COAL RESOURCES OF THE KANSAS CITY GROUP, THAYER BED, IN EASTERN KANSAS

By
WALTER H. SCHOEWE

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FOREWORD

This report is another chapter in the general coal resources inventory being made by the State Geological Survey. Early in 1942 it became evident that the coal needs of the nation would be greatly increased due to the rapidly expanding war industries, and that the already overworked transportation facilities would be still further overloaded if it became necessary to move coal long distances to the shortage areas. In order to help relieve a possible coal shortage in Kansas, the State Geological Survey initiated a program of making a detailed inventory of the Kansas coal beds that might be mined. This inventory was designed to include not only those beds now being extensively mined but also those beds containing a sizable reserve of coal that is not now being utilized, such as the beds described in this report.

Work has been completed on the coal beds of the Douglas group of rocks, which includes the Blue Mound, "Ottawa," Lower Sibley, Upper Sibley, Lower Williamsburg, and Upper Williamsburg coal beds. The results were published in 1943 in Bulletin 46, "Coal resources of the Douglas group in east-central Kansas," by A. L. Bowsher and J. M. Jewett. G. E. Abernathy made an inventory of the mined areas in the Weir-Pittsburg bed in Crawford and Cherokee counties. A preliminary map was prepared in 1942, and the final report is now in press. Field work is now in progress on the coal resources of the Wabaunsee group of rocks, which includes the Nodaway, Elmo, and Nyman coal beds.

These reports give locations and thicknesses of the beds and heating qualities of the coals studied. They include registers of both active and inactive mines. Such inventories not only have value during the emergencies of war, but also after the war they will furnish a basis for special studies on the utilization of Kansas coal and will serve as a guide to new mining operations.

Two earlier reports on Kansas coal resources have been published by the State Geological Survey. These are Bulletin 24, "Geology and coal resources of the southeastern Kansas coal field," by W. G. Pierce and W. H. Courtier, and Bulletin 32, "Coal resources of Kansas; post-Cherokee deposits," by R. E. Whitla, a general report on the post-Cherokee coal deposits of the state.

JOHN C. FRYE.

COAL RESOURCES OF THE KANSAS CITY GROUP, THAYER BED, IN EASTERN KANSAS

By Walter H. Schoewe

ABSTRACT

The Thayer coal bed of the Chanute formation, Kansas City group, crops out in eastern Kansas, and extends from Kansas City southward to the state line in Montgomery county. Mining activities of the Thayer bed have been centered at Blue Mound, Linn county; in the vicinity of Thayer, Neosho and Wilson counties; and in Montgomery county. It has been estimated that 753,488 tons of coal have been mined from this bed since 1870. The total reserves of Thayer coal are estimated at about 37,000,000 tons underlying an area of 29,000 acres in Wilson, Neosho, Montgomery, and Linn counties. Field investigations indicate that a large percentage of this coal can be mined by stripping methods.

The Chanute shale, the physical and chemical characteristics of the coal, and the mining methods generally used are described in this paper. Analyses of the Thayer coal are similar to analyses of other Kansas coals of commercial grade and indicate that this coal can be used for all general purposes. Included in the report is a list of outcrops of Thayer coal, locations of mines, production statistics, estimates of reserves, and a bibliography of Kansas coal. The trace of the coal outcrop and the location of mines and mining districts are shown on maps.

INTRODUCTION

Purpose of the investigation.—Coal ranks fourth in dollar value among the mineral products of Kansas and is exceeded only by petroleum, natural gas, and zinc. During the past decade Kansas has produced more than 3,000,000 tons of coal annually. At least 249,577,152 tons of coal, valued at $476,618,037, have been mined in Kansas since 1869. Mineral resources are generally classified as one of two types: (1) expendible resources and (2) recoverable resources. Expendible resources include coal and the other mineral fuels; when they are extracted and used they are nonrenewable. Recoverable resources are those which may be used again.

The normal demand for coal has been augmented by the war. The increased demand for the fuel minerals, together with decreased transportation facilities, labor shortages, and diversion of petroleum from civilian to war needs, has threatened a fuel short-

age in some areas. To help forestall a possible fuel shortage in Kansas and to afford a basis for future mining activities, the State Geological Survey has undertaken a detailed study of the occurrence, distribution, and total commercial reserves of Kansas coal deposits. This report, the second of a series, describes the coal resources of the Thayer bed in the Kansas City group. Bulletin 46 describes the coal resources of the Douglas group in east-central Kansas.

Previous work.—The earliest reference to the Thayer coal is by Haworth (1895, p. 276; 1895a, pp. 299, 302, 303, 305) who briefly described the coal, its stratigraphic occurrence, and its geographic distribution. General references appear in Haworth and Crane's "Special Report on Coal" (1898, pp. 49, 50, 59, 117, 133, 138, 141), published by the University Geological Survey of Kansas. A general description of the Thayer coal is given by Schrader and Haworth (1906, pp.48-51) and by Whitla (1940, pp. 11, 18, 19, 46, 47, 51, 52, 53, 61, 62). Schrader and Haworth (1906, pp. 48-51) and Schrader (1908, p. 6) describe the Thayer coal in the "Wilson" formation. The location of coal outcrops are shown on the geologic maps which accompany these reports. The occurrence of Thayer coal 2 miles east of Humboldt is mentioned by Adams, Haworth, and Crane (1904, p. 74); the stratigraphic position of the coal and its geographic distribution are mentioned in several other reports, notably Young and Allen (1925, pp. 15, 16), Moore and Landes (1927, p. 48), Newell and Jewett (1935, pp. 49, 174), Moore (1936, pp. 110, 111), Landes (1937, pp. 67, 69), and Jewett and Schoewe (1942, pp. 84-86).

Field and laboratory investigations.—Field work that forms a basis for this report was carried on from September 20 to November 5, 1943. The Thayer coal bed was mapped from near Kansas City to near the state line in Montgomery county. The thickness, physical character, stratigraphic position within the Chanute shale, character of contact rocks, and nature and thickness of overburden were studied in the field. Samples of the coal were collected from outcrops and mines. Data concerning production, mines, and mining methods were obtained from old settlers and miners living in the mining districts. Samples were analyzed by August Fleming in the laboratory of the State Geological Survey.

Acknowledgments.—In the course of the field work, many residents of the area supplied information concerning the locations

of mines in the Thayer coal and former mining operations. I wish to express my appreciation to all of these individuals who so graciously cooperated and rendered invaluable assistance. The Thayer coal investigation was carried out under the direct supervision of John C. Frye, Assistant State Geologist in charge of the Geological Survey. Special thanks are due him and John M. Jewett, of the Survey staff, for their helpful suggestions. The use of unpublished field notes and stratigraphic sections measured by John M. Jewett and Norman D. Newell is also gratefully acknowledged.

STRATIGRAPHY OF THE CHANUTE SHALE FORMATION

The Thayer coal occurs in the Chanute shale formation of the Kansas City group, Missourian series, Pennsylvanian subsystem. The Chanute formation (Moore, 1936, pp. 107-111) includes all strata above the Drum and below the Iola limestones and its outcrop extends southwestward as a narrow band from Kansas City in Wyandotte county across eastern Kansas to the Oklahoma state line in Montgomery county (fig. 1). The Thayer coal divides the Chanute shale into two parts. The Cottage Grove sandstone member, above, is predominantly tan to buff sandstone or arenaceous shale, whereas the lower member is mainly a gray and green argillaceous shale which in the southern counties contains much arenaceous shale and sandstone. The Chanute shale ranges in thickness from 6 feet near Kansas City to 160 feet in southern Montgomery county. The only fossils known from the formation are various types of plants associated with small pectanoid pelecypods found close to the coal and a few gastropods belonging to the species *Worthenia tabulata* found by Newell in a 1-foot bed of gray arenaceous shale overlying the Thayer coal south of the cen. sec. 32, T. 16 S., R. 23 E. (loc. 8). Among the plant fossils are fern leaves and calamites. The largest calamite seen measures approximately 34 by 28 by 8 inches and occurs at the head of a draw in the NE¼ sec. 9, T. 28 S., R. 18 E., Neosho county (loc. 97).

Lower unnamed member.—In the northern part of the area (Wyandotte, Johnson, and Miami counties) the upper member of the Chanute shale formation is seemingly absent. Here the formation consists essentially of gray argillaceous shale, olivine green in the lower few feet. A maroon argillaceous shale that ranges from 1 to 5 feet in thickness occurs locally near the base of the

member. A maximum thickness of 15 feet of maroon shale was observed in a road cut in the SE¼ sec. 4, T. 14 S., R. 25 E., Johnson county (loc. 2), but this zone was not found in the southern part of the state. A zone, 1 to 2 feet thick, called "marlite" by Newell (Newell and Jewett, 1935, p. 50) and described by him as "thin layers of yellowish-brown or greenish, nodular, and 'spongy' rock that ranges from a ferruginous, argillaceous limestone to a calcareous shale," occurs in the lower member immediately above the maroon shale wherever this shale is present. At other places, especially in the southern counties, the "marlite" is replaced by a zone of hard dense calcareous concretions, many of which are of the septarian type. Locally the lower shale member is arenaceous and contains sandstone beds in Neosho and Montgomery counties. The thickness of the lower shale member varies greatly not only in any one county but also from Wyandotte county in the north to Montgomery county in the south (table 1). It is possible that the lower shale member is entirely absent in secs. 1 and 23, T. 35 S., R. 15 E., Montgomery county, and in secs. 23 and 25, T. 27 S., R. 18 E., Neosho county. At these localities the entire formation is essentially sandstone and sandy shale, and no coal occurs. The formation is capped by the Iola limestone and rests directly on parts of the Cherryvale shale and the Dennis limestone.

TABLE 1.—*Range in thickness of the Chanute shale formation by members in eastern Kansas (in feet)*

County	Lower member	Thayer coal	Cottage Grove	Total
Wyandotte	6 —15	Streak	0	6 — 15
Johnson	19 —27	Streak—0.1	0 — 15	19 — 34
Miami	11.3 —18.2	Streak—0.7	0 — 30	9 — 38.2
Linn	5.4 —26.5 +	0.2—1.0	5 — 27	15.5 — 40.2
Allen	6.5 —12	0.3—0.5	7 — 18	18.5 — 19
Neosho	0 —26	0.2—1.8	6 — 65	11.5 — 65
Wilson	11.4 —32	0.5—1.8	1.5 — 70+	19.4 — 70
Montgomery	0 —88+	0.3—2.4	30 —160	74 —160

Upper or Cottage Grove sandstone member.—South of Miami county, the Chanute formation is almost everywhere divisible into

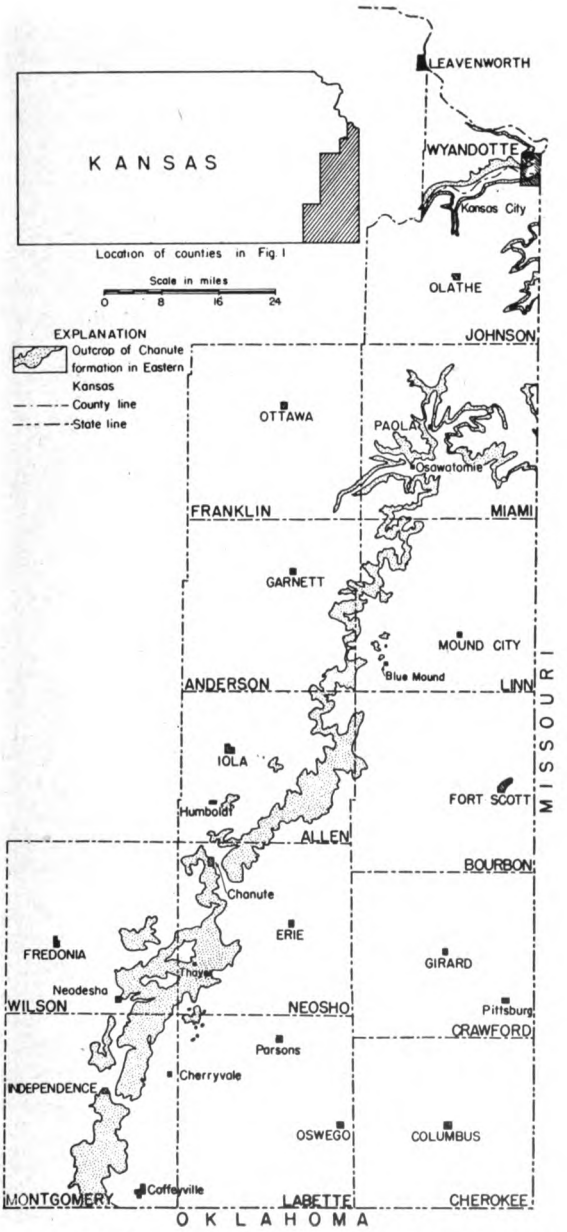


Fig. 1. Map of eastern Kansas showing outcrop area of the Chanute shale formation.

