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THE BULL MOUNTAIN COAL FIELD

MUSSELSHELL AND YELLOWSTONE COUNTIES MONTANA

BY

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AND C. T. LUPTON

COMPILED AND EDITED BY E. RUSSELL LLOYD

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CONTENTS.

ILLUSTRATIONS.

THE BULL MOUNTAIN COAL FIELD, MUSSELSHELL AND YELLOWSTONE COUNTIES, MONTANA.

By L. H. Woolsey, R. W. Richards, and C. T. Lupton.
Compiled and edited by E. Russell Lloyd.

INTRODUCTION.

POSITION AND EXTENT OF FIELD.

The Bull Mountain coal field is in Yellowstone and Musselshell counties, in the south-central part of Montana, for the most part between practically parallel stretches of Musselshell and Yellowstone rivers, just west of a line drawn southward through a point where the Musselshell veers abruptly to the north. (See fig. 1.) The area of coal-bearing rocks is roughly elliptical in form, about 50 miles long and 30 miles wide, its longer axis extending northeastward. The northern boundary of the coal-bearing rocks conforms in general with the course of Musselshell River except that west of Roundup and northwest of Musselshell it extends several miles farther north. Yellowstone River is 10 to 30 miles south of the field. The area mapped lies approximately between meridians 107° 30′ and 108° 50′ W., and parallels 46° 10′ and 46° 40′ N. The entire region has been surveyed by the General Land Office.

GENERAL FEATURES.

The field came into prominence in 1906–7, soon after the construction of the Pacific coast extension of the Chicago, Milwaukee & St. Paul Railway. Before that time the field had been considerably prospected, principally on the Mammoth coal bed, but no coal had been mined except in a small way for local use. Soon after the railway had been completed mining was begun on a large scale on the Roundup bed, and the towns of Roundup and Klein have grown up largely as a result of this industry.

The coal is high-grade subbituminous and is generally uniform in character. The beds are at most places favorably situated for mining, and good locations for mines can be readily reached by short spurs from the railway. The water supply, though not abundant, is sufficient, and some timber grows in the coulee heads and on the mountains. All the conditions in the field give promise that the growth of the coal-mining industry will be steady and persistent.

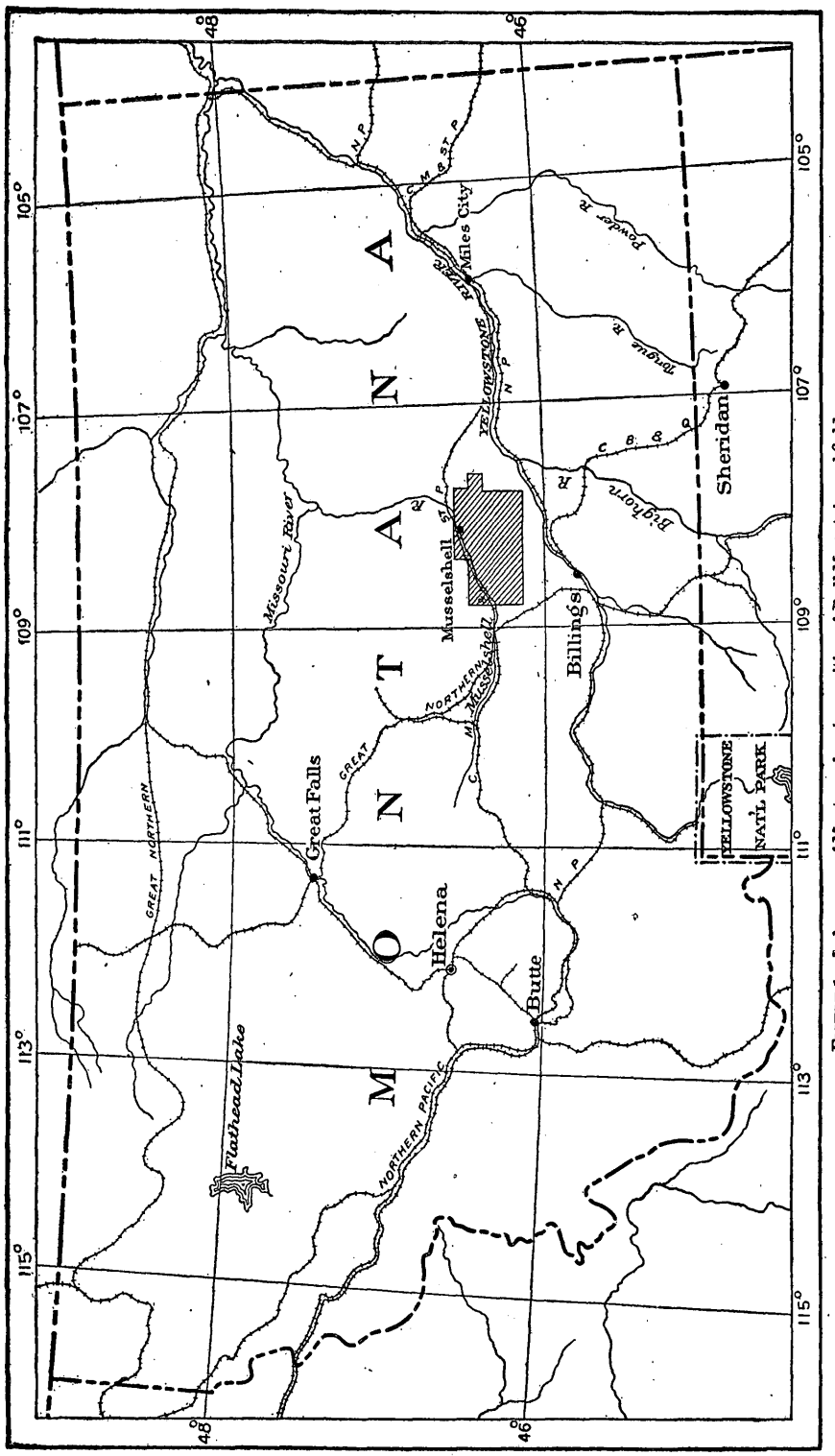


FIGURE 1.—Index map of Montana showing position of Bull Mountain coal field.

The field was carefully examined by the United States Geological Survey in the summers of 1907–1909, and preliminary reports showing its more important geologic and economic features have been published. (See p. 12.) The present bulletin contains a more detailed description of the field and of the coal beds than was presented in the preliminary reports and contains some additional information collected in 1910 and 1913.

OBJECT OF THE SURVEY.

The geologic investigations on which the present report is based were undertaken primarily for the purpose of classifying and valuing the public land with regard to coal. In order to do this it was necessary to trace the outcrops of all coal beds that were considered to be of workable thickness or that might be considered workable in the future. The thickness and the character of the coal beds were determined in all mines and prospects already opened, and where no openings were available sufficient prospecting was done to obtain the desired information. The quality of the coal was determined by analyses of samples taken from working mines or from prospects that had been recently opened. The geologic structure of the field was worked out with considerable accuracy in order to determine the depth of the coal beds below the surface and their availability for mining.

ACKNOWLEDGMENTS.

The work in the Bull Mountains was carried on by parties under the direction of Woolsey, Richards, and Lupton during the field seasons of 1907, 1908, and 1909. In the season of 1907 L. H. Woolsey, assisted by R. W. Richards and Howland Bancroft, studied and mapped a strip of country about two townships in width, from Shawmut on Musselshell River eastward to and including R. 27 E. Of this area Tps. 5 and 6 N., Rs. 24, 25, 26, and 27 E., lie within the area discussed in this report. The work was carried forward in the following season by R. W. Richards, who was assisted in the field during the month of May and until the middle of June by M. A. Pishel, and from the middle of June until the first of November by Henry Hinds, Frank R. Clark, and James H. Bridges. This party mapped the area included in Tps. 5 and 6 N., Rs. 28 and 29 E., T. 7 N., Rs. 24, 25, 26, 27, 28, and 29 E., T. 8 N., Rs. 24, 25, 26, 27, and 28 E., and T. 9 N., R. 28 E. In the season of 1909 C. T. Lupton, assisted by Henry Hinds, Burt Kennedy, and Frank L. Cleaver, completed the study of the region, mapping in detail Tps. 5, 6, and 7 N., Rs. 30 and 31 E., T. 8 N., Rs. 29, 30, 31, and 32 E., and T. 9 N., Rs. 29, 30, and 31 E. Richards and Lupton, in the summer of 1910 and Lupton in July, 1913, revisited the region in order to obtain additional information.

The work was carried on under the supervision of M. R. Campbell, assisted in 1907 and 1908 by C. A. Fisher and in 1909 by R. W. Stone. E. Russell Lloyd collaborated with Woolsey, Richards, and Lupton in compiling the present report, under the supervision of M. R. Campbell and E. G. Woodruff.

T. W. Stanton and F. H. Knowlton, paleontologists of the United States Geological Survey, and C. W. Gilmore, of the United States National Museum, examined all the collections of fossils made in the Bull Mountain field, and in the summer of 1908 Mr. Stanton visited the field and made additional collections. In all parts of the field the progress of the work was materially advanced by the assistance and hospitality of the residents and of the companies interested. For this valuable assistance acknowledgment can be made only in this general way.

METHODS OF WORK.

The coal beds are more or less lenticular. Nevertheless an effort was made to locate and define their workable portions from a study of their outcrops, supplemented by such drill records as were available in the northern part of the field. The method of work may be outlined briefly as follows:

A careful search was made in coulees and ravines over the whole area for outcrops of coal beds. All coals thus discovered were traced throughout the area, but during the field seasons of 1907 and 1908 only those having a thickness of 2 feet or more were mapped. In 1909 all beds having a thickness of 1 foot 2 inches or more were mapped. The difficulties of mapping in this much dissected country were increased by grassed slopes, forested ridges, and talus. There is a marked difference in this respect between the two sides of the Bull Mountains, for the coals are much more obscure on the north than on the south side, where erosion seems to be more active. In some parts of the field rock outcrops are few, but the more massive beds of sandstone may be traced by the benches or ledges which they produce. Wherever the outcrop of the coal is covered the horizon was traced by following the ledges, benches, and residual fragments of the sandstones. In the traverses of the coal outcrops directions were determined by pocket compass and distances by pacing on foot in rough country and on horseback in open areas, each traverse being tied to section and quarter-section corners. It was impossible to find corner stones at every desired point, especially in townships that were surveyed 15 or 20 years before the field was examined, for many of the monuments then set have been obliterated. The positions of the land corners were assumed as a rule to be correctly given on the General Land Office plats, except along the right of way

of the Chicago, Milwaukee & St. Paul Railway, where the railway survey, being later than the land survey, was accepted. Certain gross inconsistencies in the position of land corners were disclosed even by the method of work pursued, and these are shown on the maps, where an effort is made to distinguish between Government corners, doubtful Government corners, corners reported by the railway survey but not visited by members of the party, and corners established by private individuals.

The profile of the Chicago, Milwaukee & St. Paul Railway forms the basis for the vertical control. To supplement this profile, a level line 18 miles in length was run from the railroad at Musselshell station, along the Junction City and Fort McGinnis stage road, up Hawk and Coulee creeks to Wolf Springs stage station. Altitudes were carried from the railroad and from this level line to different places in the field by aneroid barometer. During the examination of the coal the topography and geologic boundaries were sketched. For the most part the outcrops of the lower coal beds in the eastern part of the field were determined by a stadia survey. Areas where coal beds were not found were mapped topographically and geologically from stations on section lines.

EARLIER PUBLICATIONS.

The reports of the early explorers and naturalists who visited Montana contain little information concerning the Bull Mountains. Although coal was reported as early as 1873 [1] no examination of the geology of the region was made until 1881, when G. H. Eldridge and Waldemar Lindgren examined in a reconnaissance way the stratigraphy and coal beds of this general region. The results of their studies are briefly given in the report of the Tenth Census,[2] in which two pages, illustrated by a map and two plates of sections, are devoted to a description of the rocks and the stratigraphy of this field. Although the authors group the rocks into what they call the "Laramie series" they describe units that correspond with those traced and mapped in the course of this investigation. The coals, which they call black lignite, "in every way much superior to the lignites farther east," are described in two pages dealing almost entirely with the Mammoth coal bed. Four plates of sections and 57 proximate analyses of this coal are given. The description of the coal brings out the essential facts concerning its extent, character, and thickness, as well as its general physical appearance. Sections of the Mammoth coal bed are given in detail, but unfortunately the locations of many of the sections are stated too briefly for identification. Wherever identification was possible, however, the measurements were found

[1] Stanley, D. S., Report on the Yellowstone expedition of 1873, p. 13, U. S. War Dept., 1874.
[2] Eldridge, G. H., Montana coal fields: Tenth Census U. S., vol. 15, pp. 753-755, pls. 58-60, 69-73, 1886.

to conform closely to those made by the Geological Survey parties. The analyses compare very closely with those given in the present report, except that they lack calorific determinations.

From 1886 to 1909 no publication was issued dealing directly with the geology of the Bull Mountains, but considerable investigation was carried on by the United States Geological Survey and by private parties in adjoining regions, and the data so collected have been drawn upon in the classification and correlation of the strata exposed in the Bull Mountain field. Directly after the completion of the field work in 1907, 1908, and 1909 preliminary reports were published in the Survey's annual volumes, Contributions to Economic Geology. The following list includes the more important publications dealing directly or indirectly with the geography and geology of this part of the State:

Geology and paleontology of the Judith River beds, by T. W. Stanton and J. B. Hatcher; with a chapter on the fossil plants by F. H. Knowlton: U. S. Geol. Survey Bull. 257, 1905.

The Bull Mountain coal field, Montana, by L. H. Woolsey: U. S. Geol. Survey Bull. 341, pp. 62–77, 1909.

The Miles City coal field, Montana, by A. J. Collier and C. D. Smith: U. S. Geol. Survey Bull. 341, pp. 36–61, 1909.

Coal near the Crazy Mountains, Montana, by R. W. Stone: U. S. Geol. Survey Bull. 341, pp. 78–91, 1909.

The Red Lodge coal field, Montana, by E. G. Woodruff: U. S. Geol. Survey Bull. 341, pp. 92–107, 1909.

Geology of the Lewistown coal field, Montana, by W. R. Calvert: U. S. Geol. Survey Bull. 390, 1909.

The central part of the Bull Mountain coal field, Montana, by R. W. Richards: U. S. Geol. Survey Bull. 381, pp. 60–81, 1910.

Stratigraphic relations of the Livingston formation of Montana, by R. W. Stone and W. R. Calvert: Econ. Geology, vol. 5, pp. 551–557, 669, and 741–764, 1910.

The eastern part of the Bull Mountain coal field, Montana, by C. T. Lupton: U. S. Geol. Survey Bull. 431, pp. 163–189, 1911.

The Little Sheep Mountain coal field, Dawson, Custer, and Rosebud counties, Mont., by G. S. Rogers: U. S. Geol. Survey Bull. 531, pp. 159–227, 1913.

A study in the petrology of sedimentary rocks, by G. S. Rogers: Jour. Geology, vol. 21, pp. 714–727, 1913.

Coal discovered in a reconnaissance survey between Musselshell and Judith, Mont., by C. F. Bowen: U. S. Geol. Survey Bull. 541, pp. 39–47, 1914.

Geology and coal resources of the area southwest of Custer, Yellowstone, and Big-horn counties, Mont., by G. S. Rogers: U. S. Geol. Survey Bull. 541, pp. 26–38, 1914.

GEOGRAPHY.

COMMERCIAL RELATIONS.

The Bull Mountain coal field came into prominence about 1906, when the westward extension of the Chicago, Milwaukee & St. Paul Railway was constructed through this part of Montana. This field

is the chief source of fuel for this new transcontinental road and in consequence has been developed very rapidly, especially in the vicinity of Roundup. This road reaches Butte, a mining and smelting center and one of the largest consumers of coal in Montana, where Roundup coal competes with coal from other fields that until recently have supplied the industries of that city. Billings, a large center of population, about 25 miles south of the southern edge of the Bull Mountain coal field and about 50 miles south of Roundup, derives its fuel supply mainly from the Red Lodge and Bear Creek districts, in Carbon County, but a railway which is now under construction between Billings and the coal beds at the south side of the mountains will doubtless result in the opening of a new coal camp, probably in the vicinity of Eldridge Mesa, in T. 6 N., R. 27 E. Coal from the mines at Roundup has been shipped as far west as Columbia River and as far east as Sioux City, Iowa.

POPULATION.

Roundup, a town of about 2,000 inhabitants, on Musselshell River, in secs. 13, 14, 23, and 24, T. 8 N., R. 25 E., is the center of population of the Bull Mountain region. The old trading post and post office was about 2 miles southwest of the present town. Klein, which has a population of about 1,500, is in sec. 36 of the same township, at the Republic Coal Co.'s mine No. 2, on a branch of the Chicago, Milwaukee & St. Paul Railway. Roundup and Klein illustrate the rapid growth of coal-mining camps. The first houses on the present site of Roundup were built in 1906 at the advent of the railroad and the first houses at Klein in 1909.

Melstone, a railroad town of about 500 inhabitants, is just outside the coal field, in secs. 30 and 31, T. 10 N., R. 31 E., near the place where Musselshell River swings abruptly north. Musselshell, in secs. 28 and 29 of T. 9 N., R. 29 E., a short distance south of the railroad, has a population of about 300 persons. Other stations along the railroad are Elso, at the western edge of the field, in sec. 18, T. 7 N., R. 25 E.; Gage, in sec. 6, T. 8 N., R. 27 E.; Delphia, which has about 75 inhabitants, in sec. 32, T. 9 N., R. 28 E.; and Japan (Absher post office), which has about 50 inhabitants, about 6 miles northeast of Musselshell, in sec. 8, T. 9 N., R. 30 E.; Pineview post office is at the Abel ranch, on Buffalo Creek, in sec. 7, T. 6 N., R. 31 E.; Buckey, an abandoned post office near the head of Razor Creek, in sec. 10, T. 5 N., R. 26 E., is a stopping point on the Roundup-Billings stage road. A new coal-mining camp has been established on Carpenter Creek, in secs. 16, 17, 20, and 21, T. 9 N., R. 30 E. It supports more than 200 inhabitants.

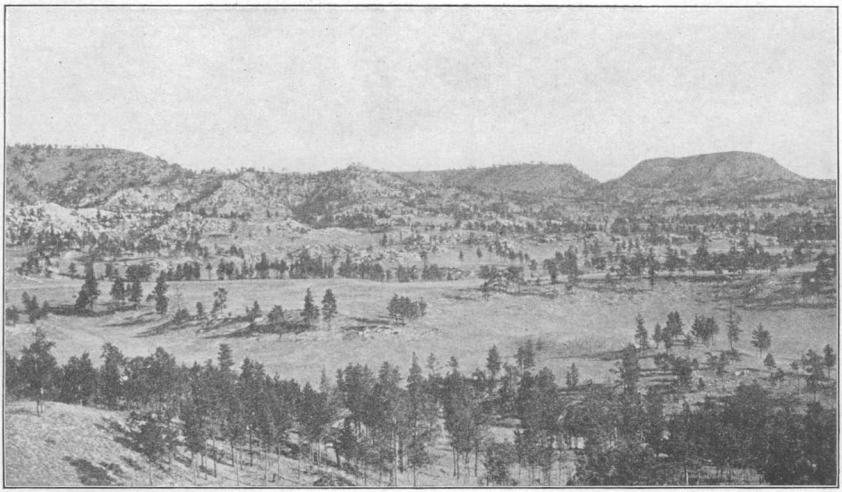
RAILROADS AND ROADS.

The Chicago, Milwaukee & St. Paul Railway follows Musselshell Valley across the northern part of the field, and short branch lines have been constructed from the railroad at Roundup to the Republic mine No. 2, at the town of Klein; from the railroad to the Keen and Davis mines, in T. 8 N., R. 25 E.; and from Japan to the Carpenter Creek coal mine, in T. 9 N., R. 30 E. The old stage road between Junction and Fort McGinnis traverses the eastern part of the area in a northwest-southeast direction, crossing the river at Musselshell, but the stages have been discontinued south of Musselshell. The Roundup-Billings road extends across the western part of the field from north to south and is joined at Buckey, in T. 5 N., R. 26 E., by the Musselshell-Billings road. A well-traveled road follows roughly the course of Musselshell River, mainly on the north side of the valley, connecting the towns of Lavina, Roundup, Musselshell, and Melstone. Secondary roads and trails are numerous, and the greater part of the field is easily accessible.

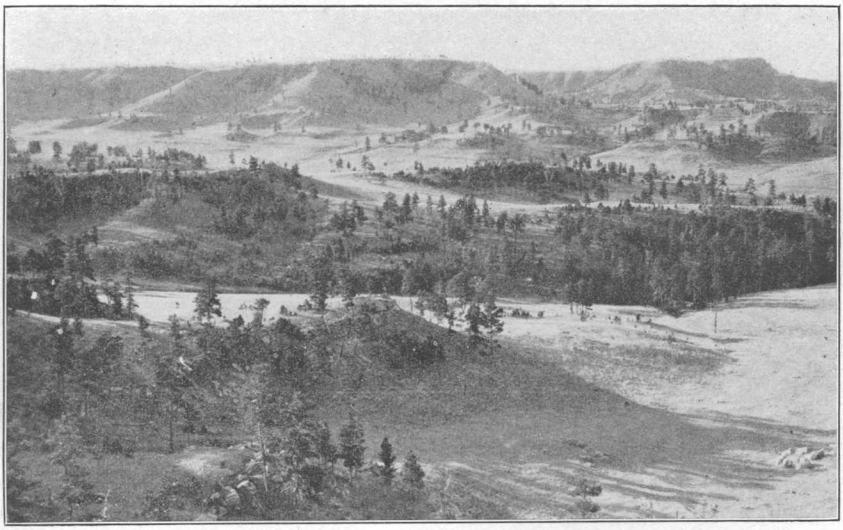
RELIEF.

When compared with their neighbors, the Crazy, Little Belt, Judith, and Big Snowy mountains, the Bull Mountains seem little more than hills. Their maximum elevation is about 4,700 feet and the maximum relief in the field about 1,800 feet. The topography of the region is peculiar and is distinct from that of the surrounding country. The rocks that contain the principal coal beds of the region (upper part of the Fort Union formation) consist of alternating beds of resistant sandstone and of much less resistant clay shale, which lie nearly horizontal over the greater part of the field. The erosion of such a series of rocks in a semiarid country gives rise to a series of nearly flat plateaus or uplands, preserved by the beds of sandstone and interrupted by steep-walled, sharply incised valleys where the streams have worn their way through the sandstone to the less resistant shale below. Two such plateaus are prominent in the Bull Mountain field. The upper of these plateaus is represented by the tops of the high mesas of the Bull Mountains; the lower by the level upland which forms the greater part of the divide between Musselshell and Yellowstone rivers and which, on the north and south sides, has been deeply dissected and to a great extent destroyed by the erosive action of these streams and their tributaries. About the border of the field, where the outcropping rocks present less differential resistance to erosion the surface is for the most part rolling prairie, such as is characteristic of the Great Plains region.

The nearly flat surface of the tops of the high Bull Mountain mesas, which stand 4,500 to 4,700 feet above sea level, is the mere remnant

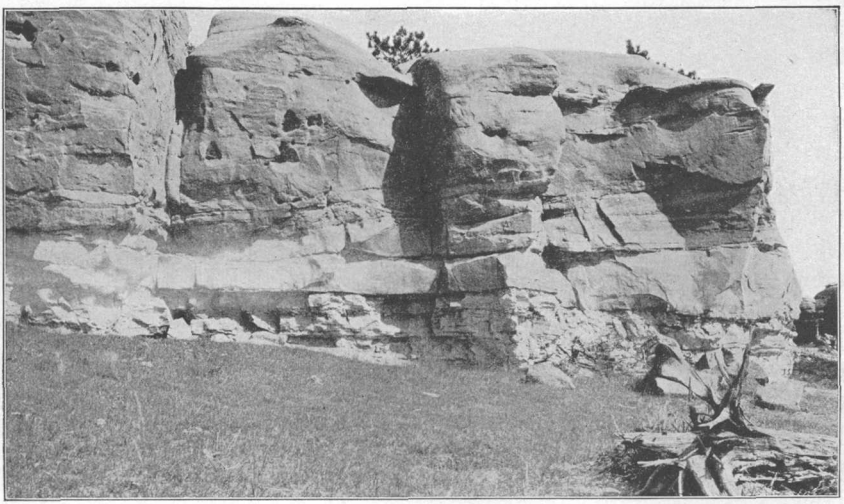


A. NORTHERN SLOPE OF ELDRIDGE MESA AND ADJACENT PLATEAU.



B. SOUTHEAST FRONT OF ELDRIDGE MESA AND ADJACENT PLATEAU.

A. SANDSTONE "RIM ROCK" 1 MILE EAST OF MUSSELSHELL, ON NORTH SIDE OF RIVER.



B. SANDSTONE "RIM ROCK" IN SEC. 5, T. 5 N., R. 31 E., SHOWING ABRUPT CHANGE IN BEDDING.

of a once extensive plateau whose preservation is due to its position in the center of the synclinal area and to the burning of the upper coal beds, which have baked and indurated the overlying sandstones and shales so that they have long withstood the erosive agencies of wind and rain. There are four of these main ridges or mesas and a number of small outlying buttes. The southernmost and largest, Eldridge Mesa, is an irregular mass that extends nearly 4 miles from north to south and about 3 miles from east to west. Its bluish gray bluffs and reddened caps are conspicuous above the lowland country from points as far south as the vicinity of Yellowstone River. Plate II shows parts of this mesa and illustrates the relations of the higher mountains to the surrounding plateau region. The northern part of the mountains proper is made up of three irregular buttes or mesas, to the westernmost of which the name Bridges Butte is given. The central mesa, in Tps. 6 and 7 N., R. 27 E., is called Taylor Mesa, and the eastern, in Tps. 6 and 7 N., R. 28 E., has long been known as Three Buttes Mesa. These mesas are separated and their walls deeply incised by the heads of the principal streams of the area, which radiate outward in all directions from the mountains. Isolated buttes with conspicuously reddened caps stand out as prominent landmarks, some rising above the general level of the tops of the mesas and others flanking their borders.

The lower plateau forms the general upland surface of the greater part of the region surrounding the high mesas and extends northeast-southwest along the Musselshell-Yellowstone divide across the central part of the field. Its surface is a broad, nearly flat plain. The elevation is 4,000 to 4,200 feet in the southwestern part of the field and gradually decreases northeast to about 3,500 feet. Near the divide the valleys are narrow and precipitous. Farther out they are deeper and wider but retain their precipitous walls. Between the valleys long ridges extend northward and southward, preserving on their flat tops the original plateau surface. These ridges are more or less dissected by coulees, many of them standing up as mere skeletons fantastically carved by the wind and the infrequent storms. In their lower courses the larger streams have wide flat valleys bordered by abrupt cliffs known as "rim rocks," which make access to the higher lands difficult and in places impossible. (See Pl. III.) In the eastern part of the field the plateau is cut through in several places by the headward erosion of the streams. Eastward from Hawk Creek the level-topped remnants of the plateau surface become gradually less extensive until, in the extreme eastern part of the field, about the headwaters of Alkali and Buffalo creeks, where the soft sandstones have yielded more rapidly to the erosive agencies, the abrupt "rim rocks" give way to rolling prairies.

Below the coal-bearing rocks is a group of shale beds (Lebo shale member of the Fort Union formation) which yield rapidly to erosive agencies. In the southern and eastern parts of the field, where the beds are practically level, the surface is a gently rolling plain, giving way locally to badlands. In the northern part of the area, where the beds are tilted, broad valleys are formed. A lower series of beds of sandstone and shale (Lance formation) outcrops on the northern side of the field, where they are in most places tilted so that the hard sandstones form a series of parallel ridges separated by narrow valleys. The Bearpaw shale in the extreme north of the field weathers into a gently rolling "gumbo" plain, which is covered with sagebrush. There are no conspicuous elevations immediately north of Musselshell River, and the surface is for the most part a rolling prairie.

DRAINAGE AND WATER RESOURCES.

The region is drained by Musselshell and Yellowstone rivers. Musselshell River flows northeast across the northern part of the field and has a flood plain varying in width from less than half a mile to nearly 4 miles. Its principal tributaries in the field, named from east to west, are Lost Horse Creek, Carpenter Creek, Hawk Creek, Fattig Creek, Schnall Coulee, Parrott Creek, Berrigan Coulee, Halfbreed Creek, Horsethief Creek, Kern Creek, Goulding Creek, and Dean Creek. Streams flowing southward to Yellowstone River are Alkali Creek, Buffalo Creek, Antelope Creek, Mill Creek, Hibbard Creek, Cow Gulch, Railroad Creek, Pompeys Pillar Creek, and Razor Creek. These streams are, for the most part, intermittent, but all of them have deeply cut valleys that are often flooded after heavy rains. Musselshell River and the lower courses of Hawk and Hibbard creeks are the only perennial streams in the field. In the vicinity of springs water flows on the surface for a short distance, then sinks into the sand and gravel of the stream bed to appear again in seeps and springs farther down the valley. The best springs are found at the bases of sandstone ledges. North of the divide springs are fairly plentiful and good water can be obtained by sinking wells from 20 to 40 feet. South of the divide water is scarce on account of the northerly dip of the rocks, which allows the underground water to move easily toward the north and is of poor quality on account of the predominance of clay and shale, which contain more alkaline salts than the sandstone. In the vicinity of Musselshell wells drilled to a depth of 150 feet or more obtain artesian water. At Musselshell and north of the river for a distance of 3 miles the water rises in wells nearly to the surface. On Mrs. Boland's land, in the SE. $\frac{1}{4}$ sec. 32, T. 9 N., R. 29 E., about

1¾ miles south of Musselshell, water flowing from a bore hole 400 feet deep is the main supply during the dry season for the lower course of Hawk Creek. Mining in the immediate vicinity undoubtedly will be somewhat retarded by the presence of this artesian basin.

CLIMATE AND VEGETATION.

The climate of the Bull Mountains is like that of all the semiarid portions of the Great Plains of the Northwest. Rain falls mostly in spring and autumn and rarely during the summer. The precipitation is somewhat heavier in the hills than on the surrounding lowlands. The uplands and higher slopes along the valleys support a growth of small pines and a few small cedars. In the heads of the coulees the pine timber is in places especially dense and heavy. The trees are, as a rule, too small for lumber but are suitable for mine timbers, fence posts, railroad ties, and telephone posts. The growth of young pines is generally abundant and, with proper conservation, should be sufficient to supply the region. Cottonwood trees are numerous along Musselshell River and grow in scattered clumps along the principal creeks, but they are practically valueless except for fuel. The entire Bull Mountain country is first-class grazing land, timber and "rim rocks" forming excellent shelter for stock. The high-level areas are, as a rule, only fringed with trees and support a luxuriant growth of "bunch" grass. The lowlands support a growth of "buffalo" grass, sagebrush, and cactus. North of the river the country is practically treeless.

AGRICULTURE.

Until very recently the agricultural development of the region has been limited to grazing on the open range. Numerous ranches are situated along the valley of the Musselshell and along some of the principal tributaries. Over most of the hilly region, however, the ranches are few, and the total population is comparatively small. Within recent years considerable areas of the flood plain of the Musselshell have been irrigated by taking water from the river in ditches and have produced rich crops of alfalfa and grain. Practically all of the river-bottom lands, as well as similar areas along the main tributaries, could be irrigated. The practicability of dry farming in the region has been demonstrated by the work of the State experimental substation north of Roundup, and within the last three or four years there has been a marked influx of homesteaders into the Bull Mountains and adjacent country. At present practically all land sufficiently level for cultivation is occupied.

GENERAL GEOLOGY.

STRATIGRAPHY.

SEQUENCE OF THE ROCKS.

The important coal-bearing formation of the Bull Mountains is the Fort Union, which belongs to the lower part (Eocene series) of the Tertiary system. The rocks of this formation consist principally of massive, buff to yellowish-gray sandstone and light-colored clay shale. The lower 200 to 300 feet of the formation contains little coal and is dark in color, olive-green, drab, and gray sandy shale predominating. In some of the more sandy beds andesitic tufaceous material has been found, and the beds have been correlated with the Lebo shale member of the Fort Union, whose type area is northeast of the Crazy Mountains.[1] Below the Lebo shale lies a series of yellowish and darker colored sandstone and shale belonging to the Lance formation, now tentatively regarded as probably belonging to the Tertiary system. These rocks, which are nearly barren of fossils, rest in turn with apparent conformity on the marine Bearpaw shale of the Upper Cretaceous, the lowest formation exposed in the region considered in this report. The flood plain deposits of Musselshell River and its tributaries and certain high-level river or terrace gravels belong to the Quaternary period. The characteristics of these formations are shown in the generalized columnar section.

Generalized section in Bull Mountain region.

System.	Series.	Formation.	Thickness.	
Quaternary.			*Feet.* 0–20	River terrace gravel, mainly from sedimentary rocks, along principal stream courses; sandy alluvium, on the uplands.
Tertiary.	Eocene.	Fort Union formation.	1,650	Alternating beds of massive, resistant, yellowish to buff sandstone, clay, shale, and coal.
			200–300	Lebo shale member; dark olive-green to brown sandy shale, and thin-bedded arkosic sandstone with beds of carbonaceous sandstone and coal—Big Dirty bed.
Tertiary (?).	Eocene (?).	Lance formation.	700–1,500	Alternating beds of massive resistant, yellowish-gray to buff sandstone, clay, and shale.
Cretaceous.	Upper Cretaceous.	Bearpaw shale.	1,000+	Dark marine shale, with calcareous concretions, abundantly fossiliferous.

[1] Stone, R. W., and Calvert, W. R., Stratigraphic relations of the Livingston formation of Montana: Econ. Geology, vol. 5, p. 746, 1910. Stone, R. W., Coal near the Crazy Mountains, Montana: U. S. Geol. Survey Bull. 341, pp. 80–82, 1909.

The probable equivalents of these formations among those in other parts of Montana and in South Dakota are as follows:

Comparison of stratigraphic sections in Montana and South Dakota.

System.	Series.	Group.	Northwestern South Dakota.[a]	Eastern Montana.[b]	Bull Mountains, Mont. (this report).	Northern and central Montana.[c]	Musselshell Valley, Mont.[d]	Livingston, Mont.[d]
Tertiary.	Eocene.		Fort Union formation.	Fort Union formation (Lebo shale member at base).	Fort Union formation (Lebo shale member at base).	Fort Union formation (?).	Fort Union formation (Lebo andesitic member at base).	Fort Union formation.
Tertiary (?).	Eocene (?).		Lance formation.	Lance formation.	Lance formation.	Laramie formation (?).	Lance formation.	
Cretaceous.	Upper Cretaceous.	Montana group.	Fox Hills sandstone.		Not represented, but apparent conformity.	Fox Hills sandstone (?).	Lennep sandstone.	Livingston formation.
			Pierre shale.		Bearpaw shale.	Bearpaw shales.	Bearpaw shale.	
						Judith River beds.	Judith River formation.	
						Claggett formation.	Claggett formation.	
						Eagle formation.	Eagle sandstone.	Eagle sandstone.

[a] Calvert, W. R., and others, Geology of the Standing Rock and Cheyenne River Indian reservations, North and South Dakota: U. S. Geol. Survey Bull. 575, p. 9, 1914.
[b] Rogers, G. S., The Little Sheep Mountain coal field, Dawson, Custer, and Rosebud counties, Mont.: U. S. Geol. Survey Bull. 531, p. 164, 1913.
[c] Stanton, T. W., and Hatcher, J. B., Geology and paleontology of the Judith River beds: U. S. Geol. Survey Bull. 257, pp. 11–14, 1905.
[d] Stone, R. W., and Calvert, W. R., Stratigraphic relation of the Livingston formation of Montana: Econ. Geology, vol. 5, p. 752, 1910.

CRETACEOUS SYSTEM.

BEARPAW SHALE.

The lowest formation outcropping in the Bull Mountain field is the Bearpaw shale, which is recognized in this part of Montana as the upper formation of the Montana group. It outcrops in the northwestern and northeastern parts of the field in T. 8 N., R. 24 E., and T. 9 N., Rs. 28, 29, 30, and 31 E. In both these areas the formation dips 5°–30° S.

The name Bearpaw shale, as applied to the series of dark marine shales lying at or near the top of the Montana group, was first used by Stanton and Hatcher [1] in 1903. Two years later the same authors published a more complete description [2] of the beds included in the formation, as follows:

These shales rest on the Judith River beds and have the lithologic character of the Pierre shales, part of which they represent. They consist chiefly of dark clays, which weather into rounded slopes and form an adobe soil. In certain zones there are numerous calcareous concretions, most of which are fossiliferous and yield a varied invertebrate fauna. Among the more common forms are the following:

Species found in Bearpaw shales.

Ostrea patina.
Avicula nebrascana.
Avicula linguiformis.
Inoceramus sagensis.
Inoceramus barabini.
Leda (Yoldia) evansi.
Lucina subundata.
Thetis circularis.
Callista deweyi.
Mactra gracilis.
Liopistha (Cymella) undata.
Anisomyon centrale.
Cinulia concinna.
Anchura americana.
Baculites ovatus.
Baculites compressus.
Placenticeras whitfieldi.
Placenticeras intercalare.
Scaphites nodosus.

This formation is named from the Bearpaw Mountains, around whose north, east, and south sides it is well developed. It is evidently the equivalent of only a part of the Pierre formation, which, in South Dakota, Colorado, and elsewhere, is defined to include all the strata between the Niobrara limestone and the Fox Hills sandstone. Whether the Bearpaw also includes the representative of the Fox Hills sandstone has not yet been definitely determined. Its limits are precisely the same as those of the beds in Alberta and Assiniboia described by the Canadian geologists as "Pierre-Fox Hills group," whose thickness is estimated as 750 feet.

The same authors [3] have described the section of Upper Cretaceous rocks exposed in the area directly north of Musselshell. Their description of the Bearpaw at this place is as follows:

In a distance of about 5 miles along the road from Willow Creek to Musselshell post office there is obtained a complete section from the base of the Judith River beds up through the Bearpaw shales into the overlying formations, which latter we did not study in detail. All of the beds dip gently to the southeast. The dip increases in the upper part of the section, being greater in the upper Bearpaw shales than in the Judith River beds, which are here clearly seen to pass beneath the Bearpaw shales. These shales, especially the upper portion, are rich in marine invertebrates, including the following species:

[1] Hatcher, J. B., and Stanton, T. W., Science, new ser., vol. 18, p. 212, 1903.
[2] Stanton, T. W., and Hatcher, J. B., Geology and paleontology of the Judith River beds: U. S. Geol. Survey Bull. 257, pp. 13–14, 1905.
[3] Idem, pp. 57–58.

Fossils obtained from Bearpaw shales near Musselshell post office.

Ostrea pellucida.
Syncyclonema rigida.
Pecten (Chlamys) nebrascensis.
Avicula nebrascana.
Avicula linguiformis.
Inoceramus barabini.
Nucula subplana (?).
Nucula planimarginata (?).
Nucula cancellata (?).
Leda (Yoldia) evansi.
Trigonarca exigua.
Lucina subundata.
Protocardia rara.
Cuspidaria ventricosa.
Liopistha (Cymella) undata.
Thetis ? circularis.
Anchura americana.
Acmaea occidentalis.
Vanikoro ambigua.
Lunatia occidentalis (?).
Haminea subcylindrica.
Cinulia concinna.
Baculites compressus.
Baculites ovatus.
Scaphites nodosus var. brevis.
Placenticeras whitfieldi.
Placenticeras intercalare.

Stone and Woolsey, in an unpublished manuscript, have described the Bearpaw shale of the region west of the Bull Mountains and south of Musselshell River in considerable detail. Their conclusions are fully in accord with those of Stanton and Hatcher as quoted above.

In mapping the Bull Mountain field no detailed study was given to the Bearpaw shale. Fossils collected by Stone and Lupton from four localities north and northeast of Musselshell, near the top of the formation, were identified by Mr. Stanton as follows:

Marine invertebrate fossils collected from the Bearpaw shale in the Bull Mountain coal field, Montana.

	No. of collection.
Anchura americana Evans and Shumard	6288
Anomia sp	6288
Avicula nebrascana Evans and Shumard	6288
Baculites compressus Say	6287
Callista deweyi Meek and Hayden	6292, 6288
Cylichna volvaria Meek and Hayden	6288
Inoceramus cripsi var. barabini Morton	6288
Inoceramus sagensis Owen	6292
Inoceramus sp	6287
Leda evansi Meek and Hayden	6288
Leda scitula Meek and Hayden	6287
Lingula nitida Meek and Hayden	6288
Lucina subundata Hall and Meek	6287
Lunatia occidentalis Meek and Hayden	6288
Mactra gracilis Meek and Hayden	6287
Nucula cancellata Meek and Hayden	6288
Ostrea pellucida Meek and Hayden	6294
Protocardia subquadrata Evans and Shumard	6288
Scaphites nodosus Owen	6288

The localities from which these collections were obtained are as follows:

6287. Flatwillow road, 5 miles northwest of Musselshell, Mont., in T. 9 N., R. 28 E. Collected by R. W. Stone.

6288. 100 yards east of Flatwillow road in bank of gully, 5 miles northwest of Musselshell, in T. 9 N., R. 28 E. Collected by R. W. Stone.

6292. About 6 miles northwest of Musselshell, Mont., on road to Willow Creek, in T. 10 N., R. 28 E. Collected by C. T. Lupton.

6294. NW. ¼ sec. 13, T. 9 N., R. 30 E., 3½ miles east of mouth of Carpenter Creek, Mont. Collected by C. T. Lupton.

The Bearpaw shale in the Bull Mountain field is overlain conformably by the shale and sandstone of the Lance formation. In other regions, however, an intermediate formation has been recognized. In the succession in northwestern South Dakota[1] the Pierre shale is followed by the Fox Hills sandstone, which probably represents a near-shore phase of sedimentation. No such lithologic unit is found in the Bull Mountains. West of the Bull Mountains, in the Musselshell Valley, Stone and Calvert[2] and Stone and Woolsey[3] have described an intermediate formation between the Bearpaw and the Lance, to which the name Lennep sandstone has been given. The formation is described as rather dark and sandy, composed of brown and greenish thin-bedded sandstone, interbedded with dark shale. The beds throughout the formation are shown by thin sections to be more or less tufaceous. The reddish-brown color distinguishes the formation from the gray to black Bearpaw shale below and from the light-gray Lance above. The thickness is from 250 to 460 feet. The fauna and flora of the Lennep is composed of fresh-water, brackish-water, and marine forms in about equal numbers, although the fresh-water and marine forms are found at separate horizons. The tufaceous character is attributed to volcanic activity farther west. This volcanic material apparently did not get as far east as the Bull Mountains at this stage, although Woolsey found it as far east as Lavina.

TERTIARY (?) SYSTEM.

LANCE FORMATION.

In the Bull Mountain region the Lance formation overlies the marine Bearpaw shale and appears to be in conformable sequence with it. Its strata outcrop continuously around the Bull Mountains but were not mapped on the east and southeast of the field. In the northern part of the field, where the dip is south, the erosion

[1] Calvert, W. R., and others, Geology of the Standing Rock and Cheyenne River Indian reservations: U. S. Geol. Survey Bull. 575, pp. 9-16, 1914.

[2] Stone, R. W., and Calvert, W. R., Stratigraphic relations of the Livingston formation of Montana: Econ. Geology, vol. 5, p. 746, 1910.

[3] Unpublished manuscript.

of the alternating beds of sandstone and shale forms a series of steep parallel "hogbacks" separated by narrow valleys. In the southern and western parts of the field, where the beds are flat or nearly so, the beds of sandstone form a series of scarps. The characteristic contrast between the topography of the Bearpaw shale and that of the Lance formation may be seen in sec. 8, T. 9 N., R. 29 E. (See Pl. IV, *A*.) The Lance formation consists of alternating beds of yellowish-gray sandstone, drab, yellow, and gray clays, clay shale, and grayish sandy shale. Sandy material predominates. The lower part of the formation is noticeably micaceous; the upper part contains thin beds of coal. The columnar section (E in Pl. VI, p. 34) was measured by R. W. Richards 10 miles northwest of Musselshell and published in his preliminary report.[1] The total of this section, which is referred to the Lance formation, has a thickness of 1,420 feet.

Sections measured by R. W. Stone north and east of Musselshell (F and G in Pl. VI) and by C. T. Lupton east of Musselshell (H and I in Pl. VI) give the Lance a thickness of 700 to 800 feet. These measurements show that the formation thins decidedly toward the east.

The fossil remains are very meager. The following list includes all determinable forms collected in the Bull Mountains during the three field seasons:

Fresh-water invertebrate fossils collected from the Lance formation in the Bull Mountain coal field, Montana.

	No. of collection.
Campeloma sp., casts	4755
Goniobasis tenuicarinata (Meek and Hayden)	6289
Goniobasis ? sp	6293, 6289
Helix sp	
Physa sp	6293
Planorbis sp	6293
Sphaerium sp	6293, 6289
Viviparus sp., casts	4755
Viviparus ? sp	6293, 6289

The localities from which these collections were obtained are as follows:

4755. Sec. 4, T. 5 N., R. 24 E. Collected by L. H. Woolsey.

6289. Bank of Musselshell River, west side of sec. 7, T. 9 N., R. 30 E., in prominent cliff above Bearpaw flat. Collected by R. W. Stone.

6293. 2 miles south of Melstone, on Lost Horse Creek, 100 to 150 feet above the top of the Bearpaw shale. Collected by C. T. Lupton.

The collections from these three localities are too meager and too poorly preserved to make possible the determination of the

[1] Richards, R. W., The central part of the Bull Mountain coal field, Montana: U. S. Geol. Survey Bull. 381, pp. 63–64, 1910.

age of the beds from the fossil invertebrates. A single fossil leaf, collected from the Lance formation in this field by R. W. Stone on the first ridge north of the valley of Lebo shale, 2½ miles north of Musselshell, has been identified by Knowlton as *Celastrus* cf. *C. curvinervis* Ward.

The stratigraphic position of the series of beds above the uppermost marine Cretaceous and below the Fort Union and the physical character of the rocks render the determination of the age of the beds fairly conclusive.

No detailed examinations of the coal beds of the Lance formation have been made. Sections were measured by R. W. Richards in two localities in T. 10 N., R. 27 E., where the Homestead coal bed is exposed, and in sec. 6, T. 6, N., R. 24 E., where two measurements were obtained on an unnamed bed. (See pp. 35, 67.)

TERTIARY SYSTEM.

FORT UNION FORMATION.

Name.—The Fort Union formation was named from a former military post on Missouri River, in North Dakota, about 3 miles from the Montana State line, where the formation is typically exposed. The name appears to have been first applied in 1862 by Meek and Hayden in their description of the beds at this place.[1] Subsequently the beds to which the name is here applied were recognized by the geologists of the Transcontinental Survey but were placed by them in the "Upper Laramie or Bull Mountain series." [2]

Lebo shale member.—Strata 200 to 300 feet thick immediately overlying the Lance and apparently conformable both with the Lance below and with the upper part of the Fort Union above are distinguishable by differences in color and physical characters. These beds have been described in the preliminary reports by Woolsey as "beds on Dean Creek;" by Richards as "somber-colored beds;" and by Lupton as "Lebo shale member of the Fort Union formation." The rocks consist of olive-green, yellow, brown, and dark sandy clay, sandy shale, and soft sandstone. The member is conspicuous on account of its dark or olive-green color and the absence of the resistant sandstone which characterizes the overlying beds of the upper part of the Fort Union and the underlying Lance formation. The contrast between the topography of the Lebo shale member and that of the upper part of the Fort Union formation is shown in secs. 33 and

[1] Meek, F. B., and Hayden, F.V., Descriptions of new lower Silurian (Primordial), Jurassic, Cretaceous, and Tertiary fossils collected in Nebraska by the exploring expedition under the command of Capt. Wm. F. Reynolds, U. S. Top. Eng., with some remarks on the rocks from which they were obtained: Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 433, 1862.

[2] Eldridge, G. H., Geology of the Laramie (Montana) coal fields: Tenth Census U. S., vol. 15, p. 744, 1886.

34, T. 5 N., R. 30 E. (See Pl. IV, *B*.) The Lebo contains two carbonaceous zones, the most prominent of which is known as the Big Dirty bed. (See pp. 35–36.)

The Lebo shale member has been traced and mapped continuously around the border of the upper Fort Union rocks. It is well exposed along the Billings-Roundup road 2 or 3 miles south of Buckey and on the east side of Dean Creek in T. 6 N., R. 24 E. The width of the outcrop as shown on the map (Pl. I, in pocket) ranges from a few hundred feet in the northern part of T. 8 N., Rs. 24 and 25 E., and T. 9 N., Rs. 28, 29, and 30 E., to several miles in T. 8 N., Rs. 26 and 27 E., and T. 8 N., R. 32 E. These variations in the width of the outcrop are due to the variations in the attitude of the strata. Where they dip steeply the outcrop is narrow, but where they are horizontal or nearly so the outcrop is extensive. On account of its relatively weak resistance to erosion the Lebo shale member is marked by a wide valley between sandstone ridges. In the eastern and southern parts of the area, where the beds are practically flat, the Lebo shale weathers into gently rolling prairie, interrupted locally by the development of badlands topography.

A part of the member on Dean Creek in the western part of the field contains andesitic material, and it is on the basis of this material and the stratigraphic position of the beds that correlation is made with the Lebo shale member, the type locality of which is northeast of the Crazy Mountains, about 60 miles farther west. The Lebo strata were first described by R. W. Stone,[1] and the name "Lebo andesitic member of the Fort Union formation" was first used by Stone and Calvert[2] in 1910. It is believed by these authors to be the stratigraphic equivalent of the upper part of the Livingston formation, which at the type locality, Livingston, Mont., is 1,400 feet thick and represents nearly the whole of the Montana group, the Lance formation, and the lower part of the Fort Union. The typical Livingston is made up largely of volcanic material and is comparatively poor in fossil remains. To the abundant supply of volcanic material, chiefly andesitic, is attributed the uniformity of the rocks throughout so great a thickness. It is but natural to suppose that the andesitic material was more widespread at some stages than at others, and the data gathered by Stone and Calvert show that both the Lennep sandstone and the Lebo shale member of the Fort Union formation represent such periods of more widespread volcanic activity. The diagrammatic sketch by Stone and Calvert[3] has been extended to show

[1] Stone, R. W., Coal near the Crazy Mountains, Mont.: U. S. Geol. Survey Bull. 341, p. 82, 1909.

[2] Stone, R. W., and Calvert, W. R., Stratigraphic relations of the Livingston formation of Montana: Econ. Geology, vol. 5, p. 746, 1910.

[3] Op. cit., p. 752.

the relations of the Livingston and other Cretaceous and Tertiary formations as far east as the Bull Mountains (fig. 2). G. S. Rogers,[1]

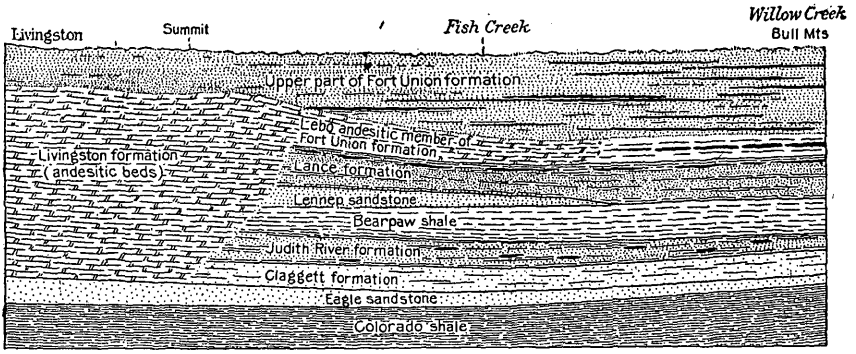


FIGURE 2.—Sketch showing probable interfingering of the formations of the Montana group in west-central Montana. (Adapted from Stone and Calvert.)

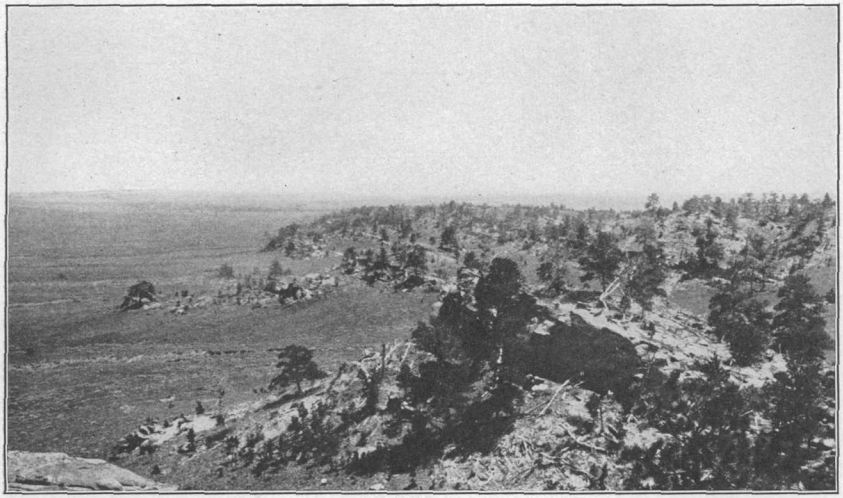
in the summer of 1911, found at the base of the Fort Union, in the Little Sheep Mountain field in eastern Montana, a series of rocks containing andesitic material which he believes represents the Lebo shale.

The few fossils collected from the Lebo shale member indicate that it should be grouped with the overlying typical Fort Union, but there is no evidence to prove that it should not be grouped with the underlying Lance formation. The fossils collected in the Bull Mountain field include fragments of a turtle shell which has been identified as *Campsemys victor*. This was obtained from a layer near the top of the member, in the NE. ¼ sec. 32, T. 5 N., R. 30 E. All the other fossils from the Lebo are leaves and have been identified as follows:

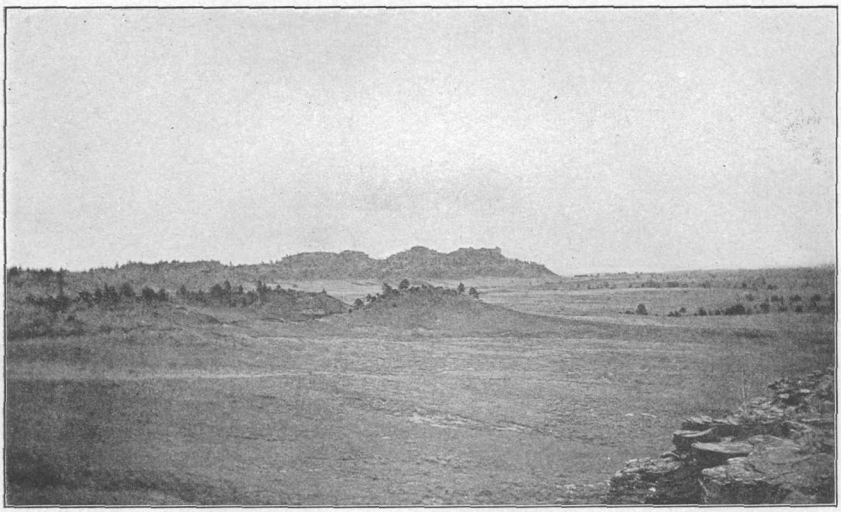
Fossil leaves from Lebo shale member of the Fort Union formation in the Bull Mountain coal field, Montana.

	No. of collection.
Monocotyledon, peculiar species	5611
Phyllites carneosus Newberry	5609
Platanus haydenii ? Newberry	1288
Platanus nobilis ? Newberry	5614
Platanus sp. cf. P. nobilis Newberry	520
Platanus raynoldsii Newberry	1288
Platanus sp. cf. P. raynoldsii Newberry	5611
Platanus sp.	1289
Populus amblyrhyncha Ward	5609
Populus cuneata Newberry	5609
Populus ? sp.	520
Pterospermites ? sp.	5609
Sequoia nordenskioldi Heer	5609, 1289
Taxodium tinajorum ? Heer	1288
Viburnum elongatum Ward	5611
Viburnum ? sp.	5609
Vitis ? sp.	5609

[1] Rogers, G. S., The Little Sheep Mountain coal field, Dawson, Custer, and Rosebud counties, Montana: U. S. Geol. Survey Bull. 531, p. 168, 1913; A study in the petrology of sedimentary rocks: Jour. Geology, vol. 21, pp. 717-724, 1913.

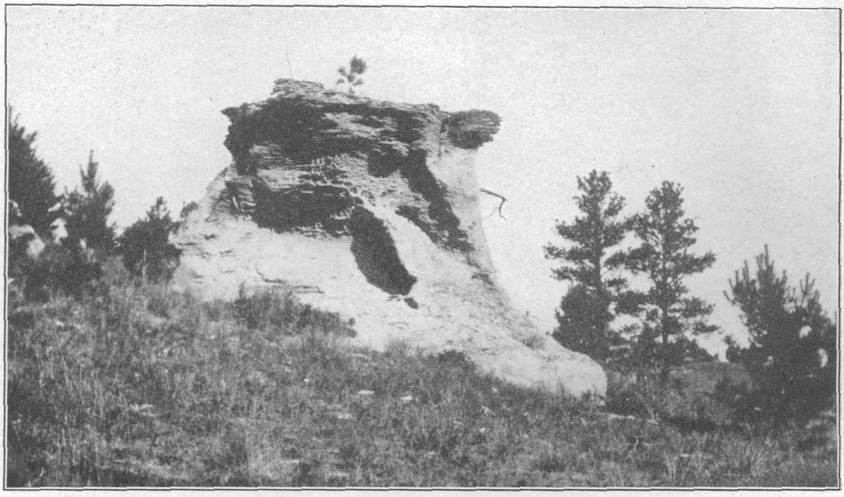


A. CONTRASTING TOPOGRAPHY OF BEARPAW (LEFT) AND LANCE (RIGHT) FORMATIONS, IN SEC. 5, T. 9 N., R. 29 E.

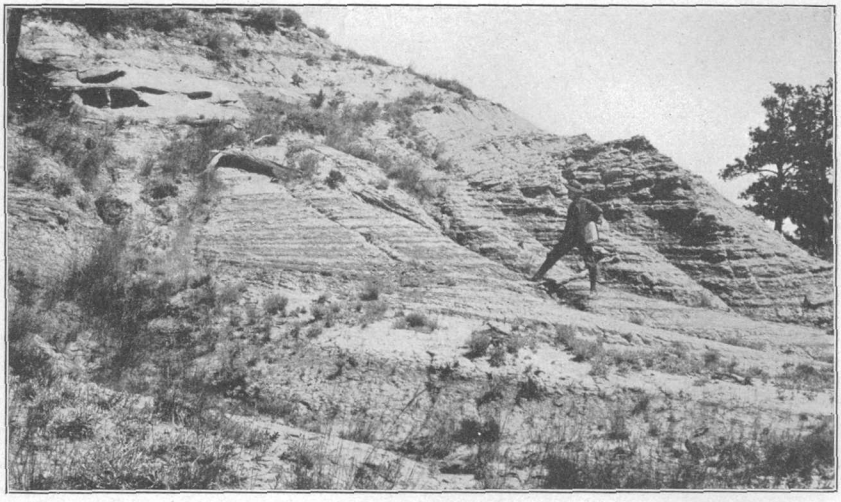


B. CONTRASTING TOPOGRAPHY OF UPPER PART OF FORT UNION FORMATION (UPPER LEFT) AND LEBO SHALE MEMBER OF THE FORT UNION (FOREGROUND), IN SEC. 34, T. 5 N., R. 30 E.

Castle Butte in central background.



A. HONEYCOMB-WEATHERED SANDSTONE OF FORT UNION FORMATION, IN T. 7 N., R. 27 E.



B. CONVERGING BEDS OF SANDY SHALE IN FORT UNION FORMATION, IN SEC. 3, T. 8 N., R. 31 E.

The localities at which these collections were made are as follows:

5611. Two and one-half miles north of Musselshell, above Big Dirty coal bed. Collected by R. W. Stone.

5609. In valley 2½ miles north of Musselshell, T. 9 N., R. 29 E. Collected by R. W. Stone.

1288. East side of Dean Creek in NW. ¼ sec. 9, T. 6 N., R. 24 E. Collected by R. W. Richards and T. W. Stanton.

5614. Southeast part of Bull Mountain coal field, in NE. ¼ sec. 32, T. 5 N., R. 30 E. Collected by C. T. Lupton.

1289. One mile north of Roundup, in NW. ¼ sec. 12, T. 8 N., R. 25 E. Collected by R. W. Richards and T. W. Stanton.

520. Fifteen miles southeast of Lavina, in secs. 33, 34, T. 5 N., R. 24 E. Collected by L. H. Woolsey.

Upper part of the Fort Union formation.—The upper part of the Fort Union formation occupies all of the center of the Bull Mountain region and contains the principal coal beds. It forms the Bull Mountains proper and covers the surrounding country in all directions for distances ranging from 4 to 18 miles. The approximate boundaries of these rocks are Musselshell River on the north, Dean Creek on the west, T. 5 N. on the south, and R. 31 E. on the east.

