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THE COAL RESOURCES OF McCONE COUNTY MONTANA

By

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THE COAL RESOURCES OF McCONE COUNTY, MONTANA

By A. J. COLLIER and M. M. KNECHTEL

ABSTRACT

McCone County includes an area of about 2,700 square miles in northeastern Montana, which, sparsely inhabited and utilized mainly for farming and stock raising, is a part of the great area of Tertiary coal beds of North Dakota, South Dakota, Wyoming, and Montana.

Altitudes within McCone County, which lies in the Missouri Plateau section of the Great Plains geomorphic province, range from 1,960 to 3,300 feet above sea level. The lowest altitudes are in the Missouri River bottom land along the northern boundary; the highest are on the Sheep Mountain divide, which crosses the extreme southeastern township of the county. The intervening land has a general slope toward the north. Two high gravel-capped terraces in the southern part of the county possibly correspond to the Cypress Hills (Oligocene) and the Flaxville (Miocene or Pliocene) plains of the Province of Saskatchewan and northern Montana. Gravel terraces near the Missouri River were probably formed during Pleistocene time.

All the exposed rocks of the county are of sedimentary origin. The coal-bearing rocks belong to the Lance (Eocene?) and Fort Union (Eocene) formations, and are underlain by sandstone beds (Colgate sandstone member, in part at least non-marine), forming the upper part of the Fox Hills sandstone (Upper Cretaceous). Underlying these are the marine sandstones of the basal member of the Fox Hills formation, and at the base of the exposed section are the Bearpaw marine sandy shales (Upper Cretaceous). Upon the eroded surfaces of the Cretaceous and Eocene rocks deposits of fluviatile, glacial, and eolian origin form a thin and discontinuous mantle.

The strata lie so nearly horizontal in most parts of the county that dips can rarely be detected without the aid of instruments. Structure contours, however, show that most of the county lies in a broad syncline, the axis of which extends from west to east across the southern townships. A monocline and associated fault extend northeastward across the central part of the county. In the extreme northeastern part the strata rise gently eastward toward the axis of the Poplar anticline.

The coal of McCone County ranks as a lignite, having a heating value of about 8,000 British thermal units, and the estimated quantity of coal is 24,938,432,000 short tons.

The coal beds are variable in thickness and in content of impurities. Those in the Hell Creek and Tullock members of the Lance formation and in the Lebo member of the Fort Union formation are, in general, extremely lenticular and variable in quality. The U (Big Dirty) bed, at the base of the Lebo, however, is in places very thick and is one of the most valuable beds in the county, notwithstanding the prevalence of partings in it. The Tongue River member of the Fort Union contains four extensive coal beds and several "local" lenses. The coal of this member is generally of better quality than that of the members underlying it, and the valuable beds are persistent over larger areas.

Clinker, formed by burning of coal beds, is common in the county and in many places affords the best means of tracing outcrops of the beds.

INTRODUCTION

Purpose and scope of report.—This report is mainly a compilation of hitherto unpublished results obtained in investigations of the coal resources of McCone County, Mont., in 1919, 1922, 1927, 1928, and 1929 by field parties under the direction of W. T. Thom, Jr., C. E. Dobbin, and A. J. Collier. The investigations were undertaken primarily for the purpose of classifying the public lands and obtaining the information necessary for the proper administration of the laws pertaining to these lands. The report includes descriptions of the thickness and extent of the coal beds and some information on the geologic structure, stratigraphy, and geomorphology of the county.

Location and relations of the county.—McCone County includes an area of about 2,700 square miles in northeastern Montana. The county is bounded on the north by the Missouri River and, except for a small area in the southeastern part of T. 17 N., R. 49 E., which is south of the divide between the Missouri and Yellowstone Rivers, lies entirely within the drainage basins of Redwater and Big Dry Creeks and of several shorter tributaries of the Missouri. It forms part of a large area in North and South Dakota, Wyoming, and Montana that is underlain by coal. The location of McCone County and its relation to other parts of this large coal-bearing area that have been described in publications of the United States Geological Survey are shown in figure 1. The names of the areas outlined and numbered on this map and references to bulletins of the Geological Survey in which they have been described are as follows:

Coal fields outlined on figure 1

No.	Field	Bulletin	No.	Field	Bulletin
1	McCone County.....	905	20	Miles City.....	341-A
2	Washburn.....	381-A	21	Marmarth.....	775
3	New Salem.....	726-A	22	Tullock Creek.....	749
4	Cannonball River.....	541-G	23	Bull Mountain.....	647
5	Standing Rock and Cheyenne River.....	575	24	Sheridan.....	341-B
6	Fort Berthold.....	471, 381	25	Powder River.....	381-B
7	do.....	726-D	26	Little Powder River.....	471-A
8	Williston.....	531-E	27	Gillette.....	796-A
9	Sentinel Butte.....	341-A	28	Northward extension of Sheridan.....	806-B
10	Northwestern South Dakota.....	627	29	Ashland.....	831-B
11	Culbertson.....	471-D	30	Rosebud.....	847-B
12	Scobey.....	751-E	31	Forsyth.....	812-A
13	Fort Peck.....	381-A	32	Richey-Lambert.....	847-C
14	Sidney.....	471-D	33	Mizpah.....	906-C
15	Glendive.....	471-D	34	Area south of Custer.....	541
16	Terry.....	471-D	35	Nesson anticline.....	691
17	Baker.....	471-D	36	Big Horn County and Crow Reservation.....	856
18	Ekalaka.....	751-F			
19	Little Sheep Mountain.....	531-F			

Previous investigations.—The presence of coal in the plains of eastern Montana, including areas in and adjacent to McCone County, was noted by the Lewis and Clark expedition ¹ in 1805. The first detailed

¹ Coues, Elliott, The history of the Lewis and Clark expedition, p. 280, New York, F. P. Harper, 1893.

geologic work was done from 1902 to 1909 by Brown,² who studied the Hell Creek beds in McCone County and in the region immediately to the west and collected from them bones of *Triceratops* and other land animals. Brown found a fossil locality in McCone County in the Colgate beds east of Big Dry Creek and north of McGuire Creek,

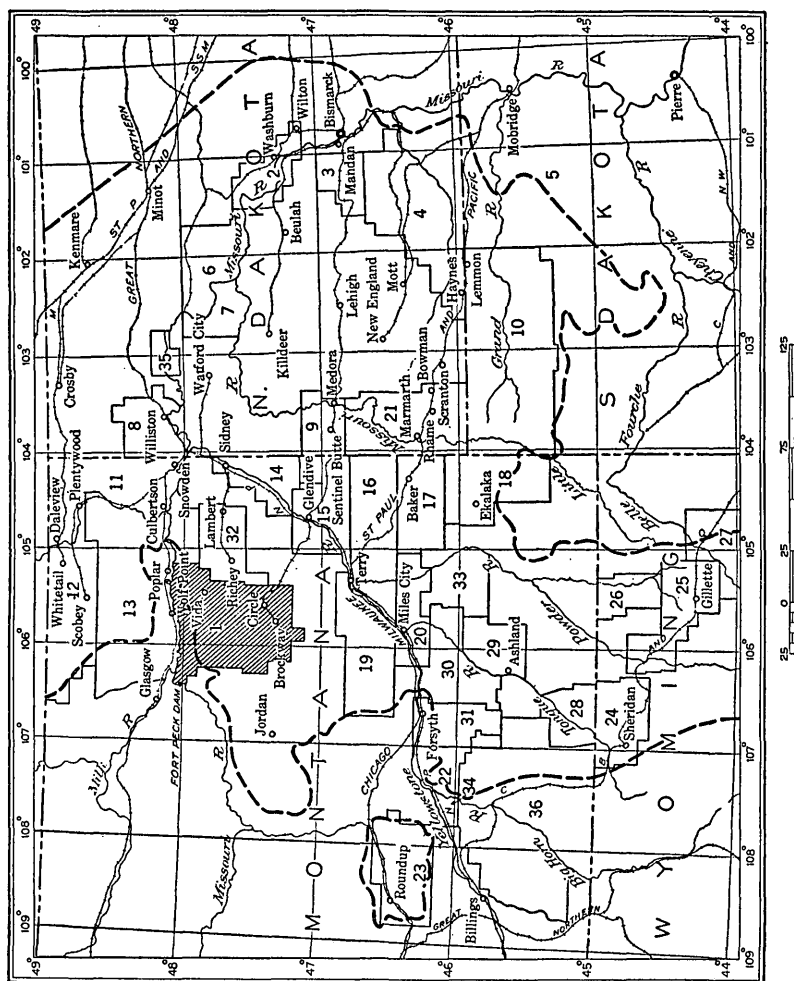


FIGURE 1.—Index map showing location of the McCone County coal field and its relation to other coal fields in eastern Montana and adjacent States. The heavy dashed line indicates the approximate limits of the area of lignites in the Lance and Fort Union formations. (See table in text for names of areas outlined and numbered.)

though most of his collections were made at Hell Creek, about 30 miles to the west. During the mapping of the Fort Peck Indian Reservation in 1908 Smith³ extended his mapping southward across the Missouri River to the south boundary of T. 26 N., Rs. 43 to 50 E.

² Brown, Barnum, The Hell Creek beds of Montana: Am. Mus. Nat. History Bull., vol. 23, pp. 823-845, 1907; Cretaceous-Eocene correlation in New Mexico, Wyoming, Montana, Alberta: Geol. Soc. America Bull., vol. 25, pp. 355-359, 1914.

³ Smith, C. D., The Fort Peck Indian Reservation lignite field, Montana: U. S. Geol. Survey Bull. 381, pp. 40-59, 1908.

Present investigation.—In 1919, W. T. Thom, Jr., assisted by W. P. Woodring, reexamined and mapped the coal in the area south of the Missouri River previously described in part by Smith. The southern limit of their work in McCone County is the south boundary of T. 25 N. A press statement⁴ released in 1921, accompanied by a contour map showing the geologic structure of the base of the Colorado group, discusses the oil possibilities of part of northeastern Montana, including the part of McCone County north of the south boundary of T. 22 N.

In 1922, C. E. Dobbin, assisted by J. E. Hoffmeister and A. H. Redfield, examined and mapped the coal in T. 23 N., Rs. 43 to 49 E., and T. 24 N., Rs. 43 to 50 E., in McCone County.

The field work on the remainder of the county was done in the summers of 1927, 1928, and 1929 by A. J. Collier, assisted by M. P. Billings, M. N. Bramlette, H. Burnside, G. R. Downs, J. K. Gustavson, C. E. Erdmann, F. S. Parker, W. G. Pierce, H. E. Thomas, E. F. Richards, E. H. Watson, and G. D. Senter. Collier also remapped small areas in the northern part of the county.

The parts of the county mapped by the different men are shown on figure 2.

The material for the present report has been compiled and the report written largely by M. M. Knechtel.

The Geological Survey's topographic maps (scale, 1:62,500; contour interval, 20 feet) of the Nashua, Frazer, Oswego, Wolf Point, Chelsea, and Poplar quadrangles (see fig. 2) were used in mapping the land between the Missouri River and latitude 48° N. The remainder of the county was mapped by traverse and triangulation with plane table and telescopic alidade, on a scale of 2 inches to the mile. Adequate horizontal control for the plane-table mapping was afforded by the surveys of the General Land Office, which cover the whole county. Vertical control for the townships near the Missouri River was obtained from the published topographic maps. Elsewhere, altitudes of coal beds were determined by stadia traverses starting from points of known altitude on the railroads at Circle and Brockway, in McCone County, and at Richey, in Dawson County.

GEOGRAPHY

Land features.—McCone County lies in the Missouri Plateau section of the Great Plains geomorphic province. The general slope of the land surface is northward from the south boundary of the county to the Missouri River. (See cross sections A-A', B-B', and C-C', pl. 8.) The Sheep Mountain divide between the Yellowstone and Missouri Rivers, which trends in general northeastward, crosses

⁴ Possible oil in northeastern Montana: Interior Dept. Press Mem. 30113, May 6, 1921.

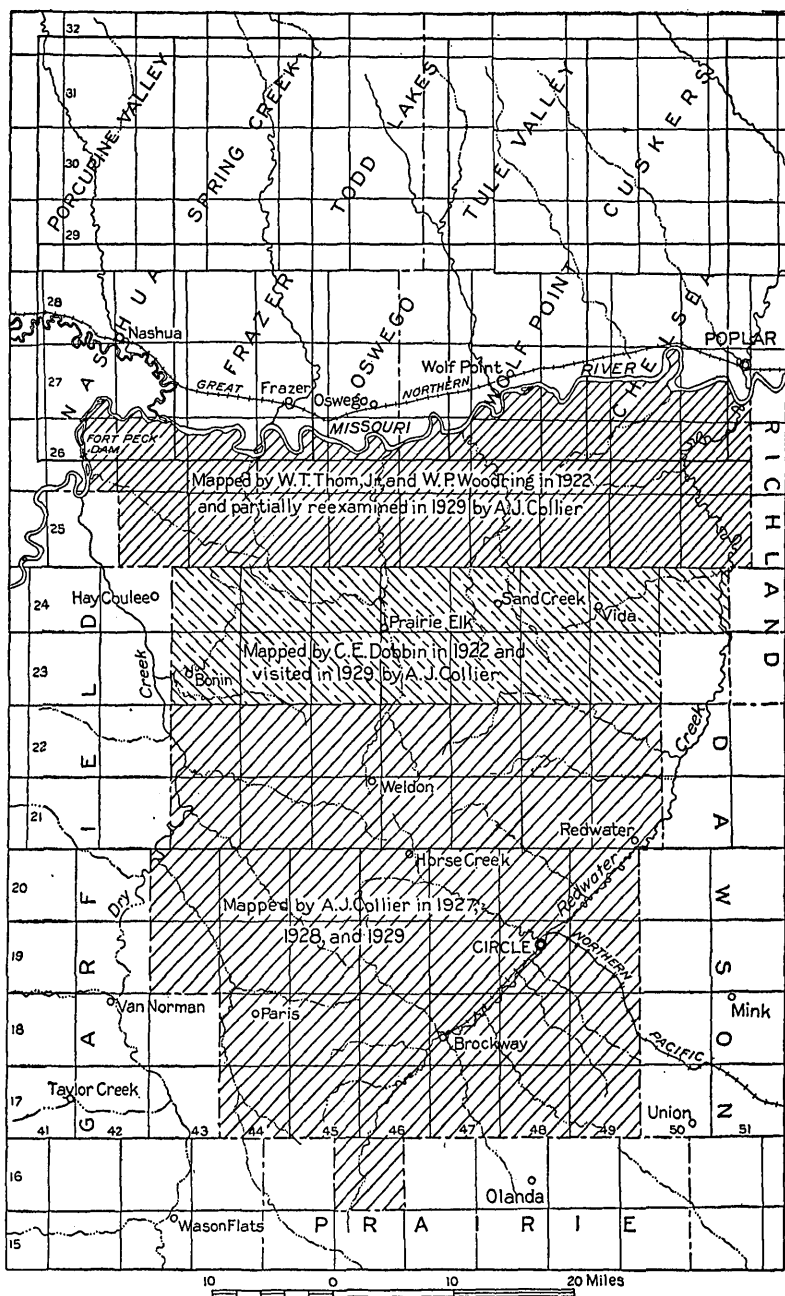


FIGURE 2.—Map showing areas in McCone County, Mont., mapped by A. J. Collier, W. T. Thom, Jr., and C. E. Dobbin. Shows also the limits of the published topographic maps of the Geological Survey in the northern part of the county.

the southeastern part of T. 17 N., R. 49 E. The altitude of this divide is about 3,300 feet and that of the Missouri River in T. 27 N., R. 50 E., is 1,960 feet. The total relief of the county is therefore a little more than 1,300 feet. The Horse Creek divide, between the areas drained by Redwater Creek and by streams flowing to Big Dry Creek and the Missouri River, extends southwestward from T. 24 N., R. 48 E., to the vicinity of Weldon and thence southward to the southern boundary of the county.

Bare steep slopes of the badlands type are common in some parts of McCone County. The Dry Creek badlands, near the western boundary, extend about 6 miles back from Dry Creek and are crossed by Timber, Nelson, and McGuire Creeks. In the northern townships of the county areas of rough topography, containing small tracts of badlands, are developed in the "breaks" of the Missouri River and of Hungry, Prairie Elk, Sand, and Redwater Creeks. Also of rugged character are the higher parts of the northwest slope of the Sheep Mountain divide in Tps. 17 and 18 N., R. 49 E.

By far the greater part of McCone County, however, consists of long, gentle slopes, only moderately incised and including much rolling grass land. The land surface descends northwestward from the Horse Creek divide to the "breaks" of the Missouri and the Dry Creek badlands, and southeastward to Redwater Creek; it rises southeastward from Redwater Creek to the rugged area near the Sheep Mountain divide.

The bottom land of the Missouri River includes the present flood plain of the river and remnants of low terraces; alluvial plains also extend along the major streams.

Drainage.—Nearly all of McCone County is drained by the Missouri River and its tributaries. An area of a few square miles in the southeastern part of T. 17 N., R. 49 E., is drained by tributaries of the Yellowstone River.

The Missouri River, which forms the northern boundary of the county, flows in broad meanders on a flood plain generally 2 to 3 miles in width. Comparison of the map made by the Missouri River Commission in 1890 and 1891⁵ with the Geological Survey's topographic maps made from 1908 to 1913 reveals that minor changes occurred in the channel of the Missouri in the interval between these surveys. Oxbow lakes and cut-off meanders indicate changes that occurred before the preparation of the earlier maps. The river falls about 90 feet in crossing McCone County from west to east.

The tributaries of the Missouri in McCone County are intermittent streams that flow throughout their courses only during the spring thaw and after rainstorms which occasionally cause floods in the

⁵ The Missouri River from Fort Benton, Mont., to Sioux City, Iowa, charts 54-67; surveyed in 1890 and 1891 under the direction of the Missouri River Commission by Corps of Engineers, U. S. A.

stream courses. At other times they are fed by scattered small springs and contain water only in pools. The northern part of the county is drained by several small tributaries of the Missouri River, but most of the county is drained by two large tributaries—Redwater Creek, which drains the southeastern and eastern parts of the county, and Big Dry Creek, which drains the western part.

Water supply.—Most of the water for domestic use is obtained from shallow dug wells near the creeks, from drilled wells a few feet to 200 or 300 feet deep, and from springs near the outcrops of coal beds. The towns of Circle, Brockway, and Vida obtain practically their entire water supplies from a single well each. A well 270 feet deep at Circle supplies water for use in the locomotives of the Northern Pacific Railway. The water in small pools along intermittent streams is generally alkaline and because of the danger of pollution is not safe for domestic use. The Missouri River offers an abundant supply of water for either domestic or commercial use, although it normally contains a large amount of mineral matter in suspension.

Perry⁶ has discussed in some detail the occurrence of ground water in this part of Montana.

Vegetation and climate.—Aldous and Deeds⁷ describe the vegetation and climate of McCone County as follows:

The vegetation of the uplands is a grama and needle grass type with western wheat grass prominent on the heavier soils and nigger wool on the lighter soils. In the breaks, black sage and western wheat grass are dominant. The Missouri River bottoms are marked by groves of cottonwood near the river and valley sage and grama on the higher bottoms. Boxelder, ash, and willow are found along the smaller streams, and in certain protected coulees there are thickets of wild rose, buck brush, chokecherry, and buffalo berry. The annual rainfall averages 13.5 inches along the Missouri River in the northern part of the county, but throughout the uplands it is approximately 15 to 16 inches. The average growing season is about 125 days along the Missouri River and 115 days on the uplands.

Some of the higher parts of the badland areas were formerly covered with a good growth of junipers, but most of these have been cut for firewood and fence posts.

According to reports of the United States Weather Bureau, the rainfall at Circle attains its maximum in June, when cloudbursts and violent hailstorms occur frequently; the minimum rainfall is in November. The annual mean temperature is 43° F.

*Industry and settlement.*⁸—McCone County, which comprises areas formerly belonging to Dawson and Richland Counties, was estab-

⁶ Perry, E. S., Ground water in eastern and central Montana: Montana Bur. Mines and Geology Mem. 2, 1931.

⁷ Aldous, A. E., and Deeds, J. F., Land classification of the northern Great Plains, Montana, North Dakota, South Dakota, and Wyoming, p. 52, U. S. Geol. Survey [mimeographed], 1929.

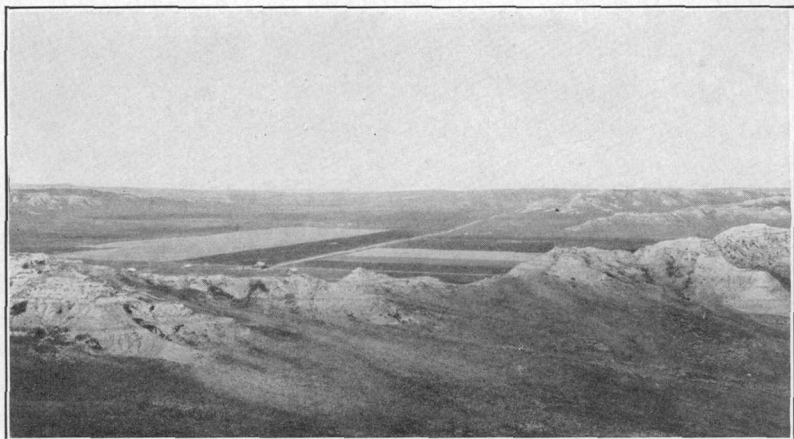
⁸ For a more extended geographic description of this part of Montana see Bowman, Isaiah, The Jordan country: Geog. Review, vol. 21, no. 1, pp. 22-55, 1931.

lished in 1919. The inhabitants are engaged mainly in farming and stock raising. The principal crops are wheat, flax, and hay; secondary crops are corn, oats, barley, and garden produce. Many horses and cattle and some sheep and hogs are raised. A small amount of coal is mined, but practically all of it is consumed within the county.

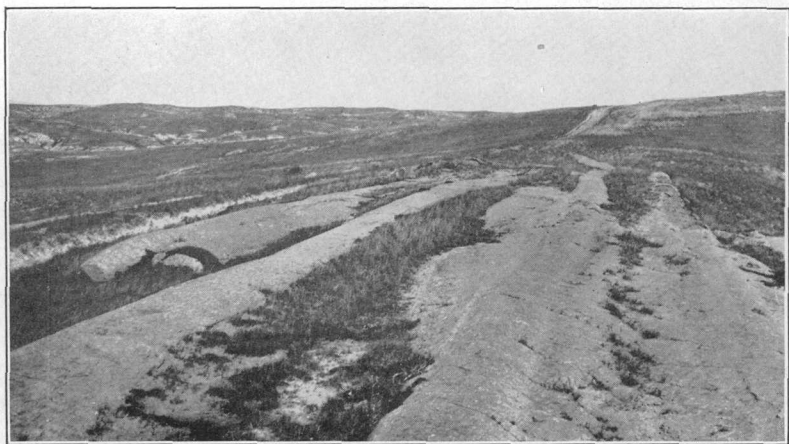
The population of the county was 4,747 in 1920 and 4,790 in 1930. The largest town is Circle, the county seat, with a population of 519 in 1930. Other towns are Brockway, the terminus of the Redwater branch of the Northern Pacific Railway, and Vida. Watkins, Horse Creek, Prairie Elk, and Sand Creek each have only a store and post office; Weldon (pl. 2, A) has, in addition, a church. Bonin has only a post office. The only buildings at Paris, the former post office and store, and the single building at Twitchel, the former post office, have long been unoccupied.

Routes of travel.—McCone County lies between the main line of the Great Northern Railway, along the north side of the Missouri River, and the main lines of the Northern Pacific Railway and the Chicago, Milwaukee, St. Paul & Pacific Railroad, along the Yellowstone River about 30 miles south of the county. Two branch lines of the Northern Pacific leave the main line at Glendive, Mont. One extends down the Yellowstone River from Glendive to Sidney, where it connects with a branch of the Great Northern. The Redwater branch of the Northern Pacific extends from Glendive through Circle to Brockway and is the only railroad in McCone County; it was completed in 1928. A branch line of the Great Northern Railway leaves the main line at Snowden, Mont., and extends through Sidney to Richey, in Dawson County, 14 miles east of McCone County; it was completed in 1920. Surveys have been made for an extension of the Redwater branch of the Northern Pacific westward to Jordan, in Garfield County, and for an extension of the branch line of the Great Northern from Richey to Vida, in the northeastern part of McCone County. (See fig. 1.)

Graded roads radiating from the principal settlements and many roads, mostly along section lines, leading to ranches and coal mines facilitate travel by automobile to all parts of the county. From Circle, the county seat, graded roads extend northward to Oswego, Wolf Point, and Poplar, northeastward to Richey, southeastward to Glendive, southward to Terry and Miles City, and westward by way of Brockway to Jordan. The road to Wolf Point crosses the Missouri River at the Wolf Point bridge, the only place in Montana below Fort Benton, about 340 miles upstream, at which wagons and automobiles could cross the Missouri without ferrying prior to construction of the Fort Peck Dam, at the northwest corner of McCone County.



A. VIEW OF WELDON, McCONE COUNTY, FROM BUTTE N. 70° E. OF THE SETTLEMENT.
Shows cultivated fields in upper valley of Prairie Elk Creek and roads running north-south and east-west



B. LOGLIKE CONCRETIONS OR CHANNEL SANDS IN LEBO SHALE NEAR BASE OF
TONGUE RIVER MEMBER OF FORT UNION FORMATION.
Sec. 13, T. 22 N., R. 46 E.

System	Series	Formation	Member	Coal beds	Section	Thickness (feet)	Character of rocks
Tertiary and Quaternary.	Oligocene to Recent.						Oligocene? to Pleistocene terrace gravels; Pleistocene and Recent silt, in part windblown, not formed by present streams; glacial drift and erratics; and Recent alluvium.
Unconformity							
Tertiary.	Eocene.	Fort Union formation.	Tongue River member.				
			P		0-9	700+	Light-yellow to lightgray alternating shale and sandstone with many persistent coal beds. Yellow predominates in lower part.
					55-100		
			Q		0-8		
					60-145		
			R		0-7		
					50-140		
			S		0-15		
Tertiary (?)	Eocene (?)	Lance formation.	Lebo shale member.				
Tertiary (?)	Eocene (?)	Lance formation.	Tullock member.				
Cretaceous.	Upper Cretaceous.	Fox Hills sandstone.	Colgate sandstone member.				
			Hell Creek member.				
Cretaceous.	Upper Cretaceous.	Fox Hills sandstone.	Tullock member.	V	20± 0-3¼ 25-60	165±	Alternating beds of light and dark somber shale, sandy shale, and sandstone; yellowish in eastern part of field, where it resembles the Tongue River member of the Fort Union. The dark shale is commonly carbonaceous, having streaks and small beds of coal from 5 to 30 feet apart.
				W	0-10 18-50		
				X	0-3¼ 12-40		
				Y	0-4¼ 10-30		
				Z	0-6		
			Hell Creek member.			135±	Mostly somber shale but has one or more beds of sandstone in the lower part, a persistent coal bed at top, and thin local coal beds in other parts of member.
Cretaceous.	Upper Cretaceous.	Fox Hills sandstone.	Colgate sandstone member.			80±	Soft light-brown sandstone containing irregular concretions of harder sandstone as large as 3 feet in diameter and locally a little coal.
			Basal member.				Dark-gray shale (Bearpaw) merging above into grayish-yellow sandy shale (basal Fox Hills), lighter in color than the Bearpaw. Both units contain abundant marine fossils; also limestone concretions arranged in bands parallel to the bedding planes. Only the upper 500 feet of these beds is exposed.
Cretaceous.	Upper Cretaceous.	Fox Hills sandstone.	Bearpaw shale.			500+	Dark-gray shale (Bearpaw) merging above into grayish-yellow sandy shale (basal Fox Hills), lighter in color than the Bearpaw. Both units contain abundant marine fossils; also limestone concretions arranged in bands parallel to the bedding planes. Only the upper 500 feet of these beds is exposed.
			Bearpaw shale.				Dark-gray shale (Bearpaw) merging above into grayish-yellow sandy shale (basal Fox Hills), lighter in color than the Bearpaw. Both units contain abundant marine fossils; also limestone concretions arranged in bands parallel to the bedding planes. Only the upper 500 feet of these beds is exposed.

Scale, 1 inch=60 feet.

GENERALIZED SECTION OF THE EXPOSED ROCKS OF McCONE COUNTY, MONT.

STRATIGRAPHY

GENERAL CHARACTER AND AGE OF THE ROCKS

All the rocks exposed in McCone County are of sedimentary origin and range in age from Upper Cretaceous to Recent. (See pl. 3.) The upper part of the marine Bearpaw shale (Upper Cretaceous) is the oldest formation that crops out in the county. It is overlain by the Fox Hills sandstone (Upper Cretaceous), which is chiefly marine, and this is in turn overlain by about 1,500 feet of nonmarine shales and sandstones of the coal-bearing Lance (Eocene?) and Fort Union (Eocene) formations. Surficial deposits ranging in age from Oligocene (?) to Recent form a thin mantle over the eroded surface of the Cretaceous and Eocene rocks in many places. They include loess, morainal material, stream gravel, and alluvial fill along present streams.

CRETACEOUS SYSTEM

UPPER CRETACEOUS SERIES

BEARPAW SHALE

The Bearpaw shale is exposed south of the Missouri River near the northwest corner of McCone County, whence its outcrop extends eastward along the river and several miles up Big Dry and Prairie Elk Creeks. The part of the Bearpaw that appears at the surface attains a thickness of more than 420 feet. Near Wolf Point, owing to the synclinal structure (see p. 18), the Bearpaw disappears below the flood plain of the river and reappears as a narrow strip near the eastern boundary of the county. The Bearpaw is a dark-gray marine shale, but is sandy in the upper part, and the transition between the Bearpaw and the overlying Fox Hills sandstone is gradational.

The Bearpaw shale crops out extensively in eastern and central Montana and is approximately equivalent to the upper part of the Pierre shale, which is exposed in large areas in North and South Dakota, Wyoming, Nebraska, and Colorado. In eastern Montana the Bearpaw is about 1,000 feet thick. It underlies the Fox Hills sandstone and overlies the Judith River formation. The Judith River exposures nearest to McCone County are at Tampico, Mont., about 27 miles to the northwest.

FOX HILLS SANDSTONE

The Fox Hills sandstone crops out in McCone County along the Missouri River and in Big Dry and Prairie Elk Creeks (pl. 4, C). It comprises two members. The basal member, which is of marine origin, ranges in thickness from less than 80 feet to 200 feet and is composed chiefly of thin beds of grayish-yellow sandy shale. The upper member is about 80 feet thick and is made up of massive beds, generally cross-bedded, of soft light-brown sandstone, containing

irregular concretions of harder sandstone as much as 3 feet in diameter. Brown apparently regarded this sandstone as equivalent to the white sandstone along the Missouri River from Hell Creek, in Garfield County, westward to the Musselshell River. He included the white beds at Hell Creek in the "basal sandstone" of the Hell Creek member of the Lance formation; Thom and Dobbin⁹ assigned them to the Colgate sandstone member of the Fox Hills formation, establishing a precedent which is followed in this report. The nonmarine origin of the Colgate member at Hell Creek is indicated by the occurrence in it of numerous remains of dinosaurs and other nonmarine vertebrates and of land plants.

Brown¹⁰ states that on Big Dry and Prairie Elk Creeks he was able to recognize both the Colgate member of the Fox Hills, described by him as the "basal sandstone of the Hell Creek formation," and the underlying marine Fox Hills sandstone beds, which he describes as "finer-grained, harder, and more compact" than their equivalents at Hell Creek, in Garfield County, about 30 miles west of McCone County. No attempt has been made in the present report to map separately the Colgate member and the underlying sandstone member of the Fox Hills formation, which are shown on plate 1 as a unit.

TERTIARY (P) SYSTEM

EOCENE (?) SERIES

LANCE FORMATION

The question whether the Lance formation should be assigned to the Cretaceous on the basis of its vertebrate faunas or to the Eocene on the evidence of its fossil plants has long been controversial. In the official classification of the Geological Survey the formation is placed in the Eocene (?).

In McCone County, where the Lance is about 300 feet thick, it is underlain by the Fox Hills sandstone, of Upper Cretaceous age, and underlies the Fort Union formation, of Eocene age. Two members of the Lance are recognized in the county—a lower, the Hell Creek member, and an upper, the Tullock member.¹¹

Hell Creek member.—The Hell Creek member consists of somber-colored shale with some interbedded sandstone, in all about 135 feet thick, cropping out along Big Dry Creek and in a broad strip of land extending eastward across the northern part of the county. Brown,¹² who named the Hell Creek deposits, stated that at Hell Creek, a

⁹ Thom, W. T., Jr., and Dobbin, C. E., Stratigraphy of Cretaceous-Eocene transition beds in eastern Montana and the Dakotas: Geol. Soc. America Bull., vol. 35, p. 400, 1924.

¹⁰ Brown, Barnum, Cretaceous Eocene correlation in New Mexico, Wyoming, Montana, Alberta: Geol. Soc. America Bull., vol. 25, p. 357, 1914.

¹¹ Since the present report was written, the Hell Creek and Tullock members have been raised to the rank of formations in the official classification of the Geological Survey, the Hell Creek being assigned to the Cretaceous and the Tullock to Cretaceous or Eocene.

¹² Brown, Barnum, The Hell Creek beds of Montana: Am. Mus. Nat. History Bull., vol. 23, pp. 823-845, 1907.

tributary of the Missouri River about 30 miles west of McCone County, "remains of *Triceratops* are found from the very base of the sandstone to the top of the beds." The sandstone referred to by Brown is the Colgate, which he regarded as the "basal sandstone" of the Hell Creek because it contains the same fauna as the overlying beds. More recent work by members of the Geological Survey¹³ has resulted in correlation of the partly nonmarine Colgate sandstone of eastern Montana with the marine uppermost Fox Hills sandstone beds at the type locality in the Cheyenne Indian Reservation, S. Dak. In McCone County the Hell Creek beds, mapped as a member of the Lance formation (pl. 4, A), overlie the Colgate sandstone.

