1.5	11,968	1½	1983	TP
			2	N/A	32.7	53.1	14.2	1.6	12,814			
			3	N/A	38.1	61.9	N/A		14,938			
83C44H (Lower 10 in. of split sample)	9, Pl. 1A	Secor hvAb	1	8.5	29.7	47.9	13.9	1.8	12,146	5	1983	TP
			2	N/A	32.5	52.3	15.2	2.0	13,282			
			3	N/A	38.3	61.7	N/A		15,666			
85C22H	24, Pl. 1A	Secor hvAb	1	1.5	34.7	55.7	8.1	1.3	13,684	8	1984	Core
			2	N/A	35.2	56.6	8.2	1.3	13,898			
			3	N/A	38.4	61.6	N/A		15,144			
85C25H	14, Pl. 1A	Secor hvAb	1	2.6	32.1	58.5	6.7	0.8	13,862	8	1985	Core
			2	N/A	33.0	60.1	6.9	0.8	14,236			
			3	N/A	35.4	64.6	N/A		15,291			
85C29H	17, Pl. 1A	Secor hvAb	1	1.4	35.5	59.2	3.9	1.4	14,535	8	1985	Core
			2	N/A	36.0	60.0	4.0	1.4	14,735			
			3	N/A	37.5	62.5	N/A		15,347			
85C31H	12, Pl. 1A	Secor hvAb	1	1.5	33.5	57.2	7.8	0.6	13,912	8	1985	Core
			2	N/A	34.0	58.1	8.0	0.7	14,119			
			3	N/A	36.9	63.1	N/A		15,340			
86C3H (Upper 10 in. of split sample)	8, Pl. 1A	Secor hvAb	1	2.0	29.8	41.7	26.5	9.2	10,362	6½	1986	Core
			2	N/A	30.4	42.6	27.0	9.4	10,573			
			3	N/A	41.7	58.3	N/A		14,490			
86C4H (Middle 10 in. of split sample)	8, Pl. 1A	Secor hvAb	1	1.4	32.2	48.9	17.5	7.5	11,898	7	1986	Core
			2	N/A	32.6	49.6	17.8	7.6	12,064			
			3	N/A	39.7	60.3	N/A		14,671			
86C5H (Lower 10 in. of split sample)	8, Pl. 1A	Secor hvAb	1	1.5	31.8	48.8	17.9	6.8	11,863	8	1986	Core
			2	N/A	32.3	49.6	18.1	6.9	12,046			
			3	N/A	39.5	60.5	N/A		14,715			
86C6H	13, Pl. 1A	Secor hvAb	1	1.6	31.1	47.3	20.1	6.3	11,633	7	1986	Core
			2	N/A	31.6	48.0	20.4	6.4	11,823			
			3	N/A	39.7	60.3	N/A		14,852			
86C11H	26, Pl. 1A	Secor hvAb	1	1.3	33.3	51.8	13.6	4.9	12,763	8½	1986	Core
			2	N/A	33.7	52.5	13.8	5.0	12,934			
			3	N/A	39.1	60.9	N/A		15,006			
86C12H (Upper 9 in. of split sample)	29, Pl. 1A	Secor hvAb	1	1.3	33.0	52.5	13.3	6.5	12,907	7½	1986	Core
			2	N/A	33.4	53.2	13.4	6.6	13,078			
			3	N/A	38.6	61.4	N/A		15,107			
86C13H (Lower 9 in. of split sample)	29, Pl. 1A	Secor hvAb	1	1.0	31.7	51.9	15.3	6.6	12,467	8½	1986	Core
			2	N/A	32.1	52.5	15.5	6.7	12,594			
			3	N/A	37.9	62.1	N/A		14,903			
88C2H	29, Pl. 1A	Secor hvAb	1	2.4	33.9	60.4	3.4	0.5	14,569	8½	1988	AcSM
			2	N/A	34.7	61.8	3.4	0.5	14,922			
			3	N/A	36.0	64.0	N/A		15,452			
83C1H	6, Pl. 1A	Secor Rider hvAb	1	2.3	22.9	35.2	39.6	3.9	8,128	1	1983	AcSM
			2	N/A	23.5	36.0	40.5	4.0	8,319			
			3	N/A	39.5	60.5	N/A		13,982			
83C23H	13, Pl. 1A	Secor Rider —	1	17.7	30.7	48.1	3.5	0.7	9,988	0	1983	AcSM
			2	N/A	37.3	58.4	4.3	0.9	12,140			
			3	N/A	39.0	61.0	N/A		12,684			
83C25H	24, Pl. 1A	Secor Rider hvAb	1	1.0	30.8	45.4	22.8	12.5	11,187	6½	1983	AcSM
			2	N/A	31.1	45.9	23.0	12.6	11,307			
			3	N/A	40.4	59.6	N/A		14,693			
83C35H	23, Pl. 1A	Secor Rider hvAb	1	0.5	32.5	48.1	18.9	11.8	11,924	7	1983	AcSM
			2	N/A	32.7	48.3	19.0	11.9	11,985			
			3	N/A	40.3	59.7	N/A		14,803			