This part of the formation is composed of sandstone in beds ranging from a fraction of a foot to 50 feet or more in thickness, interbedded with a somewhat larger proportion of clay shale, shale, and numerous beds of coal. Most of the sandstone is massive even where it is thin, but locally it is laminated. It generally retains under all conditions its soft, loose texture with few traces of stratification, so that it weathers into smooth rounded faces and locally assumes toadstool-like forms. In places, as in T. 7 N., R. 27 E., bare cliffs of sandstone weather into honeycomb-like forms (Pl. V, *A*), and in many places they form nearly vertical scarps 50 to 75 feet high. (See Pl. III, p. 15.) Its color is commonly light buff but in many places is whitish gray, and the difference in color between it and the sandstone of the Lance formation is not sufficient to mark it as a distinct lithologic unit if the two formations were adjacent. At many places the sandstone carries small brown concretions of iron ore, around which the sandstone is rich buff or tan. An irregular "clayball" conglomerate, consisting of yellow and gray clay and shale pebbles set in a matrix of yellowish-brown impure coarse-grained sandstone ranging from less than 1 foot to a maximum of about 5 feet in thickness, commonly occurs at the base of beds of massive sandstone. Small lenses of a similar conglomerate occur at different distances above the base of the sandstone. Although the beds of sandstone vary in thickness in short distances, they are surprisingly constant and may be traced as benches encircling the entire Bull Mountains.

The shale is, as a rule, clayey and soft, but in many places it is sandy and grades into shaly sandstone. Its color is gray or light green, but yellow where iron is present. Such a section of alternating

shale and sandstone weathers as a whole into a serried slope showing abrupt benches of sandstone with gracefully curved clay slopes between. An unusual example of abrupt change in thickness of the beds of sandy shale occurs in sec. 3, T. 8 N., R. 31 E. (See Pl. V, *B*.) At four or five places in the upper portion of the formation thin beds of buff limestone 1 to 3 feet in thickness occur. The limestone is extremely fine in texture, resembling lithographic limestone, and consequently preserves excellent impressions of leaves of plants. These beds of limestone and shale are the great storehouses of fossils of this formation.

Within the upper part of the formation 26 coal beds, ranging in thickness from 1 foot 2 inches to 15 feet, were examined and mapped. Several minor coal beds were found, but on account of their lack of importance were not examined in detail. In the western part of the field the coal beds are most numerous in the upper part of the series (preserved only in the Bull Mountain mesas), where they occur at intervals of 50 feet or less. The lower coal beds are separated by intervals of 100 feet or more. In the eastern part of the field, however, several beds were found in the lower part of the series which either are not represented in the western part of the field or are too thin to be important. A good conception of the relations of the coal beds, the variations in thickness of the formation, and the varying characters of the sediments can be obtained from a comparison of the careful hand-leveled sections measured in various parts of the field by Stone, Woolsey, Richards, and Lupton. (See Pl. VI.) The sections in the eastern part of the field (E, F, G, H, I, J, K, and L, in Pl. VI) demonstrate that the coal-bearing rocks are approximately 300 feet thinner in the southeast than in the vicinity of Musselshell.

The thickness of the upper part of the Fort Union in the Bull Mountain field is about 1,650 feet but was originally much greater, many hundreds of feet of strata having been removed by erosion. The greatest thickness is attained in the central Bull Mountain mesas, which are the highest points in the field.

From the abundance of fossil leaves and fresh-water shells and the numerous beds of coal it is evident that these rocks were deposited in fresh or nearly fresh waters, probably inland lakes or ancient estuaries on whose shores grew luxuriant vegetation.

Fossils collected from these rocks were identified by Messrs. Stanton and Knowlton, of the United States Geological Survey, as typical Fort Union forms. The Fort Union is the chief coal-bearing formation of the Northwest, and the Bull Mountain field is merely an outlier of the extensive areas of coal-bearing rocks found in the eastern parts of Wyoming and Montana and in Canada.

The following lists include all the fossils found in the Bull Mountain field in the upper part of the Fort Union formation.

Fresh-water invertebrate fossils collected from the Fort Union formation in the Bull Mountain coal field, Montana.

	No. of collection.
Campeloma multilineata Meek and Hayden	4757, 6296
Goniobasis tenuicarinata (Meek and Hayden)	5485
Helix sp	5485
Physa sp	6297, 5485
Thaumastus limnaeiformis Meek and Hayden?	6295, 5485
Unio priscus Meek and Hayden?	6295, 6297, 5486
Unio sp	6297, 6296
Viviparus leai Meek and Hayden	6295
Viviparus trochiformis Meek and Hayden	4757, 6291, 6295, 6297, 5485

The localities at which the collections were made are as follows:

4757. Sec. 7, T. 5 N., R. 27 E. Collected by L. H. Woolsey.

5485. About 2 miles south of Buckey, T. 5 N., R. 26 E. Collected by R. W. Richards.

6297. NE. ¼ sec. 32, T. 8 N., R. 31 E., in coulee about one-fifth mile west of Carpenter Creek and Wolf Spring road. Collected by C. T. Lupton.

6295. SW. ¼ sec. 33, T. 8 N., R. 31 E. Collected by C. T. Lupton.

5486. Sec. 23, T. 8 N., R. 25 E., one-half mile southwest of Roundup. Collected by R. W. Richards.

6291. SE. ¼ sec. 14, T. 9 N., R. 29 E. Collected by C. T. Lupton.

6296. NE. ¼ sec. 32, T. 8 N., R. 31 E. Collected by C. T. Lupton.

Fossil leaves collected from the Fort Union formation in the Bull Mountain coal field, Montana.

	No. of collection.
Andromeda delicatula Lesquereux	616
Anemia sp	522
Aralia digitata Ward	903
Aralia notata Newberry	1286
Carpites sp., probably new	1286
Carpites sp	902
Celastrus alnifolius Ward	905
Celastrus curvinervis Ward	506
Celastrus ferrugineus Ward	522
Celastrus pterospermoides Ward	506
Celastrus taurinensis Ward	526
Cornus ? sp	905
Corylus rostrata Walter	1287, 902
Corylus ? sp	522
Equisetum cf. E. haguei Knowlton	505
Equisetum sp	5613, 800
Ficus cf. F. goldiana Lesquereux	616
Ficus n. sp. ?, large-leaved	524
Glyptostrobus europaeus ungeri Heer	525, 521, 1286, 900
Hamamelites fothergilloides Saporta	902
Laurus cf. L. montana Knowlton	525
Leguminosites arachioides Lesquereux	1286
Leguminosites sp	525, 526
Onoclea sensibilis fossilis Newberry	5613, 1286, 1287
Palm rays ?	902
Phyllites carneosus Newberry	903

Fossil leaves collected from the Fort Union formation in the Bull Mountain coal field, Montana—Continued.

	No. of collection.
Platanus basilobata Ward	1286
Platanus guillemae Göppert	1286, 902
Platanus haydenii Newberry	5613, 902
Platanus mobilis Newberry	524, 526, 615, 521, 5613
Platanus raynoldsii Newberry	5612, 1286, 902
Populus amblyrhyncha Ward	5613, 5612, 1286, 902
Populus cuneata Newberry	525, 5612, 1286
Populus sp. cf. P. cuneata Newberry	615
Populus daphnogenoides Ward ?	524, 905
Populus grewiopsis Ward ?	902
Populus inaequalis Ward	525
Populus nervosa elongata Newberry	525, 1286
Populus rotundifolia Newberry	1286
Populus sp	523
Pterospermites whitei Ward	505
Rhus nervosa Newberry ?	5613, 801, 800
Sapindus affinis Newberry	525, 905
Sapindus elatus Ward ?	522
Sapindus grandifolius Ward	525, 526, 522, 523, 800, 902
Sapindus membranaceus Newberry	615, 800
Sequoia langsdorfii (Brongniart) Heer	616, 523
Sequoia nordenskiöldi Heer	526, 521, 1286, 1287
Sequoia sp	616
Taxodium occidentale Newberry	505, 506, 5612, 902, 905
Thuya interrupta Newberry	800, 801
Ulmus orbicularis Ward	905
Ulmus rhamnifolia Ward	905
Viburnum antiquum (Newberry) Hollick	506, 526, 5613
Viburnum asperum Newberry	5613
Viburnum sp	5612, 1287

The localities from which the collections were obtained are as follows:

616. Sec. 34, T. 6 N., R. 27 E., 6 miles northeast of Buckey. Collected by L. H. Woolsey.

522. Sec. 25, T. 6 N., R. 25 E., 5 miles northwest of Buckey, near head of Lamott Coulee. Collected by L. H. Woolsey.

903. Sec. 9, T. 7 N., R. 28 E., 2 miles east of Fattig. Collected by R. W. Richards.

1286. SW. ¼ sec. 23, T. 5 N., R. 26 E., 2 miles south of Buckey. Collected by T. W. Stanton.

902. Sec. 23, T. 8 N., R. 25 E., one-half mile southwest of Roundup. Collected by R. W. Richards.

905. About 7 miles southeast of Fattig, in T. 6 N., R. 28 E. Collected by R. W. Richards.

506. SE. ¼ sec. 23, T. 6 N., R. 26 E., 600 feet east of Musselshell road. Collected by L. H. Woolsey.

526. Sec. 7, T. 5 N., R. 27 E. Collected by L. H. Woolsey.

1287. SW. ¼ sec. 23, T. 5 N., R. 26 E., 2½ miles south of Buckey. Collected by T. W. Stanton and R. W. Richards.

505. SW. ¼ sec. 5, T. 5 N., R. 26 E., on Razor Creek, 2 miles northwest of Buckey. Collected by L. H. Woolsey.

5613. SW. ¼ sec. 15, T. 8 N., R. 31 E., on branch of Alkali Creek below McCleary (Ob) coal bed. Collected by C. T. Lupton.

800. T. 7 N., R. 27 E. Collected by R. W. Richards.

524. Sec. 22, T. 5 N., R. 26 E., 3 miles from head of Razor Creek. Collected by L. H. Woolsey.

525. Sec. 36, T. 6 N., R. 26 E., near head of a branch of Razor Creek, about 3 miles northeast of Buckey. Collected by L. H. Woolsey.

521. Sec. 14, T. 5 N., R. 25 E.; head of West Fork of Razor Creek, 5½ miles west of Buckey. Collected by L. H. Woolsey.

900. Sec. 4, T. 7 N., R. 25 E., 6 miles southwest of Roundup. Collected by L. H. Woolsey.

615. T. 6 N., R. 26 E., 2 miles northeast of Buckey. Collected by L. H. Woolsey.

5612. NW. ¼ sec. 13, T. 9 N., R. 29 E. Collected by R. W. Stone.

523. Sec. 33, T. 6 N., R. 27 E., 6 miles northeast of Buckey. Collected by L. H. Woolsey.

801. Near sec. 26, T. 8 N., R. 26 E., on divide between Berrigan Coulee and West Fork of Parrott Creek. Collected by R. W. Richards.

QUATERNARY SYSTEM.

Terrace gravel.—Much of the area bordering Musselshell River is mantled with deposits of gravel laid down on surfaces formed by the erosion of the older rocks. Remnants of flats built by the river when its position was 75 to 175 feet higher than at present still remain as gravel-covered benches or terraces bordering the valleys of the river and of the larger creeks. In good exposures, such as banks of streams and road cuts, the gravel is seen to be stratified, and in places as much as 20 feet thick. Most of the pebbles in these deposits are of rock that differs from the older rocks that outcrop in the vicinity. They are composed chiefly of sedimentary rocks with quartz and some igneous rocks. Most of the igneous material is porphyritic and belongs to the granite porphyries, rhyolite porphyries, and similar rocks. No igneous rock is known in the coal field, and the nearest areas from which the pebbles could have been brought are the Crazy Mountain and Snowy Mountain regions. These deposits once formed a continuous belt along the ancient streams, as the present flood plains do along the present streams, but they have been worn away in many places and are now not only irregular in outline but occur at isolated localities capping the bluffs. Where large enough, such terraces form admirable sites for towns or large plants. Few of them are more than a mile back from the present streams.

In places where they lie upon the coal-bearing rocks the terrace deposits cover the edges of coal beds which would otherwise outcrop. The approximate position of coal beds supposed to be thus covered is indicated on the maps by dotted lines across the terraced areas. (See Pls. XII to XXXVI.)

Flood-plain gravel.—The river flats, which are flooded every year or so, and the slightly higher levels, which are flooded by a freshet

every 10 to 20 years, are called flood plains. In this field only the river and the larger tributaries, such as Fattig and Hawk creeks, have developed flood plains of any importance. (See map, Pl. I, in pocket.) The deposits are composed largely of silt, sand, and pebbles of a character similar to those in the terrace gravels, but probably as a rule somewhat smaller. Oxbow lakes, "back waters," and other flood-plain features are common. The flood plains comprise the most valuable agricultural land in this field, and nearly all of them are, or can be, irrigated from ditches following the outside of the flat. Just as the streams themselves flow over coal-bearing rocks and coal beds, so they have deposited the materials composing the flood plains across the same strata and have thus covered portions of the edges of coal beds. The approximate positions of the outcrops of the coal beds beneath flood plains are marked on the maps by dotted lines.

STRUCTURE.

The structure of the Bull Mountains is comparatively simple. A broad synclinal basin occupies nearly the whole field, flattening to nearly horizontal to the east and south and extending to the north and northwest as two sharply accentuated folds. The axis of the westernmost of these folds extends from the northwest corner of T. 8 N., R. 24 E., southeastward to the high mesas of the Bull Mountains proper, crossing the river just below the mouth of Halfbreed Creek. The extension of the coal-bearing rocks across the Musselshell west of Roundup is due to this synclinal fold. The dips are steepest on the north side of the fold, the maximum being approximately along the outcrop of the Big Dirty bed. Near the southwest corner of sec. 4, T. 8 N., R. 24 E., the Lebo shale dips about 30° S. To the southeast, along the north side of the syncline, the dip gradually decreases to approximately 13° S. at Roundup and to still less farther east. South of the axis of the syncline the rocks dip northeast somewhat irregularly and at low angles—not over 4° on the north side of the river and 1° to 3° on the south side. In the northwest corner of the field the axis of this fold pitches southeast, but south of the river it is nearly flat. The dips on both sides of the fold gradually decrease to the southeast, until on the south and east of the central mesas the strata are nearly horizontal or dip slightly north. Owing to the dying out of this fold to the southeast it merges in the central part of the field with the eastern fold. This eastern syncline has caused an extension of the coal-bearing rocks across the river northwest of Musselshell. In this fold, as in the western one, the steepest dips are on the north side and are about on the line of outcrop of the Lebo shale, so that both the Lebo shale and the Lance formation outcrop in very narrow bands across T. 9 N., Rs. 27, 28, 29, and 30 E., where the beds dip 34° to 36° S.

Farther east in T. 9 N., R. 31 E., the dips are less and the outcrops are correspondingly much broader. On the south side of the fold the beds dip very irregularly in places as much as 5° N. This fold, aside from the steep dip on the north, is less marked than the one on the west side of the field. Minor folds in different parts of the field render the detailed working out of the structure somewhat tedious. The most marked of these minor folds is a small anticline which brings the Lance formation to the surface along Musselshell River near the mouth of Goulding Creek in sec. 18, T. 7 N., R. 25 E., and secs. 13, 14, 23, and 24, T. 7 N., R. 24 E. Other minor structures will be described in connection with the townships in which they occur.

THE COAL.

GENERAL FEATURES.

Coal is by far the most important mineral product of the Bull Mountain field, though shale, clay, and building stone may in the future be utilized. There has been, so far as known, no prospecting for either oil or gas, and surface evidence does not suggest their presence, except possibly at the anticline near the mouth of Goulding Creek.

All coal in this field may be classed as high-grade black lignite or subbituminous. Most of the coal beds are lenticular, showing a wide variation in thickness at different points on the outcrop. This characteristic, however, is more common with some coal beds than with others. In many places where one lens thins out the edge of another begins within a short distance at the same horizon or 5 to 10 feet above or below, so that the total thickness of coal is, roughly speaking, constant.

In general the area of the coal field is determined approximately by the area underlain by the upper part of the Fort Union formation. In the southwest and west of the region, however, the lower coal beds which outcrop about the border of the field are so thin that they were not considered worth mapping, and as a result the map shows a strip several miles wide of upper Fort Union rocks which appear to contain no coal. The 26 coal beds mapped fall into two main groups, an upper and a lower, separated by 190 to 300 feet of barren strata. The beds of the upper group outcrop on the sides and around the base of the Bull Mountain mesas, and the more important of them have been traced all the way around the central mountain mass. Owing to the rapid erosion and the steep scarps formed by the erosion of alternating beds of sandstone and shale, the beds of this upper series are in most places fairly well exposed. Where the coal has burned at the outcrop so extensively that no sections that show

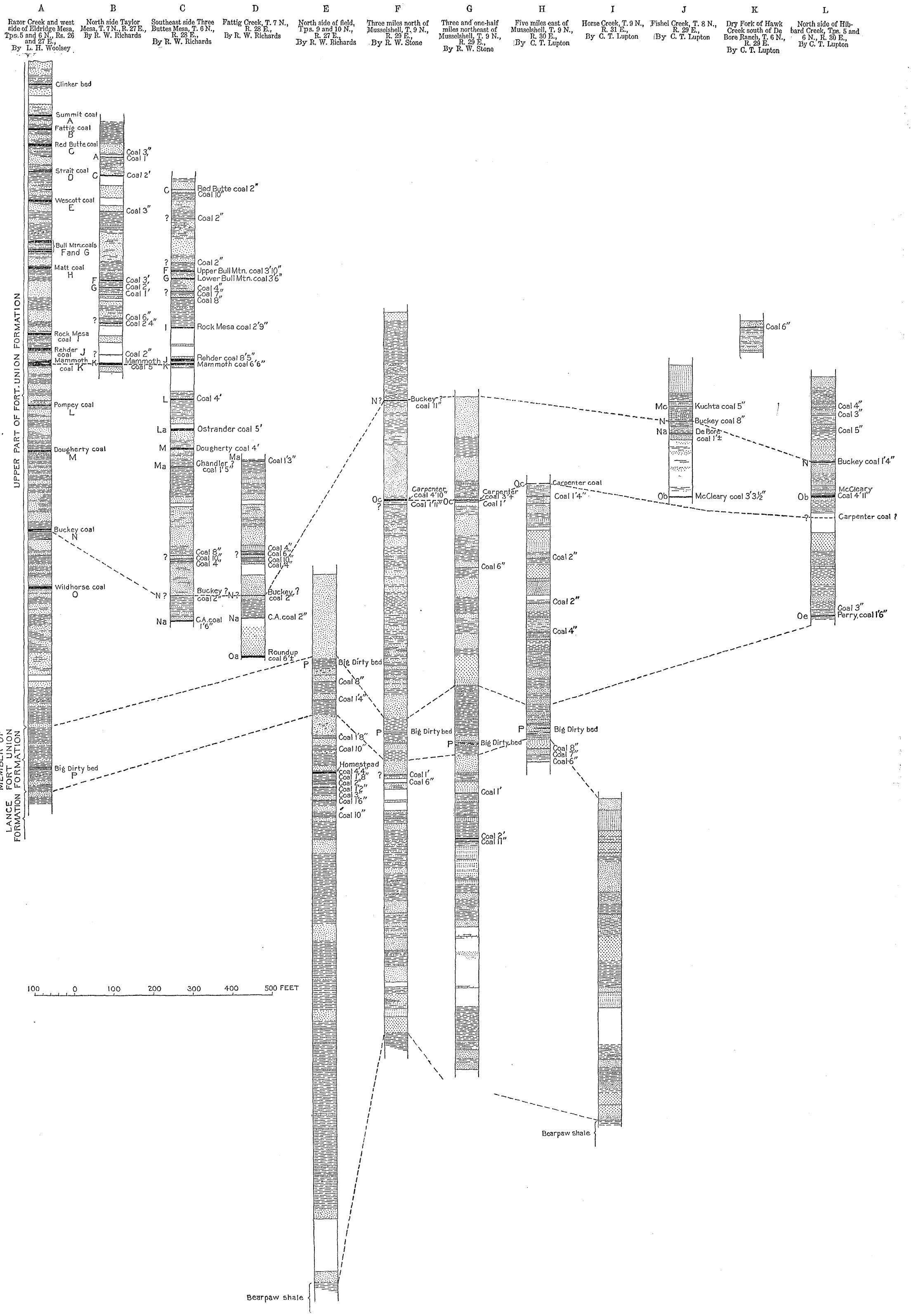
its thickness and character can be found, the bed can be easily traced by the reddening of the overlying strata. Even where the beds are hidden by talus or grassed slopes the horizon can be followed by the scarps of adjacent beds of sandstone. The Dougherty and Chandler and the beds above the Dougherty fall into this upper group. (See stratigraphic sections, Pl. VI.)

The beds of the lower group are in general much more difficult to trace, especially across the wide plateaus and on the low hills along Musselshell River. In the southwestern part of the field only two beds of this lower group were considered of sufficient importance to warrant mapping, but other beds examined and mapped in the northern and eastern parts of the field bring the number in the lower group up to nine. None of the lower beds have been traced around the mountains, and it is very probable that some of those which have been given different names on opposite sides of the mountains are in reality the same. The Roundup and Wildhorse, for instance, occupy about the same stratigraphic position. (See stratigraphic sections, Pl. VI.)

Ashes, baked clay, and slag found along the outcrop of a coal bed show that it has been burned. Where the coals of the lower group have been burned the overlying clay is baked into a natural terra cotta. The rocks above the coal have been fused in places and brownish slag is plentiful. These resistant slag beds cap many small buttes and form prominent bands along the outcrop in the northeastern part of the area. The effects of burning are much less noticeable in the upper group. The lower few inches of coal, however, is usually unburned and is overlain by fine, soft ash of various colors which aids in tracing the coal beds. One of the lower coal beds in the valley of Fishel Creek, about three-fourths mile southwest of Schrader's ranch, was burning in August, 1909. This is the only place in the field where the coal is known to be burning, and this is apparently the same bed and locality at which Lindgren noted a burning in progress in 1881.

In the northern part of the field the extent of the lower coal beds has been further explored by bore holes made by companies operating in the field. The data thus obtained have been willingly placed at the disposal of the United States Geological Survey to be used only as confidential information and have proved of great assistance. The columnar sections shown in Plate VI were measured in different parts of the field to show the variations in the character of the sediments, the intervals between coal beds, and their correlations.

The coal beds will be briefly described in order, beginning with the lowest in the stratigraphic succession. In later pages the field is described township by township and the coal beds and their relationships are described in detail. The outcrops of all coal beds that



COLUMNAR SECTIONS SHOWING DETAILS OF STRATIGRAPHY IN BULL MOUNTAIN COAL FIELD.

were mapped are shown on the maps of the separate townships. (See Pls. XII to XXXVI, inclusive.)

THE BEDS.

BEDS IN LANCE FORMATION.

The thin coal beds in the Lance formation were considered of insufficient importance for detailed mapping. The thickest and probably the best of those examined has been called the Homestead bed. The following section, measured by Richards in a prospect in T. 10 N., R. 27 E., illustrates the character of the bed:

Section of Homestead coal bed in sec. 35, T. 10 N., R. 27 E.

	Ft.	in.
Shale with coal streaks	2	0
Coal	1	3
Bone		4
Coal		4
Bone		2
Coal		3
Shale	1	0
Coal	1	1
Sandstone.		
Total section	6	5
Total coal	2	11

The sample of coal taken at this point (see analyses, p. 51) from the 1-foot 3-inch bench at the top of the bed gave a calorific value of 12,120 British thermal units in the air-dried state, and on this basis alone the coal may be considered high-grade subbituminous or possibly low-grade bituminous. The coal, although almost freshly mined, showed marked indications of weather checking. Other sections of Lance coal beds are given in the township descriptions of T. 6 N., R. 24 E., and T. 9 N., R. 31 E. The stratigraphic positions of some of the beds are shown in columnar sections E, F, and G, Plate VI.

BEDS IN LEBO SHALE MEMBER OF FORT UNION FORMATION.

The Big Dirty coal bed, called in an earlier report the Glendive bed,[1] lies near the middle of the Lebo shale member of the Fort Union formation and has been carefully examined at numerous places around the Bull Mountain field. Throughout the greater part of its extent it has a prominent outcrop and is a useful marker by which to limit the area of coal-bearing rocks. It consists of alternating layers of dark carbonaceous sandstone which weather light gray, of dark sandy shale, and of fairly good coal 2 inches to 1 foot in thickness. It is so sandy that it makes a bench where the strata are flat

[1] Woolsey, L. H., The Bull Mountain coal field, Mont.: U. S. Geol. Survey Bull. 341, pp. 66–67, 1909.

and forms a low rounded hogback where the dip is steep. Although the bed ranges from 2 to 24 feet in thickness and is one of the most prominent in the entire field, attracting the attention of ranchers and prospectors by its extensive exposures, it has at the present time little or no economic value.

BEDS IN UPPER PART OF FORT UNION FORMATION.

An almost bewildering succession of coal beds occur in the upper part of the Fort Union formation. Almost every cut bank along the creeks and coulees and every bluff where any considerable section of strata is exposed shows one or more coal beds. Twenty-six of the thickest and most extensive of these beds have been named and are also designated by letters. These beds named from top to bottom are as follows:

A. Summit.
B. Fattig.
C. Red Butte.
D. Strait.
E. Wescott.
F. Upper Bull Mountain.
G. Lower Bull Mountain.
H. Matt.
Ha. Carter.
I. Rock Mesa.
J. Rehder.
K. Mammoth.
Ka. Saddler.
L. Pompey.
La. Ostrander.
M. Dougherty ("Dorrity," Woolsey).
Ma. Chandler.
Mc. Kuchta.
N. Buckey.
Na. De Bore (C A, Richards).
O. Wildhorse.
Oa. Roundup.
Ob. McCleary ("Snelling," Richards).
Oc. Carpenter ("Snyder," Richards).
Od. Spendiff.
Oe. Perry.

The stratigraphic intervals separating the different beds in different parts of the field are shown in the columnar sections, Plate VI.

In addition to the coal beds enumerated above there are numerous thin and lenticular beds that were not considered of sufficient importance for detailed study. Some of the more important of these will be described with the townships in which they occur.

Perry coal bed (Oe, Pl. VI).—The Perry coal bed is about 20 feet stratigraphically above the top of the Lebo shale member, and is important only in Tps. 5 and 6 N., R. 31 E., and in T. 5 N., R. 30 E., where it outcrops on Buffalo, Antelope, Mill, and Hibbard creeks and on the ridges separating them. The greatest thickness (2 feet 10 inches) is reached on Mill Creek in T. 5 N., R. 31 E. Detailed sections along the outcrop show that the bed is lenticular.

Spendiff coal bed (Od).—The Spendiff coal bed has been studied by Richards on both sides of Fattig Creek in secs. 4, 5, and 8, T. 8 N., R. 28 E., where its thickness ranges from 6 to 20 inches. Its outcrop was traced for only a short distance. In T. 9 N., Rs. 28 and 29 E. a coal bed which has been observed at several points 30 feet below the Carpenter is supposed to be the equivalent of the Spendiff. Its maximum known thickness is 2 feet 1 inch.

Carpenter coal bed (=Snyder coal bed) (Oc).—The lowest of the more important coal beds of the Bull Mountain field is the Carpenter bed, about 450 feet above the top of the Lebo shale. This bed is important only in the northeastern part of the field. Along the northern limb of the eastern Bull Mountain syncline, in T. 9 N., Rs. 28 and 29 E., it dips 25° to 40° S. and outcrops in nearly a straight line. Eastward from the western part of T. 9 N., R. 30 E., the dip becomes gradually less and the outcrop can be followed in a southeasterly direction along the south side of Carpenter Creek and around the head of Lost Horse Creek to and across the Musselshell-Yellowstone divide in secs. 2 and 3, T. 8 N., R. 31 E. From that place southwest along the south side of the divide the bed is thin and was not mapped continuously. From the east border of T. 9 N., R. 29 E., to the north of T. 8 N., R. 31 E., the bed ranges in thickness from 4 to 8 feet, but a short distance beyond the border of the last-named section it is so thin as to be of little value. The maximum thickness is at W. C. Grant's prospect (No. 9, Pl. XXXV, p. 198) on Carpenter Creek (see Pl. VII, *A*) in the NE. ¼ sec. 26, T. 9 N., R. 30 E., where the bed is 8 feet 2 inches thick with two thin partings of bone and shale. Along both sides of Fattig Creek, in T. 8 N., R. 28 E., several exposures were examined on what was then called the Snyder bed. This bed, which reaches a maximum thickness of 2 feet 9 inches in Horsethief Coulee, is probably the equivalent of the Carpenter bed. Two analyses made from weathered samples collected in T. 9 N., R. 30 E., from the Carpenter bed are given on page 51. The calorific values given in the table are probably considerably less than would be obtained from unweathered samples. The physical characters of the coal indicate that it is of the same quality as the coal in other beds in the field.

McCleary coal bed (=Snelling coal bed) (Ob).—About 50 feet above the Carpenter bed is another important coal bed which, like the Carpenter, outcrops only in the eastern part of the field. Eastward from sec. 15, T. 9 N., R. 29 E., to the Musselshell-Yellowstone divide at the head of Lost Horse Creek, in sec. 2, T. 8 N., R. 31 E., the outcrop is nearly parallel to that of the Carpenter bed. The outcrop has been mapped on the south of the divide from the northern part of T. 8 N., R. 31 E., southwestward to sec. 23, T. 7 N., R. 30 E., beyond which place the bed is so thin that it was not traced. The maximum thickness is in the NE. ¼ sec. 15, T. 8 N., R. 31 E. (No. 18, Pl. XXXVI, p. 212), where 8 feet 8 inches of clean coal is exposed. The decrease in thickness along the outcrop from that place is fairly uniform in both directions.

About three-fourths mile southwest of August Schrader's ranch, on Fishel Creek (No. 1, Pl. XXIX), in T. 8 N., R. 29 E., there is a

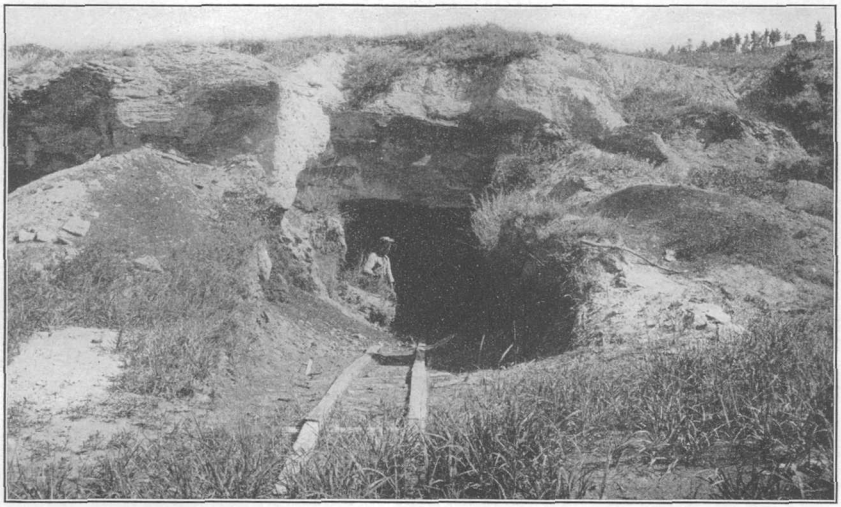
small closed outcrop of coal measuring 3 feet 3½ inches in thickness, which is probably the McCleary bed.

In the southern half of T. 6 N., R. 30 E., and the northern half of T. 5 N., R. 30 E., about the heads of Antelope, Mill, and Hibbard creeks, a coal bed has been examined which is correlated with the McCleary. The bed is thickest toward the southwest, where, on the ridge between Mill and Hibbard creeks (No. 29, Pl. XXXI, p. 180), it contains 4 feet 4 inches of coal with a 5-inch parting of bone 10 inches below the top. About the heads of both of these streams the bed is so thin that it was not mapped.

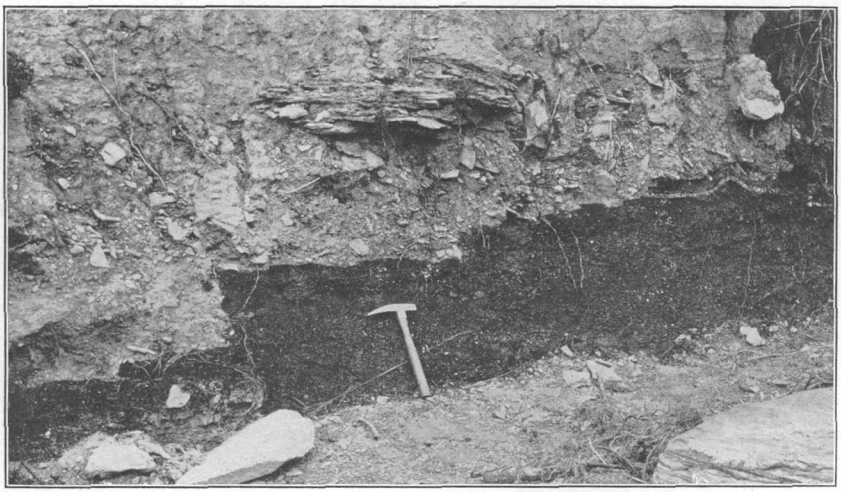
On Fattig Creek, in T. 8 N., R. 28 E., several exposures were examined on what was then called the Snelling coal bed. This bed, which reaches a maximum thickness of 2 feet 3 inches at the head of Horsethief Coulee, in sec. 14 (No. 25, Pl. XXV, p. 154), is probably the equivalent of the McCleary.

Chemical analysis was made of two samples from the McCleary coal bed. Both samples were somewhat weathered, and the freshest one gave a calorific value of a little over 10,000 British thermal units. (See p. 51.) The fresh coal would probably give a value near 12,000 British thermal units. In appearance the McCleary coal compares well with other coals in the field.

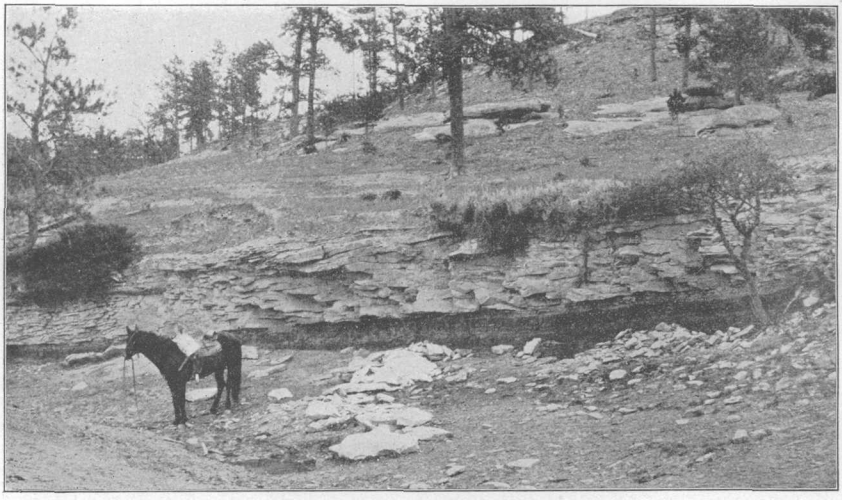
Roundup coal bed (Oa).—The Roundup coal bed outcrops in the northern and northwestern parts of the field. It is not found in the same part of the region as the McCleary bed, except on Fattig Creek, in T. 8 N., R. 28 E., where the Snelling bed, the supposed equivalent of the McCleary bed, lies about 50 feet below the Roundup bed. In the vicinity of Roundup the bed is stratigraphically about 500 feet above the top of the Lebo shale. It is at present commercially the most important coal bed in the field and is worked in all the active mines, namely, mine No. 2 of the Republic Coal Mining Co., the Commercial mine, or No. 3, of the Roundup Coal Mining Co., and the Keene mine of the Pine Creek Coal Mining Co., all near Roundup. The outcrop of the bed, so far as known, lies in T. 7 N., Rs. 25 and 28 E., and T. 8 N., Rs. 25, 26, 27, and 28 E. From a point near the north boundary of T. 7 N., R. 25 E., where the bed is only 1 foot thick, it has been traced in a general northerly direction (except for irregularities due to topography) to the nose of the main western Bull Mountain syncline in sec. 8, T. 8 N., R. 25 E. Along the northern limb of the syncline the outcrop runs southeast to Musselshell River at Roundup. From the river it extends in a general easterly direction to T. 8 N., R. 28 E., where the bed outcrops on both sides of Fattig Creek in the southern part of this township and the northern part of T. 7 N., R. 28 E. In the vicinity of Roundup the bed ranges in thickness from 4 to 6 feet. It gradually decreases in thickness eastward to about 3 feet 6 inches on the west side of Fattig Creek, beyond which it decreases sharply to 1 foot 7 inches in sec. 28, T. 8 N.,



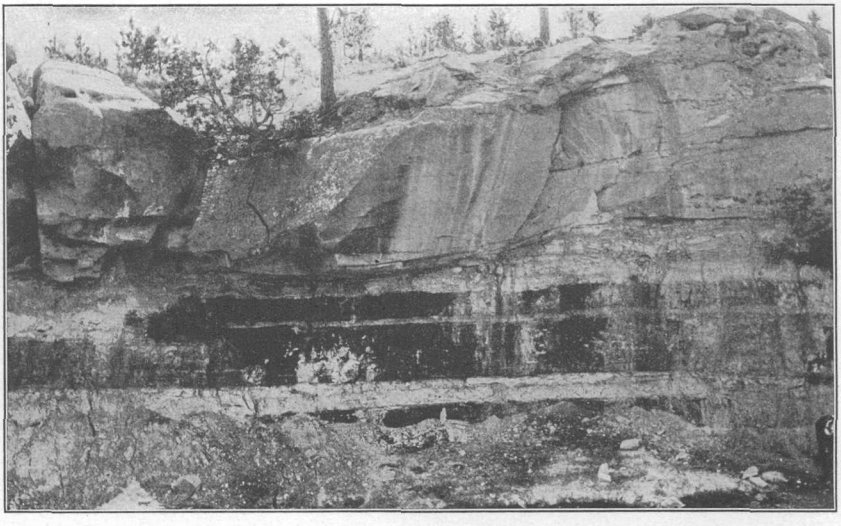
A. OPENING OF GRANT'S PROSPECT ON CARPENTER (Oc) COAL BED, IN SEC. 26, T. 9 N., R. 30 E.



B. MINOR FAULT AND FOLD IN WILDHORSE (O) COAL BED ON FORK OF EAST RAZOR CREEK, IN THE NE. ¼ SEC. 18, T. 5 N., R. 27 E.



A. OUTCROP OF BUCKEY (N) COAL BED ON FORK OF LAMOTT COULEE, IN THE NW. ¼ SEC. 36, T. 6 N., R. 25 E.



B. EXPOSURE OF MAMMOTH (K) COAL BED AT SCHLABERG CAMP, NEAR THE SE. ¼ SEC. 34, T. 7 N., R. 27 E.

Showing beginning of a parting that thickens toward the east.

R. 28 E. The Roundup coal, like other coals in the Bull Mountains, is subbituminous. Nine analyses made from samples from this bed show that it has an average calorific value of more than 11,000 British thermal units on the air-dried basis. (See pp. 51–52.) It is a good coal for steam purposes and appears to stand shipment well if mined under sufficient cover.

Wildhorse coal bed (O).—The Wildhorse coal bed outcrops on the south side of the Bull Mountain field and has nowhere been found in the same areas as either the Roundup or the McCleary beds. It is possible that future mining developments may prove that it is the equivalent of one of these beds, although the evidence at hand does not warrant this assumption. The bed has been mapped in T. 5 N., Rs. 27 and 28 E., where it lies about 350 feet stratigraphically above the top of the Lebo shale. In the eastern part of T. 5 N., R. 27 E., its thickness is only a few inches but across the greater part of that township is surprisingly constant, ranging from 2 feet 8 inches to 3 feet 9 inches. Throughout the greater part of T. 5 N., R. 28 E., it averages about 2 feet. An example of minor folding and faulting occurs on a branch of East Razor Creek in sec. 18, T. 5 N., R. 27 E. (See Pl. VII, *B.*) No samples were obtained for analysis from this bed, but its appearance indicates that the coal is similar in quality to that in other beds in the field.

De Bore or C A coal bed (Na).—The De Bore or C A coal bed is a thin but fairly persistent bed in the eastern part of the field. Southeast of the Bull Mountains, in T. 5 N., R. 28 E., and T. 6 N., Rs. 28 and 29 E., it is 95 feet stratigraphically above the Wildhorse bed and is known as the C A bed. It reaches a maximum thickness of 2 feet 9 inches of coal in sec. 36, T. 6 N., R. 28 E. (No. 6, Pl. XXIII, p. 144), but its value is impaired by a shale parting. In the northeastern part of the field the De Bore bed, which is considered to be the equivalent of the C A bed, is approximately 200 feet above the McCleary bed. At the head of Deadman Gulch, in T. 7 N., R. 30 E., however, the interval is only about 100 feet.

North of Musselshell River in T. 9 N., R. 29 E. (No. 15, Pl. XXX, p. 174), the bed has a maximum thickness of 1 foot. Farther south, along Hawk Creek (No. 18, Pl. XXX), it reaches 2 feet, but is exposed at only a few places. At the head of Carpenter Creek, in sec. 4, T. 8 N., R. 31 E. (No. 27, Pl. XXXVI, p. 212), it has a maximum thickness of 1 foot 10 inches. Seven miles farther south, in the SW. ¼ sec. 2, T. 7 N., R. 30 E. (No. 7, Pl. XXXIII, p. 186), the thickness is 1 foot 5 inches. Sections ranging from 6 inches to 1 foot 1½ inches were measured at numerous places between these two localities. The coal of this bed is of poor quality, appearing on the outcrop to be nearer lignite than subbituminous coal. No sample for chemical analysis was obtained.

Buckey coal beds (N).—The Buckey coal beds are one of the most persistent groups in the whole Bull Mountain field. The outcrops have been followed and mapped from the head of Goulding Creek in T. 6 N., R. 25 E., around the southern side of the mountains as far as the west line of T. 5 N., R. 28 E. Across this and the next township to the east the bed was so thin and the outcrops so obscure that it was not mapped. It was found again around the heads of Hibbard and Mill creeks in Tps. 5 and 6 N., R. 30 E., and from the head of Buffalo Creek northeast along the south side of the Musselshell-Yellowstone divide and in the valleys of Hawk and Carpenter creeks.

In the southwestern part of the field the Buckey coal beds lie stratigraphically about 140 feet above the Wildhorse. At many places the outcrop of only a single bed could be found, but in certain places two or three or even more coal beds were found separated by intervals which range from thin partings up to several feet. The sections measured show that all the beds are lenticular, but they are in many places very difficult to trace on account of grass and the absence of good sandstone ledges for markers. Near the middle of the southern boundary of T. 6 N., R. 26 E. (No. 2, Pl. XV, p. 154), the maximum thickness of more than 6 feet was measured. At this place the partings are near the middle of the group and are thin enough to permit the total coal to be mined as one bed. The average thickness of the principal bed of the Buckey group in this part of the field is about 3 feet. A good exposure of the principal bed occurs on Lamott Coulee, in the NW. ¼ sec. 36, T. 6 N., R. 25 E. (See Pl. VIII, *A*.) East and north from the western part of T. 5 N., R. 28 E., a single bed is found (No. 38), which in that region is about 60 feet above the C A coal bed and has a maximum thickness of 2 feet 8 inches. In the eastern and northeastern parts of the field the bed is from 25 to 40 feet above the De Bore or C A bed and is more regular in quality and thickness than any other coal in that part of the field. The maximum thickness, 3 feet, in the northwestern part of the field is in sec. 35, T. 8 N., R. 29 E. (No. 52, Pl. XXIX, p. 168). In the southeast, on Hibbard and Mill creeks, the bed ranges from 1 foot 1 inch to 1 foot 6 inches in thickness and is under comparatively thin cover.

Two samples for chemical analysis have been collected from the Buckey group, one in sec. 36, T. 9 N., R. 30 E. (laboratory No. 8464), where the bed is 1 foot 2 inches thick (No. 35, Pl. XXXV, p. 198), and the other (No. 18, Pl. XXIX, p. 168) in sec. 29, T. 8 N., R. 29 E. (laboratory No. 7195), where the bed is 2 feet 6 inches thick, and where a drift has been opened and a few loads of coal removed. These analyses (p. 53) and the physical character of the coal show that it

is of about the same grade and character as the average coals of the Bull Mountain field.

Kuchta coal bed (*Mc*).—The Kuchta coal bed is confined to the northeastern part of the field, extending south and west to the valley of Hawk Creek. It is 25 to 40 feet above the Buckey and is the highest important coal bed in this part of the field.

Across T. 9 N., Rs. 28, 29, and 30 E., its outcrop is approximately parallel to that of the Buckey but shows numerous irregularities that are due to topography. The bed dips south but at a much lower angle than the lower beds. About the heads of Carpenter and Hawk creeks and on the east side of the divide, in Tps. 8 and 9 N., R. 31 E., the bed lies near the top of the plateau. Farther down Hawk Creek it appears lower in the valley bluffs until it passes beneath Hawk Creek less than a mile south of Musselshell.

North of Musselshell River and west of the center of T. 9 N., R. 29 E., the bed is not over 1 foot 2 inches thick and has not been mapped continuously. From the center of T. 9 N., R. 29 E., eastward near to the head of Carpenter Creek, and on the southwest side of the divide as far as the northeastern part of T. 7 N., R. 30 E., the maximum thickness is 2 feet 10 inches.

Along Hawk Creek and its tributaries the bed is somewhat lenticular, ranging in thickness from less than 1 foot to 2 feet 8 inches. It is thinner on the west side of Hawk Creek than on the east.

Two samples have been collected and analyzed from the Kuchta bed, one a slightly weathered sample (laboratory No. 8467) from the Kuchta prospect (No. 53, Pl. XXXV, p. 198) in sec. 28, T. 9 N., R. 30 E., representing 2 feet 4 inches of coal; the other (laboratory No. 9129) from a small mine (No. 108, Pl. XXIX, p. 168) east of Hawk Creek in lot 23, sec. 2, T. 8 N., R. 29 E. These analyses (p. 53) and the physical characters of the coal show that it is high-grade subbituminous, corresponding very closely with other coals in the field.

Chandler coal bed (*Ma*).—The Chandler coal bed, a thin, comparatively unimportant bed about 40 feet below the Dougherty coal bed, outcrops on Railroad Creek, Cow Gulch, and Fattig Creek. The bed reaches its maximum thickness on Railroad Creek in sec. 15, T. 6 N., R. 28 E. (No. 15, Pl. XXIII, p. 144), where it is 2 feet 6 inches thick. Its physical characters are similar to those of other coal beds in the field.

Dougherty coal bed (*M*).—The Dougherty is the lowest important bed in the upper group of coal beds of the Bull Mountain field and is separated by a considerable interval from any important bed below it. On the south side of the divide the interval to the Buckey is 200 feet, but on the north side, where the Buckey is not present, the interval to the Roundup coal is 510 feet, as determined by a leveled

section near Fattig post office and a bore-hole section on the west fork of Parrott Creek. The outcrop was mapped continuously around the Bull Mountains, with the exception of a short distance in the northern part of T. 7 N., R. 27 E., where the bed is thin and the outcrop poorly exposed. At a few other places on the north side of the mountains the thickness is less than 1 foot, but under the greater part of the area the bed is fairly persistent and uniform, both in quality and thickness. In the southwestern part of the field it ranges from 1 foot 6 inches to 4 feet 4 inches in thickness. Farther east it is thicker, reaching a maximum of 4 feet 11½ inches in Cow Gulch in sec. 10, T. 6 N., R. 28 E. (No. 26, Pl. XXIII, p. 144). Details regarding the variations in thickness are given under the separate township descriptions and the maps and plates accompanying them.

The coal of the Dougherty bed is undoubtedly high-grade subbituminous, and the bed appears to be one of the cleanest and most uniformly thick in the field. The analysis of a sample laboratory No. 6830) taken from the outcrop (No. 26, Pl. XXIII, p. 144) in Cow Gulch in sec. 10, T. 6 N., R. 28 E., shows a calorific value of 10,770 British thermal units for the air-dried sample, which compares very favorably with the figures for other fresh coals in the Bull Mountain field. (See p. 53.) The analyses of two other samples, both taken in T. 6 N., R. 26 E., show, probably because of weathering, much lower calorific values. The bed in most places has an excellent sandstone cover and is underlain by shale, two valuable factors which should lead to its early development.

Ostrander coal bed (*La*).—The known outcrop of the Ostrander coal bed is confined to the southeastern, eastern, and northern slopes of the Bull Mountains, where it occupies a stratigraphic position about 60 feet above the Dougherty. The bed was mapped continuously around the upper courses of Railroad Creek, Cow Gulch, and Dry Fork of Hawk Creek and their tributaries, but only locally on the northern branches of Hawk Creek and on Fattig and Parrott creeks. The Ostrander coal bed is in most places thin and only locally attains an important thickness. The maximum, so far as known, is in T. 6 N., R. 28 E., where it ranges in thickness from 1 foot 9½ inches (No. 68, Pl. XXIII, p. 144) to 3 feet (No. 57, Pl. XXIII). The coal in this bed appears to be similar in quality to that in other beds in the field.

Pompey coal bed (*L*).—In the southwestern part of the field the Pompey is the next important coal bed above the Dougherty, from which it is separated by 110 feet of shale and sandstone. It lies about 90 feet below the Mammoth coal bed and is most prominent along the northern border of T. 5 N., R. 27 E., and in the southeast-central part of T. 6 N., R. 26 E. East of that township it is apparently absent. It is very irregular, and in many places its value is

utterly destroyed by a thick parting of shale or, locally, of sandstone, which occurs near the middle of the bed. It ranges from less than 1 foot to 5 feet in thickness, but the greater thicknesses are due to an increased thickness of shale parting without a correspondingly greater amount of coal. The lower bench of the bed carries generally the best coal, and the upper bench is apt to be bony and poor. No development has been attempted on the bed and probably will not be until the thicker and more valuable beds are exhausted.

Saddler coal bed (Ka).—The outcrop of the Saddler coal bed, so far as known, is confined to the area drained by Parrott Creek. The most important area is in the northwestern part of T. 7 N., R. 27 E., where the bed lies about 40 feet below the Mammoth coal bed and ranges in thickness from less than 1 foot (No. 41, Pl. XX, p. 130) to a maximum of 2 feet 1 inch (No. 44, Pl. XX). In the remainder of the area where the horizon was recognized the bed is thinner except for a single outcrop almost directly north of the easternmost of the Three Buttes (No. 48, Pl. XXIV), where a bed 3 feet 11 inches in thickness is exposed. This, however, may be in a slump from the Mammoth coal bed.

Mammoth (K) and Rehder (J) coal beds.—The Mammoth and Rehder are two coal beds separated by an interval which in places is so slight that the coal can be mined as a single bed but in other places is as much as 25 feet. The sketch map (Pl. IX) shows the area underlain by the two beds, the area under which it is estimated that the two beds are coincident, and the areas where it is estimated that they will have to be mined separately. An arbitrary line has been drawn from a point near the Schlaberg camp on the head of Fattig Creek in T. 7 N., R. 27 E., southwestward to a point on the outcrop on Razor Creek at the southwest corner of sec. 24, T. 6 N., R. 26 E. Northwest of this line, under Taylor Mesa, Bridges Butte, and the surrounding region, the coal beds are treated individually, the lower being called the Mammoth and the upper the Rehder. To the southeast, under Eldridge Mesa and as far east as the east section line of secs. 6, 7, and 18 of T. 6 N., R. 28 E., the two beds are considered a unit under the name Mammoth. Farther east, under Three Buttes Mesa, there are again two beds separated by an interval of 1 foot 3 inches to 7 feet 6 inches, which are treated as the upper or Rehder and the lower or Mammoth. A good illustration of the abrupt variation in thickness of the parting is the excellent exposure near Schlaberg camp (No. 56, Pl. XX, p. 130), in sec. 34, T. 7 N., R. 27 E., where the parting thickens for a short distance at the rate of 3 feet in 100. (See Pl. VIII, *B*.)

The coal beds as outlined above are the thickest and probably the most important in the Bull Mountain field. The area underlain (Pl. IX) is confined principally to Tps. 6 and 7 N., Rs. 26, 27, and

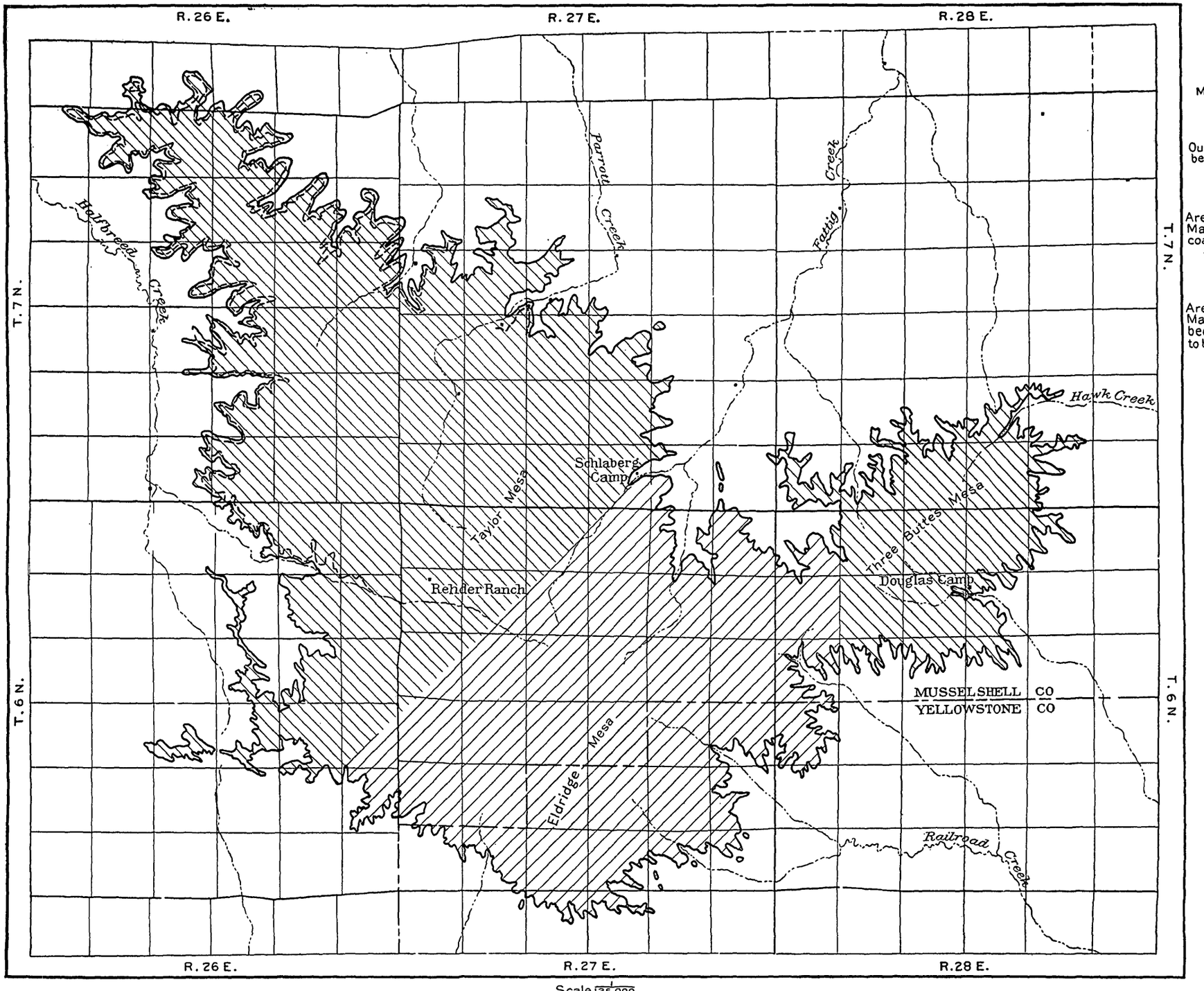
28 E., and includes all of the central Bull Mountain mesas. In the northwestern part of this area, particularly on the divide between Parrott and Halfbreed creeks, both beds are obscured along the outcrop by extensive burning which makes it difficult to obtain sufficient measurements to estimate their thickness. The effect of the burning itself, however, may be taken as a rough indication of the thickness. In other parts of the area the outcrop of one or both of the beds is so obscured by burning or by heavy grass that it was not everywhere possible to obtain desired measurements. From a careful study of all the data available the following generalized estimates have been made: In the northern part of T. 7 N., R. 26 E., each bed has a thickness of 2 or 2½ feet. Both beds are thicker toward the southeast—about 4 feet in the southeast corner of that township. The Mammoth bed averages about 5 feet in the part of T. 7 N., R. 27 E., that it underlies and in the northwestern part of T. 6 N., R. 27 E., where the beds are distinct. In the same area the Rehder thickens from about 4½ feet along the western line of range 27 to a maximum of 8 feet 5 inches of coal at Schlaberg camp (No. 66, Pl. XX, p. 130). Where the two beds are considered as one the thickness ranges from about 7 feet in the western part of T. 6 N., R. 27 E., to 13 feet 7 inches in sec. 2 of the same township (No. 22, Pl. XIX, p. 122). Under the Three Buttes Mesa the Rehder bed has an average thickness of 8 feet 6 inches and the Mammoth of 5 feet.

The value of the beds is considerably affected by numerous partings of shale, which will considerably increase the cost of mining. The above average thicknesses are based on the total coal, without taking into account the thinner partings.

As early as 1880 a mine was opened by the Northern Pacific Railway on the Mammoth coal bed in what is now sec. 24, T. 6 N., R. 27 E., and a good wagon road was constructed down Railroad Creek, over which much coal was removed. The mine was too far from the railroad, however, to be operated successfully and was soon abandoned. Since that time the development of the bed has been limited to local coal banks. The Transcontinental Railway survey of the Bull Mountain coal field in 1881[1] was practically limited to the Mammoth bed, as was the detailed examination in 1906 for the Northwestern Improvement Co.

At Douglas camp (No. 73, Pl. XXIII, p. 144) in Cow Gulch (Pl. X, p. 60), sec. 10, T. 6 N., R. 28 E., both the Mammoth and the Rehder coal beds were sampled for chemical analysis. The Rehder bed gave a calorific value of 11,610 British thermal units and the Mammoth 11,800 British thermal units for the air-dried samples (laboratory Nos. 6828 and 6831). The combined bed was also sampled in sec. 30,

[1] Eldridge, G. H., Montana coal fields: Tenth Census U. S., vol. 15, pp. 753–755, pls. 58, 59, 70, 73, 1886.



LEGEND

- Outcrop of Mammoth coal bed
- Outcrop of Rehder coal bed as far as mapped
- Area under which the Mammoth and Rehder coal beds can probably be mined as one
- Area under which the Mammoth and Rehder coal beds will probably have to be mined separately

Scale 1/125,000
0 1 2 3 4 5 MILES
1916

SKETCH MAP SHOWING AREA UNDERLAIN BY MAMMOTH AND REHDER COAL BEDS AND THEIR RELATIONS TO EACH OTHER.

T. 6 N., R. 27 E., with the results given in the table on page 53 (laboratory Nos. 5797 and 5799).

Rock Mesa coal bed (I).—From 25 to 45 feet above the Rehder coal bed a more persistent coal, named the Rock Mesa, is almost everywhere present, its outcrop closely following that of the Mammoth and Rehder beds. It is, however, erratic, in that its persistent partings here and there within short distances attain proportions deleterious to the commercial value of the coal. The bed is in most places covered by a shale roof. It develops local thicknesses of 2 to 3 feet in T. 6 N., R. 26 E., and attains over 4 feet in the southwest corner of T. 6 N., R. 27 E., beyond which to the east it is in most places less than 2 feet thick. North of the Bull Mountain mesas, however, especially in the northeast corner of T. 6 N., R. 27 E., the bed is remarkably uniform in character and thickness, presenting almost everywhere 2 to 3 feet of good coal. In this vicinity, too, the coal is particularly free from partings, whereas on the southwest side of the mountains partings are more numerous.

In sec. 20, T. 7 N., R. 27 E. (No. 69, Pl. XX, p. 130), the coal reaches a thickness of 3 feet 7 inches, but in many other places in this township it is thin or its outcrop is obscured by grass and trees. In the eastern part of the field the Rock Mesa coal ranges from less than 1 foot 6 inches to a maximum of 3 feet 4 inches, but in most places it is less than 3 feet thick.

No sample for chemical analysis has been obtained from this bed, and no attempt has been made to develop it commercially. The character of the coal is similar to that in the Mammoth and other coal beds in the field.

Carter coal bed (Ha).—On the east side of the Three Buttes, about 50 feet above the Rock Mesa, a coal bed, which has been named the Carter (Ha), has a thickness of 2 feet 9 inches in sec. 3, T. 6 N., R. 28 E., at the head of Dry Fork of Hawk Creek (No. 103, Pl. XXIII, p. 144), but thins in both directions and, so far as known, is unimportant elsewhere.

Matt coal bed (H).—The Matt coal, which is very persistent on the southwestern side of the mountains (H bed, Pl. VI), lies 170 feet above the Rock Mesa, the interval containing no coal beds of value except the Carter coal bed, mentioned above. Its usual position is 20 to 30 feet above the heavy mural sandstone which skirts the foot of the bluffs. Generally it is less than 2 feet thick, except on the northeast side and at the head of Dougherty Coulee. In the branches locally known as Strait and John Matt coulees it is between 4 and 5 feet thick. Elsewhere in this vicinity it is commonly under 3 feet. This coal bed is generally clean but in places has a thin parting near the middle.

In the vicinity of Dougherty Coulee the coal appears to be of good quality, the bed is very accessible, the country is comparatively

smooth, water is plentiful, and the rocks dip gently—about 2° NE. Nevertheless no development has been attempted.