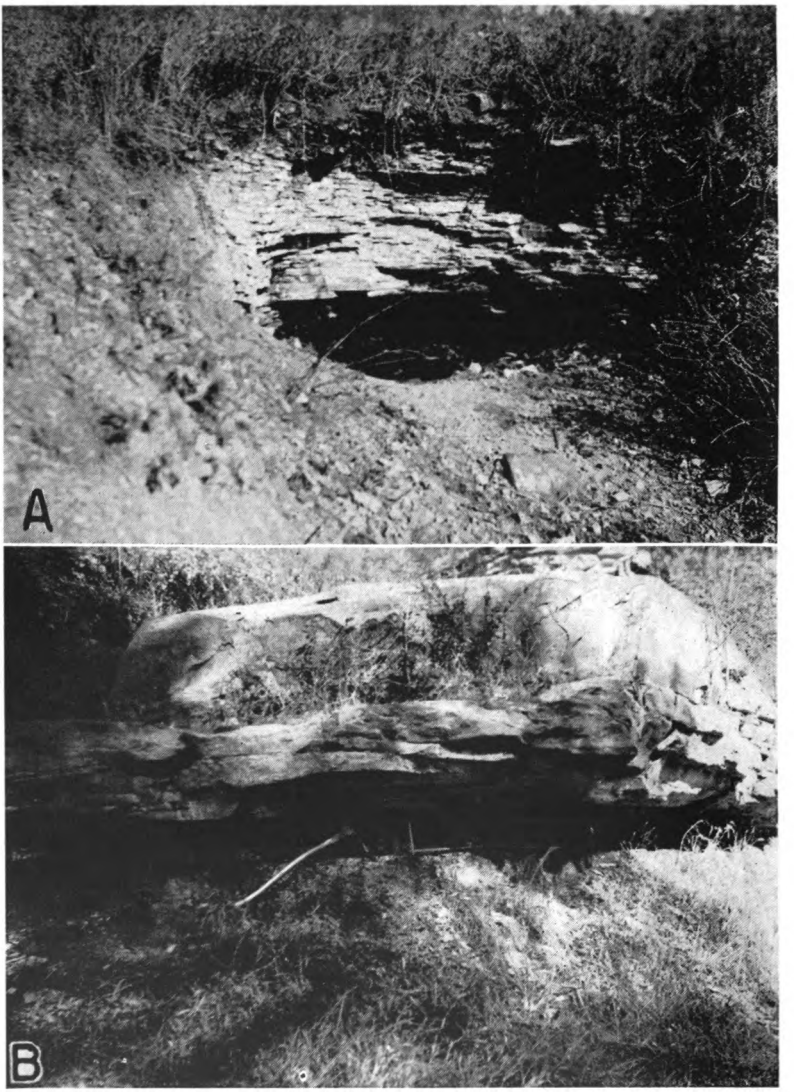


PLATE 1. *A*, Thin-bedded character of the Cottage Grove sandstone and mine entry, SE¼ sec. 30, T. 33 S., R. 16 E. *B*, Massive-bedded character of the Cottage Grove sandstone underlying Thayer coal 12 inches thick, City park zoo, Independence, Kansas.

two members. The upper member, named the Cottage Grove sandstone by Newell (Moore, 1936, p. 111) from Cottage Grove township in the southern part of Allen county, consists essentially of yellowish-brown, buff, tan, and reddish sandstone and sandy shales which increase in thickness from north to south. The member increases in thickness from 15 feet in southern Johnson county to 160 feet in southern Montgomery county (table 1). The sandstone is platy, thin, and even-bedded at many places (pl. 1A), but it is characterized by massive beds in Wilson and Montgomery counties (pl. 1B). Ripple marks and cross bedding are common features of the sandstones. Shale is more common in the Cottage Grove sandstone member from Linn county northward than in the counties to the south, although shale occurs in this sandstone at several localities south of Linn county, notably south of Independence in sec. 6, T. 33 S., R. 16 E., Montgomery county (loc. 254), where 18 feet of gray argillaceous laminated shale overlies the Thayer coal. The sandstone and sandy shales are generally soft and friable. The heavy or more massively bedded sandstone in Wilson and Montgomery counties is somewhat more firmly cemented than the thin-bedded sandstone.

Locally from one to three thin coal beds, usually less than 3 inches in thickness, occur within the Cottage Grove sandstone. At places, however, as in the SE¼ sec. 29, T. 23 S., R. 21 E., Allen county (loc. 80), the coal ranges from 3 to 5 inches in thickness. At locality 163 (NW cor. SW¼ sec. 36, T. 29 S., R. 16 E., Wilson county) the coal in the Cottage Grove member ranges from 7 to 9 inches in thickness; in sec. 29, T. 29 S., R. 17 E., it is 9.5 inches thick and 32 feet above the Thayer coal. It is also 9.5 inches thick and 31.5 feet above the Thayer coal in the cen. SE¼ sec. 29, T. 29 S., R. 17 E., Neosho county. At least three coal seams occur in the Cottage Grove sandstone about 40 feet above the Thayer coal in secs. 28 and 33, T. 29 S., R. 17 E., Wilson county. According to Whitla (1940, pp. 19, 53, 62), one of the coal beds in the Cottage Grove is 10 to 17 inches thick and has been mined in secs. 29 and 32, T. 29 S., R. 17 E.

Thayer coal.—The Thayer coal, described in detail later in this report, separates the Chanute formation into the two members described above. It varies in thickness and stratigraphic position within the formation.

TOPOGRAPHY OF THE CHANUTE SHALE FORMATION AREA

The area underlain by Chanute shale is generally flat because the formation consists of easily eroded shale, sandy shale, and soft sandstone. Along the major stream valleys, tributary stream erosion has produced a mature topography; and locally the Cottage Grove sandstone forms picturesque cliffs along the river bluffs (pl. 3C).

THE THAYER COAL

Geographic distribution.—The Thayer coal has been traced almost continuously along the strike of the Chanute formation from Wyandotte county to the Kansas-Oklahoma state line in Montgomery county (fig. 1). In Miami county from the NE cor. T. 17 S., R. 23 E. to the SW cor. T. 19 S., R. 22 E., Newell (Newell and Jewett, 1935, pp. 49, 50) reports that the Chanute formation is less than 15 feet thick and that the coal is absent. Because the coal is thin and readily becomes concealed in the road ditches by weathered debris, it is not always visible at the surface. The Thayer coal has been observed by me or is known to occur at many places, all of which are listed by counties in tables 11 to 16 at the end of this report, and shown on figures 2 to 7.

Stratigraphic position of the coal within the Chanute formation.—In Neosho, Wilson, and Montgomery counties, where the Chanute formation is thickest, opportunities to measure stratigraphic sections and to determine the position of the Thayer coal within the formation are less numerous than in Wyandotte, Johnson, Linn, and Miami counties. This is due chiefly to the fact that wherever the formation is thick, erosion in the low-dipping nonresistant shales and sandstones has developed a more or less flat topography in which the overlying Iola and underlying Drum limestones are separated by distances commonly measurable in miles. The available field data and unpublished stratigraphic sections measured by Newell and Jewett indicate that the stratigraphic position of the Thayer coal is not everywhere the same within the Chanute formation. Where the formation is less than 17 feet thick, the coal is close to the top. Elsewhere, it lies generally nearer the base, although at some places the coal is in the upper part of the formation and at other localities it is approximately in the middle (table 2). According to numerous measurements

made where only the coal and one of the bounding limestones are present, the interval between the Thayer coal and the Iola limestone ranges from 2.5 inches to 65 feet, whereas the interval between the coal and the base of the formation is 1.5 to 88 feet.

TABLE 2.—*Stratigraphic position of the Thayer coal in the Chanute shale formation*

County	Outcrop No.	Location	Thickness of Chanute formation (feet)	Position of the coal		
				Feet below Iola limestone	Feet above Drum limestone	Relative
Wyandotte	1	12-11-24 E	12	Directly	12—	Upper
Johnson	3	10-14-25 E	31.7	4.7	27	do
Miami	10	9-17-23 E	15.7	Directly	15.5	do
do	17	24-18-24 E	16.3	4	12	do
Linn	32	35-19-22 E	17.3	5	12	do
Wilson	188	29-29-17 E	30.8	5	24	do
Johnson	2	4-14-25 E	34	15	19	Middle
Miami	5	33-16-23 E	33.4	15.2	18.2	do
do	8	32-16-23 E	36.2	20	16	do
Linn	35	16-20-22 E	29.5	16	13	do
Miami	11	24-17-23 E	33.8	23.5	14	Lower
do	13	31-17-24 E	38.2	25	13	do
do	19	2-18-23 E	33	21.2	11.5	do
do	22	25-18-22 E	31.6	20	11.3	do
do	25	15-19-22 E	36.5	25	11	do
Linn	26	21-19-22 E	32.5	22	10	do
do	29	27-19-22 E	40.6	24.4	16	do
do	31	21-19-22 E	30+	17.5	12	do
do	33	32-19-22 E	28	17	10.5	do
do	37	16-20-22 E	34+	20	14	do
do	40	20-20-22 E	34	21.3	12.5	do
do	42	31-20-22 E	30+	19	10.5	do
do	43	7-21-22 E	34	25.6	8	do
do	44	17-22-21 E	37.5	25	12	do
Linn	46	25-21-21 E	23	15	8	Lower
Allen	81	1-24-20 E	20.3	13.5	6.5	do
Montgomery	252	30-32-16 E	78.7	35	42.7	do

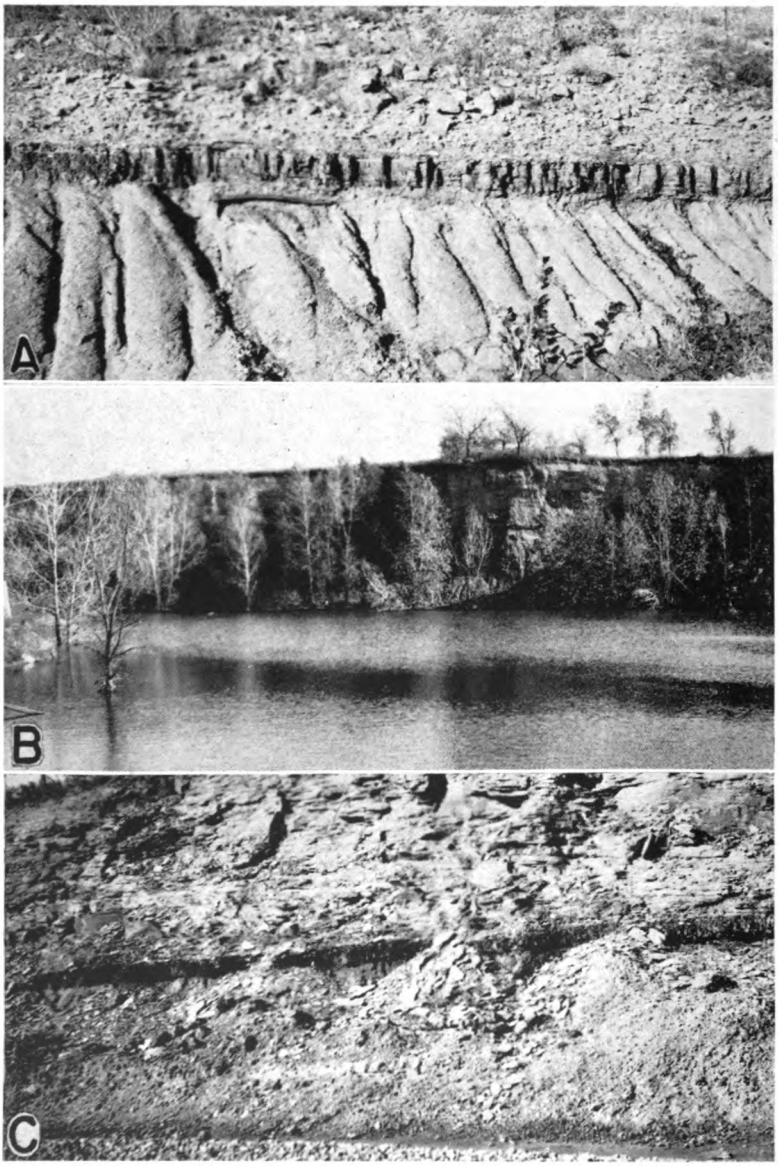


PLATE 2. *A*, Thayer coal, 11 inches thick, outcrop no. 223, SE¼ sec. 23, T. 31 S., R. 16 E., 4.75 miles east of Sycamore, Montgomery county, Kansas. Overburden 15 feet. *B*, Outcrop of the Thayer coal, 29 inches thick, at the abandoned brick-plant quarry south of Independence, outcrop no. 254, Cen. E½ sec. 6, T. 33 S., R. 16 E., Montgomery county, Kansas. *C*, Thayer coal, 9 inches thick, outcrop no. 222, 0.2 mile west of the SE cor. sec. 24, T. 31 S., R. 16 E., Montgomery county, Kansas. Overburden 12 feet.

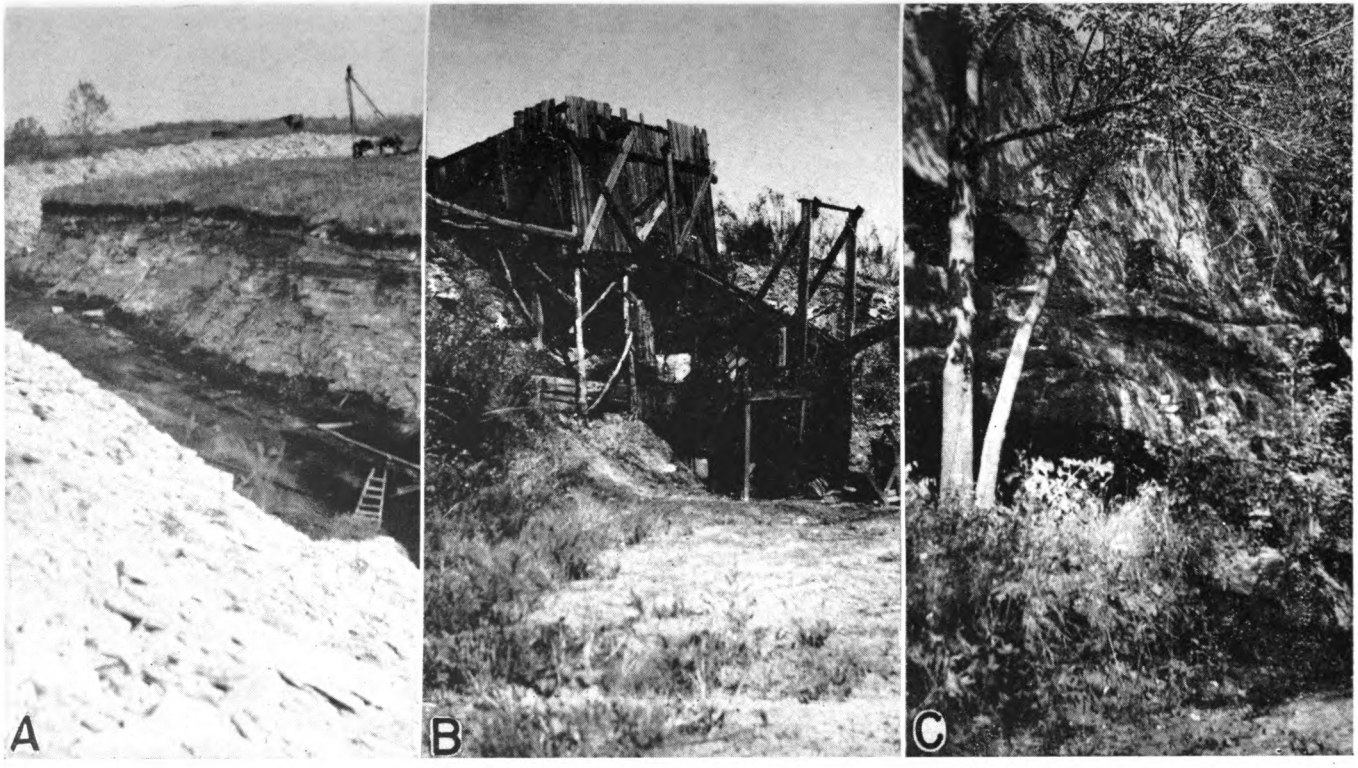


PLATE 3. *A*, Trench in the Dunbar strip coal mine, outcrop no. 202, SW cor. sec. 21, T. 29 S., R. 17 E., Wilson county, Kansas. Coal, 24 inches thick, lower dark band; basal limestone of the Iola formation upper dark band. *B*, Coal tipple at north end of the Dunbar strip coal mine. *C*, Massive bluffs of the Cottage Grove sandstone, NE¼ sec. 16, T. 33 S., R. 16 E., Montgomery county, Kansas.