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

Sample number	Map number ^a (Pl. 1,2)	Coal bed and rank ^b	Sample condition ^c	Proximate Analyses (%)					Sulfur (%)	Btu/lb	Free swelling index	Year sampled	Type of sample site ^d
				Moisture	Volatile matter	Fixed carbon	Ash						
83C37H	25, Pl. 1A	Secor Rider hvAb	1	0.4	34.2	47.1	18.3	8.9	12,269	7	1983	AcSM	
			2	N/A	34.4	47.2	18.4	8.9	12,313				
			3	N/A	42.1	57.9	N/A	15,083					
83C39H	11, Pl. 1A	Secor Rider hvAb	1	0.9	34.7	47.5	16.9	9.1	12,328	7	1983	AcSM	
			2	N/A	35.1	47.9	17.0	9.2	12,441				
			3	N/A	42.2	57.8	N/A	14,997					
85C28H	17, Pl. 1A	Secor Rider hvAb	1	1.3	34.0	43.7	20.9	7.6	11,663	6½	1985	Core	
			2	N/A	34.5	44.3	21.2	7.7	11,819				
			3	N/A	43.7	56.3	N/A	15,002					
85C30H	12, Pl. 1A	Secor Rider hvAb	1	1.1	30.5	38.1	30.3	8.5	10,121	4	1985	Core	
			2	N/A	30.9	38.5	30.6	8.6	10,239				
			3	N/A	44.5	55.5	N/A	14,757					
88C1H	29, Pl. 1A	Secor Rider hvAb	1	3.1	31.9	46.2	18.8	8.2	11,595	7½	1988	AcSM	
			2	N/A	32.9	47.7	19.4	8.5	11,967				
			3	N/A	40.8	59.2	N/A	14,848					
82C33H	(No measured section: mine in NW¼NW¼ sec. 11, T. 12 N., R. 18 E.)	Stigler —	1	0.7	33.3	52.0	14.0	4.2	12,865	7	1982	SpAcSM	
			2	N/A	33.5	52.4	14.1	4.2	12,956				
			3	N/A	39.0	61.0	N/A	15,083					
82C34H	39, Pl. 2A	Stigler —	1	13.5	30.5	52.7	3.3	0.6	10,613	0	1982	RC	
			2	N/A	35.3	60.8	3.9	0.7	12,269				
			3	N/A	36.7	63.3	N/A	12,767					
83C4H (Upper 9 in. of split sample)	27, Pl. 2A	Stigler hvAb	1	0.9	33.6	57.9	7.6	4.1	14,149	8	1983	AcSM	
			2	N/A	33.9	58.4	7.7	4.1	14,278				
			3	N/A	36.7	63.3	N/A	15,469					
83C5H (Lower 9 in. of split sample)	27, Pl. 2A	Stigler hvAb	1	1.1	31.5	59.2	8.2	5.8	13,939	8½	1983	AcSM	
			2	N/A	31.8	60.0	8.2	5.9	14,094				
			3	N/A	34.6	65.4	N/A	15,353					
84C83H	28, Pl. 2A	Stigler hvAb	1	3.0	31.9	54.5	10.6	5.6	13,348	7½	1984	AcSM	
			2	N/A	32.9	56.2	10.9	5.7	13,762				
			3	N/A	36.9	63.1	N/A	15,456					
86C14H (Sample of upper 11.5 in. bench of 15.5 in. coal bed)	22, Pl. 1A	Wainwright hvAb	1	2.0	30.0	41.6	26.4	2.7	10,440	5½	1986	Core	
			2	N/A	30.6	42.5	27.0	2.8	10,652				
			3	N/A	42.0	58.0	N/A	14,583					
86C15H (Sample of lower 3.5 in. bench of 15.5 in. coal bed)	22, Pl. 1A	Wainwright hvAb	1	1.9	32.4	47.1	18.6	2.0	11,817	8	1986	Core	
			2	N/A	33.0	48.0	18.9	2.0	12,043				
			3	N/A	40.8	59.2	N/A	14,857					