Bull Mountain coal beds (F and G).—On the southwest side of the mountains the Lower Bull Mountain coal bed lies about 45 feet above the Matt or 215 feet above the Rock Mesa. On the northeast, however, where the Matt coal bed is not present, the interval to the Rock Mesa is about 130 feet. These measurements indicate a decrease in thickness of the intervening strata of about 85 feet from the southwest to the northeast sides of the mountains.

The two Bull Mountain coal beds are very persistent and in general mark the base of the high bluffs of the southern Bull Mountain mesas. To the northwest, however, a slight dip in the rocks brings the coals down 100 feet or so below the bold bluffs of the northern mesas. These coal beds are in most places separated by only 15 to 20 feet of sandstone and a little shale. Accompanying the upper bed and lying upon it is generally a conspicuous dark-gray clay shale 20 to 30 feet thick. In places one or the other of the coal beds is of insignificant thickness, but as a rule the remaining bed is of value. Thus, in most parts of the southeastern portion of T. 6 N., R. 27 E., only one of the coal beds measures over 2 feet in thickness, and this, except locally, is the lower bed. In the northeastern portion of the township, however, both beds are regular and over 2 feet thick, the upper bed locally reaching a thickness of 3 feet 6 inches and the lower bed 3 feet 7 inches. In some localities one or the other of these beds is burned on the outcrop, in which case the horizon is marked by 10 to 12 inches of reddish to gray ashes.

Except in the southern part of T. 6 N., R. 27 E., the Bull Mountain coal beds may be reached with comparative ease, and springs of water are not far distant from the outcrop. The beds lie almost flat or rise a trifle to the southeast and the coals are of good character, but there is no development whatever.

At 45 to 60 feet above the Upper Bull Mountain coal bed a series of thin coal beds is exposed, chiefly in T. 6 N., R. 27 E. At least three beds of coal about 15 or 20 feet apart are represented, ranging in thickness from 4 inches to 1 foot 2 inches and exceptionally reaching 1 foot 10 inches. Most of the measurements were taken on the sides of the main divide in the eastern part of the township, but some were taken in secs. 9, 19, 29, and 30. The section below is representative of the mode of occurrence of these thin coal beds:

Coal beds in the NW. ¼ sec. 19, T. 6 N., R. 27 E. (No. 181).

	Ft.	in.
Coal		?
Shale	15	0
Coal		4
Shale	18	0
Coal		4
	33	8

Wescott coal bed (E).—It is doubtful if the Wescott coal bed should be given more prominence than some of the minor beds last described. It appeared in the field, however, as a consistently thicker and better coal and one that could be identified more readily from the associated rocks. It occurs about 100 feet above the Bull Mountain coal beds and, like the latter, appears in places to consist of two beds separated by 12 to 18 feet of rock. It is very generally present on the south side of the mountains from sec. 30 to sec. 34, T. 6 N., R. 27 E., where in one place it reaches a thickness of 2 feet 2 inches (No. 200, Pl. XIX, p. 122) and locally contains a thin parting and is accompanied by a thinner coal bed above.

On the whole this bed is of little present importance, for the best portions of it are difficult of access and probably will not be developed until most of the lower beds are exhausted.

Strait coal bed (D).—The Strait coal, together with the three overlying beds discussed below, outlines on the map the extent and shape of the Bull Mountain mesas. It lies about 200 feet above the Lower Bull Mountain coal bed and outcrops near the base of the mesa bluffs. The outcrop, therefore, is restricted chiefly to the three townships within which the mesas lie, namely, Tps. 6 and 7 N., R. 27 E., and T. 7 N., R. 26 E. A massive sandstone 30 to 40 feet thick in most places overlies this coal bed and forms a prominent protruding ledge or bench along the bluffs. In Eldridge Mesa the coal bed generally measures 2 feet or less in thickness, though at some places, especially in the southern half of the mesa, it is nearly 3 feet thick. Toward the northern mesas the coal thins to only a few inches. Consequently, around the northern mesas it is not deemed sufficiently important to be represented on the maps. The coal is badly cut by partings which range in thickness up to 6 inches, 1½ feet, and even 15 to 25 feet. In the latter places in reality it consists of two separate beds.

The Strait coal bed, especially its thicker portions in the southern two-thirds of the Eldridge Mesa, is everywhere more or less difficult of access. Owing to this and to its erratic character no development can be expected in the near future. In Eldridge Mesa the bed dips 1°–2° N., but in other mesas it lies nearly flat.

Red Butte coal bed (C).—The Red Butte bed lies 60 to 65 feet above the Strait bed (D) and has nearly the same distribution, outlining the main mesas of the Bull Mountains. In most places it is not well exposed, owing to the heavy talus fringing the steep bluffs of the mountains. Where uncovered, however, it measures as a rule 2 feet or less, rarely more. It is for the most part free from thick partings.

This coal bed and the others outcropping in the steep bluffs of the mountains are the least accessible beds in the field and therefore no doubt will be the last to be opened and mined. They lie practically flat, dipping perhaps slightly to the north or northwest.

Fattig coal bed (*B*).—The Fattig coal bed lies 35 or 40 feet above the Red Butte coal and outlines the Bull Mountain mesas in the same manner as the Red Butte. The Fattig coal bed is commonly thicker than the Red Butte, measuring 2 to 3 feet and being, as a rule, free from thick partings. In the northern part of Taylor Mesa it is exposed at but few places and its thickness in that locality is doubtful.

Summit coal bed (*A*).—At 35 or 40 feet above the Fattig coal bed lies the Summit or highest coal bed known in this field. Together with the Fattig and Red Butte beds it outlines the shape and extent of the large mesas which form the Bull Mountains. In general thickness the Summit coal bed resembles the Fattig, but the distribution of the thick areas is different. It presents, roughly speaking, less than 2 feet of coal in the southern portions of Eldridge and Taylor mesas and between 2 and 3 feet in the northern portions. In Bridges Butte, however, it is generally less than 2 feet.

Owing to its elevation this coal, like the Fattig and Red Butte, is among the least accessible coals of the field and undoubtedly will be the last to be developed. It lies nearly flat but has a slight dip north and northwest.

Near the crest of the Bull Mountains and averaging 70 feet above the Summit coal or 40 feet below the tops of the mesas occurs a mass of clinkers and brecciated rock, above which the rocks have been indurated and reddened for a vertical distance of about 30 feet. The shales resemble thin red tiles which bear the vivid impressions of plants and other fossils and give the prominent red color to the caps of the mesas in this region. This clinker bed doubtless marks a former coal bed of considerable thickness which, owing to the thin cover, has probably been burned throughout its extent.

PHYSICAL CHARACTER.

The coal of the Bull Mountain field is high-grade subbituminous. It is somewhat soft and is rather easily reduced to a fine granular mass by exposure to rain and sun. This disintegration is due to the escape of moisture and gases which in places may be detected by the odor for some distance from the outcrop. Although spontaneous combustion was nowhere observed it is believed to be entirely possible and to have been the cause of the burning of some of the beds.

Freshly broken coal generally presents a lustrous black surface on which the close observer may detect minute alternate layers of dullness and luster which indicate the bedding and are best seen on clean reflecting joint planes. The jointing of the coal in the earlier stages of disintegration results in more or less cubical fragments. As disintegration progresses, however, the cubes tend to break down along the bedding planes into small square plates. Bedding planes, however, are not the only and perhaps not the chief line of cleavage, the disintegration of the cubes being rather by conchoidal fracture. If the coals are rubbed against unglazed porcelain the resulting powder and streak range uniformly from blackish brown to black. The coal in the solid is apparently massive for the most part, but in mining it breaks into cubical, pentagonal, and hexagonal blocks, showing distinctly the presence of joints. In weathered coal the joints are very prominent. Commonly they are filled with thin plates of gypsum or selenite, but in some of the coals they contain small globules of amber-colored resin and small amounts of pyrite, the latter commonly distributed in thin flakes along the joint planes. Even the best coal of the region contains fragments of plants still brown and apparently unaffected by the carbonization which the coal beds have undergone. In coherence the coal is in some places tough and in others brittle and crumbly, depending on the stage of its weathering. The texture of the unweathered coal is dense and the specific gravity is low. The coal burns with a yellowish flame of moderate length and gives off a strong pungent odor of sulphur. The remaining ash is fine, grayish, and not inclined to be clinkery unless the coal is dirty.

CHEMICAL CHARACTER.

Twenty-seven samples for chemical analysis were collected in the Bull Mountain field. As shown by the table of analyses below the greater number of samples were collected from the most important beds. The Roundup bed is represented by nine analyses; the Mammoth by four; the Dougherty by three; the Carpenter, McCleary, Buckey, and Kuchta by two each; and the Homestead, Big Dirty, and Perry by one each. In order to ascertain the exact quality of the coal in this field an effort was made to collect only unweathered samples, but in many places, owing to the lack of developments, it was necessary to take somewhat weathered ones. The state of weathering is indicated in the notes following the table of analyses on pages 51–53. All of the samples for analysis were collected in a uniform manner and in compliance with specifications of the United States Geological Survey and the Bureau of Mines, as follows: A fairly fresh surface of the coal is chosen, across the face of which a perpendicular

channel of such size as to yield not less than 5 pounds for each foot of coal in the bed is cut from roof to floor. Partings more than three-eighths inch thick are discarded. An oilcloth is used to catch the coal as it falls from the channel and to exclude moisture and impurities. The coal is then crushed so that it will pass through a quarter-inch sieve, thoroughly mixed and quartered, and after opposite quarters are discarded the remainder is remixed. This process is continued until the sample is reduced to about 1 quart, which is sent in an air-tight can to the chemical laboratory to be analyzed.

Analyses of the samples were made under the direction of F. M. Stanton and A. C. Fieldner, formerly of the United States Geological Survey but now of the Bureau of Mines. The results of their work are given in the table following.

Analyses of coal samples from the Bull Mountain coal field.

Laboratory No.	Mine.	Bed.	Location.				No. on map.	Air drying loss.	Form of analysis.	Proximate.			Ash.	Ultimate.					Heating value.	
			Quarter.	Section.	T. N.	R. E.				Moisture.	Volatile matter.	Fixed carbon.		Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
6829	Local mine.....	Homestead...	.....	35	10	27	(a)	14.0	A	18.1	27.2	50.5	4.15	0.88	5.46	60.48	0.77	28.26	5,790	10,420
									B	4.8	31.7	58.7	4.82	1.02	4.54	70.32	.90	18.40	6,730	12,120
									C	.....	33.2	61.7	5.07	1.08	4.20	73.88	.94	14.83	7,070	12,730
									D	.....	35.0	65.0	.....	1.14	4.42	77.83	.99	15.62	7,750	13,410
8621	Surface outcrop...	Big Dirty.....	NW...	10	7	31	(a)	10.3	A	15.1	16.4	21.5	47.0	.17	.....	.....	.....	.....	2,140	3,850
									B	5.3	18.3	24.0	52.4	.19	.....	.....	.....	.....	2,385	4,300
									C	.....	19.3	25.3	55.4	.20	.....	.....	.....	.....	2,520	4,540
									D	.....	43.2	56.8	.....	.45	.....	.....	.....	.....	5,645	10,160
9130	.....do.....	Perry.....	NW...	16	5	31	13, Pl. XXXI.	23.3	A	29.7	29.0	37.2	4.1	.34	.....	.....	.....	.....	3,975	7,160
									B	8.3	37.8	48.5	5.4	.44	.....	.....	.....	.....	5,180	9,330
									C	.....	41.3	52.9	5.8	.48	.....	.....	.....	.....	5,650	10,170
									D	.....	43.8	56.2	.....	.51	.....	.....	.....	.....	6,000	10,800
7197	Robbins prospect.	Carpenter.....	SE....	17	9	30	6, Pl. XXXV.	13.5	A	22.8	27.0	45.6	4.65	.32	5.47	53.49	.93	35.14	4,925	8,860
									B	10.7	31.2	52.7	5.38	.37	4.59	61.84	1.08	26.74	5,695	10,250
									C	.....	35.0	59.0	6.02	.41	3.81	69.26	1.20	19.30	6,375	11,480
									D	.....	37.2	62.8	.....	.44	4.05	73.70	1.28	20.53	6,785	12,210
8466	Grants prospect..	.....do.....	NE...	26	9	30	9, Pl. XXXV.	18.7	A	28.7	25.6	39.3	6.4	.56	.....	.....	.....	.....	4,020	7,240
									B	12.3	31.5	48.4	7.8	.70	.....	.....	.....	.....	4,945	8,900
									C	.....	35.9	55.2	8.9	.79	.....	.....	.....	.....	5,640	10,150
									D	.....	39.4	60.6	.....	.87	.....	.....	.....	.....	6,195	11,150
8578	Surface prospect..	McCleary.....	NW...	32	8	31	13, Pl. XXXVI	9.5	A	20.7	26.5	46.3	6.5	.43	.....	.....	.....	.....	5,150	9,270
									B	12.4	29.3	51.1	7.2	.47	.....	.....	.....	.....	5,690	10,250
									C	.....	33.5	58.3	8.2	.54	.....	.....	.....	.....	6,495	11,690
									D	.....	36.5	63.5	.....	.59	.....	.....	.....	.....	7,075	12,740
8465	Mary McCleary and Anne Oker prospect.	.....do.....	SE....	26	9	30	14, Pl. XXXV.	19.3	A	29.4	25.4	38.8	6.4	.37	.....	.....	.....	.....	3,980	7,170
									B	12.5	31.4	48.1	8.0	.46	.....	.....	.....	.....	4,935	8,880
									C	.....	35.9	55.0	9.1	.52	.....	.....	.....	.....	5,635	10,150
									D	.....	39.5	60.5	.....	.57	.....	.....	.....	.....	6,205	11,170
5800	Prospect.....	Roundup.....	NE...	23	8	25	14, Pl. XIII...	2.7	A	12.7	28.7	50.9	7.70	.54	5.44	64.26	.88	21.18	6,130	11,030
									B	10.3	29.5	52.3	7.91	.56	5.28	66.04	.91	19.30	6,300	11,340
									C	.....	32.9	58.3	8.82	.62	4.62	73.60	1.01	11.33	7,020	12,640
									D	.....	36.1	63.9	.....	.68	5.06	80.72	1.11	12.43	7,700	13,860

a Not shown on map.

Analyses of coal samples from the Bull Mountain coal field—Continued.

Laboratory No.	Mine.	Bed.	Location.				No. on map.	Air drying loss.	Form of analysis.	Proximate.			Ash.	Ultimate.					Heating value.	
			Quarter	Section.	T. N.	R. E.				Moisture.	Volatile matter.	Fixed carbon.		Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
8803	Mine No. 1 of Republic Coal Co.	do	NW	24	8	25	16, Pl. XIII	6.5	A	13.4	28.1	52.3	6.2	.39					6,140	11,050
									B	7.4	30.0	56.0	6.6	.42					6,565	11,820
									C		32.4	60.4	7.2	.45					7,085	12,760
									D		34.9	65.1		.50					7,635	13,740
8802	Mine No. 2 of Republic Coal Co.	do	SE	36	8	25	17A, Pl. XIII	7.1	A	13.7	28.0	51.8	6.5	.46					6,210	11,180
									B	7.1	30.1	55.7	7.1	.49					6,685	12,040
									C		32.4	60.0	7.6	.53					7,195	12,950
									D		35.1	64.9		.57					7,785	14,020
17586	do	do	SE	36	8	25	17B, Pl. XIII	2.2	A	13.4	32.3	47.7	6.58	.39	5.59	63.89	.98	22.57	6,175	11,120
									B	11.5	33.1	48.7	6.73	.40	5.46	65.34	1.00	21.07	6,315	11,370
									C		37.4	55.0	7.60	.45	4.74	73.79	1.13	12.29	7,130	12,840
									D		40.4	59.6		.49	5.13	79.86	1.22	13.30	7,720	13,890
8801	Mine No. 3, or Commercial mine, of Roundup Coal Mining Co.	do	NW	23	8	25	13A, Pl. XIII	8.1	A	14.3	27.8	52.0	5.9	.48					6,135	11,050
									B	6.7	30.3	56.6	6.4	.52					6,675	12,020
									C		32.5	60.6	6.9	.56					7,160	12,890
									D		34.9	65.1		.60					7,690	13,840
17588	do	do	NW	23	8	25	13B, Pl. XIII	2.1	A	13.6	32.6	46.8	7.0	.58					6,105	10,990
									B	11.7	33.3	47.8	7.2	.59					6,235	11,220
									C		37.7	54.1	8.2	.67					7,065	12,710
									D		41.1	58.9		.73					7,690	13,840
17587	Mine No. 4 of Davis Coal Co.	do	SE	17	8	26	2B, Pl. XVII	3.4	A	14.5	31.5	47.5	6.5	.80					5,750	10,350
									B	11.6	32.6	49.1	6.7	.83					5,950	10,710
									C		36.9	55.5	7.6	.94					6,725	12,110
									D		39.9	60.1		1.02					7,280	13,100
17589	Keene mine of the Pine Creek Coal Mining Co.	do	NE	28	8	25	6B, Pl. XIII	2.0	A	13.4	33.2	45.6	7.8	.51					6,050	10,890
									B	11.7	33.9	46.5	7.9	.52					6,175	11,120
									C		38.3	52.7	9.0	.59					6,990	12,590
									D		42.1	57.9		.65					7,685	13,830
6235	Bore hole	do			6	26	(a)	13.7	A	18.4	23.3	39.1	19.2	.31					4,800	8,640
									B	5.4	27.0	45.3	22.3	.34					5,560	10,010
									C		28.6	47.8	23.6	.38					5,875	10,580
									D		37.4	62.6		.50					7,690	13,800

7195	Prospect of W. C. Grant.	Buckey.....	NE...	29	8	29	18, Pl. XXIX.	7.2	A	16.7	27.8	48.1	7.42	1.00	5.61	59.22	.97	25.78	5,680	10,230
									B	10.2	30.0	51.8	7.99	1.08	5.18	63.32	1.04	20.89	6,120	11,020
									C	.....	33.4	57.7	8.90	1.20	4.51	71.06	1.16	13.17	6,815	12,270
									D	.....	36.7	63.3	.....	1.32	4.95	78.00	1.27	14.46	7,485	13,470
8464	Surface prospect..	.....do.....	NW...	36	9	30	35, Pl. XXXV.	11.1	A	18.4	28.4	44.1	9.11	1.60	6.01	53.68	.80	28.80	5,180	9,320
									B	8.2	31.9	49.6	10.25	1.80	5.38	60.38	.90	21.29	5,825	10,490
									C	.....	34.8	54.0	11.16	1.96	4.86	65.78	.98	15.26	6,345	11,430
									D	.....	39.2	60.8	.....	2.21	5.47	74.04	1.10	17.18	7,145	12,860
8467	Kuchta prospect..	Kuchta.....	SW...	28	9	30	53, Pl. XXXV.	19.3	A	28.6	27.8	36.5	7.1	.67	.....	.....	.....	.....	3,950	7,110
									B	11.5	34.4	45.2	8.9	.83	.....	.....	.....	.....	4,895	8,820
									C	.....	38.9	51.1	10.0	.94	.....	.....	.....	.....	5,535	9,960
									D	.....	43.2	56.8	.....	1.03	.....	.....	.....	.....	6,155	11,080
9129	Todd mine.....	.....do	Lot 23.	2	8	29	108 Pl. XXIX.	14.8	A	20.7	28.6	44.7	6.0	.79	.....	.....	.....	.....	5,410	9,740
									B	6.9	33.6	52.4	7.1	.93	.....	.....	.....	.....	6,350	11,430
									C	.....	36.1	56.3	7.6	1.00	.....	.....	.....	.....	6,820	12,280
									D	.....	39.1	60.9	.....	1.08	.....	.....	.....	.....	7,385	13,290
5798	Surface prospect..	Dougherty....	NW...	36	6	26	36, Pl. XV....	3.2	A	17.0	30.8	39.6	12.6	.49	.....	.....	.....	.....	4,775	8,600
									B	14.2	31.8	40.9	13.1	.51	.....	.....	.....	.....	4,935	8,880
									C	.....	37.1	47.7	15.2	.59	.....	.....	.....	.....	5,750	10,350
									D	.....	43.7	56.3	.....	.70	.....	.....	.....	.....	6,785	12,210
5801	.....do	.....do	NE...	27	6	26	31, Pl. XV....	3.6	A	16.9	33.1	39.1	10.9	.34	.....	.....	.....	.....	4,640	8,350
									B	13.8	34.3	40.6	11.3	.35	.....	.....	.....	.....	4,815	8,660
									C	.....	39.8	47.1	13.1	.41	.....	.....	.....	.....	5,585	10,050
									D	.....	45.8	54.2	.....	.47	.....	.....	.....	.....	6,425	11,570
6830	Cow Gulch prospect.	.....do	SE....	10	6	28	26, Pl. XXIII.	16.3	A	21.6	30.5	43.0	4.9	.72	.....	.....	.....	.....	5,010	9,020
									B	6.3	36.4	51.4	5.9	.86	.....	.....	.....	.....	5,985	10,770
									C	.....	38.8	54.9	6.3	.92	.....	.....	.....	.....	6,385	11,500
									D	.....	41.5	58.5	.....	.98	.....	.....	.....	.....	6,815	12,270
5797	Surface prospect..	Mammoth....	SW...	30	6	27	8, Pl. XIX....	4.3	A	24.6	32.9	27.9	14.61	.41	4.83	41.41	.69	38.05	3,450	6,210
									B	21.2	34.3	29.2	15.27	.43	4.54	43.27	.72	35.77	3,605	6,490
									C	.....	43.6	37.0	19.37	.54	2.78	54.92	.91	21.48	4,575	8,230
									D	.....	54.1	45.9	.....	.67	3.45	68.11	1.13	26.64	5,675	10,210
5799	.....do	.....do	SW...	30	6	27	8, Pl. XIX....	3.0	A	17.4	31.2	45.1	6.34	.49	5.45	59.00	.89	27.83	5,625	10,120
									B	14.9	32.1	46.5	6.54	.50	5.28	60.82	.92	25.94	5,795	10,430
									C	.....	37.7	54.6	7.68	.59	4.25	71.47	1.08	14.93	6,810	12,260
									D	.....	40.9	59.1	.....	.64	4.60	77.42	1.17	16.17	7,380	13,280
6828	Surface prospect, Douglas camp.	.....do	NW...	10	6	28	73, Pl. XXIII.	14.8	A	18.7	29.6	46.6	5.1	.78	.....	.....	.....	.....	5,495	9,890
									B	4.5	34.8	54.7	6.0	.92	.....	.....	.....	.....	6,450	11,610
									C	.....	36.4	57.3	6.3	.96	.....	.....	.....	.....	6,755	12,160
									D	.....	38.9	61.1	.....	1.02	.....	.....	.....	.....	7,210	12,980
6831	.....do	.....do	NW...	10	6	28	73, Pl. XXIII.	12.9	A	17.4	31.2	48.1	3.3	.35	.....	.....	.....	.....	5,710	10,280
									B	5.2	35.8	55.2	3.8	.40	.....	.....	.....	.....	6,360	11,800
									C	.....	37.7	58.3	4.0	.42	.....	.....	.....	.....	6,915	12,450
									D	.....	39.3	60.7	.....	.44	.....	.....	.....	.....	7,205	12,970

[a] Not shown on map.

6829. Sample from Homestead coal bed in Lance formation, from a local mine in sec. 35, T. 10 N., R. 27 E., about 12 miles northwest of Musselshell; collected in regular manner by R. W. Richards in 1908. The bed is 4 feet 5 inches thick and contains partings of bone and shale. The sample represents only the upper bench of coal, which is 1 foot 3 inches thick. (See Bureau of Mines Bull. 22, pt. 1, p. 132; pt. 2, p. 620, 1913; U. S. Geol. Survey Bull. 381, pp. 66, 79, 1910.)

8621. Sample from Big Dirty coal bed in Lebo shale member of the Fort Union formation, from surface outcrop in the NW. ¼ sec. 10, T. 7 N., R. 31 E.; collected by C. T. Lupton and H. Hinds on August 2, 1909. The bed is 15 to 16 feet thick, all of which was sampled. The coal was badly weathered. Partings of shale, sandstone, and bone are numerous, but none were discarded in sampling. (See Bureau of Mines Bull. 22, pt. 1, p. 137; pt. 2, pp. 637–638, 1913; U. S. Geol. Survey Bull. 431, pp. 182, 186, 1911.)

9130. Sample from Perry coal bed in the upper part of the Fort Union formation, from surface outcrop on Buffalo Creek (No. 13, Pl. XXXI), in the NW. ¼ sec. 16, T. 5 N., R. 31 E., 15 miles northwest of Custer; collected in regular manner by C. T. Lupton on September 14, 1909. The thickness of the bed is 2 feet, all of which was sampled. The coal was badly weathered. (See Bureau of Mines Bull. 22, pt. 1, p. 137; pt. 2, p. 637, 1913; U. S. Geol. Survey Bull. 431, p. 186, 1911.)

7197. Sample from Carpenter coal bed in the upper part of the Fort Union formation, from the Robbins prospect (No. 6, Pl. XXXV) on Carpenter Creek, in the SE. ¼ sec. 17, T. 9 N., R. 30 E., 6 miles east of Musselshell; collected in regular manner by R. W. Richards in 1908. Sample was taken about 75 feet south from mouth of entry under about 25 feet of cover. The thickness at the point of sampling is 5 feet 5 inches, of which 4 feet 6 inches is included in sample. A 2-inch parting 11 inches above the base of the bed was discarded and 9 inches was left at the roof. The coal was somewhat weathered. (See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 633, 1913; U. S. Geol. Survey Bull. 381, pp. 69, 79, 1910; Bull. 431, p. 186, 1911.)

8466. Sample from Carpenter coal bed in the upper part of the Fort Union formation, from Grants prospect (No. 9, Pl. XXXV) on a branch of Carpenter Creek, in the NE. ¼ sec. 26, T. 9 N., R. 30 E., 9 miles east of Musselshell; collected in regular manner by C. T. Lupton on July 5, 1909. (See Pl. VII, *A*.) Sample was taken from face of coal about 15 feet from mouth of prospect under about 10 feet of cover. The thickness of bed at point sampled is 8 feet 2 inches, of which 7 feet 10½ inches was included in sample. Two partings of shale and bone near the middle were discarded. The coal was weathered. (See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 634, 1913; U. S. Geol. Survey Bull. 431, pp. 179, 186, 1911.)

8578. Sample from McCleary coal bed of the upper part of the Fort Union formation, from surface prospect on Alkali Creek, in the NW. ¼ sec. 32, T. 8 N., R. 31 E. (No. 13, Pl. XXXVI), 2 miles north of Wolf Spring; collected in regular manner by C. T. Lupton on July 30, 1909. Sample was taken from face of coal at surface. The thickness of the bed is 4 feet 11 inches, of which 4 feet 2 inches was sampled. This consists of the two upper benches, separated by half an inch of shale. The coal was badly weathered. (See Bureau of Mines Bull. 22, pt. 1, p. 137; pt. 2, p. 638, 1913; U. S. Geol. Survey Bull. 431, p. 185, 1911.)

8465. Sample from the McCleary coal bed of the upper part of the Fort Union formation, in the Mary McCleary and Anne Oker prospect on a branch of Carpenter Creek, in the SE. ¼ sec. 26, T. 9 N., R. 30 E. (No. 14, Pl. XXXV), 9½ miles east of Musselshell; collected by C. T. Lupton on July 15, 1909. Sample was taken from face of coal 50 feet southwest from mouth of drift, under about 10 to 15 feet of cover. The thickness of the bed at this place is 3 feet 7 inches, all of which was included in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 635, 1913; U. S. Geol. Survey Bull. 431, pp. 175, 185, 1911.)

5800. Sample from the Roundup coal bed of the upper part of the Fort Union formation, from a prospect in the NE. ¼ sec. 23, T. 8 N., R. 25 E. (No. 14, Pl. XIII); collected by R. W. Richards in 1908. The bed at this place has a rather persistent roof of heavy sandstone. It is 4 feet thick and contains two thin partings, one of sandstone and the other of shale. The sample represents the full thickness of coal. (See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 631, 1913; U. S. Geol. Survey Bull. 381, p. 79, 1910.)

8803. Sample from the Roundup coal bed of the upper part of the Fort Union formation, from mine No. 1 of the Republic Coal Co., in the NW. ¼ sec. 24, T. 8 N., R. 25 E. (No. 16, Pl. XIII); collected in regular manner by C. T. Lupton, August 6, 1909. The sample was taken from face of coal about 800 feet east of the foot of the shaft. The thickness of the bed at this place is 5 feet 8½ inches, all of which was included in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 137; pt. 2, p. 636, 1913; U. S. Geol. Survey Bull. 471, p. 643, 1912.)

8802. Sample from the Roundup coal bed of the upper part of the Fort Union formation from mine No. 2 of the Republic Coal Co. (No. 17A, Pl. XIII), in the SE. ¼ sec. 36, T. 8 N., R. 25 E., at the town of Klein, 3 miles south of Roundup; collected in regular manner by C. T. Lupton, August 6, 1909. The sample was taken from face of coal about 500 feet northwest of the foot of the main shaft. The thickness of the bed at this place is 5 feet 8 inches, all of which is included in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 137; pt. 2, p. 636, 1913; U. S. Geol. Survey Bull. 471, p. 643, 1912.)

17586. Sample from Roundup coal bed of the upper part of the Fort Union formation, from mine No. 2 of the Republic Coal Co. (No. 17B, Pl. XIII), in the SE. ¼ sec. 36, T. 8 N., R. 25 E., at the town of Klein, 3 miles south of Roundup; collected in regular manner by C. T. Lupton, July 21, 1913. The sample was taken from face of coal about 800 feet east of the foot of the main shaft. The thickness of the bed at this place is 5 feet 10 inches, with 1 inch of bone about 1 foot 6 inches from the base. The entire bed is included in the sample.

8801. Sample from the Roundup coal bed of the upper part of the Fort Union formation, from mine No. 3 or the Commercial mine of the Roundup Coal Mining Co. (No. 13A, Pl. XIII), in the NW. ¼ sec. 23, T. 8 N., R. 25 E., 1 mile west of Roundup; collected in regular manner by C. T. Lupton, August 6, 1909. The sample was taken from face of coal in room 25 off west entry No. 1. The thickness of the bed at this place is 5 feet 8 inches, all of which is included in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 133; pt. 2, p. 621, 1913; U. S. Geol. Survey Bull. 471, p. 643, 1912.

17588. Sample from the Roundup coal bed of the upper part of the Fort Union formation, from mine No. 3 of the Roundup Coal Mining Co. (No. 13B, Pl. XIII), in the NW. ¼ sec. 23, T. 8 N., R. 25 E., about a mile west of Roundup; collected in regular manner by C. T. Lupton, July 21, 1913. Sample was taken from face of coal about 3,000 feet west from the mine mouth. The thickness of the bed at this place is 5 feet 8 inches, all of which is represented in the sample.

17587. Sample from the Roundup coal bed of the upper part of the Fort Union formation in mine No. 4 of the Davis Coal Co. (No. 2B, Pl. XVII), in the SE. ¼ sec. 17, T. 8 N., R. 26 E., about 2½ miles east of Roundup; collected in regular manner by C. T. Lupton, July 21, 1913. Sample was taken from face of coal about 3,000 feet S. 5° W. from mine mouth. The thickness of the bed at this place is 3 feet 6 inches, all of which was included in the sample with the exception of a bone parting 2 inches thick and 2 inches below the top of the bed.

17589. Sample from Roundup coal bed of the upper part of the Fort Union formation from the Keene mine of the Pine Creek Coal Mining Co. (No. 6B, Pl. XIII), in the NE. ¼ sec. 28, T. 8 N., R. 25 E., 3 miles southwest of Roundup.; collected in regular manner by C. T. Lupton, July 19, 1913. Sample was taken from face of

coal about 500 feet northeast from mine mouth. The thickness of the bed at this place is 3 feet, all of which is represented in the sample.

6235. Sample from Roundup coal bed of the upper part of the Fort Union formation, from a bore-hole sample in T. 6 N., R. 26 E. The sample represents the full thickness of the bed. (See U. S. Geol. Survey Bull. 381, p. 79, 1910.)

7195. Sample from the Buckey coal bed of the upper part of the Fort Union formation from the Grant prospect on Fishel Creek, in the NE. ¼ sec. 29, T. 8 N., R. 29 E. (No. 18, Pl. XXIX), 8 miles south of Musselshell; collected in regular manner by R. W. Richards in 1908. The sample was taken from face of entry about 100 feet from the mouth of the prospect. The sample represented 2½ feet of coal, overlain by about 3 inches of bone and 33 feet of sandstone. (See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 633, 1913; U. S. Geol. Survey Bull. 381, p. 79, 1910.)

8464. Sample from the Buckey coal bed of the upper part of the Fort Union formation, from an outcrop (No. 35, Pl. XXXV), in the NW. ¼ sec. 36, T. 9 N., R. 30 E., about 10 miles east of Musselshell; collected by H. Hinds, July 15, 1909. The sample was slightly weathered and was collected from an open face near the surface. The thickness of the bed at this place is 1 foot 2 inches, all of which is represented in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 137; pt. 2, p. 635, 1913; U. S. Geol. Survey Bull. 431, pp. 173, 185, 1911.)

8467. Sample from the Kuchta coal bed of the upper part of the Fort Union formation, from the Kuchta prospect (No. 53, Pl. XXXV), in the SE. ¼ sec. 28, T. 9 N., R. 30 E., 7 miles east of Musselshell; collected in regular manner by H. Hinds on July 5, 1909. Sample was taken from face of coal 15 feet from mouth of prospect and was slightly weathered. The thickness of the bed at this place is 2 feet 8 inches, of which the upper 4 inches is bony and was excluded from the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 634, 1913; U. S. Geol. Survey Bull. 431, pp. 172, 185, 1911.)

9129. Sample from the Kuchta coal bed of the upper part of the Fort Union formation, from mine of Neborvig & Todd, on Hawk Creek, in lot 23, sec. 2, T. 8 N., R. 29 E. (No. 108, Pl. XXIX), about 4 miles southeast of Musselshell; collected in regular manner by H. Hinds on August 8, 1909. Sample was taken from face of coal 30 feet northeast from mine mouth. The thickness of the bed at this place is 2 feet 6½ inches, all of which was represented in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 633, 1913; U. S. Geol. Survey Bull. 431, pp. 173, 185, 1911.)

5798. Sample from the Dougherty coal bed of the upper part of the Fort Union formation, from a prospect (No. 36, Pl. XV) in the NW. ¼ sec. 36, T. 6 N., R. 26 E., 3 miles northeast of Buckey; collected in regular manner by L. H. Woolsey in 1907. The sample was taken at the surface and was badly weathered. The thickness of the bed is 2 feet 8 inches, of which the upper 9 inches contains layers of bone. All of the bed was represented in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 135; pt. 2, p. 630, 1913; U. S. Geol. Survey Bull. 341, p. 74, 1909.)

5801. Sample from the Dougherty coal bed of the upper part of the Fort Union formation, from a prospect (No. 31, Pl. XV), in the NE. ¼ sec. 27, T. 6 N., R. 26 E., 3½ miles north of Buckey; collected in regular manner by R. W. Richards in 1907. Sample was taken near the outcrop and was badly weathered. The thickness of the bed is 2 feet, all of which was represented in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 135; pt. 2; p. 631, 1913; U. S. Geol. Survey Bull. 341, p. 74, 1909.)

6830. Sample from Dougherty coal bed of the upper part of the Fort Union formation, from Cow Gulch prospect (No. 26, Pl. XXIII), in the SE. ¼ sec. 10, T. 6 N., R 28 E.; collected in regular manner by R. W. Richards in 1908. The thickness of the bed at this place is 4 feet 11½ inches with a shale parting 1 inch thick and 1½ inches

below the top. All of the bed except the shale parting was represented in the sample. (See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 632, 1913; U. S. Geol. Survey Bull. 381, pp. 74, 79, 1910.)

5797 and 5799. Two samples taken from the Mammoth and Rehder coal beds of the upper part of the Fort Union formation, from a prospect in the SW. ¼ sec. 30, T. 6 N., R. 27 E. (No. 8, Pl. XIX), 4½ miles northeast of Buckey; collected in regular manner by L. H. Woolsey in 1907. The total thickness of the bed at this place is about 8½ feet. Sample No. 5797 was taken from the upper part of the bed, which is 1 foot 5 inches thick and represents badly weathered coal, including two thin partings of shale. Sample No. 5799 was taken from the lower bench, which is about 7 feet thick and was only slightly weathered. This lower part includes a thin parting of shale. (See Bureau of Mines Bull. 22, pt. 1, p. 135; pt. 2, p. 631, 1913; U. S. Geol. Survey Bull. 341, p. 74, 1909.)

6828 and 6831. Samples taken from the Mammoth coal bed of the upper part of the Fort Union formation, from a surface outcrop at Douglas camp on Cow Gulch (No. 73, Pl. XXIII), in the NW. ¼ sec. 10, T. 6 N., R. 28 E.; collected in regular manner by R. W. Richards in 1908. The following is a detailed section of the bed exposed at this place and shows the parts of the bed included in each sample:

Sections of coal bed at Douglas Camp on Cow Gulch.

Laboratory No.	6828	6831
Rehder coal bed:	*Ft. in.*	*Ft. in.*
Coal		2 6
Coal	8 6	[a]6 0
Shale	3	3
Sandstone	2 0	2 0
Shale	6	6
Sandstone, gray	10 0	10 0
Shale	6	6
Mammoth coal bed:		
Coal	[a]2 0	2 0
Shale	1 0	1 0
Coal	[a]3 0	3 0
Thickness of bed	27 9	27 9
Thickness of coal sampled	5 0	6 0

[a] Included in sample.

(See Bureau of Mines Bull. 22, pt. 1, p. 136; pt. 2, p. 632, 1913: U. S. Geol. Survey Bull. 381, pp. 75, 79 1910.)

In the table the analyses are given in four forms, marked A, B, C, and D. Analysis A represents the composition of the sample as it comes from the mine. This form is not well suited for the comparison of one coal with another, for the amount of moisture in the sample as it comes from the mine is largely a matter of accident and consequently analyses of different samples of the same coal expressed in this form may vary widely. Analysis B represents the sample after it has been dried at a temperature a little above normal until its weight becomes constant. This form of analysis is best for comparing one coal with another. Analysis C represents the coal after all the moisture has been eliminated. Analysis D represents the coal after all moisture and ash have been theoretically removed. This is supposed to represent the true coal substance free from the most signifi-

cant impurities. Forms C and D are obtained from the others by recalculation.

In the analytical work chemists generally recognize that it is not possible to determine the proximate constituents of coal with the same degree of accuracy as the ultimate constituents. Therefore, the air-drying loss, moisture, volatile matter, fixed carbon, and ash are given to one decimal place only. In the ultimate analysis the ash, sulphur, hydrogen, carbon, nitrogen, and oxygen are given to two decimal places. It is also understood that calorific determinations to individual units are not reliable. Therefore, in the column headed "Calories," the heat values are given to the nearest five units and in the column headed "British thermal units" they are given to the nearest ten (the value of a British thermal unit being about one-half that of a calorie).

The analyses in the above table differ more widely in their proximate constituents and in heat units indicated by both calories and British thermal units than perhaps should be expected from coals of the same field having very similar physical characters and occurring under the same conditions. These differences are probably due to different stages in the deterioration or weathering of the coals due to their exposure to air, sun, and moisture. The only samples that are strictly fresh were obtained from working mines or "country banks." Those obtained from surface prospects or mines not recently operated are necessarily somewhat weathered, and a careful comparison of the table of analyses with the description of the locality and character of the sample which follows shows that practically in every case where the heating quality of the coal is low the sample was collected from a prospect or mine where the coal was weathered.

In the discussion which follows, all samples given in the above table have been considered except laboratory No. 8621, which was collected from a surface prospect on the Big Dirty coal bed, and includes not only thin streaks of coal but the alternating partings of shale, bone, and sandstone. This is indicated by the high percentage of ash, which makes up more than half the sample (52.4 per cent on the air-dried basis). The following comparisons are made on the air-dried basis: The moisture in 26 samples ranges from 4.05 per cent (laboratory No. 6828) to 21.02 per cent (laboratory No. 5797) and averages 10.0 per cent. The volatile matter in the same samples and on the same basis ranges from 27.0 per cent (laboratory No. 6235) to 37.8 per cent (laboratory No. 9130) and averages 32.4 per cent. The average of fixed carbon in 26 samples is 49.3 per cent and the variation is from 29.2 per cent (laboratory No. 5797) to 58.7 (laboratory No. 6829). The ash has a much greater range proportion-

ately, being from 3.8 per cent (laboratory No. 6831) to 22.3 per cent (laboratory No. 6235); the average, however, is only 8.2 per cent. The sulphur content is fairly constant, ranging from 0.34 per cent (laboratory No. 6235) to 1.80 per cent (laboratory No. 8464), the average being 0.64 per cent. In heating value the coals of the Bull Mountain field range from 6,490 British thermal units (laboratory No. 5797) to 12,120 British thermal units (laboratory No. 6829), the average being 10,450. As has been stated elsewhere in this report, it is firmly believed that all of the coal when unweathered contains practically the same heat content as do the coals from the working mines, which have approximately 12,000 British thermal units.

The comparison of the calories is not given because there is a direct relation between the calories and British thermal units, which are given.

AREA AND TONNAGE.

In making the following estimates of area and tonnage of coal in the Bull Mountain field the same data and, in a large measure, the same methods of computation were used as in the classification and valuation of the coal underlying the public lands. The accuracy of the results obtained must necessarily vary within wide limits in different parts of the field and for different beds. Where the coal beds are well exposed and numerous sections were measured along the outcrop the tonnage can be computed with comparatively accurate results, especially where the outcrop can be studied all the way around some central area, such as the Bull Mountain mesas. Where, on the other hand, the outcrops of the beds are obscured by grass or talus-covered slopes, or where the coal has been burned at the outcrop, the thickness of the bed and, as a result, the tonnage can only be estimated. In preparing the following estimates only those coal beds were taken into consideration which have a thickness of 1 foot 2 inches or more.

The number of cubic feet of coal in a given area is easily calculated after the thickness of the bed is determined. The specific gravity of the coal is assumed to be approximately 1.3. On this basis the number of tons in a bed 1 foot thick and 1 acre in extent is a little less than 1,800. The number of tons of coal underlying an area is as follows:

Area in acres × thickness in feet × 1,800 = number of tons.

The following table represents approximately the total tonnage in each township. The percentage which can be recovered in mining varies within wide limits. The average under present mining conditions is about 60 per cent of the total.

Estimate of area and tonnage of coal in the Bull Mountain coal fields, Montana.

Township.	Area classified as coal land.	Tonnage.	Township.	Area classified as coal land.	Tonnage.
	Acres.			*Acres.*	
T. 5 N., R. 25 E	2,800	6,990,000	T. 5 N., R. 29 E	720	1,300,000
T. 6 N., R. 25 E	4,860	14,660,000	T. 6 N., R. 29 E	13,680	36,510,000
T. 7 N., R. 25 E	9,880	35,780,000	T. 7 N., R. 29 E	14,900	96,150,000
T. 8 N., R. 25 E	8,320	81,320,000	T. 8 N., R. 29 E	24,780	213,810,000
T. 5 N., R. 26 E	5,490	22,110,000	T. 9 N., R. 29 E	15,560	158,760,000
T. 6 N., R. 26 E	23,190	217,400,000	T. 5 N., R. 30 E	9,800	29,020,000
T. 7 N., R. 26 E	22,960	359,250,000	T. 6 N., R. 30 E	3,960	7,160,000
T. 8 N., R. 26 E	12,320	99,840,000	T. 7 N., R. 30 E	16,820	73,600,000
T. 5 N., R. 27 E	13,840	106,880,000	T. 8 N., R. 30 E	26,690	355,330,000
T. 6 N., R. 27 E	23,020	722,650,000	T. 9 N., R. 30 E	9,860	158,280,000
T. 7 N., R. 27 E	24,350	364,100,000	T. 5 N., R. 31 E	5,320	11,490,000
T. 8 N., R. 27 E	11,300	47,850,000	T. 6 N., R. 31 E	2,000	6,170,000
T. 5 N., R. 28 E	8,760	34,650,000	T. 7 N., R. 31 E	2,120	9,480,000
T. 6 N., R. 28 E	23,040	342,600,000	T. 8 N., R. 31 E	15,338	170,320,000
T. 7 N., R. 28 E	23,810	182,850,000	T. 9 N., R. 31 E	810	7,190,000
T. 8 N., R. 28 E	17,840	70,880,000			
T. 9 N., R. 28 E	7,040	28,980,000		405,178	4,073,360,000

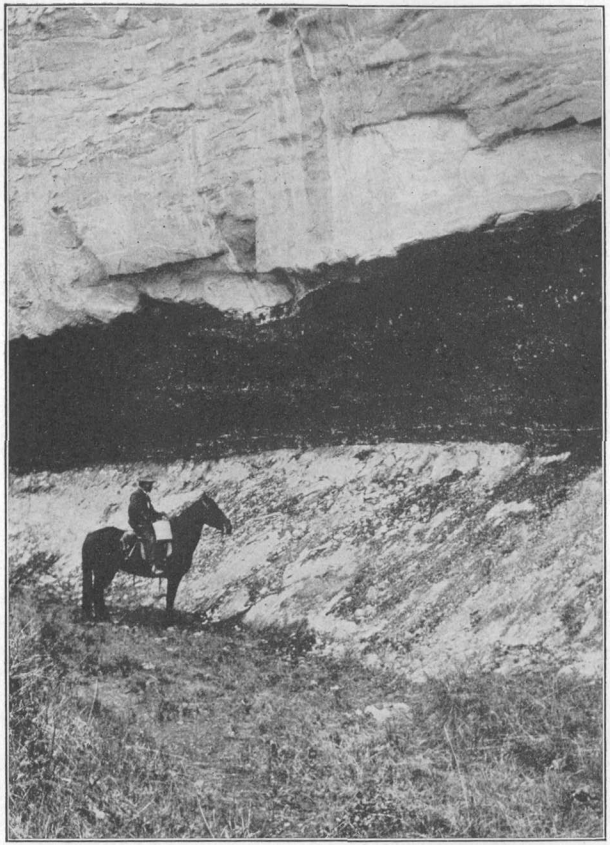
DEVELOPMENT.

COMMERCIAL MINES.

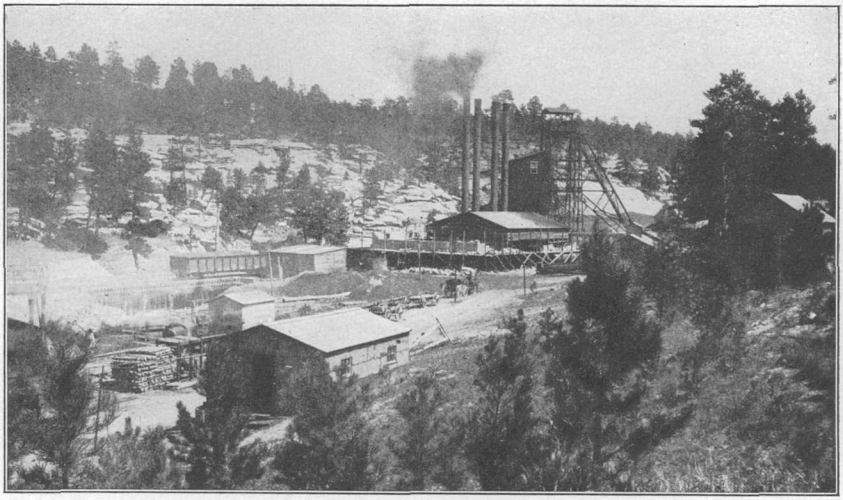
Coal mining on a commercial scale in the Bull Mountain field is at present restricted to the Roundup bed in the northwestern part of the field, on Musselshell River and a branch of Halfbreed Creek and the Carpenter bed on Carpenter Creek in the northeast part of the field. The thriving towns of Roundup and Klein, each with about 1,500 inhabitants, indicate the rapid development of the coal-mining industry. Coal of good quality was known in the Bull Mountains early in the eighties, and at that time a carload of coal was mined, presumably at the old Northern Pacific mines in sec. 23, T. 6 N., R. 27 E., and shipped to Anaconda. Commercial mining was not begun, however, until 1907, when the Republic Coal Co. attempted to work the Roundup bed by means of a slope extending under Musselshell River. The cover, consisting mainly of alluvium, permitted the entrance of great quantities of water and rendered the plan unfeasible. Then a shaft, intended originally for an air shaft on the south side of the river (No. 16, Pl. XIII, p. 80), was enlarged and used as the main shaft. The bed was reached at a depth of 137 feet and found to contain a little less than 6 feet of clean coal. The room and pillar method of mining was used. This mine was abandoned about 1912.

In September, 1908, the Roundup Coal Mining Co. opened its mine No. 3 (sometimes called mine A or Commercial mine) (see Pl. XI, *B*), about a mile west of Roundup (No. 13, Pl. XIII), on the Roundup bed. This mine has been in continuous operation ever since and has been one of the most consistent producers of the field. The room and pillar method of mining is used and the coal is brought

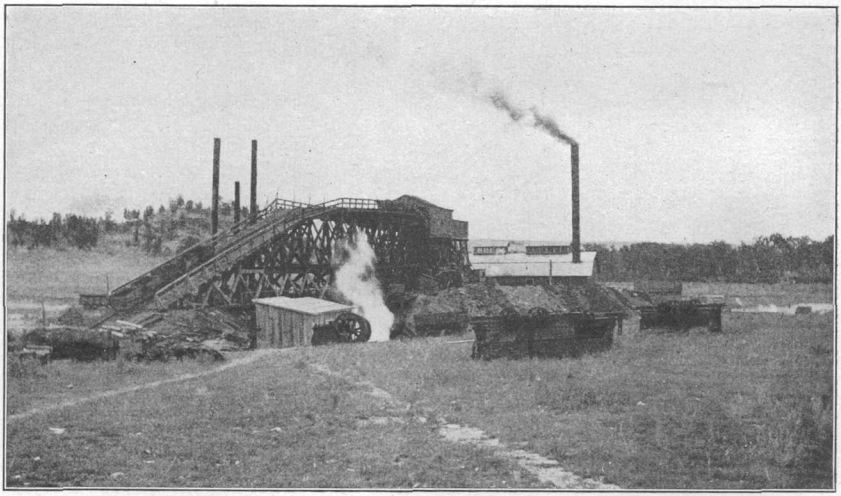
A. MAMMOTH (K) AND REHDER (J) COAL BEDS ON SOUTH SIDE OF GULCH AT DOUGLAS CAMP, IN THE NW. ¼ SEC. 10, T. 6 N., R. 28 E.



B. REHDER (J) COAL BED ON NORTH SIDE OF GULCH AT DOUGLAS CAMP.



A. POWER HOUSE AND TIPPLE AT MINE NO. 2 OF REPUBLIC COAL CO., AT KLEIN, IN SEC. 36, T. 8 N., R. 25 E.



B. TIPPLE AT COMMERCIAL (NO. 3) MINE OF ROUNDUP COAL MINING CO., ABOUT A MILE WEST OF ROUNDUP, IN SEC. 23, T. 8 N., R. 25 E.

to the surface by a hoist up a slope. In 1909 this mine produced 193,530 tons, and its annual production now closely approaches 400,000 tons.

The Republic Coal Co. opened its mine No. 2 (see Pl. XI, *A*) on the Roundup coal bed near the center of sec. 36, T. 8 N., R. 25 E. (No. 17, Pl. XIII), in March, 1909. Since that time the town of Klein, with about 1,500 inhabitants, has grown up around the mine. A shaft 347 feet deep connects the surface with the coal bed, which is a little less than 6 feet thick. In 1909 this mine produced 84,082 tons, but at present it is producing annually 300,000 to 400,000 tons.

The Davis Coal Co. in 1909 opened a mine generally known as No. 4, in the SE. ¼ sec. 17, T. 8 N., R. 26 E. (No. 2, Pl. XVII, p. 102), on the south side of the river. The daily output in July, 1913, was 500 to 600 tons. This mine was abandoned in the early part of 1914, and it is reported that the equipment was moved to Carpenter Creek in the northeastern part of the field.

The Keene mine, now owned by the Pine Creek Coal Mining Co., is in the NE. ¼ sec. 28, T. 8 N., R. 25 E. (No. 6, Pl. XIII, p. 80). The maximum daily output is reported to be about 250 tons. A short spur, about one-half mile in length, has been built from the railroad to the mine.

The Carpenter Creek Coal Co.'s mine (No. 7, Pl. XXXV, p. 198), in the NE. ¼ sec. 20, T. 9 N., R. 30 E., was put in operation during the summer and autumn of 1913, a prospect shaft having been sunk about 1908. It has been producing 600 to 700 tons daily during the winter each year since. A railroad spur 2 or 3 miles long connects it with the main line of the Chicago, Milwaukee & St. Paul Railway near Japan. The coal is brought to the surface through a shaft 138 feet deep, which cuts both the McCleary and Carpenter beds. The former is 2 feet 10 inches thick and is 83 feet below the surface, and the latter, which is the bed being mined, is reported to consist of 8 feet of clean coal broken by a 2-inch clay parting. It was impossible to measure these beds at the time the field was examined (1909) as the shaft was full of water.

COUNTRY BANKS AND PROSPECTS.

A small country bank has been opened recently on the Roundup coal bed in the SE. ¼ sec. 28, T. 8 N., R. 25 E. (No. 5, Pl. XIII, p. 80), by John Davis. The output is small and is sold entirely for domestic use to local ranchers.

A prospect drift about 50 feet in length has been made on the Roundup bed in Berrigan Coulee (No. 6, Pl. XVII, p. 102) in the NW. ¼ sec. 22, T. 8 N., R. 26 E. The coal at this place is reported to be 1 foot 10 inches thick, underlain by 1 foot 4 inches of bone.

In T. 6 N., R. 26 E., two small prospects have been opened. One of these is approximately in the SW. ¼ sec. 9 (No. 41, Pl. XV, p. 90) on the Dougherty coal bed, and the other is in the NW. ¼ sec. 36 (No. 36, Pl. XV) on the same bed. Very little coal has been removed from these prospects.

In the NE. ¼ sec. 30, T. 8 N., R. 27 E., a shaft has been sunk in order to determine if the Roundup bed is of value in that locality. The results are reported to show that it is not of economic importance.

The old Northern Pacific mines, situated in sec. 23, T. 6 N., R. 27 E., have long been abandoned. It is quite probable, however, that mining will again be carried on in this locality as soon as the railroad spur now under construction from Billings has been projected to this part of the coal field.

The Carpenter coal bed has been uncovered along Musselshell River at six places, which in order from west to east are as follows: In the NW. ¼ sec. 15, T. 9 N., R. 29 E. (No. 9, Pl. XXX, p. 174) a prospect opened by ranchers to procure fuel for domestic use has produced probably 100 to 200 tons. In the same section it is reported that in the early part of 1914 a shaft was sunk to the Carpenter bed east of the coulee near the Musselshell-Melstone road. South of the river, in the NW. ¼ sec. 13 of the same township (No. 11, Pl. XXX), there is a small prospect, evidently made to prove a coal claim. About 1½ miles to the east, in the NW. ¼ sec. 18, T. 9 N., R. 30 E. (No. 5, Pl. XXXV, p. 198), another small prospect has been made for the same purpose. Only a small quantity of coal has been taken from these two openings. A drift 100 to 200 feet long, locally known as the Robbins prospect, in the SE. ¼ sec. 17, T. 9 N., R. 30 E. (No. 6, Pl. XXXV), near Finnen's ranch on Carpenter Creek, is mostly in hill wash and has produced only a few tons of coal. In the NE. ¼ sec. 26 (No. 9, Pl. XXXV) of the same township W. C. Grant opened a small prospect on the same coal bed.

A drift on the McCleary coal bed in the SE. ¼ sec. 26, T. 9 N., R. 30 E. (No. 14, Pl. XXXV), is about 50 feet long and exposes 3 feet 7 inches of coal. A surface prospect on this bed in the NW. ¼ sec. 32, T. 8 N., R. 31 E. (No. 13, Pl. XXXVI, p. 212), is a source of fuel for the near-by ranchers. On Fishel Creek, in the NW. ¼ sec. 29, T. 8 N., R. 29 E. (No. 1, Pl. XXIX, p. 168), a small quantity of coal has been mined by near-by ranchers from a short drift in the McCleary (?) bed.

An abandoned mine (locally known as Grants prospect) in the NE. ¼ sec. 29, T. 8 N., R. 29 E. (No. 18, Pl. XXIX), about a mile south of August Schrader's ranch on Fishel Creek, is on the Buckey bed. Coal was formerly hauled to Musselshell from this mine.

A drift about 25 feet long has been made in the Kuchta bed in the SW. ¼ sec. 28, T. 9 N., R. 30 E. (No. 53, Pl. XXXV), for the purpose

of proving a coal claim. During the summer of 1909 a drift about 125 feet long on the same bed was opened by Mr. Todd in sec. 2, T. 8 N., R. 29 E. (No. 108, Pl. XXIX), about 4 miles south of Musselshell, to supply the local ranch and village trade.

In the northern part of sec. 3, T. 8 N., R. 29 E. (No. 64, Pl. XXIX), a country bank known as the Handel mine was opened about 1911 by Ben Linsebigler, of Musselshell, on the Buckey bed. The entry is about 100 feet long and the bed is under 10 to 40 feet of cover. In July, 1913, it was estimated that 1,600 tons of coal had been removed from this place.

Development work is reported on the Mammoth bed near the head of Fattig Creek.

FUTURE DEVELOPMENT.

The future development of this field will be controlled to some extent by the topographic features, the water supply, and the structure of the rocks that contain the coal beds. The accessibility of the coal depends largely on topographic features. The main plateau, on which Eldridge, Taylor, and Three Buttes mesas are situated, divides the field into two natural subdivisions, a northern slope toward the Musselshell and a southern slope toward the Yellowstone. Coal beds outcropping on the southern slope are naturally most accessible from that direction, as railroad spurs to tap the field may be extended from the main line of the Northern Pacific Railway, 12 to 15 miles to the south. The same coal which would thus be mined on the south slope extends underneath the divide and outcrops on the north slope. This northern slope has special advantages for the mining of the coal, in that it has a more plentiful water supply and is nearer to the railway (Chicago, Milwaukee & St. Paul). In fact, one coal bed which is at least 12 miles from the Northern Pacific Railway on the southern slope outcrops along the line of the Chicago, Milwaukee & St. Paul Railway on the northern slope. The higher coal beds outcropping close up to the divide are more nearly equally distant from the two railroads.

It is quite probable that the first commercial mining on the south slope will be done on the Mammoth or Rehder beds in the vicinity of Eldridge Mesa, as these beds are the thickest in this general locality. A railroad spur now being constructed northeast from Billings will, if extended to this locality, furnish an adequate means of transportation for coal from these higher beds.

As already noted (p. 16), the water supply on the southern slope is much inferior to that on the northern slope, for the rocks dip slightly north and tend to carry off any water contained in them. For this reason the coal on the south side of the mountains will probably be the last to be mined.

Practically all the intermittent streams flowing south to Yellowstone River, namely, Razor, Pompeys Pillar, Railroad, Hibbard, Mill, Antelope, and Buffalo creeks, and Cow Gulch, are natural routes for railroad spurs to reach the coal from the south slope.

On the northern slope Goulding, Halfbreed, Parrott, Fattig, Fishel, Hawk, Carpenter, and Lost Horse creeks are natural routes for railroad spurs to tap the coal field on the northern slope. It is believed that in the future practically all of the valleys named will be the sites of one or more coal mines. Naturally, valleys that head in the part of the coal field where the coal beds are thickest and of the best grade will be occupied first.

The northern slope has many more advantages for coal mining than the southern slope. Among them is the northerly dip of the rocks, which would form natural drainage for the mines; the fact that loaded cars need not be hauled but could be allowed to run to the mouths of the mines by gravity; and the presence of more water and in places of more wood for timbering.

It is believed that the next part of the Bull Mountain coal field to be exploited will be in the northeastern part of the field, in the vicinity of Carpenter Creek, where at least two beds of good coal, the Carpenter and McCleary, with thicknesses averaging 6 feet and 3½ feet, respectively, are fairly constant throughout a considerable area adjacent to the Chicago, Milwaukee & St. Paul Railway.

Another very favorable locality for mining is near the head of Parrott and Fattig creeks along the outcrop of the Mammoth and Rehder beds.

The Bull Mountain coal field is the main source of fuel for the Chicago, Milwaukee & St. Paul Railway; in fact, it is the only source worthy of consideration between Iowa and west-central Washington. This fact and the added fact that the coal is of good steaming quality necessarily make the Bull Mountain coal field one of prime importance.

DESCRIPTION BY TOWNSHIPS.

MODE OF TREATMENT.

In the following pages the Bull Mountain coal field is described in detail in township units. The ranges are taken up in order from west to east and, in each range, the townships from south to north, beginning with the southwestern corner township, T. 5 N., R. 24 E. Under each township the topography, drainage, agriculture, and geology are described briefly and the coal beds in detail. Accompanying the description are township maps on a scale of 1 inch to 1 mile, on which are shown the topography, geology, and the outcrops of all coal beds. All places where the coal beds were examined are shown on the maps, the locations being indicated by numbers for conven-

ient reference to the text and plates of coal sections. A selected number of the most complete and characteristic coal sections are shown graphically on Plates XII to XXXVI. The others are described or listed in the text.