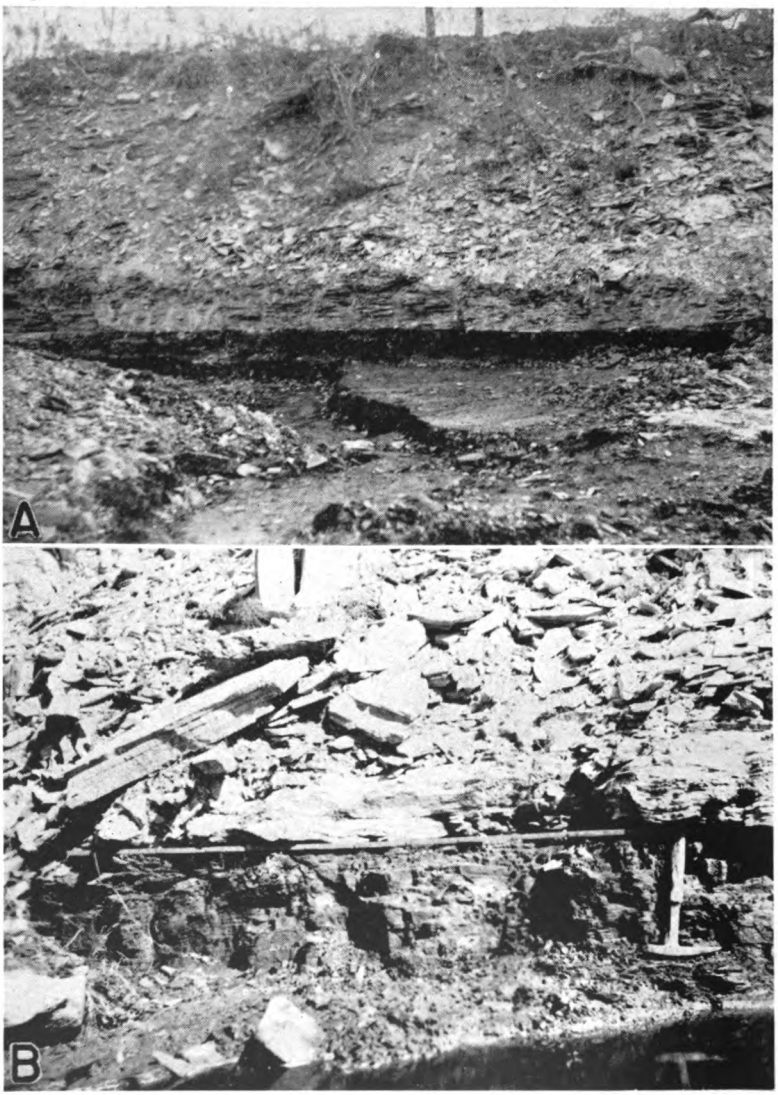


PLATE 4. *A*, Thayer coal exposed after stripping, Dunbar strip coal mine, SW cor. sec. 21, T. 29 S., R. 17 E., Wilson county. *B*, Thayer coal, 24 inches thick, exposed by stripping; overburden 11 feet; Dunbar strip coal mine.

Thickness.—The Thayer coal ranges in thickness from a thin streak to 29 inches. It is thin in Wyandotte and Johnson counties and increases in thickness southward (table 3). The maximum thickness, 29 inches, was measured in Montgomery county at the abandoned brick-plant quarry south of Independence (cen. sec. 6, T. 33 S., R. 16 E.; loc. 254; pl. 2B).

The coal does not always occur as a single bed. This is especially true where the coal is thickest. The shale parting that separates the coal is generally dark clay or black fissile shale. This is commonly 2 to 3 inches thick, but it attains a thickness of 5, 6, or 7 inches at some localities. At outcrop 163 in a creek bank (NW cor. SW¼ sec. 36, T. 29 S., R. 17 E., Wilson county) it is 4 feet thick. At outcrops 97 in Neosho county, 153, 156, and 172 in Wilson county, and 254, 270, 277, and 289 in Montgomery county, the Thayer coal is made up of three beds. At outcrops 280 and 282 in Montgomery county the coal consists of four beds. There is no uniformity in the thicknesses of the individual coal beds where the Thayer is split by shale partings. The relationship of the number of coal beds, their thicknesses and relative positions, intervening shale partings, outcrops, and locality numbers are graphically presented in figure 8.

Contact rock.—The Thayer coal is always overlain by sandstone or shale, generally even-bedded soft sandstone, argillaceous sandstone, or arenaceous shale of the Cottage Grove sandstone member of the Chanute formation (pl. 1A). Locally, massive friable

TABLE 3.—*Summary of thicknesses of the Thayer coal*

County	Thickness range (inches)	Average thickness (inches)
Wyandotte	Streak	Streak
Johnson	Streak— 1	0.5
Miami	Streak— 8.5	2.5
Linn	2.5—12	6.5
Anderson	1 — 3	2
Allen	3.5— 6	5
Neosho	2.5—20.5	8.1
Wilson	6 —20.5	10.9
Montgomery	3.5—29	10.1

soft sandstone occurs above the coal, as at locality 237 in the city park at Independence (pl. 1B). South of Independence at the abandoned brick-plant quarry, approximately in the cen. sec. 6, T. 33 S., R. 16 E. (loc. 254), the Thayer coal is overlain by laminated and argillaceous shale.

In most places the lower contact rock is gray to dark-gray argillaceous shale, although arenaceous shale is not uncommon. At outcrop 171 in the NE¼ sec. 6, T. 30 S., R. 17 E., Wilson county, the lower contact shale is black and fissile. Although underclay has been reported to occur beneath the Thayer coal (Whitla, 1940, pp. 19, 51, 52, and 62), no typical underclay or "seat earth" was observed by me in the field. The contact shale exhibits distinct bedding and characteristics common to normal shales.

Physical and chemical characteristics.—The Thayer coal is classified as a bituminous coal. As noted under "Thickness," one to three clay or shale partings separate the coal into two, three, or four distinct beds. Each separate coal bed, however, is commonly free from shale or silt. Where the shale parting is less than 1 inch thick, it is black and fissile and almost indistinguishable from the coal. The coal is bright, shiny, black, brittle, and moderately hard where it has been protected from weathering. The weathered coal displays a checkered or blocky appearance, is dull black to gray, and locally sooty in appearance. Even the weathered coal, however, tends to maintain its solidity, as crumbled fragments are nearly absent around the outcrops. Pyritized sandy woody material and pyrite concretions occur at some outcrops in the clay partings and immediately beneath the lowermost coal bed, but pyrite concretions have not been observed in the coal.

Samples of Thayer coal were collected at 13 localities. Sample number 8 is from the Dunbar strip mine, locality 202 (pls. 3A and 4; fig. 6) in the SW¼ sec. 21, T. 29 S., R. 17 E., Wilson county; sample number 4 is from a drift mine near Thayer, locality 113 (fig. 6) in the NW¼ sec. 31, T. 29 S., R. 18 E. All other samples were collected from natural exposures. All samples are channel samples. It was impractical to collect samples from most of the abandoned mines, and at many places the coal is too thin to encourage the collection of samples from outcrops. Care was exercised not to get weathered material in the samples, but the necessity of sampling from outcrops prevented the complete elimination of all weathering effects in the samples collected. The analyses

given in table 4 were made in the laboratories of the State Geological Survey of Kansas, by August Fleming, about a month after the samples had been collected. A comparison of the proximate analyses of the Thayer coal with those of other Kansas coals of commercial grade (table 5; Bowsher and Jewett, 1943, p. 57; Pierce and Courtier, 1937, p. 81; U.S. Bureau of Mines, 1929, pp. 32-37) shows that the quality of the Thayer coal is as high as the average of the coal now being mined in Kansas and that the Thayer coal is suitable for all purposes for which our present commercial coals are being used.

MINING METHODS AND PRACTICES

Mining Methods

The types of mines and mining methods employed in the Thayer coal-mining districts of Linn, Montgomery, Neosho, and Wilson counties are the same as those of east-central Kansas (fig. 1). The reader interested in details of mining methods is referred to the extensive discussion on pages 17 to 26 in the report by Bowsher and Jewett on "Coal Resources of the Douglas Group in East-Central Kansas" published in 1943 by the State Geological Survey of Kansas as Bulletin 46. The Thayer coal is thin, and mining operations are small scale.

Drift and slope mines.—With few exceptions, all of the Thayer coal mines are drift or slope mines. These mines are tunnels dug in the coal bed at right angles to the line of outcrop or slope of the coal bank. Drift mines and slope mines are essentially the same, differing only in that the drift mine tunnel is driven into the hillside or stream bank horizontally whereas the slope mine tunnel is inclined. In all of the drift and slope mines seen by me, the tunnel mouth or entry is just large enough for a person to enter the mine either "on all fours" or in a crouched position (pl. 1A). As most of the mines are operated by one person, the entry is seldom more than 30 to 48 inches wide, although some openings 6 to 7 feet wide were observed. The coal is extracted by the miner in a recumbent position. Most of the mines are now abandoned and are full of water; entries are clogged with rocky debris and the roofs are more or less caved in.

Outcrop mines.—Outcrop mines are those in which the coal is dug directly from the face of the outcrop without driving a tunnel into the stream bank or hillside. Such mines—if they properly

TABLE 4.—*Proximate analyses of the Thayer coal*
(Analyses by August Fleming in the State Geological Survey laboratories).

Outcrop No	County	Location		Moisture (percent)	Volatile matter (percent)	Fixed carbon (percent)	Ash (percent)	Sulphur (percent)	B.T.U. per pound		
									As received	Moisture free	Moisture and ash free
22	Miami	0.25 mi. N. of SW cor.	25-18-22 E	5.21	36.95	47.03	10.81	5.15	12,810	13,514	15,152
26	Linn	NE cor.	22-19-22 E	5.20	36.36	34.90	23.54	1.32	10,828	11,422	14,939
63	do	SE cor. of cemetery, NE cor. NW	32-22-22 E	2.40	35.49	52.49	9.62	0.69	13,325	13,653	15,102
113	Neosho	SW NW	31-29-18 E	10.32	36.32	46.65	6.71	0.74	11,817	13,177	14,125
121	do	SE cor. NE	1-30-17 E	2.67	32.01	59.87	5.45	1.54	14,003	14,387	15,216
123	do	NW	12-30-17 E	4.83	31.68	52.96	10.53	0.62	12,814	13,464	15,048
163	Wilson	NW cor. SW	36-29-16 E	3.78	35.80	52.30	8.12	1.34	13,479	14,009	15,316
202	do	SW	21-29-17 E	2.15	29.19	49.89	18.77	2.70	12,099	12,365	15,222
221	Montgom'y	0.6 mi. E. of SW cor.	18-31-17 E	13.15	38.98	35.97	11.90	0.38	10,018	11,535	13,093
223	do	0.2 mi. W. of SE cor.	23-31-16 E	7.25	31.13	51.40	10.22	0.78	12,073	13,017	14,629
232	do	0.4 mi. N. and 100 yds. E. of SW cor.	30-31-16 E	1.82	35.96	48.16	14.06	0.85	13,397	13,587	15,810
252	do	Independence water works plant	19-32-16 E	9.70	30.50	47.67	12.13	0.71	10,286	11,391	12,933
289	do	0.5 mi. E. and 0.15 mi. N. of SW cor.	22-34-15 E	3.50	34.52	54.31	7.67	6.00	14,062	14,572	15,783

TABLE 5.—*Average proximate analyses of Kansas coals*

County	Number of analyses	Name of coal	Moisture (percent)	Volatile matter (percent)	Fixed carbon (percent)	Ash (percent)	Sulphur (percent)	B.T.U. per pound		
								As received	Moisture free	Moisture and ash free
Crawford	3	Fort Scott[1]	2.80	40.3	47.4	9.3	3.9	13,286	13,670	15,130
Crawford and Labette	6	Bevier[1]	3.80	37.8	48.6	9.8	2.6	13,026	13,545	15,077
Cherokee	1	Fleming[1]	2.80	39.3	47.3	10.6	2.3	13,090	13,470	15,120
Cherokee and Crawford	9	Mineral[1]	4.30	34.3	48.7	12.6	3.8	12,488	13,048	15,029
Barton (Mo.), Crawford, and Cherokee	21	Weir-Pittsburg[1]	6.10	33.3	50.7	9.9	3.7	12,622	13,367	15,007
Cherokee	3	"Local"[1]	5.0	30.7	48.1	16.1	6.8	11,576	12,193	14,693
Cherokee	6	Weir-Pittsburg[2]	5.05	33.98	52.33	8.63	3.8	13,045	13,738	
Crawford		do	5.95	33.0	51.1	8.3	4.2	12,590	13,385	14,965
Leavenworth	12	Bevier[2]	11.85	35.35	39.9	12.9	4.1	11,145	12,335	14,433
Linn	11	Mulberry[2]	9.26	31.66	45.44	13.43	2.94	11,386	12,552	14,733

[1] From Pierce and Courtier (1937, p. 81).

[2] Averages computed from U.S. Bureau of Mines analyses (1929, table 7).

may be called mines—are commonly in the beds of creeks or along their banks and extend parallel to the line of outcrop. Outcrop mines are few, of local extent, and yield only a small amount of coal.

Strip mines.—The only important commercial coal mine operated in the Thayer coal during the fall of 1943 was the Dunbar strip mine (loc. 202) in the SE¼ sec. 21, T. 29 S., R. 17 E., Wilson county (pl. 4A). The overburden consists of 9 to 12 feet of soft thin-bedded sandstone capped by one or two thin beds of limestone and some argillaceous shale and is removed by a small steam shovel having a capacity of 1.5 yards. The steam shovel was located in a pit or trench (pl. 3A), 50 feet wide, that extended in a general north-south direction parallel to the line of outcrop. In the northern part of the mined area some of the trenches trend east and west and others north and south. After the removal of the overburden (pl. 4A), the coal is pried loose and loaded into trucks by hand. A large amount of coal has been taken from this mine and much more is available.