Tullock member.—The Tullock is the upper member of the Lance formation. It is composed of about 165 feet of dark carbonaceous shale and coal beds, separated by layers, usually thick and at many places cross-bedded (pl. 5, B), of light-colored sandstone, shale, and sandy shale (pl. 4, B). Steep bare slopes and cliffs are characteristic of the member. Its area of outcrop forms an irregular belt trending northeastward from T. 20 N., R. 43 E., to the vicinity of Sheep Creek, in T. 26 N., R. 49 E., in the northeastern part of the county, where, owing to the synclinal structure, the belt bends and pursues a south-eastward course to Wolf Creek, at the eastern boundary of the county. Along Sand Creek, in T. 24 N., R. 47 E., and in the eastern part of the area north of T. 24 N., yellow is the prevailing color of the Tullock member. Probably for this reason it was mistaken by Smith¹⁴ for the Fort Union formation, and it was mapped as the Tongue River member of the Fort Union even during the early stages of the present investigation. The Tullock has a more somber color in the western part of McCone County, where it is distinguished from the rocks above and below it by its greater resistance to weathering.

TERTIARY SYSTEM

Eocene Series

Fort Union Formation

The Fort Union formation, of Eocene age, is about 1,100 feet thick in McCone County. It overlies the Lance formation and, in this part of Montana, is composed of a lower part, the Lebo shale member, and an upper part, the Tongue River member.

Lebo shale member.—The Lebo shale member¹⁵ of the Fort Union formation in McCone County (pl. 6, A) consists of thick beds of white sandy clay and brownish sandstone, cross-bedded in places (pl. 5, A),

¹³ Thom, W. T., Jr., and Dobbin, C. E., Stratigraphy of Cretaceous-Eocene transition beds in eastern Montana and the Dakotas: Geol. Soc. America Bull., vol. 35, pp. 485, 486, 490, 491, 1924.

¹⁴ Smith, C. D., The Fort Peck Indian Reservation lignite field, Montana: U. S. Geol. Survey Bull. 381, p. 43, 1908.

¹⁵ Thom, W. T., Jr., and Dobbin, C. E., Stratigraphy of Cretaceous-Eocene transition beds in eastern Montana and the Dakotas: Geol. Soc. America Bull., vol. 35, pp. 493-494, 1924.

alternating with nearly black clay shale. Plate 2, *B*, shows curious loglike concretions occurring near the top of the member. Its color and the predominance of clay in it distinguish the Lebo from the pre-vaillingly sandy and yellowish Tongue River member, which overlies it. Its outcrop is a broad belt extending in a northeasterly direction across the county from T. 19 N., R. 43 E., through Weldon to the region northeast of Vida. No very reliable estimate could be made of the thickness of this member in McCone County, owing to the slight dip, the scarcity of horizon markers, and the great distance, commonly several miles, across the outcrop. Rough calculations based on data gathered at several places, however, indicate that its thickness is about 400 feet, and this figure, when assumed in the further computations upon which the structure contour map (pl. 9) is based, gives at least a plausible result in the spacing and outline of the contours. The most striking exposures are at the head of Prairie Elk Creek, in the neighborhood of Weldon (pl. 2, *A*), where about 200 feet of Lebo beds are exposed in the bare walls of the valley, which was probably cut during Pleistocene time by waters flowing along the front of the Keewatin ice sheet. Except for the U (Big Dirty) bed at its base, the Lebo member contains only a few lenses of coal, all of which are in the basal 100 feet.

Tongue River member.—The contact between the Lebo and Tongue River members of the Fort Union formation is not well defined, though its approximate position can be determined at many places in the field. In the present report it is placed somewhat arbitrarily about 50 feet below bed S, the most valuable coal bed in McCone County.

The beds of the Tongue River member are mainly yellowish or light-colored sandstones and sandy shales. They underlie all the land surface southeast of the Lebo shale outcrop, or about half of McCone County. About 700 feet of these beds are exposed in the county. The lower 400 feet contains at least four extensive coal beds (P, Q, R, and S) and several lenses of coal that occupy relatively small areas; the remaining 300 feet of strata, overlying bed P, include no coal beds of commercial value but contain several small beds which may be correlative with valuable beds in other parts of Montana. About 200 feet of the Tongue River member, above bed P, is exposed in T. 17 N., R. 49 E., along the road from Brockway to Glendive. These barren beds are more uniformly light in color than the underlying coal-bearing portion of the Tongue River member.

FORT UNION (?) FORMATION

Sentinel Butte (?) member.—The highest observed beds assigned to the Eocene in McCone County are in the Tongue River member of the Fort Union formation in the southeastern part of T. 17 N.,

R. 49 E., about 700 feet above the base of the member. On Antelope Mountain, however, about a mile east of the county, in T. 18 N., R. 50 E., and at about the same altitude, a dark shale appears which is probably in the Sentinel Butte shale member of the Fort Union (?) formation (Eocene).¹⁶ The section at Antelope Mountain is about as follows:

	<i>Feet</i>
Gravel (Oligocene or Miocene)-----	20-100
Unconformity.	
Dark shale with four thin coal beds. (Sentinel Butte (?) member of Fort Union (?) formation)-----	50
Tongue River sandstone and shale.-----	650±

OLIGOCENE OR MIOCENE TERRACE GRAVEL

Gravel deposits tentatively correlated by the present writers with the gravel on the Cypress Hills, Saskatchewan, occur on the divide crossing T. 17 N., R. 49 E. These deposits have a maximum thickness of 100 feet. Sheep Mountain, to the southwest along the divide in T. 15 N., R. 47 E.; Little Sheep Mountain, about 12 miles south of Sheep Mountain; and Antelope Mountain, in Tps. 17 and 18 N., R. 50 E., on the divide about 1 mile east of the county (pl. 7, B), all have about the same altitude as the high gravel in T. 17 N., R. 49 E. Sheep Mountain and Antelope Mountain are likewise capped by gravel. No fossils have been found in these gravel deposits, and their tentative correlation with the Oligocene gravel on the Cypress Hills, Saskatchewan, is based on their high altitude.

MIOCENE OR PLIOCENE TERRACE GRAVEL

Though no fossils have been collected in Montana in ancient terrace gravel south of the Missouri River, and though it is not known that the Flaxville gravel (see p. 15) ever extended continuously across the Missouri, a comparison of the profiles (pl. 8) suggests that the dissected plain south of the Missouri, at an altitude of 2,500 to 2,800 feet, or 500 to 800 feet below the supposed Oligocene or Miocene gravel in T. 17 N., R. 49 E., may be either a southward extension of the Flaxville plain or a separate plain representing the same stage of erosion as the Flaxville. Gravel was seen by Collier on this plain only in the region southeast of Redwater Creek, but the surface is believed to be preserved or only slightly eroded on the Horse Creek divide. In his unpublished field notes on northern McCone County (1919), W. T. Thom, Jr., states that there is in sec. 36, T. 25 N., R. 43 E., a quartzite gravel terrace, 2,781 feet above sea level which may questionably be Flaxville or may be worked-over gravel. The location and the altitude are not far from those of the Flaxville plain,

¹⁶ Smith, C. D., and Leonard, A. G., The Sentinel Butte lignite field, N. Dak., and Mont.: U. S. Geol. Survey Bull. 341, pp. 15-35, 1909.

as shown in plate 8, cross section B-B', projected between Shade Creek and Deadman Butte.

Alden ¹⁷ has discussed in some detail the occurrence and correlation of the Flaxville and other high-level gravel deposits in eastern Montana.

TERTIARY OR QUATERNARY SYSTEM

LATE PLIOCENE OR EARLY PLEISTOCENE TERRACE GRAVEL

Terraces believed to be remnants of surfaces developed in late Pliocene or early Pleistocene time (sections A-A' and B-B', pl. 8) occur 200 to 300 feet above the Missouri River, bordering its flood plain at many places in McCone County and across the river in Roosevelt and Valley Counties. These terraces are generally covered with glacial drift, but locally water-worn nonglacial gravel underlies the drift. Between the level of these terraces and that of the Flaxville plain as projected across McCone County there is an extensive area, mainly in the northern half of the county, concerning which only meager geomorphic information is available. In his unpublished field notes on northern McCone County (1919), W. T. Thom, Jr., reports remnants of gravel terraces [which may be of early Pleistocene age] at the following localities and altitudes:

	<i>Feet</i>
Sec. 32, T. 25 N., R. 42 E.	2,512
Sec. 7, T. 25 N., R. 44 E.	2,441
Sec. 6, T. 25 N., R. 47 E.	2,336
Sec. 29, T. 25 N., R. 47 E.	2,333
Sec. 4, T. 24 N., R. 47 E.	2,393

Rapid erosion in the Hell Creek, Tullock, and Lebo beds has left little if any evidence upon which to work out a detailed history of the erosion. The surface, however, was probably reduced to nearly its present form and position below the Flaxville plain in the interval between the Miocene epoch and the late Pleistocene glaciation. This interpretation is suggested by the occurrence at Wolf Point of glacial till less than 50 feet above the Missouri River ¹⁸ resting upon river gravel.

QUATERNARY SYSTEM

PLEISTOCENE GLACIAL DEPOSITS

Drift.—Rock debris brought from the north by the Keewatin ice sheet is found in the northern part of McCone County, where in places it is as much as 30 feet thick. The approximate southern limit of this material, according to Alden,¹⁹ is shown on plate 8. It consists of unstratified clay and sand mixed with boulders and pebbles of limestone and of granite and other crystalline rocks, some of them from

¹⁷ Alden, W. C., Physiography and glacial geology of eastern Montana and adjacent areas: U. S. Geol. Survey Prof. Paper 174, pp. 3-69, 1932.

¹⁸ Collier, A. J., Geology of northeastern Montana: U. S. Geol. Survey Prof. Paper 120, p. 36, 1919.

¹⁹ Alden, W. C., op. cit. (Prof. Paper 174), pl. 1.

outcrops as distant as the Hudson Bay region, and of sandstone from Cretaceous and Tertiary rock exposures nearer at hand.

Erratic boulders.—Boulders strewn on the surface for a few miles south of the southern limit of the ice advance are supposed to have been deposited by icebergs floating in water impounded by the front of the glacier.

PLEISTOCENE OR RECENT LOESS

In many parts of the county the surface is mantled by fine-grained material, or silt, generally unstratified and probably in large part wind-blown (loess).²⁰ This material is being eroded by the streams to form steep-walled coulees (pl. 7, A).

RECENT ALLUVIUM

Silt and gravel underlie the Missouri River bottom land, which in places attains a width of 3 miles, as well as the narrower flood plains of the many minor streams of McCone County.

GEOMORPHOLOGY

Several erosion surfaces developed in McCone County have been referred to in the stratigraphic discussion (pp. 13-14). Collier and Thom²¹ described four such surfaces, representing four major stages in the history of erosion, in northeastern Montana and the adjacent parts of Canada. The highest surface, and therefore the oldest, is that of the Cypress plain,²² in the Provinces of Alberta and Saskatchewan. The gravel on this surface contains remains of Oligocene land animals and may be correlated with the White River formation²³ of Nebraska and the Dakotas. Below the Cypress plain as projected across northeastern Montana, north of the Missouri River, is the Flaxville plain, which is capped by gravel that has yielded Miocene or early Pliocene mammalian remains and one doubtful Pleistocene fossil. A third surface, represented by erosion remnants below the Flaxville plain, is regarded as having developed during late Pliocene or early Pleistocene time. The fourth stage of erosion in northeastern Montana began in early Pleistocene time and resulted in the development of the lowest terrace along the Missouri River below the present mouth of the Milk River. Renewed cutting by the

²⁰ Collier, A. J., A formation hitherto unaccounted for in North Dakota: Washington Acad. Sci. Jour., vol. 8, no. 12, pp. 412-413, 1918.

²¹ Collier, A. J., and Thom, W. T., Jr., The Flaxville gravel and its relation to other terrace gravels of the northern Great Plains: U. S. Geol. Survey Prof. Paper 108, p. 184, 1918.

²² McConnell, R. G., On the Cypress Hills, Wood Mountain, and adjacent country: Canada Geol. Survey Ann. Rept., new ser., vol. 1, pp. 1c-78c, 1886.

²³ Cope, E. D., The Vertebrata of the Swift Current Creek region of the Cypress Hills: Canada Geol. Survey Ann. Rept., new ser., vol. 1, pp. 79c-85c; The species from the Oligocene or lower Miocene beds of the Cypress Hills: Canada Geol. Survey Contr. Canadian Paleontology, vol. 3, pp. 1-25, 1891. Lambe, L. M., A new species of *Hyracodon* (*H. priscidens*) from the Oligocene of the Cypress Hills, Assinibola: Roy. Soc. Canada Proc. and Trans., 2d ser., vol. 11, sec. 4, pp. 37-42, 1906; Fossil horses of the Oligocene of the Cypress Hills: Idem, pp. 43-52; Vertebrata of the Oligocene of the Cypress Hills, Saskatchewan: Canada Geol. Survey Contr. Paleontology, vol. 3, pt. 4, 1908.

Missouri then trenched this old valley bottom to a depth of 100 feet or more, and tributary valleys were also deepened before the process of stream erosion was interrupted by the invasion of northern McCone County and adjacent parts of northeastern Montana by the great ice sheet of the Iowan (?) or Illinoian (?) stage of glaciation.

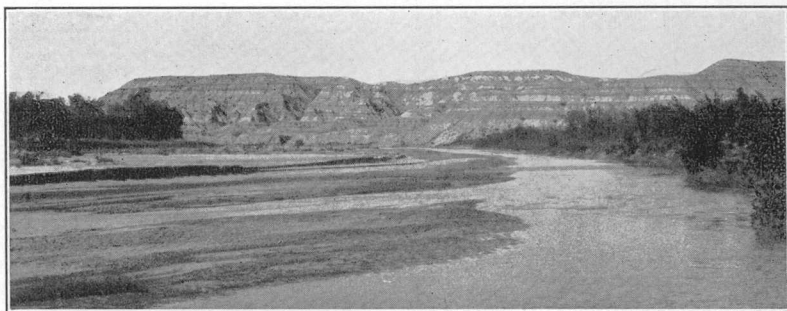
Remnants of erosion surfaces possibly corresponding to the upper two (Cypress and Flaxville) of the four erosion plains of Collier and Thom have been recognized in McCone County. The third stage (late Pliocene or Pleistocene) is probably represented by erosion to lower levels in the country lying between the Missouri River and the Horse Creek divide. The fourth erosion level is marked by the lowest terrace above the flood plain of the Missouri River and its principal tributaries.

STRUCTURE

General features.—The strata of the Bearpaw, Fox Hills, Lance, and Fort Union formations (Upper Cretaceous and Eocene), which lay nearly horizontal when they were deposited and remained so until late Eocene time, have since been tilted, folded, and faulted. No evidence is at hand as to whether the Cypress plain (Oligocene or Miocene) was developed before or after the deformation, but the Flaxville gravel (Miocene or Pliocene) was not involved in the movements and rests unconformably upon the eroded surfaces of all the rock units from the Bearpaw shale up to and including the Tongue River member of the Fort Union formation. The deformation therefore occurred after the deposition of the highest Tongue River beds and before the development of the Flaxville plain.

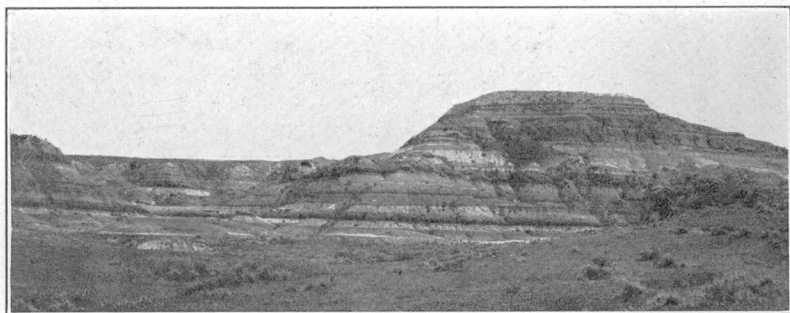
The contours on plate 9 represent the approximate configuration of the basal surface of the Colgate sandstone. The surface is projected above the northwestern part of the county, from which the sandstone has been removed by erosion, and under the southeastern part where the Colgate lies beneath younger deposits. Altitudes were determined at several hundred points scattered throughout the county on various geologic horizons, principally on coal beds of known stratigraphic position. In constructing the map the altitudes with respect to sea level on the base of the Colgate under or above these points were calculated. In making the computations each formation, in the absence of detailed data as to probable variations in thickness, was assumed to be of uniform thickness throughout. Along the outcrop of the Colgate sandstone the altitudes indicated by the contours are therefore true to the degree of accuracy obtainable by plane-table methods, but their accuracy may be expected to decrease progressively northwestward and southeastward.

The highest point, structurally, in McCone County is in the northwest corner of the county and is west of the 2,500-foot structure contour, where it crosses T. 26 N., R. 41 E.; the lowest point is in the area



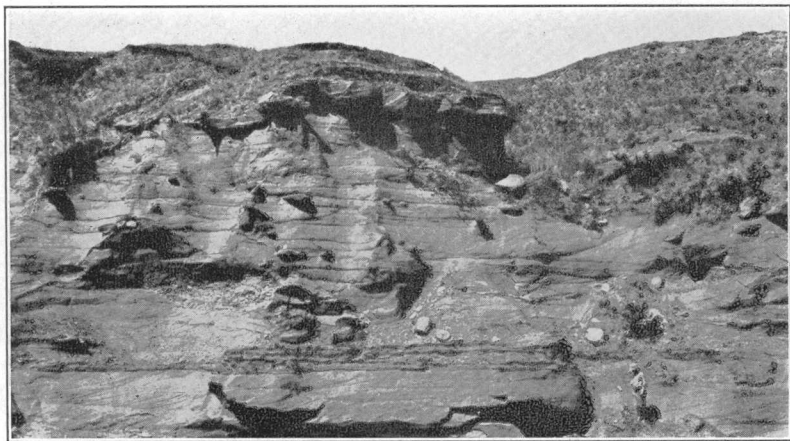
A. VIEW LOOKING DOWNSTREAM ON BIG DRY CREEK JUST BELOW THE MOUTH OF
TIMBER CREEK, T. 20 N., R. 43 E.

Bluffs consist of Hell Creek member of Lance formation.



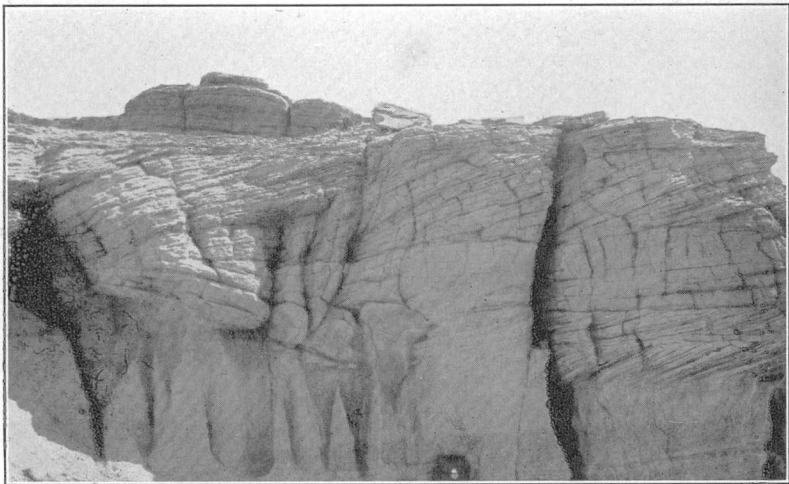
B. SHALE OF THE TULLOCK MEMBER OF THE LANCE FORMATION IN T. 23 N., R. 43 E.

Base of Tullock member is probably at edge of grass, but may be higher. Uppermost beds in cliff are probably not far below base of Lebo member.

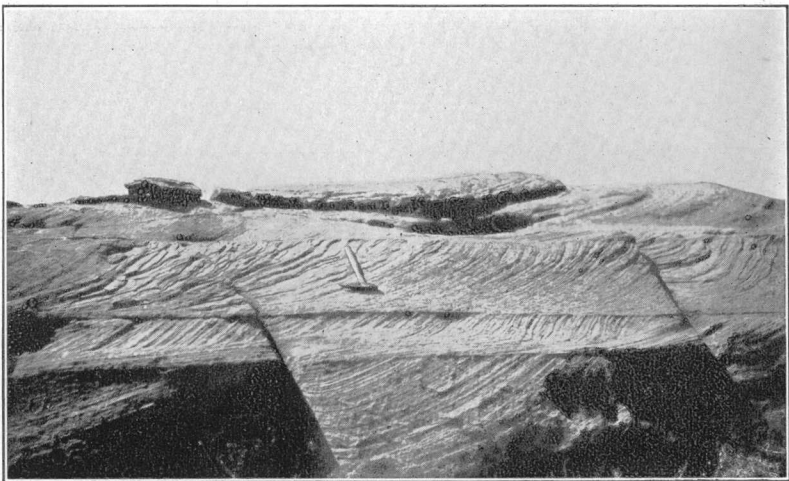


C. COLGATE SANDSTONE MEMBER OF THE FOX HILLS SANDSTONE, SEC. 21, T. 23 N., R. 43 E.

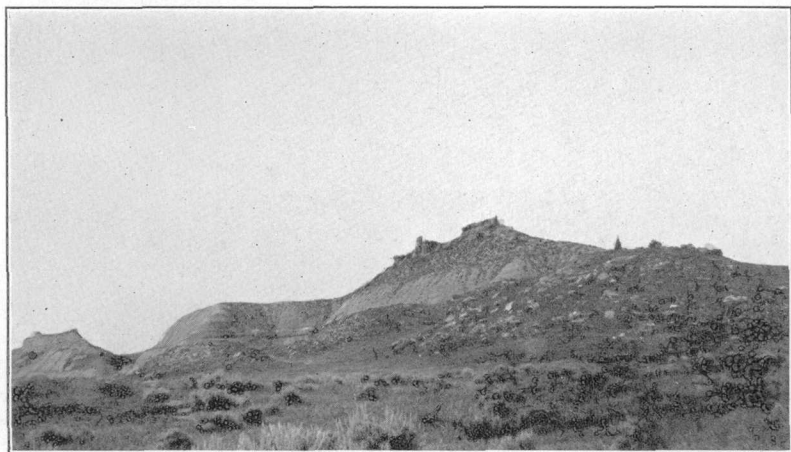
On north fork of Rock Creek, near Bonin.



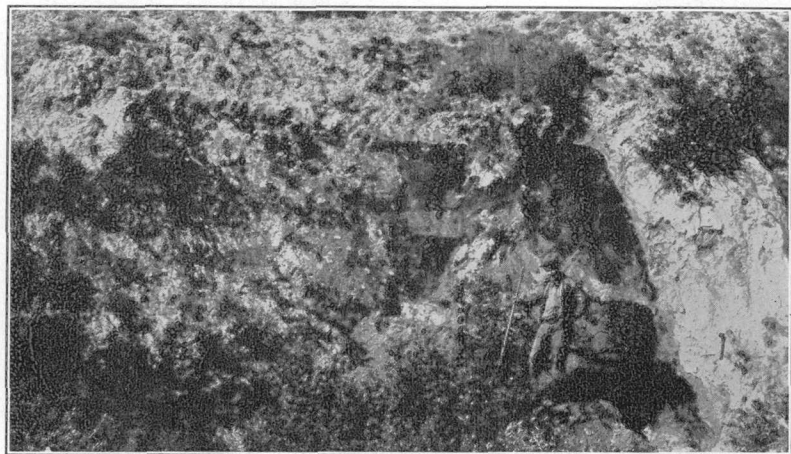
A. LEBO MEMBER OF FORT UNION FORMATION IN SEC. 15, T. 21 N., R. 43 E.



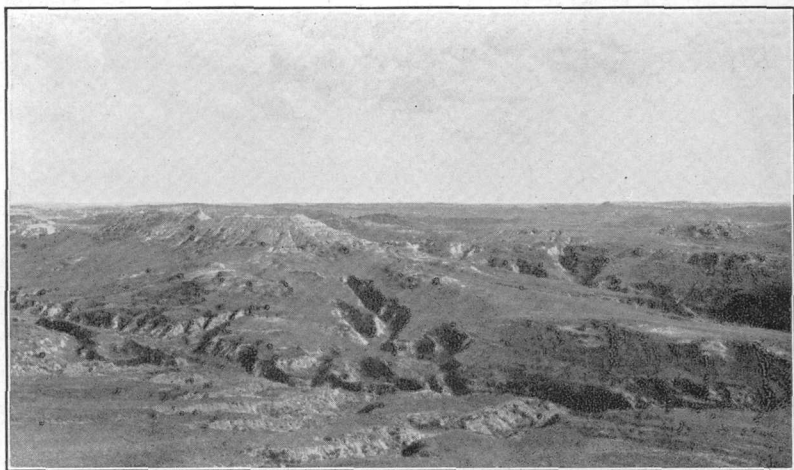
B. TULLOCK MEMBER OF LANCE FORMATION IN SEC. 10, T. 21 N., R. 44 E.
CROSS-BEDDED SANDSTONES.



A. LEBO SHALE, T. 21 N., R. 44 E.

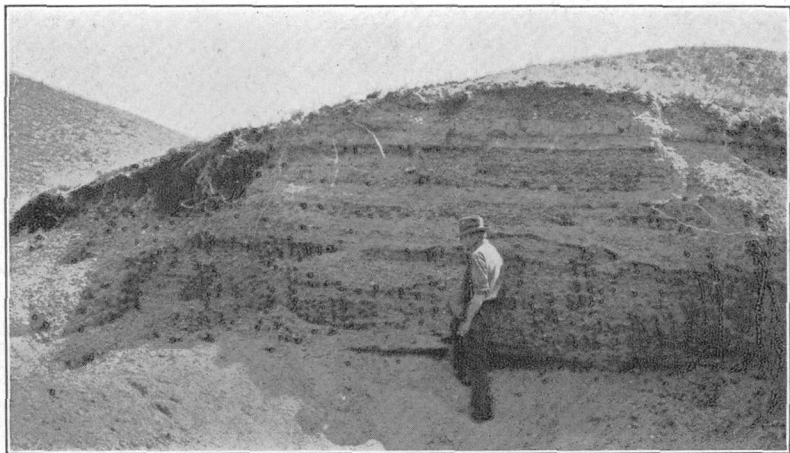


B. COAL BED S (LEFT) FAULTED (?) AGAINST LEBO SHALE (RIGHT).
Sec. 32, T. 22 N., R. 46 E.



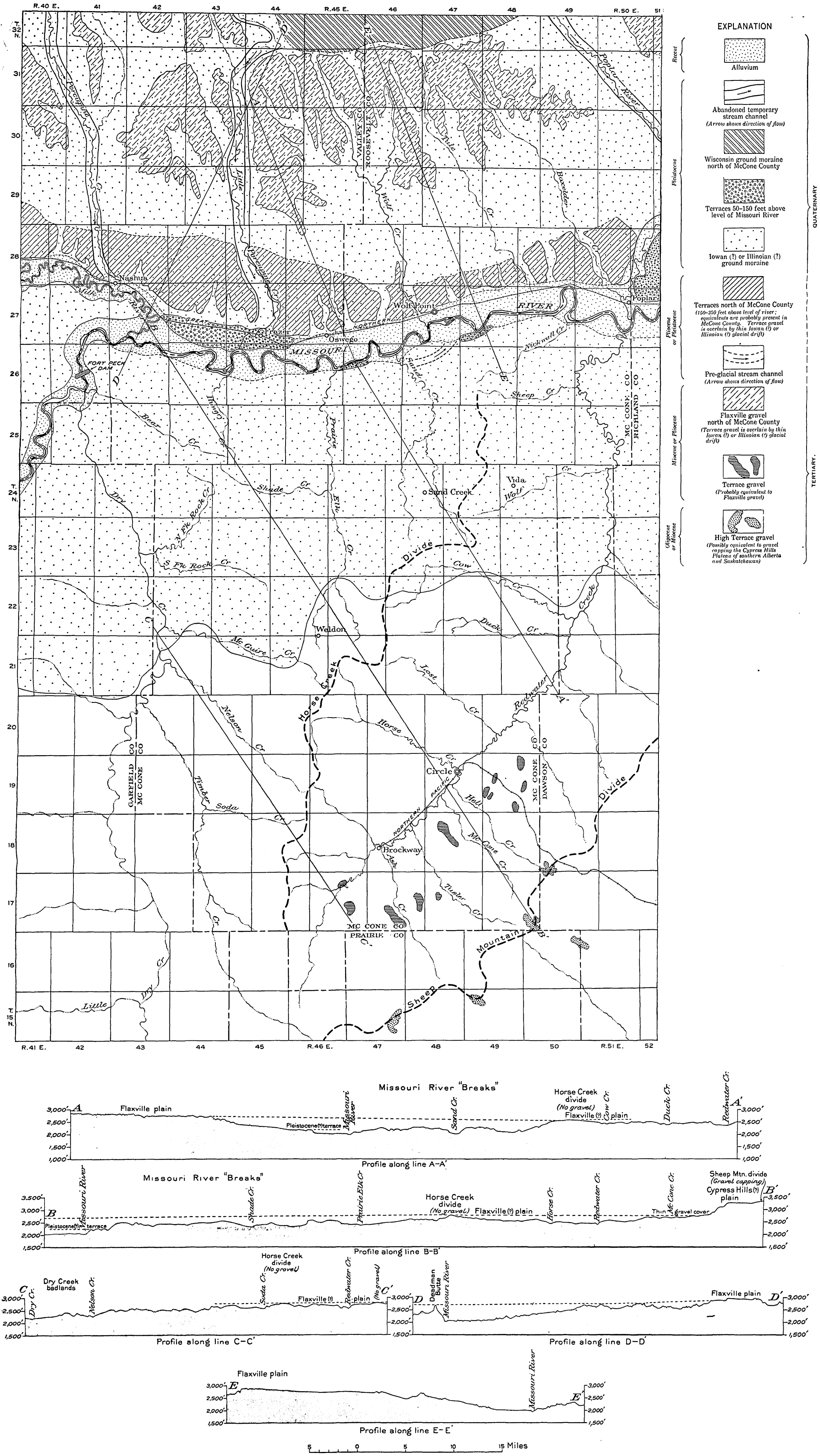
A. RECENT CUTTING OF QUATERNARY SILT, PROBABLY WINDBLOWN, RESTING UNCONFORMABLY ON ERODED SURFACE OF THE TONGUE RIVER BEDS.

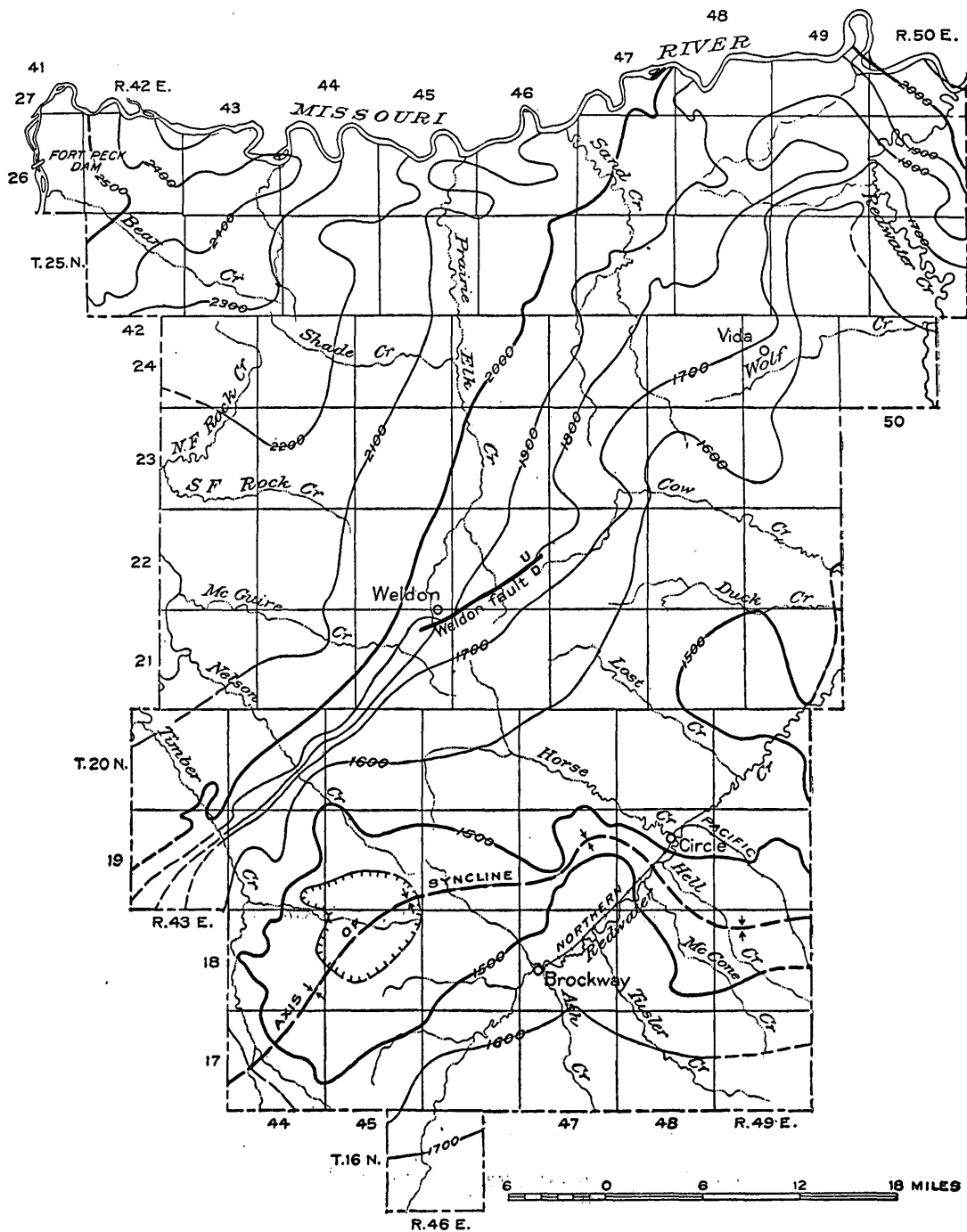
In the southeastern part of T. 20 N., R. 44 E.