T. 5 N., R. 24 E.

GEOGRAPHY.

T. 5 N., R. 24 E., on and north of the divide between Musselshell and Yellowstone rivers, is the extreme southwest corner township of the area mapped. (See Pl. I, in pocket.) No individual township map accompanies the description, for no important bed of coal has been found in the township. The plateau in the southern part of the township, which forms the divide, has in this region an elevation of a little over 4,000 feet above sea level and is several miles in width. On the north side the plateau is deeply dissected by the numerous coulees, which combine to form Dean Creek. Between the coulees the remnants of the plateau extend northward in narrow, jagged ridges with more or less precipitous walls.

There are no permanent streams within the township, but in the coulees north of the divide there are a number of good springs which furnish a moderate supply of water. It is reported that since the field examination in 1907 wells have been drilled in places in the plateau region in the southern part of the township, but the writers are not informed as to the depth at which water was reached.

Probably half of the township is adapted to dry farming and the remainder is grazing land. There is a little timber in the coulees north of the divide, but the best of it has been cut.

GEOLOGY.

The rocks underlying the township belong to the Lance and Fort Union formations. The beds of sandstone and shale grouped as Lance underlie the extreme southwest corner of the township and also a broad belt extending northwest and southeast across the central part. Overlying these the series of predominantly dark shales and thin beds of sandstone which constitutes the Lebo shale member of the Fort Union extends across the township from northwest to southeast in two belts, one in the south-central part between the two areas of Lance and the other on the northeast between the Lance and the upper part of the Fort Union. The rocks of the upper part of the Fort Union, consisting predominantly of yellow sandstone with a lesser amount of shale, occupy only a small area in the northeastern corner of the township.

On the top of the plateau near the south line of the township are a number of sinklike depressions partly filled with alluvium and consti-

tuting small lakes during the wet season. The fact that neither easily soluble rocks, such as limestones, nor channels of ground-water circulation, such as fault and joint planes, are found in this region makes it evident that these are not solution sinks. It is possible that they represent old "bison wallows" which have been maintained and enlarged by wind erosion.

In the northeastern part of the township the beds dip gently northeast toward the main Bull Mountain syncline. This dip accounts for the arrangement of the formations in parallel belts, the width of the belts being governed by the thickness of the beds, the degree of dip, and to some extent by the topography. In the southwestern part of the township a minor northwest-southeast syncline forms a trough in which lies the southern belt of Lebo shale. The Quaternary deposits on top of the plateau are not affected by these folds.

COAL.

No coal of economic importance occurs within the township, but thin coal beds appear in all the rocks exposed. The Big Dirty coal bed occupies a stratigraphic position about the middle of the Lebo shale and consists of 5 to 8 feet of alternating carbonaceous shale and sandstone and low-grade coal.

T. 6 N., R. 24 E.

GEOGRAPHY.

T. 6 N., R. 24 E., lies on the west side of the area mapped, almost entirely south of Musselshell River, which crosses the northwest corner. No individual map of the township is given. Practically the whole township is drained by Dean Creek, which flows northward across its central part in a narrow steep-sided valley with numerous small side valleys. The high rugged ridge along the eastern border is a dissected remnant of the plateau which farther south forms the divide between the Musselshell and Yellowstone drainages.

The water supply in the township in 1907 consisted only of a few springs or waterholes on Dean Creek. Only small areas in the township are sufficiently level to be cultivated, the chief value of the land being for grazing and for timber. The flood plain of Musselshell River in sec. 6 is partly irrigated and produces good crops of hay.

GEOLOGY.

The rocks outcropping in the township belong to the Lance and Fort Union formations. The gray micaceous sandstone and light-colored shale of the Lance formation occupy nearly all of the area west and a narrow strip east of Dean Creek. The drab and olive-green sandy shale of the Lebo shale member of the Fort Union formation outcrops in a comparatively narrow belt on the east slopes of

Dean Creek valley and occupies a small area on the west slope in sec. 5. Overlying this is the massive buff sandstone and shale of the upper part of the Fort Union, which underlies all of the high ridge in the eastern part of the township. The valley of Musselshell River, which crosses sec. 6, is filled with flood-plain deposits, which in this vicinity are only about one-half mile in width.

All the strata dip gently east toward the axis of the main Bull Mountain syncline.

COAL.

No coal of economic importance outcrops within the township, although local and, in most places, thin coal beds occur throughout the rocks exposed. These were examined at several places, but none of them were considered of sufficient value to warrant mapping.

The following section was measured on a coal bed in the Lance formation on the south side of Musselshell River, in the SW. ¼ sec. 6:

Section of Lance formation in the SW. ¼ sec. 6, T. 6 N., R. 24 E.

	Ft.	in.
Sandstone	10±	
Clay shale	10±	
Sandstone, gray	2±	
Clay shale, gray	5±	
Shale, grayish brown		2
Coal		½
Sandstone		⅛
Coal, weathered		1
Shale, light brown		¼
Coal		3¼
Sandstone, gray, with plant fragments		1¼
Coal		3
Shale		¼
Coal		8½
Bone, weathering gray		2
Coal		4
Bone		½
Coal		8
Shale, carbonaceous	1±	
Sandstone	5	0
Total coal	2	4¼

Total partings, 4⅛ inches.

This coal has a fairly bright luster on fresh fracture and weathers into platy fragments characteristic of subbituminous coal. Another coal section 600 feet southwest has a total thickness of 2 feet 2 inches.

T. 7 N., R. 24 E.

GEOGRAPHY.

Only the part of T. 7 N., R. 24 E., that lies adjacent to Musselshell River was examined. The river flows northeast across the township

from sec. 32 to sec. 13. The nearly level flood-plain is about one-half mile in width. North of the river the surface rises gradually and merges into a region of rolling prairies. To the southeast, however, toward the Bull Mountains, the slopes are much steeper.

The greater part of the township is adapted to dry farming, and large areas are now under cultivation. The rich alluvial river flats, although comparatively narrow, are partly irrigated and produce good crops of hay. Water for domestic and stock use can be obtained in wells in some parts of the township. Both the main line of the Chicago, Milwaukee & St. Paul Railway and the county road connecting the towns along Musselshell River follow the valley.

GEOLOGY.

The rocks outcropping in the part of the township mapped include a massive sandstone at the top of the Lance formation, the full thickness of the Lebo shale member of the Fort Union formation, the lower few hundred feet of the upper part of the Fort Union, and the alluvial flood-plain deposits of Musselshell River.

The sandstone at the top of the Lance outcrops on both sides of the river bottom in the southwest corner of the township and in the eastern part. There is also a considerable area of Lance in the unmapped northwestern part. The drab and olive-green sandy shale of the Lebo shale member of the Fort Union occupies an irregular area on both sides of the river bottom and also a broad area extending northwestward from the river to the center of the north township line. The overlying upper part of the Fort Union outcrops in the higher parts of the township in the southeast and northeast corners and also north of the river in secs. 27 and 28.

The structure in this township is probably as complicated as in any part of the Bull Mountain field, but it is simple when compared with the folded area farther west along Musselshell River. The main western syncline of the Bull Mountains northeast of the township is succeeded on the southwest by a small anticline which plunges steeply northwest and southeast and which brings to the surface the upper sandstone of the Lance in the eastern part of the township. A small syncline succeeds this anticline on the southwest, and in the trough of this syncline lies the area of upper Fort Union in secs. 27 and 28. The relations of the strata are somewhat further complicated by minor faults, whose details are not fully understood.

COAL.

All the strata exposed in the township, with the exception of the alluvial river deposits, contain local beds of coal, none of which was considered of sufficient importance to warrant mapping. The Big

Dirty coal bed outcrops at two places on Kern Creek. At the most western outcrop, about 4 miles from Elso, it has the following section:

Section of Big Dirty coal bed in T. 7 N., R. 24 E.

	Ft.	in.
Shale, carbonaceous, with streaks of coal	2	11
Coal		10
Dirt		8
Bone		½
Coal		6
Shale, carbonaceous		5
Coal		3
Shale, carbonaceous	1	5
Coal		5
Shale, carbonaceous		10
Coal		½
Bone		2
Clay, sandy		6
Coal		3
Total coal	2	3½

The lower outcrop on Kern Creek, about 2 miles from its mouth, contains 2 feet of coal near the bottom of the bed. Coal taken from the bed at this place has been used by several ranchers with fairly good results, but it contains a large amount of ash and slacks in a short time. The probability of a bed of this character improving with depth or distance back from the outcrop is too remote to be considered, and capital expended in its development would undoubtedly be wasted.

T. 8 N., R. 24 E.

GEOGRAPHY.

T. 8 N., R. 24 E., is the extreme northwest corner township of the area mapped. As no coal of economic importance is present in this township no individual map is presented. The township includes the west end of the westernmost syncline of the field and is drained principally by Horsethief and Kern creeks, the divide between which trends eastward in the southern half of the township. The southern, western, and northern parts are gently rolling and in places smooth, but the central and eastern parts are hilly and rather deeply dissected by the coulees which unite to form Horsethief Creek. In secs. 22, 23, 26, and 27 the surface is plateau-like and is covered sparsely with small pine and cedar.

There are no permanent streams within the township, but there are many seep springs along Horsethief Creek. In this valley it is believed good water can be obtained in comparatively shallow wells. It is reported that artesian water was found in a well a few miles west of this township near the junction of Cameron and Pole creeks, which unite to form Horsethief Creek.

Probably half of the township is adapted for dry farming, the remainder being excellent grazing land. But little timber of value remains in this township.

GEOLOGY.

The rocks outcropping in the township belong to the Bearpaw, Lance, and Fort Union formations. The Bearpaw, consisting of drab marine shale, is exposed in the northwest corner of the township. The Lance formation, consisting principally of beds of sandstone and shale, outcrops in the southwestern and northern parts of the township. In places in the Bull Mountain coal field it contains thin beds of coal, but none of importance is known in this part of the field. Conformably above these beds lies the Lebo shale member of the Fort Union formation, consisting of dark-colored shale, a few thin beds of sandstone, and the conspicuous Big Dirty coal bed, which is situated near the middle of the member and is very persistent, though of little value. Owing to its steep dip the Lebo shale member outcrops in a narrow belt in the northern part of the township but appears more broadly in the western and southwestern parts. The rocks of the upper part of the Fort Union, consisting principally of yellowish-gray sandstone with a lesser amount of shale, occupy the central and eastern parts of the township. No coal is known to be present in these rocks in this township.

In the northern part the strata dip as much as 30° S. and strike almost east and west. In the western and southwestern parts the beds dip much more gently east and northeast. The strata of the upper part of the Fort Union formation in the central and eastern parts of the township lie nearly flat.

COAL.

No coal of economic importance exists within the township. The Big Dirty coal bed (of no present economic value) occupies a stratigraphic position about the middle of the Lebo shale and consists of an alternating series of carbonaceous shale and sandstone and low-grade coal.

T. 5 N., R. 25 E.

GEOGRAPHY.

The divide between Musselshell and Yellowstone rivers crosses T. 5 N., R. 25 E., in a northeasterly direction. The broad, gently rolling plateau which forms the divide is maturely dissected on the north and south sides, where the topography is characterized by skeletal to massive, flat-topped ridges with intervening gulches cut well back toward the divide. The plateau ranges from 3,900 to 4,200 feet in elevation. Sinklike depressions, filled partly with alluvium and constituting water holes or tiny lakes during the wet season, form an interesting feature of the plateau surface. The fact that neither easily

soluble rocks, such as limestones, nor channels of ground-water circulations, such as fault and joint planes, are found in this region makes it evident that these are not solution sinks. The absence of outcrops in this immediate vicinity makes it impossible to demonstrate that they are structural in character. It is possible that they represent old "bison wallows" which have been enlarged and maintained by wind erosion.

The gulches have terraced walls formed by the erosion of alternating beds of heavy sandstone and clay shale. The sandstone beds form a series of cliffs locally known as "rim rocks," which are nearly impassable and which, combined with short stretches of wire fence, shut in extensive pastures.

The plateau portion of the township is so easily traversed that well-marked roads are absent except where travel is crowded well up on the divide by the gulch heads of Razor and Goulding creeks and where in consequence a fairly good road has been developed.

At the time of the field examination in 1907 the Clark ranch, in the northwest corner of sec. 6, was the only permanently inhabited ranch in the township. Since that time it has been found that portions of the plateau area are adapted to dry farming, and a much larger part of the township is occupied than is indicated on the maps (Pl. I, in pocket, and eastern half of township on Pl. XIV).

GEOLOGY.

The geologic section of the rocks exposed in the township comprises portions of the Fort Union and Lance formations and small areas of alluvium. The beds of gray sandstone of the Lance formation underlie the southern third of the township and are bordered on the north by the olive-green to drab shale of the Lebo shale member of the Fort Union. The width of the outcrop of the Lebo is dependent mainly upon variation in dip and ranges from about one-third mile to about 1½ miles. The northern half of the township is underlain by the coal-bearing portion of the Fort Union, which consists of alternating beds of sandstone, clay shale, and coal. The sandstone beds predominate and form prominent cliffs or rim rocks. The strata in this part of the field dip gently northeast.

COAL.

Stratigraphic relations.—The western half of the township contains no coal of economic importance, and no individual map of it is given. The eastern half has been mapped with T. 5 N., R. 26 E. (See Pl. XIV, p. 84.) Local coal beds have been found at several places in the Lance formation but are in general so thin or lenticular that they are not of economic value. One of these beds, 1 foot thick, is exposed in the NE. ¼ sec. 25 (No. 1, Pl. XIV).

Near the middle of the Lebo shale member of the Fort Union is the Big Dirty coal bed, which, though not important as a coal bed, is in most parts of the field a good horizon marker. In this township, however, it is so thin as to furnish scarcely a blossom, and its outcrop was not mapped. A local bed 10 inches thick near the base of the Lebo was measured in the SW. ¼ sec. 23 (No. 2).

In the upper part of the Fort Union the Buckey (N) coal beds are the most important and are limited in distribution mainly to the four northeastern sections (secs. 1, 2, 11, and 12). A thin bed found on a small stream in the NW. ¼ sec. 14 (No. 3) with a thickness of 7 inches probably corresponds to the Wildhorse (O) bed, which lies stratigraphically about 100 feet below the Buckey. The Dougherty (M) coal bed, 150 feet above the Buckey beds, underlies a small knoll on the eastern margin of sec. 1. The stratigraphic intervals between these beds are shown in the vertical section (A in Pl. VI, p. 34).

Buckey (N) coal beds.—The outcrops of the Buckey (N) beds are in most places entirely concealed either by talus from the overlying shale and sandstone or by burning. The zone of rocks discolored by the combustion of the coal is the best marker for tracing the coal beds. The following section, measured by Richards in 1910 in a gulch in the NW. ¼ sec. 11 (No. 4), shows two beds.

Section of Buckey coal beds in sec. 11, T. 5 N., R. 25 E. (No. 4).

	Ft.	in.
Sandstone, yellowish gray, soft	25	
Clay shale, sandy	5	
Coal, shaly to blocky, weathered		10
Shale, carbonaceous		1
Coal, shiny		7
Shale, carbonaceous, on fresh fracture looks coaly	1	9
Coal		9
Clay shale		8
Coal		3
Shale, carbonaceous		2
Coal		7
Shale		1
Coal	2	7
Clay shale		6
Sandstone, gray, soft	10	
Clay shale		4
Coal, blocky, weathering streaky but shiny on fresh break		10
Bone with streaks of coal		½
Coal, weathering streaky but shiny on fresh break		5
Clay shale.		
Total coal in upper bed	5	7
Total coal in lower bed	1	3

Farther east, in the SE. ¼ sec. 11 (No. 5), another exposure shows 1 foot 11 inches of coal, the upper 2 inches of which is shaly. This is probably the lower of the Buckey beds.

Dougherty (M) coal bed.—The Dougherty (M) coal bed is exposed on the northwest slope of the knoll in sec. 1, where the following section was measured:

Section of Dougherty coal bed in the NE. ¼ sec. 1, T. 5 N., R. 25 E. (No. 6).

	Ft.	in.
Shale, carbonaceous		3
Coal		11
Shale		2
Coal		9
Total coal	1	8

The physical characteristics of the coal exposed in the sections above show that it is the same as the coal in other parts of the Bull Mountains, which is shown by a number of chemical analyses from different beds in different parts of the field to be high-grade subbituminous. (See general description and analyses, pp. 48–53.)

Development.—No mines or prospects have been opened in the township. The development of the Buckey beds in the northeastern corner of the township may be accomplished from entries in the heads of Goulding and Lamott coulees on the north side of the divide or in the heads of the several forks of Razor Creek on the south side of the divide. Entries on the north side will have the advantage of mining up the dip and of being accessible through valleys with lower gradients.

T. 6 N., R. 25 E.

GEOGRAPHY.

T. 6 N., R. 25 E., lies north of the Musselshell-Yellowstone divide west of the Bull Mountains proper. It is drained by Goulding Creek and its branches, which flow northward or northwestward through deep canyons separated by long, skeletal ridges with terraced slopes. The stage of erosion is mature when compared with that of the undissected plateau area to the south.

The roads of the township lie in the valleys of Goulding Creek, Goulding Coulee, and Lamott Coulee. The only ranch in the township in 1907 was that of Spidel & Lamott in sec. 8. The lands of the township are mainly utilized for grazing. The heads of the coulees and the sides of the ridges support a fairly heavy growth of pine.

GEOLOGY.

The rocks which outcrop in the township belong wholly to the upper portion of the Fort Union formation and consist of a series of alternating sandstone, clay shale, and coal beds. The sandstone beds are the most conspicuous, for they are relatively the most resistant to erosion and form the vertical cliffs and skeletal tops of the ridges. The strata dip gently northeast in all parts of the township.

COAL.

Stratigraphic relations.—The coal beds examined are confined to the eastern half of the township, which is included on the township map with T. 6 N., R. 26 E. (Pl. XV, p. 90). Two of the important coals of the field were mapped within the township—the Buckey (N) group of coal beds and the Dougherty (M) bed. The lower of these, the Buckey group, outcrops in the sides of the steep valleys in the southeastern part of the township. The Dougherty bed, stratigraphically about 150 feet above the Buckey, appears near the tops of high ridges in the eastern part of the township.

No samples for chemical analysis were obtained in the township, but the physical characteristics show that the coal may be slightly inferior in grade to that found in other parts of the Bull Mountain field. (For general character and chemical analyses see p. 53.)

Buckey (N) coal beds.—The Buckey (N) coal beds outcrop high up on the side of the ridge on the northeast side of the upper valley of Goulding Creek in secs. 27, 28, 34, and 35. Their horizons lie above the top of the ridge on the south side of the valley. On the east side of the valley an examination of the beds was made at seven places (Nos. 1 to 7 inclusive, Pl. XV), which shows the group to consist of three beds, one of which has a thickness of 3 feet 1 inch in sec. 34 (No. 3). Where the outcrops swing around the end of the ridge in sec. 21 (No. 7) none of the three beds is over a few inches in thickness. In the adjoining valley on the east the outcrop is at a much lower level owing to the northeasterly dip of the rocks. The maximum thickness measured in this valley is 2 feet 10 inches at the head of the valley in sec. 36 (No. 10). Northward the bed thins abruptly, being only 8 inches thick at No. 14 (sec. 23). The outcrop was followed for only a short distance north of that place.

A selected number of representative coal sections are shown graphically in Plate XV (p. 90). The others measured on the bed are as follows:

Coal sections on the Buckey (N) coal bed in T. 6 N., R. 25 E.

[See also Pl. XV.]

No. on map, Pl. XV.	Location.	Section.	Ft.	in.	No. on map, Pl. XV.	Location.	Section.	Ft.	in.
1	Sec. 35, SW. ¼...	Coal bloom ?			7	Sec. 21, SE. ¼....	Coal in three benches, all thin.		
2	Sec. 34, NE. ¼....	Coal, weathered.....	2	9	8	Sec. 23, SW. ¼...	Coal bloom in sod.		
4	Sec. 27, SW. ¼...	Shale.			9	Sec. 26, NE. ¼....	Coal.....		8
		Coal.....	2	6	12	Sec. 26, NE. ¼....	Coal.....	1	9
		Shale.			14	Sec. 23, SW. ¼...	Coal.....		8
6	Sec. 28, NE. ¼....	Sandstone.....	40	0					
		Coal, bony....		7					
		Shale.....		8					
		Coal, bony....	1	2					
		Shale.....	15	0					
		Coal.....		4					

Dougherty (M) coal bed.—The Dougherty coal bed, which outcrops on the very tops of the ridges in secs. 24 and 25 and also in secs. 1, 12, and 13, is much obscured by soil and in some places is burned. No complete sections of the bed were measured in this township, but measurements in the adjoining townships to the east show a thickness of about 2 feet 6 inches. A thickness of 1 foot 6 inches of coal, measured near the north line of the NE. ¼ sec. 25 (No. 15) represents only part of the bed. At the other places indicated on the map (No. 16, sec. 24, SW. ¼; No. 17, sec. 24, NW. ¼; No. 18, sec. 13, NE. ¼; and No. 19, sec. 12, SE. ¼, Pl. XV) the bed is shown at the surface only by coal bloom.

Development.—No mines or prospects have been opened in the township, and the remoteness of its coals from present transportation lines will retard their development.

T. 7 N., R. 25 E.

GEOGRAPHY.

Musselshell River crosses the northwestern part of T. 7 N., R. 25 E., from southwest to northeast, its flood plain averaging about half a mile in width. The principal tributaries are Goulding Creek, Naderman Coulee, and Halfbreed Creek. The topography near the river bottoms is comparatively smooth, but in the southern and eastern parts of the township is of the rugged type characteristic of the northern borders of the Musselshell-Yellowstone plateau region, consisting of long spurs separated by narrow, steep-sided valleys. The valleys and hillsides are well timbered.

The only post office in the township is Elso, in the NW. ¼ sec. 18, on the Chicago, Milwaukee & St. Paul Railway, which follows the north side of Musselshell River. The county road from Lavina to Roundup also follows the north side of the river, and good secondary roads make parts of the township accessible. The water supply is obtained from Musselshell River, from Halfbreed and Goulding creeks, which are perennial in parts of their courses, and from a spring on Hay Coulee in sec. 26.

The flood plain of Musselshell River and of Goulding and Halfbreed creeks is well adapted for farming, and some of it has been irrigated with good results. Much of the bench land in the township is adapted to dry farming.

GEOLOGY.

The topmost strata of the Lance formation outcrop in a small area near the mouth of Goulding Creek. Just above these rocks the olive-green sandy shale and arkosic sandstone of the Lebo shale member of the Fort Union formation occupy the broad, nearly flat valley of Goulding Creek below the mouth of Hay Coulee and extend on both

sides of the bottom land of the river across secs. 7 and 18 into secs. 5 and 8. Rocks belonging to the upper part of the Fort Union outcrop over the greater part of the township. They consist of alternating beds of sandstone, clay shale, and coal, among which heavy beds of buff to yellowish gray sandstone are predominant.

The strata dip about 3° E. in the western and central parts of the township and as low as 1° E. in the eastern part. In the vicinity of Elso a low anticline brings the sandstones of the Lance formation to the surface.

COAL.

Stratigraphic relations.—The Big Dirty coal bed lies at about the middle of the Lebo shale member and affords a valuable horizon marker. Its outcrop extends in an irregular ellipse around the Elso anticline in secs. 7, 18, and 19. The following section, which is fairly typical of the bed, was measured near the Elso schoolhouse:

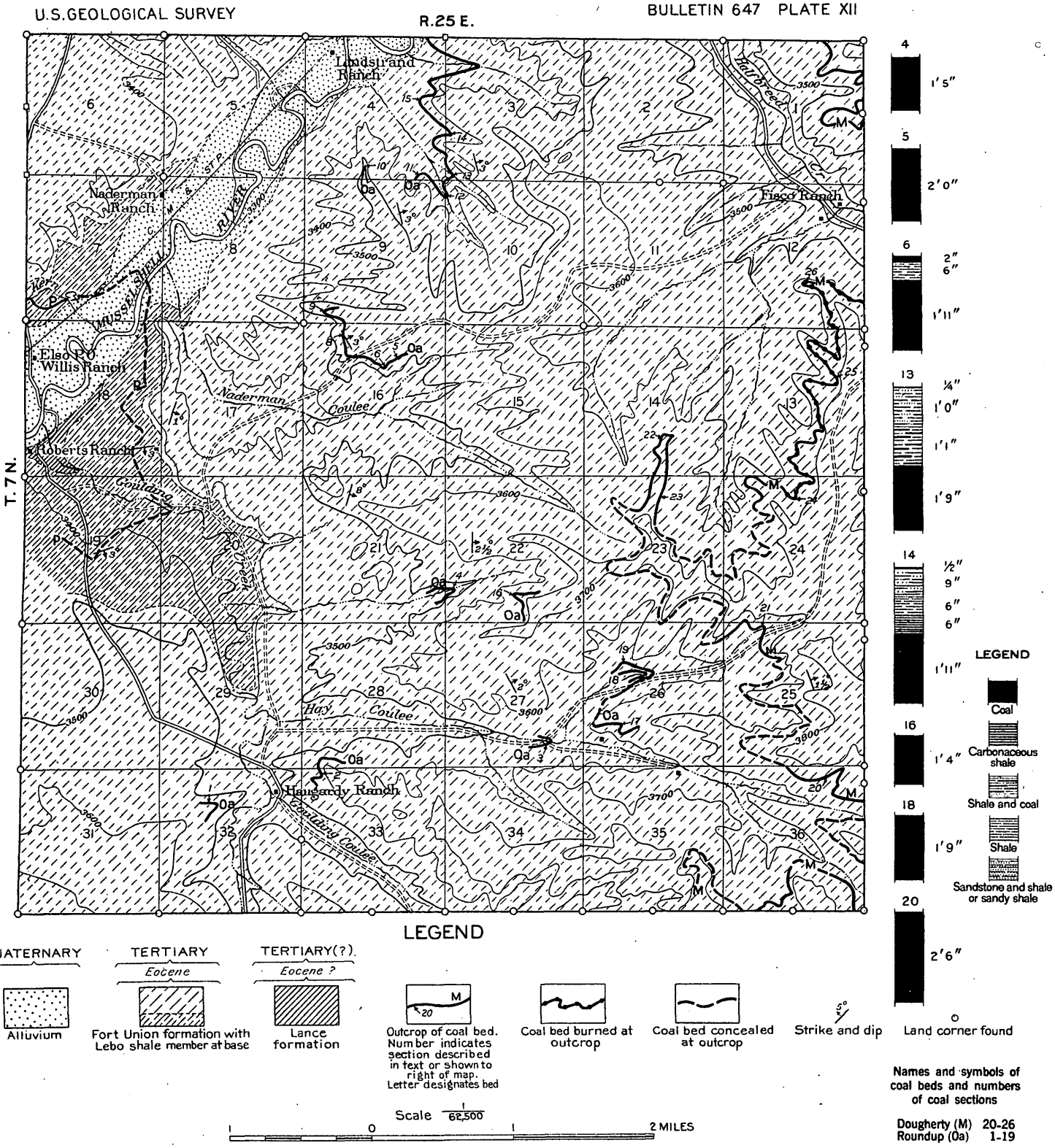
Section of Big Dirty coal bed near Elso schoolhouse, in sec. 7, T. 7 N., R. 25 E.

	Ft.	in.
Shale, carbonaceous, sandstone, and coal	5	0
Shale	2	0
Shale, carbonaceous, sandstone, and coal	5	0
Coal, impure	1	6
	13	6

Two of the important coal beds of the upper part of the Fort Union formation outcrop within the township—the Roundup (Oa) and the Dougherty (M) beds—the former outcropping in the valley of Goulding Creek and on the south side of Musselshell River valley, and the latter high on the hills in the eastern part of the township. About 510 feet of strata separates these two beds, in most places barren of coal but containing a few local beds in the south-central part of the township. (See Pl. XII.)

The coal of both the Roundup and Dougherty beds is high-grade subbituminous, and its calorific value is over 11,000 British thermal units. No sample for chemical analysis was obtained from this township, but analyses of samples from the same beds in adjoining townships are shown on pages 51–53.

Roundup (Oa) coal bed.—The Roundup (Oa) coal bed outcrops in the northern part of the township in the steep bluffs about a mile southeast of Musselshell River. This bed, which is important and is being mined extensively in the vicinity of Roundup, appears in this township to be split into three or more benches or beds separated by lenticular shale partings. The maximum thickness reached by any of the beds is 2 feet, in the NE. ¼ sec. 16 (No. 5, Pl. XII) The



MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 7 N., R. 25 E., MONTANA

outcrop was not mapped continuously and is shown on the map as a number of isolated exposures or groups of exposures at each of which one or more of the benches is present. Representative coal sections are shown graphically in Plate XII. The others measured within the township are as follows:

Coal sections on the Roundup (Oa) coal bed in T. 7 N., R. 25 E.

[See also Pl. XII.]

No. on map, Pl. XII.	Location.	Section.	Ft.	in.	No. on map, Pl. XII.	Location.	Section.	Ft.	in.
1	Sec. 32, NW. ¼..	Coal.....		10	10	Sec. 4, SW. ¼....	Coal.....		10
2	Sec. 33, NW. ¼..	Coal.....		10	11	Sec. 4, SE. ¼.....	Coal.....	1	7
3	Sec. 27, SE. ¼....	Coal.....		10			Concealed....	12	9
7	Sec. 16, NW. ¼..	Coal.....		6	12	Sec. 10, NW. ¼..	Coal.....	1	4
8	Sec. 16, NW. ¼..	Coal.....		6	15	Sec. 4, NE. ¼....	Coal.....	1	½
9	Sec. 9, SW. ¼....	Coal.....		7					
		Shale.....	2	0					
		Coal.....		2					

Local coal beds between the Roundup and Dougherty.—A few local coal beds, none of which has been mapped except for very short distances, lie in the 500 feet or more of strata between the Roundup and the Dougherty. Measurements were made at four places (Nos. 16 to 19, inclusive). Of these, Nos. 16 and 18 are represented graphically on Plate XII, and Nos. 17 and 19 are as follows:

Coal sections on local beds between Roundup and Dougherty beds in T. 7 N., R. 25 E.

[See also Pl. XII.]

No. on map, Pl. XII.	Location.	Section.	Ft.	in.	No. on map, Pl. XII.	Location.	Section.	Ft.	in.
17	Sec. 26, SW. ¼...	Coal.....	1	7	19	Sec. 26, NW. ¼..	Coal.....		6

Dougherty (M) coal bed.—The Dougherty (M) coal bed is the most important in the township, although it underlies only small areas on the tops of the ridges in the eastern tier of sections. In some places it is marked by a burned zone but is largely concealed by a heavy soil mantle. One complete measurement of the bed was obtained in the NE. ¼ sec. 36 (No. 20, Pl. XII), where it is 2 feet 6 inches thick. At the other locations shown on the map (Nos. 21 to 26) only partial measurements were obtained, which are shown in the following table:

Coal sections on the Dougherty (M) coal bed in T. 7 N., R. 25 E.

[See also Pl. XII.]

No. on map, Pl. XII.	Location.	Section.	Ft.	in.
21	Sec. 25, NW. ¼..	Coal.....	2	8+
		Base not exposed.		
22	Sec. 14, SE. ¼....	Coal.....	3+	
23	Sec. 23, NE. ¼...	Ash.....		6
24	Sec. 24, NE. ¼...	Ash, indeterminate.		
		Coal.....		10
25	Sec. 13, NE. ¼...	Ash.		
		Coal.....	1	0
26	Sec. 12, SE. ¼....	Ash.....		2
		Clay.....		1
		Ash.....		9

Development.—The Dougherty (M) coal bed, because of its thickness and excellent grade of coal, is probably the only bed in the township upon which economic development will be feasible for many years to come. Points of entry suitable for mining small areas can undoubtedly be selected in this township, but any systematic plan of development will involve entries in the valleys in the township to the east which lead into Halfbreed Creek. In such mining it will be possible to plan workings so as to mine up the dip of the strata, and the entries will be accessible to the Halfbreed Creek spur of the Chicago, Milwaukee & St. Paul Railway.

T. 8 N., R. 25 E.

GEOGRAPHY.

T. 8 N., R. 25 E., lies on both sides of Musselshell River, which crosses it from southwest to northeast. About one-fourth of the area is southeast of the river. The flat river bottom lands have an average width of about half a mile. The remainder of the township comprises two types of topography—rolling prairie and "rim-rocked" gulches separated by narrow smooth-topped ridges. The drainage is into the Musselshell by numerous tributaries, of which Halfbreed Creek is the largest. Roundup, the center of population in the Bull Mountain region, is in sec. 13, and the mining town of Klein is in sec. 36. The old stage road from Billings to Lewistown traverses the township from north to south, crossing the river at Old Roundup in sec. 22 and thence leading south along the valley of Halfbreed Creek. Numerous secondary roads make all parts of the township easily accessible. The Chicago, Milwaukee & St. Paul Railway crosses the township along the valley of Musselshell River, and its western divisions obtain the greater part of their fuel supply from the mines of this vicinity.

GEOLOGY.

The gray sandstone and clay shale of the Lance formation outcrop over a considerable area in the northern part of the township. They are overlain on the south by a narrow band of the olive-green and drab shale and coarse yellow sandstone of the Lebo shale member of the Fort Union. South of this band and over the larger part of the township there are outcrops of the soft buff sandstone, gray clay shale, and intercalated coal beds of the upper part of the Fort Union.

The structure is simple. A broad syncline crosses the township from northwest to southeast, its main axis lying nearly parallel to and about a mile south of the northern outcrop of the Roundup coal bed. North of the axis the dips are sharp, reaching a maximum of 25° S. or SW., the steepest being near the west township line. Southwest of the axis, however, the dips are low and irregular, generally toward the east or northeast.

COAL.

Stratigraphic relations.—The Big Dirty (P) coal bed, which has an average thickness of about 10 feet, has been traced across the township from the southwest corner of sec. 6 to the northeast corner of sec. 13. It consists of alternating layers of carbonaceous shale and sandstone with thin streaks of coal and is not valuable under present mining conditions. In the upper part of the Fort Union the Roundup (Oa) coal bed, about 550 feet above the Big Dirty, is the most important in the township. The Dougherty (M) coal bed, stratigraphically 513 feet above the Roundup, outcrops near the tops of the highest hills in the eastern part of sec. 36, where it is concealed by a heavy soil mantle. Data obtained in adjoining townships show that the thickness of the Dougherty bed is about 2 feet 6 inches. (See Pl. XIII.) The Chandler (Ma) coal bed, about 40 feet below the Dougherty, presumably underlies a part of sec. 25 but is concealed by the soil mantle.

Roundup (Oa) coal bed.—The Roundup (Oa) bed outcrops on the northeast side of the synclinal axis from the eastern edge of the township in sec. 13 to the southeast corner of sec. 8, where it swings around the end of the syncline. The dip is about 12° SSW. On the southwest side of the syncline the outcrop has a general northerly trend and the bed dips 1° to 5° E. The exposures are generally poor on account of the low relief and thick covering of soil. From the Commercial mine (No. 3) of the Roundup Coal Mining Co., in the NW. ¼ sec. 23, eastward the outcrop is concealed by the alluvium of Musselshell River. On the north side of the syncline the bed has a fairly uniform thickness of a little less than 6 feet. On the south-

west wing, however, it appears to be represented by two and in places three beds, separated by intervals of 4 to 20 feet. A selected number of coal sections are represented graphically in Plate XIII and show in general the variations in thickness of the bed. The few other sections follow:

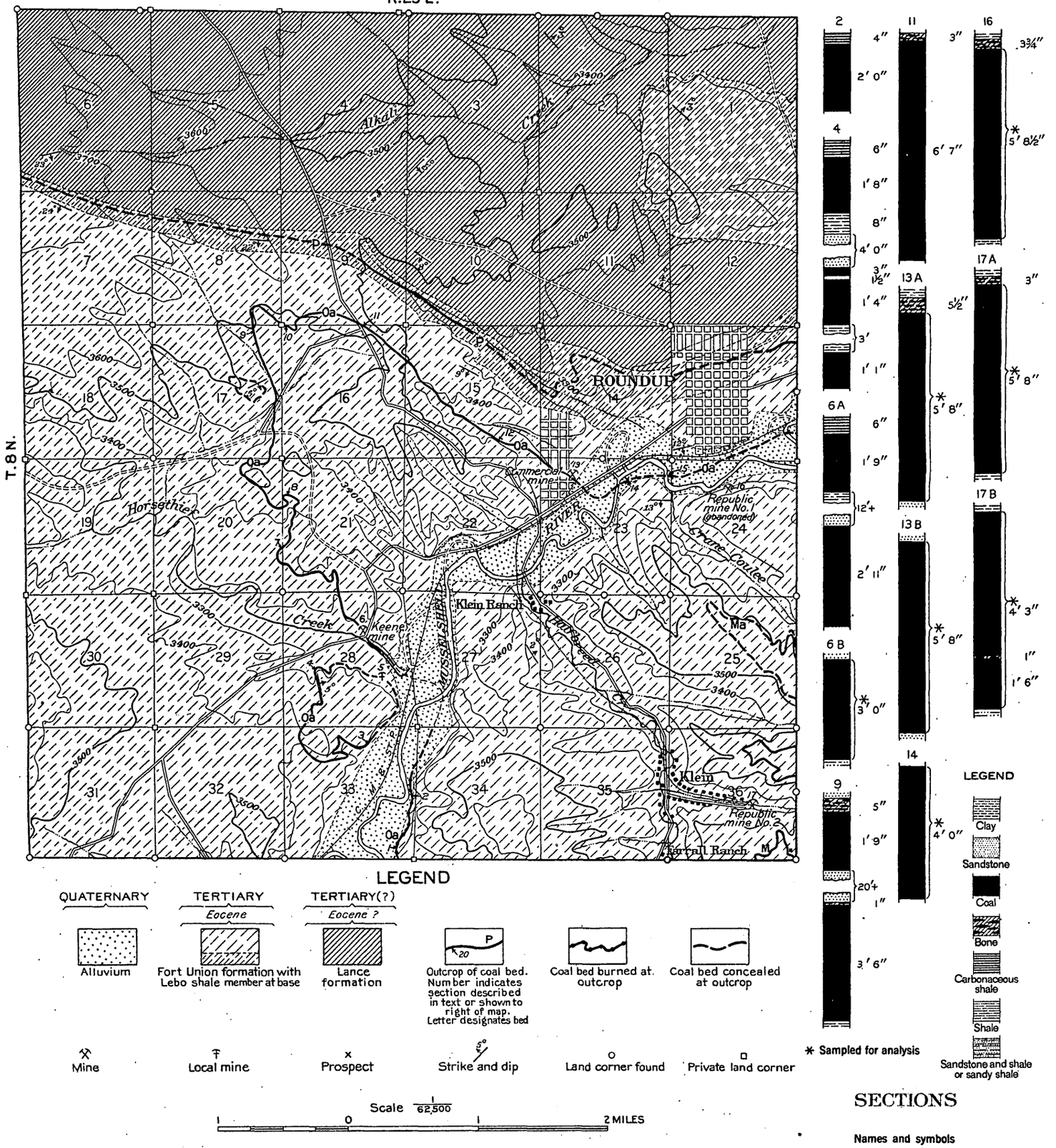
Coal sections on the Roundup (Oa) coal bed in T. 8 N., R. 25 E.

[See also Pl. XIII.]

No. on map, Pl. XIII.	Location.	Section.	Ft.	in.
1	Sec. 33, SE. ¼....	Shale, burnt	4	0
		Sandstone....	5	0
		Shale.....	4	0
		Coal.....		2
		Sandstone..	1	0
		Coal.....		11
		Shale, sandy.	4	4
		Coal.....	1	0
3	Sec. 33, NE. ¼...	Coal.....	1	9
		Sandstone....	5	0
		Coal.....		4
		Shale.....		½
		Coal.....	1	2
		Shale.....		6
		Coal.....	1	2
5	Sec. 28, SE. ¼....	Sandstone....		
		Coal.....	3	0
		Shale, sandy.		
7	Sec. 20, SE. ¼....	Shale, carbonaceous...		5
		Coal.....	1	11
		Shale, sandy.	10±	
		Coal.....	3	6
8	Sec. 21, NW. ¼...	Coal.....	2	5+
10	Sec. 16, NW. ¼...	Coal.....	3	6
12	Sec. 15, SE. ¼....	Coal.....	4±	
15	Sec. 23, NE. ¼...	Coal..... Base not exposed.	4+	

The chemical composition of the Roundup coal bed in this township is well known from seven analyses made from samples collected within it. These include one from the Republic mine No. 1, two from the Republic mine No. 2, two from the Commercial mine (No. 3), one from the Keene mine, and one from an old prospect (No. 14) in the NE. ¼ sec. 23. These samples gave an average heating value of a little over 11,500 British thermal units in the air-dried condition. The complete analyses are given in detail and are discussed on pages 51–52, 58–59.

Development.—The first coal mined on a commercial scale in the township was taken from mine No. 1 of the Republic Coal Co., in the NW. ¼ sec. 24 (No. 16, Pl. XIII), during the autumn of 1907. At first the coal was removed through a slope extending under Musselshell River, but the cover, consisting mainly of alluvium, permitted the entrance of great quantities of water and rendered the method unfeasible. A shaft on the south side of the river, which had been originally intended for an air shaft, was enlarged and used as the main shaft. The coal, which was penetrated at a depth of 137 feet, was mined by the room and pillar method. Mule haulage was used underground. The mine was equipped with a complete pumping, hoisting, and loading plant. The coal bed contained an average of about 5 feet 8 inches of clean coal, which was used mine run or stored in



LEGEND

QUATERNARY
Alluvium

TERTIARY
Eocene
Fort Union formation with Lebo shale member at base

TERTIARY(?)
Eocene ?
Lance formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Mine

Local mine

Prospect

Strike and dip

Land corner found

Private land corner

Scale 1/62,500
1 0 1 2 MILES

SECTIONS

Names and symbols of coal beds

Dougherty (M)
Chandler (Ma)
Roundup (Oa)
Big Dirty (P)

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 8 N., R. 25 E., MONTANA

pockets that fed directly into coal cars. Analysis of a sample (laboratory No. 8803) collected from the mine is given on page 52. The water that drained into the mine is reported to have been of excellent quality and to have been used for a time for domestic purposes by some of the inhabitants of Roundup. This mine was abandoned about 1912.

The Commercial mine (or No. 3) of the Roundup Coal Mining Co., in the NW. ¼ sec. 23 (No. 13A and 13B, Pl. XIII), on the Roundup bed, was opened in October, 1908. It was designed to supply coal for the consumption of towns along the railway, the entire production of the Republic Coal Co. being utilized by the Chicago, Milwaukee & St. Paul Railway, but it now supplies coal for both railroad and domestic use, run-of-mine coal being used by the railroad and lump, egg, and slack sold for domestic fuel. In July, 1913, the daily output was about 1,300 tons, or about 400,000 tons annually, estimating that the mine was operated 300 working days. The coal is brought to the main entry by mules and electric motors, and from there is raised to the surface up a slope about half a mile in length by a hoist near the tipple. About 75 company houses are near the mine, and many others are near by between the mine and Roundup. The coal is approximately the same in thickness and quality as at mine No. 1, above described. Analyses of two samples (laboratory Nos. 8801 and 17588) taken in this mine are given on page 52.

Mine No. 2 of the Republic Coal Co. was opened in the SE. ¼ sec. 36 (No. 17A and 17B, Pl. XIII), in March, 1909. The Roundup bed is reached by a 350-foot shaft. The daily output in July, 1913, was from 1,200 to 1,500 tons. The town of Klein has grown up around the mine and now consists of about 350 houses for miners, a schoolhouse, and several stores. The room-and-pillar method of mining is employed. Much of the coal is loaded in box cars by a cradle box-car loader, and practically all the product is used by the railroad. The roof of the mine is sandstone and little propping is necessary. Two samples for analysis were collected in this mine, one (laboratory No. 8802), about 500 feet northwest and the other (laboratory No. 17586) about 800 feet east of the base of the shaft. (See p. 52.)

The Keene mine, now owned by the Pine Creek Coal Mining Co., is in the NE. ¼ sec. 28 (No. 6, Pl. XIII), on a short spur of the Chicago, Milwaukee & St. Paul Railway. The extreme length of the slope is about 1,500 feet. The Roundup bed at this place is believed to be in two benches, the lower one of which is being mined. At the time the mine was last visited (in July, 1913) no coal was being mined. It is reported that the average daily production is about 250 tons and that it is used entirely for domestic purposes. A sample for analysis (laboratory No. 17589) was collected and is described on page 52.

A small "country bank" was opened about 1912 in the SE. ¼ sec. 28 (No. 5, Pl. XIII) by John Davis. The entry is about 125 feet in length and is on the Roundup coal bed, here 3 feet thick. The coal mined is sold entirely to the local ranchers.

T. 5 N., R. 26 E.

GEOGRAPHY.

T. 5 N., R. 26 E., lies on the south side of the Musselshell-Yellowstone divide and on the south side of the Bull Mountain field. The maximum elevation on the divide in the northwest corner of the township is over 4,200 feet, and the minimum, in the southeast corner, less than 3,300 feet, so that the maximum relief is nearly 1,000 feet. The township is drained southward by Razor Creek and its tributaries. Owing to the general northward dip of the strata there are few springs, and as a result there were at the time of field examination only two ranches in the township. Buckey, the only post office in the township, is an old stage station near the head of Razor Creek in sec. 10. The stage road crosses the township from north to south, following the course of Razor Creek in the north half of the township. Secondary roads are few, but all parts of the township, except the western mountainous portion, are easily accessible.

GEOLOGY.

The gray sandstone and clay shale of the Lance formation outcrop in the southern tier of sections and extend some distance up Razor and West Razor creeks. North of these rocks and overlying them the olive-green and drab shale and coarse yellowish sandstone of the Lebo shale member of the Fort Union formation outcrop in an irregular belt from less than one-fourth of a mile to nearly 1½ miles wide. Just above this shale and sandstone lie the coal-bearing rocks of the upper part of the Fort Union, extending over more than half of the township. These coal-bearing rocks consist of alternating beds of massive sandstone, clay shale, shale, and coal beds, of which the yellow sandstone is most prominent.

The strata dip gently north in all parts of the township.

COAL.

Stratigraphic relations.—In the Lebo shale member two dirty carbonaceous beds have been recognized, the Big Dirty (P) coal bed and a lower bed, whose known outcrop is almost wholly in sec. 28, where it ranges in thickness from 2 feet 6 inches to 4 feet 2 inches. The Big Dirty bed, which lies stratigraphically near the middle of the

Lebo shale member, is well exposed at numerous places along its outcrop, which extends across the township. A section measured in the SE. ¼ sec. 19 shows a thickness of 1 foot 1 inch. Farther east the bed is thicker, reaching a maximum near the east border of over 6 feet. Both of the coal beds in the Lebo are composed of low-grade coal with numerous thin partings of shale and sandstone, and neither could be mined profitably under present conditions.

In the upper part of the Fort Union formation three coal beds—the Wildhorse (O), the Buckey (N), and the Dougherty (M)—outcrop within the township. The Wildhorse bed is stratigraphically 450 feet above the Big Dirty bed and the Buckey bed is about 140 feet higher. The Dougherty bed from 150 to 200 feet above the Buckey underlies a small hill in sec. 6. (See Pl. XIV.) The coal in these beds appears to be uniform in character with that in other parts of the field—that is, high-grade subbituminous. The general physical and chemical characters are described on pages 48–59.

Wildhorse (O) coal bed.—The Wildhorse (O) coal bed is comparatively unimportant in this township. It was mapped for only a short distance in sec. 13 (see Pl. XIV), where the bed is much broken up by shale partings. The two sections following were measured:

Coal sections on the Wildhorse (O) coal bed in T. 5 N., R. 26 E.

No. on map, Pl. XIV.	Location.	Section.		No. on map, Pl. XIV.	Location.	Section.	
			Ft. in.				*Ft. in.*
1	Sec. 13, SE. ¼....	Coal.....	2	2	Sec. 13, SE. ¼....	Coal.....	3
		Shale.....	2			Shale.....	1
		Coal.....	1			Coal.....	5
		Shale.....	1			Shale.....	1 4
		Coal.....	3			Coal.....	1 5
		Interval.....	6 11				
		Coal.....	9				

Buckey (N) coal bed.—The Buckey (N) coal bed, stratigraphically about 140 feet above the Wildhorse, outcrops in the northern and northwestern parts of the township. The outcrop of the bed has been sketched nearly across the township, but is concealed in part by a heavy soil mantle and by burning along the outcrop. The thickness and character of the ash suggest that the thickness of the coal near the east border of the township is 5½ to 6 feet. A section measured in sec. 33, T. 6 N., R. 26 E., shows 8 feet 3 inches of coal and shale. The bed appears to be split up into several benches by shale partings, which in places are so thick that the benches are in reality distinct beds. The measurements listed below are believed to represent only one of the less important of these benches, the thicker bench exposed in sec. 33, T. 6 N., R. 26 E., being concealed by the soil mantle.

Coal sections on the Buckey (N) coal bed in T. 5 N., R. 26 E.

No. on map, Pl. XIV.	Location.	Section.	Ft.	in.
3	Sec. 5, NE. ¼....	Coal.....	1	3
4	Sec. 5, NE. ¼....	Coal.....	1	6
5	Sec. 4, NW. ¼...	Coal.....		11
6	Sec. 4, SE. ¼.....	Coal.....	1	3
7	Sec. 2, NW. ¼...	Coal.....		8
		Shale.....		2
		Coal.....	1	3
		Total coal.	1	11
8	Sec. 2, SW. ¼....	Coal.....		9
9	Sec. 2, SE. ¼.....	Coal.....	1	0
10	Sec. 2, NE. ¼....	Coal.....		7½
		Bone.....		2
		Coal.....	1	3
		Total coal.	1	10½
11	Sec. 12, NW. ¼...	Coal.....	1	10
12	Sec. 11, NE. ¼...	Ash.....		9
13	Sec. 11, NE. ¼...	Ash.....		9
		Coal.....		6
14	Sec. 11, SE. ¼....	Ash and coal...	2	2
		Shale.....		10
		Coal.....		4
15	Sec. 12, SE. ¼....	Ash.....	1	6
		Shale.....		10
		Coal.....		7
		Shale.....		10
		Coal.....		7
		Total coal.	1	2

Development.—Except for a shallow pit in the Big Dirty coal bed west of the county road in sec. 22, there has apparently been no attempt to develop the coals in this township.

The fact that the coals of this township are readily accessible to the proposed railway line between Roundup and Billings may lead to their early development. Favorable places for entry for mining can be selected in the coulee bottoms, but more northerly ones will generally afford the best and most economic mining.

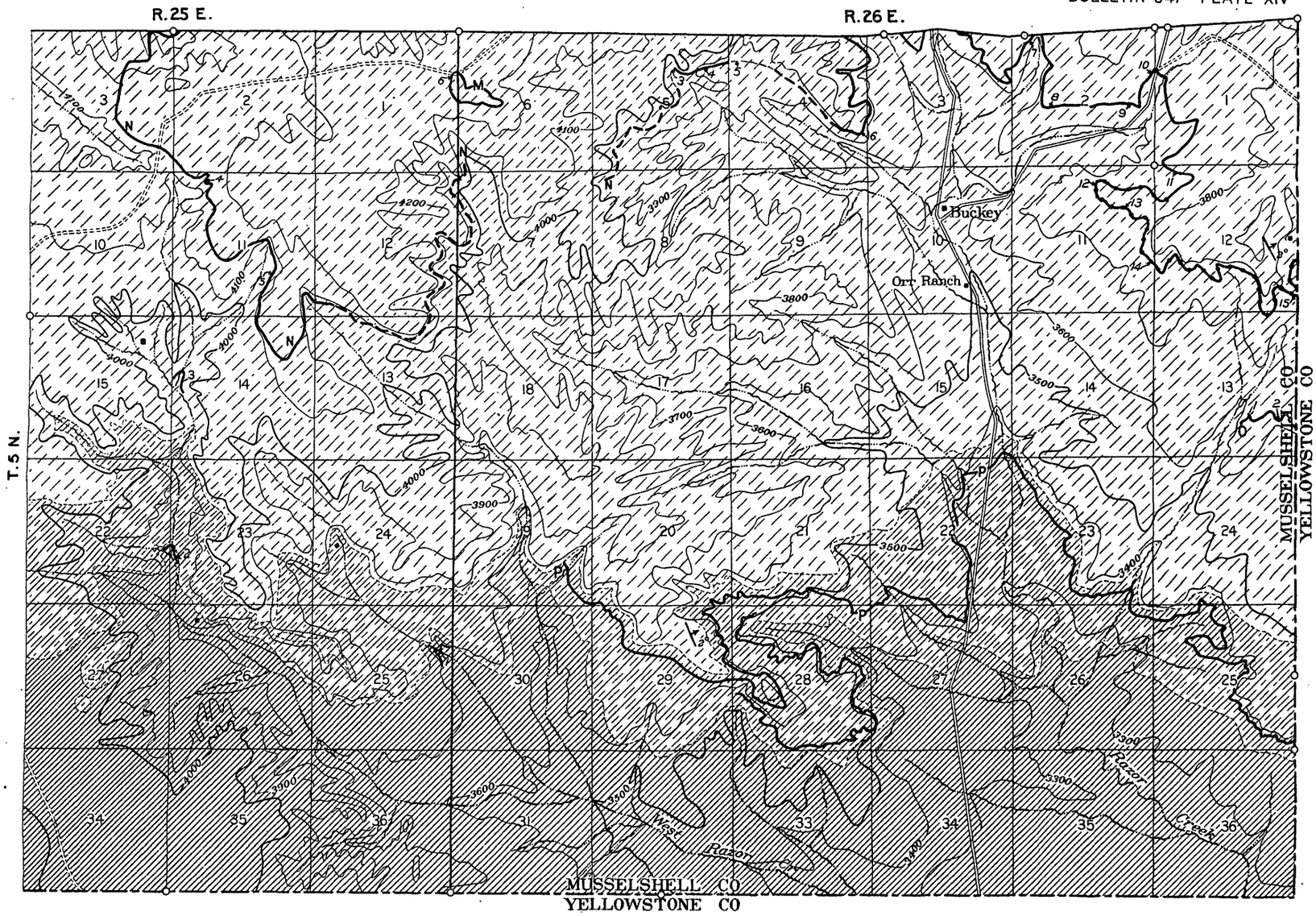
T. 6 N., R. 26 E.

GEOGRAPHY.

T. 6 N., R. 26 E., lies west of the Bull Mountains proper and comprises a portion of a partly dissected plateau of nearly horizontal sandstone and shale. The Yellowstone-Musselshell divide swings across the township from the southwest corner to the middle of the eastern boundary. The valley heads of Halfbreed, Goulding, and Razor creeks and their tributaries, which drain the township, have a canyon-like character mainly due to the steplike benches produced by the differential erosion of an alternation of soft shale and resistant sandstone.

The ridges between the valleys and subordinate gulches are in places massive and in places skeletal remnants. They have smooth tops which nearly conform to the general plateau level. The difference in elevation between the highest point on the main divide and the lowest points in the valleys of Halfbreed and Razor creeks is not much in excess of 400 feet.

The township is crossed centrally from north to south by the Billings-Roundup road and in the southeast corner by the Billings-Musselshell road. Both of these roads are maintained by Musselshell County.



LEGEND

TERTIARY
Eocene
Fort Union formation with Lebo shale member at base

TERTIARY(?)
Eocene ?
Lance formation

Outcrop of coal bed. Number indicates section described in text. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500

0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 5 N., R. 26 E., AND EASTERN PART OF T. 5 N., R. 25 E., MONTANA

The lands of the township are utilized chiefly for grazing. Some of the coulee bottoms contain a small acreage of wild hay land, and the northern and western slopes carry some pine, the better portion of which on the north side of the divide has been cut.

The water supply is limited to "water holes" and wells. The only ranch in the township at the time of the examination was situated in sec. 19 on Goulding Coulee. Since that time a number of ranches have been located along Dougherty Creek in the northeastern part of the township.

GEOLOGY.

All the surface rocks in the township belong to the upper part of the Fort Union formation. They consist of alternating beds of sandstone, clay shale, and coal, of which the buff to yellowish-gray sandstone is predominant and especially conspicuous where reddened by the burning of the underlying coal beds.

The strata of the township have a low but nearly uniform dip northeast.

COAL.

Stratigraphic relations.—Ten coal beds have been examined and their outcrops mapped for longer or shorter distances within the township. (See Pl. XV.) In addition, the Wildhorse (O) bed, which outcrops in the township to the south, underlies at least the southern part of this township. The following table shows the stratigraphic relations of these beds and the numbers of the coal sections measured on each.

Stratigraphic relations of coal beds in T. 6 N., R. 26 E., and the numbers of the sections measured on each.

	Feet.
Summit (A) coal bed, no measurement.	
Interval	40
Fattig (B) coal bed, no measurement.	
Interval	35
Red Butte (C) coal bed, no measurement.	
Interval	240
Upper Bull Mountain (F) coal bed, Nos. 107 and 108.	
Interval	45
Matt (H) coal bed, No. 106.	
Interval containing local bed, No. 105	170
Rock Mesa (I) coal bed, Nos. 87 to 104, inclusive.	
Interval	25
Mammoth (K) and Rehder (J) coal beds, Nos. 65 to 86, inclusive.	
Interval containing local coal bed, Nos. 59 to 64	90
Pompey (L) coal bed, Nos. 45 to 58, inclusive.	
Interval	110
Dougherty (M) coal bed, Nos. 6 to 44, inclusive.	
Interval	200
Buckey (N) coal beds, Nos. 1 to 4, inclusive.	
Interval	140
Wildhorse (O) coal bed.	

The coal in all these beds is apparently nearly uniform in character throughout this and adjoining townships. Chemical analyses of two badly weathered samples which were obtained from the Dougherty coal bed—one in the NE. ¼ sec. 27 (No. 31) and the other in the NW. ¼ sec. 36 (No. 36)—are included with other analyses from the Bull Mountain field on page 53.

The coal beds are described in order, beginning with the lowest, the Buckey group; the most important are the Dougherty and the Mammoth-Rehder.

Buckey (N) coal beds.—The Buckey group of coal beds is composed of two principal beds or benches and one or more thinner beds. The beds are separated by shale or clay of varying thickness. Coal section No. 2 (Pl. XV), in the SE. ¼ sec. 33, shows the character of the beds and of the partings. The three sections listed below represent only parts of the group. The beds outcrop for only short distances in the valleys in secs. 33 and 34, but from the structure and measurements in this and adjoining townships it seems evident that the most important has a thickness of 2 to 6 feet under the southern part of the township.

Coal sections on the Buckey (N) coal bed in T. 6 N., R. 26 E.

[See also Pl. XV.]

No. on map, Pl. XV.	Location.	Section.	No. on map, Pl. XV.	Location.	Section.
		Ft. in.			*Ft. in.*
1	Sec. 33, SE. ¼....	Coal..... 9	4	Sec. 34, SW. ¼...	Coal..... 9
					Shale..... 4
3	Sec. 34, lot 1....	Coal..... 2+			Coal..... 1 5+
					Base not exposed.
					Total coal. 2 2+

Dougherty (M) coal bed.—The Dougherty coal bed is stratigraphically about 200 feet above the Buckey beds and about 200 feet below the Mammoth. Its outcrop has been traced continuously across the southern part of the township from the northwest of sec. 30 to the southeast of sec. 36. On the north side of the divide it outcrops around the head of Goulding Coulee, in secs. 7, 18, 19, and 20, at an elevation of approximately 4,000 feet. Farther north, on Halfbreed Creek, in secs. 4 and 5, it outcrops at an elevation of about 3,750 feet. Its average thickness is about 3 feet. Presumably the coal bed underlies with nearly uniform thickness all the central and northern parts of the township except the portions of the valleys of Goulding and Halfbreed creeks below the outcrop. The Dougherty coal is especially noteworthy for the absence of bone and shaly partings. Its outcrop is much obscured by surface wash and is in many places burned but is shown on the map at 39 places,

A few of the more representative coal sections are shown in Plate XV and the others are listed below, but at many places only surface indications of the bed were found and at others only a part of the bed was examined. Analyses of two weathered samples of the Dougherty coal collected in this township—one at the outcrop in the NW. ¼ sec. 36 (No. 36) and the other in the NE. ¼ sec. 27 (No. 31, Pl. XV)—are shown on page 53 (laboratory Nos. 5798 and 5801).

Coal sections on the Dougherty (M) coal bed in T. 6 N., R. 26 E.

[See also Pl. XV.]