A small amount of coal was mined by the stripping method at two places of limited extent in Montgomery county. At both places the overburden was no more than 3 or 4 feet thick and was removed by means of a team and scraper from areas 200 to 300 feet in diameter.

Shaft mines.—Four small shaft mines that have produced Thayer coal were visited. These shafts were located 300 feet or less from the coal outcrop. Two are located in the Blue Mound mining district of Linn county, one in Montgomery county, and one in Wilson county (table 6).

Three of the shaft mines are well-like openings on the surface surrounded by dump piles of sandstone, shale, and coal. In each case the bottom of the shaft was concealed from view by water. One mine, located in the Blue Mound mining district of Linn county, in the NE cor. SW¼ sec. 29, T. 22 S., R. 22 E. (loc. 59), has a shaft 8 to 9 feet deep covered by a small building containing the haulageway which is 3 feet wide and 2.5 feet high. An old automobile engine was used for operating the hoist.

Mining Practices

With few exceptions, Thayer coal mining has been of a noncommercial nature. Most of the mines were designed to be operated by one or two men, and the coal has generally been used as a

TABLE 6.—*Locations and dimensions of shaft mines*

Locality No.	County	Mining district	Location	Shaft dimension (feet) Width	Depth
55	Linn	Blue Mound	SW cor. NE¼ 29-22-22 E	3+	18
59	do	do	NE cor. SW¼ 29-22-22 E	3+	8
239	Montgomery	Chouteau-Irish Cr.	Cen. NW¼ 36-31-16 E	6	15-20
184	Wilson	Chetopa Creek	SW cor 29-29-17 E	6 × 15	10-

winter fuel supply for the miner and his family. Local citizens report that during the early period of mining the landowner was paid a royalty of 1 to 1.5 cents for each 80-pound bushel of coal that was mined. In recent years, however, the standard practice (Glennon, 1937, p. 10) has been to pay the landowner 75 cents to 1 dollar per week for the privilege of mining coal on his property regardless of the amount of coal mined and the purpose for which it is to be used by the miner. Mining of Thayer coal has been almost entirely a secondary occupation carried on only during the winter months.

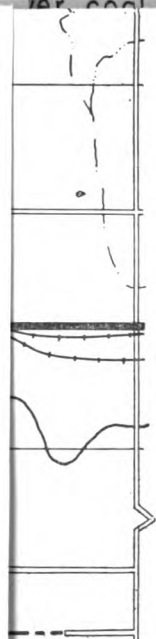
PRODUCTION

Past production.—Statistics on the early production of Thayer coal are exceedingly fragmentary and incomplete. This incompleteness in the record is due largely to the fact that most of the mining was and still is of a noncommercial type. While it is not definitely known just when and where the Thayer coal was first mined, old residents report that the coal was mined as early as 1870 or about the same time that the mining districts were first settled. Official record of coal mining as early as 1875 in Montgomery, Neosho, and Wilson counties is contained in one of the early reports of the Kansas State Board of Agriculture (Gray, 1875, pp. 345, 355, 426). Lieutenant-Governor M. J. Salter is quoted (p. 355) as reporting that 62,500 tons of coal, selling for $3.50 per ton, were mined in sec. 6, T. 30 S., R. 18 E., Neosho county, in 1875. It is believed that the amount reported is in error because it is in no

way comparable with production figures of other years. It is probable that the amount reported should have been in terms of bushels instead of tons, the bushel having been the accepted unit of measurement at that time. On this basis, Neosho county would have produced 2,500 tons of coal, an amount commensurate with production figures of other years. This coal was used primarily for domestic purposes, although a large amount (amount not stated) was shipped and used as fuel throughout the three counties mentioned above. Some of the Thayer coal, however, was hauled by the wagon load outside of the coal-producing counties. One former miner living several miles east and south of Neodesha in Wilson county stated that coal was hauled to Independence and Parsons, towns 17 and 25 miles distant respectively from the place where the coal was mined. Montgomery and Neosho counties produced respectively 2,000 and 8,000 tons of coal in 1880 (Hudson, 1881, pp. 245, 247). The following year Montgomery county had seven coal companies in operation and mined 1,182 tons of coal valued at $8,680 (Sims, 1883, p. 347). The Thayer coal district in 1887 is listed as having produced 750,000 bushels (30,000 tons) of coal (Findlay, 1888, p. 65). Production figures for later years show this to be entirely out of proportion, and it is my opinion that 3,000 tons or 75,000 bushels is more likely the amount of coal mined in Neosho county in 1887. According to published data, the annual output of Thayer coal in the Blue Mound district of Linn county amounted to 50 tons of coal in 1933 (Glennon, 1934, pp. 63, 88) and 150 tons in 1934 (Glennon, 1935, pp. 61, 79). Like the coal mining in Neosho, Wilson, and Montgomery counties, mining in the Blue Mound district of Linn county is essentially a noncommercial localized enterprise; therefore coal production statistics are not available.

Present production.—The discovery of oil and gas and the resulting free or cheap gas to landowners brought about a sharp decline in the mining activities of the Thayer coal, a decline aided materially by increased shipments of Cherokee coal from the Pittsburg and surrounding coal districts. According to the annual reports of the Mine Inspection Division and Mine Rescue Station of the Labor Department, State of Kansas, the number of mines and the annual production of Thayer coal has sharply decreased in the last 10 years. The report of 1942 (Delplace, 1943, pp. 8, 46, 47) lists only one mine in operation in all the Thayer coal-mining districts. In 1942 Wilson county produced 1,378 tons of coal from one

TGOMERY COUNTY, KANSAS



- ● Thayer coal outcrop localities
- × Thayer coal mines
- 237 Outcrop or mine number (232) Parentheses indicate coal analysis.

- Federal or State Highway
- Graded road
- Ungraded road
- Section line
- Township line without road
- Railroad

strip mine located in the SW¼ sec. 21, T. 29 S., R. 17 E. (loc. 202).

The published data show a total of 157,088 tons of coal mined from the Thayer bed. For the reasons discussed above, this amount is undoubtedly far below the actual number of tons mined (table 7).

Estimated Thayer coal mined.—During the course of the field studies on the Thayer coal in Linn, Montgomery, Neosho, and Wilson counties, all available information concerning former mining activities was gathered from miners and residents. Many abandoned mines, drift openings, and outcrop workings were visited. The data gathered from these sources indicate that the pro-

TABLE 7.—*Production of Thayer coal on the basis of published data (in tons)*

Year	Linn county	Montgomery county	Neosho county	Wilson county	Total
1875			62,500?		62,500?
1880		2,000	8,000		10,000
1881		1,182			1,182
1885			7,660		7,660
1887			30,000?		30,000?
1921			3,700		3,700
1925			4,475		4,475
1926			4,541		4,541
1927			4,535		4,535
1931			2,792		2,792
1932			1,262		1,262
1933	50		1,224	844	2,118
1934	150		996	215	1,361
1935			1,000	1,500	2,500
1936			500	2,162	2,662
1937			480	2,750	3,230
1938			480	2,492	2,972
1939			450	2,543	2,993
1940			450	3,100	3,550
1941				1,677	1,677
1942				1,378	1,378
Totals	200	3,182	135,045	18,661	157,088

duction figures cited in table 7 are much too small for the total amount of coal mined. It is impossible to arrive at an accurate figure for the total production of Thayer coal but estimates have been made on the basis of field data. The Thayer coal-mining districts are well known and their limits defined. Maps included in this report show the location of the mines and the trace of the coal outcrop in each mining district. With five exceptions, all of the mines are drift mines which penetrate the coal banks from 75 to 200 yards and which average 100 yards in length. Mine entries are spaced at least 100 feet apart and in most places at much greater distances. Accordingly, the coal-mined area is a belt about 300 feet wide that parallels the line of coal outcrop. If it can be assumed on the basis of the type of mining employed and the spacing of mine entries that no more than 35 percent of the coal in the mined belt has been extracted, then the cumulative production of all Thayer coal, both commercial and noncommercial, to December 31, 1943, is 756,488 tons. The estimated cumulative production of the Thayer coal by mining districts is summarized in table 8.

The cumulative tonnage of the Thayer coal mined, as listed in table 8, is an estimate intended to show the magnitude of the coal produced. Relatively little of the Thayer coal has been mined; most of it remains as reserve.

RESERVES

For the purpose of this report all parts of the coal bed 6 inches or more thick, regardless of the thickness and character of overburden, are considered coal reserves. The lower limit of 6 inches was selected because coal of this thickness was formerly mined in the now abandoned Sycamore mining district north of Independence in Montgomery county. It is undoubtedly true that the part of this reserve included in beds near the lower limit of thickness cannot be mined economically at the present time or in the immediate future because of competition from thicker coal beds and other types of fuel. These thin beds may be mined, however, on a local basis for the miner's winter fuel supply; at some time in the future they may be counted as a commercial reserve.

Bases for computing reserves.—Field investigations show the Thayer coal to be essentially a continuous deposit throughout the area of Chanute shale outcrop except where erosion has removed the coal. In the region of outcrop the coal extends beneath the

TABLE 8.—*Estimated cumulative Thayer coal production by mining districts from 1869 to December 31, 1943*

Mining district	County	Length of outcrop along which mines are located (feet)	Average length of mine (feet)	Area from which coal has been mined (square feet)	Area of coal mined (sq. ft.)	Thickness of coal mined (inches)	Area of coal mined (acres)	Tons of coal per acre	Estimated tons of coal mined
Blue Mound	Linn	8,976	300	2,692,800	942,480	12	21.6	1,500	32,400
Thayer-Coal Hollow	Neosho	31,680	300	9,504,000	3,326,400	18	76.6	2,250	172,350
Chetopa creek	Wilson	44,880	300	13,464,000	4,712,400	18	108.1	2,250	243,225
Dry creek-Washington branch	do	7,920	300	2,376,000	831,600	12	19.1	1,500	28,650
Prior-Choteau	Montgomery	5,280	300	1,584,000	554,400	12	12.7	1,500	19,050
Sycamore	do	7,260	300	2,178,000	762,300	7	17.5	875	15,313
Independence, North	do	5,280	300	1,584,000	554,400	18	42.4	2,250	95,400
Independence, South	do	3,960	300	1,188,000	415,800	18	29.7	2,250	66,825
North Jefferson, Coal-Clear creeks	do	17,600	300	5,280,000	1,848,000	18	12.7	2,250	28,575
East Jefferson	do	9,900	300	2,970,000	1,039,500	12	23.8	1,500	35,700
South Jefferson, Spring-Fawn creeks	do	12,320	300	3,696,000	1,293,600	16	9.5	2,000	19,000
Totals									756,488

area capped by the overlying Iola limestone. In estimating the Thayer coal reserves, the following procedure was followed: (1) all territory between outcrops where the coal is 6 inches or more thick was considered; (2) between outcrops, thicknesses of coal were computed on the assumption of a uniform thickness gradient and plotted as such on a map; (3) lines of equal coal thicknesses were drawn through places where the coal is 6, 9, 12, and 18 inches thick; (4) where practicable, reserves were computed for areas where the coal has a known or computed thickness of 6 to 9 inches, 9 to 12 inches, 12 to 18 inches, and more than 18 inches; (5) in computing the tonnage for the various coal areas as classified in item 4, the minimum thickness of the coal was used; and (6) the assumption was made that a Thayer coal-bearing acre contains 125 tons of coal per inch of coal bed.

The amount of coal that may be recovered from a coal-bearing acre will depend upon the type of mining employed. Because of the shallow depth of the coal beneath the surface, 60 feet or less in the area studied, most of the Thayer coal which can be produced will probably be mined by the stripping method. The effect of the type and character of the overburden on possible future stripping operations was not studied.

Total Thayer coal reserves.—The total Thayer coal reserves are estimated at 36,822,750 tons. Of this amount, 1,078,500 tons occur in the bed where it is 6 to 9 inches thick; 13,252,500 tons are coals 9 to 12 inches thick; 14,893,500 tons are coals 12 to 18 inches thick; and 7,598,250 tons are coals 18 inches or more thick. A summary of the estimated Thayer coal reserves by mining districts is presented in table 9.

Wyandotte, Johnson, Miami, Allen, and Anderson counties.—For all practical purposes, there are no Thayer coal reserves in Wyandotte, Johnson, Miami, Allen, and Anderson counties, although coal 6 to 9 inches thick was observed at a few scattered outcrops in Allen and Miami counties. A possible 9-inch coal may underlie most of sec. 14, T. 26 S., R. 19 E., Allen county. In the center of this section (loc. 86), a 6 to 9-inch coal crops out in the bed and bank of a small stream. Core drilling may reveal the continuation of this coal seam elsewhere in the section.

Linn county.—The reserves of Thayer coal in Linn county are restricted to the Blue Mound mining district (fig. 4), a mound and outlier of Chanute shale occupying more than one-half of section

29 and two-tenths of sec. 32, T. 22 S., R. 22 E. north of the town of Blue Mound. The mining in this district has been limited to the edges or escarpments of the mound. The area of coal reserve is estimated at 291 acres; 241 acres, including 271,125 tons of coal, are underlain by coal 9 to 12 inches thick; 50 acres, including 37,500 tons, are underlain by coal 6 to 9 inches thick. The overburden of soft thin-bedded sandstone and sandy shale is 15 to 30 feet thick.