B. ROAD CUT IN CYPRESS HILLS (?) GRAVEL NEAR TOP OF ANTELOPE MOUNTAIN.

In sec. 31, T. 18 N., R. 50 E., about 1 mile east of McCone County.





MAP SHOWING GEOLOGIC STRUCTURE OF McCONE COUNTY, MONT.

enclosed by the 1,400-foot depression contour west of Brockway. The maximum structural relief is therefore more than 1,100 feet.

Except in the narrow zone along the monoclinal fold extending southwestward from Weldon, the dips are ordinarily so gentle in McCone County that the strata appear to be horizontal. The structure contour map, however, indicates that most of the county lies in a broad syncline whose axis crosses the southern townships. In the geologic cross sections A-A', B-B', and C-C', plate 1, the vertical scale is 8.8 times the horizontal, and the inclination of the strata on the flanks of the syncline is therefore greatly exaggerated. Dobbin and Erdmann²⁴ regard this syncline as part of a great syncline, about 250 miles in length, extending westward to Fergus County and eastward to Fallon County, Mont., known in its western part as the "Blood Creek syncline" and in its eastern part as the "Sheep Mountain syncline." The axis of the syncline at the east boundary of McCone County as shown on plate 9 is about 15 miles north of the position indicated on Dobbin and Erdmann's map, but the two maps agree more closely as to the location of the axis in the southwestern part of the county.

Weldon fault and monocline.—Extending northeastward from T. 19 N., R. 43 E., to the northeastern part of T. 21 N., R. 45 E., southwest of Weldon, is a zone in which the southeastward dip is slightly greater than that of the very gently inclined strata to the northwest and southeast (pl. 9). A monocline is thereby defined in which the strata dip 1°–3° SE. (See section C-C', pl. 1.) Unlike the dips elsewhere in McCone County, which are generally much less than 1° and may be determined only through use of surveying instruments, those along the front of the Weldon monocline are sufficiently steep to be noticeable at a glance. Vantage points from which the dip of the monocline is plainly visible may be found near the old stage road in the northwestern part of T. 21 N., R. 46 E., and northeast of the Crooker ranch, in T. 20 N., R. 44 E.

About 1½ miles southwest of Weldon the monocline ends, and for about 8 miles in a northeasterly direction a fault drops the beds on the southeast side, with a throw probably between 100 and 160 feet (section B-B', pl. 1). Except in one small area—the valley of Prairie Elk Creek, in which Lebo shales crop out—all the rocks along the southeast side of the fault, where bed S is well exposed, are in the Tongue River member of the Fort Union. There are three small areas of high ground on which Tongue River beds are exposed northwest of the fault near its southwest end, but elsewhere the rocks exposed on its northwest side are in the Lebo member of the Fort Union formation. Whether this fault is simple or composite was not determined. At locality 5 (pl. 6, B) the fault exposed may be merely one of several

²⁴ Dobbin, C. E., and Erdmann, C. E., Structure contour map of the Montana plains, U. S. Geol. Survey, 1932.

minor faults forming a fault zone. Northeastward for many miles beyond the Weldon fault no faulting or pronounced warping was found. (See section A-A', pl. 1.)

Poplar anticline.—The axis of the Poplar anticline,²⁵ which trends in a northwesterly direction, crosses the Missouri River about 2 miles east of the northeast corner of McCone County: The rocks along Redwater Creek in the northeastern townships are on the flank of this anticline and have a southwesterly dip toward the axis of a southward-plunging syncline that crosses the Missouri about 9 miles east of Wolf Point and extends southward into T. 25 N., R. 49 E.

COAL

STRATIGRAPHIC POSITION AND CHARACTER OF THE COAL BEDS

Coal bed in the Fox Hills sandstone(?).—In the S½ sec. 5, T. 20 N., R. 43 E., a thin, valueless coal bed, 30 feet above the water level of Big Dry Creek and about 315 feet stratigraphically below bed U, is thought to be in the Colgate member of the Fox Hills sandstone, and in sec. 32, T. 27 N., R. 48 E., a bed of carbonaceous shale was found in the Colgate, but elsewhere in the county no coal or carbonaceous beds have been seen below the Hell Creek member of the Lance formation. Hance²⁶ reports a small coal bed in the Colgate sandstone southwest of Glendive, Mont.

Coal beds in the Hell Creek member of the Lance formation.—The coal beds in the Hell Creek member of the Lance formation are lenticular and of little value. They cannot be correlated with certainty from place to place and probably represent local deposits of carbonaceous matter laid down when extensive marshes were absent or short-lived in this region, either because the deposition of sediments was rapid and continuous or because the climate was not favorable to the accumulation of coal-forming matter.

Bed Z, one of the least valuable beds in McCone County (see table, p. 26), is probably not a single continuous bed but rather a succession of lenses of coal in about the same stratigraphic position. Lenses in the Hell Creek member, at more widely spaced horizons below bed Z and developed in small isolated areas, do not admit of grouping in this manner. These lenses are described in the present report as "local" beds. No local beds of value were observed in the Hell Creek.

Coal beds in the Tullock member of the Lance formation.—Coal beds are more numerous in the Tullock than in the Hell Creek member of the Lance formation. The Tullock strata consist of alternating light and somber-colored shales, sandstones, and thin coal beds (pl. 4, B).

²⁵ Dobbin, C. E., and Erdmann, C. E., op. cit. Thom, W. T., Jr., and Woodring, W. P., Possible oil in northeastern Montana: U. S. Dept. Interior Press Mem. 9584, May 6, 1921.

²⁶ Hance, J. H., The Glendive lignite field, Dawson County, Mont.: U. S. Geol. Survey Bull. 471, p. 273, 1912.

Some of the dark shale beds contain thin streaks of coal which locally are thick enough to be of economic value. As in the Hell Creek member, correlation of the coal beds from place to place is difficult, and beds V, W, X, and Y, which are of little value (see table, p. 26), are all probably discontinuous, each being merely several lenses at about the same horizon. It is also convenient to describe some Tullock lenses as "local" beds.

Coal beds in the Lebo shale member of the Fort Union formation.—The shales of the Lebo member, which is about 400 feet thick in McCone County, contain few coal beds. In accordance with the usage in reports on neighboring coal fields, the U (Big Dirty) bed is regarded in the present report as the base of the Lebo, though it could more appropriately, perhaps, be included in the Tullock as one of the numerous coal beds scattered through that member of the Lance formation.

Within the Lebo member several lenses of coal that cannot be traced through any great distance are described in this report as "local" beds.

In neighboring areas in the Dakota coal field, the supposed correlatives of bed U of McCone County are commonly known as the "Big Dirty bed." As implied in the name, the coal in this bed as a rule contains many impurities; this is characteristic of most of its exposures in McCone County (pl. 10, B). However, the coal in this bed is extremely variable in quality from place to place, and at many points on its outcrop good coal may be found in sufficient thickness for profitable mining. (See table, p. 26.) The maximum observed thickness of coal, measured at locality 2, T. 20 N., R. 44 E., is 20 feet, most of which is impure. Coal 15 feet thick in a mine at locality 4, T. 23 N., R. 44 E., is of greater value, being free from partings. At several places in the county bed U is split into two benches by thick partings, as on Nelson Creek in T. 20 N., R. 44 E., where there is a parting in the bed ranging in thickness from 4 to 14 feet. The bed has burned along its outcrop in parts of T. 20 N., Rs. 43 and 44 E.; T. 23 N., Rs. 44 and 45 E.; and T. 24 N., R. 46 E.

Bed T is probably not a single bed but a number of lenses occupying isolated areas in the Lebo shale above bed U. The greatest observed thickness was measured at locality 25, T. 20 N., R. 43 E., where the coal bed is 11½ feet thick, including a shale parting 3 inches thick. The thickness and quality of coal in the lenses of bed T are variable, and at many exposures the coal is too thin or too impure to be of value. (See table, p. 26.)

Coal beds in the Tongue River member of the Fort Union formation.—The most promising coal beds in McCone County are in the lower 400 feet of the Tongue River member of the Fort Union formation. Bed S (pl. 11, A, B) near the base, and bed P, about 350 feet higher,

have been traced farthest, but between them several more or less local beds contain coal of value.

The coal in bed S is rather persistently of good quality and is generally thick enough to mine. (See table, p. 26.) Locally in T. 22 N., Rs. 47 and 49 E., T. 23 N., Rs. 47, 48, and 49 E., and T. 24 N., R. 49 E., coal assigned to this bed, in some places doubtfully, is less than 2½ feet thick, and the bed may even be absent in parts of T. 22 N., Rs. 47 and 49 E. The maximum observed thickness of coal in bed S is that measured at locality 17, T. 19 N., R. 44 E., where it is 18 feet thick, including two shale partings aggregating 8 inches in thickness. Other exposures at which the bed is very thick were examined at locality 8, T. 20 N., R. 44 E., where the thickness, including 2 inches of shale, is 13¼ feet; at locality 2, T. 20 N., R. 45 E., where 16½ feet of coal includes 6 inches of bony coal near the top; at locality 3, T. 20 N., R. 45 E., where 12 feet 1 inch of coal contains 1 foot 2 inches of bone near the top; and at locality 5, T. 21 N., R. 45 E., where the thickness, including 6 inches of shale, is 14 feet. Bed S has burned rather extensively along the outcrop in Tps. 19 and 20 N., R. 44 E., and in Tps. 21 and 22 N., R. 46 E. The Weldon fault displaces the bed at its outcrop in Tps. 21 and 22 N., R. 46 E.

Not uncommonly the outcrop of bed R (pl. 10, A) is split into two benches by a thick parting, as at several places in T. 18 N., Rs. 47 and 48 E.; T. 19 N., Rs. 48 and 49 E.; and T. 21 N., R. 49 E. Elsewhere only one bench could be found. As in bed Q and most other beds in McCone County, correlation of bed R from place to place is difficult in many parts of its outcrop.

The upper bench of bed R is characteristically impure and valueless, though it contains some good coal in T. 19 N., R. 49 E., and at locality 6, T. 18 N., R. 48 E., a small amount of it has been mined, notwithstanding its poor quality. The lower bench generally contains more than 2½ feet of good coal but is thinner locally in T. 19 N., Rs. 47 and 49 E.; in T. 20 N., Rs. 45 and 47 E.; in T. 21 N., Rs. 46, 48, and 49 E.; and in T. 22 N., R. 48 E. It is mined at several places on Tusler, Redwater, Butte, Horse, Dry Ash, and Gyp Creeks and is sold in Circle under the trade name "Tusler Creek coal." (See table, p. 26.) Bed R has burned extensively in Tps. 18, 19, and 20 N., R. 44 E. but elsewhere in the county its outcrops rarely show evidence of burning.

Correlation of bed Q is difficult along much of its outcrop in McCone County. Probably the coal mapped as bed Q is not everywhere the same bed but rather a number of lenses at about the same stratigraphic horizon. In Tps. 17 and 18 N., R. 47 E., this coal has burned rather extensively, but in the remainder of the county little burning of its outcrop has occurred. The bed is nearly everywhere more than 2½ feet thick, but locally in T. 16 N., R. 46 E.; T. 18 N., R. 48 E.; T.

19 N., Rs. 47, 48, and 49 E.; and T. 20 N., Rs. 46, 47, 48, and 49 E., it is thinner. The maximum observed thickness of good coal in the bed is 8 feet, measured at locality 4, T. 18 N., R. 45 E., and at locality 7, T. 19 N., R. 47 E. (See table, p. 26.)

The coal of bed P is variable in thickness but of rather uniformly good quality. (See table, p. 26.) It has burned extensively and in some parts of its outcrop unburned exposures are difficult to find. It can be traced across the southern part of the county but in the western part it cannot be positively identified north of T. 18 N. The maximum observed thickness of the bed in McCone County is 9 feet, at locality 8, T. 16 N., R. 46 E., and at locality 6, T. 18 N., R. 46 E. At some localities in T. 18 N., Rs. 46 and 47 E.; T. 19 N., R. 45 E.; T. 20 N., Rs. 45 and 48 E., and T. 21 N., R. 46 E., its outcrops show less than 2 feet 6 inches of coal, but the thickness of good coal commonly exceeds 3 feet. Bed P appears in general to thin northward. The strata for about 500 feet above bed P are almost barren of coal, no coal beds more than 1½ feet thick having been found in them.

In the strata between beds P, Q, R, and S occur several coal beds, or lenses, which are traceable for only short distances. These are treated in this report as "local" beds.

PHYSICAL AND CHEMICAL PROPERTIES

Three samples taken from coal beds in the Tongue River member of the Fort Union formation in McCone County, as nearly as possible according to the method prescribed by the United States Bureau of Mines, proved on analysis to be lignite. Results of analyses of these and of samples of coal obtained elsewhere in Montana and North Dakota are given in the table on page 22. The strip pits from which the samples were collected were being worked when visited.

Analysis A-45271 was made on lignite from a strip pit in sec. 30, T. 18 N., R. 49 E., 9½ miles south of Circle, on a tributary of McCone Creek. The sample represents 2 feet of woody black lignite taken from blocks of lignite at the base of an exposure of bed P 5 feet 6 inches thick. It was collected by C. E. Erdmann September 10, 1928.

Analysis A-44879 was made on lignite from the Aus mine, a strip pit 4½ miles southwest of Circle, near Redwater Creek, in sec. 32, T. 19 N., R. 48 E. The bed is 4 feet 9 inches thick; the roof is light-gray siltstone, and the floor clay. The sample represents 3 feet 9 inches of woody black lignite in bed R. It was collected by C. E. Erdmann August 11, 1928.

Sample A-45063 came from a strip pit on a local coal bed in sec. 13, T. 19 N., R. 49 E., 8 miles east of Circle. The bed is 3 feet 10 inches thick, and the roof is clay. The sample represents 1 foot of woody black lignite from the lower part of the working face. The sample was collected by C. E. Erdmann September 1, 1928.

Analyses of coal from *McCone County, Mont., and other fields*

Lignite from McCone County

Laboratory no.	Mine	Location	Stratigraphic position	Form of analysis ¹	Proximate				Ultimate				Air drying loss	Heat value British thermal units
					Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	
A-45271	Unnamed	Sec. 30, T. 18 N., R. 49 E.	Tongue River member of Fort Union formation (bed P).	A B C D	30.6 24.6 --- ---	27.6 29.9 39.7 47.7	30.1 32.8 43.5 52.3	11.7 12.7 16.8 ---	1.1 1.2 1.6 1.9	6.7 6.3 4.7 5.7	41.8 45.4 60.2 72.4	0.8 .8 1.1 1.3	37.9 33.6 15.6 18.7	7,220 7,840 10,400 12,500
A-44879	Aus.	Locality 15, T. 19 N., R. 48 E.	Tongue River member of Fort Union formation (bed R).	A C D	25.8 --- ---	31.2 42.1 45.7	37.1 50.0 54.3	5.9 7.9 ---	.3 .4 .4	6.4 4.7 5.1	49.1 66.2 71.9	.8 1.1 1.2	19.7 21.4 ---	8,160 11,000 11,940
A-45063	Unnamed	Sec. 13, T. 19 N., R. 49 E.	Tongue River member of Fort Union formation (local bed R).	A B C D	34.0 27.1 --- ---	29.5 32.6 44.7 49.0	30.9 34.0 46.7 51.0	5.7 6.3 8.6 ---	.4 .5 .6 .7	6.9 6.5 4.7 5.2	43.2 47.7 65.4 71.6	.8 .9 1.2 1.3	43.0 38.1 19.5 21.2	9.7 8,170 11,210 12,260

Lignite from well-developed mines northeast, east, and southeast of McCone County

23008	Ranous	Daleview, Sheridan County, Mont.	Hell Creek member of Lance formation.	A C D	36.6 --- ---	23.2 36.5 43.3	30.3 47.9 56.7	9.9 15.6 ---	0.2 .4 .5	6.3 3.5 4.1	38.3 60.5 71.6	0.5 .8 .9	44.8 19.2 22.9	26.5 --- ---	6,140 9,680 11,480
20033	Dakota Products	New Salem, N. Dak., sec. 15, T. 139 N., R. 85 W.	Tongue River member of Fort Union formation.	A C D	38.5 --- ---	27.6 44.9 50.9	26.6 43.3 49.1	7.3 11.8 ---	1.3 2.1 2.4	7.0 4.5 5.1	39.2 63.8 72.4	.6 1.0 1.1	44.6 16.8 19.0	35.6 --- ---	6,700 10,900 10,360
A-3229	Current & Marengo	Broadus, Powder River County, Mont.	do	A C D	30.8 --- ---	26.8 38.8 43.7	34.6 50.0 56.3	7.8 11.2 ---	.3 .4 .5	6.4 4.3 4.8	44.9 65.0 73.2	.7 1.0 1.1	39.9 18.1 20.4	24.2 --- ---	7,560 10,920 12,310

Subbituminous coal

29004	Roundup 4	Roundup, Musselshell County, Mont., composite of 3 analyses.	Tongue River member of Fort Union formation.	A C D	13.6 --- ---	32.9 38.0 41.9	45.4 52.7 58.1	8.1 9.3 ---	0.7 .8 .9	5.6 4.7 5.2	62.0 71.7 79.1	1.0 1.1 1.3	22.6 12.4 13.5	3.5 --- ---	10,600 12,360 13,680
A-19659	Rosebud	Colstrip, Rosebud County, Mont.	do	A C D	24.1 --- ---	28.4 37.4 41.4	40.2 53.0 58.6	7.3 9.6 ---	.7 1.0 1.1	6.2 4.7 5.2	53.6 70.6 78.1	.7 1.0 1.1	31.5 13.1 14.5	6.6 --- ---	9,090 11,960 13,230

¹ A, sample as received; B, air dried at ordinary room temperature; C, dried at temperature of 105° C.; D, moisture- and ash-free.

Most of the coal in the Tertiary fields of North and South Dakota, Montana, and Wyoming is either lignite or subbituminous coal. Both lignite (brown coal) and subbituminous coal, sometimes called "black lignite," give a brown streak, contain large percentages of water before exposure to the weather, and slack readily on drying. The Dakota lignites usually appear black as seen at outcrops. The lignite of McCone County occurs in beds of extremely variable thickness, which commonly contain numerous partings. In natural exposures it is black and is commonly disintegrated and sooty, owing to weathering. However, in the Berry mine, at locality 7, T. 16 N., R. 46 E., the lignite is distinctly brown.

BURNING OF THE COAL BEDS

The coal in each of the coal-bearing formations of McCone County has burned at many places along the outcrops, forming masses of clinker, known also as "porcellanite"²⁷ and "scoria," which is commonly red, though locally black, gray, green, or yellow. The term "scoria" was probably applied to the clinker because of its resemblance to volcanic scoria. It consists, for the most part, of baked and fused rock of the overburden, some of it vitrified and in part bricklike, together with soil baked red. Large pieces held near a compass may cause the needle to swing, and compass bearings taken in the neighborhood of large bodies of clinker are unreliable. In the coal beds of the Hell Creek member clinker is only locally developed, but in the higher formations many of the coal beds, notably beds U, S, and P, have burned extensively, and the conspicuous outcrops of clinker aid materially in tracing these beds across the county. (See pl. 11, B.)

The only place in McCone County at which burning is known to be still in progress is in the neighborhood of the Blowout mine, in T. 23 N., R. 47 E. The presence of clinker fragments in the gravel on Antelope and Sheep Mountains indicates that burning of coal beds began in this region before Miocene time.

Coal beds may be ignited by spontaneous combustion, by lightning, or by prairie fires. Clinker from areas of burned coal is used as road metal, as ballast on railroads, and, rather rarely, as building material for houses.

PROSPECTING

Fresh natural exposures of the coal beds of McCone County are rare. Proper examination of outcrops usually requires digging with a shovel or pick, and occasionally a hand auger can be used to advantage for this purpose. (See pl. 12, A, B.)

²⁷ Hares, C. J., *Geology and lignite resources of the Marmarth field, southwestern North Dakota*: U. S. Geol. Survey Bull. 775, pp. 57-58, 1928.

As the strata are nearly horizontal in all parts of the county, many of the individual beds can be followed by hand leveling from outcrop to outcrop. Altitudes of the beds, if determined at short intervals, aid in correlating the outcrops. In many parts of the area clinker due to burning of the coal beds affords the easiest means of tracing.

MINING

Coal mining in McCone County has been carried on in numerous small operations, most of which are strip pits worked intermittently to supply the needs of the sparse population of the region. Many of the mines furnish coal to only a few ranchers; others produce a small amount for sale in Circle, Vida, Brockway, and Wolf Point.

Among the mines that had produced the most coal in 1927 were the Berry mine, at locality 7, T. 16 N., R. 46 E.; the mine at locality 9, T. 18 N., R. 45 E.; the Tusler mine, at locality 8, T. 18 N., R. 47 E.; the Aus mine, at locality 15, T. 19 N., R. 48 E.; the Le Valley mine, at locality 16, T. 19 N., R. 44 E.; the White mine, at locality 1, T. 21 N., R. 45 E.; the Bryant mine, at locality 3, T. 21 N., R. 46 E.; the Crooker mine, at locality 13, T. 20 N., R. 44 E.; the Kassner mine, at locality 1, T. 20 N., R. 49 E.; the mines at localities 3 and 6, T. 21 N., R. 49 E.; the Blowout mine, at locality 3, T. 23 N., R. 47 E.; the Thomas mine, at locality 8, T. 24 N., R. 47 E.; the Wheir mine, at locality 9, T. 24 N., R. 47 E.; the Deed Cash mine, at locality 1, T. 24 N., R. 48 E.; numerous small mines in T. 25 N., R. 47 E.; and the underground workings at locality 2, T. 26 N., R. 48 E. Details of these and other workings are given in the descriptions of coal by townships.

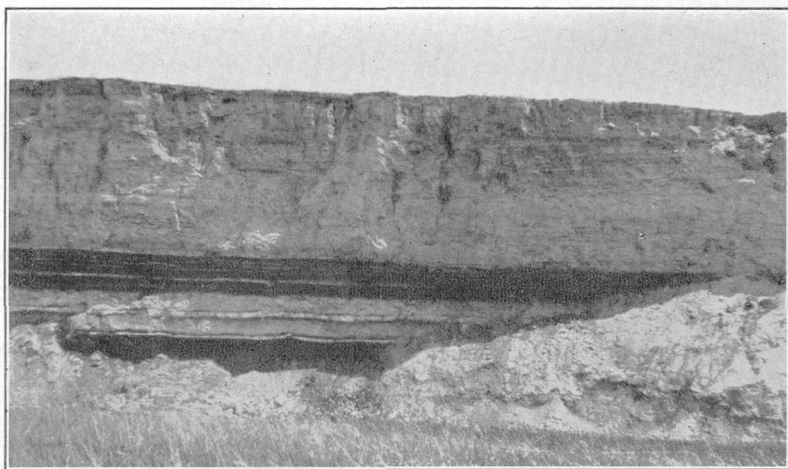
Among the most promising areas for development of large mines are a narrow belt along the outcrop of bed S extending from T. 18 N., R. 44 E., to T. 22 N., R. 46 E.; parts of the valleys of Redwater Creek and its tributaries Duck and Cow Creeks, in Tps. 21 and 22 N., R. 49 E.; and the northeastern part of T. 20 N., R. 49 E. At many places in these areas coal could be mined by stripping methods similar to that employed at Colstrip, Mont.²⁸

DETAILS OF COAL BY TOWNSHIPS

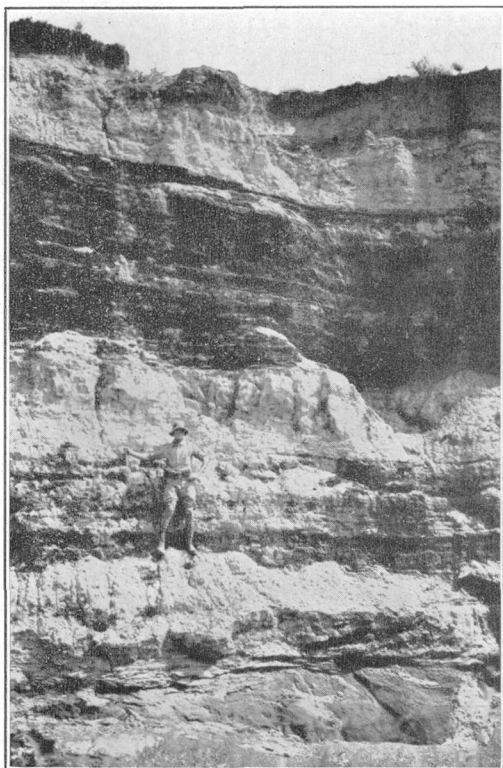
For the purpose of classifying coal lands the United States Geological Survey, somewhat arbitrarily, regards as valueless beds of coal less than 3 feet 2 inches thick and having a heating value not exceeding 8,000 British thermal units, air-dried.^{28a} As the three samples of coal from the neighborhood of Circle listed on page 22 average about 8,080 British thermal units and as it is possible that some of

²⁸ Dobbin, C. E., The Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Mont.: U. S. Geol. Survey Bull. 812, pp. 34-35, pl. 9, 1929.

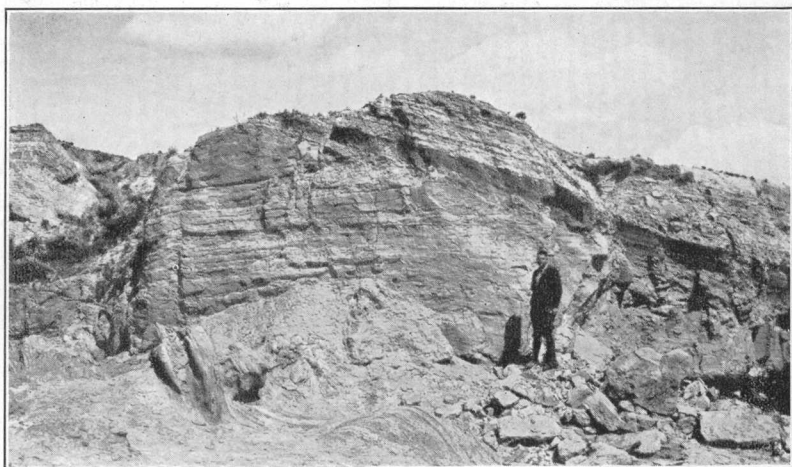
^{28a} Smith, G. O., and others, The Classification of the public lands: U. S. Geol. Survey Bull. 537, pp. 70-71, 1913.



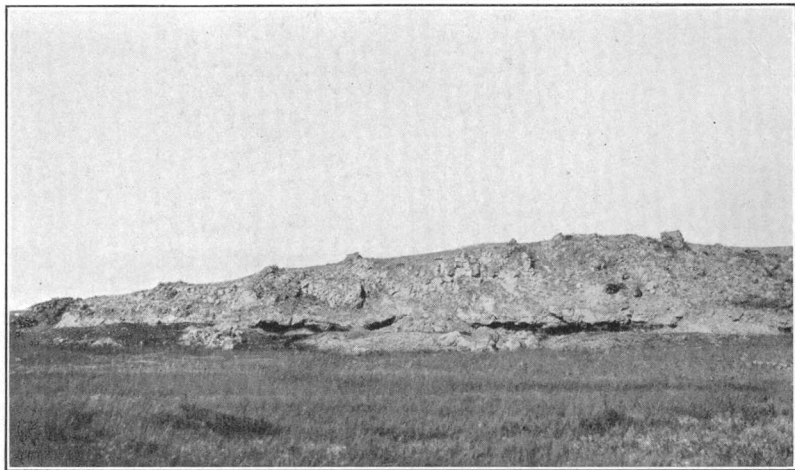
A. OUTCROP OF COAL BED R NEAR BERRY MINE, SEC. 24, T. 18 N., R. 47 E.
Illustrates prevalence of partings in the coal of this bed.



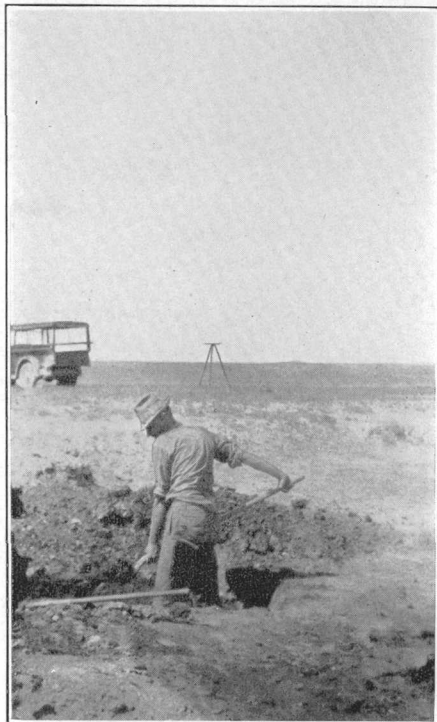
B. OUTCROP OF UPPER AND LOWER BENCHES OF THE COAL BED U (BIG DIRTY) IN
SEC. 6, T. 20 N., R. 44 E.



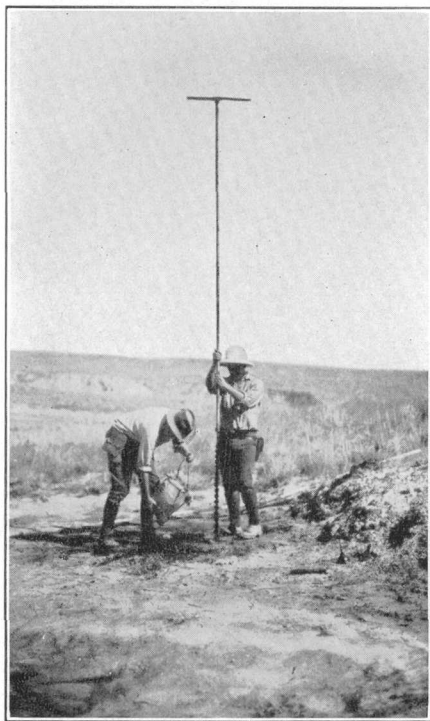
A. STRONGLY CROSS-BEDDED SANDSTONE IN THE TONGUE RIVER MEMBER OF THE
FORT UNION FORMATION AT BRYANT MINE, SEC. 8. T. 21 N., R. 46 E.
Coal bed S is concealed.



B. CLINKER ABOVE PARTING IN COAL BED S AT CROOKER MINE, T. 20 N., R. 44 E.



A. DIGGING OUT POORLY EXPOSED COAL BED P IN T. 16 N., R. 46 E.



B. PUTTING DOWN HAND AUGER HOLE TO DETERMINE THICKNESS AND CHARACTER OF COAL BED U (BIG DIRTY), WHICH IS POORLY EXPOSED IN SEC. 3, T. 19 N., R. 43 E.

the coals in other parts of McCone County, for which analyses are not available, may give higher heating values, 2 feet 6 inches has been chosen as the minimum thickness for valuable coal beds in the following descriptions. In determining the thickness of coal beds for the purpose of classifying them as to value, allowance is made for partings by the method prescribed by the Geological Survey.²⁹ In general, only sections in which the coal measures 2 feet 6 inches or more in thickness are shown in the graphic illustrations, and beds containing less than that thickness of coal are generally omitted from the map (pl. 1).

AMOUNT OF COAL

The tonnage figures for the coal reserves of McCone County, as set forth in the following table by townships and by beds, are based on the average thicknesses of the coal beds in the various townships, as measured at the scattered outcrops, and the probable acreage underlain by each bed, as determined from the map, allowance being made for burning in the neighborhood of clinker outcrops. They are not intended to represent exact tonnages but rather the minimum amounts of coal which the valuable beds could reasonably be expected to yield if mined to exhaustion.

The coal of beds T, V, W, X, Y, and Z is extremely variable in thickness and quality, and for this reason estimates of their coal content are hazarded only in the vicinity of their outcrops. Beds P, Q, R, S, and U, however, are fairly persistent in both thickness and quality, and tonnages are given for their probable extension under cover from the outcrops to the boundaries of the county. The tonnages of "local" beds are included in the figures for the coal beds nearest to them in the stratigraphic section.

²⁹ Ibid.