No on map, Pl. XV	Location.	Section.		No. on map, Pl. XV.	Location.	Section.	
		Ft.	*in.*			*Ft.*	*in.*
7	Sec. 7, SW. ¼...	Coal.....	8+	26	Sec. 28, NE. ¼...	Coal and ash. 1	0
8	Sec. 18, SW. ¼...	Coal bloom, shaly.		27	Sec. 27, NW. ¼..	Ash on west side road. Coal bloom on east side.	
9	Sec. 19, NE. ¼...	Coal bloom.					
10	Sec. 17, SW. ¼...	Coal..... May be at slightly higher horizon.	6+	28	Sec. 27, SW. ¼...	Coal..... 1+	
				29	Sec. 27, NE. ¼...	Coal bloom and ash.	
11	Sec. 20, NW. ¼..	Coal..... 1	6+	32	Sec. 27, SE. ¼....	Coal bloom and ash.	
12	Sec. 20, near S. ¼ corner.	Coal bloom.		33	Sec. 35, NW. ¼..	Coal bloom.	
13	Sec. 19, SE. ¼....	Coal bloom.		34	Sec. 25, SW. ¼...	Coal..... 2 Partly eroded.	2+
14	Sec. 19, SE. ¼....	Coal bloom.					
15	Sec. 19, SW. ¼...	Coal..... 3	5+	35	Sec. 36, NW. ¼..	Coal, shaly..	4
16	Sec. 30, NW. ¼..	Coal..... 2	7+			Coal..... 1	6+
17	Sec. 30, SE. ¼....	Coal..... 1+		37	Sec. 36, near E. ¼ corner.	Coal, shaly..	5+
18	Sec. 32, SW. ¼...	Coal..... 2+				Coal..... 1	4+
19	Sec. 32, NW. ¼..	Coal..... 1	6+	39	Sec. 5, near E. ¼ corner.	Ash.....	9
20	Sec. 32, NW. ¼..	Coal..... 2+		40	Sec. 4, SW. ¼....	Ash and coal 1+	
21	Sec. 32, NE. ¼...	Coal..... 1	6	42	Sec. 5, NE. ¼....	Coal.....	2
22	Sec. 28, SW. ¼...	Coal bloom and ash.				Shale..... 1	6
						Coal..... 3	2
23	Sec. 28, SW. ¼...	Coal.....	9+			Total coal.. 3	4
24	Sec. 28, NW. ¼..	Coal..... 3	0	43	Sec. 5, NW. ¼....	Ash.....	10
25	Sec. 28, NE. ¼...	Shale, coaly.	11	44	Sec. 5, NE. ¼....	Ash.	
		Coal..... 3+					

Pompey (L) coal bed.—The Pompey coal bed, about 110 feet above the Dougherty, appears near the top of the Musselshell-Yellowstone divide in the central part of the township. From the southwestern part of sec. 23, on the south side of the divide, the outcrop has been traced westward to the central part of sec. 20, then northward and across the divide between Goulding Coulee and Halfbreed creek to the southwestern part of sec. 16. On account of the thinness and the lack of exposures the bed was not traced farther east, but isolated

exposures in secs. 6, 7, 9, and 15 are correlated with this bed. Fourteen sections and partial sections were measured, of which the thickest, 2 feet 5 inches, is in the SW. ¼ sec. 21 (No. 54). Three of these coal sections are shown in Plate XV, and the others are listed below. They give a good idea of the variations in the thickness of the bed.

Coal sections on the Pompey (L) coal bed in T. 6 N., R. 26 E.

[See also Pl. XV.]

No. on map, Pl. XV.	Location.	Section.	No. on map, Pl. XV.	Location.	Section.
		Ft. in.			Ft. in.
45	Sec. 6, NW. ¼...	Coal bloom.	51	Sec. 17, NW. ¼..	Coal, poor..... 1 8
46	Sec. 7, SW. ¼....	Coal bloom.	52	Sec. 20, NE. ¼...	Coal bloom.
47	Sec. 9, NE. ¼....	Coal..... 1 2	54	Sec. 21, SW. ¼...	Coal..... 2 5
48	Sec. 15, SW. ¼...	Coal..... 7	55	Sec. 21, SW. ¼...	Coal bloom.
49	Sec. 16, SW. ¼...	Coal..... 1 6	56	Sec. 22, SW. ¼...	Coal, poor..... 2+
50	Sec. 17, NE. ¼...	Coal bloom.			

Local coal beds between Pompey and Mammoth beds.—About 40 feet below the Mammoth coal bed is a local bed which was examined at four places in sec. 3, where it showed thicknesses of 9 inches to 2 feet 2 inches (Nos. 59 to 62). No. 62 is shown in Plate XV, and the other three, together with measurements of other local and unimportant coal beds between the Pompey and Mammoth, are listed below.

Sections of local coal beds between the Mammoth and Pompey coal beds in T. 6 N., R. 26 E.

[See also Pl. XV.]

No. on map, Pl. XV.	Location.	Section.	No. on map, Pl. XV.	Location.	Section.
		Ft. in.			Ft. in.
54	Sec. 21, SW. ¼...	Coal..... 1 3 18 feet above Pompey bed.	63	Sec. 15, SW. ¼...	Coal..... 1 0 50 feet above Pompey.
59	Sec. 3, NW. ¼...	Coal..... 1 11 40 feet below Mammoth.	64	Sec. 25, NW. ¼..	Coal..... 10 10 to 20 feet below Mammoth.
60	Sec. 3, SE. ¼....	Coal..... 9			
61	Sec. 3, SE. ¼....	Coal..... 6 Coal and shale... 2 Coal..... 3			

Mammoth (K) and Rehder (J) coal beds.—The Mammoth coal bed, 90 feet above the Pompey, is the thickest and one of the most valuable in the Bull Mountains, though it has not yet been mined to any extent. Good exposures of this bed were found in sec. 25, but elsewhere in the township its outcrop is burned or is concealed by surface material. This bed can be easily traced by the benches formed by adjacent beds of sandstone and, where burned, by the resultant reddening of the overlying beds along the outcrop.

The greatest thickness of the Mammoth bed in this township was found in sec. 25 (No. 77), where 6 feet 7 inches of coal is exposed.

The bed includes several thin partings, one of which thickens very abruptly toward the north and separates the upper portion so far from the lower that in the northern part of the township it will have to be mined as a separate bed. This upper portion is called the Rehder coal bed in this report. The Mammoth coal bed is very inadequately shown in the sections on Plate XV and listed below, but it is better exposed in the townships to the north and east. The bed ranges in thickness from an estimated minimum of 2 feet at the north border of the township to a maximum of over 6 feet 7 inches in sec. 25. This extreme variation is due mainly to the splitting off of the Rehder bed.

The Rehder coal bed is separated from the Mammoth in the northeast corner of the township by a sandstone 25 to 30 feet thick. Toward the south this sandstone decreases in thickness, so that the Rehder bed in the southern half of the township constitutes the upper portion of the Mammoth bed. Good exposures were found on the north side of Dougherty Creek and along the Billings-Musselshell road in sec. 13. The thickness ranges from a minimum of 2 feet 2 inches (No. 84, Pl. XV) to an estimated maximum of 4 feet 6 inches in the northeast corner of sec. 1.

The following tables and the graphic sections on Plate XV include all the measurements made within the township on these two beds.

Coal sections on the Mammoth (K) and Rehder (J) coal beds in T. 6 N., R. 26 E.

[See also Pl. XV.]

Mammoth (K) coal bed.

No. on map, Pl. XV.	Location.	Section.	No. on map, Pl. XV.	Location.	Section.
		Ft. in.			*Ft. in.*
65	Sec. 11, NW. ¼..	Coal, bloom.	74	Sec. 21, SW. ¼...	Coal, bloom.
66	Sec. 11, SE. ¼...	Coal..... 2 9+	75	Sec. 23, SW. ¼...	Poor exposure of coal, no base.
69	Sec. 15, SE. ¼....	Bloom.	76	Sec. 25, NW. ¼..	Coal..... 2 3½ Shale.
70	Sec. 15, NW. ¼..	Bloom.			
71	Sec. 4, SE. ¼.....	Bloom.			
72	Sec. 10, SW. ¼...	Coal..... 1 Shale..... 1 3 Coal..... 3+ Total coal. 3 1			

Rehder (J) coal bed.

84	Sec. 13, SW. ¼...	Coal..... 2 2 28 feet below Rock Mesa bed.	86	Sec. 25, NW. ¼..	Coal..... 10+ 30 feet above Mammoth bed.

Rock Mesa (I) coal bed.—From 25 to 35 feet above the Rehder bed a persistent coal bed, known as the Rock Mesa, outcrops continuously across the northeastern and eastern parts of the township from

sec. 3 to sec. 25, following fairly closely the outcrop of the Mammoth and Rehder beds. The 18 coal sections shown on Plate XV and listed below indicate that the bed ranges in thickness from 1 foot 8 inches to about 3 feet, the average being about 2 feet 2 inches. In sec. 12 (No. 105) a thin coal bed was found 25 feet above the Rock Mesa bed. The section measured at that place is included in the list below.

Coal sections on and above Rock Mesa (I) coal bed in T. 6 N., R. 26 E.

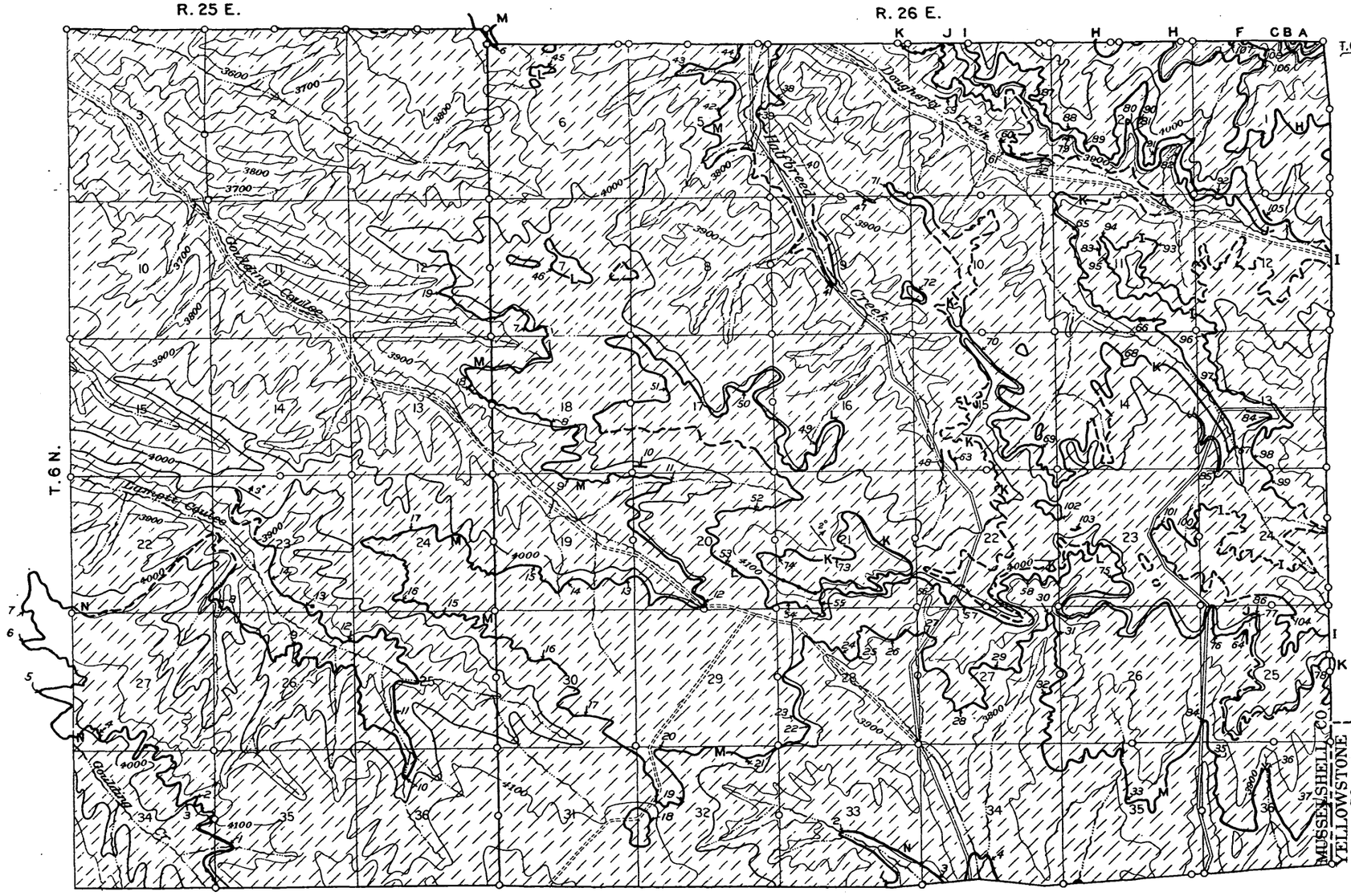
[See also Pl. XV.]

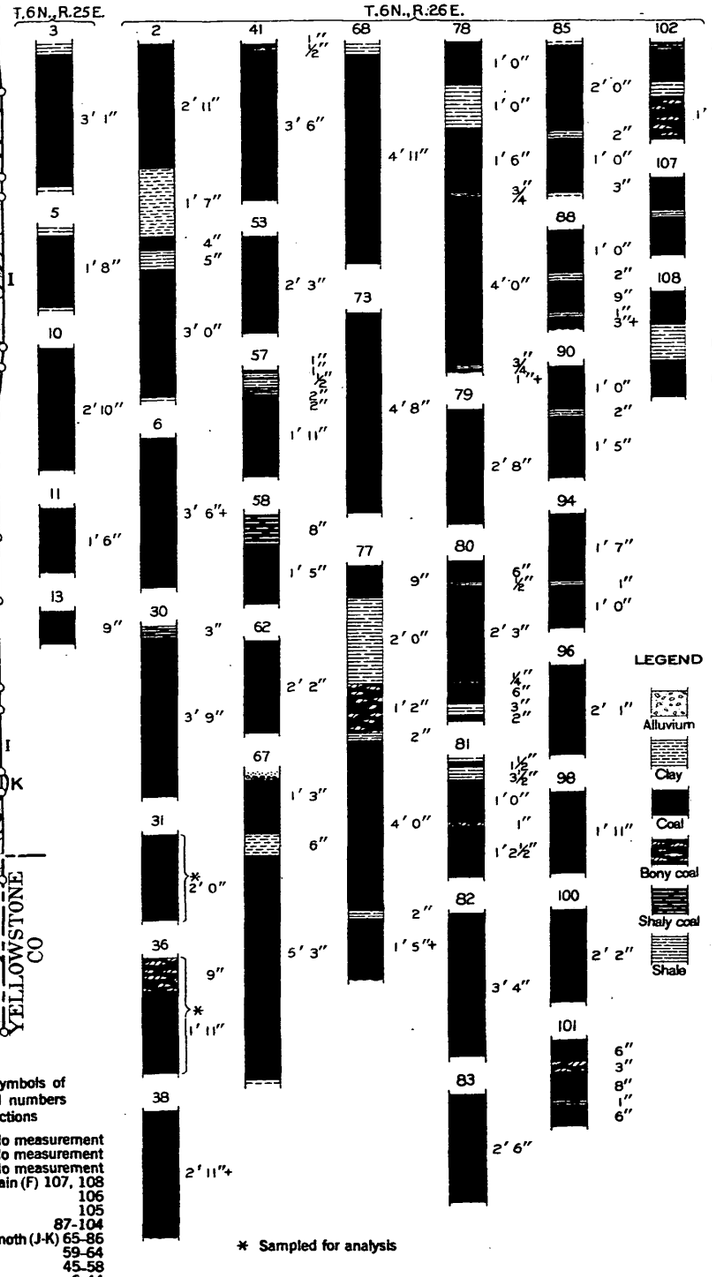
No. on map, Pl. XV.	Location.	Section.	Ft.	in.
87	Sec. 3, NE. ¼...	Coal	3	0
		35 feet above Rehder coal.		
89	Sec. 2, SW. ¼....	Coal	1	6
		Coal, bony		5
		Coal		5
		Shale and coal.		3
91	Sec. 2, SE. ¼.....	Coal	1	6+
92	Sec. 1, SW. ¼....	Coal	2	0
93	Sec. 11, NE. ¼...	Coal	1	10+
95	Sec. 11, NW. ¼..	Coal	2	8
97	Sec. 13, NW. ¼..	Coal	2	1+
99	Sec. 24, NE. ¼...	Coal		7
		Shale		4
		Coal	1+	
103	Sec. 23, NW. ¼..	Coal	2	3+
		49 feet above Mammoth coal.		
104	Sec. 25, NE. ¼...	Coal		3
		Ash	1	1
		Coal		4
105	Sec. 12, NE. ¼...	Coal		½
		Shale		6
		Coal		6
		25 feet above Rock Mesa coal.		

Matt (H) coal bed.—The Matt coal bed, 170 feet above the Rock Mesa, appears on the south face of a spur of Bridges Butte in sec. 1 and in the northeastern part of sec. 2. Only one partial section in sec. 1 (No. 106) was measured, where the thickness is over 2 feet. A measurement in sec. 6, T. 6 N., R. 27 E. (No. 70, Pl. XIX), shows a thickness of 3 feet of coal with a 4-inch shale parting. It is possible that the Matt coal bed is the same as the Lower Bull Mountain bed, for the two, though mapped independently in different parts of the field, are separated by similar intervals from adjacent coal beds. Future mining development will settle this question.

Upper Bull Mountain (F) coal bed.—The Upper Bull Mountain coal bed is 45 feet above the Matt coal and is separated from it by a bed of sandstone. The coal bed was traced for only a short distance into the northern part of sec. 1. It contains 1 foot 8 inches of coal but includes a central shale parting 2 to 10 inches thick. Two sections were measured. (See Pl. XV.)

Red Butte (C), Fattig (B), and Summit (A) coal beds.—The Red Butte, Fattig, and Summit coals outcrop for short distances on the south bluff of Bridges Butte but were nowhere measured in this township. As determined in the adjoining townships the Red Butte





SECTIONS

* Sampled for analysis

TERTIARY
Eocene
Fort Union formation

LEGEND

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Prospect

Strike and dip

Land corner found

Names and symbols of coal beds and numbers of coal sections

Summit (A)	No measurement
Fattig (B)	No measurement
Red Butte (C)	No measurement
Upper Bull Mountain (F)	107, 108
Matt (H)	106
Local	105
Rock Mesa (I)	87-104
Rehder and Mammoth (J-K)	65-86
Local	59-64
Pompey (L)	45-58
Dougherty (M)	6-44
Buckey (N)	1-4

Scale 1/62,500

0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 6 N., R. 26 E., AND EASTERN PART OF T. 6 N., R. 25 E., MONTANA

bed measures about 2½ feet and the Fattig and Summit beds each about 3 feet.

Development.—No coal has been mined in the township, but prospects have been opened in secs. 9 and 36 on the Dougerty bed. The coal beds will presumably be mined from the northern side, the choice being influenced by the northeast dip of the beds and the easier access to railroad transportation. There are, however, numerous favorable places of entry on the south side of the divide, and the inclination of the beds is not great enough to seriously hamper mining.

T. 7 N., R. 26 E.

GEOGRAPHY.

T. 7 N., R. 26 E., lies on the northwestern side of the Bull Mountains proper and, except for its northeastern portion, which is drained by a fork of West Parrott Creek, lies wholly within the drainage basin of Halfbreed Creek. The present surface configuration is the result of the long-continued action of intermittent water and wind erosion on nearly horizontal beds of shale and sandstone. The area is well dissected, and the creek valley and coulees have steep terraced walls which are rendered difficult of access by the cliffs of heavy sandstone. Trails cross these sandstons on the ends of the ridges and in the bottoms of the gulches. The ridges range from skeletal to massive, but the tops of both varieties are in most places smoothly rounded and easily traversed. In the southeast corner of the township a high Z-shaped hill (Bridges Butte) has an altitude of about 4,400 feet. The elevation of Halfbreed Creek at the point where it leaves the township is less than 3,400 feet. The range in elevation or the relief is over 1,000 feet.

The heavy sandstone normally has a buff to yellow tinge and locally is very soft and readily eroded, but upon baking, through the burning of underlying coal, it assumes a bright red tinge which makes it especially conspicuous. The shale in places has been fused into a porcelain-like clinker darker than that of baked sandstone.

The hillsides of the township are covered with a moderate growth of pine and a thin undergrowth of "jack pine." The large timber has been cut for use in the construction work on the Chicago, Milwaukee & St. Paul Railway.

The only running water in the township is found north of sec. 33, in Halfbreed Creek, whose principal source is the "Big Spring," in sec. 21. A smaller spring was noted in sec. 25 and a well in sec. 12. It is possible to obtain water at comparatively shallow depths almost anywhere in the valleys by drilling into the underlying beds of sandstone, which are natural reservoirs.

The principal county road in the township is that from Roundup to Billings along Halfbreed Creek. Three secondary roads cross the divide between Halfbreed and Parrott creeks.

GEOLOGY.

All the rocks exposed in the township belong to the upper part of the Fort Union formation, of which about 1,000 feet of strata is exposed. The formation consists of alternating beds of sandstone, clay, shale, and coal, of which the buff to yellowish-gray sandstone is predominant. The structure is simple. A synclinal trough with gently dipping sides extends northwest and southeast across the township, its axis coinciding with the main ridge between Halfbreed and Parrott creeks. The maximum dips in the township are not over 2°.

COAL.

Stratigraphic relations.—Fourteen coal beds, ranging in thickness from a few inches to 4 feet 6 inches, have been traced and mapped for longer or shorter distances, and the Roundup coal bed is believed to underlie the entire township. (See Pl. XVI.) The following table shows the stratigraphic relations of the coal beds and the number of sections measured on each bed:

Stratigraphic relations of coal beds in T. 7 N., R. 26 E., and the numbers of the sections measured on each.

	Feet.
Top.	
Summit (A) coal bed, Nos. 68 to 71, inclusive.	
Interval	35–45
Fattig (B) coal bed, Nos. 64 to 67, inclusive.	
Interval	30–35
Red Butte (C) coal bed, Nos. 61 to 63, inclusive.	
Interval	60–80
Strait (D) coal bed, No. 60.	
Interval	175±
Upper Bull Mountain (F) coal bed, Nos. 46 to 59, inclusive.	
Interval	12–25
Lower Bull Mountain (G) coal bed, Nos. 43 to 45, inclusive.	
Interval	?
Matt (H) coal bed, No. 42.	
Interval	80±
Carter (Ha) coal bed, No. 41.	
Interval	50
Rock Mesa (I) coal bed, Nos. 27 to 40, inclusive.	
Interval, including local coal bed, No. 26	35
Rehder (J) coal bed, Nos. 21 to 25, inclusive.	
Interval, including local coal bed, No. 20	25–35
Mammoth (K) coal bed, Nos. 17 to 19, inclusive.	
Interval	40
Saddler (Ka) coal bed, Nos. 15 and 16.	
Interval	100±
Ostrander (La) coal bed, No. 14.	
Interval	60
Dougherty (M) coal bed, Nos. 1 to 13, inclusive.	
Interval	510
Roundup (Oa) coal bed, not exposed.	

The coal in all these beds is high-grade subbituminous, uniform in character with the coal in other parts of the field. The general physical and chemical properties of the coal in the Bull Mountain field are discussed on pages 48–59.

Dougherty (M) coal bed.—The Dougherty coal bed, stratigraphically 510 feet above the Roundup coal bed, outcrops on both sides of Halfbreed Creek about halfway up the sides of the first steep slopes. The bed is also exposed for a short distance on Parrott Creek in secs. 1 and 2. It presumably underlies the whole of the township except the valleys of Halfbreed and Parrott creeks, which lie below the outcrop. At a number of places the coal has been burned, and in other places the outcrop is concealed by the heavy wash from the slopes above. Good exposures of the bed obtained at several localities in the valley of Halfbreed Creek show a nearly uniform increase in thickness from about 2 feet in the northern part of the township to 4 feet 6 inches in sec. 32 (No. 3, Pl. XVI). No measurement was made on Parrott Creek in the northeast corner of the township, but measurements in adjoining townships show that the thickness decreases to less than 2 feet in that direction. The graphic sections on Plate XVI and the following list show the data obtained at 13 places on the Dougherty bed in the valley of Halfbreed Creek.

Coal sections on the Dougherty (M) coal bed, in T. 7 N., R. 26 E.

[See also Pl. XVI.]

No. on map, Pl. XVI.	Location.	Section.	No. on map, Pl. XVI.	Location.	Section.
		Ft. in.			*Ft. in.*
4	Sec. 33, SW. ¼...	Ash..... 1 0	8	Sec. 21, NW. ¼..	Coal..... 2+
5	Sec. 33, NW. ¼..	Coal bloom.	9	Sec. 21, NW. ¼..	Coal..... 3 3
6	Sec. 33, NW. ¼..	Coal bloom.	11	Sec. 6, SW. ¼....	Ash..... 6
7	Sec. 28, SW. ¼...	Coal bloom.	12	Sec. 6, NW. ¼...	Coal..... 1 11

Ostrander (La) and Saddler (Ka) coal beds.—In the SW. ¼ sec. 1 (No. 14) on the west fork of Parrott Creek an isolated exposure shows the following coal section:

Coal section No. 14, SW. ¼ sec. 1, T. 7 N., R. 26 E.

	Ft.	in.
Coal, impure		4
Shale	1	6
Coal		10
Total coal	1	2

This is probably the equivalent of the Ostrander (La) bed, which reaches its maximum development in T. 6 N., R. 28 E. The Saddler (Ka) coal bed, about 40 feet below the Mammoth, was measured at two places in sec. 12—No. 15 in the NW. ¼ and No. 16 in the NE. ¼—

where the thicknesses are 1 foot 6 inches and 1 foot 9 inches, respectively.

Mammoth (K) and Rehder (J) coal beds.—The Mammoth and Rehder coal beds, separated in this township by an interval of 25 to 35 feet, are stratigraphically about 200 feet above the Dougherty. Their outcrops lie on both sides of the northwest-southeast ridge between Halfbreed and Parrott creeks and were easily traced throughout the township by prominent lines of clinker and reddened sandstone and shale where the beds have been burned out. Only in a very few places would it be possible to obtain coal sections without extensive trenching or drilling, and the few measurements which were obtained give a very inadequate idea of the importance of these beds. Though the evidence is not conclusive, each bed probably has a thickness of 4 feet or more on the east side of the township around the head of Parrott Creek. Westward the thickness is not so great. On the bluffs facing Halfbreed Creek the Mammoth bed has a thickness of 2 to 2½ feet, whereas the Rehder bed is from 2½ to 3 feet thick.

Three locations (Nos. 17, 18, and 19) on the Mammoth bed, one (No. 20) in the NE. ¼ sec. 5 on a thin intermediate bed 8 inches thick, and five (Nos. 21 to 25) on the Rehder bed are shown on the map (Pl. XVI). The coal sections at Nos. 18, 22, and 25 are represented graphically in Plate XVI. The data obtained at other places on the Mammoth and Rehder beds are listed below.

Coal sections on the Mammoth (K) and Rehder (J) coal beds in T. 7 N., R. 26 E.

[See also Pl. XVI.]

Mammoth (K) coal bed.

No. on map, Pl. XVI.	Location.	Section.	No. on map, Pl. XVI.	Location.	Section.
		Ft. in.			*Ft. in.*
17	Sec. 15, SE. ¼....	Coal, burned.	19	Sec. 4, NW. ¼...	Coal, burned.... 3±

Rehder (J) coal bed.

21	Sec. 34, NW. ¼...	Coal..... 2 4	24	Sec. 5, NE. ¼....	Coal, burned.... 3±
23	Sec. 15, SE. ¼....	Coal, burned.... 3±			

Local coal between Rehder and Rock Mesa coal beds.—In the NW. ¼ sec. 14 (No. 26) a bed of coal 1 foot 6 inches thick was found between the Rehder and Rock Mesa beds. The section measured at that place is shown in Plate XVI.

Rock Mesa (I) coal bed.—The Rock Mesa coal bed outcrops on both sides of the long ridge which extends across the township northwestward from Bridges Butte. Northwest of sec. 23 it is the highest bed

on this ridge. Though only about 35 feet above the Rehder bed and as a rule outcropping on the same slopes, the Rock Mesa bed is not nearly so much burned at the outcrop. It is much concealed, however, by surface wash and afforded only a few good sections for measurement. The data, all of which are included in the table below or shown graphically in Plate XVI, show a range in thickness of only 6 inches, from 2 feet 3 inches to 2 feet 9 inches, the average being about 2 feet 5 inches.

Coal sections on the Rock Mesa (I) coal bed in T. 7 N., R. 26 E.

[See also Pl. XVI.]

No. on map, Pl. XVI.	Location.	Section.		No. on map, Pl. XVI.	Location.	Section.	
			Ft. in.				*Ft. in.*
27	Sec. 34, SW. ¼...	Ash.....	4	36	Sec. 15, SW. ¼...	Coal.....	1 6
						Bone.....	1
28	Sec. 27, SE. ¼....	Coal bloom.				Coal.....	10
						Total coal..	2 4
29	Sec. 27, SE. ¼....	Coal bloom.					
31	Sec. 26, NE. ¼...	Coal.....	2 5+	37	Sec. 9, SE. ¼.....	Shale.	
						Coal.....	1 6
32	Sec. 26, NW. ¼...	Coal.....	2 5			Bone.....	2
						Coal.....	10
33	Sec. 22, SE. ¼....	Coal.....	6			Shale.	
		Shale.....	3 0				
		Coal.....	2 4			Total coal..	2 4
		Shale.....	5 0				
		Coal.....	8	38	Sec. 9, NE. ¼....	Coal.....	1 2
						Bone.....	1
34	Sec. 22, NE. ¼...	Shale, carbonaceous.....	3			Coal.....	1 1
		Coal.....	1 5			Total coal..	2 3
		Shale.....	3				
		Coal.....	10	40	Sec. 24, NE. ¼...	Coal.....	2+
		Total coal..	2 3				

Carter (Ha) coal bed.—A single exposure on what is probably the Carter coal bed was found about 50 feet above the outcrop of the Rock Mesa bed in the SW. ¼ sec. 34 (No. 41). The bed at this place is 1 foot 2 inches thick.

Matt (H) coal bed.—The Matt coal bed was traced from the south for about half a mile into sec. 35. Only one section was measured in the township, in the SW. ¼ sec. 35 (No. 42). The thickness at this place is 1 foot.

Lower Bull Mountain (G) coal bed.—The Lower Bull Mountain coal bed, 12 feet below the Upper Bull Mountain coal bed, has been traced for a short distance on the north side of the ridge in secs. 25 and 26. It is of no great importance in this township, the maximum thickness being a little over 2 feet. Three measurements were made, one of which (No. 44) is shown graphically in Plate XVI. The others are as follows:

Coal sections on the Lower Bull Mountain (G) coal bed in T. 7 N., R. 26 E.

[See also Pl. XVI.]

No. on map, Pl. XVI.	Location.	Section.	No. on map, Pl. XVI.	Location.	Section.
		Ft. in.			*Ft. in.*
43	Sec. 26, SE. ¼....	Coal..... 2+ 12 feet below the Upper Bull Mountain bed.	45	Sec. 25, SE. ¼....	Coal..... 2+

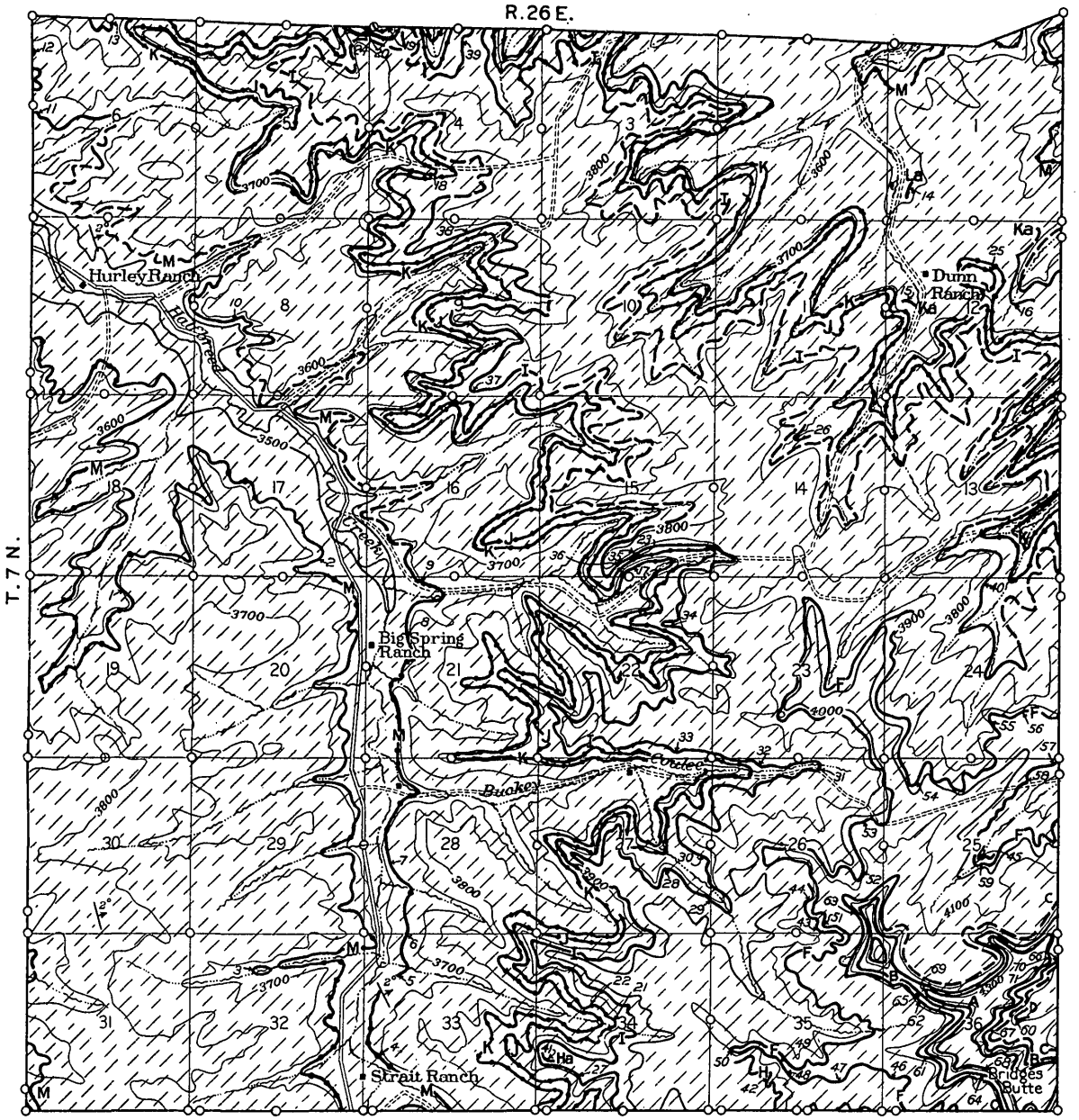
Upper Bull Mountain (F) coal bed.—The Upper Bull Mountain coal bed has been mapped continuously around the part of Bridges Butte which lies in the southwestern part of the township. The exposures along its outcrop are better than on any of the lower beds in the township. The coal bed, however, is not important, for it is in most places broken into thin benches by shale partings. The maximum thickness of 2 feet 6 inches in the township is under a narrow ridge in the SE. ¼ sec. 24 (No. 55, Pl. XVI). The graphic sections in Plate XVI and the sections given in the following list include all the measurements.

Coal sections on the Upper Bull Mountain (F) coal bed in T. 7 N., R. 26 E.

[See also Pl. XVI.]

No. on map, Pl. XVI.	Location.	Section.	No. on map, Pl. XVI.	Location.	Section.
		Ft. in.			*Ft. in.*
47	Sec. 35, SE. ¼....	Coal..... 9 Shale..... 10 Coal..... 10	52	Sec. 26, SE. ¼....	Coal..... 1 6
		Total coal.. 1 7	54	Sec. 25, NW. ¼..	Shale, carbonaceous..... 1 Coal..... 1 9 Shale..... 1 Coal..... 3
49	Sec. 35, SW. ¼...	Coal..... 9 Shale..... 7 Coal..... 7 Shale..... 4 Coal..... 9			Total coal.. 2 0
		Total coal.. 2 1	56	Sec. 24, SE. ¼.....	Coal..... 2+
50	Sec. 35, SW. ¼...	Coal..... 9 Shale..... 9 Coal..... 1 0	57	Sec. 25, NE. ¼...	Coal..... 1 1 Shale..... 1 Coal..... 1½
		Total coal.. 1 9			Total coal.. 1 2½
51	Sec. 26, SE. ¼....	Coal..... 9	58	Sec. 25, NE. ¼...	Coal..... 2 3+ Base not exposed.

Strait (D), Red Butte (C), Fattig (B), and Summit (A) coal beds.—Bridges Butte lies principally in sec. 36 but extends into secs. 35 and 26. High up on its sides are three coal beds. The lowest of these, the Red Butte, is approximately 240 feet above the Bull Mountain coals and 30 to 35 feet below the Fattig, which in turn is 35 to 45



LEGEND

TERTIARY
Eocene
Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

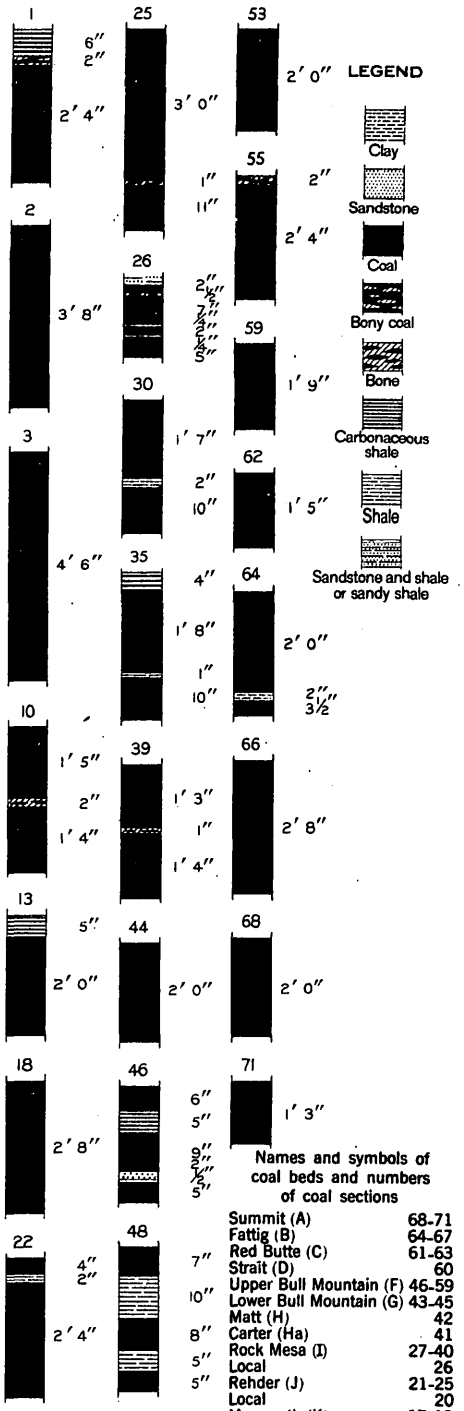
Coal bed burned at outcrop

Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500
0 1 2 MILES



Names and symbols of coal beds and numbers of coal sections

Summit (A)	68-71
Fattig (B)	64-67
Red Butte (C)	61-63
Strait (D)	60
Upper Bull Mountain (F)	46-59
Lower Bull Mountain (G)	43-45
Matt (H)	42
Carter (Ha)	41
Rock Mesa (I)	27-40
Local	26
Rehder (J)	21-25
Local	20
Mammoth (K)	17-19
Saddler (Ka)	15, 16
Ostrander (La)	14
Dougherty (M)	1-13
Roundup (Oa)	Not exposed

SECTIONS

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 7 N., R. 26 E., MONTANA

feet below the Summit bed. Good exposures have been found on all these beds. The average thickness of the Red Butte bed is 1 foot 4 inches; of the Fattig, 2 feet 7 inches; and of the Summit, 1 foot 5 inches. The Strait coal bed, 60 to 80 feet below the Red Butte, is exposed at only one place on the east side of Bridges Butte. The graphic sections in Plate XVI and the sections given in the following lists include all measurements made on these four beds.

Coal sections on the Strait (D), Red Butte (C), Fattig (B), and Summit (A) coal beds in T. 7 N., R. 26 E.

[See also Pl. XVI.]

Strait (D) coal bed.

No. on map, Pl. XVI.	Location.	Section.		No. on map, Pl. XVI.	Location.	Section.	
			Ft. in.				*Ft. in.*
60	Sec. 36, SE. ¼..	Coal.....	6				

Red Butte (C) coal bed.

61	Sec. 36, SW. ¼...	Coal.....	3	63	Sec. 26, SE. ¼....	Coal.....	1 1

Fattig (B) coal bed.

65	Sec. 36, NW. ¼..	Coal.....	2 8	67	Sec. 36, SE. ¼...	Coal.....	2 6

Summit (A) coal bed.

69	Sec. 36, NW. ¼.	Coal.....	1 8	70	Sec. 36, NE. ¼..	Coal.....	6
						Shale.....	2
						Coal.....	4
						Total coal...	10

Development.—The coal beds of this township have not been developed, and no coal has been mined except possibly from surface prospects opened by ranchers to obtain a few wagonloads. Mining operations will probably be first begun in the heads of the branches of Parrott Creek in the northeastern part of the township, where the Mammoth and Rehder beds each have a thickness of about 4 feet, presumably slightly greater than in the western part of the township. A railroad spur could easily be constructed up Parrott Creek to this locality. Some of the higher coal beds outcropping in and adjacent to Eldridge Mesa can be most advantageously mined from the heads of branches of Parrott Creek. The valley of Halfbreed Creek, which crosses the western part of the township in a general northwest direction, is an ideal route for a railroad spur by which to remove the coal from mines in the western half of the township.

T. 8 N., R. 26 E.

GEOGRAPHY.

Musselshell River flows northeastward across the north-central part of T. 8 N., R. 26 E., and its nearly flat flood plain is about half a mile in width. The northern half of the township is a gently rolling, heavily grassed prairie and has a gradual slope toward the river. Toward the south the surface rises more abruptly, and the valleys of the streams are separated from the plateau or bench lands by almost vertical cliffs of rim rocks. The most important valleys occupied by intermittent streams are Berrigan Coulee and West Parrott Creek and its tributary, Spring Creek, on the south side of the river, and Willow Creek on the north side. Musselshell River and a few springs in the southern part of the township have hitherto furnished the water supply, but the geology and structure are such that an abundant supply may be expected at comparatively shallow depths in the valleys.

The Chicago, Milwaukee & St. Paul Railway follows the north side of the river, as does the county road connecting Roundup with the towns to the east. The greater part of the township is easily accessible by secondary roads.

Much of the area, particularly the northern part, is adapted to dry farming. In addition a considerable part of the flood plain of Musselshell River has been irrigated with excellent results. The steep slopes and the higher mesas are clothed with a moderate growth of pine.

GEOLOGY.

Rocks of the Lance formation and of the Lebo shale member and the upper part of the Fort Union formation outcrop in the township. The gray sandstone and clay shale of the Lance formation outcrop over parts of secs. 4, 5, and 6 and are overlain by the somber shale and coarse yellow sandstone of the Lebo shale member, which is 200 to 300 feet in thickness. This member outcrops over most of the area north of Musselshell River and extends in a narrow strip south of the river across secs. 12, 11, and part of 10. The upper or coal-bearing part of the Fort Union underlies nearly all the southern two-thirds of the township and consists of alternating beds of sandstone, clay, shale, and coal, of which the buff to yellowish-gray sandstone is predominant, though in beds which are extremely variable in thickness and which locally give way to bedded sandy shale with intercalated clay. The total thickness of the strata exposed is about 1,800 feet. The main synclinal axis of the Bull Mountains crosses the township in a southeast direction from sec. 30 to sec. 33. North of this axis the dips are low and somewhat irregular. Along the outcrops of the Roundup coal bed they are 3°–8° S.

COAL.

Stratigraphic relations.—The Big Dirty coal bed occupies a stratigraphic position about the middle of the Lebo shale, but across the greater part of the township its outcrop is covered by the alluvial deposits of Musselshell River. Indications of coal were observed at two places along the main outcrop in secs. 1 and 7. Small outliers of the bed outcrop in hills in secs. 2 and 3. A partial exposure in sec. 2 shows about 2 feet of impure sandy coal corresponding fairly well in character with the thick bed of intercalated shale, thin sandstone, and coal which is found in adjoining townships.

In the upper part of the Fort Union seven coal beds have been studied and mapped. Of these the Roundup, Dougherty, Mammoth, Rehder, and Rock Mesa are the most important. The last three, however, underlie only very small areas in the township. (See Pl. XVII.)

The following table shows the stratigraphic relations of the coal beds and the number of coal sections which have been examined on each bed. The numbered sections refer to numbers on the map, Plate XVII.

Stratigraphic relations of coal beds in T. 8 N., R. 26 E., and the numbers of the sections measured on each.

	Feet.
Rock Mesa (I) coal bed, no measurements.	
Interval	35
Rehder (J) coal bed, no measurements.	
Interval	25–35
Mammoth (K) coal bed, no measurements.	
Interval	40
Saddler (Ka) coal bed, No. 42.	
Interval	160
Dougherty (M) coal bed, Nos. 29 to 41, inclusive.	
Interval	40
Chandler (Ma) coal bed, Nos. 17 to 28 inclusive.	
Interval, containing unidentified coal beds, Nos. 12 to 16 inclusive	470
Roundup coal bed (Oa), Nos. 1 to 11 inclusive.	
Interval to top of Lebo shale member of the Fort Union formation	500

The coal in these beds is of the same character as that in other parts of the Bull Mountain field. The physical and chemical characters are discussed on pages 48–59. The beds are described below from the bottom up.

Roundup (Oa) coal bed.—The Roundup coal bed has been traced chiefly by the "blossom," from a point near the Newton ranch in sec. 18 to the east border of sec. 24. The comparatively few coal sections measured in this township, the sections in the township to the west, and the numerous exposures of "blossom" and burned coal show that the thickness of the Roundup decreases continuously from

west to east, declining from over 6 feet in sec. 13, T. 8 N., R. 25 E., to about 1 foot in sec. 24 of this township. One of the former important coal mines of the field, the Davis mine (No. 4), was located on this bed in sec. 17 (No. 2, Pl. XVII), where a sample was obtained for chemical analysis (laboratory No. 17587, p. 52). A local mine has been opened in the NW. ¼ sec. 22 (No. 6). The bed was examined at 11 places in the township. Two of the sections measured (Nos. 2 and 6) are shown graphically in Plate XVII, and the others are as follows:

Coal sections on the Roundup (Oa) coal bed in T. 8 N., R. 26 E.

[See also Pl. XVII.]

No. on map, Pl. XVII.	Location.	Section.		No. on map, Pl. XVII.	Location.	Section.	
			Ft. in.				*Ft. in.*
1	Sec. 18, SE. ¼...	Ash.....	1 3	8	Sec. 14, SW. ¼...	Coal.....	1 7
3	Sec. 16, SW. ¼...	Coal bloom.		9	Sec. 23, NE. ¼...	Ash.....	3
4	Sec. 16, SE. ¼...	Coal bloom.		10	Sec. 24, NW. ¼..	Ash.....	2
5	Sec. 15, SW. ¼...	Coal bloom.				Coal.....	6
7	Sec. 14, SW. ¼...	Coal.....	1 6	11	Sec. 24, NW. ¼..	Coal, burned...	2± 0

Unidentified beds between Roundup and Chandler coal beds.—The five sections following represent local coal beds between the Roundup and Chandler. Nos. 12, 13, and 14 were obtained from a thin bed or series of thin beds about 30 feet above the Roundup. Nos. 15 and 16 are only a short distance stratigraphically below the Chandler bed. No. 15 is on Berrigan Coulee in sec. 28, 50 to 100 feet below the supposed horizon of the Chandler bed, which here is not mapped.

Coal sections on unidentified coal beds between the Roundup and Chandler beds in T. 8 N., R. 26 E.

No. on map, Pl. XVII.	Location.	Section.		No. on map, Pl. XVII.	Location.	Section.	
			Ft. in.				*Ft. in.*
12	Sec. 17, SE. ¼... Reported by Republic Coal Co.	Shale, sandy.....	1 0	13	Sec. 16, SE. ¼...	Coal.....	8
		Shale, carbonaceous.	1	14	Sec. 24, SW. ¼...	Coal.....	3
		Shale.....	6			Shale.....	3
		Coal.....	3			Coal.....	3
		Shale, carbonaceous.	2			Total coal..	6
		Coal.....	4				
		Shale, carbonaceous.	1	15	Sec. 28, NE. ¼...	Coal.....	1 4
		Coal.....	3	16	Sec. 29, NW. ¼..	Coal.....	4
		Shale, carbonaceous.	6				
		Coal.....	1				
		Shale.....	1 9				
		Coal.....	3				
		Shale, sandy.					
		Total coal 30 feet above Oa.	1 2				

Chandler (Ma) coal bed.—The Chandler coal bed, stratigraphically about 470 feet above the Roundup, has been traced around the headwaters of the northward-flowing streams in secs. 19, 20, 29, 30, and 31, in which the bed is well exposed. It was also found in sec. 27 and about the head of Spring Creek in sec. 35, but was not mapped between these places. In the western part of the township nine measurements (Nos. 17 to 25, inclusive) were made which show thicknesses of 7 inches to 1 foot 6 inches. On Spring Creek, in sec. 35 (No. 27) the thickness is 3 feet. Four representative coal sections on this bed are shown graphically in Plate XVII and the remainder are as follows:

Coal sections on the Chandler (Ma) coal bed in T. 8 N., R. 26 E.

[See also Pl. XVII.]

No. on map, Pl. XVII.	Location.	Section.	Ft.	in.	No. on map, Pl. XVII.	Location.	Section.	Ft.	in.
17	Sec. 31, NW. ¼...	Coal.....		8	22	Sec. 19, SE. ¼....	Coal.....	1	2
18	Sec. 30, NW. ¼...	Coal.....		10	23	Sec. 19, SE. ¼....	Coal.....		10
19	Sec. 30, NW. ¼...	Coal.....		10±	24	Sec. 30, NE. ¼....	Coal.....	1	6
20	Sec. 19, SW. ¼...	Shale, carbonaceous.....		8	25	Sec. 29, SW. ¼...	Coal.....	1	4
		Coal.....		7			60 feet below Dougherty bed.		

Dougherty (M) coal bed.—The Dougherty coal bed, about 510 feet above the Roundup, outcrops around the heads of all the northward-flowing streams in the township from sec. 31 to sec. 36 and is one of the most important beds in the township. As a rule, the exposures are good, but locally the coal has been burned at the outcrop and in places is concealed by surface material. The bed maintains a nearly uniform thickness, averaging about 2½ feet across the township. Six representative coal sections are shown in Plate XVII, and the others were measured as follows:

Coal sections on the Dougherty (M) coal bed in T. 8 N., R. 26 E.

[See also Pl. XVII.]

No. on map, Pl. XVII.	Location.	Section.	Ft.	in.	No. on map, Pl. XVII.	Location.	Section.	Ft.	in.
29	Sec. 31, SW. ¼...	Coal.....	2	0	36	Sec. 27, SW. ¼...	Coal.....	2	5
32	Sec. 29, SE. ¼...	Coal.....	1	7½	38	Sec. 34, SW. ¼...	Coal.....	2	8
33	Sec. 28, SW. ¼...	Coal.....	2	6	39	Sec. 34, SW. ¼...	Coal.....	2	8
34	Sec. 28, SW. ¼...	Coal.....	2	6					

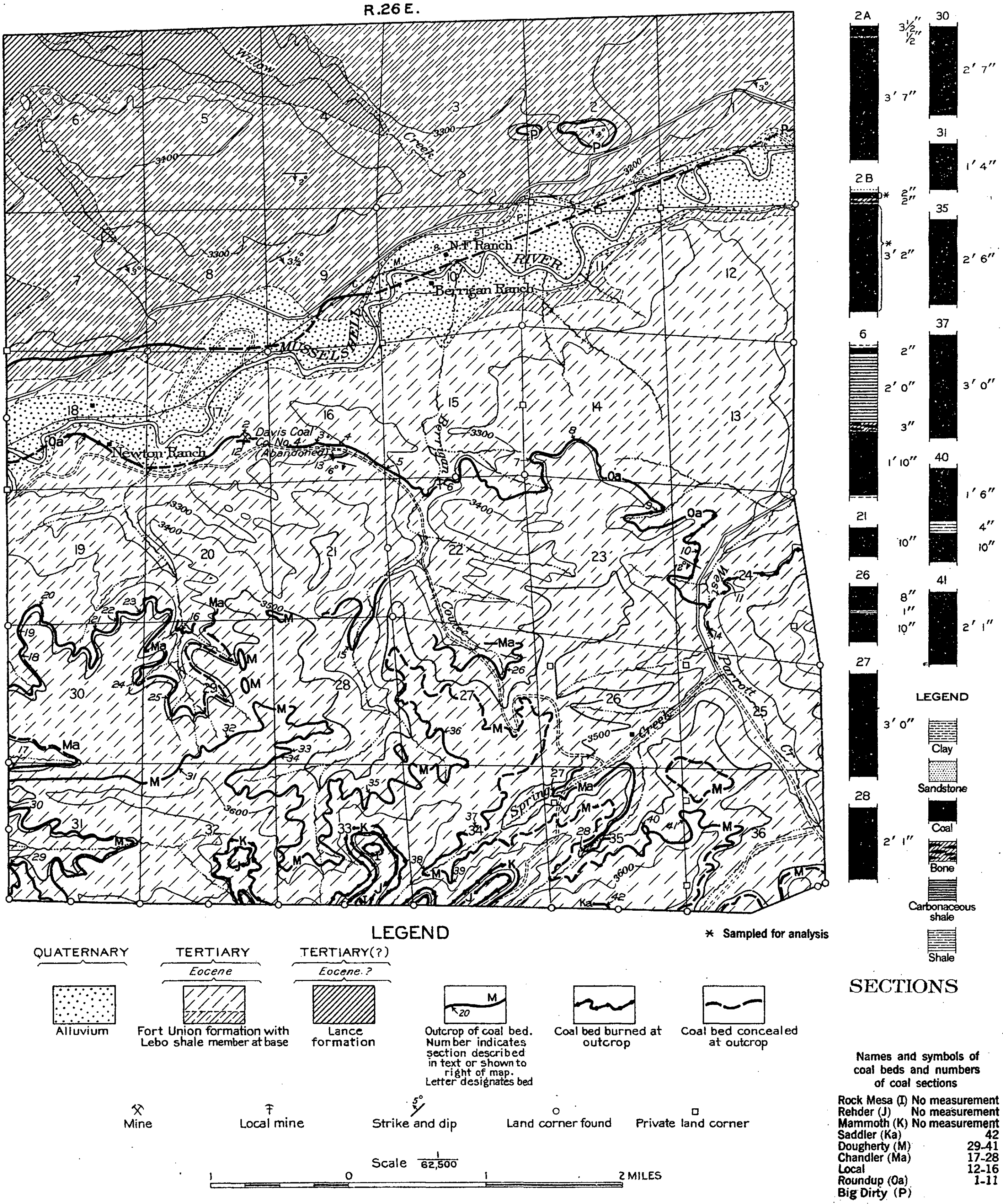
Saddler (Ka) coal bed.—A single exposure of a bed 160 feet above the Dougherty, near the township line in the SW. ¼ sec. 35 (No. 42), showed a thickness of 1 foot 11 inches. The bed, which was not traced in either direction, is probably the Saddler coal.

Mammoth (K), Rehder (J), and Rock Mesa (I) coal beds.—The Mammoth, Rehder, and Rock Mesa coal beds outcrop high on the end of the long ridge which extends across T. 7 N., R. 26 E., and into T. 8 N., R. 26 E., in secs. 32, 33, and 34. The Mammoth and Rehder coals are separated by an interval of 25 to 35 feet and are stratigraphically 200 feet above the Dougherty. These beds are so much burned along the outcrop that no sections could be found.

Development.—At the time of the field examination of this township by the Geological Survey party in 1908, no attempt had been made to develop the coals, but in the following year a mine, locally known as No. 4, was opened in the SE. ¼ sec. 17 on the Roundup bed by the Davis Coal Co. This mine was operated with fair regularity until 1914, when it was abandoned on account of excess water and the thinness of the coal, and the equipment was removed to Carpenter Creek, in sec. 20, T. 9 N., R. 30 E. A sample for analysis (laboratory No. 17587, p. 52) was collected at the end of the main entry, 3,000 feet S. 5° W. from the mouth of the slope. The slope has a pitch of about 10°. The daily output at the time of maximum production was 500 to 600 tons.

A local mine, with a drift about 50 feet in length, had been opened on the Roundup bed in Berrigan Coulee, in the NW. ¼ sec. 22, in July, 1913. The output from this place was used entirely for local domestic purposes. The coal is reported to be only 1 foot 10 inches thick, and for that reason the mine will never be a large producer. The Chandler, Dougherty, Saddler, Mammoth, Rehder, and Rock Mesa coal beds outcrop about the heads of branches of Half Breed and West Parrott creeks, Berrigan Coulee, and a small coulee joining Musselshell River from the south in sec. 17, and the coal contained in these beds could be mined and removed over comparatively short railroad spurs. The next mining in this township will probably be undertaken on the tributaries of West Parrott Creek.

The coal beds of the township are favorably situated for early development, in that they may be made readily accessible by short railway spurs, and mining conditions are favored by the fact that mines properly located will have access to fairly ample tonnages without excessive hoisting expense.



MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 8 N., R. 26 E., MONTANA

T. 5 N., R. 27 E.

GEOGRAPHY.

T. 5 N., R. 27 E., lies directly south of Eldridge Mesa, the lower slopes of which extend into the northern tier of sections. Around this mesa lies a broad plateau, which in this part of the field has an elevation of approximately 3,800 feet and is dissected by numerous southward-trending coulees, tributaries of Pompeys Pillar and East Razor creeks. This plateau is partly preserved in long skeletal ridges between the valleys. The characteristic rim rocks of the Bull Mountain field are well developed both in the valley walls and on the sides of the higher ridges in the central and northern parts of the township. The longest of the ridges which extend southward culminates in "The Cruiser," a rugged mass of bare, alternating cliffs of sandstone and benches of shale, with prominently exposed coal beds.

The water supply of the township is limited to a few natural springs, which have been supplemented locally by shallow wells. No attempt at dry farming was known at the time the region was visited, and the lands were being used mainly for winter grazing.

A wagon trail crosses the township in a northwesterly direction, and a fairly good road follows Pompeys Pillar Creek to the old Northern Pacific mines in the township to the north.

The timber is mainly aspen but includes a moderate amount of pine and cedar.

GEOLOGY.

Rocks of the Lance formation and of both members of the Fort Union outcrop within the township. The gray sandstone and clay shale of the Lance formation outcrop over a small area in secs. 31 and 36 and are overlain by 200 to 300 feet of olive-green and brownish shale and coarse-grained sandstone which make up the Lebo shale member of the Fort Union. The upper or coal-bearing part of the Fort Union outcrops over the greater part of the township. It consists of alternating beds of sandstone, clay shale, and coal, the buff to yellowish-gray sandstone being predominant. The strata are nearly horizontal but locally dip 1°–1½° N.

COAL.

Stratigraphic relations.—The valuable coal beds in this township, as in all the Bull Mountain field, lie in the upper part of the Fort Union formation. The Big Dirty (P) bed in the Lebo shale member,

although of considerable interest as a horizon marker, is of little economic value. (See Pl. XVIII.) The following table shows the stratigraphic relationships of the six principal coal beds in the upper part of the Fort Union which outcrop in this township:

Stratigraphic relations of the coal beds in T. 5 N., R. 27 E., and the numbers of the sections measured in each.

	Feet.
Top.	
Rock Mesa (I) coal bed, No. 93.	
Interval	75–80
Mammoth (K) coal bed, Nos. 89 to 92, inclusive.	
Interval	90
Pompey (L) coal bed, Nos. 80 to 88, inclusive.	
Interval	110
Dougherty (M) coal bed, Nos. 65 to 79, inclusive.	
Interval	200
Buckey (N) coal bed, Nos. 34 to 64, inclusive.	
Interval including local beds, Nos. 25 to 33, inclusive	140
Wildhorse (O) coal bed, Nos. 1 to 24, inclusive.	
Interval	450
Big Dirty (P) coal bed.	

The area underlain by a given coal bed depends on the position of the bed in the section. The lower beds underlie a large part of the township and the upper beds only a very small area on the lower slope of Eldridge Mesa.

The coal is fairly uniform in quality in all the beds, as it is elsewhere in the Bull Mountain field, and is shown by analyses of samples from different parts of the field to be high-grade subbituminous. No sample was obtained in this township.

Big Dirty (P) coal bed.—The Big Dirty coal bed occupies a stratigraphic position about the middle of the Lebo shale. Its outcrop has been traced from the western border of sec. 30 to the eastern border of sec. 36, although from sec. 32 to sec. 35 it lies south of the township line. (See Pl. XVIII.) The sections exposed are uniform in character with those of the same bed in other parts of the field, consisting of alternating bands of carbonaceous shale, thin sandstone, bone, and coal. In the sections measured in this township and the northern part of T. 4 N., R. 27 E., the thickness ranges from 3 feet 4 inches to 6 feet 9 inches, the thickest section being in the SW. ¼ sec. 29. A typical section measured near the southeast corner of the township is as follows:

Section of Big Dirty coal bed near southeast corner of T. 5 N., R. 27 E.

	Ft.	in.
Coal and shale		10
Coal with partings, the thickest of which are one half-inch	2	3
Shale		2
Coal		6

	Ft.	in.
Shale		½
Coal		2
Sandstone		¼
Coal		2
Shale, brown		1
Total section	4	2¾

Wildhorse (O) coal bed.—The Wildhorse coal bed in the upper part of the Fort Union, 450 feet above the Big Dirty bed, has been traced across the middle of the township in an irregular easterly direction from sec. 18 to sec. 24. The outcrop is for the most part well exposed, and a large number of good sections have been measured on it. Across the greater part of the township the thickness is fairly uniform, averaging from 3 to 3½ feet and ranging from 2 feet 3 inches to 3 feet 9 inches. In sec. 18, however, the bed is only about a foot thick. Representative coal sections are shown graphically in Plate XVIII, and others are given below.