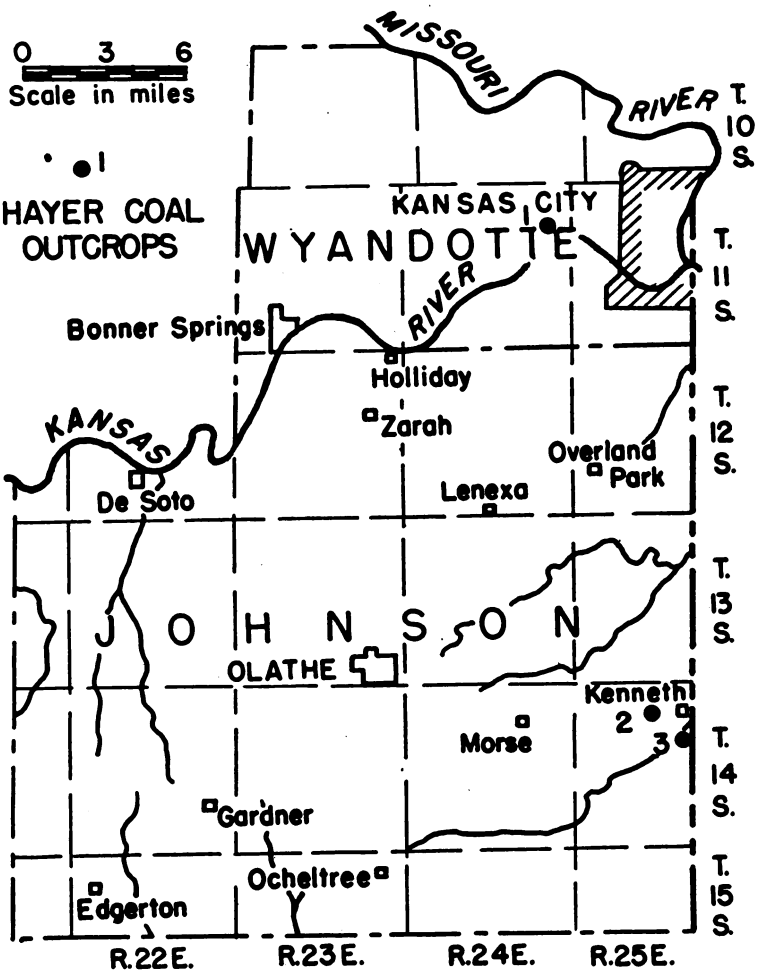


FIG. 2. Map of Wyandotte and Johnson counties, Kansas, showing location and outcrop numbers of the Thayer coal.

The Thayer coal is 14 inches thick at locality 52 (NE cor. sec. 16) along the escarpment of another mound. Although it has been mined at this place, the abrupt local change in thickness and inadequate data preclude consideration of this area as a potential coal reserve. Inadequate data also prevent the estimation of reserves in secs. 23, 24, 25, and 26 west of Blue Mound (fig. 4).

Neosho and Wilson counties.—In estimating the coal reserves of Neosho and Wilson counties, the entire region including the Thayer-Coal Hollow mining district of Neosho county and the Chetopa Creek and Dry Creek mining districts of Wilson county

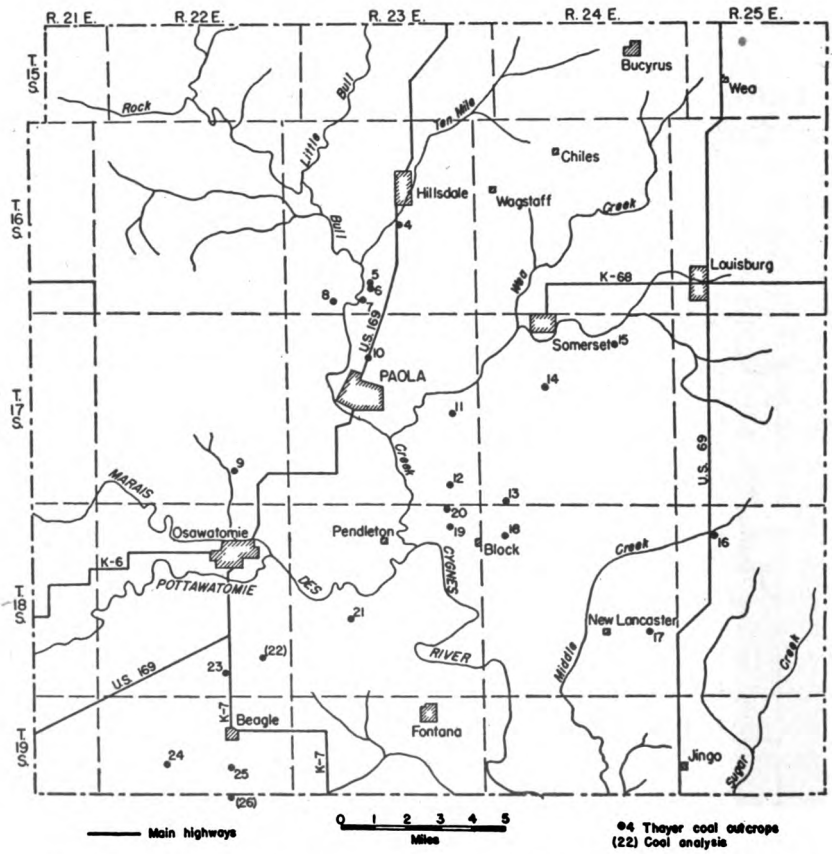


FIG. 3. Map of Miami county, Kansas, showing location and outcrop numbers of the Thayer coal.

TABLE 9.—*Estimates of Thayer coal reserves*

Mining district	County	6-9 inches		9-12 inches		12-18 inches		18+ inches		Total for mining district or county	
		Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons
Blue Mound	Linn	50	37,500	241	271,125					291	308,625
Chetopa-Thayer-Coal Hollow-Dry Creek	Neosho-Wilson	3,190	478,500	6,349	7,142,625	7,247	10,870,500	3,302	7,429,500	20,088	25,921,125
Prior-Choteau-Irish	Montgomery	575	431,250	1,188	1,336,500	838	1,257,000			2,601	3,024,750
Sycamore	do	175	131,250	1,063	1,195,875					1,238	1,327,125
Independence	do			788	886,500					788	886,500
Independence, South	do					100	150,000	75	168,750	175	318,750
North Coal creek	do			163	183,375					163	183,375
Coal creek	do					625	937,500			625	937,500
Coal-Clear-Bluff	do			1,888	2,124,000					1,888	2,124,000
Bluff	do					350	525,000			350	525,000
Spring-Fawn	do			100	112,500	769	1,153,500			869	1,266,000
Totals		3,990	1,078,500	11,780	13,252,500	9,929	14,893,500	3,377	7,598,250	29,076	36,822,750

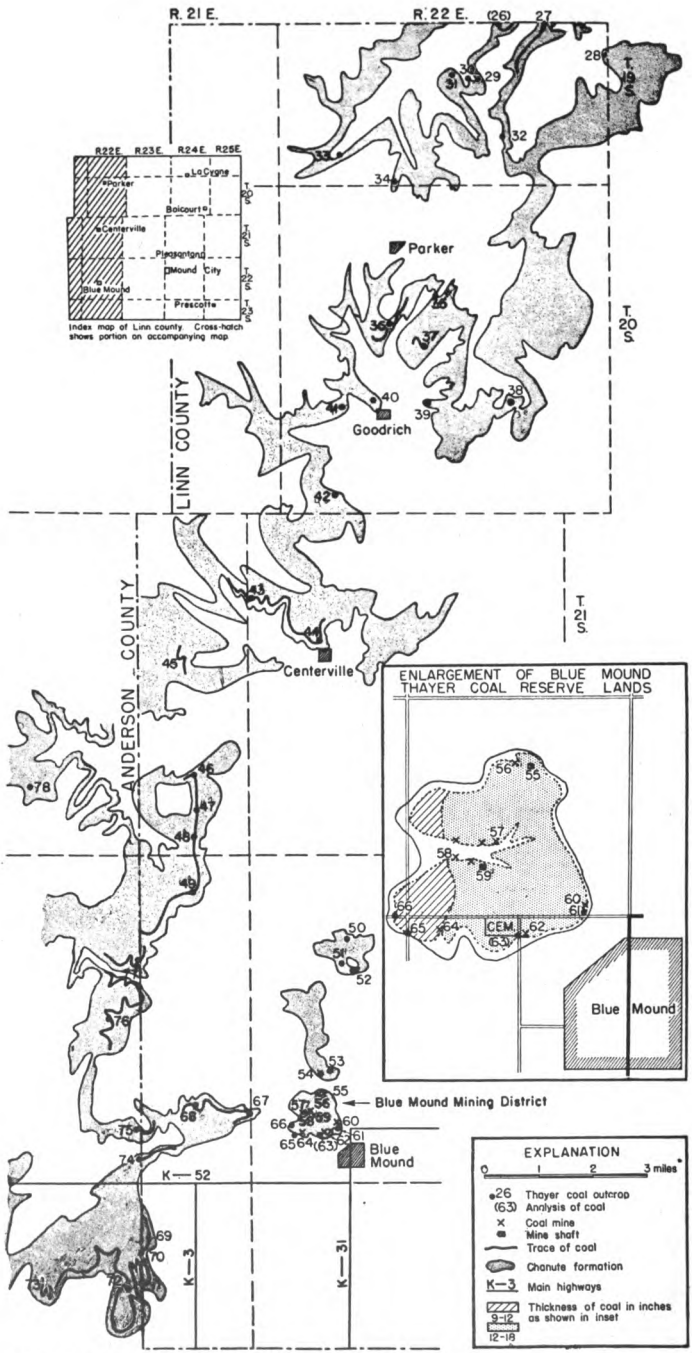


FIG. 4. Map of Linn and Anderson counties, Kansas, showing location and outcrop numbers of the Thayer coal.

was considered as a unit (fig. 7), even though mining activities have been restricted to the named districts (fig. 6). It is estimated that Neosho and Wilson counties include 20,888 acres of reserve coal land containing 25,921,125 tons of coal distributed on the basis of coal thickness as shown in table 9. The reserve coal land is essentially flat except along the borders of the major stream courses. The 15 to 60 feet of overburden consists mainly of soft Cottage Grove sandstone and sandy shale capped in the Chetopa Creek district and a few other localities by a thin remnant of the Iola limestone.

Montgomery county.—Montgomery county contains an estimated 8,697 acres of reserve coal land underlain by 10,393,000 tons of coal. Acreage and tonnage of the Montgomery county reserve

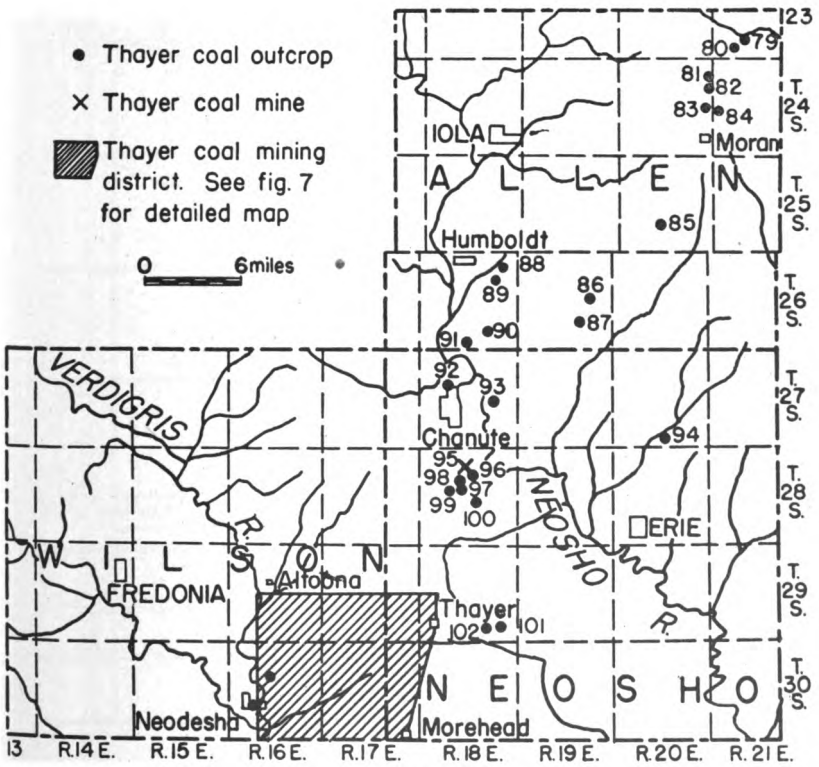


FIG. 5. Map of Allen, Neosho, and Wilson counties, Kansas, showing location and outcrop numbers of the Thayer coal.