Estimated amount of coal in McCone County, by beds and townships, in thousands of tons

	Tongue River member				Lebo member		Tullock member				Hell Creek member	Total
	P	Q	R	S	T	U	V	W	X	Y	Z	
T. 16 N., R. 46 E.	47,800		165,000	300,000		250,000						762,800
T. 17 N., R. 44 E.	1,000	151,300	231,000	300,000		250,000						832,300
T. 17 N., R. 45 E.	37,150	151,200	231,000	300,000		250,000						903,350
T. 17 N., R. 46 E.		70,650	237,600	300,000		250,000						838,250
T. 17 N., R. 47 E.		135,450	165,000	300,000		250,000						894,400
T. 17 N., R. 48 E.	80,100	135,450	165,000	300,000		250,000						873,600
T. 18 N., R. 44 E.	32,750	173,168	162,450	294,150		250,000						813,518
T. 18 N., R. 45 E.	202,300	165,450	165,000	300,000		250,000						1,083,200
T. 18 N., R. 46 E.	124,300	104,550	165,000	300,000		250,000						943,850
T. 18 N., R. 47 E.	46,650	4,000	162,800	300,000		250,000						740,350
T. 18 N., R. 48 E.		145,000	165,000	300,000		250,000						752,050
T. 18 N., R. 49 E.	17,000			13,800		250,000						877,000
T. 18 N., R. 43 E.	2,430	12,150	80,550	416,610	2,300	2,300						13,800
T. 18 N., R. 44 E.	88,150	141,200	143,650	300,000		250,000						516,340
T. 18 N., R. 45 E.	214,450	145,000	165,000	300,000		250,000						923,000
T. 18 N., R. 46 E.	3,900	119,750	165,000	300,000		250,000						1,074,450
T. 18 N., R. 47 E.		1,250	106,920	300,000		250,000						838,650
T. 18 N., R. 48 E.		23,200	101,550	300,000		250,000						698,170
T. 18 N., R. 49 E.					32,400	102,850						679,750
T. 20 N., R. 43 E.				38,000		344,016						135,250
T. 20 N., R. 44 E.		34,850	3,450	490,700	4,050	250,000						384,066
T. 20 N., R. 45 E.		60,150	165,000	300,000		250,000						775,150
T. 20 N., R. 46 E.		10,000	165,000	300,000		250,000						775,150
T. 20 N., R. 47 E.			12,900	517,000		250,000						725,000
T. 20 N., R. 48 E.						250,000						775,900
T. 20 N., R. 49 E.											5,750	5,750
T. 21 N., R. 43 E.						117,360						117,360
T. 21 N., R. 44 E.				154,600		250,000						404,600
T. 21 N., R. 45 E.		22,150	8,650	314,400		250,000						595,200
T. 21 N., R. 46 E.		8,200	165,000	300,000		250,000						723,200
T. 21 N., R. 47 E.		637	165,000	300,000		250,000						715,637
T. 21 N., R. 48 E.			2,900	128,750		250,000						381,650
T. 22 N., R. 43 E.						1,000						1,000
T. 22 N., R. 44 E.					1,450	28,502					1,750	32,702
T. 22 N., R. 45 E.						5,200						5,200
T. 22 N., R. 46 E.				25,100		3,450						28,550
T. 22 N., R. 47 E.				121,650		250,000						371,650
T. 22 N., R. 48 E.				39,950								39,950
T. 22 N., R. 49 E.				120,800								120,800
T. 23 N., R. 44 E.						40,500			1,450		8,750	50,700

[illegible]

T. 16 N., R. 46 E.

At locality 2, sec. 9, a coal bed that is too thin to be of value is estimated to be about 100 ft. stratigraphically lower than bed P and is therefore tentatively correlated with bed Q.

At locality 8 a thin valueless coal bed was observed 7 ft. below the main seam of bed P. (See fig. 3.)

The coal of bed P, which has formed extensive clinker in the high parts of this township, was examined at 8 localities, and at 6 of these, where both top and bottom could be seen, the range in thickness is 6 ft. 3 in. to 9 ft. Strip pits in bed P at localities 1, 7, 8, and 10 have furnished fuel for local use. No measurement of the bed was made at locality 10, in sec. 34.

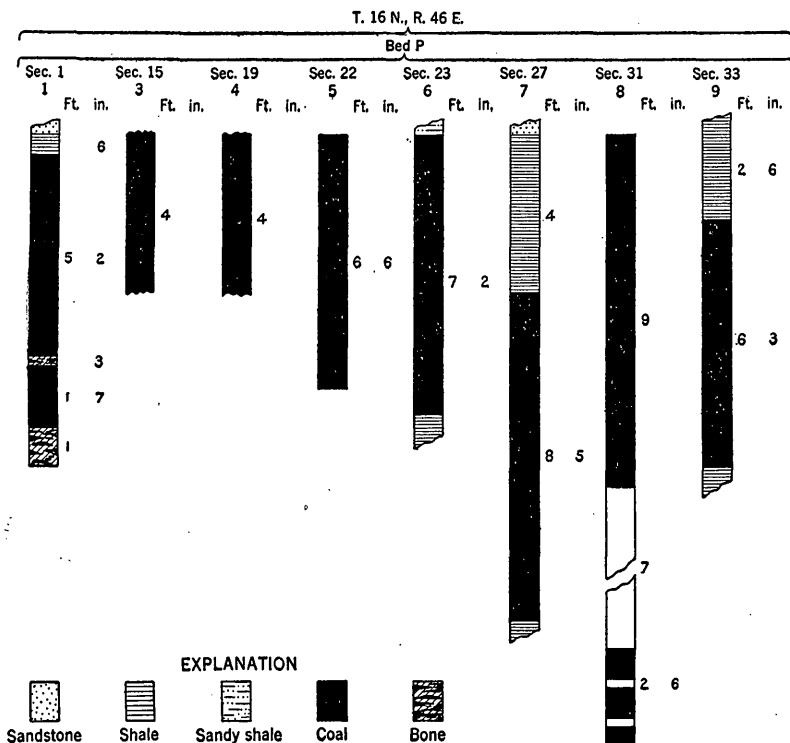


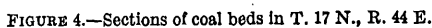
FIGURE 3.—Sections of coal beds in T. 16 N., R. 46 E.

T. 17 N., R. 44 E.

A coal bed, possibly correlative with bed S, occurring roughly 50 feet below bed R and measuring 4 ft. 9 in. in thickness, is well exposed about 1,000 ft. west of the southwest corner of T. 17 N., R. 44 E. It is not exposed within the township but undoubtedly underlies at least a part of its area.

A coal bed that is tentatively correlated with bed R of the valley of Redwater Creek is exposed in the valleys of Hay and Timber Creeks and in the southwestern part of sec. 31. Except in the vicinity of the Hedstrom ranch, west of Timber Creek, in sec. 32, where smut and evidence of the burning of this coal bed were noted, the only exposures of it found along Hay and Timber Creeks are on the east and northeast banks. The over-all thickness of the coal in the bed averages about 7½ ft. (fig. 4), but several partings are ordinarily present above the valuable portion, which is 5 ft. 11 in. to at least 7 ft. thick, is practically free

The coal of bed Q, which is poorly exposed in this township, ranges in thickness from 2 ft. 6 in. to 3 ft. 7 in. at 5 localities examined, but the coal of the upper part of the bed is somewhat impure at locality 2. This bed was not seen on the east flank of the divide between Timber and Little Dry Creeks, which trends in a



The coal of bed P is 7 ft. 6 in. thick at locality 7 and is probably about 8 ft. thick at localities 5 and 6, where the upper 3 or 4 ft. is slacked. Elsewhere the coal of the bed appears at the outcrop to be almost entirely burned out, but unburned portions are probably present under cover within the numerous areas surrounded by clinkered outcrops in the northeastern part of the township.

Coal bed Q is poorly exposed in T. 17 N., R. 45 E., and is difficult to trace. It is most easily found by measuring downward a vertical distance of about 100 ft.

from bed P. The only measurement of the full thickness of coal in this bed was made at locality 4 (fig. 5), where it contains 4 ft. of coal, mainly dull black but including a few thin seams of bright coal.

Clinker due to burning of coal in bed P, which attains a thickness of $8\frac{1}{2}$ ft. at locality 2, is extensively distributed in this township. Several rather large bodies of this coal remain unburned, however; chief among them is that which underlies the divide between Big Dry and Redwater Creeks in the north-central part of the township, where the completely slacked coal at localities 1 and 2 has been exposed by recent headward cutting of tributaries of Skull Creek through the rim of clinker that encloses the area of unburned coal. The cover on the coal here probably does not exceed 90 ft. Other masses of the unburned coal of bed P were found in secs. 15, 16, 18, 19, 24, and 34.

T. 17 N., R. 46 E.

Exposures of bed R extend southwestward up Redwater Creek as far as locality 5, T. 17 N., R. 46 E., and the bed underlies most of this township. At locality 5 it is at least 5 ft. thick and at locality 3 it contains 6 ft. 2 in. of clean coal. It has been mined at both localities to supply coal for local use. (See fig. 5.)

The coal in a poorly exposed bed which is thought to be bed Q averages 3 ft. 4 in. in thickness at 5 localities visited.

No unburned outcrops of bed P were found in this township, though its clinker occurs in small areas near the north, east, and west margins of the township.

T. 17 N., R. 47 E.

A coal bed about 100 ft. stratigraphically below bed P and therefore tentatively correlated with bed Q is represented by outcrops of clinker in the valley of Ash Creek, in the north-central part of T. 17 N., R. 47 E. No unburned outcrop of this coal bed was found.

Measurements of the coal in bed P show an average thickness of $5\frac{1}{2}$ ft., and it probably exceeds $2\frac{1}{2}$ ft. throughout this township. (See fig. 6.) The position of its outcrop is indicated in many places by masses of clinker. Coal for the use of local ranchers has been taken from this bed at several places, as at localities 1, 4, and 5.

T. 17 N., R. 48 E.

Bed Q shows $3\frac{1}{2}$ ft. of lignite in two strip pits at localities 2 and 5, T. 17 N., R. 48 E. (fig. 6), and is mined also in the NW $\frac{1}{4}$ sec. 16.

The coal in bed P, about 100 ft. stratigraphically higher than coal Q, ranges in thickness from 3 ft. to 6 ft. 2 in. at 4 localities visited. A small amount of coal has been taken from this bed at localities 6 and 7, but the coal was not measured at these localities.

T. 17 N., R. 49 E.

No coal bed with a thickness as great as 30 in. has been found exposed in T. 17 N., R. 49 E. Bed P, however, which is not everywhere thick enough to be of value but which locally attains a thickness of $5\frac{1}{2}$ ft. in the adjacent townships to the north and west, probably underlies all of this township at depths ranging, roughly, from 100 to 500 ft. below the surface.

T. 18 N., R. 44 E.

Bed S, which is exposed at numerous places on the east bank of Timber Creek in secs. 5 to 8, T. 18 N., R. 44 E., contains coal of good quality. At locality 17 only 2 ft. of coal in the upper part of this bed is exposed, and its full thickness was determined only at localities 2 and 4. (See pl. 13.) A small amount of this coal has been mined at locality 7 for local use.

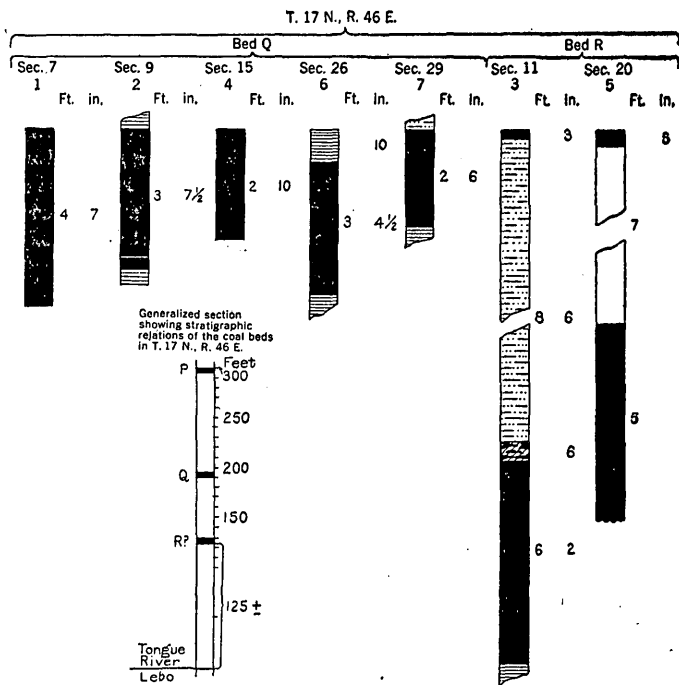


FIGURE 5.—Sections of coal beds in T. 17 N., Rs. 45 and 46 E.

An outcrop of coal 2 ft. 1 in. thick at locality 17, about 24 ft. above bed S, may belong to the same local bed as an outcrop of coal 2 ft. 8 in. thick about 21½ ft. above bed S at locality 3, and as another outcrop of a thin coal bed at locality 5, about 16 ft. above bed S.

The coal of bed R, which crops out extensively in the northern and western parts of this township, has there burned at nearly all its exposures. At an

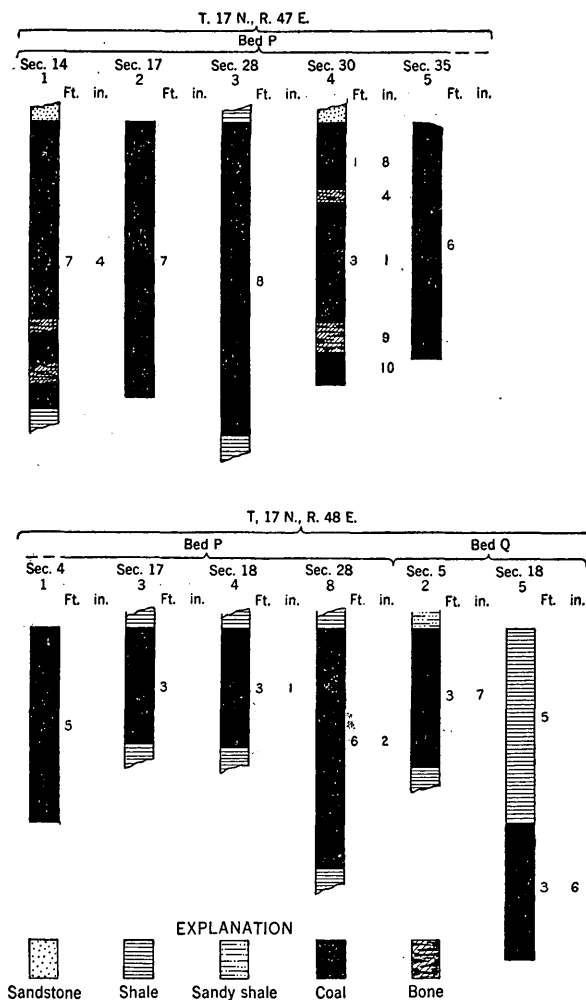
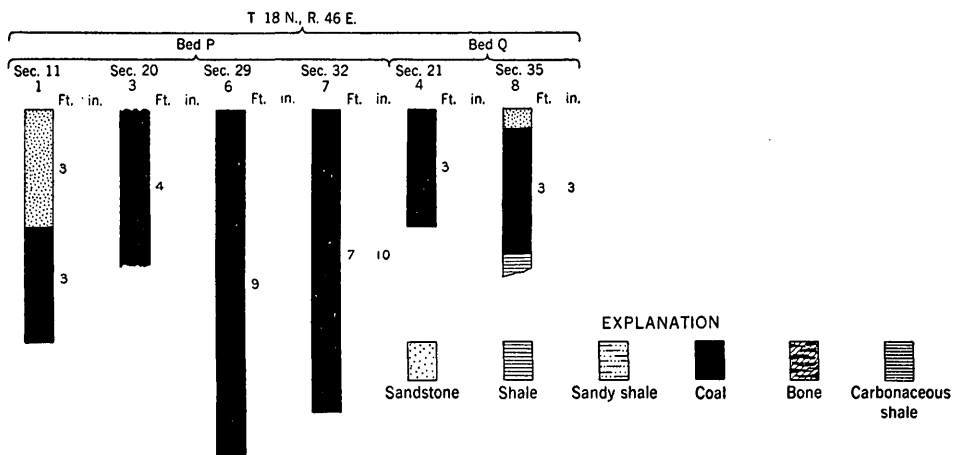
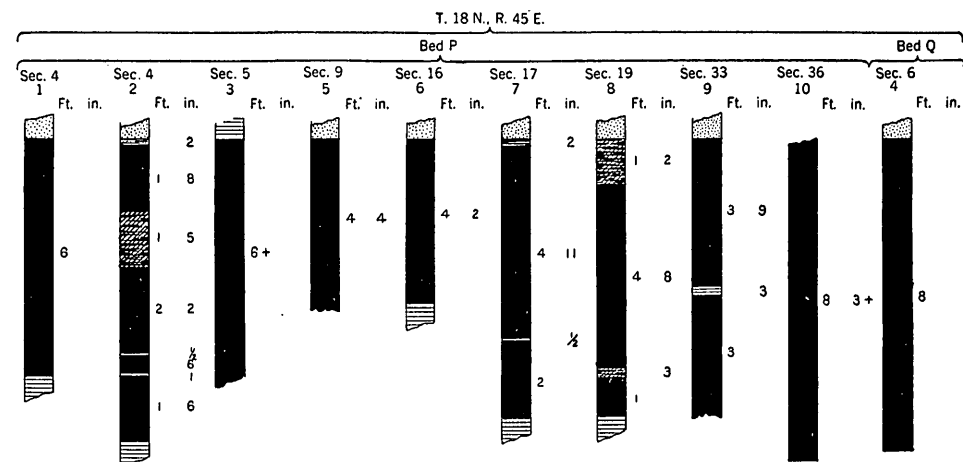


FIGURE 6.—Sections of coal beds in T. 17 N., Rs. 47 and 48 E.

unburned outcrop at locality 16 the full thickness of coal, free from partings, is 5 ft. 3 in. At locality 1, where the bed is much weathered, a measurement of 3 ft. 7 in. represents only a part of the full thickness of the coal, the top of the bed having been removed by erosion. Only 1 ft. of coal at the top of the bed is exposed at locality 20.

Bed Q is rather easily traced by means of its clinker in the north half of this township. In the south half exposures of this bed are rare. At 7 localities visited the bed contains 3 ft. or more of clean coal, free from partings. Incomplete sections were measured at localities 8 and 14. A small amount of coal





SECTIONS OF COAL BEDS IN T. 18 N., RS. 45 AND 46 E.

has been taken from a strip pit in bed Q a few hundred feet south of locality 18 and from another at locality 19.

The coal of bed P in this township, where unburned, is much weathered. Its full thickness at locality 10 is 7 ft. 1 in., including four thin partings, and at locality 13 is 7 ft. 9 in. free from partings. Incomplete sections were measured at localities 11, 12, and 22.

T. 18 N., R. 45 E.

Bed Q is exposed in secs. 5 and 6, T. 18 N., R. 45 E., along Soda Creek, and its outcrop is probably under a thin alluvial cover in the northwest corner of sec. 7. Its thickness of 8 ft. at locality 4 (pl. 14) was determined by boring with an auger.

Bed P, whose thickness at 9 outcrops examined ranges from 4 ft. 2 in. to more than 8 ft., may be as much as 10 ft. thick at locality 10. The coal at most of these outcrops is thoroughly weathered, but at the Potter mine, locality 9, a good exposure shows it to be mainly dull black, with numerous layers of bright coal. Its outcrop has burned extensively in the southern part of the township.

T. 18 N., R. 46 E.

No outcrop of bed R was seen in T. 18 N., R. 46 E., but it is probably present under cover of alluvium on Redwater Creek in secs. 25 and 36.

Bed Q is exposed at locality 8, and borings with an auger revealed it at locality 4. (See pl. 14.) It is undoubtedly present beneath the sod in the approximate position indicated by the dotted line on the map.

Bed P, which is thickest in the southwestern sections of the township, may be traced by means of large masses of clinker. At locality 6 it contains 9 ft. of coal. At locality 3 the unburned outcrop of this bed is much weathered. At locality 5 a coal bed which may be bed P is only 2 ft. thick and is much weathered. The coal is 2,752 ft. above sea level at locality 7, 2,651 ft. at locality 3, 2,632 ft. at locality 1, and 2,679 ft. at locality 2. These outcrops at different levels were all assigned to bed P on the basis of similarity in appearance of the coal. If this correlation is correct the beds dip northwestward between localities 7 and 3 and between localities 2 and 1.

No coal is known to have been mined in this township.

T. 18 N., R. 47 E.

The coal of the R beds is well exposed in the cut banks of Tusler Creek. The upper and lower R beds are separated by 7 ft. of strata at locality 13 (fig. 7), by 16 ft. at locality 14, by 12 ft. at locality 8, and by 42 ft. at locality 7. Coal of the lower R bed is mined at localities 7, 8, and 13 and is locally advertised as "Tusler Creek coal." The most productive working is the mine at locality 13, operated by C. A. Berry. The lower R bed has also yielded coal for local use in a small tributary of Redwater Creek at locality 15. At locality 9 an auger boring through the alluvial cover disclosed 2½ ft. of weathered coal, and at locality 5 coal has been produced from a strip pit known as the "Stony Butte mine." A seam of coal a few inches thick at locality 5, 20 to 25 ft. above that which is mined, may represent the upper R bed. Coal of the upper R bed from this township is not known to be used for fuel.

Bed Q is poorly exposed, and at localities 4 and 16 it can be seen only after digging or boring through the covering mantle of soil and gravel. The coal of the bed has burned at several places, especially in the northwestern part of the township. Unburned portions of it are much weathered when under light cover.

Bed P is exposed, in general poorly, on the grassy divide between Cotter and Stony Butte Creeks and as an outlier near the south edge of sec. 35. Clinker

ledges, projecting through the sod at a few places, aid in tracing the bed. At locality 1 the coal in bed P is 3 ft. thick; at locality 2, 2 ft. 4 in.; and at locality 3, only 1 ft. Its thickness in this township may therefore be contrasted with thicknesses of 8 to 10 ft. in the adjoining areas to the west and south.

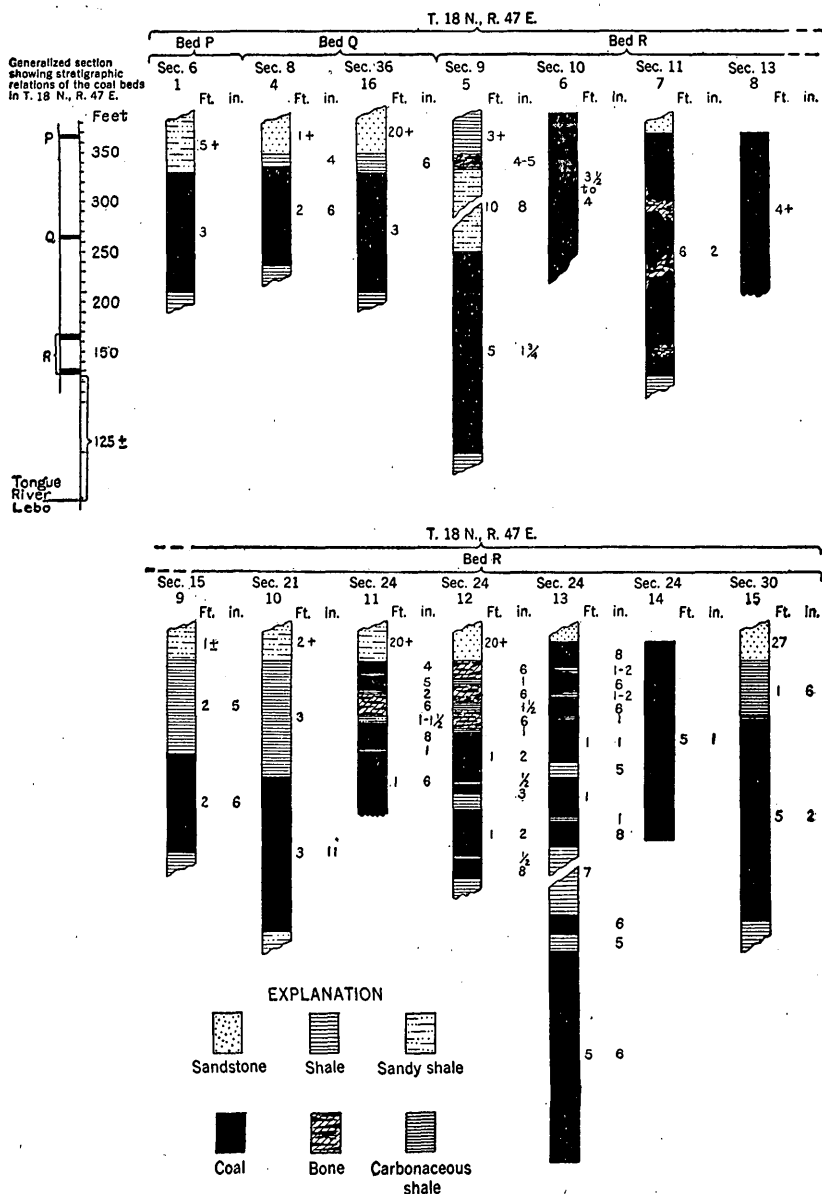


FIGURE 7.—Sections of coal beds in T. 18 N., R. 47 E.

T. 18 N., R. 48 E.

The lower and upper R beds crop out in the northwestern part of T. 18 N., R. 48 E. They lie nearly horizontal and underlie the rest of the township at a maximum depth below the surface of about 350 ft. (See fig. 8.) Both the upper

and lower R beds are exposed at a strip mine near locality 4, where, as also at localities 2 and 3, the coal of the lower bed is practically free from the partings and impure coal layers characteristic of the upper R bed. Mining at these localities has been confined to the lower R bed. Coal in the upper R bed has been mined at locality 6 for local use, in spite of the fact that at that place the coal, in its 4 ft. of thickness, includes impurities which render it of very little value. The maximum thickness of cover on the upper R bed probably does not exceed 100 ft.

The local coal bed below bed Q crops out at locality 18, where it is too thin for profitable mining.

The coal of bed Q, measuring 4 ft. 4 in. and 2 ft. 11 in. at localities 18 and 19, respectively, may be represented near the center of sec. 12 by a seam 2 ft. thick, including an 8-in. clay parting.

The local coal bed below bed P is only 1 ft. thick at its outcrop at locality 14 and appears to be absent elsewhere in this township.

Where examined in this township the coal of value in bed P ranges in thickness from 2 ft. 2 in. at locality 11 to 6 ft. 7 in. at locality 10. The upper 2½ to 4 ft. of coal is ordinarily of good quality, being freer from impurities than the lower layers. At locality 14 the coal is 4 ft. thick but contains so much impure matter as to be valueless. In secs. 8 and 9 the bed is completely masked by gravel. Strip pits in the bed are located at localities 5, 10, and 13.

The coal of the local bed 90 ft. above bed P is only 1 ft. 2 in. thick at locality 15. It is also exposed to the south in sec. 33 and is probably present at the surface elsewhere in the township.

T. 18 N., R. 49 E.

A local coal bed, thin and of no value, about 20 ft. below bed P, crops out in secs. 19 and 30, T. 18 N., R. 49 E.

The coal of bed P is well exposed on the tributaries of McCone Creek in the southwestern part of the township, where its thickness ranges from 2 ft. to 5 ft. 6 in. at the localities examined. (See fig. 9.) The bed thins eastward, and on the forks of Hell Creek, to the north, the coal of a bed tentatively correlated with bed P is too thin to be of value. Small strip mines at localities 6, 8, and 11 have furnished coal for local use.

T. 19 N., R. 43 E.

The lower bed W (?) at localities 1 and 3, T. 19 N., R. 43 E., averages 7 ft. in thickness; the coal of bed U is from 9 to 12 ft. thick in secs. 1, 3, and 6. The coal of these beds, however, at the localities visited in this township, is so impure as to be valueless. Bed T contains clean coal, but it is too thin to be mined profitably at localities examined in secs. 3, 4, and 31. Two thin benches mapped at locality 2 probably belong to bed T. The coal of bed S is present in the southeastern sections of this township, where its outcrop has burned at many places. The coal of the unburned bed, as seen at locality 4, is 6 ft. thick and is free from partings. (See fig. 10.)

T. 19 N., R. 44 E.

Bed U crops out in T. 19 N., R. 44 E., only in sec. 6, on the banks of a tributary of Timber Creek. At locality 7 a thickness of at least 4 ft. of clean coal of bed U was observed, the base of the bed being concealed (fig. 10), but about 1,000 ft. to the west, at locality 6, the coal of this bed is mainly impure and therefore valueless. It occurs at locality 6 in two benches; the upper bench is 3 ft. thick and is separated from the lower bench, which is 3 ft. 3 in. thick, by 11 in. of shale and bone coal.

Bed T and the local bed below it, cropping out in secs. 5 and 6, are variable both in thickness and with respect to the stratigraphic interval separating the beds. At localities 8 and 9 the coal of both beds is less than 30 in. thick. The

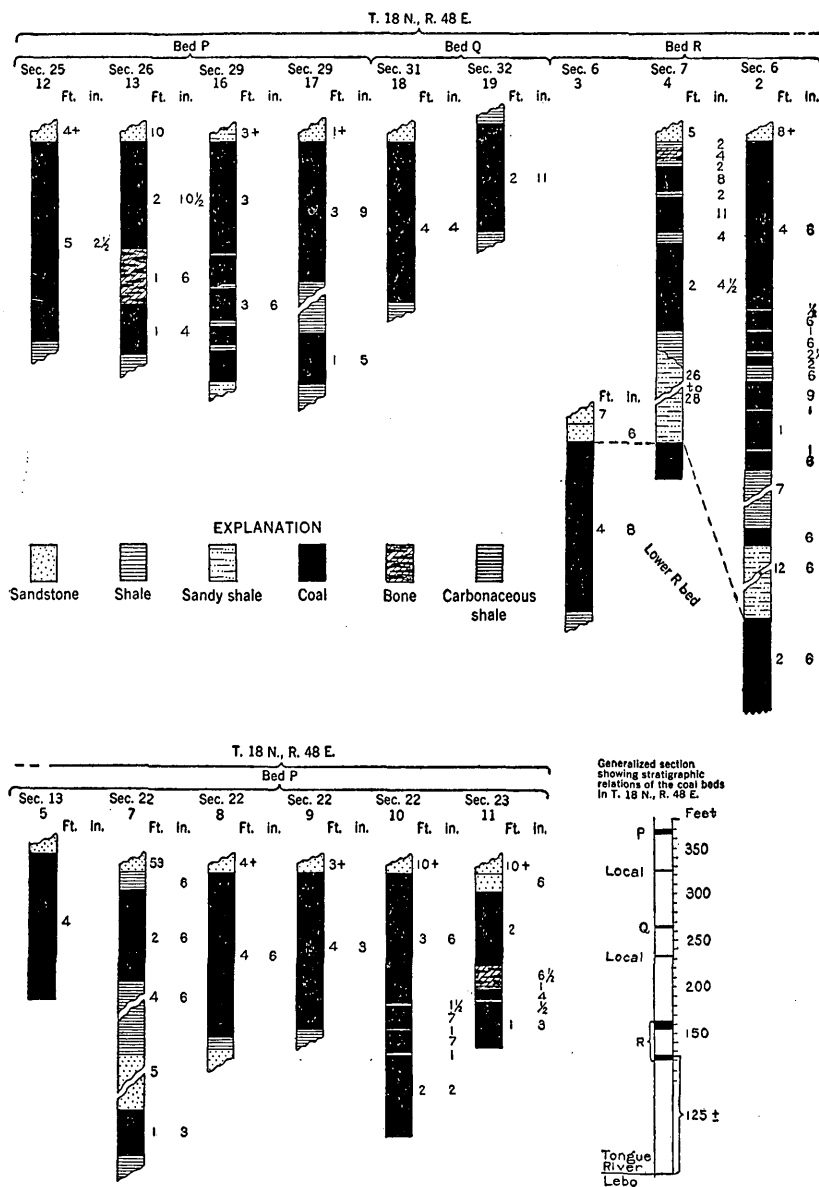


FIGURE 8.—Sections of coal beds in T. 18 N., R. 48 E.

local bed, which is probably near the top of the Lebo member of the Fort Union formation, is not shown on figure 10. (See p. 38.)

A local coal bed that crops out below bed S near the east boundary of sec. 5 is there only 1 ft. 8 in. thick and was not found elsewhere in the township.

The outcrop of bed S is confined to the west half of the township, where its coal has clinkered so generally that unburned exposures of it are found with difficulty. A measurement of the coal in the unburned bed S at locality 17 shows its thickness, including two thin partings, to be at least 17 ft., but whether the unburned bed attains this thickness under the cover in the eastern part of the township is not known. Coal was formerly taken from this bed at locality 16, where 2½ ft. of coal, containing partings, underlies 5 ft. of clinker and rests upon clean, black lignite, of which 3 ft. is visible and a basal portion of unknown thickness is concealed by water. At locality 18, 3 ft. 10 in. of coal and shale,

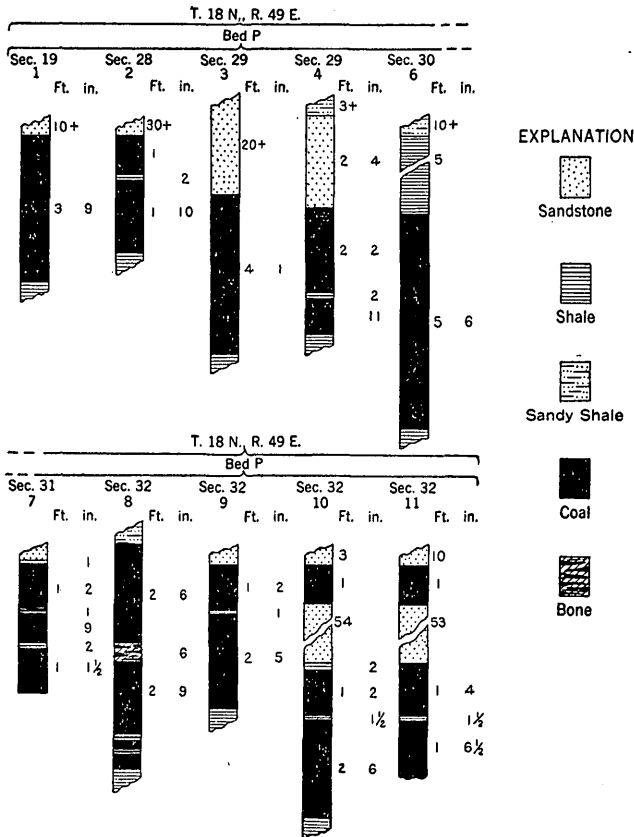


FIGURE 9.—Sections of coal beds in T. 18 N., R. 49 E.

the top of which is 12 ft. below the base of the clinkered bed S, is regarded as a bench of bed S.

The coal of bed R has almost entirely burned at its outcrop in this township. Where unburned, it is as a rule thickly covered, and for this reason was found only in secs. 9 and 10, where the quality of the coal in it is good. Its thickness at locality 10 is 4½ ft.; at locality 11, 5 ft. 11 in.

Bed Q was found only in the southern part of sec. 36, and it could not be traced northward.

The coal of bed P at locality 20 is 6 ft. 7 in. thick, but much of it is impure, and the bed at this place is therefore valueless. At locality 15 the coal is of good quality and is 5 ft. thick. At locality 12 an incomplete thickness of 3 ft. 9 in. was measured.