Coal sections on the Wildhorse (O) coal bed in T. 5 N., R. 27 E.

[See also Pl. XVIII.]

No. on map, Pl. XVIII.	Location.	Section.	Ft.	in.	No. on map, Pl. XVIII.	Location.	Section.	Ft.	in.
2	Sec. 18, SW. ¼...	Coal	1	0	12	Sec. 28, NW. ¼...	Coal	2	10
4	Sec. 18, SE. ¼...	Ash	1	1	13	Sec. 28, NW. ¼...	Coal	2	10
5	Sec. 18, SE. ¼...	Ash	1	0	15	Sec. 28, NW. ¼...	Coal	3	1
6	Sec. 18, SE. ¼...	Coal		10	18	Sec. 22, SW. ¼...	Coal	3	4
8	Sec. 20, SE. ¼...	Ash	1	0	20	Sec. 23, NW. ¼...	Coal	3	0
9	Sec. 20, SE. ¼...	Ash	1	2	22	Sec. 23, NE. ¼...	Coal	3	4
10	Sec. 29, NE. ¼...	Coal, impure	3	3	23	Sec. 13, SW. ¼...	Coal	3	0

Local coal bed between Wildhorse and Buckey coal beds.—A local bed between the Wildhorse and Buckey coal beds has been examined at nine places in secs. 17, 18, 20, and 15 but has not been mapped continuously. The maximum thickness is 2 feet 10 inches in the SW. ¼ sec. 17 (No. 27), and its average thickness in secs. 17, 18, and 20 is nearly 2 feet. The bed probably is the same as the C A coal bed, mapped by Richards and Lupton in the eastern part of the field. The following are sections within the township:

Sections of coal bed between the Wildhorse and Buckey beds in T. 5 N., R. 27 E.

No. on map, Pl. XVIII.	Location.	Section.	Ft.	in.	No. on map, Pl. XVIII.	Location.	Section.	Ft.	in.
25	Sec. 18, NE. ¼...	Coal	2	1	30	Sec. 20, NW. ¼..	Coal	1	5
26	Sec. 18, NE. ¼...	Coal	2	0	31	Sec. 20, NW. ¼..	Coal	1	6
27	Sec. 17, SW. ¼...	Coal	2	10	32	Sec. 20, NW. ¼..	Coal	1	6
28	Sec. 17, SW. ¼...	Coal	1	9	33	Sec. 15, SW. ¼..	Coal	1	8
29	Sec. 17, SW. ¼...	Coal	1	6					

Buckey (N) coal beds.—The Buckey coal beds, the most persistent coal beds of the Bull Mountain field, are stratigraphically 140 feet above the Wildhorse. Their outcrop has been traced in an irregular easterly direction across the township from sec. 7 to sec. 13. There has been very little burning of the coal along the outcrop, and exposures are for the most part good, so that a large number of sections have been measured. The individual beds are separated by intervals of shale or sandstone which in places are mere partings of a few inches and in other places reach several feet. In several of the sections shown in Plate XVIII or listed below there is a single important bed with thinner beds above and below. In a larger number, however, only one bed is shown, the others being either absent or not exposed at the place of examination. A considerable variation in thickness from place to place is manifest. Locally the thickness of a single bed is as high as 5 feet (No. 47), but thicknesses of 4 feet or over are maintained for only short distances. The following table and the graphic sections in Plate XVIII include all the coal sections measured on the Buckey group of beds within the township.

Coal sections on the Buckey (N) coal beds in T. 5 N., R. 27 E.

[See also Pl. XVIII.]

No. on map, Pl. XVIII.	Location.	Section.	Ft.	in.	No. on map, Pl. XVIII.	Location.	Section.	Ft.	in.
36	Sec. 7, SE. ¼....	Ash.....		7	50	Sec. 15, NW. ¼...	Coal.....	4	6
37	Sec. 7, NE. ¼....	Coal.....	2±		52	Sec. 15, NE. ¼...	Coal.....	3	4
38	Sec. 8, SW. ¼....	Coal.....	3	10	54	Sec. 14, NE. ¼...	Coal.....	2	6
40	Sec. 20, NE. ¼...	Coal.....	1	3	56	Sec. 11, NW. ¼...	Coal.....	2	9+
		Shale.....		6					
		Coal.....	2	4	57	Sec. 11, SE. ¼....	Coal.....	2	6+
		Total coal.	3	7	59	Sec. 12, SW. ¼...	Coal.....	2	2
41	Sec. 20, NE. ¼...	Coal.....	2	0	60	Sec. 13, NE. ¼...	Coal.....	2	0
44	Sec. 16, NW. ¼...	Coal.....	1	6	61	Sec. 13, NE. ¼...	Coal.....	1	7
45	Sec. 16, SW. ¼...	Coal.....	1	6+	63	Sec. 13, NE. ¼...	Coal.....		10
47	Sec. 21, NE. ¼...	Coal.....	5	0	64	Sec. 13, SE. ¼....	Coal.....		10
48	Sec. 22, NW. ¼...	Coal.....	1	6					

Dougherty (M) coal bed.—The Dougherty coal bed 200 feet above the Buckey bed outcrops along the foot of the lower steep scarp of Eldridge Mesa and has been traced all the way across the township from sec. 6 to sec. 1. The bed is in places somewhat obscured by grassed slopes, but a sufficient number of sections were measured to show the character of the coal and the thickness of the bed. The thickness is fairly constant throughout the part of the township which the bed underlies, averaging about 2 feet 6 inches and reaching

a maximum of 3 feet 3 inches in the NW. ¼ sec. 5 (No. 66). Although the bed was examined at 15 places, complete measurements were obtained at only eight. Five of the sections are shown graphically in Plate XVIII, and the remainder are given below:

Coal sections on the Dougherty (M) coal bed in T. 5 N., R. 27 E.

[See also Pl. XVIII.]

No. on map, Pl. XVIII.	Location.	Section.		No. on map, Pl. XVIII.	Location.	Section.	
			Ft. in.				*Ft. in.*
67	Sec. 5, SE. ¼....	Coal.....	2+	72	Sec. 3, SW. ¼....	Bloom.	
68	Sec. 5, SE. ¼....	Coal.....	2 10	75	Sec. 2, NW. ¼....	Coal.....	2 0
69	Sec. 5, SE. ¼....	Bloom.		76	Sec. 2, NE. ¼....	Coal.....	2 6+
70	Sec. 9, NE. ¼....	Coal.....	2 3	78	Sec. 1, NW. ¼....	Bloom.	
71	Sec. 4, SE. ¼....	Bloom.		79	Sec. 1, NE. ¼....	Coal and ash..	1 0

Pompey (L) coal bed.—The Pompey coal bed lies stratigraphically 110 feet above the Dougherty and is exposed on the same slopes of Eldridge Mesa. The outcrop was mapped continuously around the slopes of the mountain from sec. 5 to sec. 1 but was not traced across the township line in either direction. Within this distance the outcrop is well exposed, and a number of good sections were measured. These show that the bed is fairly persistent in character and contains 1 foot 5 inches (No. 88) to 3 feet (No. 85) of coal. It is characterized by a persistent parting, which in most places is so thick as to render the coal practically valueless. Four of the coal sections measured are shown in Plate XVIII, and the remainder are as follows:

Coal sections on the Pompey (L) coal bed in T. 5 N., R. 27 E.

[See also Pl. XVIII.]

No. on map, Pl. XVIII.	Location.	Section.		No. on map, Pl. XVIII.	Location.	Section.	
			Ft. in.				*Ft. in.*
82	Sec. 4, SE. ¼....	Coal, bony.....	1 0	84	Sec. 3, SW. ¼....	Coal.....	1 0
		Shale.....	6	86	Sec. 2, NE. ¼....	Coal, bony.....	1 0
		Coal.....	1 2			Shale.....	4 0
		Total coal	2 2			Coal, good.....	1 8
						Total coal	2 8
83	Sec. 3, SW. ¼....	Coal, bony.....	11				
		Shale and sandstone.....	1 2	88	Sec. 1, NE. ¼....	Coal.....	3
		Coal, good.....	1 7			Sandstone.....	10 0
		Total coal	2 6			Coal.....	1 5
						Total coal	1 8

Mammoth (K) coal bed.—The Mammoth coal bed, 200 feet above the Dougherty and about 90 feet above the Pompey, outcrops on the south flank of the Bull Mountains and underlies approximately 250 acres in the northern parts of secs. 3, 4, and 5. Two complete sections and two partial sections were measured in this township.

The western section (No. 89) contains 8 feet 9 inches of good coal and the eastern section (No. 92) 14 feet 11 inches of coal with a number of thin partings of shale and bone. Section No. 92 is shown in Plate XVIII, and the other three are as follows:

Coal sections on the Mammoth (K) coal bed in T. 5 N., R. 27 E.

[See also Pl. XVIII.]

No. on map, Pl. XVIII.	Location.	Section.		No. on map, Pl. XVIII.	Location.	Section.	
			Ft. in.				*Ft. in.*
89	Sec. 4, NW. ¼...	Coal	8 9	91	Sec. 4, NE. ¼....	Coal	3+
90	Sec. 4, NW. ¼...	Coal	4 6+				

Rock Mesa (I) coal bed.—The Rock Mesa coal bed is a comparatively thin but persistent coal bed which lies 75 to 80 feet above the Mammoth and outcrops on the same slopes. In this township it underlies only a few acres in the northern part of sec. 4, where the following measurement was made:

Coal section on the Rock Mesa (I) coal bed in NE. ¼ sec. 4, T. 5 N., R. 27 E. (No. 93).

	Ft.	in.
Coal		4
Shale		6
Coal		4
Shale	1	0
Coal	1	5
Total coal	2	1

Development.—No coal has been mined in this township except possibly from a few surface prospects by ranchers for domestic use. The coal beds of value can be most easily developed in the valleys of East Razor Creek and the tributaries of Pompeys Pillar Creek, which drain south to Yellowstone River. The scarcity of a natural water supply on the south slope of the Bull Mountains will prove a handicap in mining operations, but it is believed that fairly good water can be obtained by drilling comparatively deep wells. In order to remove the coal from this township most advantageously it would be necessary to bridge Yellowstone River and to construct railroad spurs 15 to 20 miles in length from the Northern Pacific Railway up the valleys of Razor and Pompeys Pillar creeks.

T. 6 N., R. 27 E.

GEOGRAPHY.

In the south-central part of T. 6 N., R. 27 E., lies the main southern Bull Mountain mesa, for which the name Eldridge Mesa is here adopted. The nearly flat top of the mesa covers an area of 5 to 6

LEGEND

TERTIARY
Eocene
Fort Union formation with Lebo shale member at base

TERTIARY(?)
Eocene ?
Lance formation

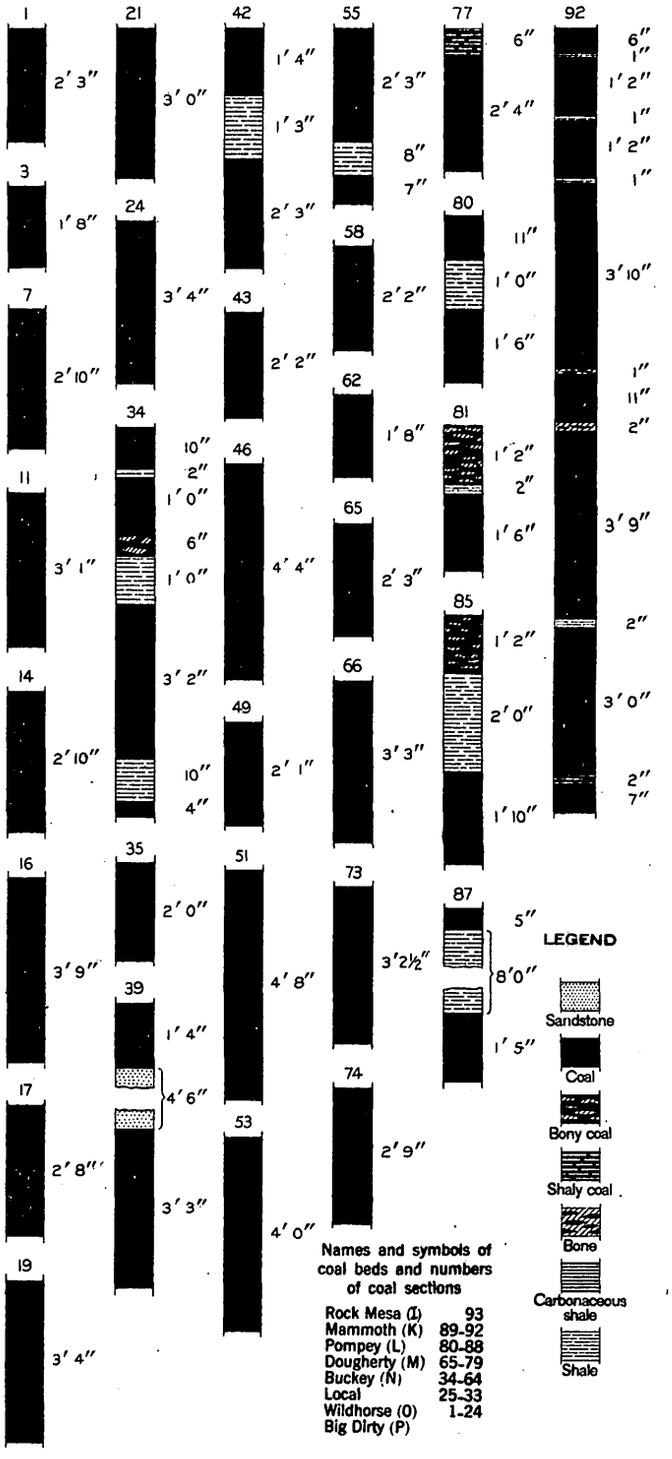
Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500
1 0 1 2 MILES



Names and symbols of coal beds and numbers of coal sections

Rock Mesa (I)	93
Mammoth (K)	89-92
Pompey (L)	80-88
Dougherty (M)	65-79
Buckey (N)	34-64
Local	25-33
Wildhorse (O)	1-24
Big Dirty (P)	

SECTIONS

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 5 N., R. 27 E., MONTANA

square miles and has an average elevation of about 4,650 and a maximum elevation of over 4,700 feet, which is the highest point in the Bull Mountains. The steep bluffs or scarps on the southern and eastern sides of this mesa are so prominent that they are easily seen from the neighborhood of Yellowstone River, 20 to 30 miles to the south. Toward the east the mesa gives way to a narrow, rugged divide, on which stand the "Three Buttes," in T. 6 N., R. 28 E. On the northwest a low divide separates Eldridge Mesa from the smaller Taylor Mesa, which lies partly in the northwest corner of the township and partly in the townships to the north and west. The borders of the mesa are steep, rugged, and in places precipitous and are clothed with a fairly heavy growth of timber, which is more abundant on the north and west sides than on the south and east. The tops of the mesas are heavily grassed and almost devoid of timber. The heads of some of the principal drainage lines of the region, Dougherty, Fattig, Railroad, and Razor creeks, are in this township.

The burning of the higher coal bed in the Bull Mountains has caused a pronounced reddening, hardening, and even fusion of the shales and sandstones overlying it. This clinker resists erosion and stands out as conspicuous red caps on the tops of mesas and buttes and on the long ridges which radiate from Eldridge and Taylor mesas. The fantastic forms of these erosion remnants are the result of the long-continued action of rain and wind. The most conspicuous of the outlying hills are Squaw Points, Square Butte, and Red Butte.

At the time of the survey there was only one ranch—the Rehder ranch, in sec. 7—in the township. The coulee heads and flat uplands furnish excellent pasturage for cattle and sheep, and a moderate amount of wild hay is cut. Water is scarce on the south side of the mountains on account of the northward dip of the strata. There are, however, several good springs in the northern coulees and at least three good springs within 100 to 150 feet of the top of Eldridge Mesa. By sinking wells a moderate supply of water could probably be obtained in any of the coulees.

GEOLOGY.

All the rocks of the township belong to the upper or coal-bearing member of the Fort Union formation. They consist of alternating beds of sandstone, clay shale, and coal. Of these the massive, buff to yellowish-gray sandstones are most prominent, forming the steep cliffs or scarps of the mesas and coulee walls. The beds of sandstone are, however, very irregular in thickness and locally disappear, giving place to grayish thin-bedded sandstones with intercalated clay shale. The total thickness of the rocks exposed in this township is about 1,000 feet. The strata appear to be almost horizontal over

the greater part of the township, but the careful level measurements of the Northwestern Improvement Co. show that they dip about 250 feet to the north in a distance of 6 miles.

COAL.

Of the 27 coal beds in the Bull Mountain field that were considered of sufficient importance to receive individual names 13 outcrop and at least two others underlie parts of this township. In addition a number of local beds, generally of small extent and thickness, outcrop at different horizons. (See Pl. XIX.) The stratigraphic relations of the coal beds and the numbers of coal sections measured on each bed within the township are shown in the following table.

Stratigraphic relations of the coal beds in T. 6 N., R. 27 E., and the numbers of the sections measured in each.

	Feet.
Summit (A) coal beds, Nos. 310 to 336, inclusive.	
Interval	35–45
Fattig (B) coal bed, Nos. 274 to 309, inclusive.	
Interval	30–35
Red Butte (C) coal bed, Nos. 247 to 273, inclusive.	
Interval	65
Strait (D) coal bed, Nos. 208 to 246, inclusive.	
Interval including local coal bed, Nos. 203 to 207	75±
Wescott (E) coal bed, Nos. 193 to 202, inclusive.	
Interval including local coal beds, Nos. 181 to 192, inclusive.	100
Upper Bull Mountain (F) coal beds, Nos. 149 to 180, inclusive.	
Interval	12–25
Lower Bull Mountain (G) coal bed, Nos. 98 to 148, inclusive.	
Interval including local coal beds, Nos. 94 to 97, inclusive.	45?
Matt (H) coal bed, Nos. 70 to 93, inclusive.	
Interval	170
Rock Mesa (I) coal bed, Nos. 27 to 69, inclusive.	
Interval including local coal bed, Nos. 24, 25, and 26	25–35
Mammoth (K) and Rehder (J) coal beds, Nos. 8 to 23, inclusive.	
Interval including local coal beds, Nos. 5, 6, and 7	90
Pompey (L) coal bed, Nos. 2, 3, and 4.	
Interval	110
Dougherty (M) coal bed, No. 1.	
Interval	200
Buckey (N) coal bed, not exposed.	
Interval	140
Wildhorse (O) coal bed, not exposed.	

The Mammoth (K) and Rehder (J) coal beds in the greater part of the township are considered as benches of a single bed. The Mammoth bed is by far the most important bed in the township. The study of the Bull Mountain coal beds by Eldridge and Lindgren [1] in 1881 and the detailed examination by J. N. Potts for the Northwestern Improvement Co. in 1906, were practically confined to this pair of beds.

Wildhorse (O) and Buckey (N) coal beds.—The Wildhorse coal bed outcrops in the townships south of the Bull Mountains and presumably underlies at least the southern part of this township. It is estimated that the coal is 1 foot 6 inches thick along the southern boundary and thins progressively toward the north to 1 foot along a line drawn approximately from the southwest corner of the township to the middle of the east boundary of sec. 25. The Buckey coal bed likewise outcrops in the townships to the south and is regarded as progressively thinning northward to about 1 foot along a line drawn approximately from the southwest corner of sec. 19 to the southwest corner of sec. 36. In the southwest corner of the township it is estimated to be 3 feet 6 inches thick.

Dougherty (M) coal bed.—The Dougherty coal bed outcrops for less than half a mile in the southwest corner of sec. 31 and appears at the east line of sec. 36 on Railroad Creek. It has been examined, however, in all the surrounding townships and presumably underlies the whole township with an average thickness of about 2 feet 6 inches. The section measured in sec. 36 (No. 1) is shown graphically in Plate XIX.

Coal beds between Dougherty and Mammoth coal beds.—The Pompey (L) coal bed, which lies about 110 feet above the Dougherty, is comparatively unimportant in this township. It outcrops around the heads of Razor and East Razor creeks in secs. 31 and 32 and on Railroad Creek in sec. 36. It was not mapped, however, and was examined at only three places, where the following sections were measured:

Coal sections on the Pompey (L) coal bed in T. 6 N., R. 27 E.

No. on map, Pl. XIX.	Location.	Section.		No. on map, Pl. XIX.	Location.	Section.	
			Ft. in.				*Ft. in.*
2	Sec. 32, SW. ¼...	Coal.....	1 8	4	Sec. 36, near east quarter corner.	Coal.....	1 2
3	Sec. 36, SE. ¼....	Coal.....	11				

[1] Eldridge, G. H., Montana coal fields: Tenth Census U. S., vol. 15, pp. 753–755, 1884.

In the stratigraphic interval of 90 feet between the Pompey and Mammoth beds local coal beds were measured at three widely separated places, as follows:

Coal sections on local coal beds between the Mammoth and Pompey beds in T. 6 N., R. 27 E.

No. on map, Pl. XIX.	Location.	Section.	No. on map, Pl. XIX.	Location.	Section.
		Ft. in.			*Ft. in.*
5	Sec. 30, SW. ¼...	Coal..... 1 10+	7	Sec. 36, SW. ¼...	Coal..... 1 0
6	Sec. 32, SW. ¼...	Coal..... 9			

Mammoth (K) and Rehder (J) coal beds.—The Mammoth coal bed in this township is about 200 feet above the Dougherty bed. Its outcrop has been traced around the heads of Razor and East Razor creeks in the southwest part of the township across secs. 30, 31, and 32; on Pompeys Pillar and Railroad creeks in the southeast part of the township across secs. 34, 35, 36, 25, and 24; across the northeastern part of sec. 1, and around the head of a branch of Fattig Creek in sec. 2. A very careful detailed survey of the outcrop of the bed was made in 1906 for the Northwestern Improvement Co. by a party in charge of J. N. Potts. In the course of this survey the bed was prospected by open cuts and bore holes at numerous places. Many of these openings, however, had become so covered before the examination by the U. S. Geological Survey party that it was difficult to verify all the measurements. The thickest portions of the bed are found in secs. 24 and 25, where it locally measures over 12 feet, and around the head of Fattig Creek, where the total thickness of coal is from 10 feet 10 inches to 13 feet 9 inches. In the southwest corner of the township the total thickness of the coal ranges from 5 to 8 feet. In the western part, owing to the presence of a sharply thickening sandstone parting, the bed is separated into two portions which will have to be mined separately. In the northwestern part the lower or Mammoth bed is estimated to contain 4 to 5 feet and the upper or Rehder bed 2½ feet to 7½ feet of coal. The general average for the Rehder is about 5 feet. The parting separating the two beds ranges from a maximum thickness of about 25 feet in the northwest of the township to less than 2 feet approximately along a line drawn from the west quarter corner of sec. 19 to the northeast corner of sec. 4 (Pl. IX, p. 44). The Rehder bed is not exposed in this township, the thicknesses given above being estimated from the thicknesses at the outcrop in adjacent townships. The Mammoth bed was sampled at a surface prospect in sec.

30 (No. 8), two samples being taken, one from the upper and one from the lower part of the bed (laboratory Nos. 5797 and 5799). The results and a discussion of the analyses are given on page 53. The graphic sections on Plate XIX and the table below show all the measurements which were obtained on the Mammoth bed in this township and include several furnished by the Northwestern Improvement Co. Three sections, Nos. 24, 25, and 26, on a local coal bed a short distance above the Mammoth bed in secs. 31 and 32 are included in the table.

Coal sections on the Mammoth (K) coal bed and on a local coal bed above the Mammoth bed in T. 6 N., R. 27 E.

[See also Pl. XIX.]

Mammoth (K) coal bed.

No. on map, Pl. XIX.	Location.	Section.	Ft.	in.	No. on map, Pl. XIX.	Location.	Section.	Ft.	in.
10	Sec. 32, NW. ¼	Coal	4+		19	Sec. 24, SW. ¼	Coal	3+	
11	Sec. 32, NW. ¼	Coal	5		20	Sec. 24, SE. ¼	Coal	6+	
13	Sec. 34, SW. ¼	Coal	5+		23	Sec. 2, NW. ¼	Coal	10	10
14	Sec. 34, NE. ¼	Coal	7+						
15	Sec. 35, NE. ¼	Coal	2+						
16	Sec. 25, NW. ¼	Coal	12+						
17	Sec. 24, SW. ¼	Coal	5+						
18	Sec. 24, SW. ¼	Coal, with thin partings of shale	8	2					
		Shale		1					
		Coal	3	11					
		Total coal	12	1					

Local coal bed.

24	Sec. 31, NE. ¼	Coal	1	10	26	Sec. 32, SE. ¼	Coal	7	
25	Sec. 32, NW. ¼	Coal	1	6					

Rock Mesa (I) coal bed.—The next important coal above the Mammoth in T. 6 N., R. 27 E., is a fairly persistent bed known as the Rock Mesa. The interval is 25 to 35 feet and the outcrop is approximately parallel to that of the Mammoth and is well exposed, so that sections could be measured at almost any place desired. In the southwestern and southeastern parts of the township the bed is about 2 feet thick, but locally (No. 28) is 5 feet or more. Around the head of Fattig Creek in the northeast of the township the thickness ranges from 2 feet 2 inches to over 3 feet. The average thickness of the bed under the greater part of the township is about 2 feet. The local variations are shown by the following list of sections and by the selected sections shown in Plate XIX.

Coal sections on the Rock Mesa (I) coal bed in T. 6 N., R. 27 E.

[See also Pl. XIX.]

No. on map, Pl. XIX.	Location.	Section.	Ft.	in.
28	Sec. 30, SW. ¼...	Coal, bony in places.....	4	0
		Shale.....		3
		Coal.....		9+
		Total coal	4	9
29	Sec. 30, SE. ¼....	Ash.....		
		Shale.....		2
		Coal.....		9
		Shale.....	3	0
		Coal.....		10
30	Sec. 30, SE. ¼....	Shale, carbonaceous.....		6
		Coal.....	1	2
		Shale.....		1
		Coal.....		11
		Total coal	2	1
31	Sec. 30, SE. ¼....	Shale, carbonaceous.....		6
		Coal.....		11
		Shale.....		2
		Coal.....		7
		Shale.....		1
		Coal.....		8
		Total coal	2	2
32	Sec. 31, NE. ¼...	Coal.....	2	0
33	Sec. 29, SW. ¼...	Coal.....	2	3+
35	Sec. 32, NE. ¼...	Coal.....	1	9
37	Sec. 33, SW. ¼...	Coal.....	1	6
39	Sec. 34, SE. ¼....	Coal and shale.....	1	3
		Shale.....		7
		Coal.....		10
		Coal and ash.		6
40	Sec. 35, NE. ¼...	Coal and ash.		7
41	Sec. 26, NE. ¼...	Coal.....		3
		Shale.....		2
		Coal.....		10
		Total coal	1	1
43	Sec. 24, center...	Coal.....		8
44	Sec. 24, NE. ¼...	Coal.....		2
		Shale.....	3	0
		Coal.....		3
		Shale.....	2	0
		Coal.....		6
47	Sec. 1, SE. ¼.....	Coal.....	2	5
48	Sec. 1, NW. ¼...	Coal.....	2	6
50	Sec. 1, NW. ¼...	Ash.....		8
51	Sec. 1, SW. ¼....	Coal.....	2	3½
52	Sec. 1, SW. ¼....	Coal.....	2	3
53	Sec. 1, SW. ¼....	Ash.....		3
54	Sec. 1, SW. ¼....	Ash.....		4–6
55	Sec. 1, SW. ¼....	Coal.....		8
		Ash.....		4
57	Sec. 12, NW. ¼..	Coal.....	2	6+
58	Sec. 12, NW. ¼..	Coal.....	2	2
59	Sec. 12, SW. ¼...	Coal.....	2	7
60	Sec. 12, SW. ¼...	Coal.....	2	2
61	Sec. 12, SE. ¼....	Coal.....	2	4
62	Sec. 12, SW. ¼...	Coal.....	2	2+
65	Sec. 10, NE. ¼...	Coal, bony at top.....	2	5+
66	Sec. 3, NW. ¼...	Coal.....	2	6
67	Sec. 3, NW. ¼...	Coal.....	2	9

Matt (H) coal bed.—The Matt coal appears 170 feet above the Rock Mesa coal bed, the intervening strata being destitute of beds of any value, and is fairly persistent throughout the township. On the south side of Eldridge Mesa it lies 20 to 30 feet above the massive sandstone at the foot of the bluffs. The bed is best developed about the head of Dougherty Creek in the forks locally known as John Matt and Strait coulees, in secs. 6, 7, 8, 17, 18, 19, and 20, where the thickness ranges from 3 feet to 4 feet 8 inches. On the east side of sec. 19 (No. 78) the bed is split up by thick shale partings, and farther south it is absent or is only 7 to 10 inches thick. The bed is less than 2 feet thick in the eastern half of the township and was not mapped. The more representative coal sections are

shown graphically in Plate XIX and the remainder are included in the following list:

Coal sections on the Matt (H) coal bed in T. 6 N., R. 27 E.

[See also Pl. XIX.]

No. on map, Pl. XIX	Location.	Section.	Ft.	in.
72	Sec. 7, NE. ¼....	Coal.....	2	1
74	Sec. 8, SW. ¼....	Coal.....		10
		Shale.....		1
		Coal.....	2	10+
		Total coal.	3	8
76	Sec. 17, NW. ¼..	Coal, shaly...		4
		Coal.....	2	5
		Total coal.	2	9
79	Sec. 30, NW. ¼..	Shale, no coal.		
81	Sec. 29, SW. ¼...	Coal.....		3½
		Shale.....		4½
		Coal.....		4½
		Total coal.		8
82	Sec. 29, SW. ¼...	Coal.....		6
		Shale.....		4
		Coal.....		4
83	Sec. 29, SW. ¼...	Coal.....		2
		Shale.....		3
		Coal.....		5
84	Sec. 32, NE. ¼...	Coal.....		3
		Shale.....		2½
		Coal.....		4
85	Sec. 32, NE. ¼...	Coal.....		8
		Shale.....		2
		Coal.....		5
86	Sec. 34, SW. ¼...	Coal.....		6
87	Sec. 27, SE. ¼....	Shale, containing 2 to 5-inch coal seams.....	2	0
88	Sec. 26, SW. ¼...	Coal.....		7
		Shale.....		4
		Coal.....		6
		Total coal.	1	1
89	Sec. 26, NE. ¼...	Coal.....		7
		Shale.....		4
		Coal.....		6–
		Total coal.	1	1
90	Sec. 23, SW. ¼...	Coal.....	1±	
91	Sec. 23, SE. ¼....	Coal.....		6
		Shale.....		5
		Coal.....		2
		Shale.....		3
		Coal.....		6
		Total coal.	1	2
92	Sec. 23, NW. ¼..	Ash.....		6±
93	Sec. 23, NW. ¼..	Coal.....		6
		Shale.....		5
		Coal.....		8
		Total coal.	1	2

Local coal beds between Matt and Bull Mountain coal beds.—In the 45-foot interval between the Matt and the Lower Bull Mountain coal beds a local bed was found on Dougherty Creek in sec. 8 and on a southwest spur of Eldridge Mesa in secs. 29 and 30. Two of the measurements made at these places (Nos. 94 and 96) are shown graphically in Plate XIX, and the other two are as follows:

Coal sections on local coal beds between the Matt and Lower Bull Mountain beds in T. 6 N., R. 27 E.

[See also Pl. XIX.]

No. on map, Pl. XIX	Location.	Section.	Ft.	in.
95	Sec. 8, SW. ¼....	Coal.....	1	3
97	Sec. 29, SW. ¼...	Coal..... 35 feet below G.	1	3

Bull Mountain coal beds (F and G).—Forty-five feet above the Matt coal, in many places separated from it by a bed of sandstone, is the lower of the two Bull Mountain coal beds, which here generally mark the base of the high bluffs of the mesas and buttes. The lower bed has been mapped everywhere in the township except for about a mile in sec. 6 and has been measured at many places. Its average thickness is about 3 feet in the central and southwestern parts of the field but decreases sharply toward the northwest and is less than a foot in parts of sec. 6. The upper bed was found only locally on the western and southern sides of Eldridge Mesa, except around the head of Railroad Creek in secs. 23 and 24, where its thickness ranges from a few inches to 2 feet 8 inches (No. 159, Pl. XIX). On the north side of the mesa in the Fattig Creek basin the thickness averages about 2 feet 6 inches and at one place (No. 165) is as much as 3 feet 6 inches. Numerous sections were measured, a few of which are shown in Plate XIX and the remainder in the following table. Both beds are burned locally at the outcrops, and at many of the places indicated on the map only ash was found.

Coal sections on the Lower and Upper Bull Mountain coal beds in T. 6 N., R. 21 E.

[See also Pl. XIX.]

Lower Bull Mountain (G) bed.

No. on map, Pl. XIX	Location.	Section.	Ft.	in.
99	Sec. 18, NE. ¼...	Coal	3	0
102	Sec. 18, SW. ¼...	Coal	3	0
103	Sec. 18, SW. ¼...	Coal	2	6
106	Sec. 29, SW. ¼...	Bloom.		
108	Sec. 32, NE. ¼...	Coal, shaly..		9
		Coal, sulphurous	2	3
		Shale		4
		Coal, bony	1	3
109	Sec. 33, SW. ¼...	Coal	2+	
110	Sec. 33, SW. ¼...	Coal	2+	
112	Sec. 34, NW. ¼...	Coal		10
114	Sec. 26, SW. ¼...	Coal	1+	
116	Sec. 26, NE. ¼...	Coal, burned, probably about	2	0
117	Sec. 23, SW. ¼...	Coal	1	6
		Shale		1
		Coal	1	9
		Total coal	3	3
120	Sec. 23, NE. ¼...	Ash, 25 feet below Upper Bull Mountain coal.		
121	Sec. 23, NE. ¼...	Coal	2	5+
123	Sec. 24, NW. ¼...	Coal and ash.	1	0
125	Sec. 24, NE. ¼...	Coal	3	0
126	Sec. 24, NE. ¼...	Coal and ash.	1	0
127	Sec. 13, SE. ¼...	Ash.		
129	Sec. 12, SE. ¼...	Coal, bony near middle	2	11
133	Sec. 13, NW. ¼...	Coal, about 14 feet below Upper Bull Mountain coal bed	3	6+
134	Sec. 12, SW. ¼...	Coal	2	10
135	Sec. 12, SW. ¼...	Coal	2	0
136	Sec. 11, SE. ¼...	Ash		10±
137	Sec. 11, SE. ¼...	Coal	2	10
139	Sec. 14, NE. ¼...	Coal	3	3
140	Sec. 14, NE. ¼...	Coal	3	3
141	Sec. 14, NW. ¼...	Coal	3	3
143	Sec. 10, SE. ¼...	Ash		8
144	Sec. 10, NE. ¼...	Ash		1
		Coal	1	1
145	Sec. 10, NE. ¼...	Coal and ash.	1	3
147	Sec. 9, NE. ¼...	Coal	2	3+

Coal sections on the Lower and Upper Bull Mountain coal beds in T. 6 N., R. 27 E.—Continued.

[See also Pl. XIX.]

Upper Bull Mountain (F) coal bed.

No. on map, Pl. XIX	Location.	Section.	Ft.	in.
151	Sec. 30, NE. ¼...	Coal..... 25 feet above Lower Bull Mountain coal bed.	1	0
152	Sec. 30, SE. ¼....	Coal.....		8
		Shale.....		2
		Coal.....		6
		Shale, with 1 to 6 inch coal seams.	4	0
153	Sec. 29, SW. ¼...	Coal..... 25 feet above Lower Bull Mountain coal bed.		7+
154	Sec. 32, NE. ¼...	Coal, bony...		5
155	Sec. 34, NW. ¼...	Shale, with ½-inch seams of coal.... Horizon doubtful.	1	6
156	Sec. 34, NW. ¼..	Coal.....		5±
157	Sec. 34, NW. ¼...	Shale, with 1 to 2 inch coal seams. Horizon doubtful.	2	0
160	Sec. 23, NW. ¼...	Coal.....		9
161	Sec. 23, NE. ¼...	Ash.....		8
162	Sec. 24, NE. ¼...	Coal.....		2-3
163	Sec. 13, SE. ¼...	Ash.....		6
164	Sec. 12, NE. ¼...	Ash..... 15 feet above Lower Bull Mountain coal bed.		9
168	Sec. 13, NW. ¼...	Coal.....	2+	
169	Sec. 12, SW. ¼...	Coal.....	1	0
		Coal, bony...		3
		Coal.....	1	3
		Total coal. 12 feet above Lower Bull Mountain bed.	2	6
170	Sec. 14, NE. ¼...	Coal.....	2	10
171	Sec. 13, NW. ¼...	Coal.....	2	6
174	Sec. 14, NW. ¼...	Coal.....	2	7
176	Sec. 10, NE. ¼...	Ash.....		8
177	Sec. 3, NE. ¼....	Coal.....	2	6
180	Sec. 4, SE. ¼.....	Coal.....	2	6

Coal beds between Bull Mountain and Strait coal beds.—Several comparatively thin coal beds occur at intervals of 15 to 40 feet between the Bull Mountain coal beds and the Strait (D) bed, about 200 feet above the Lower Bull Mountain bed. One of these, the Wescott (E) bed, is about 100 feet above the Upper Bull Mountain bed and locally reaches a significant thickness (No. 200, Pl. XIX). Its irregularity and lenticular form, however, render it of little value. The graphic sections in Plate XIX and the following tables show the thicknesses, the locations, and generally the stratigraphic positions of all the coal exposures found on beds between the Bull Mountain and the Strait. In the first table are shown sections of beds below the Wescott coal; in the second, sections of the Wescott; and in the third, sections of local beds above the Wescott.

Sections on coal beds between the Bull Mountain and Strait beds in T. 6 N., R. 27 E.

[See also Pl. XIX.]

Coal beds between Bull Mountain and Wescott beds.

No. on map, Pl. XIX.	Location.	Section.	Ft.	in.
181	Sec. 19, NW. ¼..	Coal.....		?
		Interval.....	15	0
		Coal.....		4
		Interval.....	18	0
		Coal.....		4
182	Sec. 30, SE. ¼...	Shale, with 2, 3, and 8 inch coal seams...	8	0
		Interval.....	15	0
		Coal.....		6
		Base 53 feet above Lower Bull Mountain coal bed.		
184	Sec. 29, SW. ¼...	Coal.....		7
		Interval.....	15	0
		Coal.....		11
		Shale.....		5
		Coal.....		7
		Base 56 feet above Lower Bull Mountain coal bed.		
185	Sec. 23, SW. ¼...	Coal beds, 2 inches to 8 inches.		
		Interval.....	27	0
		Coal.....	1	2
186	Sec. 23, SW. ¼...	Shale, with coal seams 4 inches to 6 inches thick.....	8	0
		Interval.....	32	0
		Coal.....		6
187	Sec. 23, NE. ¼...	Coal.....	1'	2
		62 feet above Upper Bull Mountain bed.		
		Coal.....	1	1
		20 feet above Upper Bull Mountain bed.		
		Coal.....		10
		35 feet above Upper Bull Mountain bed.		
188	Sec. 14, NE. ¼...	Coal.....		10
		60 feet above Upper Bull Mountain bed.		
191	Sec. 10, NE. ¼...	Coal.....	1	7
		About 30 feet above Upper Bull Mountain bed.		

Wescott (E) coal bed.

193	Sec. 9, SW. ¼....	Coal.....	1	0
195	Sec. 29, SE. ¼...	Coal.....	2	2
197	Sec. 29, SW. ¼...	Coal.....	1	3
		Coal, bony...		3
		Coal.....		3
		Interval.....	25	0
		Coal.....	1	0
		Coal, bony...		4
		Coal and shale	4	6
199	Sec. 34, NW. ¼..	Coal.....		10
202	Sec. 9, SW. ¼....	Coal.....	1	0

Coal beds between Wescott and Strait beds.

203	Sec. 30, SE. ¼...	Coal.....		8
		38 feet below Strait coal bed; 20 feet below this coal there is a series of 2-inch to 8-inch coal seams.		
205	Sec. 26, NW. ¼..	Coal.....	1	1
		55 feet below Strait bed.		
207	Sec. 23, NE. ¼...	Coal.....		6
		38 feet below Strait bed.		

Strait (D) coal bed.—The Strait coal bed, about 200 feet above the Lower Bull Mountain coal bed, outcrops near the base of the steep slopes of Eldridge and Taylor mesas and outlines their extent and shape. (See Pl. XIX.) The outcrop lies within the township except where the northern Taylor Mesa extends beyond the northwest corner. A massive sandstone 30 to 40 feet thick overlies the Strait coal bed and forms a prominent protruding ledge or bench along the bluffs. The Musselshell road, where it crosses the divide between Fattig and Dougherty creeks, passes through a notch in this sandstone and the underlying coal bed, which is exposed on both sides of the road. Around Eldridge Mesa this bed in most places measures 2 feet or less in thickness, though at some places, especially in the southern half of the mesa, it is nearly 3 feet thick, In Taylor Mesa the bed is thinner, in many places less than 1 foot. The bed is well exposed, and a large number of sections have been measured. A few of these are shown graphically in Plate XIX, and the remainder are listed in the following table, in which are included several measurements on a local bed 15 to 20 feet higher in the section.

Coal sections on the Strait (D) coal bed in T. 6 N., R. 27 E.

[See also Pl. XIX.]

No. on map, Pl. XIX.	Location.	Section.	Ft.	in.
208	Sec. 8, NE. ¼....	Coal.....	1	0
		Shale, with thin beds of coal....	27	0
		Coal.....		¾
		Shale.....		4
		Coal.....		5
210	Sec. 4, NW. ¼...	Coal.....		6–9
211	Sec. 16, NW. ¼..	Coal.....	1	7
		May be the coal bed 15 feet above Strait bed.		
212	Sec. 16, NW. ¼...	Coal.....	1	0
214	Sec. 17, SE. ¼....	Coal.....	1	8
		15 feet above Strait bed.		
216	Sec. 29, NE. ¼....	Shale.....		6
		Coal, fair...		6
		Coal, good..	2+	
		Total coal.	2	6+
220	Sec. 29, SE. ¼....	Coal.....	1±	
221	Sec. 29, SE. ¼....	Coal.....	1	2
225	Sec. 33, SE. ¼....	Black dust...		5
		Shale.....	4	0
		Coal and ash		10
226	Sec. 33, NE. ¼...	Coal.....	2	0
228	Sec. 28, SE. ¼....	Coal.....	1	6
229	Sec. 27, SW. ¼...	Coal.....	1	10
		Shale and coal	30	0
		Coal.....		11
231	Sec. 27, SW. ¼...	Coal.....	1	10
232	Sec. 27, NE. ¼...	Coal bloom.		
		Shale.....	5	0
		Coal.....	2	2+
233	Sec. 26, NW. ¼...	Coal.....	1	8
237	Sec. 22, NE. ¼...	Coal.....	1	6
238	Sec. 23, NW. ¼..	Coal.....	1	1
239	Sec. 23, NE. ¼...	Coal.....	1	0
240	Sec. 14, SE. ¼....	Coal.....	1	4+
241	Sec. 13, SE. ¼....	Upper coal.	1	6
		Lower coal.	1	5
242	Sec. 13, SE. ¼....	Coal and ash		6
		Shale and sandstone.	25	0
		Coal.....		4
243	Sec. 14, SW. ¼...	Coal.....		4+
		Shale and coal	20	0
		Coal.....	1	2
244	Sec. 15, NW. ¼...	Coal.....	1	3
245	Sec. 10, SE. ¼....	Coal.....	1	0
		Shale and coal	20	0
		Coal.....	1	0
246	Sec. 10, SW. ¼...	Coal.....	1	0

Coal beds above Strait (D) coal bed.—Above the massive sandstone which overlies the Strait coal bed occurs a series of coal beds, the most important of which are the Red Butte (C), Fattig (B), and Summit (A). (See Pl. XIX.) These lie 35 or 40 feet apart, the lowest being 65 feet above the Strait coal, and follow the tops of the mesas and buttes which form the Bull Mountains. None of the three exceeds 3 feet in thickness, so far as known. The lowest or Red Butte bed is not well exposed owing to the heavy talus fringing the steep bluffs of the mountains, but where exposed it rarely exceeds 2 feet in thickness. The Fattig bed is commonly thicker than the Red Butte, measuring 2 to 3 feet almost everywhere. The Summit bed is very similar to the Fattig in general thickness but is differently distributed. It presents less than 2 feet of coal in the southern portions of Eldridge Mesa, between 2 and 3 feet in the northern portions, and generally less than 2 feet in the Taylor Mesa. These three beds are commonly free from thick partings, but their position high in the mountains makes them the least accessible coal beds in the region surveyed.

Near the crest of the Bull Mountains, and averaging about 70 feet above the Summit bed, or 40 to 60 feet below the tops of the mesas, occurs a mass of clinkers and brecciated rock which has been indurated and reddened for a vertical distance of about 30 feet. This doubtless marks a bed of coal of considerable thickness, which, owing to the thin cover, has been burned through its entire extent.

Representative coal sections of the Red Butte, Fattig, and Summit beds are shown graphically in Plate XIX. All additional measurements are listed in the following table:

Sections on coal beds above the Strait bed in T. 6 N., R. 27 E.

[See also Pl. XIX.]

Red Butte (C) coal bed.

No. on map, Pl. XIX.	Location.	Section.	Ft.	in.
250	Sec. 4, NW. ¼...	Coal.....	1	8±
252	Sec. 20, NE. ¼...	Coal, with 1-inch shale parting...	1	9
253	Sec. 20, SE. ¼....	Coal.....	1	7
257	Sec. 33, SE. ¼....	Coal.....	1	6
		Shale.....		2
		Coal.....		6
259	Sec. 27, SW. ¼...	Coal.....	1	10
260	Sec. 27, SW. ¼...	Coal.....	2	2
262	Sec. 27, NE. ¼...	Coal.....	1	9
265	Sec. 22, NE. ¼...	Ash..... 77 feet below Summit bed.		4

Sections on coal beds above the Strait bed in T. 6 N., R. 27 E.—Continued.

Red Butte (C) coal bed—Continued.

No. on map, Pl. XIX.	Location.	Section.	Ft.	in.
267	Sec. 23, NW. ¼..	Coal.....	1	8
268	Sec. 14, SE. ¼....	Coal.....	1	11
269	Sec. 15, NW. ¼...	Coal.....	1	8
		25 feet above sandstone above Strait bed.		
271	Sec. 10, SW. ¼...	Coal.....	2	4+
		80 feet above Strait bed.		
272	Sec. 10, SW. ¼...	Coal.....	2	2+

Fattig (B) coal bed.

274	Sec. 5, SW. ¼....	Coal, good..	2	4
		35 feet above Red Butte bed.		
277	Sec. 8, NE. ¼....	Coal.....	2	3
		100 feet above Strait bed and 35 feet above Red Butte bed.		
278	Sec. 16, NE. ¼...	Coal.....	2	9
		35 feet below bloom of Summit bed.		
279	Sec. 15, SW. ¼...	Coal.....	2	9+
281	Sec. 16, SW. ¼...	Coal.....	2	3
282	Sec. 16, SW. ¼...	Coal.....	2	5
284	Sec. 20, NE. ¼...	Coal.....		5+
286	Sec. 20, SE. ¼...	Coal.....	1	6
		Shale.....		½
		Coal.....		10
287	Sec. 21, SW. ¼...	Coal.....	2	4
		35 feet below Summit bed.		
289	Sec. 29, SW. ¼...	Ash.....	1	6
291	Sec. 33, SE. ¼...	Coal.....		6
		Shale.....	4	0
		Coal and ash		6
292	Sec. 33, NE. ¼...	Coal.....	3	5
		Shale.....	1	3
		Clay, sandy..	15	0
		Coal.....		1
293	Sec. 33, NE. ¼...	Coal.....		9
		Shale.....		10
		Coal.....	2	1
		Total coal.	2	10
294	Sec. 28, SE. ¼...	Coal.....		8
		Shale.....		5
		Coal.....	1	6
		Total coal.	2	2
296	Sec. 27, SW. ¼...	Coal.....		7
		Shale.....	1	6
		Coal.....	1	5
298	Sec. 27, NE. ¼...	Coal.....	2	5
302	Sec. 22, SE. ¼...	Coal.....		4
		Shale.....		6
		Coal.....	2	4
		Total coal.	2	8
303	Sec. 14, SE. ¼....	Coal.....		2
		Shale.....		2
		Coal.....	1	10
		Total coal.	2	0
305	Sec. 15, SE. ¼...	Coal.....	2	0
306	Sec. 15, NW. ¼..	Large coal bloom 30 feet above Red Butte bed.		
307	Sec. 15, NW. ¼..	Coal, bony..	2+	
		40 feet below Summit bed.		
308	Sec. 10, SW. ¼...	No coal.		
309	Sec. 9, SW. ¼....	Coal.....	2	6
		125 feet above Strait bed.		

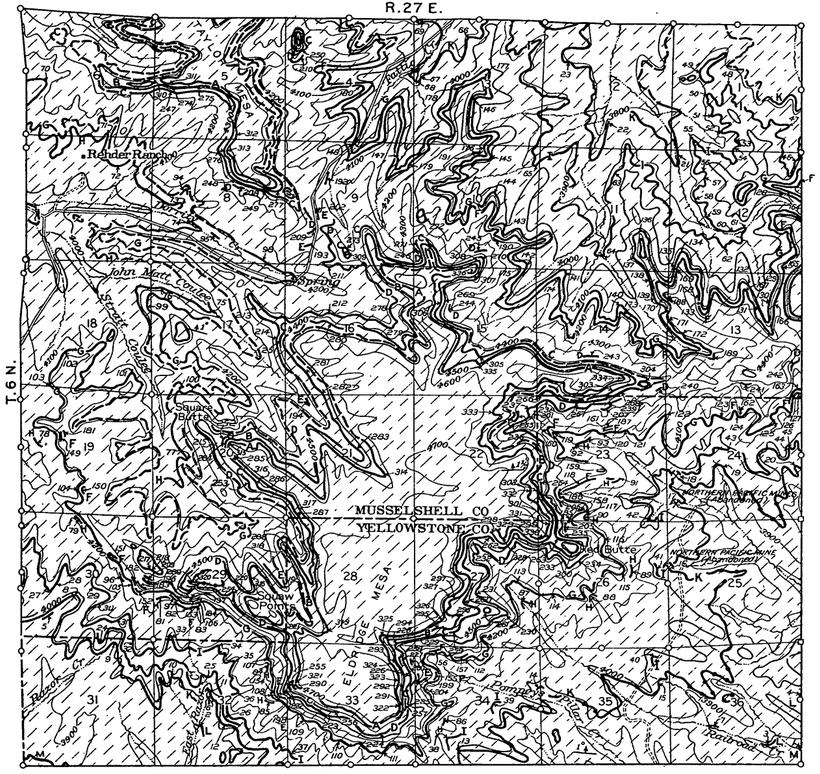
Sections on coal beds above the Strait bed in T. 6 N., R. 27 E.—Continued.

Summit (A) coal bed.

No. on map, Pl. XIX.	Location.	Section.	F.	in.
311	Sec. 5, SW. ¼....	Coal..... 40 feet above Fattig bed.		8±
313	Sec. 8, NE. ¼....	Coal.....		8
		Shale.....	2±	
316	Sec. 20, SE. ¼...	Coal.....		9½
317	Sec. 21, SW. ¼...	Coal.....	1	6
		Poor exposure.		
318	Sec. 29, NE. ¼...	Ash..... 38 feet above Fattig bed.		7
319	Sec. 28, SW. ¼...	Ash.....		8
320	Sec. 29, SW. ¼...	Ash.....	1	0
322	Sec. 33, SE. ¼...	Ash.....		5
323	Sec. 33, NE. ¼...	Coal.....	1	6
324	Sec. 33, NE. ¼...	Coal.....		6
325	Sec. 28, SE. ¼...	Coal.....		6
		Poor exposure.		
327	Sec. 27, SW. ¼...	Black dust.	Ft.	7
328	Sec. 27, NE. ¼...	Coal.....	1	0
		Burned out in upper part.		
329	Sec. 27, NE. ¼...	Coal.....	2	3
330	Sec. 26, NW. ¼..	No coal.		
331	Sec. 26, NW. ¼..	Coal..... 32 feet above Fattig bed.	2	7
332	Sec. 22, SE. ¼...	Coal, burned, clinker above.		
334	Sec. 14, SE. ¼...	Coal.....	2	3½
336	Sec. 15, NW. ¼..	Coal.....	2	3+
		Beneath massive sandstone.		

Development.—When the field was examined, the old Northern Pacific mine on the Mammoth bed in sec. 24, locations 16, 17, and 18, constituted the only development work on any of the coal beds in this township. This mine was opened in the early eighties by the Northern Pacific Railway and was abandoned soon because of its distance from the railroad and because all necessary fuel could be obtained from the Red Lodge coal field, 45 to 50 miles southwest of Billings. The total production of the old Northern Pacific mine is probably not more than 1,000 tons. No other coal is known to have been mined in the township, except possibly a few tons from surface prospects by ranchers for domestic use.

As this township is believed to contain more coal than any other in the Bull Mountain field, and as the coal beds are easily accessible both from the north and south, it is reasonable to expect that numerous mines will be located within its limits. It was reported in June, 1914, that considerable prospecting and other work preparatory to opening a commercial mine was being done on the Mammoth bed in the northern part of the township at the head of Fattig Creek. This locality is ideal for mining the Mammoth bed, as it is situated



LEGEND

TERTIARY

Eocene

Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Strike and dip

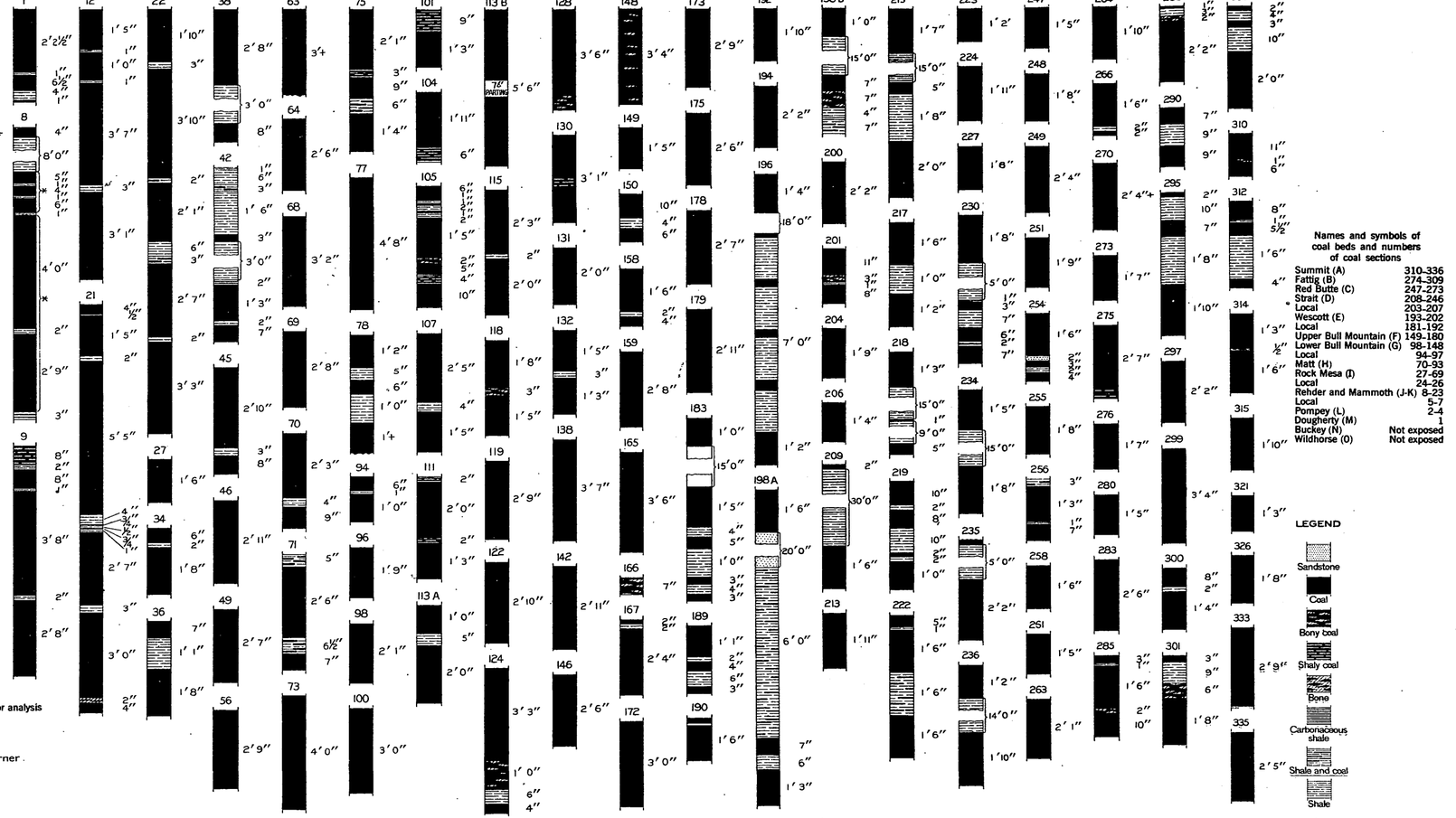
Land corner found

Private land corner

Scale 1/62500

0 1 2 MILES

* Sampled for analysis



SECTIONS

Names and symbols of coal beds and numbers of coal sections

Summit (A)	310–336
Fattig (B)	274–309
Red Butte (C)	247–273
Strait (D)	208–246
Local	203–207
Wescott (E)	193–202
Local	181–192
Upper Bull Mountain (F)	149–180
Lower Bull Mountain (G)	98–148
Local	94–97
Matt (H)	70–93
Rock Mesa (I)	27–69
Local	24–26
Rehder and Mammoth (J-K)	8–23
Local	5–7
Pompey (L)	2–4
Dougherty (M)	1
Buckey (N)	Not exposed
Wildhorse (O)	Not exposed

LEGEND

Sandstone

Coal

Bony coal

Shaly coal

Bone

Carbonaceous shale

Shale and coal

Shale

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 6 N., R. 27 E., MONTANA

only 20 miles south of the Chicago, Milwaukee & St. Paul Railway in a valley that forms a natural route for a railroad spur. Many of the other valleys which head in this township and which radiate from Eldridge Mesa are excellent natural routes for railroad spurs from both the north and south. Water and timber for mining use are more plentiful on the north side of the divide between Musselshell and Yellowstone rivers than on the south.

T. 7 N., R. 27 E.

GEOGRAPHY.

T. 7 N., R. 27 E., lies on and north of the central Bull Mountains in a region where the upper branches of Fattig and Parrott creeks have cut the plateau that surrounds the higher mesas into canyon-like valleys and ridges with flat or gently rounded tops. In the southwestern part of the township Taylor Mesa forms a remnant of a higher plateau surface, which is preserved only on the higher mesas.

The coulees and valley walls are clothed with a moderate growth of yellow pine, which is especially heavy about the heads of the coulees. The water supply is limited mainly to shallow wells, but includes a little running water on Fattig Creek in the vicinity of Schlaberg camp.

Several ranches are located in the township, the land of which is utilized chiefly for grazing. Parts of the valley bottoms are adapted to dry farming, and small areas have been irrigated. The Musselshell-Billings road crosses the southeastern part of the township and with the stream valleys and flat-topped ridges affords easy access to all parts of the township.

GEOLOGY.

A series of rocks about 1,200 feet in total thickness, exposed in this township, belongs wholly to the upper or coal-bearing portion of the Fort Union formation. It consists of alternating beds of sandstone, clay shale, and coal, of which the buff to yellowish-gray sandstones are predominant, forming steep bluffs or scarps along the valley walls and at the edges of the high mesas. In the northern and central parts of the township the beds dip 2½° to 6° SW. In the high mesas in the southwestern part of the township the strata are practically horizontal.

COAL.

Stratigraphic relations.—Sixteen coal beds have been studied and mapped in the township. (See Pl. XX.) The following table shows their stratigraphic relations and the numbers of the sections examined on each bed:

Stratigraphic relations of coal beds in T. 7 N., R. 27 E., and the numbers of the sections measured on each.

	Feet.
Summit (A) coal bed, Nos. 134 to 139, inclusive.	
Interval	35–45
Fattig (B) coal bed, Nos. 127 to 133, inclusive.	
Interval	30–35
Red Butte (C) coal bed, Nos. 119 to 126, inclusive.	
Interval, including local coal beds, Nos. 115 to 118, inclusive	60–80
Strait (D) coal beds, Nos. 107 to 114, inclusive.	
Interval	75±
Wescott (E) coal bed, No. 106.	
Interval, including local beds, Nos. 102 to 105	100
Upper Bull Mountain (F) coal bed, Nos. 85 to 101, inclusive.	
Interval	12–25
Lower Bull Mountain (G) coal bed, Nos. 75 to 84, inclusive.	
Interval, including the Matt(?) coal bed	130
Rock Mesa (I) coal bed, Nos. 67 to 74, inclusive.	
Interval	25–35
Rehder (J) and Mammoth (K) coal beds, Nos. 48 to 66, inclusive.	
Interval, including local beds, Nos. 46 and 47	40
Saddler (Ka) coal bed, Nos. 38 to 45, inclusive.	
Interval	40±
Pompey (L) coal bed, No. 37.	
Interval	60±
Ostrander (La) coal bed, No. 36.	
Interval	60
Dougherty (M) coal bed, Nos. 6 to 35, inclusive.	
Interval	40
Chandler (Ma) coal bed, Nos. 2 to 5, inclusive.	
Interval, including Buckey coal bed	470
Roundup (Oa) coal bed, No. 1.	