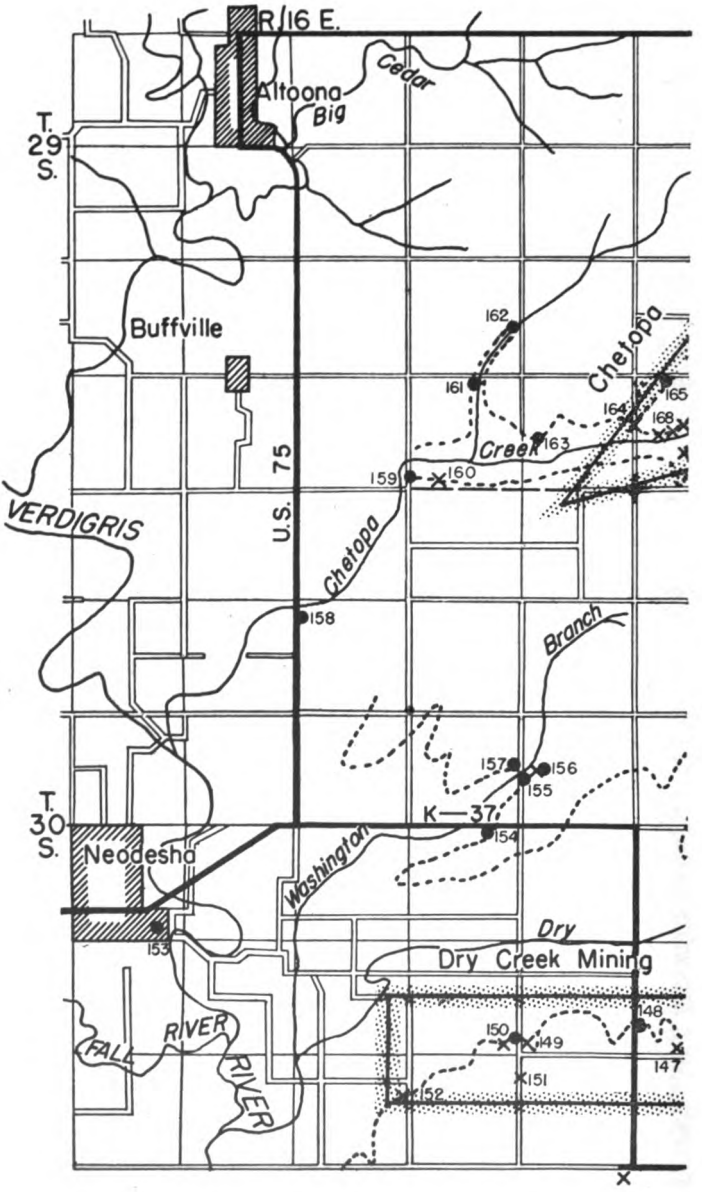
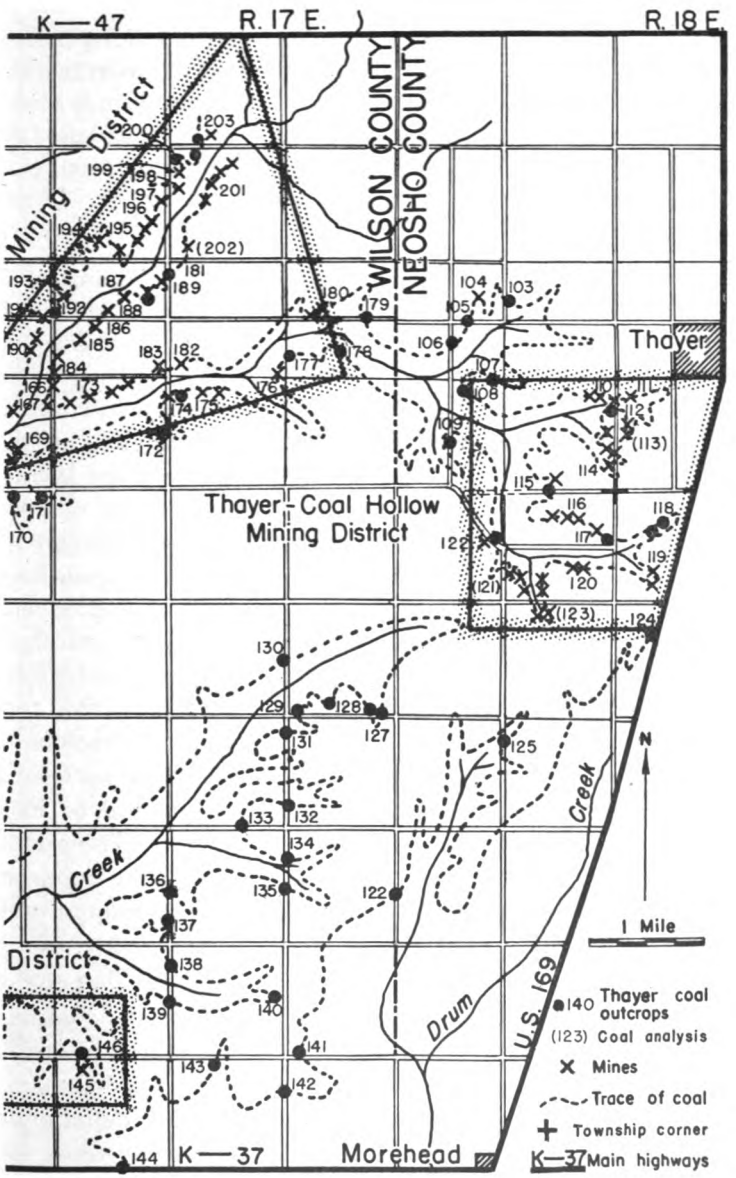


FIG. 6. Map of Neosho and Wilson counties, Kansas, showing



coal-mining districts and location of mines and outcrops.

coal on the basis of the thickness of the bed are shown in table 9. The reserve coal lands of Montgomery county are believed to consist of nine separate areas in all but one of which mining has been carried on in the past (pl. 5). The overburden is 15 to 60 feet thick and consists of thin- to thick-bedded sandstone and sandy shale of the Cottage Grove sandstone. Just south of Independence (loc. 254) the overburden consists of shale capped by sandstone.

ECONOMICS OF THE THAYER COAL

The unmined Thayer coal as reserve coal.—Mining of the Thayer coal on a commercial basis has practically ceased. Labor shortage, indifference to mining as an occupation by the younger generation, price ceilings, and competition from other coal beds and other fuels are some of the factors that have contributed to the decline of mining of the Thayer coal. It is estimated that there are 37,000,000 tons of unmined Thayer coal more than 6 inches in thickness in the Kansas City group. For reasons stated elsewhere in this report this coal may reasonably be considered reserve coal.

It is impossible to foresee the requisite economic conditions to bring the Thayer coal bed into significant commercial production. It is important to know our coal reserves, however, even though they may not in some cases be mined for many years in the future. In the case of the Thayer bed, the data contained in this report can be used to furnish the basis for many small operations that might supply an extremely local area. The thicker parts of the bed, particularly where more than 18 inches, should be looked upon as a commercial reserve at the present time. The quantity of mineable coal in the Thayer bed assumes greater importance when we consider that it is sufficient to supply an amount of coal equal to the present total coal output of the state for 9 years.

Core drilling.—Although it is reasonably certain that the coal beneath the surface of the coal reserve lands forms a continuous deposit and that within limits the thickness of the coal is fairly uniform and predictable, it is nevertheless recommended that sufficient tests by core drilling be made to establish definitely the actual thickness of the coal in areas thought worthy of exploitation. Such tests could be made with relative ease, speed, and low cost as the nonresistant sandstone overburden is usually less than 40 feet and seldom more than 60 feet thick.

The Neosho-Wilson counties region.—The Neosho-Wilson counties reserve coal lands (fig. 7), comprising 20,088 acres, offer the best possibilities for large-scale coal mining. This region includes the Thayer-Coal Hollow mining district of Neosho county and the Chetopa Creek and Dry Creek mining districts of Wilson county. The area surrounding the Chetopa Creek mining district in Wilson county (figs. 6 and 7) is the most promising in this region. As indicated by the coal outcrops, it contains the thickest coal deposits. The area includes the only commercial coal mine (strip) (loc. 202) of any importance in the entire Thayer coal region. Partly capped by the basal limestone member of the Iola limestone formation, the overburden ranges from 12 feet to 30 feet in thickness. It is estimated that there are 3,302 acres containing coal 18 inches or more thick in the area surrounding the Chetopa Creek mining district.

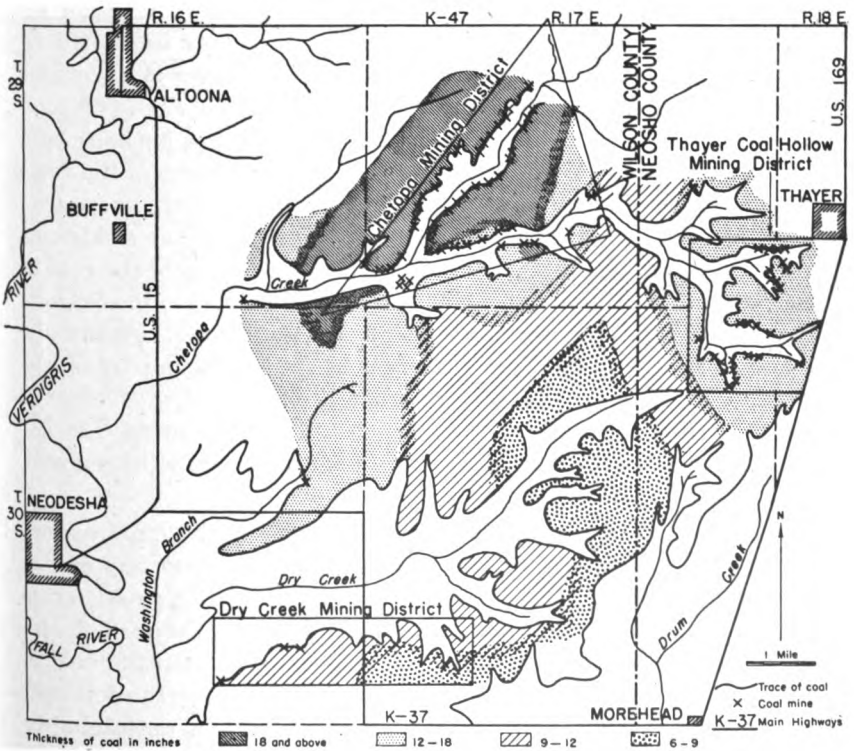


FIG. 7. Map of Neosho and Wilson counties, Kansas, showing reserve coal lands.

Quantitatively, 7,429,500 tons of coal should be recoverable from this reserve land.

Adjacent to the Chetopa Creek reserve coal lands just mentioned are the 12- to 18-inch coal reserve lands that extend eastward to the Thayer-Coal Hollow district and southward toward the Dry Creek mining district (figs. 6 and 7). These reserve coal lands comprise an estimated 7,247 acres underlain by 10,870,500 tons of coal. In addition to the areas in which the coal is more than 12 inches thick, there are more than 6,000 acres of 9 to 12-inch coal lands and more than 3,000 acres where the coal is 6 to 9 inches thick. These areas are estimated to contain an additional 7,621,125 tons of coal.

Montgomery county coal reserves.—The Montgomery county coal reserve lands (pl. 5) total 8,697 acres of which 2,682 acres are underlain by coal 12 to 18 inches thick, 5,190 acres by coal 9 to 12 inches thick, and 750 acres by coal 6 to 9 inches thick. South of Independence, coals more than 18 inches thick are estimated to underlie at least 75 acres. Because the coal reserve lands of the county are scattered and none contain more than 3,000,000 tons of coal, it is inferred that small scale operators are perhaps best suited to the area. With the exception of the thickness of the coal, conditions in all of the nine reserve areas in the county are essentially the same. The overburden is composed of soft sandstone except for the small area south of Independence where the coal is overlain directly by shale. South of Independence, as in the Spring-Fawn Creek mining district (pl. 5), the sandstone is generally thicker bedded than it is in the areas in the northern part of the county. The overburden ranges from 15 to 60 feet in thickness. North of Independence the overburden is seldom more than 30 feet thick, but in the Spring-Fawn Creek area in the southern part of the county it is 60 feet thick (pl. 5).

Because conditions are essentially the same in the nine reserve coal areas in the county, it is not advisable to suggest any one of them for special consideration. Other conditions being equal, it follows that those areas in which the coal is thickest might normally be investigated first. On the other hand, areas in which the coal is thinner but has greater areal extent and thinner overburden may prove to yield more returns. The salient conditions pertaining to the more important parts of each of the nine reserve coal areas in the county are summarized in table 10.

TABLE 10.—*Summary of salient conditions pertaining to the Montgomery county, Kansas, reserve coal lands.*

Area	Location	Thickness of coal (inches)	Thickness of overburden (feet)	Character of overburden	Acres	Estimated reserves (tons)
Irish creek	25, 35, 36-31-16 E	12-18	15-40	Thin-bedded sandstone	650	975,000
Choteau creek	18, 19-31-17 E	12-18	20-30	Thin-bedded sandstone	188	282,000
	7, 8, 18, 24-31-16 E	9-12	20-30	Thin-bedded sandstone	875	984,375
Sycamore	19, 30, 31-31-16 E	9-12	20-40	Thin-bedded sandstone		
	6-32-16 E	9-12		and shaly sandstone	1,063	1,195,875
Coal creek	24, 25-33-15 E	12-18	30-40	Shale to shaly sandstone	625	937,500
Bluff creek	7, 18-34-16 E	12-18	15-20	Thin-bedded sandstone	350	525,000
Coal, Clear,	24, 25, 36-33-15 E	9-12	20-35	Shaly sandstone		
and Bluff	1-34-15 E	9-12	20-35	to	1,888	2,124,000
creeks	19, 30-33-16 E	9-12	20-30	thin-bedded sandstone		
	6-34-16 E	9-12	30-40			
Spring-Fawn creeks	15, 16, 21, 22-34-15 E	12-18	40-60	Massive sandstone	769	1,153,500
Independence, North*	13, 24-32-15 E	9-12	20-30	Shaly sandstone capped		
	18, 19-32-16 E	9-12	20-30	by sandstone	788	211,500
Independence, South	6-33-16 E	12-18	30-40	Shale and thin-bedded	100	150,000
	6-33-16 E	18+	30-40	sandstone	75	168,750

* Coal underlying City of Independence not considered.

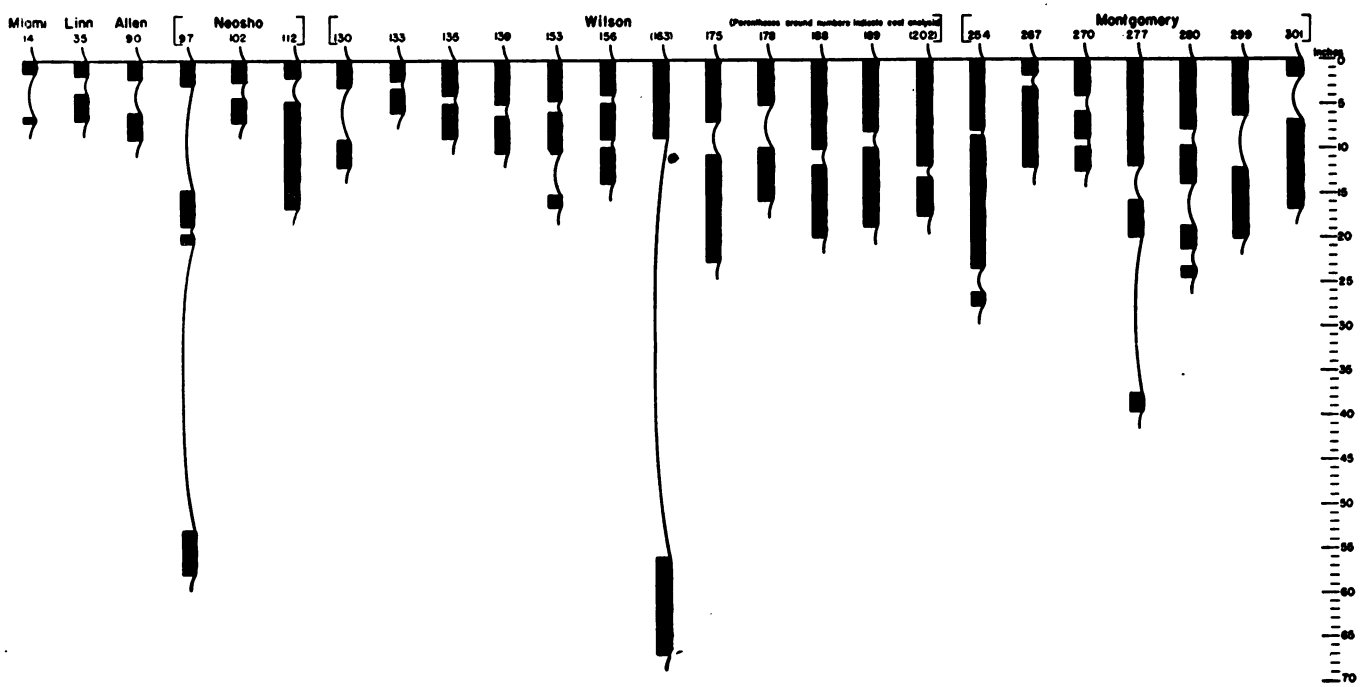


FIG. 8. Thayer coal sections showing variations in the number of coal beds, intervening clay partings, thicknesses, and relative positions of the thicker coals and the thinner coals.