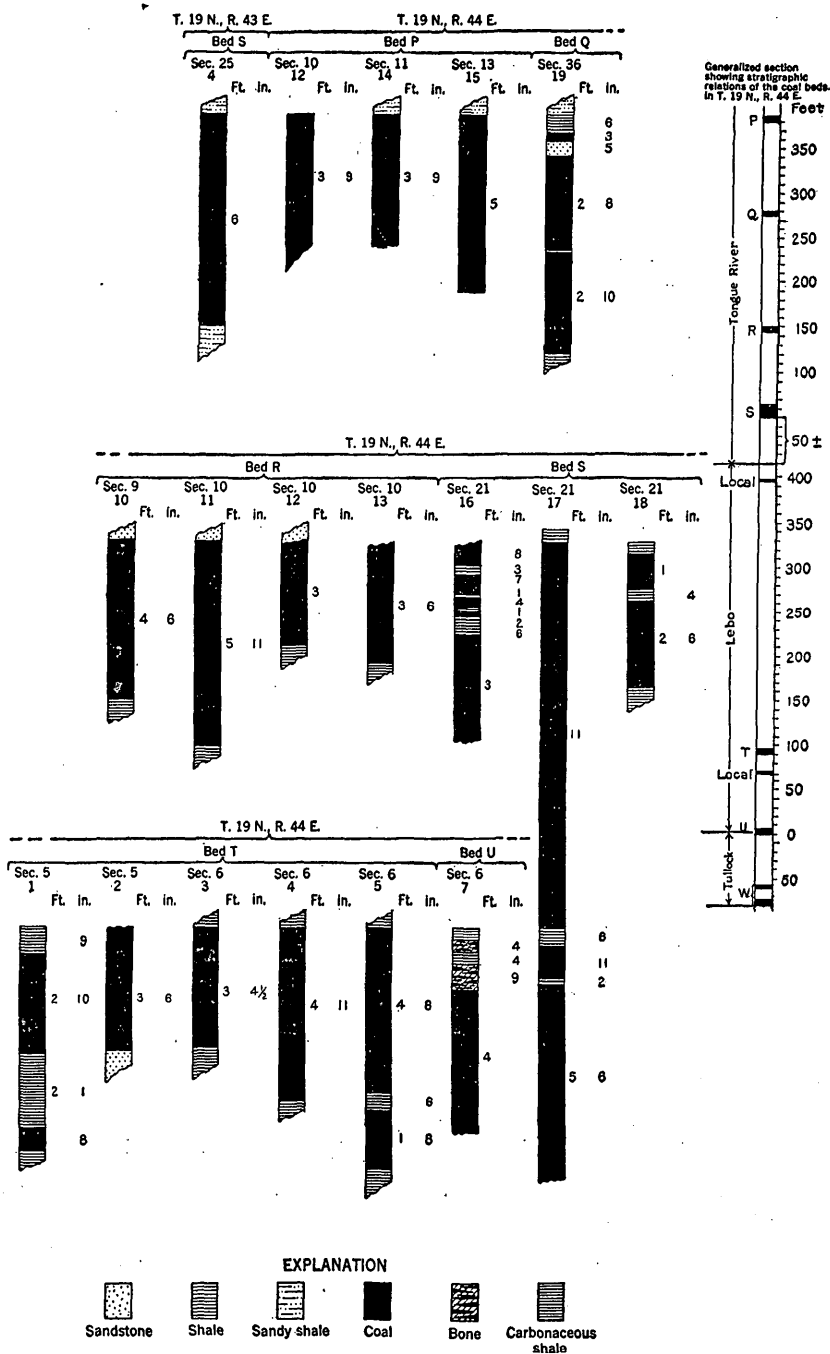


FIGURE 10.—Sections of coal beds in T. 19 N., Rs. 43 and 44 E.

T. 19 N., R. 45 E.

A bed of coal 3 ft. 4 in. thick at locality 3, T. 19 N., R. 45 E. (pl. 15), is tentatively regarded as bed R, though the stratigraphic interval to bed Q is not known. A small amount of the coal has been mined at this locality. Clinker, formed by burning of this coal, was found in secs. 6 and 7.

Bed Q is rather poorly exposed and somewhat difficult to trace in this township. It contains an average thickness of 4 ft. 8 in. of coal at 4 localities visited.

In sec. 12 the coal bed shown on the accompanying map as bed P(?) is only 53 ft. stratigraphically higher than bed Q of sec. 1 and may therefore be a local bed about halfway between beds P and Q. At localities 6 and 7 the thickness of this bed is only 2 ft., whereas the average thickness at localities 5 and 8 is 3 ft. 9 in. This is probably the same bed as that at locality 4, where the thickness of good coal is 2 ft. 9 in. Bed P, as indicated by rather numerous measurements, probably exceeds 30 in. in thickness nearly everywhere else in this township. A little coal for local fuel supply has been taken from bed P(?) at localities 4 and 8.

T. 19 N., R. 46 E.

Several ranches obtain their supplies of coal from bed P(?) at locality 1, T. 19 N., R. 46 E. (See pl. 15.) In sec. 7, immediately east of locality 8, T. 19 N., R. 45 E., in 260 ft. of sandstone and shale overlying bed P(?), three thin coal beds were found, of which the thickest measured 1 ft. 6 in. and was 150 ft. above bed P(?).

T. 19 N., R. 47 E.

Bed R undoubtedly underlies most of T. 19 N., R. 47 E., but its outcrops are found only in secs. 35 and 36, near the mouth of Antelope Creek, and in sec. 1, near the headwaters of a tributary of Horse Creek. At each of the outcrops examined only one seam of bed R was found, though two benches of it may be present, as in the townships to the south and east. At localities 2, 3, and 19 the coal is less than 30 in. thick. No other measurements of this bed were made in this township.

A local coal bed about 40 ft. vertically below bed Q is 2 ft. 1 in. thick at locality 14 and is present at the east margin of this township, just west of its outcrop at locality 8, T. 19 N., R. 48 E., where it is at least 2 ft. 7 in. thick.

A coal bed 1 ft. thick at locality 15 and an impure coal bed 2 ft. 1 in. thick at locality 18 may be correlatives of a local clinkered coal bed at locality 10, roughly 25 ft. below the Q coal.

The most valuable and most extensively exposed coal bed in this township is bed Q, the coal of which, at the outcrops examined, ranges in thickness from 1 ft. 11 in. at locality 6, to 8 ft., reported to have been found at a depth of 60 ft. in a well at locality 7. (See fig. 11.)

The local coal bed 45 to 60 ft. above bed Q was found only at locality 9, where it is much weathered. It does not occur in the well at locality 7 and cannot be definitely correlated with any bed cropping out elsewhere in McCone County, though local coal beds at about the same horizon are present in T. 20 N., R. 47 E., and T. 21 N., R. 46 E.

Outcrops of a coal bed that may represent bed P appear in secs. 3, 4, and 10, but no trace of it could be found elsewhere in the township. Near locality 4, the only place at which its thickness was measured, the maximum cover on this bed does not exceed 40 ft.

T. 19 N., R. 48 E.

A local coal bed below the lower R bed at locality 1, T. 19 N., R. 48 E., is 2 ft. 1 in. thick and appears to be the same bed as a coal 1 ft. 3 in. thick at locality 9, and is possibly the same as a bed 2 ft. thick with a $3\frac{1}{2}$ -in. parting at locality 11.

A local coal bed at a slightly lower stratigraphic level, which crops out in sec. 36, T. 20 N., R. 48 E., was not seen in this township, but it probably occurs beneath alluvium in the flood plain of Redwater Creek in secs. 1 and 2.

The lower and upper R beds, traceable from the surrounding townships, are exposed in this township in the valleys of Redwater and Horse Creeks. They are continuous with the R beds at the Berry mine, on Tusler Creek, in T. 18 N., R.

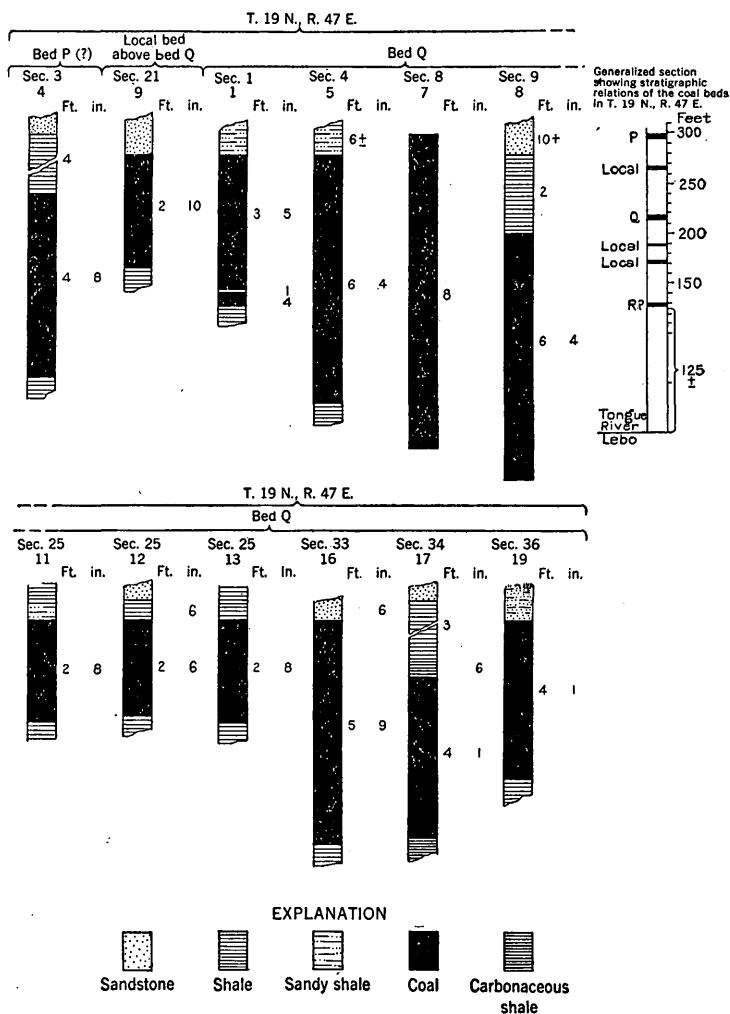


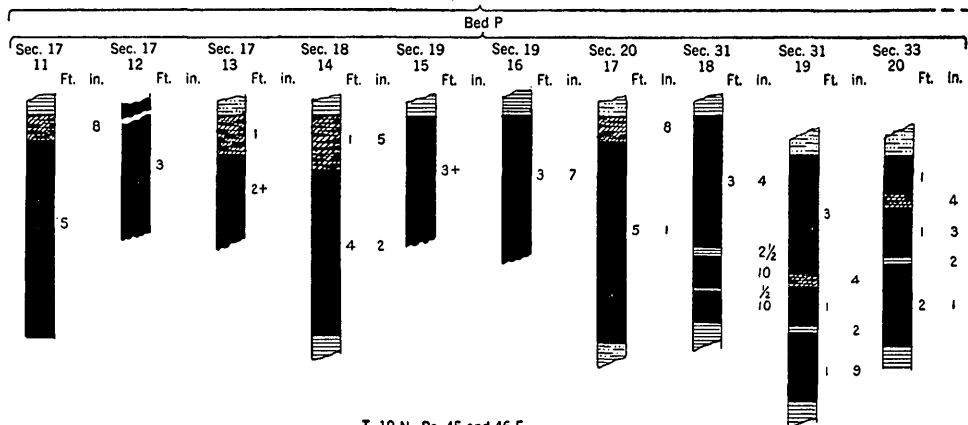
FIGURE 11.—Sections of coal beds in T. 19 N., R. 47 E.

47 E. The coal of the upper bed is usually impure and of little value, though both it and that of the lower bed may be represented by the coal beds which are mined for local fuel supplies at the strip mines at locality 2. (See fig. 12.) A small amount of coal is produced from the lower R bed at the strip mine of M. L. Aus, locality 15, and is sold in the town of Circle, 4 miles distant.

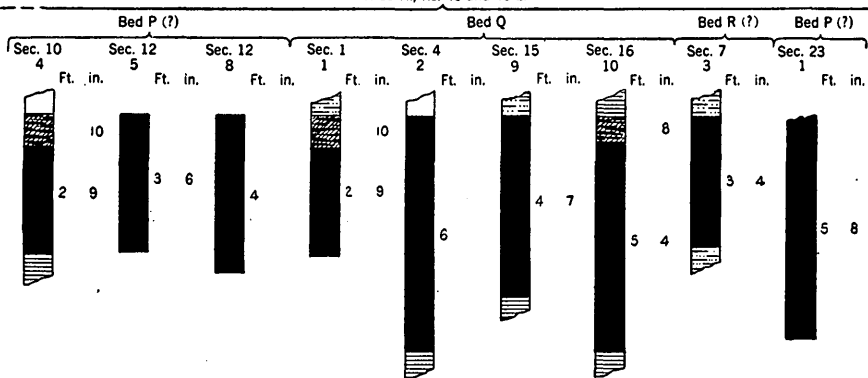
A local coal bed, a few feet above the upper R bed, is too thin to be mined profitably at localities 1 and 15 and at several other exposures examined.

A local coal bed, roughly 35 ft. below bed Q, is at least 2 ft. 7 in. thick at locality 8, and 1 ft. 7 in. of coal exposed at locality 7 is tentatively correlated with this bed.

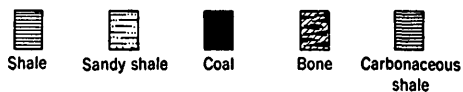
T. 19 N., Rs. 45 and 46 E.



T. 19 N., Rs. 45 and 46 E.



EXPLANATION



SECTIONS OF COAL BEDS IN T. 19 N., RS. 45 AND 46 E.

A bed assumed to be bed Q is only 1 ft. 9 in. thick near locality 13 and slightly over 3 ft. thick at locality 18. Bed Q was not measured elsewhere in the township.

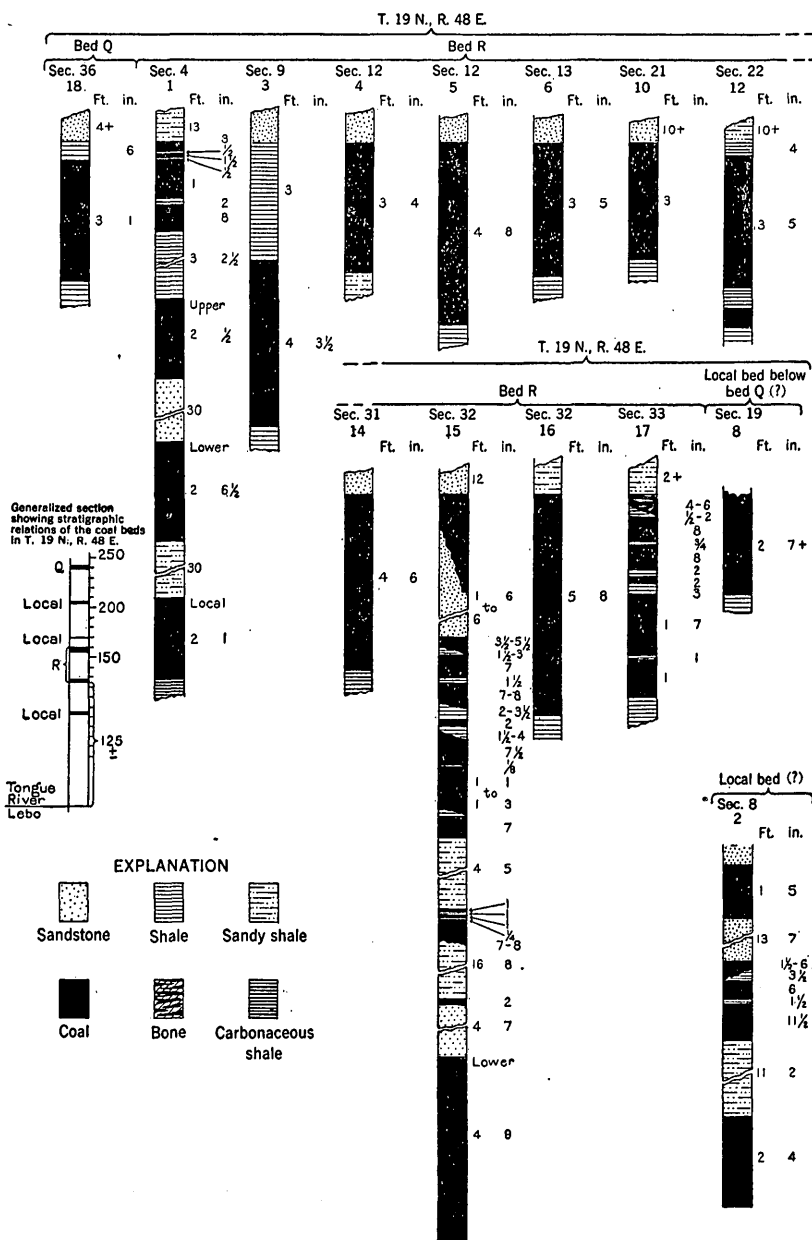


FIGURE 12.—Sections of coal beds in T. 19 N., R. 48 E.

T. 19 N., R. 49 E.

Two coal beds at or a few feet above the horizon of bed S are exposed in the western part of sec. 9, T. 19 N., R. 49 E., but are too thin to be of value. A local bed about 25 ft. higher crops out in secs. 8 and 9, where it is worthless.

The lower and upper R beds are extensively exposed in the north half of the township. The lower R bed, at the exposures examined (fig. 13), ranges in thickness from 2 ft. to 6 ft. 8 in., including partings. The bed has been mined at

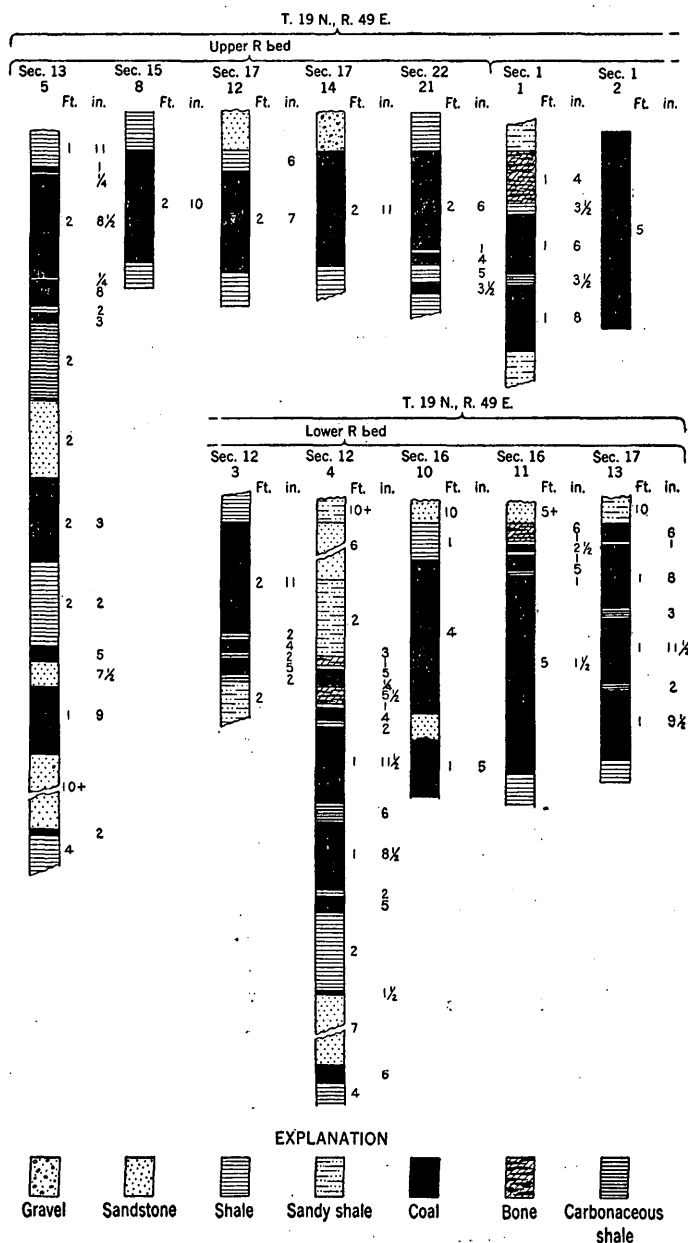


FIGURE 13.—Sections of upper and lower R beds in T. 19 N., R. 49 E.

localities 2 and 11. The upper R bed is usually thin and impure in this township, but at 5 localities it contains good coal exceeding 2 1/2 ft. in thickness.

The thickness of a local coal bed above the upper R bed ranges from 1 ft. 8 in. to 3 ft. 10 in. This coal where it is exposed in the central part of the township is

tentatively correlated with a bed that appears on Cottonwood Creek in sec. 13. The bed has been mined for local fuel supplies at localities 6 and 9. (See fig. 14.)

Bed Q (?) is well exposed in the rough country at the head of Gyp Creek in secs. 14, 15, 22, and 23, where it is tentatively correlated with a bed that crops out on Cottonwood Creek at locality 24. In secs. 14 and 15 the coal is much weathered, but in secs. 22 and 23 the outcrops show a clean woody black lignite. At an exposure in the NE¼ sec. 15 the bed shows only 2 ft. 3 in. of coal, but at all other exposures visited it exceeds 2½ ft. in thickness.

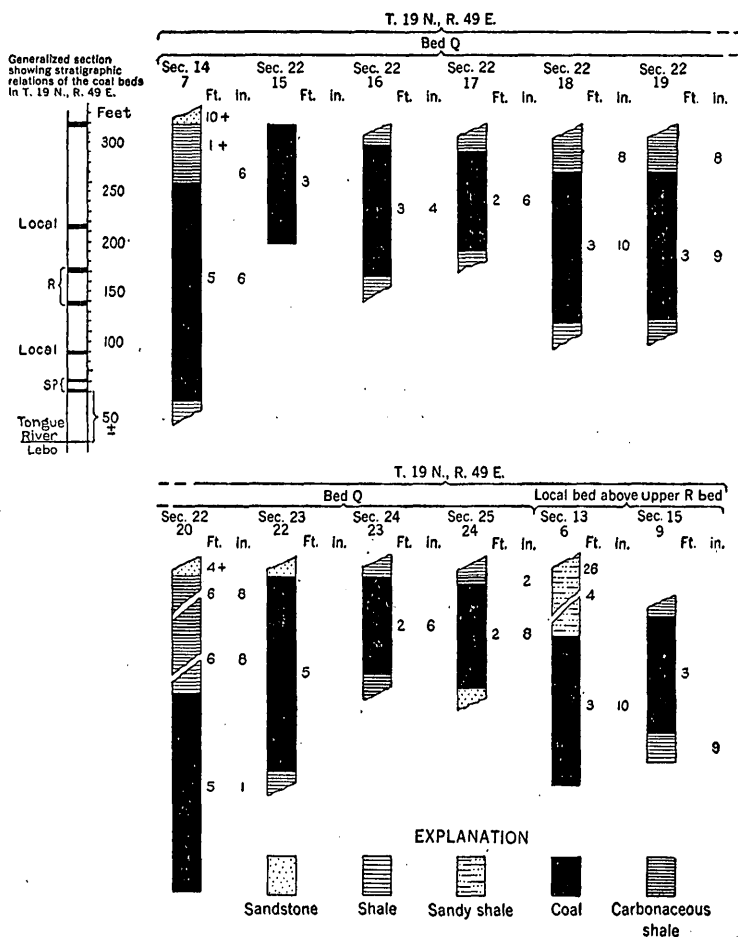


FIGURE 14.—Sections of bed Q(?) and a local bed above the upper R bed in T. 19 N., R. 49 E.

T. 20 N., R. 43 E.

The lowest coal bed in T. 20 N., R. 43 E., a thin local bed, is also the lowest, stratigraphically, in McCone County. This bed, which was not found elsewhere in the county, is about 30 ft. above the water level of Big Dry Creek in the S¼ sec. 5 and about 315 ft. below bed U. It is therefore thought to be in the Colgate member of the Fox Hills formation, and the prevalence of sandstone beds in the vicinity of its outcrop seems to support this view.

The coal of two thin beds in the Hell Creek member of the Lance formation in the northwestern part of the township is of no value, and bed Z, at the top of the

Hell Creek member in the adjoining township to the north, could not here be found.

Of three coal beds below bed U in the upper part of the Tullock member of the Lance formation, the lower two, at the localities examined, are too thin to be of value, and at 9 localities the coal in the uppermost, which is mapped as bed W, is so impure as to be valueless.

The coal of bed U at locality 16 measures 17½ ft. in over-all thickness, which is a little more than its thickness at other localities visited in this township. It is prevailingly impure at most outcrops. At some places, however, it contains benches of good coal, and at locality 3, where there is a small strip mine, a thickness of 9 ft. 6 in. of clean coal, free from partings, was measured. In parts of secs. 14, 23, and 29 the bed is divided into two benches by a thick parting. (See pl. 16.)

A coal bed mapped as bed T is rather extensively developed in this township. It extends into secs. 6, 7, and 30 of T. 20 N., R. 44 E., but it could not be followed farther east. At locality 25 this coal bed shows 11½ ft. of coal, including a 3-in. shale parting, but its average thickness is less, and at many of its outcrops so large a proportion of the coal is impure that mining it would be unprofitable.

T. 20 N., R. 44 E.

A coal bed that may be bed W is 6 ft. thick at locality 5, T. 20 N., R. 44 E., and about 13 ft. of strata here separate it from a higher bench containing 1 ft. 11 in. of coal, the greater part of which is impure. A coal bed near locality 6, containing 2 ft. 7 in. of clean coal, is thought to be the equivalent of the upper coal bed at locality 5. (See fig. 15.)

Bed U crops out extensively along Nelson and Coal Creeks, where the coal contained in it is generally of rather poor quality, though valuable lenses are locally present. On Nelson Creek the bed is divided into two benches by a parting ranging in thickness from 4 to 14 ft. Owing to the low gradient of the creek, the low southeastward dip, and the rather great thickness of the bed, including the thick parting, the top and base of the bed cross the creek at points more than a mile apart. As bed U is followed up Coal Creek the parting is observed to thin and disappear below locality 2, and the coal continues upstream as a single bed.

Outcrops of a coal bed that is tentatively correlated with bed T were seen on the east side of Nelson Creek in secs. 15 and 23. The average thickness of coal in the bed at 3 localities visited here is 3 ft. 7 in. (See fig. 16.) A coal bed mapped as bed T in T. 20 N., R. 43 E., extends into secs. 6 and 7 of this township, but no measurements of it were made here.

A local coal bed 2 ft. thick and 30 to 40 ft. above bed T was seen about 350 ft. east of the northwest corner of sec. 23.

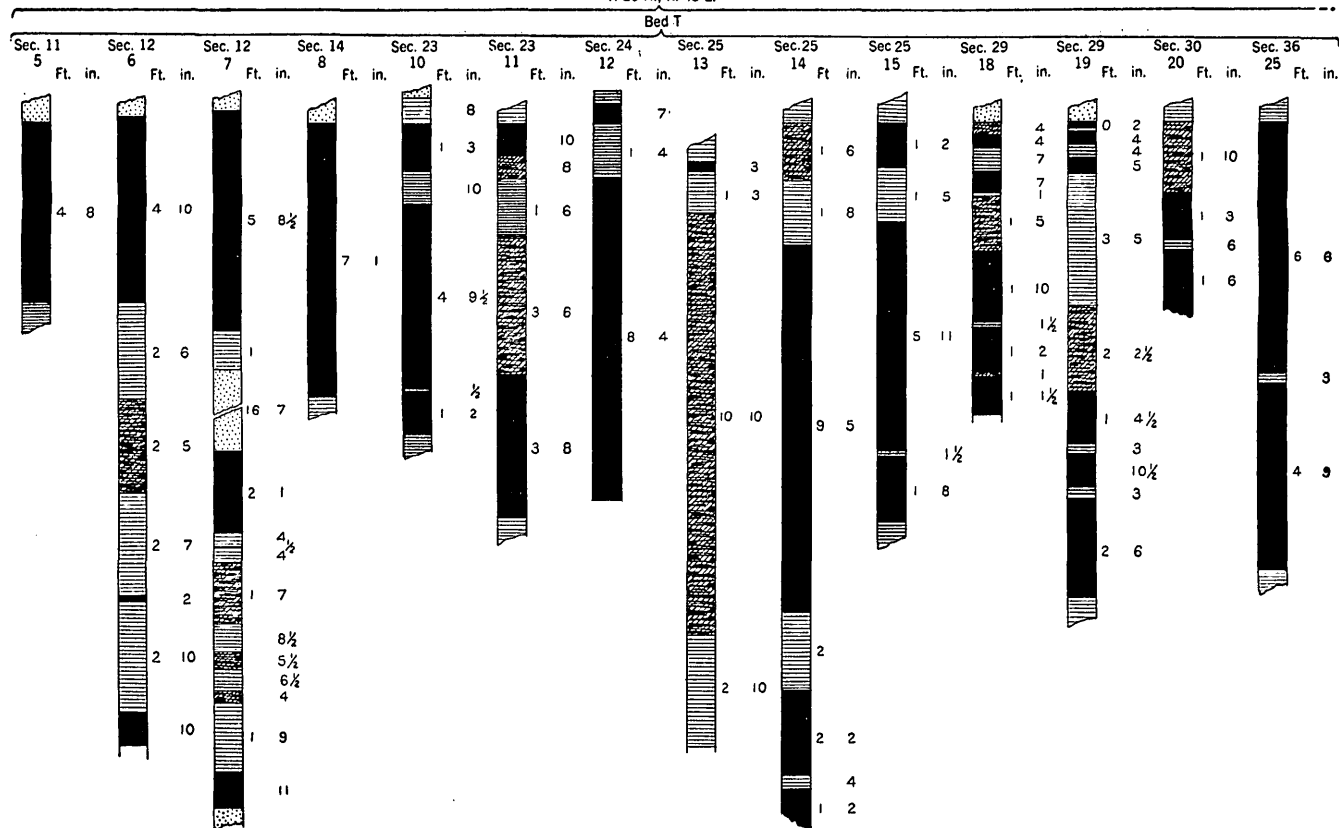
Extensive burning along the outcrop has made bed S easy to trace in this township, but exposures of the unburned coal are scarce. A measurement of the complete thickness of the unburned bed at locality 8 shows 13 ft. of coal. A small strip mine at locality 13, known as the Crooker mine, furnishes coal of rather good quality for local use.

The coal of bed R crops out in S½ sec. 35, but no measurements of its thickness were made.

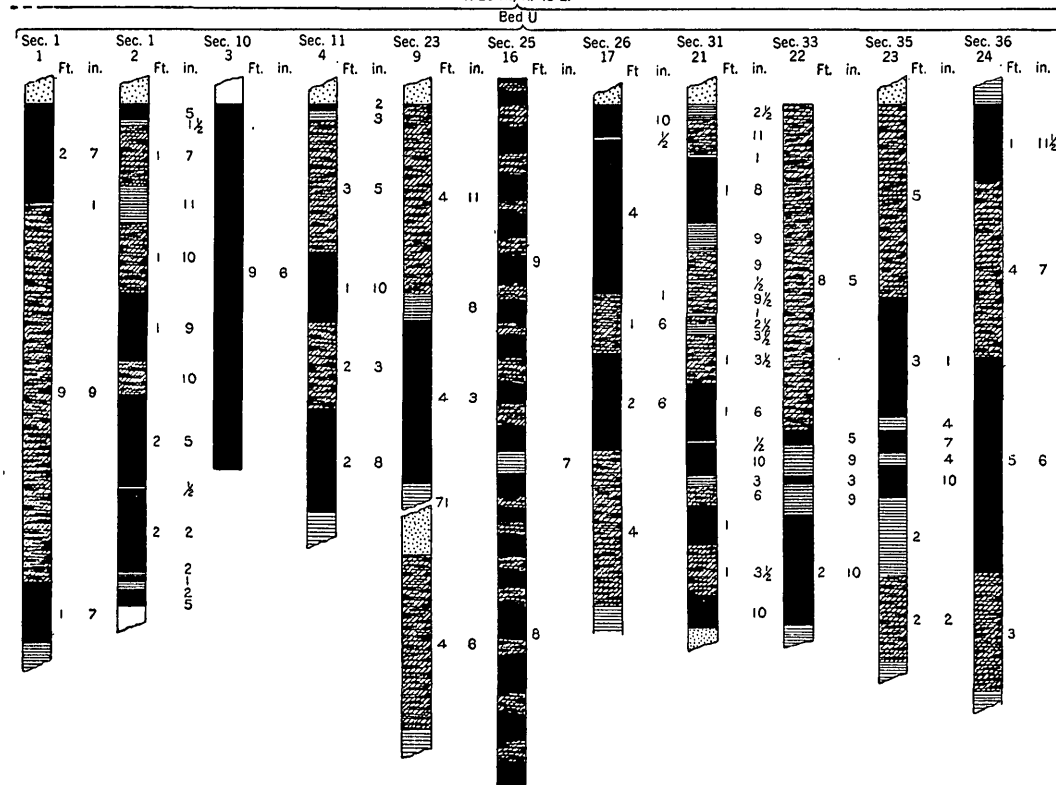
T. 20 N., R. 45 E.

Bed S underlies the whole of T. 20 N., R. 45 E., except about 3 square miles in the northwestern part, where its outcrop was traced mainly by means of its clinker. Owing to its thickness of 14 ft. 9 in. at locality 2 and of 10 ft. of clean coal, free from partings, at locality 3, this bed appears to offer an opportunity for profitable mining in this township. (See fig. 17.)

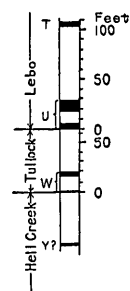
T. 20 N., R. 43 E.



T. 20 N., R. 43 E.



Generalized section showing stratigraphic relations of the coal beds in T. 20 N., R. 43 E.



EXPLANATION

Sandstone Shale

Coal Bone

Carbonaceous shale

SECTIONS OF COAL BEDS IN T. 20 N., R. 43 E.

A coal bed 3 ft. 1 in. thick at locality 4 but only 2 ft. 6 in. thick, including some clay partings, at locality 1, and less than 2 ft. thick in sec. 2, is regarded as bed R.