^aData point number on map (sample site) corresponds to measured section number or core-hole number, Appendix 2, this report. For type of sample site, see right-hand column above.

^bhvAb, high-volatile A bituminous; hvBb, high-volatile B bituminous; hvCb, high-volatile C 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; RC, road cut; SP, shale pit; SpAcSM, stockpile - active strip mine; TP, Test Pit.

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

Coal	Face cleat	Butt cleat	Degrees of separation*	Location
Lower Witteville	N. 35° W.	N. 65° E.	100	SE¼SE¼NE¼SW¼ sec. 26, T12N, R18E
	N. 45° W.	N. 44° E.	89	SE¼SE¼NE¼SW¼ sec. 26, T12N, R18E
	N. 45° W.	N. 48° E.	93	SW¼NE¼SE¼SW¼ sec. 26, T12N, R18E
Peters Chapel	N. 48° W.	N. 52° E.	102	NE¼NW¼NW¼NE¼ sec. 26, T12N, R17E
Rowe	N. 35° W.	N. 54° E.	89	SW¼SW¼NW¼NW¼ sec. 25, T11N, R17E
Secor	N. 25° W.	N. 63° E.	88	SW¼NW¼SE¼NW¼ sec. 13, T11N, R16E
	N. 47° W.	N. 49° E.	96	SE¼SW¼SW¼SE¼ sec. 13, T11N, R16E
	N. 44° W.	N. 45° E.	89	SW¼SE¼NE¼SE¼ sec. 24, T11N, R16E
	N. 51° W.	N. 39° E.	90	SW¼SW¼NE¼NW¼ sec. 14, T11N, R17E
	N. 50° W.	N. 40° E.	90	NE¼NE¼NW¼NE¼ sec. 14, T11N, R17E
	N. 50° W.	N. 38° E.	88	NW¼SW¼SE¼SE¼ sec. 15, T11N, R17E
	N. 42° W.	N. 52° E.	94	SW¼SE¼NE¼SW¼ sec. 6, T11N, R18E
	N. 47° W.	N. 45° E.	92	NE¼SW¼SW¼NW¼ sec. 3, T12N, R17E
	N. 44° W.	N. 44° E.	88	SW¼SE¼NW¼SE¼ sec. 16, T12N, R17E
	N. 47° W.	N. 42° E.	89	NW¼NW¼NE¼NE¼ sec. 21, T12N, R17E
	N. 49° W.	N. 44° E.	93	NW¼NW¼NE¼NE¼ sec. 21, T12N, R17E
Secor Rider	N. 46° W.	N. 40° E.	86	SE¼SW¼SW¼SE¼ sec. 13, T11N, R16E
	N. 47° W.	N. 50° E.	97	SE¼SW¼NE¼SE¼ sec. 24, T11N, R16E
	N. 49° W.	N. 44° E.	93	SW¼SE¼NE¼SE¼ sec. 24, T11N, R16E
	N. 53° W.	N. 39° E.	92	SW¼SW¼NE¼NW¼ sec. 14, T11N, R17E
	N. 51° W.	N. 38° E.	89	NE¼NE¼NW¼NE¼ sec. 14, T11N, R17E
	N. 55° W.	N. 43° E.	98	NW¼SW¼SE¼SE¼ sec. 15, T11N, R17E
	N. 38° W.	N. 55° E.	93	SW¼SE¼NE¼SW¼ sec. 6, T11N, R18E
Stigler	N. 35° W.	N. 60° W.	95	NW¼NW¼NW¼SW¼ sec. 36, T11N, R17E
	N. 36° W.	N. 54° E.	90	SW¼SW¼NE¼SW¼ sec. 36, T11N, R17E
	N. 60° W.	N. 30° E.	90	SW¼SE¼NE¼SE¼ sec. 3, T12N, R18E

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