Linn county coal reserves.—The only Thayer coal reserve area outside of Neosho, Wilson, and Montgomery counties is the Blue Mound area in Linn county (fig. 4), described elsewhere in this report. Of the 291 acres of reserve coal land, 241 are underlain by coal 9 to 12 inches thick. Because the overburden consists of soft thin-bedded sandstone and sandy shale and is no more than 15 to 20 feet thick, it is reasonable to assume that strip-mining costs should not be excessive and that the extraction of 27,000 tons of coal might prove profitable.

Noncommercial coal reserves.—As estimated in the section on "Production" (pp. 103-106), only 35 percent of the coal in the narrow belt paralleling the trace of coal outcrop has been mined. An equal amount of coal can undoubtedly be recovered by the "gophering" type of mining practiced by the noncommercial farmer-miner, as the coal is much more widespread than is realized by the people living in the coal region.

REGISTER OF THAYER COAL OUTCROPS AND LOCALITIES

To facilitate the finding of outcrops of the Thayer coal and the location of mines for future coal exploitation as well as for use in further stratigraphic work, all coal outcrops and mine locations known to exist are listed by counties in tables 11 to 16.

TABLE 11.—*Register of Thayer coal outcrops in Wyandotte, Johnson, and Miami counties, Kansas*

Outcrop No.[1]	Location		Type of outcrop	Thickness of coal (inches)	Stratigraphic position of coal within Chanute formation	Author-ity[2]
	Wyandotte county					
1	SW cor.	12-11-24 E	Road cut	Streak	At top	J. N.
	Johnson county					
2	0.2 mi. W. of SE cor.	4-14-25 E	do	0.25-1	15 feet below top	S.
3	SE cor.	10-14-25 E	do	Streak	4.7 feet below top	N.
	Miami county					
4	NW cor. NE	22-16-23 E	do	0.5-2	18.1 feet below top	S.
5	NE cor.	33-16-23 E	Road and RR. cut	1.5-2	18.1 feet above base	S.
6	Near cen. N. line	33-16-23 E	RR. cut	3.5	21 feet above base	N.
7	Near cen.	33-16-23 E	do	6	20 feet below top	N.
8	S. of cen	32-16-23 E	Road cut	3	16 feet above base	S.N.
9	0.25 mi. E. of SW cor.	26-17-22 E	do	8.5	0.2 feet below top	N.
10	NE cor. SW	9-17-23 E	Composite—RR. cut to top of quarry	3	15.5 feet above base	N.
11	NW cor.	24-17-23 E	Road cut	3.5	14 feet above base	S.N.
12	0.3 mi. S. of NW cor. NW	36-17-23 E	do	4	12.5 feet above base	S.
13	0.25 mi. W. of SE cor.	31-17-24 E	do	3	13 feet above base	N.
14	0.15 mi. S. of NE cor.	17-17-24 E	do	0.5-1.5	14 feet above base	S.
15	S. side of SW	6-18-24 E	do	3	13 feet above base	N.
16	SE cor.	6-18-25 E	do	3	4.5 feet below top	N.
17	E. of SW cor.	24-18-24 E	do	3.5	12 feet above base	N.
18	SW cor.	2-17-24 E	do	1-1.5	18 feet above base	S.
19	0.25 mi. N. of SE cor.	2-18-23 E	do	3	11.5 feet above base	S.N.
20	NE cor.	2-18-23 E	do	3	15.5 feet below top	N.
21	0.25 mi. W. of cen. E. line	20-18-23 E	do	3	16.5 feet above base	N.
(22)	0.25 mi. N. of SW cor.	25-18-22 E	do	3	11.2 feet above base	S.N.
23	0.25 mi. S. of NE cor.	34-18-22 E	do	Streak	Near top	N.
24	NW cor.	16-19-22 E	do	3	30 feet below top	N.
25	E. side of NE	15-19-22 E	do	6	11 feet above base	N.

[1] Parentheses around numbers indicate analyses in table 4.
[2] J., Jewett; N., Newell; S., Schoewe.

TABLE 12.—*Register of Thayer coal outcrops and mines in Linn county, Kansas*

Outcrop No.[1]	Location		Type of outcrop	Thickness of coal (inches)	Stratigraphic position of coal within Chanute formation	Author-ity[2]
(26)	NE cor.	22-19-22 E	Road cut	6	10 feet above base	S.
27	0.1 mi. W. of NE cor.	23-19-22 E	do			S.
28	E. line	24-19-22 E		12	6.5 feet above base	N.
29	NW cor. NE	27-19-22 E		3	16 feet above base	J.
30	NE cor. NW	27-19-22 E		3.5		J.
31	SW cor.	22-19-22 E	do	5	12 feet above base	S.
32	NW cor.	35-19-22 E		3.5	12 feet above base	J.
33	SW cor. NW	32-19-22 E		6	10.6 feet above base	N.
34	E. line	32-19-22 E		6	20.3 feet below top	J.
35	0.2 mi. W. of NE cor.	16-20-22 E	do	6	13 feet above base	J.
36	SW cor. NW	16-20-22 E	do	5		S.
37	SW cor. SE	16-20-22 E	do	3	14 feet above base	S.
38	0.15 mi. E. of SW cor.	23-20-22 E	do	9	30 feet below top	S.
39	NW cor. NE	21-20-22 E	do	2	15 feet above base	S.
40	0.3 mi. W. of SE cor.	20-20-22 E	do	3	12.5 feet above base	S.
41	NW cor.	29-20-22 E	do	6	15 feet above base	N.
42	0.3 mi. N. of SE cor.	31-20-22 E	do	4	10.5 feet above base	S.
43	NW cor. SW	7-21-22 E	do	5	8 feet above base	S.
44	W. of school	17-21-22 E	do	5	12 feet above base	S.
45	0.1 mi. W. of SE cor. NE	14-21-21 E	do			S.
46	0.4 mi. N. of SW cor.	25-21-21 E	do		8 feet above base	S.
47	0.3 mi. S. of NW cor.	36-21-21 E	do	3	8 feet above base	S.
48	200 ft. N. of RR. tracks	36-21-21 E	do	4		S.
49	0.2 mi. N. of SE cor.	2-22-21 E	do	3		S.
50	NE cor. SE	8-22-22 E	do	Trace	23 feet above base	S.
51	SE cor.	8-22-22 E	do	1-2		S.
52	NW cor.	16-22-22 E	Mine	14		S.

TABLE 12.—Register of outcrops and mines in Linn county, *continued*

Outcrop No.[1]	Location		Type of outcrop	Thickness of coal (inches)	Stratigraphic position of coal within Chanute formation	Authority[2]
53	0.3 mi. W. of SE cor.	20-22-22 E	Road cut	8		S.
54	NW cor. NE	29-22-22 E	do	3		S.
55	NW cor. SW NE	29-22-22 E	Shaft and drift mines			S.
56	0.2 mi. N. of SE cor. NW	29-22-22 E	Mines			S.
57	Cen. SW	29-22-22 E	do	10+		S.
58	Cen. SW	29-22-22 E	do			S.
59	NE cor. SW	29-22-22 E	Mine (shaft)			S.
60	0.2 mi. W. of SE cor.	29-22-22 E	Mines	12		S.
61	0.2 mi. W. of SE cor.	29-22-22 E	Road cut	12		S.
62	NW cor. NE	32-22-22 E	Mines			S.
(63)	SE cor. of cemetery, NE cor. NW	32-22-22 E	Road cut	14		S.
64	0.15 mi. E. and 0.1 mi. S. of NW cor.	32-22-22 E	Mine			S.
65	0.1 mi. S. of NE cor.	31-22-22 E	Road cut	3		S.
66	0.2 mi. W. of SE cor.	30-22-22 E	do	12		S.
67	0.3 mi. N. of SE cor.	24-22-21 E	do	8.25		S.
68	Cen. E. line	23-22-21 E	do	4.5		S.
69	0.15 mi. E. of SW cor.	2-23-21 E	do	3		S.
70	0.2 mi. S. of NW cor.	11-23-21 E	do	3		S.
71	SW cor.	11-23-21 E	do	3		S.

[1] Parentheses around numbers indicate analyses in table 4.

[2] J., Jewett; N., Newell; S., Schoewe.

TABLE 13.—*Register of Thayer coal outcrops in Anderson and Allen counties, Kansas*

Outcrop No.	Location		Type of outcrop	Thickness of coal (inches)	Stratigraphic position of coal within Chanute formation	Authority[1]
	Anderson county					
72	0.2 mi. W. of SE cor.	10-23-21 E	Road cut			S.
73	0.1 mi. E. of SW cor.	9-23-21 E	do			S.
74	0.3 mi. N. of SE cor.	34-22-21 E	do			S.
75	0.1 mi. W. of NE cor.	34-22-21 E	do	3.5	10 feet above base	S.
76	SE cor. SW	15-22-21 E	do	2		S.
77	NE cor.	15-22-21 E	do	1		S.
78	SW cor.	28-21-21 E		6		N.
	Allen county					
79	0.5 mi. S. of NE cor.	29-23-21 E	do			S.
80	0.2 mi. W. of SE cor.	29-23-21 E	do	3		S.
81	SE cor.	1-24-20 E	do	3.5	6.5 feet above base	N.
82	0.2 mi. S. of NE cor.	12-24-20 E	do	3.5	6.5 feet above base	N.
83	0.2 mi. N. of SW cor.	13-24-20 E	do	4	10.2 feet below top	S.
84	0.2 mi. E. of SW cor.	18-24-21 E	do	8		S.
85	NW cor.	27-25-20 E		6	13 feet below top	N.
86	Cen.	14-26-19 E	Stream bank	9		S.
87	Cen. SE	22-26-19 E	do	5		S.
88	SW cor.	1-26-18 E	Creek and road cut	3.5	18 feet below top	N.
89	SW cor. NE	11-26-18 E	Stream bank	7	23 feet below top	S.H.A.
90	SE cor. SW	26-26-18 E	do	5		S.
91	SE cor.	33-26-18 E		6	13 feet above base	N.

[1] A., Adams; H., Haworth; N., Newell; S., Schoewe.

TABLE 14.—*Register of Thayer coal outcrops and mines in Neosho county, Kansas*

Outcrop No.[1]	Location		Type of outcrop	Thickness of coal (inches)	Stratigraphic position of coal within Chanute formation	Authority[1]
92	Ash Grove Cement Plant, Chanute	17-27-18 E	Quarry	3.6	6 feet below top	J.
93	Cen.	23-27-18 E	Road cut	2		S.
94	NW cor.	34-27-20 E	Ravine	3.6	7.2 feet above base	J.
95	0.1 mi. W. of road, NE cor.	9-28-18 E	Mine	5		S.
96	NE cor.	9-28-18 E	Road cut	5		S.
97	0.2 mi. W. of road, S. line NE	9-28-18 E	Heads of draws	14		S.
98	SE cor. SW	9-28-18 E		7.2	26 feet below top	N.
99	150 ft. S. of bridge, NW cor.	16-28-18 E	Creek bank	3	37.5 feet below top	S.
100	SE cor. NE	15-28-18 E	Road cut	2.4	10 feet above base	N.
101	0.2 mi. W. of SE cor.	27-29-18 E	do	5		S.
102	SE cor.	28-29-18 E	Creek bank	7		S.
103	0.2 mi. N. of SW cor. NW	25-29-17 E	Road cut	25		S.
104	Cen. NE	26-29-17 E	Mine			S.
105	0.1 mi. E. of SW cor. SE	26-29-17 E	Road cut			S.
106	0.2 mi. S. of NE cor. SW	26-29-17 E	do	4		S.
107	SE cor.	26-29-17 E	do			S.
108	NW cor. NE	35-29-17 E	do	14		S.
109	NW cor. SE	35-29-17 E	do			S.
110	0.1 mi. W. of road, NE cor. NE	36-29-17 E	Mines			S.
111	0.2 mi. S. of NE cor.	36-29-17 E	Road cut	14		S.
112	0.2 mi. S. of NW cor. and E.	31-29-18 E	Mines			S.
(113)	SW NW	31-29-18 E	do	14		S.
114	SE	36-29-17 E	do	14		S.
115	0.3 mi. E. of SE cor.	36-29-17 E	Road cuts, mine			S.
116	N. line SE NW	1-30-17 E	Mines			S.
117	SE cor. NE	1-30-17 E	do			S.
118	NW	6-30-18 E	do			S.
119	SW	6-30-18 E	do			S.
120	0.1 mi. S. of road, NE cor. SW	1-30-17 E	do			S.

(121)	SW	1-30-17 E	do	14	S.
122	SE cor. NE	2-30-17 E	do		S.
(123)	NW	12-30-17 E	do	14	S.
124	0.4 mi. S. of NE cor. NW, U.S. 169	7-30-18 E	Road cut		S.
125	0.2 mi. S. of NW cor.	13-30-17 E	do		S.

[1] Parentheses around numbers indicate analyses in table 4.
[2] J., Jewett; N. Newell; S., Schoewe.

TABLE 15.—*Register of Thayer coal outcrops and mines in Wilson county, Kansas*

Outcrop No.	Location		Type of outcrop	Thickness of coal (inches)	Stratigraphic position of coal within Chanute formation	Authority[1]
126	0.4 mi. N. of SW cor.	22-30-17 E	Road cut	6		S.
127	0.1 mi. W. of SE cor.	10-30-17 E	do			S.
128	0.4 mi. E. of SW cor.	10-30-17 E	do			S.
129	0.1 mi. E. of SW cor.	10-30-17 E	do			S.
130	NE cor. SE	9-30-17 E	do	6		S.
131	0.1 mi. S. of NW cor.	15-30-17 E	do			S.
132	0.1 mi. N. of SW cor.	15-30-17 E	do			S.
133	0.3 mi. W. of SE cor.	16-30-17 E	do	6		S.
134	0.3 mi. S. of NW cor. NW	22-30-17 E	do			S.
135	0.4 mi. N. of SE cor.	22-30-17 E	do	8		S.
136	0.4 mi. N. of SE cor.	20-30-17 E	do			S.
137	0.15 mi. N. of SE cor.	20-30-17 E	do			S.
138	0.2 mi. S. of NW cor.	28-30-17 E	do			S.
139	SW cor. NW	28-30-17 E	do	9		S.
140	NE cor. SE	28-30-17 E	Stream bank			S.
141	0.2 mi. E. of NW cor.	27-30-17 E	Road cut	3		S.
142	0.3 mi. S. of NW cor.	34-30-17 E	do			S.
143	0.4 mi. E. of NW cor.	33-30-17 E	do	6		S.
144	0.3 mi. W. of SE cor.	32-30-17 E	do			S.
145	0.2 mi. E. of NW cor	32-30-17 E	Mine			Sch.