The outcrop of bed Q could not be traced southward from sec. 23, but is tentatively correlated with a similar coal bed in secs. 26, 27, and 36. At 5 outcrops exposing both top and base of the bed the thickness of clean coal ranges from 4 ft. to 5 ft. 2 in. Coal has been taken from bed Q at localities 5 and 9.

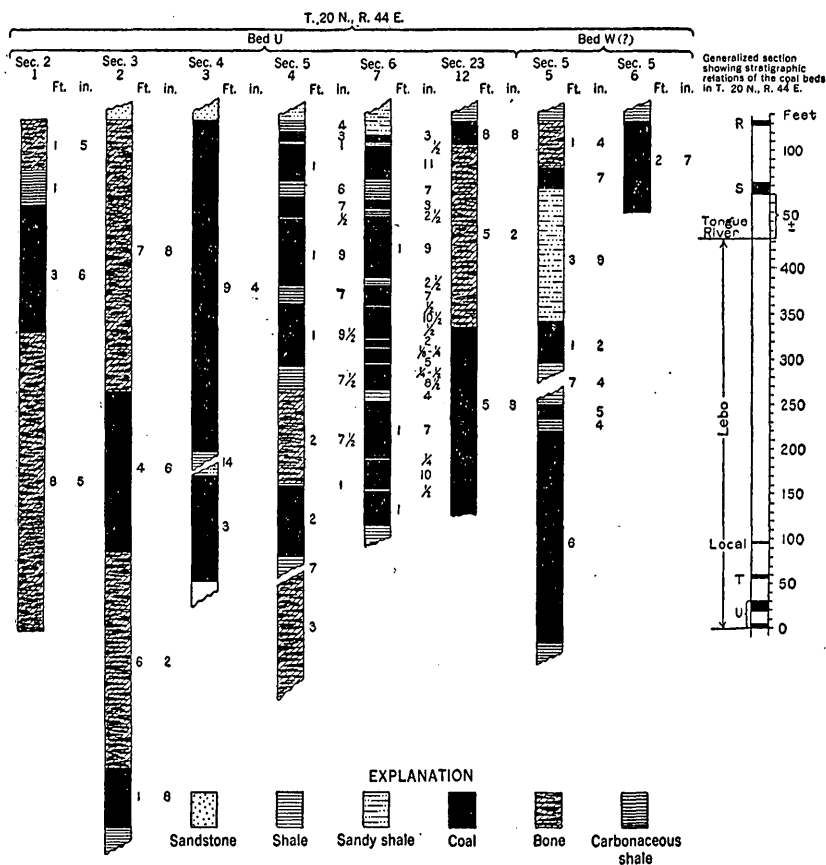


FIGURE 15.—Sections of beds U and W(?) in T. 20 N., R. 44 E.

A coal bed only about 60 ft. above bed Q but tentatively correlated with bed P has been mined at several places in secs. 25 and 26. This bed is but 2 ft. 3 in. thick, however, at locality 8, the only place where it was measured.

T. 20 N., R. 46 E.

At 5 localities in secs. 3, 4, 5, and 8, T. 20 N., R. 46 E., the full thickness of coal in bed Q, or in beds that may have been erroneously correlated with it, ranges from 10 in. to 2 ft. 1 in. Numerous measurements of the coal of bed Q at other places in the township (fig. 18) show its thickness to be at least 2 ft. 6 in.; at locality 8 it is 5 ft. thick and free from partings.

A thin coal bed at locality 2 appears to be about 45 ft. higher than bed Q; a coal bed 1 ft. thick at locality 1 and two thin seams parted by 7 ft. 6 in. of shale at locality 16 are, roughly, 50 ft. below bed Q.

T. 20 N., R. 47 E.

The coal in bed R in T. 20 N., R. 47 E., averages a little more than 2 ft. in thickness but does not attain 2 ft. 6 in. at localities 2, 6, 8, and 11. It is assumed that this bed is nowhere thick enough for profitable mining in this township, though there is a small strip pit in it at locality 8.

The coal of a local bed below bed Q is 1 ft. 2 in. thick at locality 7 and may belong to the same bed as an outcrop of coal 2 ft. 5½ in. or more in thickness at locality 5 and another that contains 2 ft. 10 in. of coal at locality 3. (See fig. 19.)

The coal in a bed that is correlated with bed Q of surrounding townships ex-

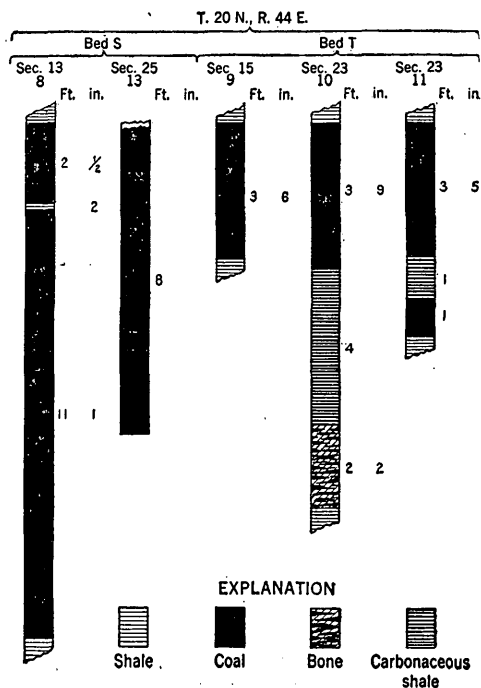


FIGURE 16.—Sections of beds S and T in T. 20 N., R. 44 E.

ceeds 2 ft. 6 in. in thickness at localities 1 and 10 but is less than 2 ft. 6 in. thick at localities 4 and 9.

A local coal bed above bed Q is known only from its clinker in the northwestern and northeastern sections of the township.

T. 20 N., R. 48 E.

No bed containing as much as 2 ft. 6 in. of coal was found at the surface in T. 20 N., R. 48 E., but the whole township, except about 1½ square miles eroded by Horse Creek in secs. 31 and 32, is probably underlain by the R beds at depths probably not exceeding 120 ft., and by bed S about 80 ft. stratigraphically lower than the R beds. Thin coal seams at localities 1, 3, 4, 5, 6, and 7 may represent bed Q, and a 1 ft. 7 in. bed of coal at locality 2 is possibly bed P.

T. 20 N., R. 49 E.

The coal of bed S of the townships north of T. 20 N., R. 49 E., which is the Carroll bed of the Richey-Lambert area, is exposed in this township at Charles Kassner's mine, locality 1, where it is 9 ft. thick. (See fig. 20.) Coal from this mine is sold in the town of Circle, about 11 miles to the southwest. From the

Kassner mine southwestward along Redwater Creek bed S offers an opportunity for extensive strip mining. If the coal maintains a thickness of 9 ft., an area averaging 1 mile in width, extending a distance of 6 miles along the stream, should yield about 62,000,000 tons of coal.

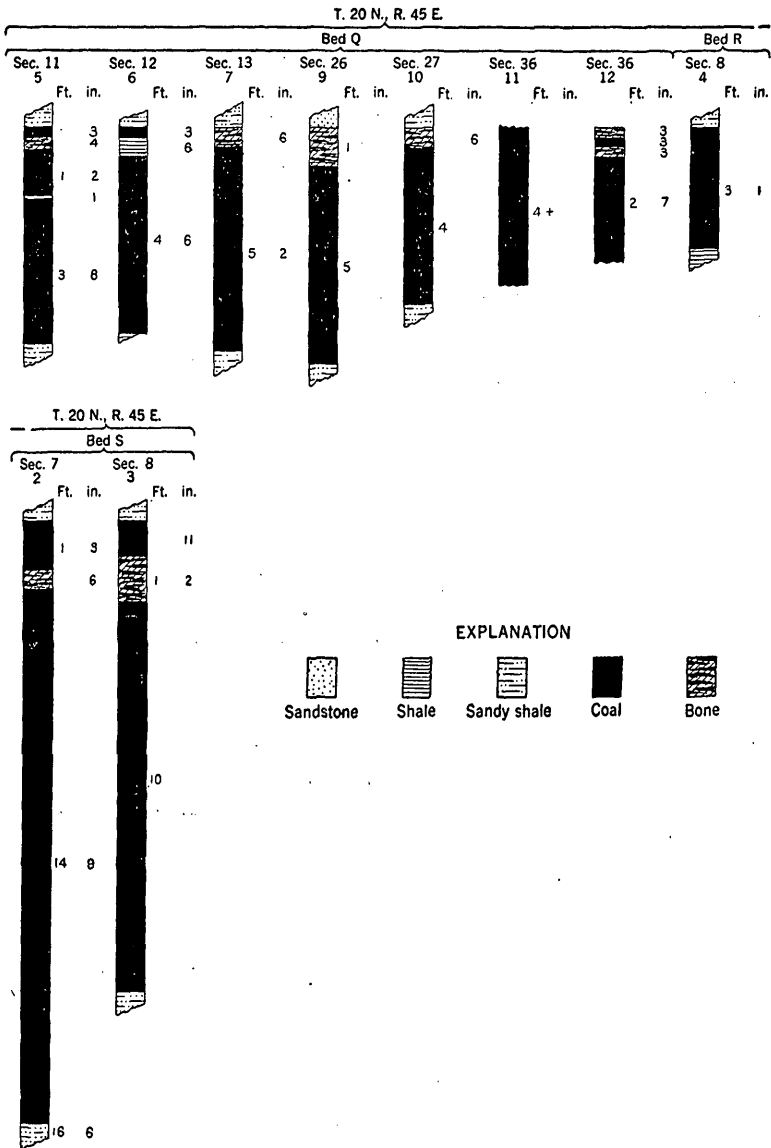


FIGURE 17.—Sections of coal beds in T. 20 N., R. 45 E.

The coal of a local bed above bed S is more than 2 ft. 6 in. thick at 5 localities, and it has been mined in the bottom of Redwater Creek at locality 6, where its thickness is not known.

Bed R was found only in the southeastern part of the township. The coal bed at locality 10, though appearing to be about 25 ft. below this bed, may be a part of it.

The coal bed above bed R in secs. 34 and 35 may be either bed Q or a part of the local bed above the upper R bed in T. 19 N., R. 49 E. It is probably the Gaines bed of the Richey-Lambert area. In this township it is thin and valueless.

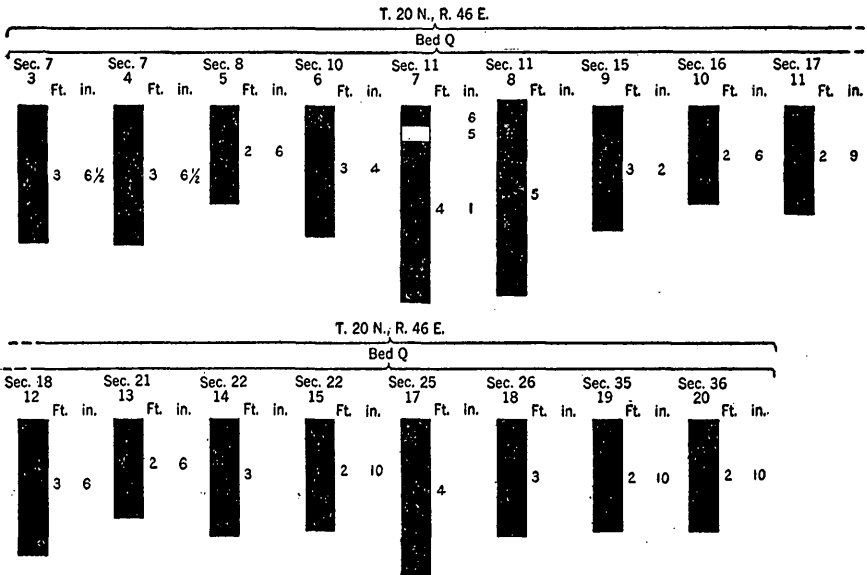


FIGURE 18.—Sections of bed Q in T. 20 N., R. 46 E.

T. 21 N., R. 43 E.

A local impure coal bed which measured 2 ft. 10 in. in thickness 1,000 ft. south of the northeast corner of sec. 21, T. 21 N., R. 43 E., and which is 1 ft. 3 in. thick

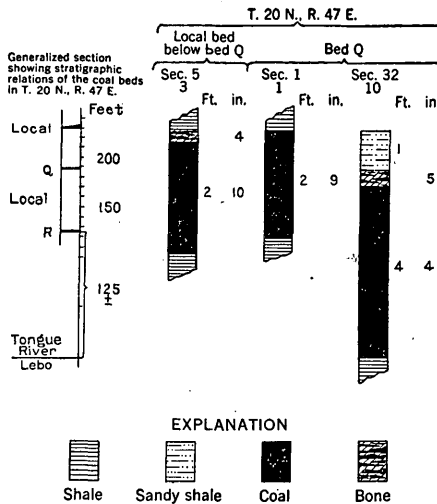


FIGURE 19.—Sections of coal beds in T. 20 N., R. 47 E.

in the south-central part of sec. 8, may be one of the two local beds in the Hell Creek member of the Lance formation found in T. 20 N., R. 43 E. Unmapped coal seen near the center of sec. 4 may belong to the same bed. Owing to its thinness and the poor quality of its coal, this bed is of no value.

The coal of bed Z in this township is variable in thickness and in quality. The coal at locality 6 represents the portion of the bed below a parting which is 2 ft. 4 in. thick at locality 5, the coal above this parting being replaced by mudstone at locality 6. (See fig. 21.) A mudstone parting which is 4 or 5 ft. thick at locality 4 is more than 25 ft. thick a few hundred feet southwestward.

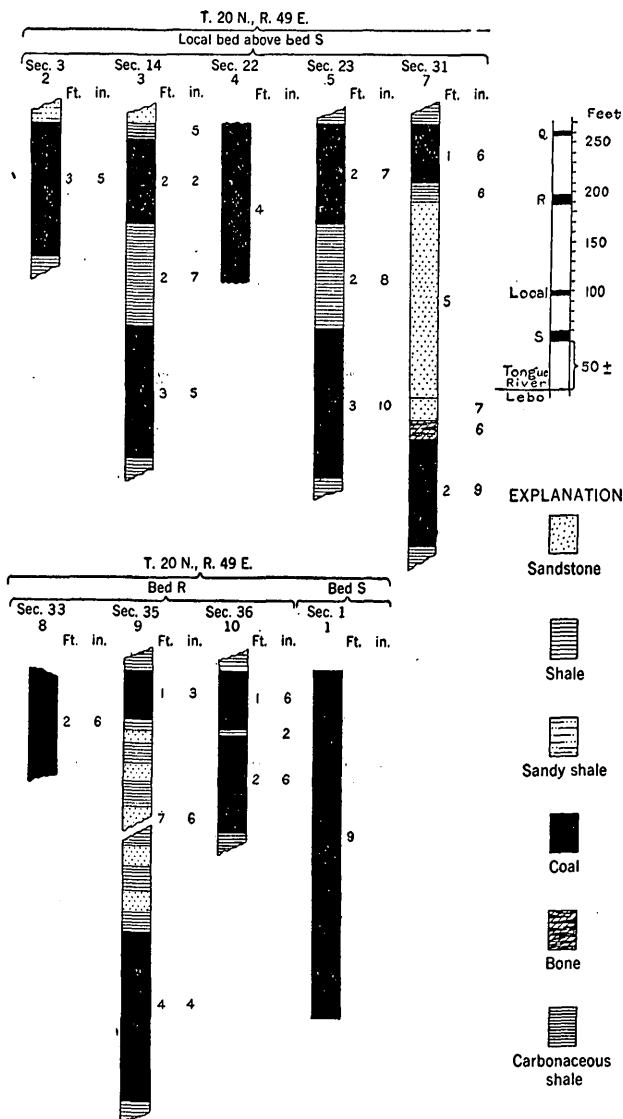


FIGURE 20.—Sections of coal beds in T. 20 N., R. 49 E.

The coal in bed U was measured at 25 places in this township and was found to range in thickness from $3\frac{3}{4}$ to $6\frac{1}{2}$ ft., but, except at one exposure, that at locality 8, it was everywhere observed to be so impure as to be worthless.

A local coal bed about 90 ft. higher than bed U and 2 ft. thick was seen on the divide in the center of sec. 13.

T. 21 N., R. 44 E.

The coal of bed Z appears at the surface of T. 21 N., R. 44 E., only in sec. 6. At localities 1 and 2 it shows a thickness of 2 ft., free from partings in the upper of its two benches, the lower of which is about 1 ft. thick and about 8 ft. below the upper.

No coal was found in this township between beds U and Z.

Except at localities 3 and 4 (fig. 22), the coal of bed U at all the 10 exposures visited in the north half of this township is so impure as to be worthless. A general improvement in the quality of this coal and an increase of its thickness were observed in the south half of the township, though at localities 5, 7, and 9 the coal is rendered valueless by partings and impure layers. At locality 6 the exposed upper 4 ft. 6 in. is of good quality. In sec. 31 the main coal seam of bed U is

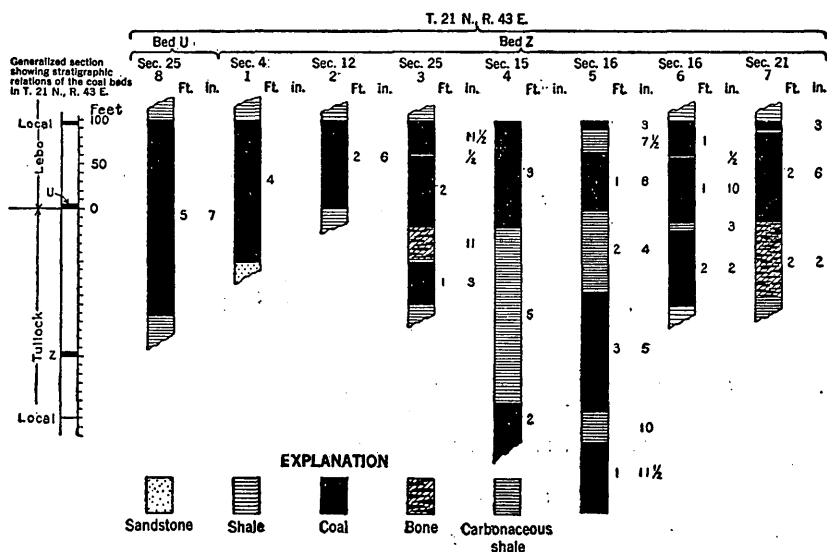


FIGURE 21.—Sections of coal beds in T. 21 N., R. 43 E.

about 14 ft. above the bed of coal, which is 4 ft. 7 in. thick but impure at locality 9 and 4 ft. thick at locality 10 but which seems to be absent elsewhere in the township.

The relative stratigraphic positions of several unmapped thin coal beds in the Lebo member of the Fort Union formation are shown in figure 22.

T. 21 N., R. 45 E.

Exposures of bed S at the White mine, locality 1, T. 21 N., R. 45 E., at an altitude about 150 feet higher than Weldon post office (sec. 1), and at localities 2, 3, and 4 (fig. 22), show only part of the thickness of the bed. The full thickness at these localities is probably comparable with that at locality 5, where the over-all thickness, determined by boring with an auger, is about 14 ft., including a parting 6 in. thick about 3 1/2 ft. above the base. At locality 4 only 2 ft. of the bed was measured.

T. 21 N., R. 46 E.

A local bed 1 ft. 4 in. thick and about 33 ft. below bed S crops out at locality 1, T. 21 N., R. 46 E., but was not observed elsewhere in this township.

The coal of bed S probably averages at least 8 ft. in thickness (fig. 23) in the northern part of this township, though at most localities visited the full thickness

was not seen. Several thousand tons of coal has been taken from bed S at the Bryant mine, locality 3, and small quantities have been mined at localities 5 and 6.

Bed R, which crops out south of bed S, shows less than 30 in. of clean coal at 5 out of 9 localities examined. Though the bed is thin, the coal is of good quality,

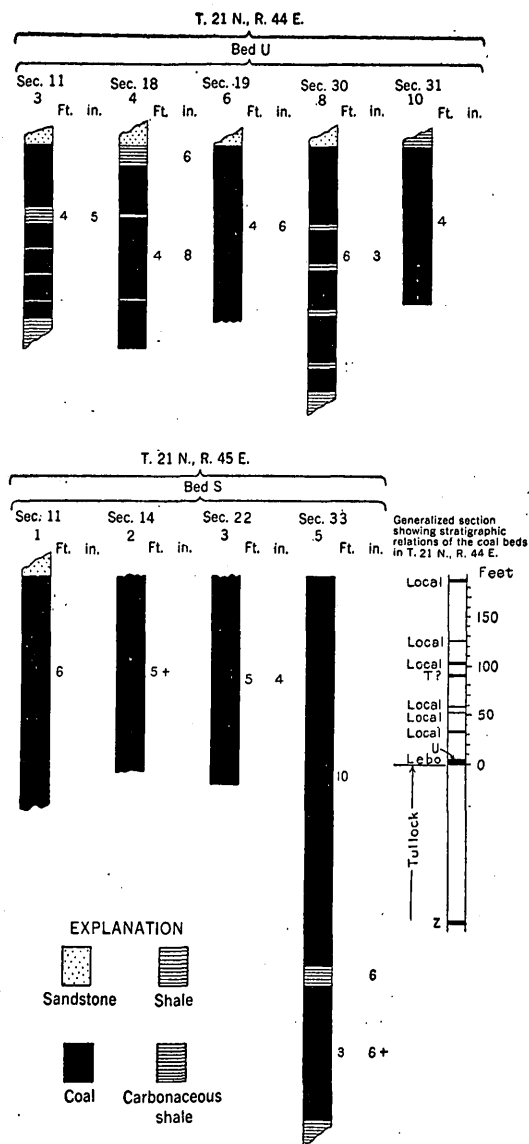


FIGURE 22.—Sections of coal beds in T. 21 N., Rs. 44 and 45 E.

and several thousand tons of it has been produced by mining along the sides of the deep canyons in secs. 15 and 16. The lowermost bed in the group measured at locality 15 (fig. 24) is probably bed R.

An unmapped thin coal bed that crops out at localities 17 and 18 and northwest of locality 23 is about 55 ft. above bed R and is therefore probably at about the same horizon as outcrops of coal in several townships to the south and southeast.

The bed at the base of the section measured in a small strip mine at locality 23 and doubtfully mapped as bed Q is not known with certainty to be exposed at localities 8, 9, 10, 12, 13, 14, 15, 19, 20, 21, 22, 24, and 25, and some of the measurements made at these localities may be on the higher coal beds examined at locality 23, the uppermost of which is probably bed P. A small working in this bed was seen also at locality 15. A coal bed appears in a similar stratigraphic position in T. 21 N., R. 48 E.

A local coal bed at locality 13 is 2 ft. 7 in. thick and about 31 ft. above bed Q.

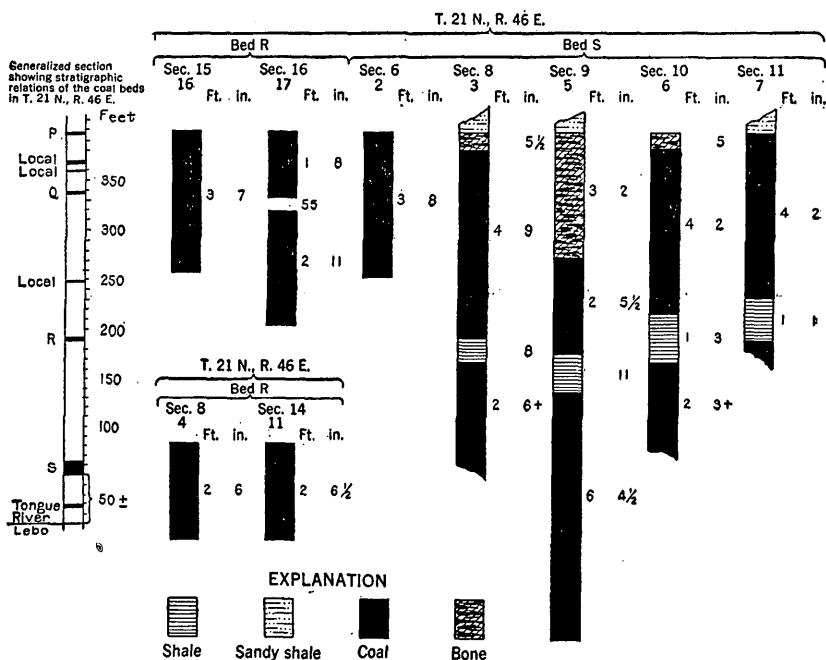


FIGURE 23.—Sections of beds R and S in T. 21 N., R. 46 E.

T. 21 N., R. 47 E.

A coal bed, believed to be bed Q, averages 2 ft. 10 in. in thickness at 6 localities in T. 21 N., R. 47 E. (fig. 25). The coal of a local bed about 20 ft. higher is 1 ft. 8 in. thick at locality 5 and 2 ft. 8 in. thick at locality 8. No coal is known to have been mined in this township, but bed S is probably not more than 350 ft. below the surface at any place and may be within 100 ft. of the bottom of Lost Creek in the southeastern part of the township.

T. 21 N., R. 48 E.

The coal of bed S, which is the most valuable bed exposed in T. 21 N., R. 48 E., crops out only in the northeast corner of sec. 1, where coal was formerly taken from a strip pit at locality 1. (See fig. 25.) This bed has been traced from the east along Duck Creek and undoubtedly underlies all of this township except the small area north of its outcrop in sec. 1.

Coal 2 ft. thick at about the same horizon as the R beds in townships to the south crops out at locality 3.

What is probably bed Q was seen in several exposures near the tops of hills, as at localities 2 and 6.

Clinker was found at locality 5, about 24 ft. higher than the coal at locality 6.

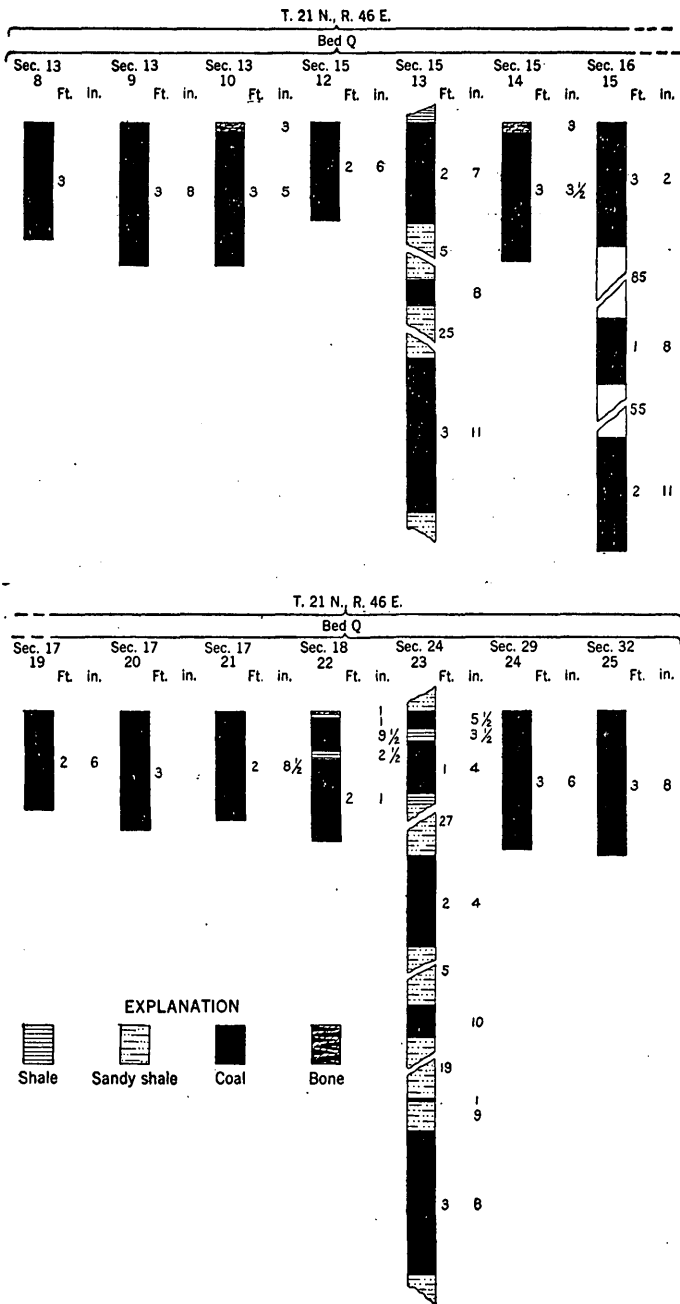


FIGURE 24.—Sections of bed Q in T. 21 N., R. 46 E.

T. 21 N., R. 49 E.

The coal of bed S at the outcrops examined in T. 21 N., R. 49 E., ranges in thickness from 2 ft. 8 in. to 7 ft. 11 in. (See fig. 25.) In a strip mine at locality 6 its thickness is probably at least 8 ft. A strip mine has been worked at locality 3. Coal S appears to be present and of workable thickness everywhere in this township, except for a total of about 4 square miles in the southeastern and northern parts of the township, where it has been eroded by Redwater and Duck Creeks.

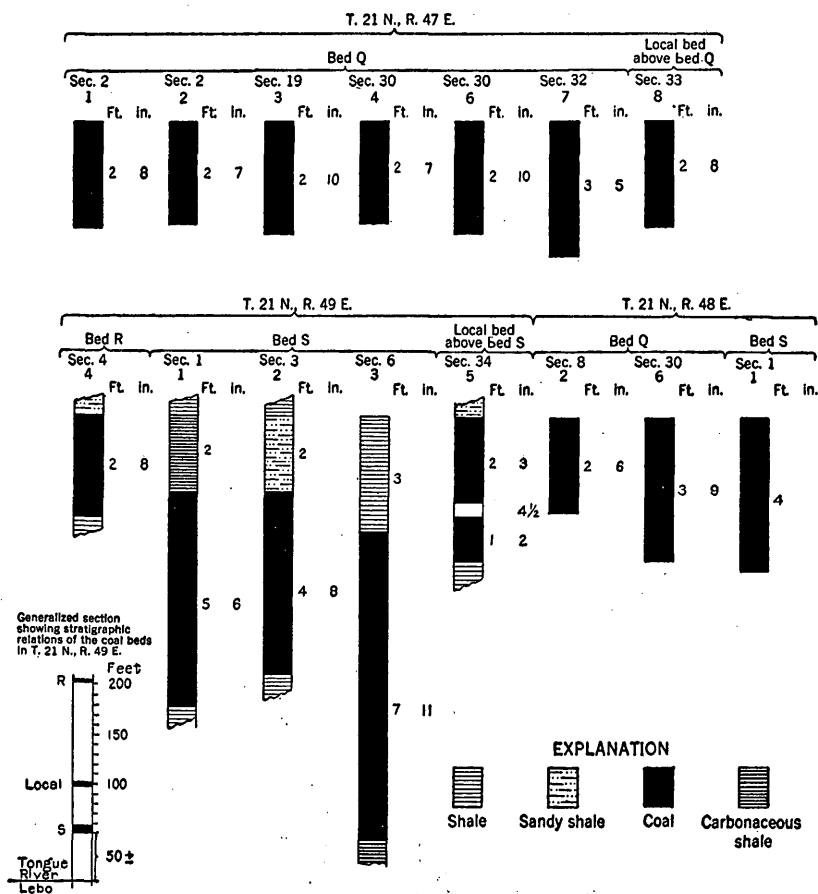


FIGURE 25.—Sections of coal beds in T. 21 N., Rs. 47, 48, and 49 E.

A local coal bed above bed S, which is unmapped in this township except in sec. 36 but which in T. 20 N., R. 49 E., attains a thickness of 4 ft., is 3 ft. 9 1/2 in. thick, including a 4 1/2-in. parting at locality 5, but is so thin as to be valueless at other exposures visited in secs. 34 and 36.

The coal of bed R crops out at locality 4 in two benches, separated by 3 ft. of sandy shale, of which only the lower bench is of value. Elsewhere in sec. 23 and in secs. 14 and 15 both benches are too thin for profitable mining. In the SE 1/4 sec. 36 bed R is probably of workable thickness, as two benches of it, each 2 1/2 ft. thick with a 2 1/2-ft. parting between them, were measured in sec. 5, T. 20 N., R. 50 E., about 150 ft. beyond the township line.

T. 22 N., R. 43 E.

The coal of bed Z at locality 2, T. 22 N., R. 43 E., is about 3 ft. thick but is very impure, and at locality 3 the bed is too thin to be of value. In the E½ sec. 25 an unmapped outcrop of a coal bed 2 ft. 11 in. thick, including a 3-in. shale parting, may also belong to bed Z.

A coal bed at locality 1, containing 2 ft. of impure coal, is about 30 ft. below the horizon of bed U and may be bed Y or may correspond to the thin bench that is about 15 ft. 9 in. below the main bed U at locality 5. (See fig. 26.)

Bed U crops out around two small areas in sec. 12. The upper 3 ft. of the bed, as exposed at localities 4 and 5, is badly slacked. The strip pit in this bed at locality 4 extends eastward into T. 22 N., R. 44 E.

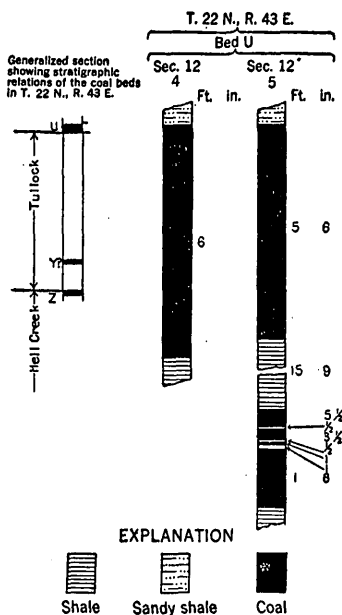


FIGURE 26.—Sections of bed U in T. 22 N., R. 43 E.

T. 22 N., R. 44 E.

The coal of bed Z is exposed at locality 17, T. 22 N., R. 44 E., where it is 3 ft. 2 in. thick (fig. 27), including one parting. At locality 16 it is about 170 ft. lower than bed U but only 2 ft. 4 in. thick. In unmapped outcrops near the north line of sec. 6 it is too thin to be of value.