The coal beds enumerated above underlie larger or smaller parts of the township according to their position in the stratigraphic column. The Roundup, which is the lowest, underlies practically the whole township. The Summit, Fattig, and Red Butte, which are the highest, underlie only the highest buttes. The most important of the coal beds are the Roundup, the Dougherty, and the Rehder-Mammoth.

The physical character of the coal is nearly uniform in all the beds and is like that of the coal found in other parts of the field. No sample was obtained for chemical analysis in this township, but the analyses obtained from the same beds elsewhere in the field show the character clearly. (See pp. 51–53.)

The coal beds will be described in order, beginning with the lowest, the Roundup bed.

Roundup (Oa) coal bed.—It is estimated from measurements in the township to the north and east that the Roundup coal bed underlies nearly all of T. 7 N., R. 27 E. Its thickness decreases from about 3 feet 6 inches in the northwest to less than 1 foot in the southeast. The bed outcrops for only a short distance in the township in the NE. ¼ sec. 1, where a thickness of over 4 feet was measured (No. 1, Pl. XX.)

Buckey (N) coal bed.—The Buckey coal has been studied in T. 7 N., R. 28 E., and presumably underlies the eastern part of the township. No sections were measured, but the thicknesses in the township to the east indicate that the bed becomes thinner toward the west and probably is a little over 1 foot thick under secs. 12, 13, and 24 and less than a foot farther west. The stratigraphic interval between this bed and the Roundup is not known.

Chandler (Ma) coal bed.—The Chandler coal bed, 40 feet below the Dougherty or about 470 feet above the Roundup bed, was found on Fattig Creek in sec. 25 and in the northwest corner of sec. 24. Four sections (Nos. 2 to 5, inclusive), showing thicknesses from 10 inches to 2 feet, were measured. In the NW. ¼ sec. 25 (No. 3) the thickness is only 10 inches, but at the other localities it is greater. (See Pl. XX).

Dougherty (M) coal bed.—The Dougherty coal bed is stratigraphically 510 feet above the Roundup bed, as determined from a bore hole on Parrott Creek. Measurements made in sec. 7 show a thickness as great as 1 foot 11 inches. The bed was not traced continuously in the northwestern part of the township, but isolated exposures, presumably on the Dougherty bed on the divide between Parrott Creek and West Parrott Creek, show a thickness of 1 foot or less. The bed was measured again in the NE. ¼ sec. 16 (No. 15), where it has a thickness of 1 foot 6 inches. From that place to the southwest corner of the township it was traced by exposures of coal, burned coal, and blossom. The maximum thickness of over 3 feet 6 inches was found in an outlying hill in the NW. ¼ sec. 14 (No. 20). The average thickness under all of the southern and central part of the township is probably about 2 feet 6 inches.

Thirty locations were made within the township on the Dougherty coal bed, but at many of them only partial sections, bloom, or burned remnants of the bed were found. Representative sections are shown in Plate XX, and others are given below.

Coal sections on the Dougherty (M) coal bed in T. 7 N., R. 27 E.

[See also Pl. XX.]

No. on map, Pl. XX.	Location.	Section.	Ft.	in.
6	Sec. 7, NW. ¼...	Coal, weathered		6
		Coal	1	6
7	Sec. 7, NW. ¼...	Coal	1	11
8	Sec. 8, NW. ¼...	Coal	1	2
		Shale		1
		Coal		6
		Total coal	1	8
10	Sec. 7, NE. ¼....	Coal bloom	..	..
11	Sec. 5, SE. ¼.....	Coal		6
12	Sec. 5, SW. ¼....	Coal		6
		Coal, bony		8
		Total coal	1	2
13	Sec. 6. NE. ¼....	Coal	1	0
18	Sec. 15, SE. ¼....	Ash		4
		Shale		2
		Coal		3
19	Sec. 14, SW. ¼...	Coal	1	4
		Shale		½
		Coal		4
		Total coal	1	8
20	Sec. 14, NW. ¼..	Coal	3	6+
22	Sec. 14, SW. ¼...	Coal	2	1
		Shale		1
		Coal		4
		Total coal	2	5
23	Sec. 14, SE. ¼....	Coal bloom.		
24	Sec. 23, NE. ¼...	Ash		4½
25	Sec. 23, NE. ¼...	Ash		5
27	Sec. 23, SE. ¼....	Ash	1	0
29	Sec. 25, NW. ¼..	Coal	2	7
		Shale		1½
		Coal		4
		Total coal	2	11
30	Sec. 35, NW. ¼..	Coal bloom.		
31	Sec. 36, NW. ¼..	Coal	2	7
34	Sec. 25, NE. ¼...	Coal	2	8
35	Sec. 24, SE. ¼....	Ash		7½

Minor and local coal beds between Dougherty and Mammoth coal beds.—A bed of coal 6 inches in thickness in the NE. ¼ sec. 26 (No. 36) is correlated with the Ostrander (La) bed, which is best developed in T. 7 N., R. 28 E.

At another isolated exposure in the SW. ¼ sec. 8 (No. 37) a bed of coal 1 foot 3½ inches in thickness was found with a half-inch parting of shale 2½ inches from the top. This bed is correlated with the Pompey (L) bed, which in T. 5 N., R. 27 E., and T. 6 N., R. 26 E., lies 90 feet below the Mammoth bed.

The Saddler (Ka) coal bed is about 40 feet below the Mammoth bed and 160 feet above the Dougherty. Several isolated measurements have been obtained on the east side of the ridge dividing Parrott Creek from West Parrott Creek and on West Parrott Creek in sec. 18. The maximum thickness is 2 feet 1 inch, in the NE. ¼ sec. 16 (No. 44, Pl. XX). Farther north the thickness varies considerably. Four of the more representative coal sections on this bed are shown graphically in Plate XX, and the others are given in the table below.

Coal sections on the Saddler (Ka) coal bed in T. 7 N., R. 27 E.

[See also Pl. XX.]

No. on map, Pl. XX.	Location.	Section.		No. on map, Pl. XX.	Location.	Section.	
			Ft. in.				*Ft. in.*
40	Sec. 5, SE. ¼....	Coal, bony.....	1 1	43	Sec. 9, SE. ¼....	Coal bloom.	
41	Sec. 9, SW. ¼....	Coal.....	6	45	Sec. 16, NE. ¼...	Ash.....	6

In the NE. ¼ sec. 18 two exposures of a local bed (Nos. 46 and 47) were found between the Saddler and Mammoth beds, the thicknesses being 8 inches and 10 inches, respectively.

Mammoth (K) and Rehder (J) coal beds.—The outcrops of the Mammoth and Rehder coal beds follow the northern and northeastern face of Taylor Mesa in an irregular line from sec. 18 on the west to sec. 35 on the southeast of the township. The outcrops are in most places concealed by a soil mantle, and the coal is in many places burned, so that it is difficult to obtain satisfactory measurements except in coulee bottoms.

Throughout the greater part of the area underlain by these coal beds in the township the interval between them is about 15 feet and is occupied mainly by a massive sandstone. This interval becomes gradually less toward the southwest, and near Schlaberg camp in sec. 34 (Nos. 56 and 66, Pl. XX) it decreases from 3 feet to 9 inches in less than a hundred feet. (See Pl. VIII, *B*, p. 39.) Southeast of this point the two beds are minable as one bed and are described as the Mammoth coal bed. At Schlaberg camp the combined bed has a thickness of 14 feet 2 inches of coal, exclusive of two partings. The lower 5 feet 9 inches represent the Mammoth proper and the upper 8 feet 5 inches the Rehder. Farther northwest the Mammoth bed has a thickness of 4 to 5 feet. The Rehder is also thinner in the same direction and at the western boundary of the township has an estimated thickness of 4 feet 6 inches. In the graphic sections in Plate XX and in the sections given in the following table are included four sections, Nos. 51B, 52B, 53, and 62, which were measured by Eldridge in 1881.

Coal sections on the Mammoth (K) and Rehder (J) coal beds in T. 7 N., R. 27 E.

[See also Pl. XX.]

Mammoth (K) coal bed.

No. on map, Pl. XX.	Location.	Section.	No. on map, Pl. XX.	Location.	Section.
		Ft. in.			*Ft. in.*
49	Sec. 20, NE. ¼; Sealey's well.	Coal..... 5	53	Sec. 22, SE. ¼; section by Eldridge.	Coal..... 1 6 Parting..... 5± Coal..... 2 5 Total coal. 3 11

Rehder (J) coal bed.

					Ft. in.
57	Sec. 18, SW. ¼...	Coal, burned at outcrop.	61	Sec. 21, NE. ¼...	Ash..... 11
58	Sec. 18, NW. ¼..	Coal, burned at outcrop.	62	Sec. 22, SE. ¼; section by Eldridge.	Coal..... 3
59	Sec. 17, NW. ¼..	Coal, burned at outcrop.			
60	Sec. 17, SE. ¼...	Coal, burned at outcrop.	63	Sec. 22, SE. ¼...	Coal, burned at outcrop.

Rock Mesa (I) coal bed.—About 80 feet above the Mammoth coal bed a persistent coal bed called the Rock Mesa outcrops approximately parallel to the Rehder and Mammoth. The bed is in most places covered by shale and contains persistent partings, which in places within short distances become so thick as to seriously affect the commercial value of the coal. The maximum thickness of the bed, 3 feet 7 inches, is found in sec. 20 (No. 69, Pl. XX), but in many places it contains only small amounts of coal or its outcrop is obscured by grassed and forested slopes. The average thickness under the part of the area underlain by the bed within the township is about 2 feet 8 inches. The graphic sections in Plate XX and the following lists show the thickness of the bed within the township.

Coal sections on the Rock Mesa (I) coal bed in T. 7 N., R. 27 E.

[See also Pl. XX.]

No. on map, Pl. XX.	Location.	Section.	No. on map, Pl. XX.	Location.	Section.
		Ft. in.			*Ft. in.*
68	Sec. 20, NW. ¼..	Ash..... 4½	71	Sec. 21, NE. ¼...	Coal..... 1 5+
70	Sec. 20, SE. ¼...	Coal..... 1 3	74	Sec. 34, SE. ¼...	Ash..... 8

Matt coal bed (H).—The extreme southwestern part of the township is undoubtedly underlain by the Matt coal bed, which outcrops in the townships to the south and southwest. Its estimated thickness at the southwest corner of the township is 1 foot 2 inches. The measured interval between the Rock Mesa and the Matt coal in T. 6 N.,

R. 27 E., is 170 feet; and the interval between the Rock Mesa and the Lower Bull Mountain in T. 7 N., R. 27 E., is only 130 feet. These intervals indicate that probably the Matt and Lower Bull Mountain coal beds may eventually prove to be identical.

Bull Mountain coal beds (F and G).—The Bull Mountain coal beds outcrop close to the base of the high mesas and buttes of the Bull Mountains. The two beds are separated by 12 to 20 feet of sandstone and shale, and the lower bed is stratigraphically about 130 feet above the Rock Mesa coal bed. The upper bed is in most places overlain by a conspicuous dark-gray clay shale 20 to 30 feet thick. The area underlain by the two beds lies in the southwestern part of the township, almost wholly within secs. 27 to 33, inclusive. The average thickness of the lower bed is about 2 feet under most of the area, but falls as low as 1 foot 4 inches in sec. 30. The upper bed is fairly uniform in thickness, averaging 3 feet 1 inch. Representative sections on each bed are shown graphically in Plate XX, and all other measurements are included in the following list.

Coal sections on the Lower Bull Mountain (G) and Upper Bull Mountain (F) coal beds in T. 7 N., R. 27 E.

[See also Pl. XX.]

Lower Bull Mountain (G) bed.

No. on map, Pl. XX.	Location.	Section.		No. on map, Pl. XX.	Location.	Section.	
		Ft.	*in.*			*Ft.*	*in.*
75	Sec. 30, SE. ¼...	Coal..... 2	7	83	Sec. 27, SW. ¼...	Burned.	
78	Sec. 28, NW. ¼..	Coal..... 2	0	84	Sec. 33, NE. ¼...	Coal..... 2	2
80	Sec. 28, NE. ¼...	Coal..... 1	10				

Upper Bull Mountain (F) coal bed.

85	Sec. 30, NW. ¼..	Coal bloom.	92	Sec. 29, NE. ¼...	Coal..... 3 6
86	Sec. 30, NW. ¼..	Coal bloom.	95	Sec. 28, NE. ¼...	Coal..... 2 6
90	Sec. 29, NW. ¼..	Coal, top not exposed.... 1 6+	97	Sec. 27, NW. ¼..	Coal..... 2+

Upper coal beds.—Two narrow spurs of Taylor Mesa extend into the southern part of the township—one in secs. 31 and 32, the other in secs. 32, 33, and 28. There is also a small isolated butte, the Dumbbell Butte, in sec. 29. High on the sides of these mesas and buttes is a series of coal beds, which, however, are at present of comparatively little value on account of their inaccessibility and the small area which they underlie. Five of these beds are persistent and have received names—the Wescott (E), Strait (D), Red Butte (C), Fattig (B), and Summit (A) coal beds. For convenience all of the sections measured on these beds and the intermediate local beds are listed together.

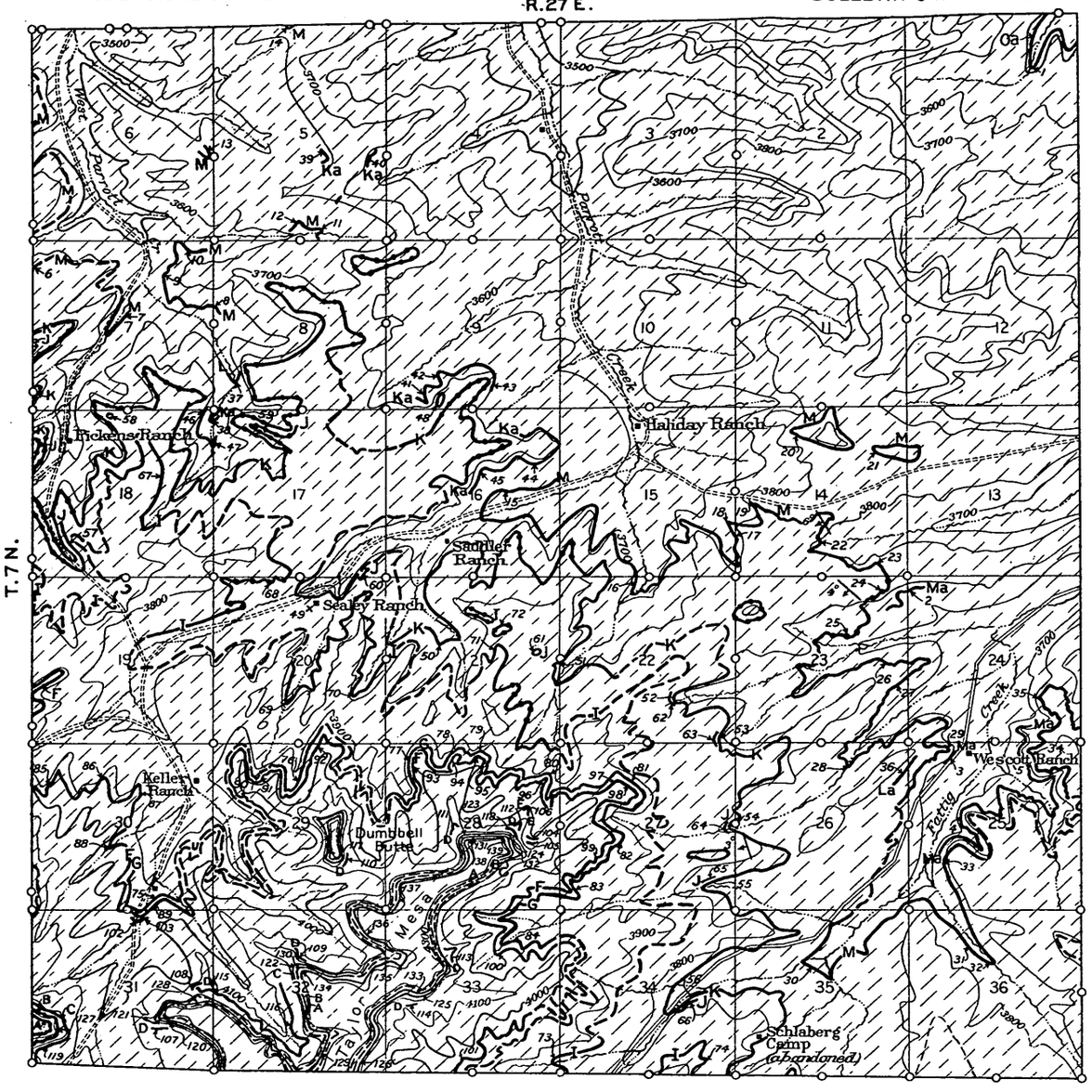
Coal beds were found at five places (Nos. 102 to 106) in the 200 feet of strata between the Upper Bull Mountain coal bed and the Strait coal bed. Of these a bed in the NE. ¼ sec. 28 (No. 106) has been correlated with the Wescott coal bed, which in T. 6 N., R. 27 E., has a maximum thickness of 2 feet 2 inches. The Strait coal bed outcrops near the base of the steep slopes and is overlain by a massive sandstone 30 to 40 feet thick, which forms a prominent scarp. The thickness of the bed ranges from less than a foot to a maximum of 2 feet 3 inches in sec. 28 (Nos. 107 to 114, inclusive). The interval between the Strait and Red Butte coal beds is 60 to 80 feet. Within this interval there is a coal bed, which on the north side of the eastern mountain spur and in Dumbbell Butte has a thickness of about 2 feet 6 inches (Nos. 115 to 118). The Red Butte bed has an average thickness of 2 feet (Nos. 119 to 126), and the Fattig coal bed, 30 to 35 feet higher, averages 1 foot 9 inches (Nos. 127 to 133). The highest coal bed in the Bull Mountains is the Summit bed, which is 35 to 40 feet above the Fattig and which has an average thickness in this township of 3 feet. Selected sections from each of these coal beds are shown graphically in Plate XX. All the other observations made are recorded below.

Coal sections on upper coal beds in T. 7 N., R. 27 E.

[See also Pl. XX.]

Minor coal beds between Upper Bull Mountain and Wescott beds.

No. on map, Pl. XX.	Location.	Section.		No. on map, Pl. XX.	Location.	Section.	
		Ft.	*in.*			*Ft.*	*in*
102	Sec. 31, NE. ¼...	Coal.....	8	103	Sec. 31, NE. ¼...	Coal.....	6
		Shale.....	6			20 feet above Upper Bull Mountain bed.	
		Coal.....	8				
		Shale.....	4				
		Coal.....	5				
		Total coal. 45 feet above Upper Bull Mountain bed.	1 9	104	Sec. 28, SE. ¼...	Coal..... 1	6
				105	Sec. 28, SE. ¼...	Coal..... 1	8
Wescott (E) coal bed.							
106	Sec. 28, NE. ¼...	Coal.....	10				
Strait (D) coal bed.							
108	Sec. 31, NE. ¼...	Coal.....	9	113	Sec. 33, NW. ¼...	Coal..... 1	6
109	Sec. 32, NW. ¼...	Coal and ash... 1	0	114	Sec. 33, SW. ¼...	Coal.....	9
111	Sec. 28, SW. ¼...	Coal..... 2	3				



TERTIARY
Eocene

Fort Union formation

LEGEND

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

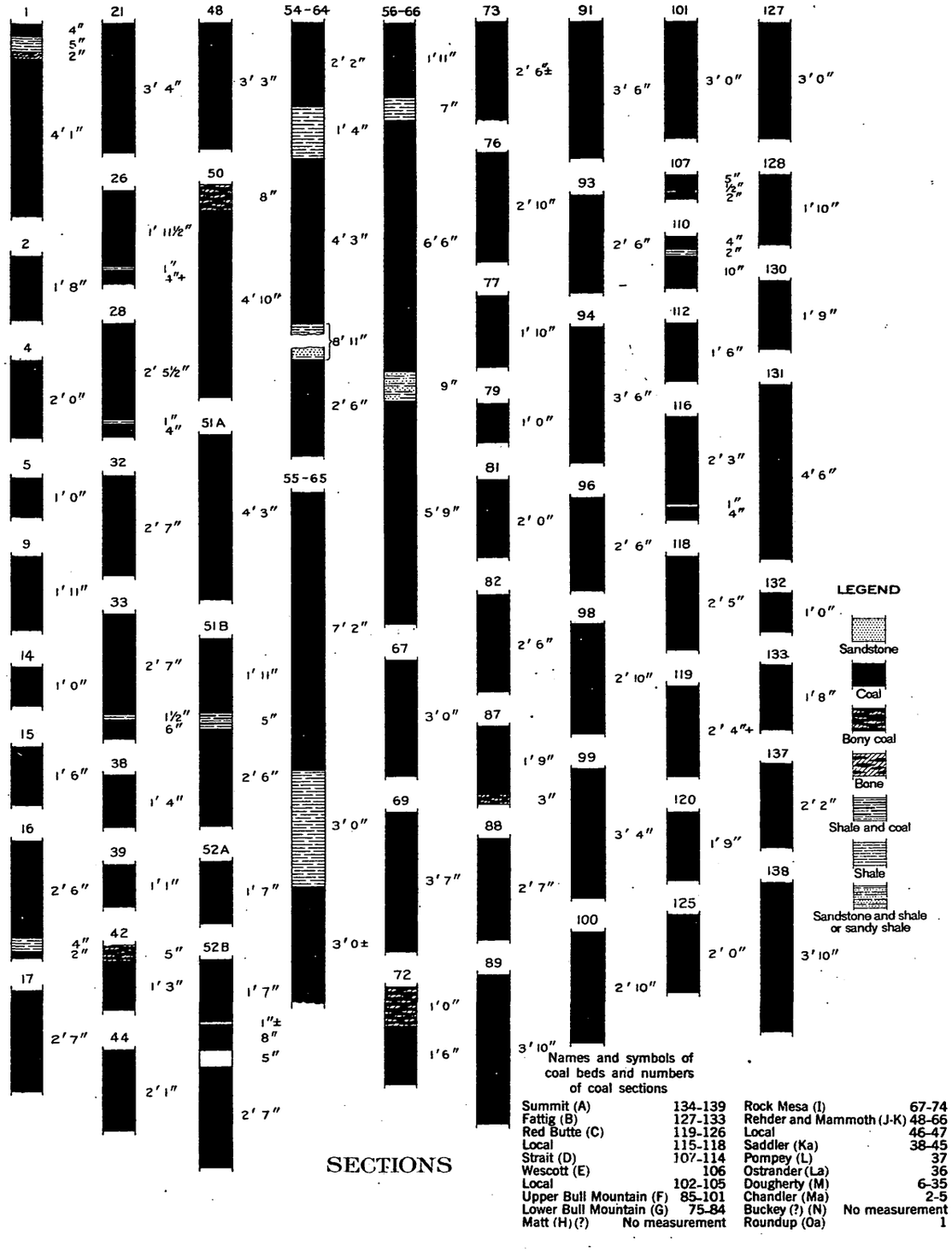
Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500
1 0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 7 N., R. 27 E., MONTANA



SECTIONS

Names and symbols of coal beds and numbers of coal sections

Summit (A)	134-139	Rock Mesa (I)	67-74
Fattig (B)	127-133	Rehder and Mammoth (J-K)	48-66
Red Butte (C)	119-126	Local	46-47
Local	115-118	Saddler (Ka)	38-45
Strait (D)	107-114	Pompey (L)	37
Wescott (E)	106	Ostrander (La)	36
Local	102-105	Dougherty (M)	6-35
Upper Bull Mountain (F)	85-101	Chandler (Ma)	2-5
Lower Bull Mountain (G)	75-84	Buckey (?) (N)	No measurement
Matt (H) (?)	No measurement	Roundup (Oa)	1

Coal sections on upper coal beds in T. 7 N., R. 27 E.—Continued.

Local coal bed between Strait and Red Butte beds.

No. on map, Pl. XX.	Location.	Section.		No. on map, Pl. XX.	Location.	Section.	
			Ft. in.				*Ft. in.*
115	Sec. 32, SW. ¼...	Coal bloom.		117	Sec. 29, SE. ¼...	Ash and coal.	10

Red Butte (C) coal bed.

121	Sec. 31, SE. ¼...	Bone.....	2	123	Sec. 28, SW. ¼...	Coal.....	2 2
		Coal.....	1 2+	124	Sec. 28, SE. ¼...	Coal.....	2 2
122	Sec. 32, NW. ¼..	Ash and coal...	3	126	Sec. 32, SE. ¼...	Coal.....	2 0

Fattig (B) coal bed.

129	Sec. 32, SE. ¼...	Coal bloom.					

Summit (A) coal bed.

134	Sec. 32, NE. ¼...	Coal bloom.		136	Sec. 32, NE. ¼...	Coal.....	2+
135	Sec. 33, NW. ¼..	Coal.....	2+	139	Sec. 28, SE ¼....	Coal.....	3 10

Development.—No coal has been mined in this township except possibly a few tons from surface prospects for domestic use by ranchers. The valleys of West Parrott, Parrott, and Fattig creeks are natural routes for railroad spurs, and from their heads some of the thickest coal beds in the entire Bull Mountain coal field can be most advantageously mined. It is reported that some development work is being done in the vicinity of Schlaberg camp, on Fattig Creek in the southeastern part of the township.

Water and timber for mine use are fairly plentiful.

The lower coal beds (Roundup and Buckey), if of economic value in this township, can be most easily mined from shafts in the valley bottoms. The upper coal beds should be mined from slopes and drifts on the hillsides.

T. 8 N., R. 27 E.

GEOGRAPHY.

T. 8 N., R. 27 E., lies on the north side of the Bull Mountain field along Musselshell River, which flows eastward across the northern part in a wide flat valley. North and south of the river the surface rises in a series of moderately steep bluffs separated by wide terraces. South of the central part of the township, however, the slopes are more abrupt and the flat-bottomed stream valleys are separated from the uplands by nearly vertical rim rocks.

The principal source of water supply is Musselshell River, the only perennial stream. Parrott Creek and Schnall Coulee contain running water only occasionally. A study of the rock strata and the structure of the region leads to the belief that water could be reached at a comparatively shallow depth almost anywhere in the valleys.

Nearly all the northern half of the township and parts of the southern half are adapted to dry farming. In addition the flood plain of Musselshell River is in part irrigated by water from the river.

The Chicago, Milwaukee & St. Paul Railway follows the north side of Musselshell River and is nearly paralleled by the county road connecting Roundup with the towns to the east. Gage post office is on the railroad in sec. 6, and there are a number of ranches in the valleys of Musselshell River and Parrott Creek.

GEOLOGY.

The somber shale and coarse yellow sandstone which make up the Lebo shale member of the Fort Union formation outcrop over the area north of Musselshell River and in a narrow strip south of its flood plain. Above these rocks lie the sandstone and shale of the upper part of the Fort Union formation, which outcrop over nearly all the part of the township south of the river. The total thickness of the outcropping beds is about 1,600 feet. In this part of the Bull Mountains the strata dip very gently south.

COAL.

Big Dirty (P) coal bed.—The Big Dirty coal bed, which lies about the middle of the Lebo shale member of the Fort Union, outcrops prominently in the railway cut in sec. 3, half a mile east of the Arkwright Sheep Co.'s ranch, exposing about 6 feet of coaly shale. To the west, in sec. 6, the outcrop is very conspicuous, as it covers a dip slope for a considerable distance. Although it was not possible to obtain an actual measurement of the bed in this part of the township, it appears to be at least 20 feet thick and to be composed of alternating beds of carbonaceous shale and sandstone, with thin layers of coal. Fragments of the eroded coal collect in the coulees and appear to be of a fairly good quality.

Roundup (Oa) coal bed.—The only valuable coal bed in the township is the Roundup, which outcrops along a general east and west line a little south of the center of the township and along some of the tributaries of Fattig Creek in the southeast corner. The coal is in many places burned at the outcrop and is largely concealed by a soil mantle, so that only few complete sections were obtained. These are sufficient, however, to show that the coal is of fairly uniform grade and thickness across the township. The average thickness is from 2 feet 6 inches to 3 feet. The coal is of a high-grade subbituminous character with fairly good stocking qualities. No sample for chemical

analysis was obtained from this township, but the character of the Roundup coal is shown by samples taken near Roundup. (See pp. 51–52.) Two local coal beds were observed in the township, one 35 to 46 feet below the Roundup bed and the other about 15 feet above it. In the following list the coal sections measured on these local beds are included with those on the Roundup bed. A few sections on the Roundup bed are shown graphically in Plate XXI.

Coal sections on the Roundup (Oa) coal bed in T. 8 N., R. 27 E

[See also Pl. XXI.]

No. on map, Pl. XXI.	Location.	Section.	Ft.	in.
1	Sec. 19, NW. ¼...	Sandstone, platy	1	0
		Shale	2	0
		Ash and coal.		1½
		Shale		5
3	Sec. 19, SE. ¼.....	Ash and coal.		8
		Coal..... 46 feet below Roundup coal bed.	1	11
4	Sec. 29, SE. ¼....	Shale, sandy...	6	0
		Ash		1½
		Shale and ash		6
		Shale		4
		Ash		5
		Shale, sandy.		
5	Sec. 28, SW. ¼...	Coal.....	1	0
6	Sec. 21, SE. ¼....	Coal.....	2	4
8	Sec. 20, NW. ¼..	Ash		5
9	Sec. 21, NE. ¼....	Sandstone.		
		Shale, sandy.	5±	
		Coal..... Base not exposed.	2	2+
11	Sec. 22, NW. ¼...	Coal, much weathered at top.....	2	3
12	Sec. 22, SW. ¼...	Coal..... Base not exposed.	1	9+
13	Sec. 23, SW. ¼....	Coal..... Base not exposed.	2+	
15	Sec. 23, SE. ¼.....	Coal bloom.		
16	Sec. 23, NE. ¼....	Coal bloom.		
17	Sec. 23, NE. ¼....	Coal..... ±15 feet above Roundup coal bed.		5
18	Sec. 23, NE. ¼....	Coal bloom.		
19	Sec. 24, NW. ¼...	Coal..... 15 feet above Roundup coal bed.		5
20	Sec. 13, SW. ¼....	Coal.....	1	3
		Bone.....		½
		Coal.....	1	3
		Total coal....	2	6
21	Sec. 13, SW. ¼....	Coal.....		3½
		Bone.....		½
		Coal.....	1	0
		Shale.....		9
		Coal..... 35 feet below Roundup coal bed.		2
22	Sec. 13, SW. ¼....	Coal.....	2	8
23	Sec. 13, SE. ¼....	Ash		10
24	Sec. 13, SE. ¼.....	Coal.....	2	7+
26	Sec. 24, SE. ¼.....	Coal..... 15 feet above Roundup coal bed.	1	6
28	Sec. 24, SE. ¼....	Coal..... 35 feet below Roundup bed.	1	1

Development.—No coal is known to have been mined in this township, except possibly a few tons from surface prospects by ranchers for domestic use. A shaft was sunk on the Roundup bed in the NE. ¼ sec. 30 to determine if it is of value in that locality. The re-

sults are reported to show that it is not of economic importance at this place.

Owing to the thinness of the Roundup bed, which is the only one of importance outcropping in or underlying this township, it is doubtful if commercial mines will be located here. Country banks will undoubtedly supply the local demand for fuel.

T. 9 N., R. 27 E.

GEOGRAPHY.

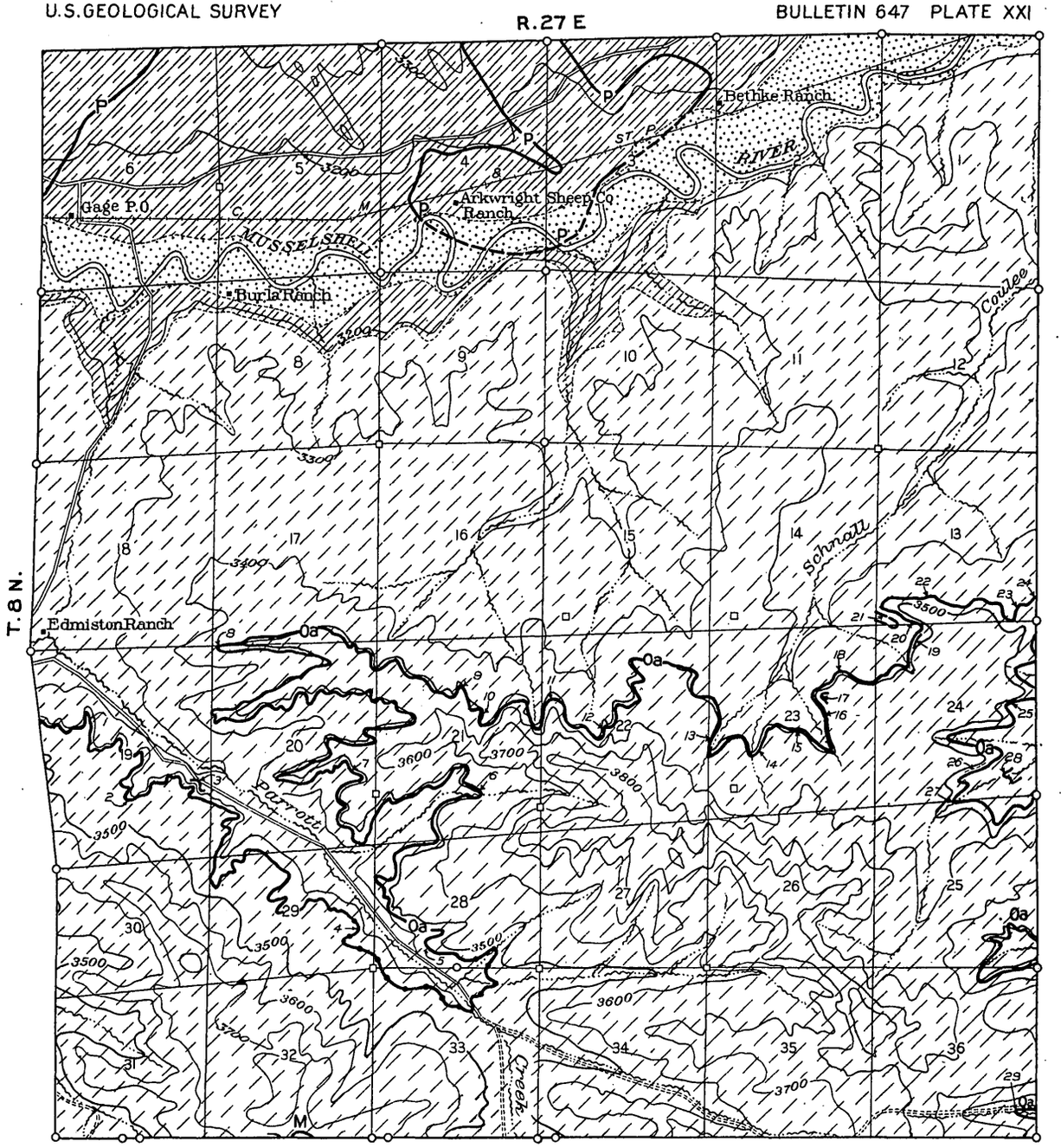
T. 9 N., R. 27 E., lies on the northern side of the Bull Mountain coal field and is drained by short intermittent streams flowing southeastward to Musselshell River. So far as known it contains no coal of economic value, and only a reconnaissance examination was made. In the northeastern and eastern parts the surface is generally smooth. Farther south it is rolling and somewhat broken along the divides between the stream courses. In the southern and eastern parts the land is generally rough. Badlands are developed locally along the north border of the township and to a greater extent a little north of the north township line. There are a few springs within the township; and water can be obtained almost everywhere by digging or drilling shallow wells in the valley bottoms.

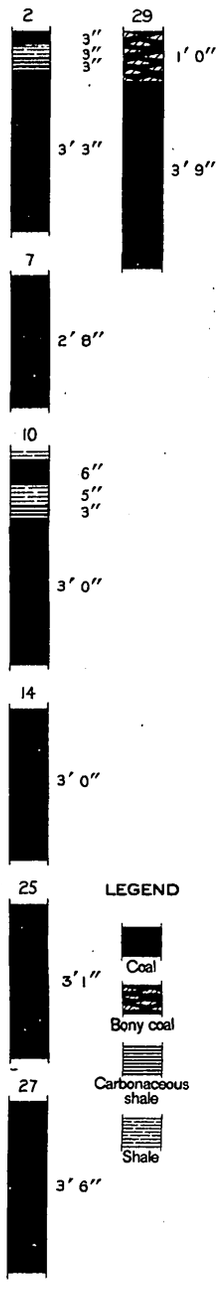
GEOLOGY AND COAL.

The surface rocks of the township belong to the Fort Union formation. The Lebo shale member is fairly well exposed in the western and southwestern parts and consists of about 200 feet of olive-drab sandy shale and shaly sandstone with a prominent carbonaceous zone (Big Dirty coal bed) near the middle. This coal bed is well exposed in the SE. ¼ sec. 19 east of the wagon road but is of no economic importance. The upper coal-bearing portion of the Fort Union formation, consisting of yellowish-gray sandstone and shale, constitutes the surface rocks in the greater part of the township, but is not known to contain any coal of economic importance. Many of the sandstone beds are lenticular, in places attaining a thickness as great as 75 feet but within a short distance giving place to soft sandy shale.

The Lance formation, which conformably underlies the Fort Union rocks, contains in its upper part a few coal beds. A few hundred feet north of this township, in the SW. ¼ sec. 35, T. 10 N., R. 27 E., coal has been mined from the Homestead bed referred to in Richards's report.[1] This is the only locality in the Bull Mountain field where coal of economic importance is known in the Lance formation.

[1] Richards, R. W., The central part of the Bull Mountain coal field, Mont.: U. S. Geol. Survey Bull. 381, p. 66, 1908.





LEGEND

QUATERNARY

Alluvium

TERTIARY

Eocene

Fort Union formation with Lebo shale member at base

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Land corner found

Private land corner

SECTIONS

Names and symbols of coal beds

Dougherty (M)
Roundup (Oa)
Big Dirty (P)

Scale 1/62,500

0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 8 N., R. 27 E., MONTANA

Structurally the rocks in this township form an asymmetric syncline. Along its northern edge the beds dip as much as 45° S. and strike almost east and west; along its southwest side they dip gently northeast; and in the central and eastern parts they lie nearly flat.

T. 5 N., R. 28 E.

GEOGRAPHY.

T. 5 N., R. 28 E., lies southeast of the central Bull Mountain mesas. In the northwestern part of the township the topography is characteristic of the Bull Mountain region, consisting of a plateau surface deeply dissected by southeastward-flowing streams that have their sources in narrow, canyon-like valleys. In the eastern and southern parts nearly parallel, broad, flat-topped ridges extend southeastward from the highlands and are separated by steep bluffs from the wide, smooth valleys, the most important of which are those of Pompeys Pillar and Railroad creeks. All the stream channels are dry except for a short time in the rainy season or after violent storms. On account of the slight northward dip of the strata nearly all the water that finds its way underground flows northward through the porous sandstone, and in consequence there are only one or two springs in the township. Water, however, could probably be reached by boring to a considerable depth. Except for the scarcity of water, much of the central and southern part of the township is adapted to dry farming. A moderate growth of pine is found in the coulee heads and over the higher plateaus in the northwestern part.

At the time of the field examination there was no ranch in the township, the area being used mainly for winter grazing.

GEOLOGY.

The rocks exposed in the township all belong to the Fort Union formation. In the southern and southeastern parts the shale and coarse sandstone of the Lebo shale member extend up the valleys in broad V-shaped areas. Above the Lebo lie the buff sandstone and shale of the upper part of the Fort Union, which outcrop over the greater part of the township. All the beds dip gently north at angles not greater than 2°.

COAL.

Stratigraphic relations.—Four coal beds have been mapped within the township, though none of them reach any great thickness in this part of the field. (See Pl. XXII.) Their stratigraphic relations and the numbers of the sections measured on each bed are shown in the following table:

Stratigraphic relations of the coal beds in T. 5 N., R. 28 E., and the numbers of the sections measured on each.

	Feet.
Dougherty (M) coal bed, No. 41.	
Interval	200
Buckey (N) coal bed, Nos. 36 to 40, inclusive.	
Interval	60
C A or De Bore (Na) coal bed, Nos. 25 to 35, inclusive.	
Interval	95
Wildhorse (O) coal bed, Nos. 1 to 24, inclusive.	
Interval to top of Lebo shale member	330

The character of the coal in this township is similar to that in other parts of the Bull Mountain field. No sample was obtained for chemical analysis within the township, but analyses of samples from other parts of the field show that the coal is high-grade subbituminous.

Wildhorse (O) coal bed.—The Wildhorse coal bed is the lowest of the coal beds in the upper part of the Fort Union in this part of the field. It lies stratigraphically about 330 feet above the top of the Lebo shale member and reaches its maximum importance in this township. Its outcrop extends generally northeast from sec. 19 to sec. 1 and can be followed almost continuously. The bed was examined and measured at 24 places. The maximum thickness of 3 feet 5 inches was found in sec. 19 (No. 5), northeast of which the bed is thinner and in sec. 1 measures only 1 foot 1 inch to 1 foot 8 inches. The average for the township is about 1 foot 10 inches. These variations in thickness are shown by the graphic sections in Plate XXII and by the additional sections in the following table:

Coal sections on the Wildhorse (O) coal bed in T. 5 N., R. 28 E.

[See also Pl. XXII.]

No. on map, Pl. XXII.	Location.	Section	Ft.	in.
1	Sec. 19, SW. ¼...	Coal	3±	
		Base not exposed.		
4	Sec. 19, SE. ¼...	Coal	2	9
7	Sec. 17, SW. ¼...	Coal	2	8½
9	Sec. 17, SE. ¼...	Coal	1	11½
10	Sec. 16, SW. ¼...	Coal	1	6½
11	Sec. 21, NE. ¼...	Coal	1	3
13	Sec. 10, SW. ¼...	Coal		10½
15	Sec. 10, SW. ¼...	Coal	1	8
16	Sec. 10, NW. ¼...	Shale, carbonaceous		4
		Shale		½
		Coal	2	2
18	Sec. 11, NW. ¼...	Coal	1	5½
20	Sec. 1, SW. ¼...	Coal		3
		Shale		1½
		Coal		11
		Total coal	1	2
20	50 feet east of above.	Coal		2
		Shale		1
		Coal	1	3
21	Sec. 12, NW. ¼...	Coal	1	7
22	Sec. 1, NE. ¼...	Coal		4
		Shale, sandy		1
		Coal	1	4
		Total coal	1	8

C A (Na) coal bed.—The C A coal bed, known as the De Bore coal in the part of the field surveyed by Lupton, lies about 95 feet above the Wildhorse. Its westernmost measurement was obtained in sec. 19, where it has a thickness of 1 foot 4 inches. Toward the northeast it is somewhat thicker—about 2 feet in sec. 9—but measurements in secs. 3, 4, and 9 show that it is there divided into two benches by clay 6 inches to 2 feet thick. The graphic sections in Plate XXII and the sections given in the following list include all the measurements on the C A bed within the township.

Coal sections on the C A (Na) coal bed in T. 5 N., R. 28 E.

[See also Pl. XXII.]

No. on map, Pl. XXII.	Location.	Section.	Ft.	in.
25	Sec. 19, NW. ¼....	Coal.....	1	4
26	Sec. 17, SE. ¼.....	Shale, brown		6
		Coal.....	1	1
		Shale, brown....		3
		Total coal..	1	1
30	Sec. 4, SE. ¼.....	Coal.....		6
		Shale.....	1	6
		Coal.....	1	5
		Total coal..	1	11
32	Sec. 3, SW. ¼....	Coal.....		6
		Shale.....		6
		Coal.....		6
		Shale.....	2	0
		Coal.....	1	6
		Total coal..	2	6
33	Sec. 3, SE. ¼.....	Coal.....		6
		Shale.....	2	0
		Coal.....	1	8
		Total coal..	2	2
34	Sec. 3, SE. ¼.....	Coal.....		6
		Shale.....		6
		Coal.....		5
		Coal, bony.....		4
		Total coal..	1	3

Buckey coal bed (N).—The Buckey (N) coal bed, 60 feet above the C A bed, has not been mapped continuously in this township, except for a short distance in sec. 18, where it contains 2 feet 6 inches of coal split by a shale parting which materially affects its value. A few isolated exposures show that the bed is thinner toward the northwest. Two coal sections are shown in Plate XXII, in addition to which the following were measured:

Coal sections on the Buckey (N) coal bed in T. 5 N., R. 28 E.

[See also Pl. XXII.]

No. on map, Pl. XXII.	Location.	Section.	Ft.	in.
38	Sec. 17, SE. ¼....	Coal.....	1	9
		Shale.....		9
		Coal.....		5
		Shale.....		1
		Coal.....		6
		Total coal...	2	8
39	Sec. 3, SW. ¼....	Coal.....	1	1
40	Sec. 4, NE. ¼.....	Coal.....		8

Dougherty (M) coal bed.—The Dougherty coal bed underlies only a small area northwest of sec. 6, where a thickness of 1 foot 4 inches was found (No. 41). It is approximately 200 feet above the Buckey.

Development.—No coal has been mined from this township except possibly a few tons from surface prospects by ranchers for domestic use. Although the coal beds are comparatively thin, it is possible that at some time in the future they will be mined on a commercial scale, and then the valleys of Railroad and Pompeys Pillar creeks and their tributaries will serve as natural routes for spurs from the Northern Pacific Railway, 15 to 20 miles to the south. Very probably the coal will be mined only in country banks and surface prospects. Timber for mine use is fairly plentiful, but water is rather scarce.

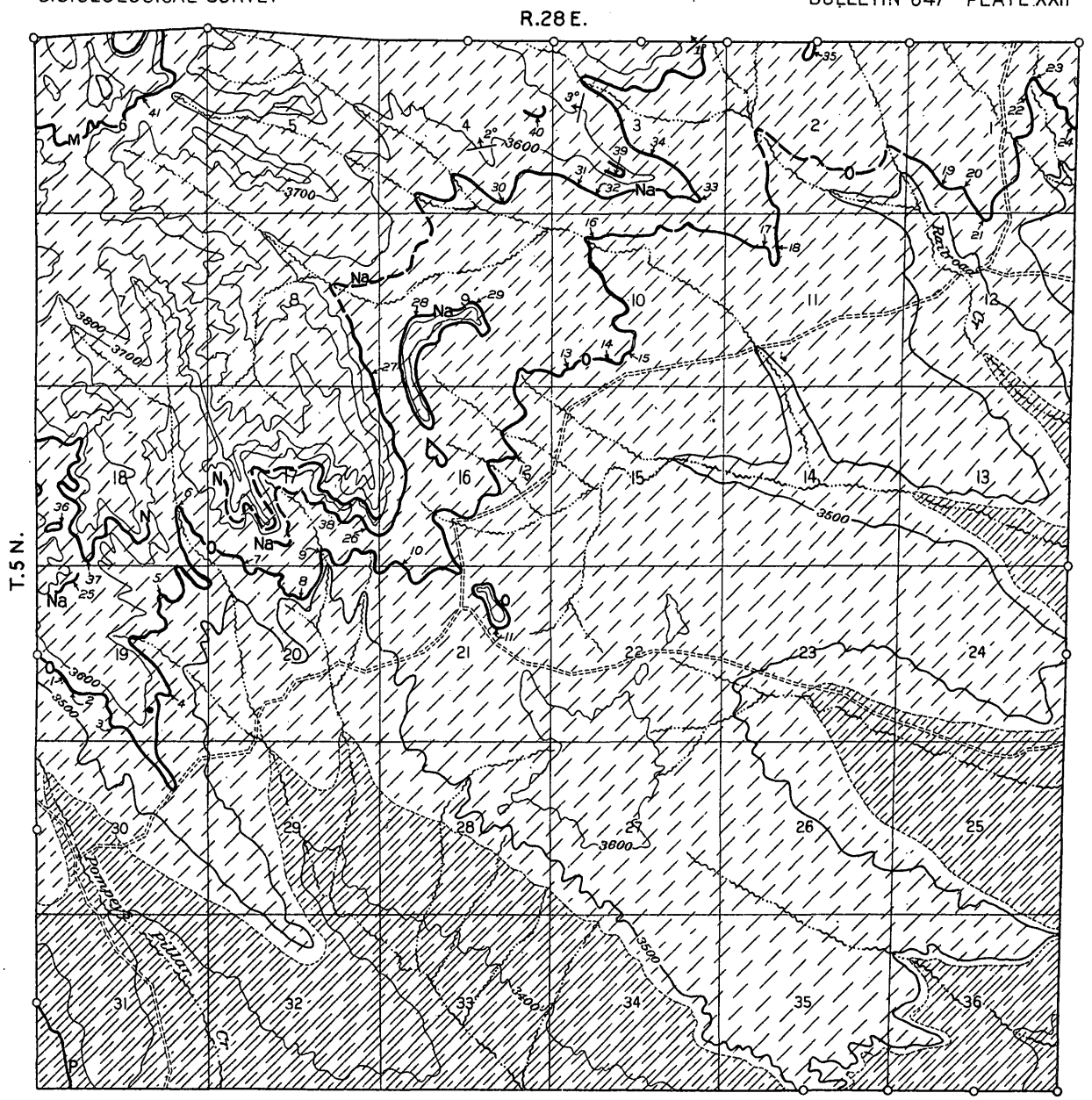
T. 6 N., R. 28 E.

GEOGRAPHY.

T. 6 N., R. 28 E., is the easternmost of the two townships which embrace the greater part of the central Bull Mountain mesas. The Three Buttes Mesa extends in very irregular form across the northwestern part of the township, its top lying about 4,200 feet above sea level, above which individual buttes rise 200 to 300 feet. The cliff-like borders of the Three Buttes Mesa are deeply incised by the headward erosion of the numerous small coulees, which radiate in all directions. At an elevation of 3,700 or 3,800 feet another wide, gently undulating plateau forms a bench of varying width around the central mesa and stretches away to the east, where it forms the divide between the Musselshell and Yellowstone drainage systems. In the southeastern part of the township is a series of long, nearly parallel ridges, separated by steep bluffs from the wide, smooth valleys. The principal valleys are occupied by Railroad and Cow Gulch creeks, which flow southeastward to Yellowstone River, and Dry Fork of Hawk Creek, the largest tributary of Musselshell River in the Bull Mountain field. These valleys contain running water only after heavy rains, the water supply of the township being practically limited to springs at Douglas and C A camps and to a few scattered water holes. Water could undoubtedly be obtained from some of the underlying rocks by comparatively shallow wells. Small areas along Railroad and Cow Gulch creeks are adapted to dry farming, but the greater part of the township can be used only for grazing. The higher slopes and coulees are clothed with a thick growth of small pine.

GEOLOGY.

The rocks outcropping in this township belong wholly to the upper or coal-bearing portion of the Fort Union formation. They consist of buff to yellowish-gray sandstone, clay shale, and coal beds, of which the sandstone is most prominent and forms the rugged scarps



LEGEND

TERTIARY
Eocene

Fort Union formation with Lebo shale member at base

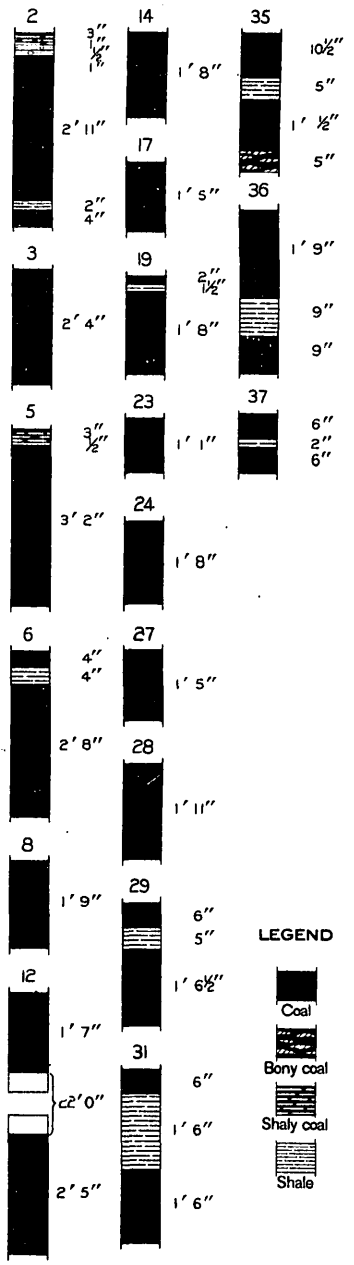
Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500
0 1 2 MILES



Names and symbols of coal beds and numbers of coal sections

Dougherty (M)	41
Buckey (N)	36-40
"CA" or De Bore (Na)	25-35
Wildhorse (0)	1-24

SECTIONS

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 5 N., R. 28 E., MONTANA

or rim rocks of the mesa and plateaus. The strata dip north or northwest at a maximum angle of 2°.

COAL.

Stratigraphic relations.—Ten coal beds have been studied and mapped in the township. (See Pl. XXIII.) The stratigraphic relations and the number of coal sections measured on these beds are shown in the following table:

Stratigraphic sections of coal beds in T. 6 N., R. 28 E., and the numbers of the sections measured on each.

	Feet.
Upper Bull Mountain (F) coal bed, Nos. 116 to 121, inclusive.	
Interval	12–20
Lower Bull Mountain (G) coal bed, Nos. 107 to 115, inclusive.	
Interval	80
Carter (Ha) coal bed, Nos. 103 to 106, inclusive.	
Interval, including local bed at No. 102	50
Rock Mesa (I) coal bed, Nos. 80 to 101, inclusive.	
Interval	80
Mammoth (K) and Rehder (J) coal beds, Nos. 69 to 79, inclusive.	
Interval	140
Ostrander (La) coal bed, Nos. 56 to 68, inclusive.	
Interval	60
Dougherty (M) coal bed, Nos. 17 to 55, inclusive.	
Interval	40
Chandler (Ma) coal bed, Nos. 11 to 16, inclusive.	
Interval	220
C A (Na) coal bed, Nos. 1 to 10, inclusive.	

The Wildhorse (O) bed, which lies stratigraphically about 95 feet below the C A bed and 330 feet above the top of the Lebo shale member, probably also underlies the southern half of the township. It is estimated that this bed thins toward the north and is not more than 1 foot thick 2 miles north of the south line of the township.

Above the Upper Bull Mountain coal bed, the highest bed in the stratigraphic section above, lie a number of coal beds, which, either on account of their thinness or on account of the small area which they underlie, have not been considered of sufficient importance to warrant mapping.

Chemical analyses of samples from the Dougherty coal bed at the Cow Gulch prospect in the SE. ¼ sec. 10 (No. 26, laboratory No. 6830) and from both the Mammoth and Rehder beds in sec. 10 (No. 73, Pl. XXIII, laboratory Nos. 6828 and 6831) show for the Dougherty coal bed a calorific value of 10,770 British thermal units and for the Mammoth and Rehder beds 11,610 and 11,800, respectively, for the air-dried samples. (See p. 53.) The coal in the beds from which no samples were obtained is similar in character to that in the Dougherty and Mammoth beds. Both the analyses and the physical character

show it to be high-grade subbituminous, uniform with the coal in other parts of the Bull Mountain field.

C A (Na) coal bed.—The C A (Na) coal bed, which in the part of the field surveyed by Lupton is called the De Bore bed, outcrops in the southeast corner of the township in secs. 25, 35, and 36. It is well exposed and with a little digging can be measured at almost any place desired. Its maximum thickness is in sec. 36 (No. 6), where it contains 2 feet 9 inches of coal separated into benches by persistent partings. The C A coal is of poorer quality than other coals in the Bull Mountain field, appearing on the outcrop to be nearer lignite than subbituminous. The following sections, in addition to those shown graphically in Plate XXIII, were measured in this township:

Coal sections on the C A (Na) coal bed in T. 6 N., R. 28 E.

[See also Pl. XXIII.]

No. on map, Pl. XXIII.	Location.	Section.	Ft.	in.
2	Sec. 35, SW. ¼...	Coal		1
		Shale		1
		Coal		4½
		Shale		6½
		Coal	1	1
		Total coal	1	6½
5	Sec. 36, SW. ¼...	Coal	1	10
6	Sec. 36, NE. ¼...	Coal	1	0
		Shale		10
		Coal		7
		Shale		3
		Coal	1	2
		Shale, brown		2
		Total coal	2	9
8	Sec. 36, NE. ¼...	Coal		9
		Shale		2
		Coal	1	6
		Total coal	2	3

Chandler (Ma) coal bed.—An interval of about 260 feet separates the C A coal bed from the Dougherty, the next higher bed of any importance. The Chandler (Ma) bed, 40 feet below the Dougherty, was found on the divide between Cow Gulch and a branch of Railroad Creek in secs. 14, 15, 22, and 23 but is of only local importance. The greatest thickness, 2 feet 6 inches, was measured in the SW. ¼ sec. 15 (No. 15, Pl. XXIII). The graphic sections in Plate XXIII and the sections given in the following table show all the measurements that were made on this bed.

Coal sections on the Chandler (Ma) coal bed in T. 6 N., R. 28 E.

[See also Pl. XXIII.]

No. on map, Pl. XXIII.	Location.	Section.	Ft.	in.
12	Sec. 23, NE. ¼...	Coal	1	9
14	Sec. 14, SW. ¼...	Coal	1	8
16	Sec. 22, NW. ¼...	Coal	1	8

Dougherty (M) coal bed.—The outcrop of the Dougherty coal bed extends from the southwest corner of the township in an irregular northeasterly direction to about the northeast corner. (See map, Pl. XXIII.) Throughout the greater part of this distance the exposures are good and numerous sections were measured. At several places the bed has been burned along the outcrop but can be easily traced by the line of reddened clinker or baked shale. Its thickness ranges from about 1 foot to nearly 5 feet, being greatest in sec. 10 (No. 26, SE. ¼), where a sample (laboratory No. 6830) was obtained for chemical analysis. (See p. 53.) The graphic sections in Plate XXIII and the following table include all the measurements made on the Dougherty bed within this township.

Coal sections on the Dougherty coal bed (M) in T. 6 N., R. 28 E.

[See also Pl. XXIII.]

No. on map, Pl. XXIII.	Location.	Section.	Ft.	in.
18	Sec. 12, NE. ¼...	Coal	1	4½
		Shale, sandy		1½
		Coal		1
		Total coal	1	5½
21	Sec. 13, NE. ¼...	Ash		5
		Coal		4
22	Sec. 11, SE. ¼...	Ash		4
23	Sec. 11, SE. ¼...	Coal	1	8
24	Sec. 11, SW. ¼...	Coal	4	1
25	Sec. 11, SW. ¼...	Ash		7
		Coal	1	8
26	Sec. 10, SE. ¼... Analysis 6830, Cow Gulch prospect.	Coal		1½
		Shale		1
		Coal	4	9
		Total coal	4	10
29	Sec. 23, SW. ¼...	Coal	1	11
30	Sec. 22, NE. ¼...	Coal	1	10
32	Sec. 22, NW. ¼...	Coal	1	10
33	Sec. 22, NW. ¼...	Coal		5
		Shale		½
		Coal	1	9½
		Total coal	2	2½
34	Sec. 22, SW. ¼...	Coal	2	9
		Shale		1
		Coal		6
		Total coal	3	3
38	Sec. 21, NW. ¼...	Coal	2	1
		Shale	4	0
		Coal		1½
		Total coal	2	2½
39	Sec. 21, SW. ¼...	Coal	1	9
		Shale		1
		Coal		2
		Total coal	1	11
40	Sec. 21, NW. ¼...	Coal	2	6½
42	Sec. 20, NE. ¼...	Coal	1	9
44	Sec. 28, NW. ¼...	Coal	1	6
		Shale		½
		Coal		10
		Shale		1
		Coal		2
		Total coal	2	6
45	Sec. 29, NE. ¼...	Coal	2	6
47	Sec. 29, NE. ¼...	Coal	2	3
48	Sec. 29, NW. ¼...	Coal	2	6
50	Sec. 30, SE. ¼...	Coal	2	5
		Shale		1
		Coal		6
		Total coal	2	11
51	Sec. 30, SW. ¼...	Coal	2	2
52	Sec. 31, NE. ¼...	Ash.		
54	Sec. 31, SW. ¼...	Coal		6
		Shale		3
		Coal		6
		Total coal	1	0
55	Sec. 31, SW. ¼...	Coal	1	3
		Shale		9
		Coal		9
		Total coal	2	0

Ostrander (La) coal bed.—The Ostrander coal bed, 60 feet above the Dougherty, is fairly persistent, though not very thick. Its outcrop is nearly parallel with that of the Dougherty, and, though the bed is not so well exposed, it can be followed with considerable certainty across the greater part of the township. The coal has been burned at only a few places. The thickness, as shown by the graphic sections in Plate XXIII and by the following list of coal sections, is from 1 foot 9 inches to 3 feet.

Coal sections on the Ostrander coal bed (La) in T. 6 N., R. 28 E.

[See also Pl. XXIII.]