TABLE 15.—Register of outcrops and mines in Wilson county, *continued*

Outcrop No.	Location		Type of outcrop	Thickness of coal (inches)	Stratigraphic position of coal within Chanute formation	Author-ity[1]
146	0.2 mi. E. of SW cor.	29-30-17 E	Road cut	9		S.
147	SE cor. SW	30-30-17 E	Ravine			S.
148	0.2 mi. N. of SW cor.	30-30-17 E	Road cut	9	24 feet above base	S.
149	SW cor.	25-30-16 E	Mine	10		S.
150	SE	26-30-16 E	do			Sch.
151	SE cor.	26-30-16 E	Creek bank	10-12	65 feet below top	S.N.
152	SE cor. NE	34-30-16 E	Mine			Sch.
153	Verdigris river bridge, SE part of Neodesha	20-30-16 E	River bank	10.5	4.2 feet below top	S.
154	0.25 mi. W. of NE cor.	23-30-16 E	Road cut			S.
155	NW cor. SW	13-30-16 E	do	7		S.
156	SW cor. NW	13-30-16 E	Creek bank	12		S.
157	SE cor. NE	14-30-16 E	Road cut			S.
158	S. of Chetopa cr. bridge, NE cor.	9-30-16 E	Road cut	5		S.
159	0.2 mi. N. of SE cor.	34-29-16 E	Creek bank	12		S.
160	0.15 mi. E. of SW cor.	35-29-16 E	Mine			S.Sch.
161	NW cor. NE	35-29-16 E	Creek bank	2		S.
162	NE cor. SE	26-29-16 E	do			S.
163	NW cor. SW	36-29-16 E	do	9-11		S.
164	SE cor. NE	36-29-16 E	Road cut			S.
165	0.3 mi. W. of NW cor.	31-29-17 E	do	1.5		S.
166	NE cor.	31-29-17 E	Mine			Sch.
167	SW cor. NE	31-29-17 E	do			S.
168	Cen.	31-29-17 E	Creek bank, mines			S.
169	NW cor. SE	31-29-17 E	Mines surrounding mound			S.
170	NW cor. NE	6-30-17 E	Road cut			S.
171	0.2 mi. W. of NE cor.	6-30-17 E	Creek bank	12		S.
172	NE cor. SE	32-29-17 E	do	14		S.

173	Cen. NW	32-29-17 E	Creek bank, mines			S.
174	W. side	33-29-17 E	Road cut	6	56 feet below top	S.N.
175	E. of bridge, NW cor.	33-29-17 E	Creek bluff	19		S.
176	SE cor.	28-29-17 E	Creek bank, mine			Sch.
177	0.3 mi. N. of SE cor.	8-29-17 E	Creek bank			S.
178	0.2 mi. S. of road, SW cor. SE	27-29-17 E	Creek bluff	11		S.
179	NW cor. SE	27-29-17 E	Mine	7		S.Sch.
180	NW	27-29-17 E	do			Sch.
181	NE cor.	29-29-17 E	Creek bank	16.8	8 feet below top	N.
182	W. side	28-29-17 E	Road cut	6	56 feet below top	N.
183	N. of road, SE cor.	29-29-17 E	Gullies	18	40.2 feet below top	Sch.N.
184	SW cor.	29-29-17 E	Creek bank, road cut, mines	9.6	8 feet below top	N.S.
185	Cen. SW	29-29-17 E	Creek bank, mines			S.
186	0.15 mi. W. of SW cor. NW	29-29-17 E	Mine			Sch.
187	Cen. NE	29-29-17 E	do			S.
188	Cen. NE	29-29-17 E	Road cut	18	5 feet below top	S.
189	0.1 mi. S. of NW cor.	28-29-17 E	do	19	4 feet below top	S.
190	Cen. SE	30-29-17 E	Creek bank, mines			S.
191	0.2 mi. W. of SE cor. NE	30-29-17 E	Mine			S.Sch.
192	SE cor. NE	30-29-17 E	Mine, road out			S.
193	0.1 mi. N. of SW cor.	29-29-17 E	Mine			S.
194	0.15 mi. N. of SE cor. SW	20-29-17 E	do			S.
195	0.1 mi. N. of SW cor. SE	20-29-17 E	do			S.
196	NE cor. SE and south	20-29-17 E	Mines along creek			S.
197	SE cor. NE	20-29-17 E	Mines			S.
198	0.5 mi. S. of NW cor.	21-29-17 E	do	11		S.W.
199	0.3 mi. S. of NW cor.	21-29-17 E	do			S.
200	First draw E. of school, NW cor.	21-29-17 E	Creek bank			S.
201	NE NW	21-29-17 E	Mines			S.
202	SW	21-29-17 E	Dunbar strip mine	17-24	1.8-11.5 feet below top	S.
203	SE cor. SW	16-29-17 E	Road cut	12	1.5 feet below top	N.

[1] N., Newell; S., Schoewe; Sch., Schrader; W., Whitla.

TABLE 16.—*Register of Thayer coal outcrops and mines in Montgomery county, Kansas*

Outcrop No.[1]	Location		Type of outcrop	Thickness of coal (inches)	Author-ity[2]
204	0.35 mi. E. of NE cor.	3-31-16 E	Road cut	4	S.
205	0.3 mi. E. of NE cor.	3-31-16 E	do	4	S.
206	0.1 mi. E. of NE cor.	3-31-16 E	do	4	S.
207	NW cor.	10-31-16 E	do		S.
208	0.5 mi. E. of NW cor.	2-31-16 E	do	7	S.
209	NW cor.	6-31-17 E	Mine		Sch.
210	SW cor. NW	8-31-17 E	Road cut	10	S.
211	0.3 mi. E. of SW cor.	8-31-17 E	do	11	S.
212	0.6 mi. E. of SW cor.	7-31-17 E	do	10	S.N.
213	0.3 mi. S. of NW cor.	12-31-16 E	do	1.5	S.
214	SW cor.	11-31-16 E	Mine		Sch
215	NW cor. SW	10-31-16 E	Road cut		S.
216	0.2 mi. S. of NE cor.	16-31-16 E	do	6	S.
217	0.1 mi. S. of NE cor.	15-31-16 E	Shaft mine		S.
218	SE cor. NE	15-31-16 E	Mine		Sch.
219	0.4 mi. S. of NE cor.	15-31-16 E	Road cut	3	S.
220	NW cor. SW	18-31-17 E	do	2	S.
(221)	0.6 mi. E. of SW cor.	18-31-17 E	do	14	S.
222	0.2 mi. W. of SE cor.	24-31-16 E	do	9	S.
(223)	0.2 mi. W. of SE cor.	23-31-16 E	do	11	S.
224	0.2 mi. W. of SE cor. NE	22-31-16 E	Creek bank		S.
225	0.2 mi. S. and 0.1 mi. W. of NE cor.	21-31-16 E	Ravine	10	S.
226	0.25 mi. S. of NW cor. NE	21-31-16 E	Gully	2	S.
227	SW cor. SE	18-31-16 E	Road cut	7	S.
228	SE cor. SW	18-31-16 E	Mine		Sch.
229	Cen. NE	19-31-16 E	do		Sch.
230	SE cor.	19-31-16 E	do		Sch.
231	SE cor. and north	19-31-16 E	Mines		S.
(232)	0.4 mi. N. and 100 yds. E. of SW cor.	30-31-16 E	Creek bank	13	S.
233	NE cor. NW	35-31-16 E	Mines	18	S.
234	SW cor. SE	26-31-16 E	Mine		Sch.
235	0.2 mi. E. and 0.1 mi. N. of SE cor.	26-31-16 E	Strip mines	12	S.
236	0.35 mi. N. and 0.2 mi. E. of SW cor.	25-31-16 E	Mine	11	S.
237	0.3 mi. S. of NW cor.	30-31-17 E	Road cut	9	S.
238	NW cor.	36-31-16 E	do	15	S.
239	Cen. NW	36-31-16 E	Shaft mine	16	S.
240	0.4 mi. N. of SW cor.	36-31-16 E	Road cut	15	S.
241	SW cor.	36-31-16 E	Mine		Sch.

TABLE 16.—Register of outcrops and mines in Montgomery county, *continued*

Outcrop No.[1]	Location		Type of outcrop	Thickness of coal (inches)	Authority[2]
242	0.4 mi. W. of SE cor.	35-31-16 E	Road cut	12	S.
243	SE cor.	34-31-16 E	do	Trace	S.N.
244	0.1 mi. E. of NW cor. NE	6-32-16 E	do		S.
245	Cen.	7-32-16 E	Creek bank		S.
246	0.3 mi. N. of SE cor.	7-32-16 E	Road cut	3	S. Sch.
247	N. line of S½	13-32-15 E	do	12	S.N.
248	0.3 mi. W. of U.S. 75, SE	13-32-15 E	do	10	S.N.
249	0.2 mi. S. of Elk river bridge on U.S. 75	18-32-16 E	do	12	S. Sch.
250	Cen. SE, Independence park zoo	19-32-16 E	Ravine	12	Sch. S.
251	SE cor. NW	19-32-16 E	Mine		Sch.
(252)	Independence park, water works plant	19, 30-32-16 E	Road cut, mines	12-14[3]	Sch. S.N.
253	SE NW	6-32-16 E	Road cut	14	S.
254	Cen.	6-33-16 E	Brick plant quarry	25	Sch. S.
255	SE cor. NE	6-33-16 E	Mine		Sch.
256	0.1 mi. S. of NE cor. NW	18-33-16 E	do		Sch. S.
257	Cen. NW	17-33-16 E	Mines		Sch. S.
258	NW cor. SE	17-33-16 E	Road cut		S.
259	0.2 mi. W. and 0.4 mi. N. of SE cor. SW	17-33-16 E	Mines		S.
260	0.15 mi. E. of NW cor. SW	17-33-16 E	Mine		Sch.
261	0.3 mi. W. of SE cor.	13-33-15 E	Road cut	13	N.
262	0.4 mi. S. of NW cor., Coal creek	19-33-16 E	Mine		Sch.
263	W. line SE	24-33-15 E	Creek bank mines	13	S.
264	NE cor. SE	24-33-15 E	Road cut	9	S.
265	0.4 mi. N. of SW cor., Coal creek	19-33-16 E	Mine		Sch.
266	200 yds. S. of road, 0.3 mi. E. of NW cor.	25-33-15 E	Creek bank, mine	13	S.
267	0.25 mi. S. and 0.1 mi. E. of NW cor. NE	30-33-16 E	Road cut	10.5	S.
268	SW cor. SE	30-33-16 E	Mine		S. Sch.
269	0.2 mi. S. of NE cor.	36-33-15 E	Road cut	8	S.
270	0.2 mi. W. of SE cor.	36-33-15 E	do	9.5	S.
271	0.2 mi. E. of SW cor.	31-33-16 E	do		S.
272	0.4 mi. E. of SW cor.	1-33-15 E	Creek bank, mine		S.
273	0.4 mi. E. of NW cor.	12-34-15 E	do		S. Sch.
274	0.3 mi. S. of NW cor.	12-34-15 E	Road cut	20	S.

TABLE 16.—Register of outcrops and mines in Montgomery county, *continued*

Outcrop No.[1]	Location		Type of outcrop	Thickness of coal (inches)	Authority[2]
275	NW cor. SW	13-34-15 E	do		S.
276	SE cor. pasture, 0.1 mi. N. and W. of SE cor.	13-34-15 E	Ravine		S.
277	NW cor. SW	7-34-16 E	Road cut	18	S.
278	0.5 mi. W. of SE cor., 0.1 mi. N. of road, S. line	7-34-16 E	Mines		S.
279	0.1 mi. S. of NE cor.	7-34-16 E	Road cut		S.
280	NE cor.	18-34-16 E	do	8	S.
281	Cen. NE NW	18-34-16 E	Mines		S.
282	0.1 mi. S. of NW cor.	18-34-16 E	Road cut	15	S.
283	0.1 mi. S. and E. of NW cor. NE	16-34-15 E	Stream bank		S.
284	NE cor. and 0.3 mi. W. along stream	16-34-15 E	Bluffs, mines		S.
285	NW cor. and 0.3 mi. S. along stream	15-34-15 E	do		S.N.
286	W. and S. lines	26-34-15 E		9.6[4]	N. Sch.
287	S. bank Fawn creek and road	21-34-15 E	Mines		S.
288	Ravine parallel to road, SW	22-34-15 E	do		S. Sch.
(289)	0.5 mi. E. and 0.15 mi. N. of SW cor.	22-34-15 E	do	10	S.
290	0.35 mi. W. of SE cor.	22-34-15 E	Road cut		S.
291	0.15 mi. S. and 0.4 mi. W. of NW cor.	27-34-15 E	Ravine		S.
292	SW cor. NW	26-34-15 E	Escarpment		S.
293	0.1 mi. E. of SW cor.	26-34-15 E	Road cut	3	S.
294	0.2 mi. S. of NW cor.	35-34-15 E	do		S.
295	150 ft. S. of RR. tracks	35-34-15 E	do	6	S.
296	250 ft. E. of bridge, NE cor. NW	2-35-15 E	do	1	S.
297	0.5 mi. N. of SE cor.	3-35-15 E	do		S.
298	0.25 mi. N. of SE cor.	3-35-15 E	do		S.
299	0.3 mi. S. of NE cor.	10-35-15 E	do	14	S.
300	NE cor. SE	10-35-15 E	do		S.
301	Cen. NW	11-35-15 E	do	12	S.

[1] Parentheses around numbers indicate analyses in table 4.

[2] N., Newell; S., Schoewe; Sch., Schrader.

[3] Coal 42.7 feet above the base of the Chanute shale formation.

[4] Coal 58.3 feet below the top of the Chanute shale formation.

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