The coal of bed U is variable in thickness and quality. In the strip pit at locality 4 (fig. 26) it is 6 ft. thick. The strip pit at locality 8 exposes over 10 ft. of coal, which, however, is mainly impure and has not been worked for several years. Workings were found also at localities 1 and 14.

The coal of bed T (?), about 75 ft. above bed U at locality 22, is 2 ft. 6 in. thick, but it is thinner at localities 9 and 23. It is near the horizon of a local bed in T. 20 N., R. 43 E.

T. 22 N., R. 45 E.

Bed U at locality 1, T. 22 N., R. 45 E., contains 5 ft. of coal (fig. 27), including a 3-in. shale parting, but at locality 2 it is represented by three very thin benches of coal separated by thick partings. East of sec. 10 and in the south half of the township this bed is not exposed.

A bed of clean coal about 1 ft. 6 in. thick in a small unmapped outlier in sec. 32 may be bed S but is more probably a lower bed.

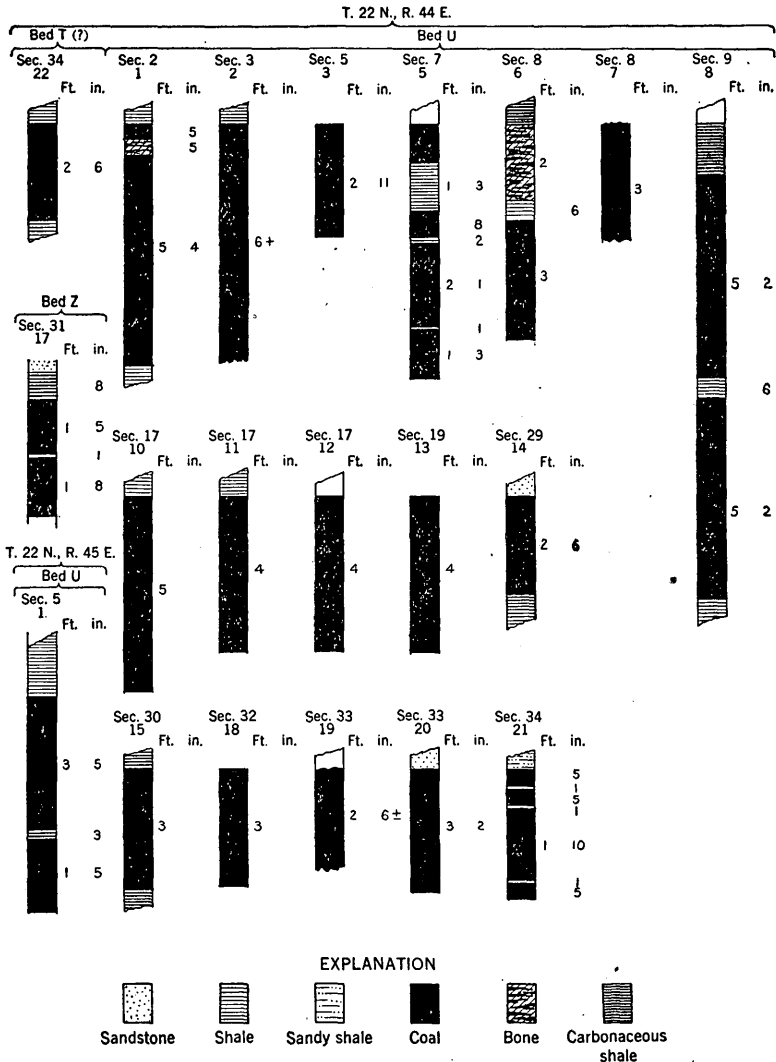


FIGURE 27.—Sections of coal beds in T. 22 N., Rs. 44 and 45 E.

T. 22 N., R. 46 E.

Bed U is exposed in the northwestern part of T. 22 N., R. 46 E. The coal at locality 7 (fig. 28) probably represents the lowermost bench at locality 5, T. 23 N., R. 46 E. (fig. 33), where this bed has been mined notwithstanding the poor quality of its coal.

No coal beds of value were found in this township in the interval between beds U and S.

Throughout that part of the township north of a fault (p. 17) which trends about N. 50° E. from sec. 31 to sec. 13 bed S has been completely removed by erosion, except in the SW¼ sec. 31. South of the fault, at localities 1, 2, 3, 5,

and 6, the coal of this bed forms two or more benches; the greatest thickness in a single bench is 5 ft. in the lower bench at locality 6. The coal at locality 4 is tentatively assigned to bed S, though the fault prevents tracing of the bed between this locality and the outcrops to the south.

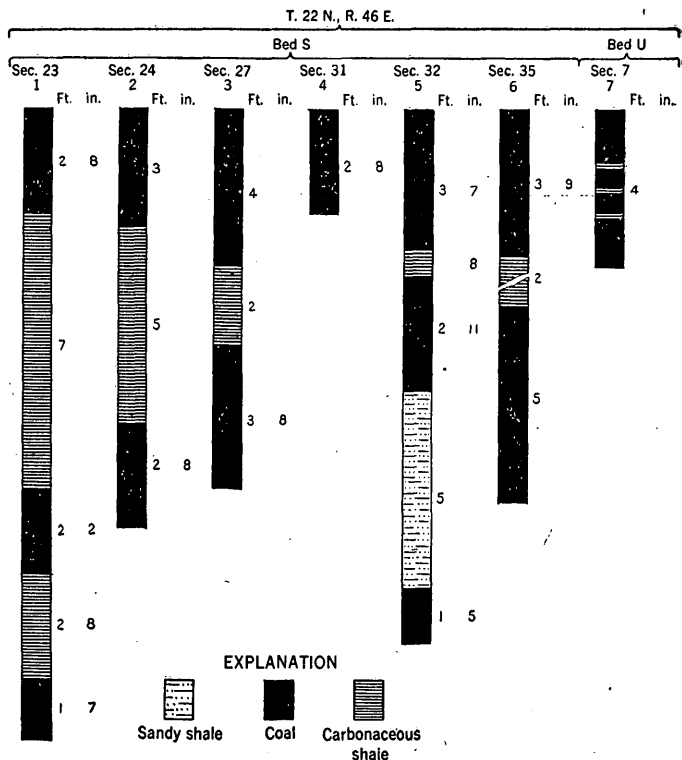


FIGURE 28.—Sections of coal beds in T. 22 N., R. 46 E.

T. 22 N., R. 47 E.

A coal bed thought to be bed S of the south half of McCone County consists of two benches, separated by 6 to 8 ft. of shale, at localities 2, 4, and 5, T. 22 N., R. 47 E. (fig. 29). In secs. 6 and 7 it is probably represented by one or more of several thin beds in about 40 ft. of strata. No coal bed 2½ ft. or more in thickness was found in the east half of the township. Either bed S is there represented by a zone of thin beds shown by the dotted line on the map, or the outcrops are covered. A rather large amount of the coal has been mined at localities 1 and 5.

T. 22 N., R. 48 E.

The coal of bed S, which is traceable into the township to the east, is exposed in secs. 1 and 2, T. 22 N., R. 48 E., along Cow Creek and in secs. 35 and 36 along Duck Creek. It underlies the surface of this township everywhere except in the narrow strips removed by erosion in these creeks. Small quantities of the coal have been mined for local use at localities 1, 2, and 6, and the bed appears to offer opportunities for further mining in this township. (See fig. 29.)

Coal beds seen at localities 3 and 4 at about the horizon of the R beds exposed in townships to the south are thin and of no value.

T. 22 N., R. 49 E.

The coal of bed S in T. 22 N., R. 49 E., shows thicknesses ranging from 1 ft. 11 in. to 7 ft. 2 in. (See fig. 30.) Eliminating about 7 sections in the north-western part of the township in which the coal is thin and 8 sections where it has been eroded by Cow and Duck Creeks leaves an area of about 21 square miles in this township underlain by coal S. It is probable that in half of this area the coal is under less than 50 ft. of overburden. Coal has been taken from bed S at several places. Stripping at the Melby mine, locality 2, has yielded over 1,000 tons of lignite, and at the Shirk mine, near locality 1, roughly 6,000 tons. Similar mining operations have been carried on at localities 3 and 6.

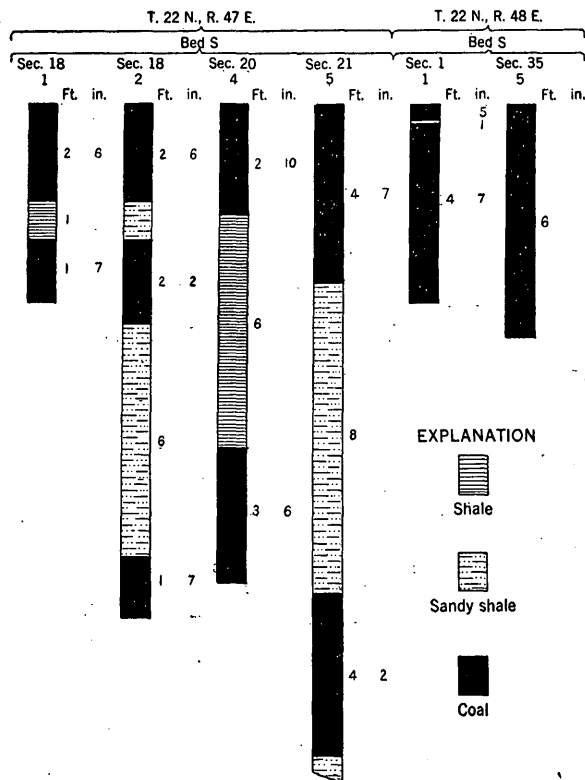


FIGURE 29.—Sections of coal beds in T. 22 N., Rs. 47 and 48 E.

An unmapped coal bed at about the same stratigraphic position as the coal 40 ft. above bed S in T. 21 N., R. 49 E., is 1 ft. 6 in. thick in the southern part of sec. 23.

T. 23 N., R. 43 E.

Several thin beds in the Tullock and Hell Creek members of the Lance formation crop out in secs. 14, 23, and 36, T. 23 N., R. 43 E., but no bed of commercial value was found in this township.

T. 23 N., R. 44 E.

The coal of bed Z attains 2½ ft. or more in thickness at localities in the north-eastern part of T. 23 N., R. 44 E., but elsewhere in the township it is so thin that no effort was made to map it. (See fig. 31.)

The coal of bed X crops out persistently in this township but was nowhere observed to have a thickness as great as $2\frac{1}{2}$ ft. except at locality 5, where 2 ft. 8 in. of coal was measured in one bench.

Unburned coal of bed U probably underlies an area of about 3 square miles in the southeastern part of the township, but most of its outcrop has clinkered. At locality 4, where the unburned bed is 15 ft. thick and free from partings, the bed is mined by ranchers residing nearby.

T. 23 N., R. 45 E.

Bed Z attains a thickness of more than $2\frac{1}{2}$ ft. in secs. 7 and 1, T. 23 N., R. 45 E., but elsewhere in the township it is not thick enough to warrant mapping.

A local coal bed at least 2 ft. 7 in. thick was observed 40 ft. above bed Z at locality 2. (See fig. 32.)

Bed X is less than $2\frac{1}{2}$ ft. thick at all the exposures examined, except along its outcrop between the $E\frac{1}{2}$ sec. 18 and the $N\frac{1}{2}$ sec. 10.

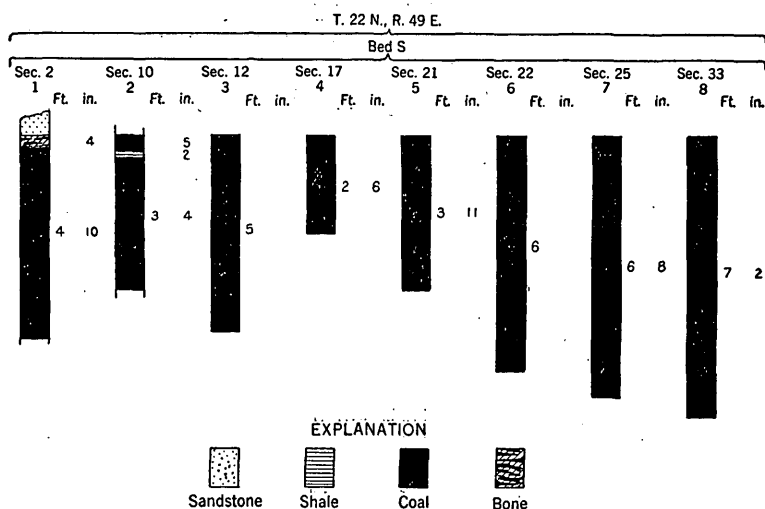


FIGURE 30.—Sections of bed S in T. 22 N., R. 49 E.

The outcrop of bed U has clinkered in the western part of the area between Shade and Flying V Creeks, but the unburned bed underlies areas in secs. 11, 14, 15, 22, and 23, where its average thickness, to judge from outcrops, is about 8 ft. In the fairly level grassy country south of Flying V Creek the outcrop of bed U is obscure but can be traced by means of scattered showings of smut. Better exposures occur near the head of Figure B Creek in secs. 31, 32, and 33.

T. 23 N., R. 46 E.

The coal of bed Z is exposed in sec. 5, T. 23 N., R. 46 E. (fig. 33), but its outcrop is concealed by alluvium in secs. 6, 7, and 8.

Bed U at locality 5 is split into two benches of coal about 25 ft. apart, but only one bench was seen at localities 1, 2, and 4. In this township most of the outcrop of bed U is concealed by soil, and no coal bed of economic value was found above this bed.

T. 23 N., R. 47 E.

The coal of bed S crops out in the bluffs north of the high divide in the central part of T. 23 N., R. 47 E. At locality 4 it is only 2 ft. thick, but farther east, at localities 1, 2, and 3, it averages about 4 ft. (See fig. 33.) Small strip mines are opened on this bed at localities 2 and 3.

No other coal bed of economic value appears at the surface of this township, but bed U underlies its whole area at depths ranging, approximately, from 50 to 300 ft.

T. 23 N., R. 48 E.

The coal of bed S at locality 2, T. 23 N., R. 48 E., is 4 ft. thick and at a small strip pit near locality 2 is 4 ft. 7 in. thick, including a thin parting. (See fig. 33.) The bed thins eastward and at locality 3 is only 1 ft. 4½ in. thick. No other bed of value was found in this township, but bed U underlies its whole surface.

T. 23 N., R. 49 E.

The coal of bed S is poorly exposed in the south half of T. 23 N., R. 49 E., but it is probably of good quality and of adequate thickness for mining, as indicated

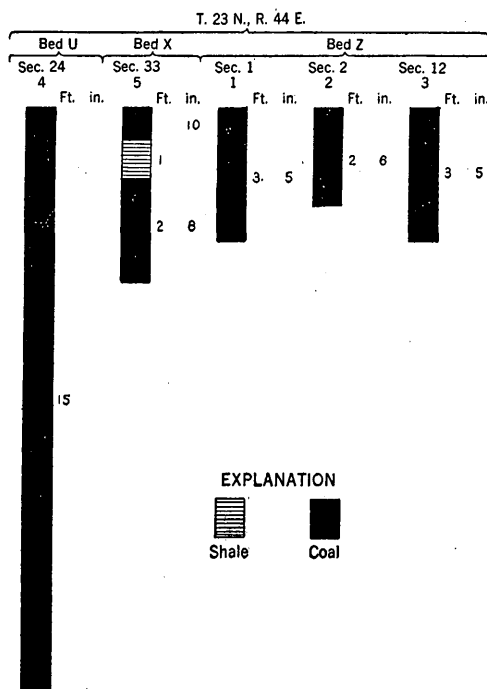


FIGURE 31.—Sections of coal beds in T. 23 N., R. 44 E.

by the exposures at the Melby and Shirk mines, in the adjacent township to the south. In the north half of this township coal S is only 1 ft. 11 in. thick at locality 4 and 2 ft. thick at locality 5, but at locality 1 it shows a thickness of at least 3 ft. 6 in. (See fig. 33.)

Coal 1 foot thick at locality 2 is about 70 ft. stratigraphically higher than bed S.

T. 24 N., R. 43 E.

Beds of coal crop out around nearly all the high buttes in the eastern part of T. 24 N., R. 43 E., but at all exposures visited the coal is less than 2 ft. 6 in. thick, except at locality 1, where bed Z contains 3 ft. of clean coal. (See fig. 37.) At this locality a local bed of coal about 4½ ft. lower than bed Z, is only 2 ft. thick.

T. 24 N., R. 44 E.

Bed Z crops out in the northeastern and southeastern parts of T. 24 N., R. 44 E., and in sec. 7. At localities 1 and 3 measurements on this bed show a bench of

coal 1 ft. 10 in. thick, which may be one of the two benches exposed at localities 2 and 4. (See fig. 37.) Along its outcrop in secs. 4, 9, 10, 11, and 12 the coal of bed Z is mined by local ranchers at many places. No other coal beds of value were found in this township.

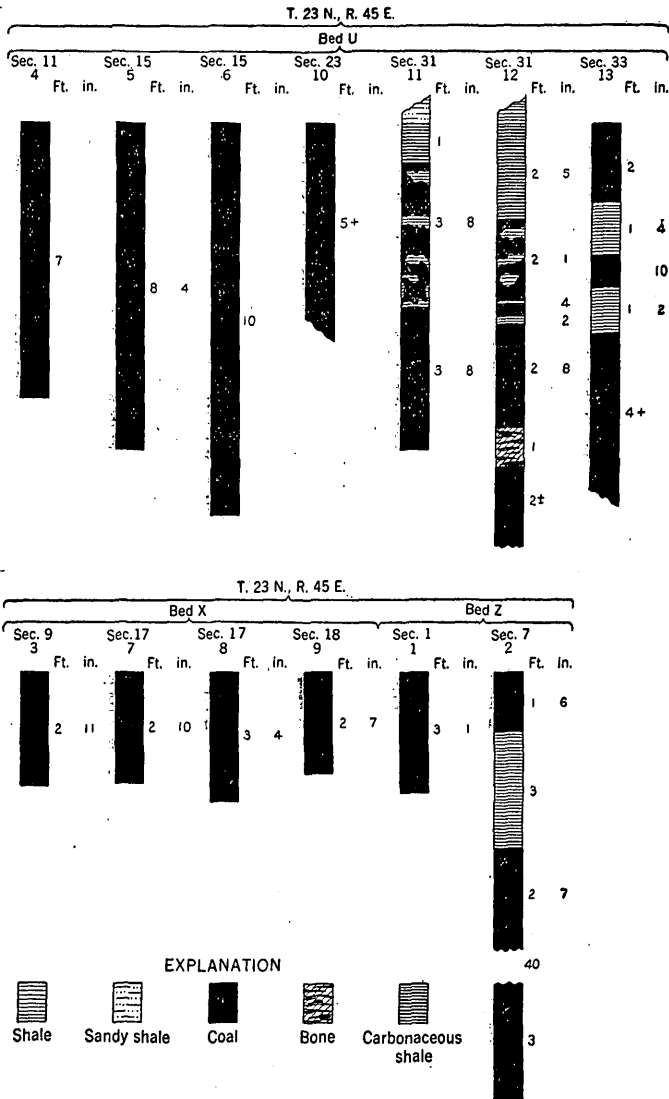


FIGURE 32.—Sections of coal beds in T. 23 N., R. 45 E.

T. 24 N., R. 45 E.

Only one coal bed, bed Z, was seen at the surface of T. 24 N., R. 45 E. It crops out on a narrow ridge in secs. 29, 30, and 31. At locality 1 it is 2 ft. 4 in. thick.

T. 24 N., R. 46 E.

The coal of bed Z in secs. 3, 10, 15, 29, and 32, T. 24 N., R. 46 E., ranges in thickness from 2 ft. 6 in. to 4 ft. (fig. 34), but at locality 4 the bed is only 1 ft. 3 in.

thick. It continues to be very thin through secs. 21 and 28 and also in secs. 1, 2, and 12.

The outcrop of bed U is easily traced along the grassy slopes by following its smut and clinker. The unburned bed underlies about 6 square miles, mainly in the northeastern and southeastern parts of the township. Throughout this area it is probably more than 2 ft. 6 in. thick and under a comparatively thin cover.

T. 24 N., R. 47 E.

Bed X at locality 2, T. 24 N., R. 47 E., contains 2 ft. 6 in. of clean coal, and at locality 1 its thickness is 3 ft. 1 in., including a 2-in. shale parting. (See fig. 35.)

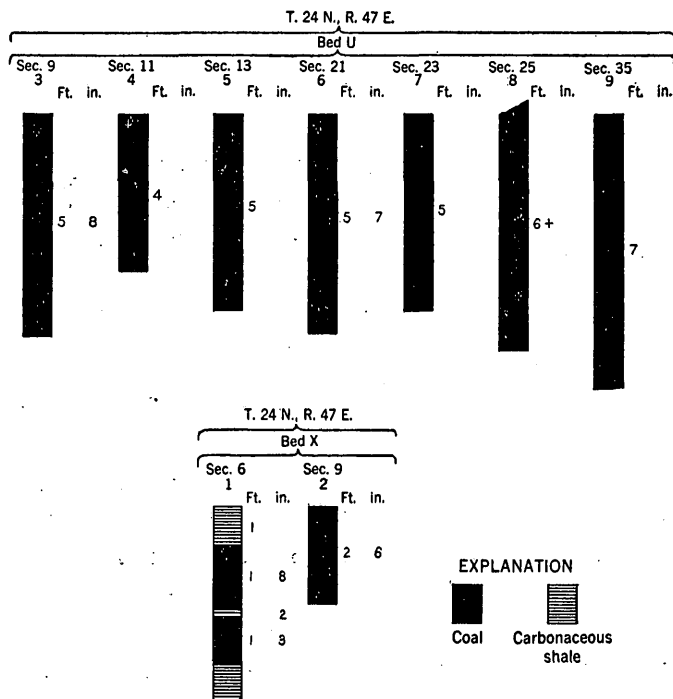


FIGURE 35.—Sections of coal beds in T. 24 N., R. 47 E.

Except in the vicinity of these exposures, this bed is so thin that no effort was made to map it.

The outcrop of bed U was traced over the grassy country mainly by means of its clinker, but measurements of its thickness were obtained only with great difficulty, especially in the southwestern part of the township. At 7 localities examined the unburned bed ranges in thickness from 4 to 7 ft. Coal has been mined in this bed at the Thomas mine, locality 8, where there are three entries, and at the Whier mine, locality 9, where an entry 80 ft. long, now caved in, has been driven.

T. 24 N., R. 48 E.

Almost the whole area of T. 24 N., R. 48 E., is underlain by bed U, which crops out in the NW¼ sec. 19, at the Deed Cash mine, locality 1, where it is mined by ranchers residing nearby. The coal bed is reported to be 8 ft. thick in this mine. (See fig. 36.)

A local bed about 50 ft. above bed U is exposed at locality 2, where it has been mined by Peter Freeburg.

T. 24 N., R. 49 E.

At localities 1 and 2, T. 24 N., R. 49 E., coal probably belonging to bed U, has been mined by stripping along its outcrop to supply neighboring ranches. (See fig. 36.) This coal bed underlies the whole surface of the township, except about 3 square miles in the northeastern part, where erosion by Wolf Creek has removed it.

Clinker, probably representing the coal of bed S, was seen in secs. 34 and 36, but no unburned outcrops of this bed were found.

T. 24 N., R. 50 E.

Exposures of coal are rare in T. 24 N., R. 50 E., owing to the presence of glacial drift in the uplands and of extensive gravel terraces in the valleys of Redwater and Wolf Creeks.

The coal at locality 2 is probably bed U, and that at the small strip mine at locality 1 is thought to be bed S. (See fig. 36.)

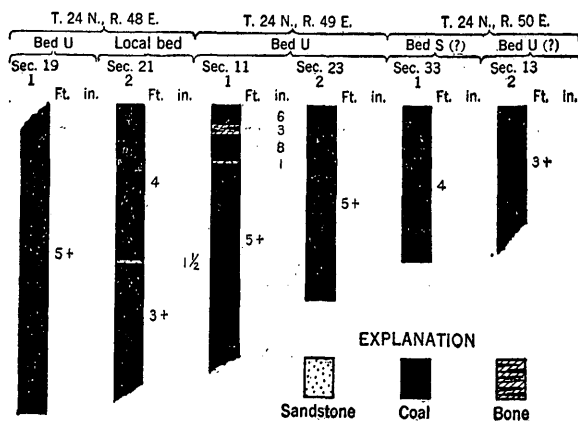


FIGURE 36.—Sections of coal beds in T. 24 N., Rs. 48, 49, and 50 E.

T. 25 N., R. 43 E.

No bench of coal more than 1 ft. 6 in. thick was found in T. 25 N., R. 43 E., and isolated outcrops here cannot be certainly correlated with beds in other parts of McCone County.

The coal of bed Z (?) at locality 1 occurs in two benches, of which the lower is 1 ft. 6 in. thick and is separated from the upper, which is 1 ft. 3 in. thick, by 4 ft. of shale.

About 35 ft. above bed Z (?) at locality 1 there is a 10-ft. zone of carbonaceous shale containing thin lenses of coal which may belong to bed Y, and about 135 ft. above bed Z (?) in sec. 36 a zone of carbonaceous shale may represent bed U.

Unmapped outcrops of thin coal beds in secs. 25, 32, 33, and 35 are probably all near the horizon of bed W.

T. 25 N., R. 44 E.

The few isolated outcrops of coal in the southwestern part of T. 25 N., R. 44 E., cannot be traced into other townships, and their correlation is uncertain. No thick bed of coal was seen.

The coal of bed Z(?) at locality 1 is 2 ft. 3 in. thick, including two thin partings, and at locality 2 it is 1 ft. 2 in. thick. Several thin beds of coal are contained in about 120 ft. of shale and sandstone overlying bed Z(?) near locality 1.

The lowest coal bed observed in T. 25 N., R. 46 E., is an unmapped local bed which, near locality 9, is 1 ft. 2 in. thick and is 39 ft. below bed Z(?); near locality 15 it is 1 ft. 11 in. thick and 29 ft. below bed Z(?). It was not observed anywhere to attain a thickness of 2½ ft.

Bed Z(?), unmapped in this township, was measured at 14 places, at all of which it is less than 2½ ft. thick.

In most of the northern part of the township bed Y is either thin or absent, but in some places in the southern part its thickness is more than 2½ ft., as at localities 11, 15, 16, 17, and 18. (See fig. 37.) An incomplete section measured at locality 14 shows 2 ft. 6 in. of coal containing half an inch of shale. At localities 12 and 13

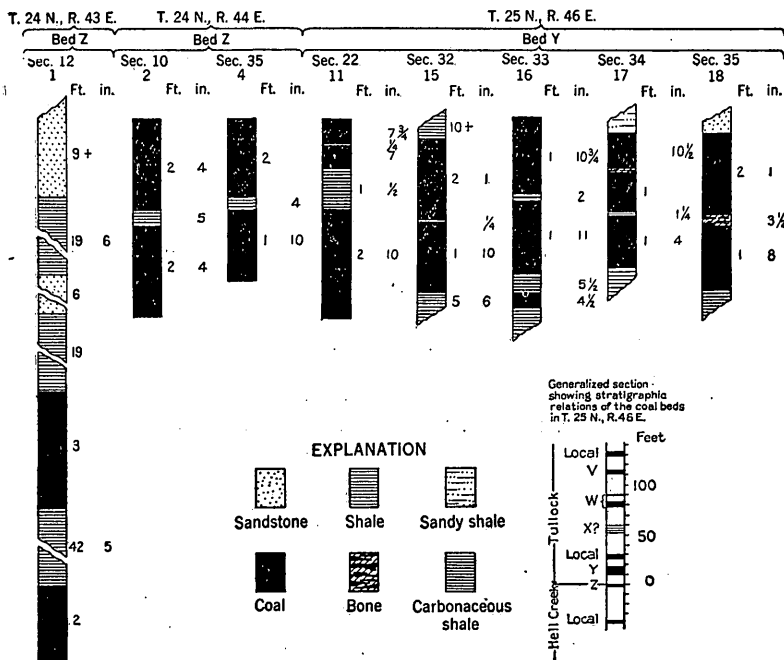


FIGURE 37.—Sections of coal beds in T. 24 N., Rs. 43 and 44 E., and T. 25 N., R. 46 E.

the bed contains less than 2½ ft. of good coal, and at localities 2, 3, 4, 9, and 10 it is represented by carbonaceous shale with or without traces of coal.

Carbonaceous shale at localities 1, 5, 6, 7, and 8 is thought to represent bed X.

In 115 ft. of strata overlying bed Y in this township at least 6 coal beds are present, as shown in figure 37. The data in hand indicate that each of these beds contains less than 2½ ft. of good coal everywhere in this township, but locally they may be thick enough to be of economic value.

An unmapped bed of coal, which is 7 in. thick near locality 6 and 1 ft. 5 in. thick near locality 11, T. 25 N., R. 47 E., is correlated with bed Z.

The coal of bed Y is variable in thickness in this township. The greatest thickness measured, at a point a few hundred feet west of locality 18, is 9 ft., including three shale partings having a total thickness of about 8 in. Other outcrops of this bed showing more than 2½ ft. of coal occur at localities 1, 2, 8, and 11. (See fig. 38.) At localities 6, 12, 14, 16, and 19 the thickness of good coal in

the bed is less than $2\frac{1}{2}$ ft. In the NE $\frac{1}{4}$ sec. 28 and at locality 8 the bed has been mined for local coal supplies.

In a local coal bed below bed X, near localities 4, 6, 16, 18, 28, 31, and 33, the good coal is less than $2\frac{1}{2}$ ft. thick, and near localities 8, 11, 14, and 17 this bed is

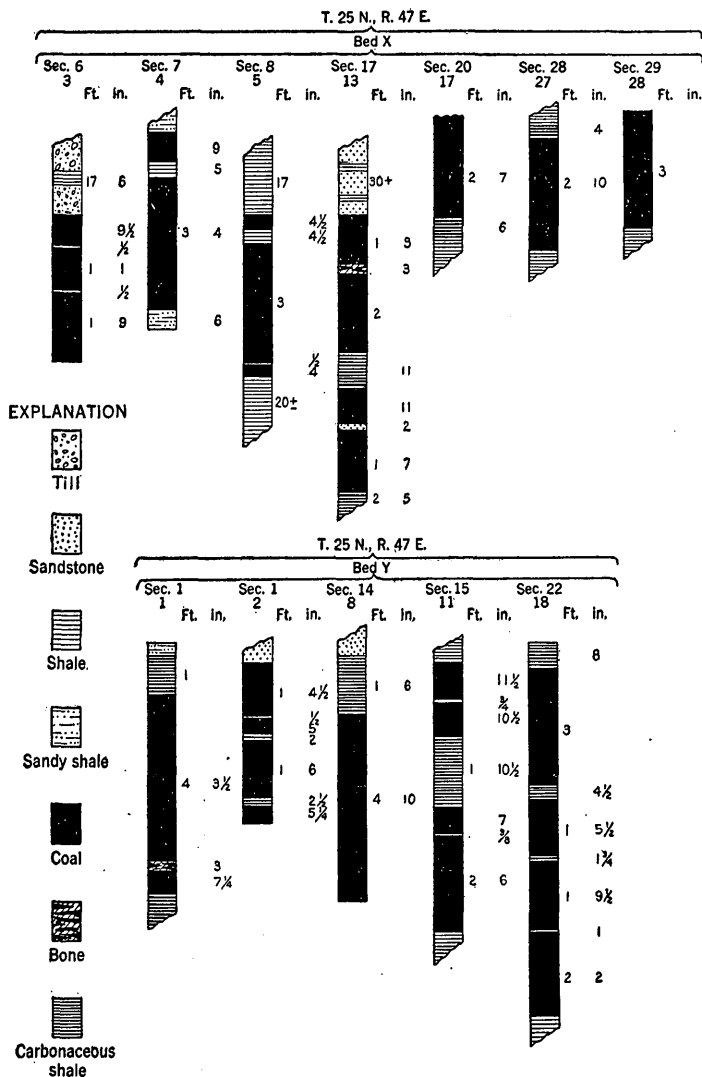


FIGURE 38.—Sections of beds X and Y in T. 25 N., R. 47 E.

probably absent. It probably does not attain a thickness of $2\frac{1}{2}$ ft. in this township.

Bed X at locality 13 is 7 ft. 1 in. thick, including three partings aggregating 1 ft. 4 in. This bed also shows more than $2\frac{1}{2}$ ft. of coal at localities 3, 4, 5, 17, 27, and 28. (See fig. 38.) Near locality 6 the coal of the bed has been partly replaced by the overlying sandstone, and the part remaining is 1 ft. thick. Near localities 14, 15, 16, and 31 the bed is less than 2 ft. 6 in. thick, and at locality 11 it is absent.

Outcrops of coal assigned to the lower W bed were examined at or near localities 6, 8, 9, 11, 15, 16, 20, 24, 27, 28, 31, and 32, but only at localities 24 and 32 is the bed thick enough to be considered of economic value. (See fig. 39.) At all

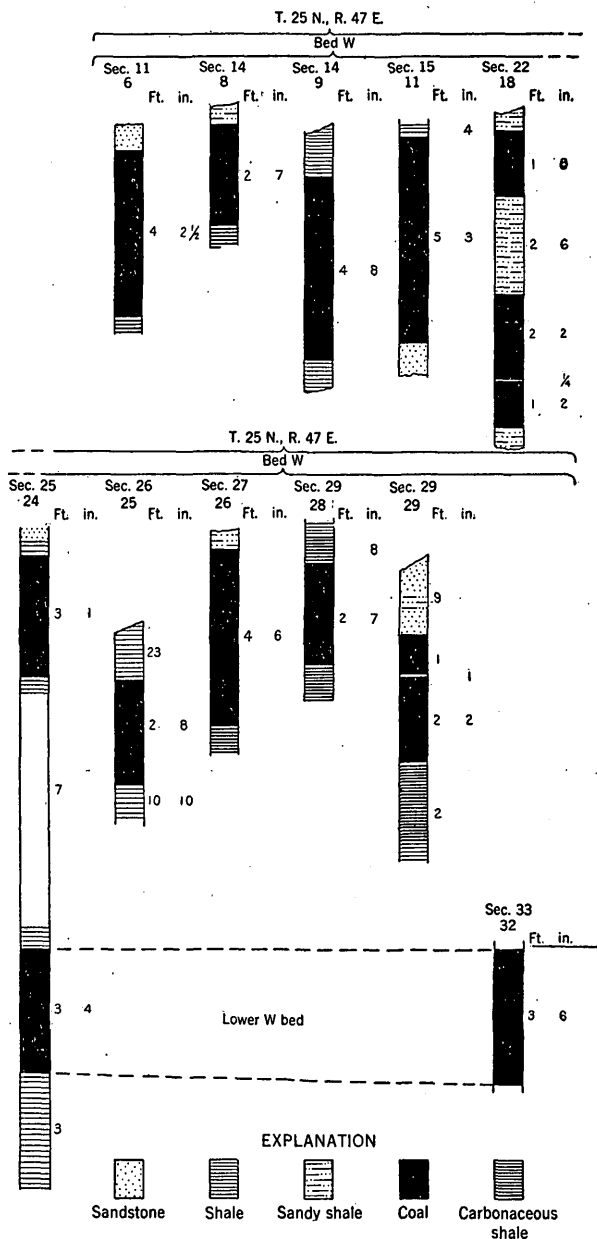


FIGURE 39.—Sections of bed W in T. 25 N., R. 47 E.

the other localities mentioned its thickness is less than 2½ ft. and in secs. 7 and 8 it is probably absent.

The upper W bed attains a thickness of 5 ft. 3 in. near locality 11 and exceeds 2½ ft. in thickness at 9 other localities. At localities 7, 14, and 32 it is too thin

to be of value. At locality 9 and in the NE¼ sec. 23 small strip mines have been opened on this bed.

Bed V, unmapped in this township, was examined at localities 10, 15, 26, and 33. The greatest thickness of coal seen at these places was 2 ft. 5 in., measured at locality 33.

A local coal bed about 17 ft. below bed U is 5 ft. 2 in. thick, including two thin partings, at locality 33 and is more than 3 ft. thick at locality 26 (fig. 40), but at localities 10 and 32 its thickness is less than 2½ ft., and at locality 21 it is represented by 7½ ft. of carbonaceous shale.

Near locality 21 bed U is 7 ft. 4 in. thick, including four partings aggregating 1 ft. 6½ in. Coal is mined from it at locality 22 (fig. 40), and the clinker that has

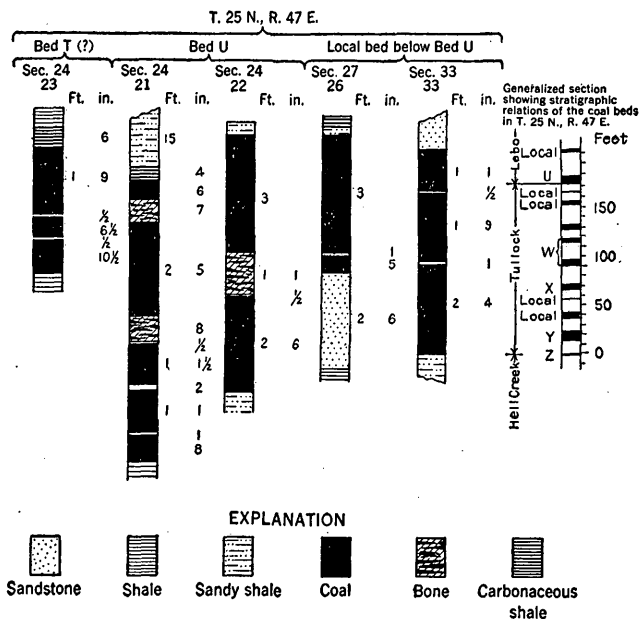


FIGURE 40.—Sections of coal beds in T. 25 N., R. 47 E.

developed along its outcrop in sec. 35 indicates that it may be of value in other parts of the township. It is represented near locality 26 and at locality 30 by a bed of carbonaceous shale.

Near locality 22 a local coal below bed T (?) is 2 ft. 10 in. thick, including two partings whose total thickness is 3 in. and which render the bed valueless.

A single measurement of bed T (?) made at locality 23, showed 3 ft. 2 in. of coal, including two partings, each half an inch thick. (See fig. 40.) Resting upon bed T (?) at this locality is 12 ft. of light-colored shale, above which is a zone of carbonaceous shale 9½ ft. thick.

T. 25 N., R. 48 E.

Bed Y in T. 25 N., R. 48 E., was measured only at locality 3. (See fig. 41.) Near the same locality bed X is believed to be represented by a zone of carbonaceous shale 10½ ft. in thickness, and about 11 ft. below this is a bed of carbonaceous shale 1 ft. thick.

The lower W bed was not found in this township.

At locality 2 there is 3 ft. of coal in one bench of the upper W bed, but at locality 4 this bed contains only 2 in. of coal and at locality 5 only 1 ft.

Bed V shows 2 ft. 7 in. of coal at locality 7, but at locality 9 it is valueless, the thickness of 2 ft. 9 in. including three-quarters of an inch of shale and 6 in. of bone.

At locality 1 the over-all thickness of the coal in bed U is 2½ ft., including two partings, each half an inch thick; at locality 6 this bed contains one parting, half an inch thick, in 2 ft. 10½ in. of coal.

In a small strip mine at locality 8 a coal bed tentatively mapped as bed T (?), having an over-all thickness of 7 ft. 4 in., is 150 ft. stratigraphically higher than bed U. In the intervening strata five coal beds were observed, all of which show less than 2½ ft. of marketable coal and are therefore considered valueless.

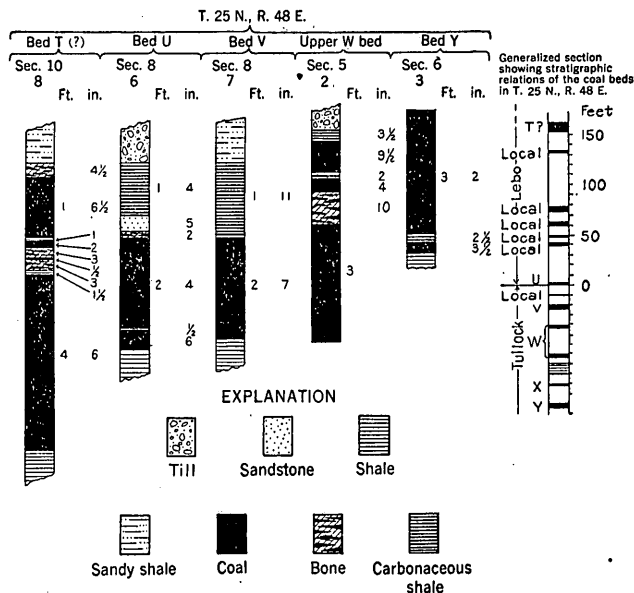


FIGURE 41.—Sections of coal beds in T. 25 N., R. 48 E.

T. 25 N., R. 49 E.

The lower W (?) bed, which has been prospected at locality 5, T. 25 N., R. 49 E., is 6 ft. below the upper W bed and measures 7 ft. 3 in. in thickness, including four thin partings (fig. 42), but at locality 3 the same bed shows only 1 ft. 10 in. of coal, and in a well at locality 2 it was not found.

The upper W coal bed exceeds 2½ ft. in thickness at localities 3, 5, 8, and 9. At locality 10 a well is reported to penetrate 9 ft. of coal believed to be at this horizon, and in a well at locality 2 the coal of this bed is said to be 4 ft. thick. At locality 5 a small amount of coal has been taken from the bed.

At locality 3 an unmapped bed 8 ft. below bed U contains 1 ft. 10 in. of coal.

Bed U was examined at a small mine at locality 4, where it contains 8 ft. 2 in. of coal, including two partings, each half an inch thick. A well at locality 1 is reported to penetrate 13 ft. of coal, probably bed U, at a depth of 50 ft., and a few hundred feet south of this the bed has been prospected, though its full thickness has not been exposed. A rancher reports that in clearing out a spring at locality 7 he dug through 6 or 7 ft. of slacked coal, probably belonging to this zone. The coal of this bed at locality 6 appeared to be rather thick but it was not measured.

Higher coal beds undoubtedly are present in the till-covered uplands occupying the southeastern and southern parts of this township, where exposures of coal are scarce, and smut resulting from the disintegration of coal was seen at a few places.

A 212-ft. well at locality 11 is reported to have penetrated a "fairly good coal bed" at a depth of 97 ft., but probably other coal beds were encountered in drilling to that depth.

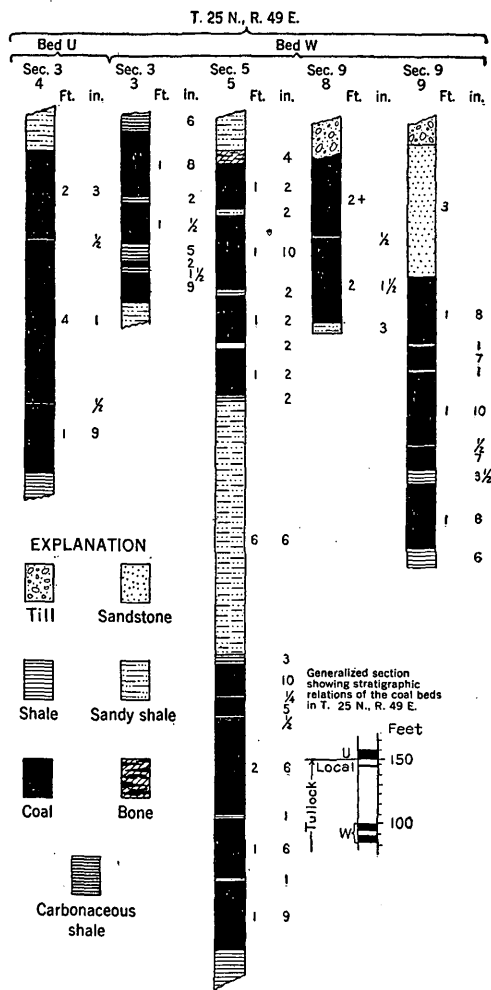


FIGURE 42.—Sections of coal beds in T. 25 N., R. 49 E.

T. 25 N., R. 50 E.

The coal of the lower W bed ranges from 2 ft. 7 in. to more than 10 ft. in thickness at 4 localities visited in T. 25 N., R. 50 E. (See fig. 43.) At locality 9 the bed is 7 ft. thick but contains little coal. Prospect pits in this bed were found at localities 5, 10, and 11.

The upper W bed in a small prospect pit at locality 6 contains 2 ft. 10 in. of coal in one bench; at locality 2 it contains only 2 ft. 1 in. of coal.

A measurement of the upper or lower W bed at locality 12 shows 2 ft. 2 in. of coal and 3 in. of carbonaceous shale.

At locality 3 a local bed about 43 ft. below bed U contains 11 in. of impure coal, and one 15 ft. below bed U shows 10 in. of coal. A few hundred feet west of the

same locality a partial measurement of bed U showed 5 ft. 8 in. of coal. Greater thicknesses are shown by partial sections at localities 7 and 8, and the full thickness at locality 4 is 9 ft. 7 in., including three partings aggregating 3 in. This

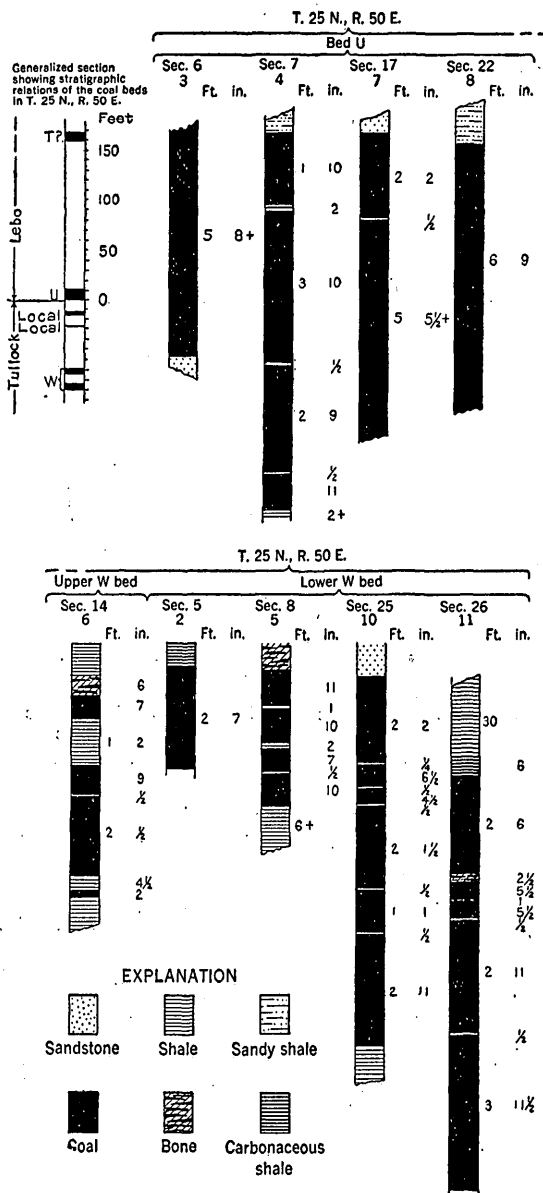


FIGURE 43.—Sections of coal beds in T. 25 N., R. 50 E.

bed is reported to contain 13 ft. of coal half a mile west of locality 3, 15 ft. in a well at locality 1, 9 1/2 ft. of weathered coal with two thin partings at locality 4, and probably 8 ft. or more of good coal at localities 7 and 8.

T. 26 N., R. 47 E.

The only measurement of the unmapped bed Z(?) in T. 26 N., R. 47 E., obtained at locality 4, showed 1 ft. 1 in. of coal, underlain by 2 in. of carbonaceous shale.

The coal in bed Y, at 5 of the 6 exposures examined in this township (fig. 44), exceeds 2½ ft. in thickness, but near locality 5 its principal bench contains only 2 ft. 4 in. of coal, separated by 1 ft. of bone from a lower bench containing 9 in. of coal.

At locality 7 the unmapped bed X contains 2 in. of coal and 2 ft. of carbonaceous shale.

At locality 7 the unmapped upper W bed shows 1 ft. 2 in. of impure coal.

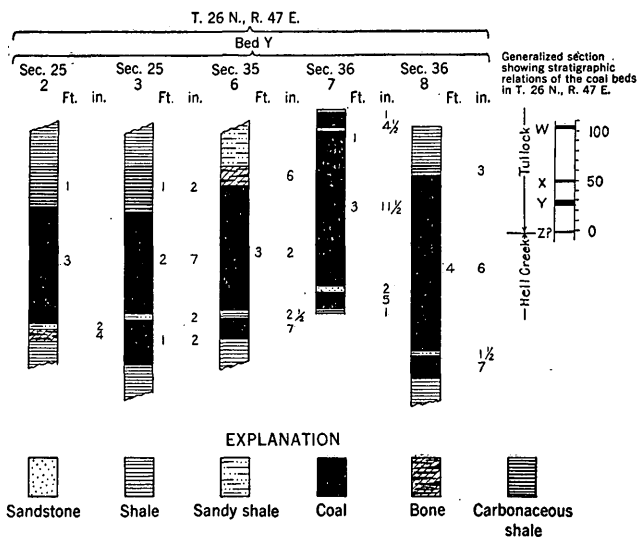


FIGURE 44.—Sections of coal beds in T. 26 N., R. 47 E.

T. 26 N., R. 48 E.

Bed Z at locality 2, T. 26 N., R. 48 E., is 5½ ft. thick, including four partings aggregating 4¾ in. (See fig. 45.) At this point two drifts in the bed, which were full of water when examination was made, are said to extend about 100 ft. from the outcrop. At locality 7 the coal of this bed is only 1 ft. 5 in. thick, and at locality 3, though the over-all thickness is more than 6 ft., the coal is rendered valueless by impure layers about 3 ft. in total thickness. At locality 4 the bed is 2½ ft. thick, including a 2½-in. parting.

Bed Y contains 1½ ft. of coal at locality 8 and the same thickness, with impure layers, at locality 7. At locality 2 this bed is represented by 3 ft. of carbonaceous shale, and at locality 11 by 4 ft. of carbonaceous shale overlain by less than 1 ft. of coal.

A local bed about 12 ft. above bed Y contains 6 in. of coal near locality 7.

Bed X near locality 11 has an over-all thickness of 3 ft. 2 in., about one-third of which is good coal. Near locality 7 it contains 1 ft. 3 in. of coal. At locality 8 the bed is represented by 2 ft. 5 in. of carbonaceous shale.

At locality 8 a local bed about 18 ft. above bed X contains 1 ft. 9 in. of coal and 3½ ft. of carbonaceous shale. Near locality 7 it contains 10 in. of bony shale.

At locality 20 the lower W bed consists of 5½ ft. of carbonaceous matter, of which about 4 ft. is good coal. At locality 1 this bed is represented by 3 ft.

4 in. of carbonaceous shale containing thin layers of coal; near locality 2 the bed contains 1 ft. 3 in. of coal and $3\frac{1}{2}$ ft. of bony shale; at locality 8, 1 ft. 6 in. of coal and $1\frac{1}{2}$ in. of carbonaceous shale; at locality 24, $5\frac{1}{2}$ in. of coal overlain by 1 ft. 3 in. of carbonaceous shale; at locality 25, 1 ft. 3 in. of coal and some carbonaceous shale.

The coal of the upper W bed, which near localities 10 and 19 exceeds $2\frac{1}{2}$ ft. in thickness, is only 1 ft. 6 in. thick at locality 1, 1 ft. 11 in. at locality 8, and 1 ft.

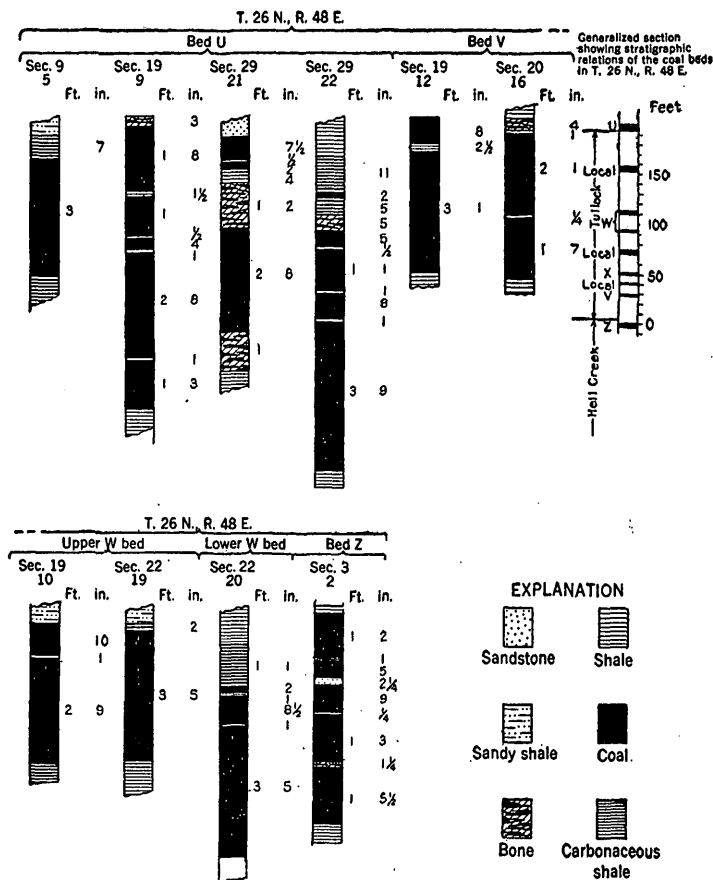


FIGURE 45.—Sections of coal beds in T. 26 N., R. 48 E.

10 in. near locality 9. At locality 17 it consists of 2 ft. 1 in. of bone containing thin lenses of coal.

Bed V is more than $2\frac{1}{2}$ ft. thick at localities 12 and 16, but at locality 13 it consists almost entirely of bone and clay. It was seen also at localities 6, 18, and 27, where it shows no good coal.

At locality 9 a local bed 15 ft. below bed U contains 2 ft. of coal and a few inches of bone; at locality 14 the same bed contains 1 ft. of good coal; at locality 22, 2 ft. 6 in., including a 2-in. parting; at locality 21, 1 ft. 6 in. of coal; at locality 23, 11 ft. of carbonaceous shale containing thin layers of coal.

At 4 of the 9 exposures of bed U examined in this township the coal exceeds $2\frac{1}{2}$ ft. in thickness, but at locality 15 it is only 2 ft. 1 in. thick; at locality 14, 3 ft.

5½ in., including partings aggregating 8½ in.; at locality 26, 1 ft. 7 in.; at locality 27, 3 ft. 2 in., only half of which is coal; near locality 16, 8 ft., almost entirely bone and clay. In the S½ sec. 33 the beds at this horizon are apparently barren of coal.

T. 26 N., R. 49 E.

The coal of bed Z at locality 5, T. 26 N., R. 49 E., is 2 ft. 8 in. thick, including a 1-in. parting. (See fig. 46.) It is concealed in secs. 1, 2, 11, and 12, and no further measurements of it were obtained in the township.

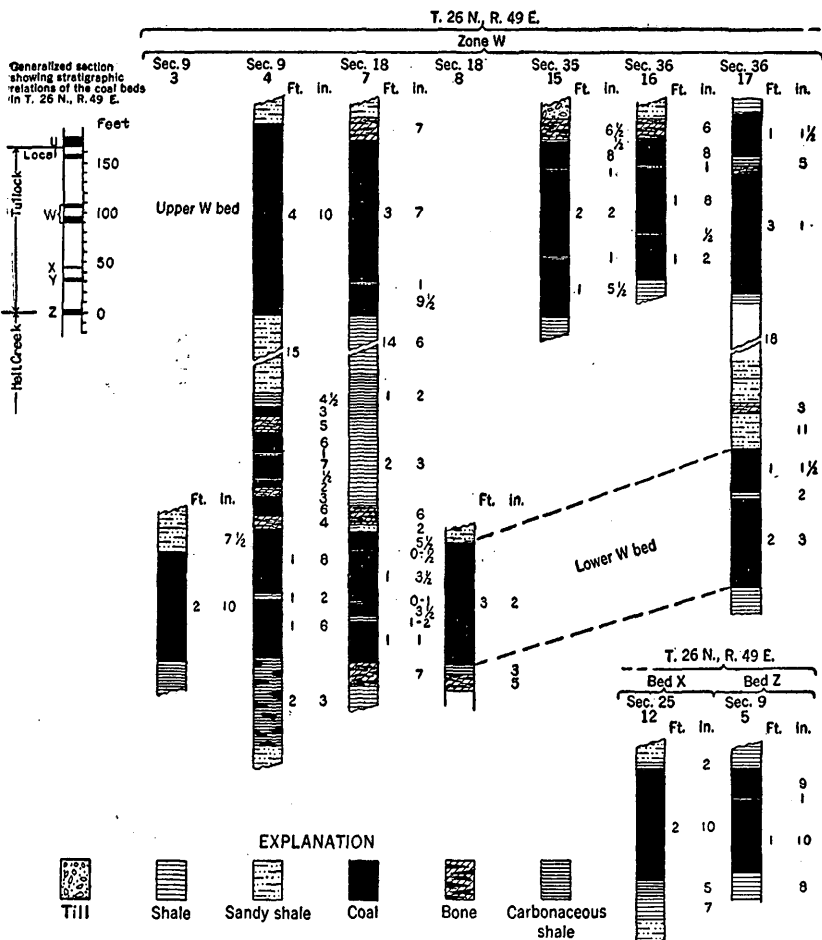


FIGURE 46.—Sections of coal beds in T. 26 N., R. 49 E.

An unmapped local (?) bed about 12 ft. below bed X was examined at locality 1, where it contains only 1 ft. 7 in. of coal.

Bed X contains 2 ft. 10 in. of coal at locality 12 but is less than 2½ ft. thick at localities 6, 10, 11, 13, and 14.

At 5 of the 9 exposures visited the coal of the lower W bed is more than 2½ ft. thick. At locality 16 it is about 3 ft. thick but consists mainly of bone; the bed is similar to this at localities 9 and 11. At locality 2 it is represented by 6 ft. of carbonaceous shale.

At 5 of the 7 exposures examined the coal of the upper W bed measures more than 2½ ft. in thickness. At locality 2 it is 2 ft. 3 in. thick, including a 1½-in. parting. At locality 9 the bed is represented by 1 ft. 4 in. of carbonaceous shale.

T. 26 N., R. 50 E.

Bed Z measures more than 2½ ft. in thickness at localities 5, 6, and 7, T. 26 N., R. 50 E. (fig. 47), but at locality 5 it is too impure to be of value, though it has

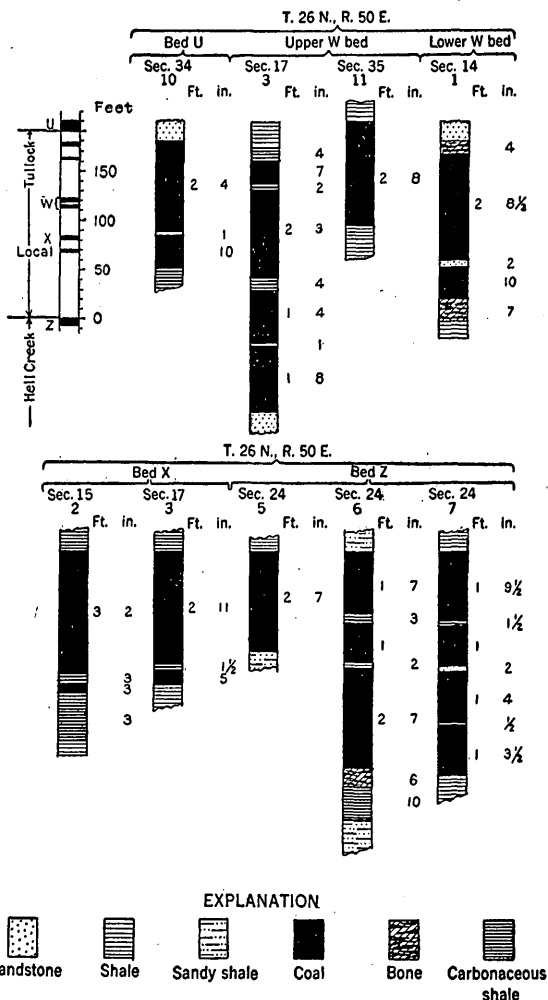


FIGURE 47.—Sections of coal beds in T. 26 N., R. 50 E.

been mined a few hundred feet to the northwest. The bed thins toward the west and is absent at the west line of sec. 13. Coal from this bed, obtained in several strip mines in secs. 13 and 24, is hauled by wagon to the town of Poplar, across the Missouri River in the northeastern part of T. 27 N., R. 51 E.

An unmapped local bed of coal about 8 ft. below bed X is less than 2½ ft. thick at localities 5, 6, and 7.

Bed X contains 3 ft. 2 in. of good coal at locality 2, 3 ft. 4 in. at locality 3, and 2 ft. 7 in. near locality 5, but less than 2½ ft. at or near localities 4, 6, 7, and 8.

The lower W bed contains 3 ft. 6½ in. of coal at locality 1, but less than 2½ ft. at or near localities 2, 3, 4, 7, 9, and 10.

The upper W bed is the most valuable coal bed in this township. In a prospect pit near locality 3 its over-all thickness, including three thin partings, is 6 ft. 5 in., and at locality 11 it contains 2 ft. 8 in. of good coal. At locality 9 the bed is 4 ft. thick but contains little coal, and at locality 10 it consists entirely of bone and carbonaceous shale.

An incomplete section of bed U near locality 10 shows a thickness of 3 ft. 3 in., including 1 in. of carbonaceous shale. The bed is probably thicker than this elsewhere in secs. 34, 35, and 36, and the cover on it there probably does not exceed 40 ft.

T. 27 N., R. 48 E.

In sec. 32, T. 27 N., R. 48 E., a bed of carbonaceous shale was seen in the Colgate member of the Fox Hills sandstone. (See p. 18.)

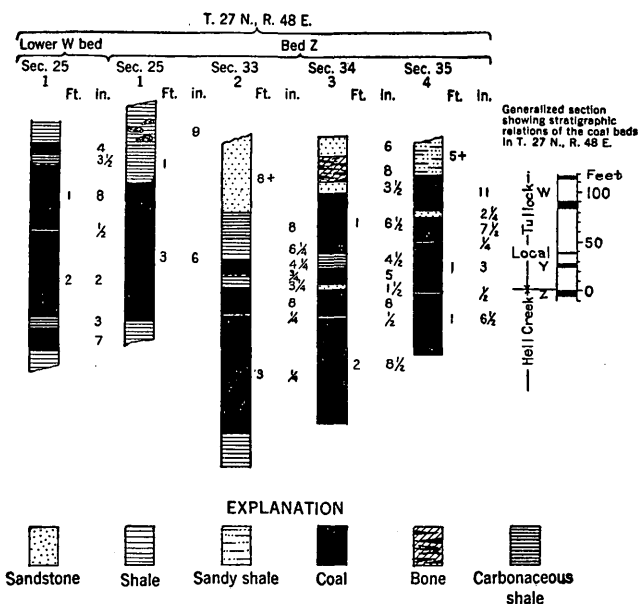


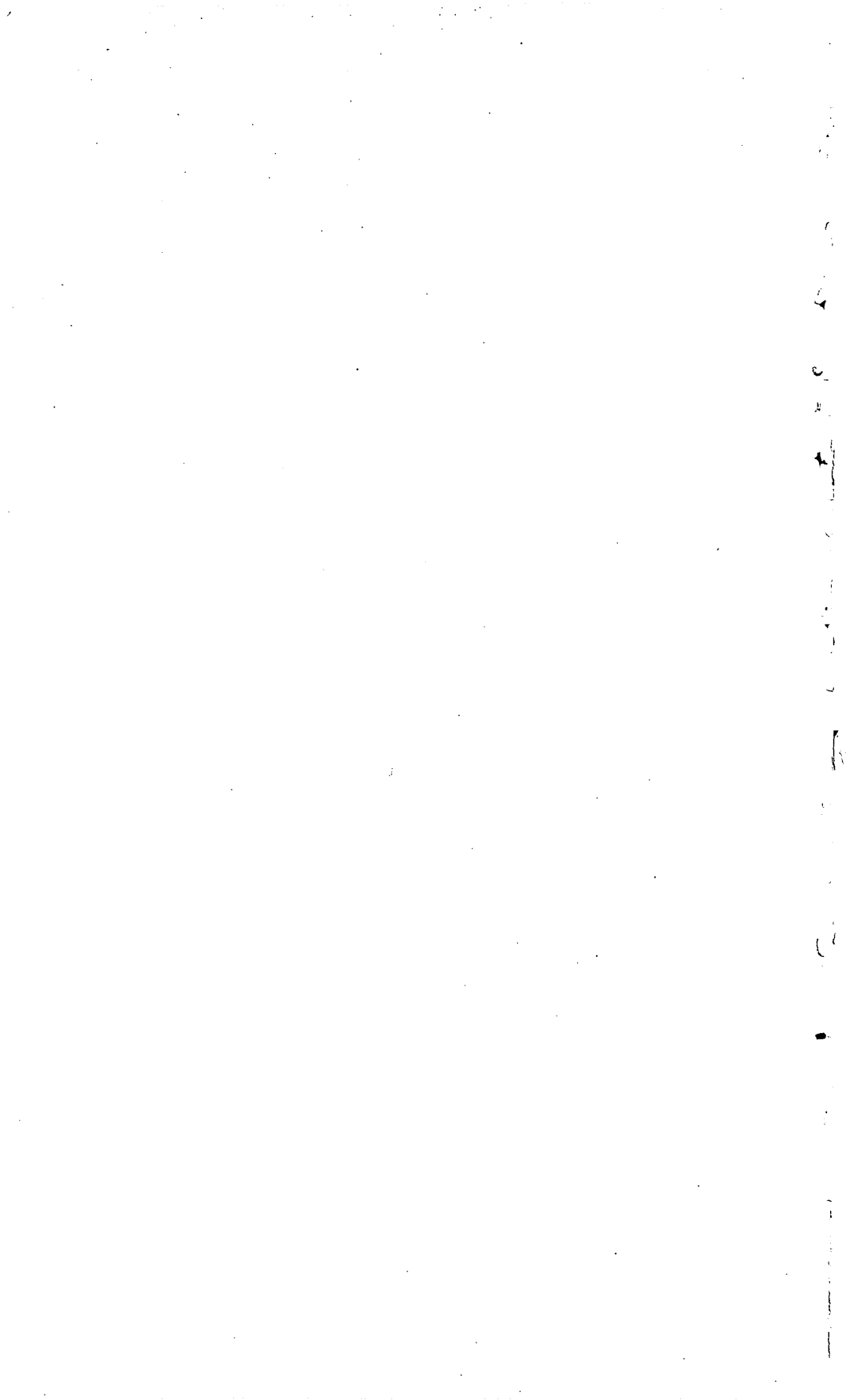
FIGURE 48.—Sections of coal beds in T. 27 N., R. 48 E.

The coal of bed Z exceeds 2½ ft. in thickness at 4 localities examined in the southern part of the township. (See fig. 48.) At locality 2 a small amount of coal has been stripped from the bed by local ranchers. The section at locality 3 was measured at the entrance to a drift, reported to be 100 ft. long, which was partly full of water when visited.

At locality 1 bed Y contains 1 ft. 1 in. of carbonaceous shale and 8 in. of coal; a local bed 12 ft. higher at the same locality contains 11 in. of carbonaceous shale and coal.

The coal of the lower W bed at locality 1 has an over-all thickness of 5 ft. 4 in., including three partings with an aggregate thickness of 7 in.

The upper W bed at locality 1 contains 11 in. of coal and 1 ft. 5 in. of carbonaceous shale. It is underlain at this locality by 6 ft. of gray shale, separating it from a bed of carbonaceous shale 5 ft. thick.



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