No. on map, Pl. XXIII.	Location.	Section.	Ft.	in.	No. on map, Pl. XXIII.	Location.	Section.	Ft.	in.
56	Sec. 11, SW. ¼...	Ash.....		7	62	Sec. 29, NE. ¼...	Coal.....	2	5
		Shale.....	1	0					
		Coal.....		8±	64	Sec. 29, NW. ¼...	Coal.....	1	9
59	Sec. 17, SE. ¼....	Coal.....	2	4	65	Sec. 29, NW. ¼...	Coal.....	1	10
61	Sec. 20, NW. ¼...	Coal.....	2	6	66	Sec. 30, SW. ¼...	Coal.....	1	11

Mammoth (K) and Rehder (J) coal beds.—The Mammoth coal bed and its companion, the Rehder, are the thickest and probably the most important in the Bull Mountain field. In T. 6 N., R. 28 E., they outcrop on both sides of Three Buttes Mesa near the base of the gradual slope which separates the wide plateau below from the mesa cliffs. On the south side of the mesa the outcrops extend in an irregular line from sec. 2 to sec. 19 and on the north side lie wholly in sec. 6. The beds are separated by an interval of shale or of shale and sandstone which, on the south side of Three Buttes Mesa, has a thickness of 1 foot 3 inches to 7 feet 6 inches. The interval was not measured on the north side of the mesa, but farther west at Schlaberg camp in T. 7 N., R. 27 E., it is only 9 inches to 3 feet thick, and in a large part of T. 6 N., R. 27 E., the two beds are mapped and described as one. The full thickness of both beds was measured at three places (Nos. 73, 74, and 75, Pl. XXIII). In the western tier of sections the two beds are separated by so small an interval that they can be mined as one. The total thickness of the combined bed ranges from about 11 feet in secs. 6 and 7 to over 14 feet in sec. 19, these estimates being based largely on measurements made in T. 6 N., R. 27 E. (See pp. 112–113.) Farther east, where the two beds must be mined separately, the average thickness of the upper or Rehder bed is about 8 feet 6 inches and that of the lower or Mammoth is about 5 feet.

Two samples for chemical analysis were obtained, one from each bed on the south side of the gulch at Douglas camp in sec. 10 (No. 73, Pl. XXIII). The appearance of the two beds at that place is shown in Plate X.

All the complete sections measured on these two beds are shown graphically in Plate XXIII. Three partial sections on the Mammoth bed are as follows:

Coal sections on the Mammoth (K) coal bed in T. 6 N., R. 28 E.

[See also Pl. XXIII.]

No. on map, Pl. XXIII.	Location.	Section.	Ft.	in.
69	Sec. 7, NW. ¼...	Ash.....	1	11
		Parting.....		3
		Coal.....		11
		Parting.....		3
		Coal.....	2	10
		Total coal.	3	9
78	Sec. 30, NW. ¼..	Shale.		
		Ash.....		3
		Shale.....		2
		Coal.....	4	4½
79	Sec. 19, SW. ¼...	Shale and sandy shale.....		4
		Coal, base not exposed.....	6+	

Rock Mesa (I) coal bed.—About 80 feet above the Mammoth is the persistent coal bed known as the Rock Mesa, which is, however, not very important in this township. Its outcrop is approximately parallel with that of the Mammoth bed, and its average thickness is 2 feet to 2 feet 6 inches. Both above and below the Rock Mesa coal bed are thin coal beds separated by a few feet of shale. In several of the coal sections in Plate XXIII and in the following list these thin beds are included.

Coal sections on the Rock Mesa coal bed (I) in T. 6 N., R. 28 E.

[See also Pl. XXIII.]

No. on map, Pl. XXIII.	Location.	Section.	Ft.	in.
80	Sec. 7, NE. ¼....	Sandstone....	3	0
		Shale.....	1	9
		Coal.....	2	8
81	Sec. 6, SE. ¼.....	Sandstone....	4	0
		Coal.....		6
		Shale.....	1	6
		Shale, carbonaceous...	1	2
		Shale.....	9	0
		Coal.....	1	6
		Ash.....		4±
		Shale.		
82	Sec. 5, SW. ¼....	Sandstone....	10	0
		Shale.....	1	2
		Coal.....		4
		Shale, carbonaceous...		5
		Shale.....	2	10
		Sandstone....	1	6
		Shale.....	3	3
		Coal.....	2	8
		Shale.		
84	Sec. 9, NE. ¼....	Shale.....	7	10
		Coal.....	2	6
		Shale.		

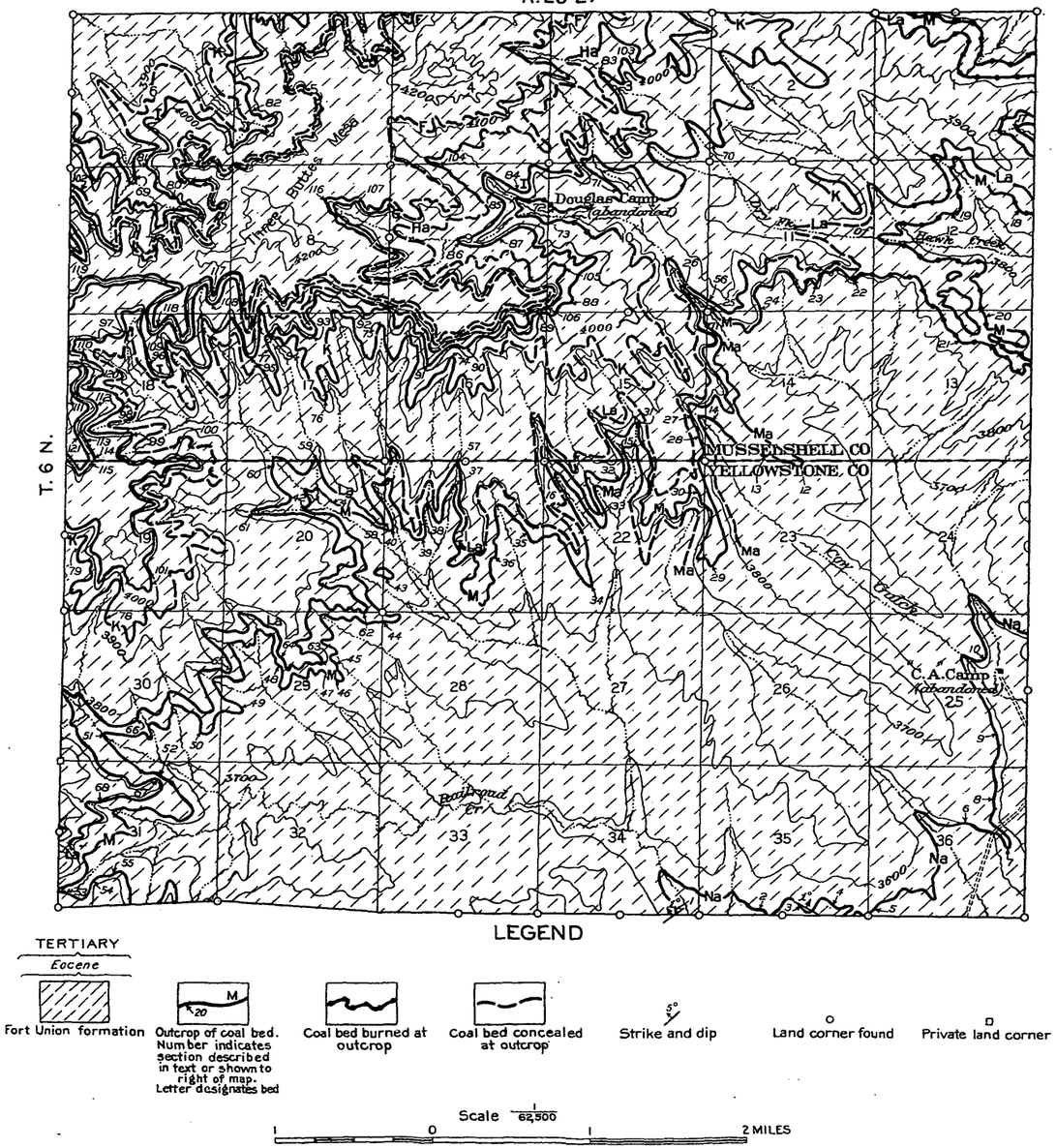
Coal sections on the Rock Mesa coal bed (I) in T. 6 N., R. 28 E.—Continued.

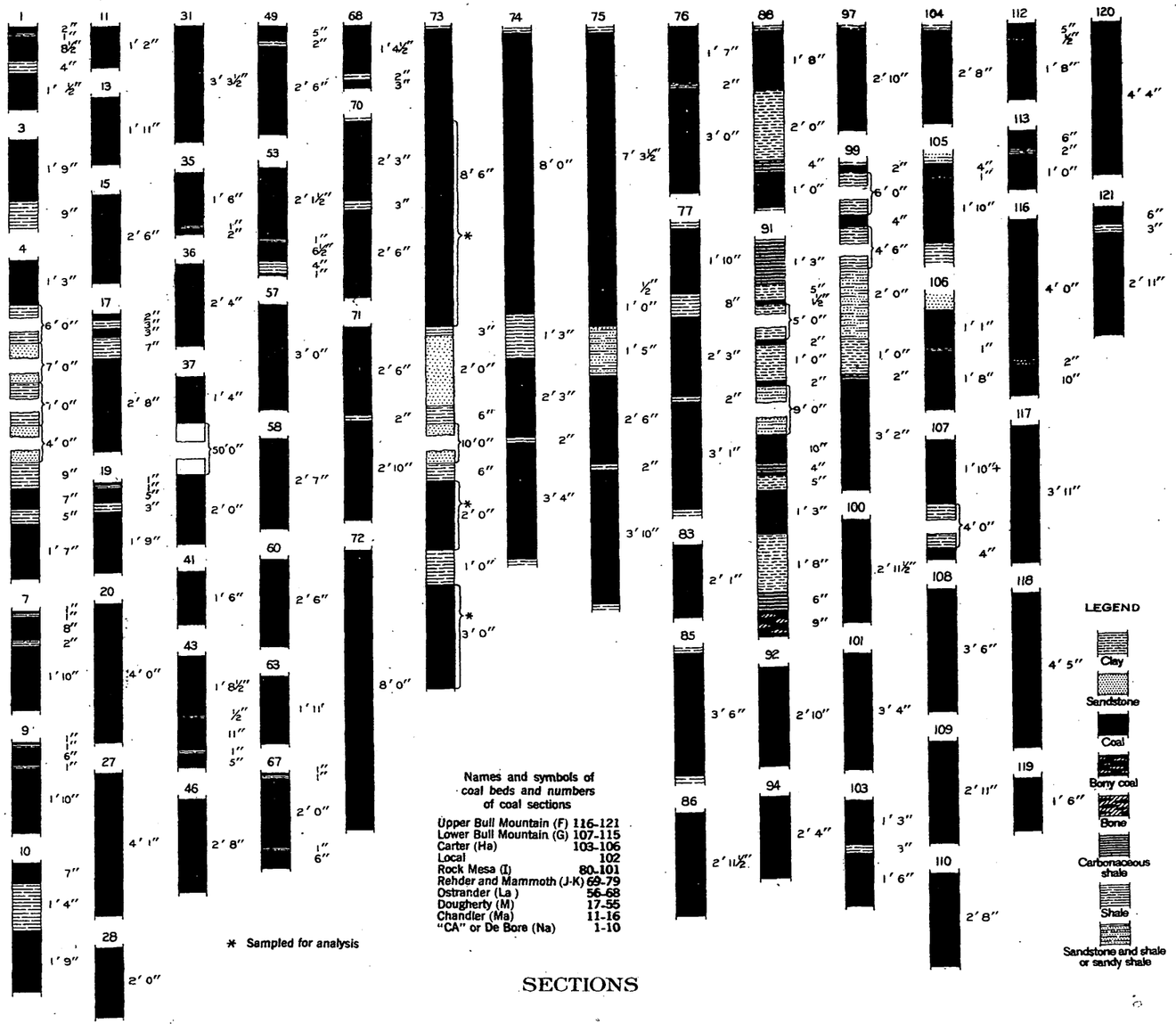
[See also Pl. XXIII.]

No. on map, Pl. XXIII.	Location.	Section.	Ft.	in.
87	Sec. 9, NE. ¼....	Coal.....	2	3
89	Sec. 16, NE. ¼...	Sandstone....	10	
		Clay shale....	1	
		Coal.....		4
		Shale, carbonaceous...		3
		Clay shale....	4	5
		Coal.....	1	0
		Shale, purple.		
90	Sec. 16, NW. ¼..	Shale.		
		Coal.....		5
		Shale, carbonaceous...		2
		Shale.....		10
		Coal.....		3
		Shale.....		½
		Coal.....	1	0
		Shale.....	1	8
		Coal.....	1	3
		Shale, purple.		
93	Sec. 17, NE. ¼...	Shale.		
		Coal.....		8
		Shale, sandy..	5	0
		Clay shale....	1	0
		Coal.....	2	4
		Shale, purple.		
95	Sec. 17, NW. ¼..	Shale.		
		Coal.....	2	9½
		Shale, purple.		
96	Sec. 18, NE. ¼...	Clay shale....	1	6
		Coal.....	2	11½
		Clay shale, purple.		
98	Sec. 18, SW. ¼...	Shale.		
		Coal.....	3	2½
		Shale.		
102	Sec. 7, NW. ¼...	Coal (above Rock Mesa bed)	1	2

Carter (Ha) coal bed.—The Carter coal bed outcrops on the east side of Three Buttes Mesa about 50 feet above the Rock Mesa and can be traced from the south of sec. 8 eastward on the south side and around the northeast end of the mesa. A maximum thickness of 2 feet 9 inches was found in sec. 3 (No. 103) and sec. 10 (No. 106), and 2 feet 8 inches in sec. 9 at the head of Cow Gulch (No. 104). The sections measured on this bed are shown graphically in Plate XXIII.

Bull Mountain (F and G) coal beds.—The outcrops of the Bull Mountain coal beds in general outline Three Buttes Mesa in the northwestern part of the township, the lower bed (G) being about 130 feet above the Rock Mesa as against 45 feet observed by Woolsey in the southwestern part of the field. The two beds are separated by 12 to 20 feet of sandstone and shale. The upper bed is in most places overlain by a conspicuous dark-gray clay shale 20 to 30 feet thick. Both beds are thickest in the western part of the mesa, where the average for the lower bed is 3 feet in sec. 7 and for the upper bed a little less than 4 feet in secs. 4 and 5. The average of of each bed throughout the part of the township which they underlie is about 2 feet. The greatest thickness measured on the lower bed is 3 feet 6 inches in the SE. ¼ sec. 7 (No. 108) and on the upper bed 4 feet 5 inches in the NW. ¼ sec. 18 (No. 118). The majority of the coal sections measured on these two beds are shown graphically in Plate XXIII and only three, all on the lower bed, are included in the following table:





Names and symbols of coal beds and numbers of coal sections

Upper Bull Mountain (F)	116-121
Lower Bull Mountain (G)	107-115
Carter (Ha)	103-106
Local	102
Rock Mesa (I)	80-101
Rehder and Mammoth (J-K)	69-79
Ostrander (La)	56-68
Dougherty (M)	17-55
Chandler (Ma)	11-16
"CA" or De Bore (Na)	1-10

* Sampled for analysis

SECTIONS

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 6 N., R. 28 E., MONTANA

Coal sections on the Lower Bull Mountain (G) coal bed in T. 6 N., R. 28 E.

[See also Pl. XXIII.]

No. on map, Pl. XXIII.	Location.	Section.		No. on map, Pl. XXIII.	Location.	Section.	
			Ft. in.				*Ft. in.*
111	Sec. 18, SW.¼....	Coal.....	2 9	115	Sec. 19, NW.¼..	Coal.....	1
114	Sec. 7, SW.¼....	Coal.....	2			Sandstone.....	4
						Coal.....	1
						Coal, bony.....	3
						Shale.....	2
						Coal.....	4
						Total coal..	2 4

Development.—No coal has been mined in this township except possibly a few tons from surface prospects by ranchers for domestic use. As the thicker coal beds underlie the western and northern parts of the township, and as the valleys of Hawk, Fattig, and Railroad creeks and of Cow Gulch furnish natural routes for spurs from the Chicago, Milwaukee & St. Paul Railway on the north and the Northern Pacific on the south, it seems very probable that a number of commercial mines will some day be located in this township. To remove coal to the railroads, spurs approximately 20 miles in length would be required. The thinner coal beds probably will be mined in places from country banks. Timber for mining use is fairly plentiful along the Musselshell-Yellowstone divide, but water is scarce except for seep springs, the principal ones being located at C A and Douglas camps.

T. 7 N., R. 28 E.

GEOGRAPHY.

T. 7 N., R. 28 E., lies on the northern slopes of the Bull Mountains. Along the south line of the township Three Buttes Mesa rises to an elevation of about 4,400 feet. Its northern slopes are deeply incised by the headward erosion of the numerous coulees. At the foot of these steep slopes is a lower plateau surface, which encircles the Bull Mountain mesas and extends northeast along the divide between Fattig and Hawk creeks. This plateau is dissected by numerous valleys, particularly in the northern part of the township, where little of the original surface remains. The valleys are in most places separated from the uplands by sandstone rim rocks. Fattig Creek and its numerous small tributaries drain the greater part of the area. The water supply of the township is derived from three or four springs, shallow wells at the several ranches, and a few water holes.

The southern portion and the higher ridges support a scanty growth of pine. Considerable areas in the northern part of the township have proved to be adapted for dry farming, but the great part of the township is utilized only for grazing and small cuttings of wild hay.

GEOLOGY.

The rocks which outcrop within the township belong wholly to the upper or coal-bearing part of the Fort Union formation. They consist of buff to yellowish-gray sandstone, clay shale, and coal beds, of which the sandstone is most prominent, forming the steep scarps or rim rocks of the high mesa and of the valley walls. The total thickness of the rocks which outcrop in the township is about 1,200 feet. All dip gently but variably south at a maximum angle of about 3°.

COAL.

Stratigraphic relations.—Eleven coal beds have been studied and mapped within the township and a number of coal sections measured on each bed. (See Pl. XXIV.) The Roundup, Dougherty, and Mammoth coal beds are the most important. The stratigraphic relations are shown below.

Stratigraphic relations of coal beds in T. 7 N., R. 28 E., and the numbers of the sections measured on each.

	Feet.
Bull Mountain (F and G) coal beds. No sections measured.	
Interval	80
Carter (Ha) coal bed, Nos. 78 to 80, inclusive.	
Interval	50
Rock Mesa (I) coal bed, Nos. 61 to 77, inclusive.	
Interval	80
Mammoth (K) and Rehder (J) coal beds, Nos. 49 to 60, inclusive.	
Interval	40
Saddler (?) (Ka) coal bed, No. 48.	
Interval	100
Ostrander (La) coal bed, Nos. 41 to 47, inclusive.	
Interval including local coal beds, Nos. 37 to 40, inclusive	60
Dougherty (M) coal bed, Nos. 20 to 36, inclusive.	
Interval	40
Chandler (?) (Ma) coal bed, Nos. 15 to 19, inclusive.	
Interval, including local coal bed, No. 14	160
Buckey (N) coal bed, Nos. 10 to 13, inclusive.	
Interval, including local bed, No. 9	310
Roundup (Oa) coal bed, Nos. 2 to 8, inclusive.	
Interval	50±
Snelling (Ob) coal bed, No. 1.	

In addition to the coal beds enumerated above there are above the Bull Mountain coal beds a number of beds of less importance, which have not been mapped in this township. These beds are for the most part concealed on the timbered slopes and where exposed show sections too thin to warrant mapping.

Although no analysis was made of samples from this township, the physical characters indicate that the coal is fairly uniform with that of the beds throughout the Bull Mountain field.

Snelling (Ob) coal bed.—The Snelling coal, a local bed found in the township to the north (T. 8 N., R. 28 E.), extends up Fattig Creek into the NW. ¼ sec. 5 (No. 1) of this township, where it has a thickness of 1 foot 1 inch. Its stratigraphic position is about 500 feet above the top of the Lebo shale member of the Fort Union formation and about 50 feet below the Roundup coal bed.

Roundup (Oa) coal bed.—The Roundup coal bed is of much less importance in this part of the field than it is in the vicinity of Roundup. It outcrops on Fattig Creek in secs. 4, 5, and 6. Along the west line of the township the thickness of the bed is about 3 feet 9 inches (Nos. 2 and 5, sec. 6, Pl. XXIV), but it decreases to the east and northeast, as is shown by the following coal sections, by the graphic sections in Plate XXIV, and by similar sections measured in T. 8 N., R. 27 E. (See p. 133.)

Coal sections on the Roundup (Oa) coal bed in T. 7 N., R. 28 E.

[See also Pl. XXIV.]

No. on map, Pl. XXIV.	Location.	Section.			No. on map, Pl. XXIV.	Location.	Section.		
			Ft.	*in.*				*Ft.*	*in.*
4	Sec. 5, NW. ¼...	Coal.....	2	6	7	Sec. 5, NW. ¼...	Coal.....	2	9
6	Sec. 5, SW. ¼....	Coal.....	2	8					

Coal beds between Roundup and Dougherty coal beds.—An interval of 510 feet of strata separates the Roundup coal bed from the next higher bed of importance, but several thin beds occur within this interval. The most important of these is the Buckey (N) coal bed, which was not mapped continuously in this township but was measured at four widely separated points (Nos. 10 to 13, inclusive) on Fattig Creek and its tributaries. The bed ranges in thickness from 1 foot 2 inches to 1 foot 9 inches.

The Chandler (Ma) coal bed, 40 feet below the Dougherty, was measured at five points (Nos. 15 to 19 inclusive). Its maximum thickness in the township is only 10 inches.

The following list includes all the measurements made on the coal beds between the Roundup and Dougherty beds.

Coal sections on minor and local coal beds between the Roundup and Dougherty beds in T. 7 N., R. 28 E.

Local bed.

No. on map, Pl. XXIV.	Location.	Section.		No. on map, Pl. XXIV.	Location.	Section.	
			Ft. in.				*Ft. in.*
9	Sec. 18, NE. ¼...	Coal.....	7				

Buckey (N) bed.

10	Sec. 18, NW. ¼...	Coal.....	1 9	12	Sec. 11, SW. ¼...	Coal.....	1 2
11	Sec. 5, SW. ¼....	Shale.		13	Sec. 12, NW. ¼...	Coal.....	1 7
		Coal.....	1 9			Shale.....	8 0
		Shale.				Coal.....	9

Local bed.

14	Sec. 22, NE. ¼...	Coal.....	1±				

Chandler (Ma) bed.

15	Sec. 30, NW. ¼...	Coal.....	6	18	Sec. 13, SW. ¼...	Coal.....	10
16	Sec. 23, SW. ¼...	Coal.....	8	19	Sec. 25, NW. ¼...	Coal.....	7
17	Sec. 15, SE. ¼....	Coal.....	8				

Dougherty (M) coal bed.—The Dougherty coal bed, the next important bed above the Roundup, is 510 feet stratigraphically above that bed. Its outcrop has been traced across the township in an irregular easterly direction from sec. 19 to sec. 13 and around the heads of the branches of Hawk Creek in secs. 24, 25, and 36. The outcrop of the bed outlines approximately the lower of the prominent plateaus at the base of Three Buttes Mesa. Measurements on this and on the other side of the mesa, in T. 6 N., R. 28 E., indicate that the bed is thickest along the bluffs at the head of Hawk Creek, where it averages about 3 feet. Under the main Three Buttes Mesa the average thickness is about 2 feet 6 inches. The bed has been burned at the outcrop, so that at many places only an approximation of its thickness could be reached by a study of the coal and ash remaining. A selected number of representative sections are shown graphically in Plate XXIV and, with those in the following table, include all the sections and partial sections measured in the township.

Coal sections on the Dougherty (M) coal bed in T. 7 N., R. 28 E.

[See also Pl. XXIV.]

No. on map, Pl. XXIV.	Location.	Section.	Ft.	in.
20	Sec. 30, NE. ¼...	Ash.		
22	Sec. 29, NW. ¼..	Coal.....	1	8
26	Sec. 23, NW. ¼..	Ash.....		5
		Coal.....		7
		Shale.....		1½
		Coal.....		9
28	Sec. 14, SW. ¼...	Ash.....		5
		Coal.....		9½
		Shale.....		5
		Coal.....		7
29	Sec. 14, NW. ¼...	Ash.....		4
		Coal.....		10
		Shale.....		6
		Coal.....		6
30	Sec. 24, NW. ¼...	Coal..... 4+ Base not exposed.		
31	Sec. 13, SE. ¼....	Coal.....	3	7
32	Sec. 13, SE. ¼....	Ash.....		5½
34	Sec. 36, NE. ¼...	Coal		9
		Ash.....		3
		Shale.....		4
		Ash.....		4
		Coal.....		8
35	Sec. 36, NW. ¼...	Coal	3	8+
36	Sec. 36, SW. ¼...	Coal.....		1½
		Shale.....		6
		Coal.....		4
		Shale.....		2
		Coal.....	2	7+

Coal beds between Dougherty and Mammoth coal beds.—On a branch of Fattig Creek in sec. 30 four coal beds are exposed in a steep bluff. The lowest of these is the Dougherty bed (see No. 20 above), above which are two beds 8 inches in thickness (Nos. 37 and 38), 4 feet 6 inches and 39 feet, respectively, above the Dougherty. Sixty-three feet above the Dougherty is the Ostrander (La) coal bed, 1 foot 2 inches in thickness (No. 41). The Ostrander bed was measured in seven places within the township and was found to range in thickness from 6 inches to 2 feet, the maximum thickness lying in the SE. ¼ sec. 35 (No. 47). About 40 feet below the Mammoth coal bed, in the NE. ¼ sec. 32 (No. 48, Pl. XXIV) a coal bed was observed which has a total thickness of 3 feet 11 inches. The bed was not found elsewhere in the township but corresponds in position with the Saddler (Ka) coal bed, which is exposed in T. 7 N., R. 27 E. (p. 126). However, it is probably a slump from the Mammoth bed above. The graphic sections in Plate XXIV and the sections given in the following list include all coal sections measured on beds between the Dougherty and Mammoth coal beds.

Coal sections on minor and local coal beds between the Dougherty and Mammoth beds in T. 7 N., R. 28 E.

[See also Pl. XXIV.]

Local coal bed.

No. on map, Pl. XXIV.	Location.	Section.	No. on map, Pl. XXIV.	Location.	Section.
		Ft. in.			*Ft. in.*
37	Sec. 30, NE. ¼...	Coal..... 8 4 feet 6 inches above Dougherty.	39	Sec. 24, SW. ¼...	Coal..... 1 3
			40	Sec. 29, SW. ¼...	Coal..... 10
38	Sec. 30, NE. ¼...	Coal..... 8 39 feet above Dougherty.			

Ostrander (La) coal bed.

42	Sec. 30, NE. ¼...	Coal..... 1 4	46	Sec. 13, SW. ¼...	Coal..... 6
44	Sec. 22, NW. ¼..	Coal..... 1 0	47	Sec. 35, SE. ¼....	Coal..... 2 0
45	Sec. 14, SW. ¼...	Coal..... 1 1 Interval..... 5 0 Coal..... 1 7			

Mammoth (K) and Rehder (J) coal beds.—Two hundred feet above the Dougherty is found the thickest coal bed of the township—the Mammoth—and its companion bed, the Rehder, which is separated from it by shale and sandstone from a few inches to 30 feet in thickness. The interval, however, was not measured in this township. In many places the outcrop of both beds is deeply covered by a soil mantle, and most of the sections measured were only partial. Two of the best sections (Nos. 55 and 57, Pl. XXIV) are taken from the earlier report by Eldridge.[1] The total coal in the Mammoth bed has an average thickness of about 5 feet and in the Rehder bed of about 8 feet 6 inches. No complete section of the Rehder bed was obtained in this township. The graphic sections in Plate XXIV and the sections given in the following list include all the measurements made on these two beds.

[1] Eldridge, G. H., Montana coal fields: Tenth Census U. S., vol. 15, pp. 753-755, 1886.

Coal sections on the Mammoth (K) and Rehder (J) coal beds in T. 7 N., R. 28 E.

[See also Pl. XXIV.]

Mammoth (K) coal bed.

No. on map, Pl. XXIV.	Location.	Section.			No. on map, Pl. XXIV.	Location.	Section.	
			Ft.	*in.*				*Ft.* *in.*
49	Sec. 31, SE. ¼...	Coal.....	2	7	56	Sec. 35, NW. ¼..	Ash.....	2
							Shale.....	2
53	Sec. 28, SW. ¼...	Coal.....	3	9			Ash.....	5
							Shale.....	2
							Coal.....	8

Rehder (J) coal bed.

58	Sec. 28, SW. ¼...	Coal.....	1	4	60	Sec. 35, NW. ¼..	Coal.....	1 2
59	Sec. 27, SW. ¼...	Ash.....		1				
		Coal.....	1	0				

Rock Mesa (I) coal bed.—About 80 feet above the Mammoth is the persistent Rock Mesa coal bed, whose outcrop is approximately parallel to that of the Mammoth. From sec. 33 eastward the sections measured show thicknesses of 2 feet to 2 feet 7 inches. Exposures measured in sec. 34 show from 6 inches to 1 foot. Shale partings, which have been found at several places, appear to be local. The sections measured on the bed are shown graphically in Plate XXIV or are included in the following list.

Coal sections on the Rock Mesa (I) coal bed in T. 7 N., R. 28 E.

[See also Pl. XXIV.]

No. on map, Pl. XXIV.	Location.	Section.			No. on map, Pl. XXIV.	Location.	Section.	
			Ft.	*in.*				*Ft.* *in.*
62	Sec. 32, SW. ¼...	Coal.....	2	5	73	Sec. 34, NW. ¼..	Coal.....	10
64	Sec. 32, NE. ¼...	Coal.....	2	3	74	Sec. 34, NW. ¼..	Coal.....	8
65	Sec. 33, NW. ¼..	Coal.....	2	3	76	Sec. 34, NE. ¼...	Coal.....	1 0
67	Sec. 33, NW. ¼..	Coal.....	2	0	77	Sec. 35, NW. ¼..	Coal.....	1 3
70	Sec. 33, NE. ¼...	Coal.....	1	5			Horizon questioned.	
71	Sec. 33, NE. ¼...	Coal.....		10				

Carter (Ha) coal bed.—The Carter coal bed, about 50 feet above the Rock Mesa, has been traced around the northeast end of the Three Buttes Mesa. Three measurements (Nos. 78, 79, and 80), which show thicknesses of 1 foot 3 inches to 2 feet 2 inches, are shown on Plate XXIV.

Bull Mountain (F and G) coal beds.—The outcrops of the Bull Mountain coal beds outline in general the Three Buttes Mesa in the southern part of the township and are separated from the Rock Mesa bed by an interval of about 130 feet. The two beds are separated by only 12 to 20 feet of sandstone and shale. The upper bed is in most places overlain by a conspicuous dark-gray clay shale 20 to 30 feet thick. No measurement was obtained in this township on either bed, but the evidence gathered on the south side of Three Buttes Mesa (T. 6 N., R. 28 E., pp. 144–145) indicates an average thickness of 2 feet for each.

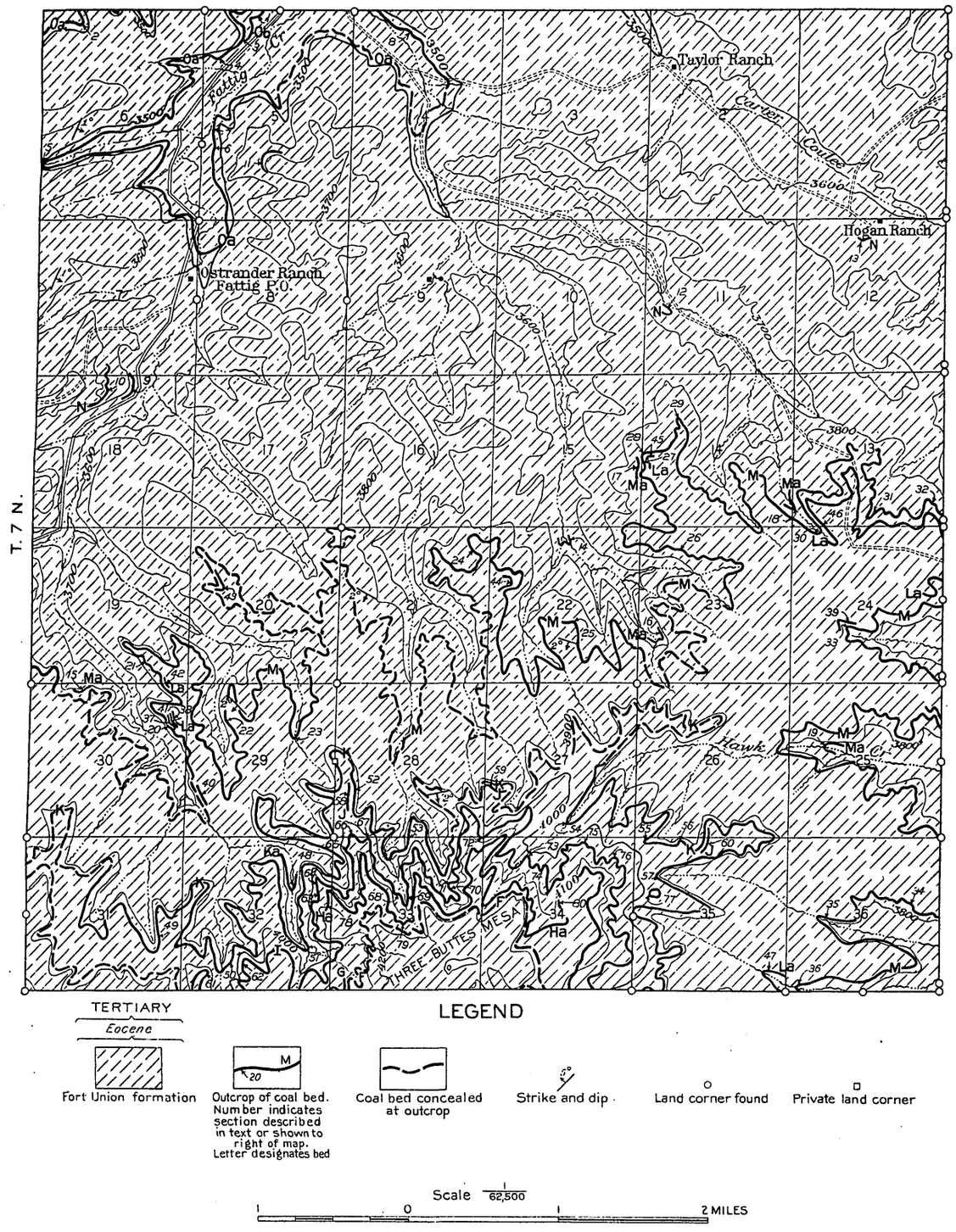
Development.—No coal is known to have been mined in this township except possibly a few wagonloads by ranchers from surface prospects for domestic use. The first commercial mining will probably be on the Mammoth and Rehder coal beds in the heads of coulees which drain into Fattig Creek in the southwestern part of the township, as the coal beds are thicker and more easily accessible in that locality than anywhere else. The heads of the minor valleys which drain into Fattig Creek from the central and eastern parts of the township and those which drain into Hawk Creek in the southeastern part of the township will undoubtedly furnish satisfactory sites for mines. The natural water supply as well as the timber supply on the north side of the divide is greater than on the south slope. A spur from the Chicago, Milwaukee & St. Paul Railway, 7 or 8 miles in length, would enter the township along the valley of Fattig Creek.

T. 8 N., R. 28 E.

GEOGRAPHY.

T. 8 N., R. 28 E., lies in the plateau region between the Bull Mountains and Musselshell River. Fattig Creek flows northward across its western part in a wide flat valley and empties into Musselshell River about a mile north of the township line. Within the township it receives a number of tributaries, of which Guy Coulee on the west and Horsethief, Snyder, and Carter coulees on the east are the largest. All the valleys have comparatively wide, flat bottoms separated from the neighboring uplands by steep slopes or vertical cliffs of sandstone. The uplands are the much dissected remnants of an old plateau surface, above which a few sharp buttes, such as Chimney Butte in sec. 28, stand out as prominent landmarks.

The water of the township consists of a few springs and shallow wells deriving their supply from the sandstones. Fattig Creek is intermittent except for short distances.



TERTIARY
Eocene

Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed concealed at outcrop

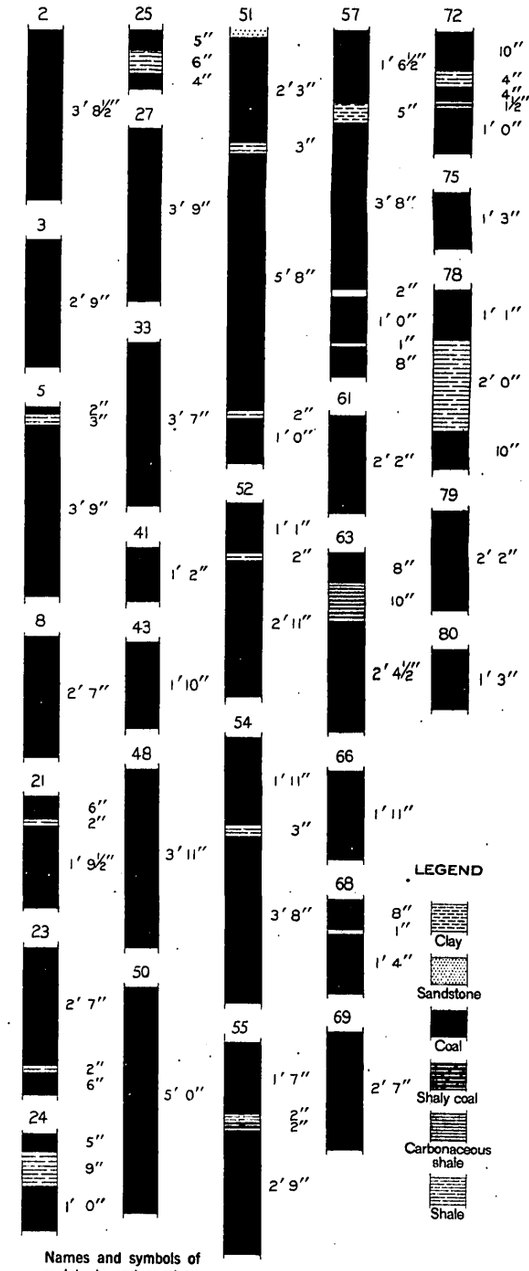
Strike and dip

Land corner found

Private land corner

Scale 1/62,500
0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 7 N., R. 28 E., MONTANA



Names and symbols of coal beds and numbers of coal sections

Bull Mountain (F-G)	No measurement
Carter (Ha)	78-80
Rock Mesa (I)	61-77
Rehder and Mammoth (J-K)	49-60
Saddler (?) (Ka)	48
Ostrander (La)	41-47
Local	37-40
Dougherty (M)	20-36
Chandler (Ma) (?)	15-19
Local	14
Buckey (N)	10-13
Local	9
Roundup (Oa)	2-8
Snelling (Ob)	1

SECTIONS

GEOLOGY.

The rocks outcropping in the township belong wholly to the upper or coal-bearing portion of the Fort Union formation and consist of prominent cliff-making buff sandstone, clay shale, and coal beds. The strata are practically horizontal.

COAL.

Four coal beds—the Spendiff (Od), Snyder (Oc), Snelling (Ob), and Roundup (Oa)—have been studied and partly mapped. (See Pl. XXV.) The first three beds are comparatively unimportant. They locally show sections nearly 3 feet in maximum thickness but are very lenticular in character. The Snelling and Snyder beds are probably the same as the McCleary and Carpenter beds, which outcrop around the eastern border of the Bull Mountain field.

The Roundup coal bed outcrops on both sides of Fattig Creek in the southwestern corner of the township at an elevation of about 3,500 feet. On the west side of the creek the average thickness is about 2 feet 6 inches but on the east side is less. Sections in secs. 28 and 29 show thicknesses of 1 foot 7 inches to 2 feet 4 inches. About the head of Horsethief Coulee, in secs. 1, 11, 12, 13, and 14, is the probable continuation of the bed with a thickness of 1 foot to 2 feet 3 inches.

Above the Roundup bed in the southeastern part of the township are a few local beds, lenticular in character, which locally reach a thickness of 1 foot 8 inches (Nos. 55 to 62).

The coal in all these beds is high-grade subbituminous, uniform in quality with the coal in other parts of the Bull Mountain field.

A selected number of sections, represented graphically in Plate XXV, show in general the characters of the different beds. All other measurements are included in the following table:

Coal sections in T. 8 N., R. 28 E.

[See also Pl. XXV.]

Spendiff (Od) coal bed.

No. on map, Pl. XXV.	Location.	Section.	Ft.	in.	No. on map, Pl. XXV.	Location.	Section.	Ft.	in.
1	Sec. 5, SE. ¼....	Coal.....	1	0	6	Sec. 3, SW. ¼....	Coal.....		6
3	Sec. 9, NW. ¼...	Coal.....	1	0	7	Sec. 4, SW. ¼....	Coal.....	1	0
5	Sec. 3, SW. ¼....	Coal.....		6	8	Sec. 2, NE. ¼....	Coal.....	1	0

Coal sections in T. 8 N., R. 28 E.

[See also Pl. XXV.]

Snyder (Oc) coal bed.

No. on map, Pl. XXV.	Location.	Section.	Ft.	in.	No. on map, Pl. XXV.	Location.	Section.	Ft.	in.
9	Sec. 5, SE. ¼	Coal	1	9½	17	Sec. 3, NE. ¼	Coal	1	9+
12	Sec. 20, NE. ¼	Coal		6	18	Sec. 2, SE. ¼	Coal		6
13	Sec. 29, NE. ¼	Coal	1	8	19	Sec. 1, SW. ¼	Coal	1	0
15	Sec. 15, NE. ¼	Coal		8½					

Snelling (Ob) coal bed.

21	Sec. 8, NW. ¼	Coal	1	9	27	Sec. 14, SE. ¼	Coal	1	0
23	Sec. 22, NW. ¼	Coal		6	28	Sec. 11, SW. ¼	Coal		10
24	Sec. 14, NW. ¼	Coal		10	30	Sec. 11, NE. ¼	Coal	1	5
26	Sec. 14, SE. ¼	Coal	1	10	32	Sec. 1, SE. ¼	Coal	1	10

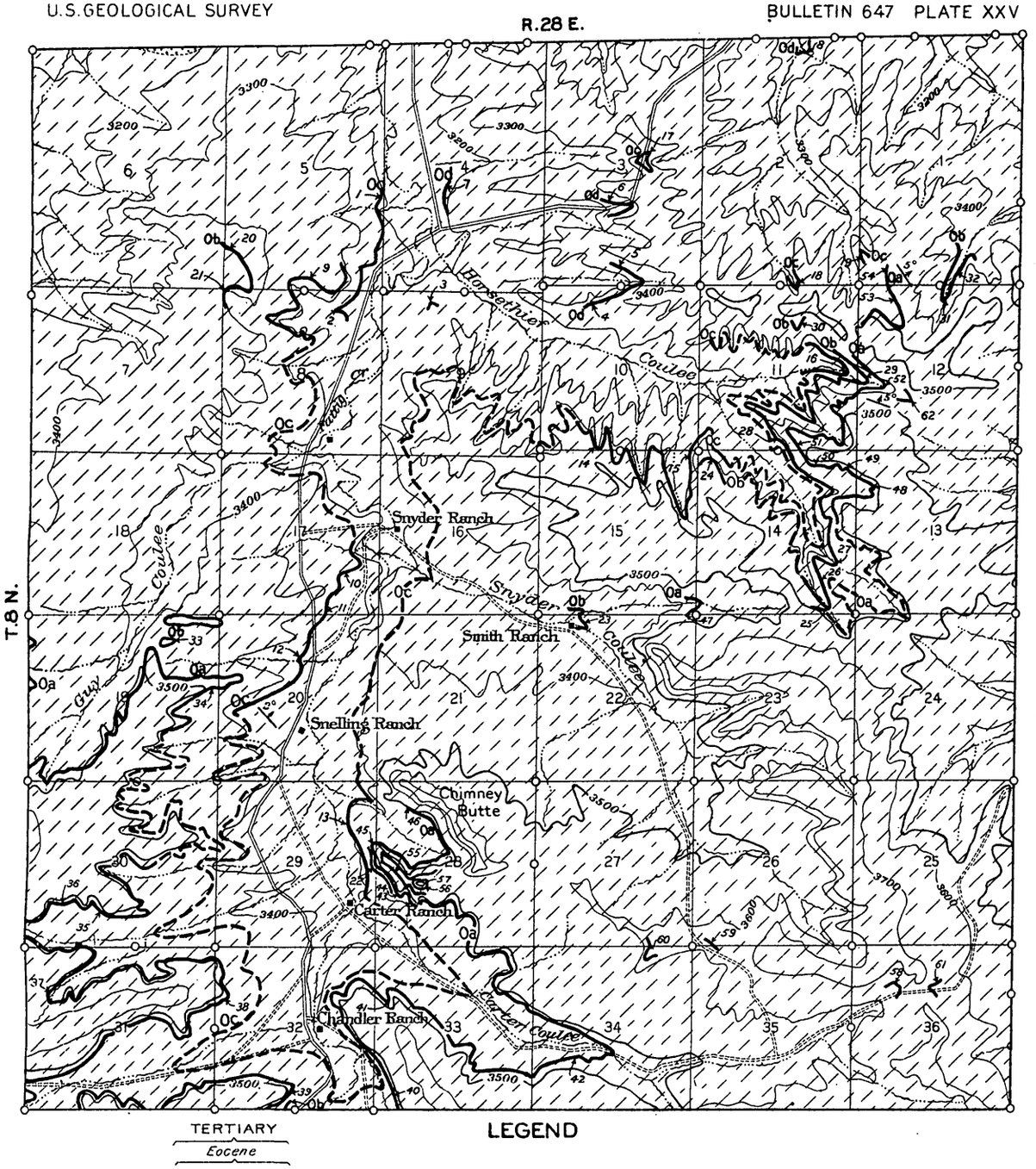
Roundup (Oa) coal bed.

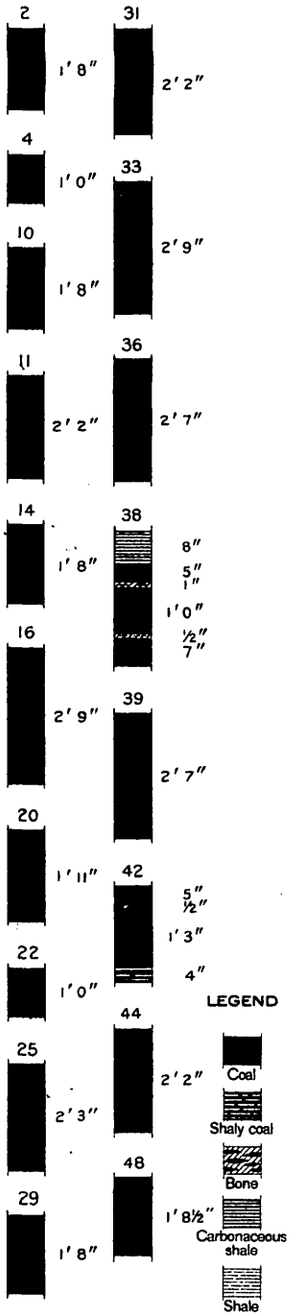
34	Sec. 19, NE. ¼	Coal	2	3	46	Sec. 28, NW. ¼	Coal	1	7
35	Sec. 30, SW. ¼	Coal	2	8	47	Sec. 22, NE. ¼	Coal		7
37	Sec. 31, NW. ¼	Coal	1+		49	Sec. 14, NE. ¼	Coal	1	10
40	Sec. 33, SW. ¼	Coal, bony	2	2	50	Sec. 14, NE. ¼	Coal		8
41	Sec. 33, NW. ¼	Coal	1	2	51	Sec. 11, SE. ¼	Coal	1	6
		Shale		1					
		Coal		7	52	Sec. 12, SW. ¼	Coal	2	3
							Coal, bony		3
43	Sec. 28, SW. ¼	Coal	2	2					
					53	Sec. 12, NW. ¼	Coal bloom.		
45	Sec. 29, NE. ¼	Coal	2	4					
					54	Sec. 1, SW. ¼	Coal	1	0

Local coal beds above Roundup coal bed.

55	Sec. 28, SW. ¼	Coal		8	59	Sec. 26, SW. ¼	Coal	1	6
56	Sec. 28, SW. ¼	Coal	1	0	60	Sec. 34, NE. ¼	Coal	1	3
57	Sec. 28, SW. ¼	Coal		10	61	Sec. 36, NE. ¼	Coal		9
58	Sec. 36, NW. ¼	Coal	1	8	62	Sec. 12, SW. ¼	Coal	1	8

Practically no coal has been mined from this township except possibly a few wagonloads from surface prospects by ranchers for domestic use. The valleys of Fattig Creek, Carter, Snyder, Horsethief, and Guy coulees are natural routes for spurs from the Chicago, Milwaukee & St. Paul Railway, a short distance north of the township. The Roundup coal bed in the southwestern part will probably be the first bed mined on a commercial scale, as it is thicker and apparently more constant than any other. Natural water supply and timber for props are fairly abundant.





LEGEND

TERTIARY
Eocene

Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500

1 0 1 2 MILES

Names and symbols of coal beds and numbers of coal sections

Local	55-62
Roundup (Oa)	33-54
Snelling (Ob)	20-32
Snyder (Oc)	9-19
Spendiff (Od)	1-8

SECTIONS

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 8 N., R. 28 E., MONTANA

T. 9 N., R. 28 E.

GEOGRAPHY.

T. 9 N., R. 28 E., lies on the north side of the Bull Mountain field in and north of the valley of Musselshell River. The flat valley floor of the river is half a mile to a mile in width and is in places bordered by steep bluffs, those on the south side of the river being somewhat higher and more abrupt than those on the north. North of the valley the surface is that of a moderately dissected plateau. It is terminated by an escarpment, made by the upturned edges of the Fort Union rocks, which extends slightly south of east from the northwestern corner of the township. Beyond, on the north, a rolling prairie has developed upon Bearpaw shale.

Water is taken from Musselshell River at several places for irrigating the flood plain. The other parts of the township are poorly supplied with springs, but the structure of the rocks suggests that a fairly abundant artesian supply could be obtained from wells of moderate depth in the coulee bottoms in the central part of the township.

GEOLOGY.

The rocks outcropping in the township embrace the upper part of the Bearpaw shale, all of the Lance formation, all of the Lebo shale member of the Fort Union formation, the lower 400 to 500 feet of the upper part of the Fort Union, and Quaternary river deposits forming the terraces and flood plain of Musselshell River. The upper part of the marine Bearpaw shale extends across the northern part of the township with a moderate south dip. It is succeeded by the sandstone and shale of the Lance formation, which occupy a belt about half a mile in width from sec. 6 to sec. 12 and dip 20°–25° S., somewhat more steeply than the Bearpaw shale. Succeeding the Lance to the south and overlying it is the Lebo shale member of the Fort Union, which dips 25°–30° S. and in consequence occupies a strip only a few hundred feet in width.

Near the outcrop of the Lebo shale member the succeeding sandstone and shale of the upper part of the Fort Union dip steeply south, but farther south the dip decreases until at the south border of the township the strata are nearly horizontal or dip gently north. The variations in the attitude of the beds show that an asymmetric syncline with the steeper dips on the northern limb crosses the township from east to west with its axis just north of Musselshell River.

COAL.

Coal in Lance formation.—The Lance formation contains thin coal beds, but no sections were located in this township. The stratigraphic section (E in Pl. VI) across the eroded northern limb of the syncline shows the character of these beds.

Big Dirty (P) coal bed.—The Big Dirty coal bed, stratigraphically near the middle of the Lebo shale member of the Fort Union, was measured in sec. 5, where it shows two benches of carbonaceous shale and sandstone, 4 and 3 feet thick, which contain thin beds of coal and which are separated by a bed of sandstone 2 feet 6 inches thick.

Coal beds in upper part of Fort Union formation.—Four coal beds, all of small importance, outcrop in the steeply dipping beds immediately south of the outcrop of the Lebo shale member of the Fort Union formation. The topmost of these beds is local and unimportant (No. 11). The three lower beds are correlated with three of the beds which are exposed in T. 8 N., R. 28 E.—the Spendiff (Od), Snyder (Oc), and Snelling (Ob). The maximum thickness (2 feet 1 inch) of the lowest, the Spendiff, is in sec. 11 (No. 4, Pl. XXVI), but other measurements show that it is lenticular and of little importance. The Snyder bed has a thickness of 1 foot 7 inches in sec. 11 (No. 9) but is thinner in both directions from that locality. The Snelling bed was measured at only one place in sec. 11 (No. 10), where it has a thickness of 1 foot. All these coal beds have a much greater thickness farther east, where the two upper ones have received different names, being known as the Carpenter and McCleary.

In the central and southern parts of the township only two outcrops of coal beds have been studied. In the southeastern part of sec. 23 (No. 12) a bed 2 feet 2 inches in thickness underlies the top of a small hill, and by the roadside in the northeast part of sec. 31 (No. 13) another local bed shows a thickness of 1 foot.

The coal in all these beds is high-grade subbituminous, uniform in quality with that in other parts of the Bull Mountain field. The graphic sections in Plate XXVI and the following list include all the measurements made within the township.

Coal sections in T. 9 N., R. 28 E.

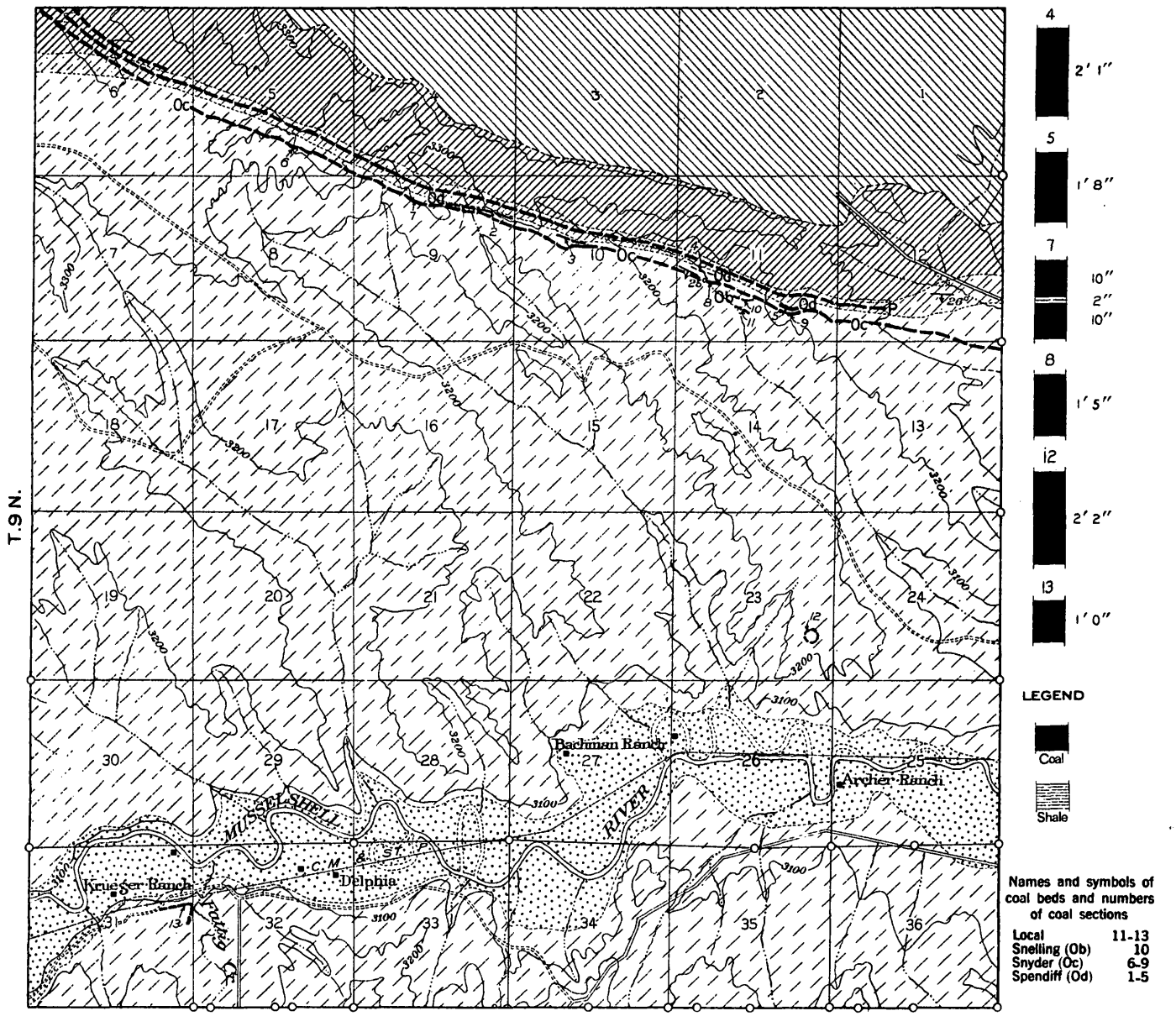
[See also Pl. XXVI.]

Spendiff (Od) coal bed.

No. on map, Pl. XXVI.	Location.	Section.	Ft.	in.	No. on map, Pl. XXVI.	Location.	Section.	Ft.	in.
1	Sec. 9, NE. ¼	Coal		10	3	Sec. 10, NW. ¼	Coal		3
2	Sec. 9, NE. ¼	Coal		7					
		Coal and shale		6					

Snyder (Oc) coal bed.

6	Sec. 5, SE. ¼	Coal		4	9	Sec. 11, SE. ¼	Coal	1	7



MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 9 N., R. 28 E., MONTANA

Coal section in T. 9 N., R. 28 E.—Continued.

Snelling (Ob) coal bed.

No. on map, Pl. XXVI.	Location.	Section.	
			Ft. in.
10.....	Sec. 11, SW. ¼.....	Coal.....	1 0

Local coal bed.

11.....	Sec. 11, SW. ¼	Coal.....	5

Development.—No coal has been mined in the township except possibly a few wagonloads from surface prospects for domestic use by local ranchers. It is doubtful if the township will ever produce much coal, for the known beds are in general thin and of little economic importance. The maximum thickness of any coal bed is 2 feet 2 inches (No. 12) and is exposed in an isolated hill in the SE. ¼ sec. 23. A few country banks may be opened on the Spendiff bed in the northern part of the township, but it is believed that they will not produce enough to warrant the construction of a spur from the railroad 4 miles to the south.

T. 5 N., R. 29 E.

GEOGRAPHY.

T. 5 N., R. 29 E., lies on the south side of the divide between Musselshell and Yellowstone rivers southeast of the Bull Mountains. It is essentially a region of long, wide, flat-topped ridges separated by wide valleys. The sides of the ridges are rugged and in places steep. The principal valleys are occupied by the intermittent Railroad and Cow Gulch creeks. The valleys are well adapted for dry farming and the hills for pasture. The water supply, however, is meager and is obtained from a few springs and water holes.

GEOLOGY.

The upper part of the Lance formation, the Lebo shale member of the Fort Union formation, and the lower few hundred feet of the upper part of the Fort Union embrace all the rocks outcropping within the township. The gray sandstones at the top of the Lance occupy small areas in the lower stream valleys of Railroad and Cow Gulch creeks. Above them lie the drab and olive-green shales of the Lebo shale, which occupies a broad, irregular area in the southern part of the township, extending a long distance up the streams. The yellow sandstone and brown and gray shale of the Fort Union outcrop in the northern part of the township and extend southward for long distances along the high ridges. All the strata dip gently north.

COAL.

Local beds of coal are contained in all the strata exposed in the township but are in general too thin to be of economic importance. Hence no large scale map of the township is published. The Big Dirty coal bed occupies a stratigraphic position about the middle of the Lebo shale member and consists of alternating bands of carbonaceous shale and sandstone and coal, with a total thickness of 2 to 24 feet. Though important as a horizon marker the bed at present has no economic value. Coal beds were examined at other horizons in the Lebo shale and in the upper part of the Fort Union, but none was considered of sufficient value to warrant mapping.

T. 6 N., R. 29 E.

GEOGRAPHY.

T. 6 N., R. 29 E., lies east of the Bull Mountains and is crossed centrally by the divide between Musselshell and Yellowstone rivers—a broad plateau with an average elevation of about 3,800 feet above sea level. Locomotive Butte, in sec. 21, is a prominent topographic feature. The northern part of the township is drained by branches of Hawk Creek, of which Dry Fork is the largest. Several small valleys lead southward, those occupied by Cow Gulch and Hibbard creeks being the largest. The valleys have in general wide, nearly flat floors, which are separated from the uplands by steep scarps of rim rocks. No running water is present in the valleys except for a short time after a heavy rainfall. The water supply of the township is limited to a few water holes, but shallow wells in the thicker sandstones would doubtless furnish a moderate but constant supply.

GEOLOGY.

All the rocks which outcrop in the township belong to the upper or coal-bearing portion of the Fort Union formation. They consist of alternating beds of sandstone, clay shale, and coal, of which the sandstone is the most prominent, forming the rugged scarps or rim rocks of the valley walls, mesas, and buttes. The beds are practically horizontal.

COAL.

Stratigraphic relations.—The exposures of coal in the township have been referred to four beds. (See Pl. XXVII.) The stratigraphic relations of these beds and the number of coal sections measured on each bed are shown in the following table:

Stratigraphic relations of coal beds in T. 6 N., R. 29 E., and the numbers of the sections measured on each.

	Feet.
Top.	
Ostrander (La) coal bed, Nos. 20 to 22, inclusive.	
Interval	60
Dougherty (M) coal bed, Nos. 16 to 19, inclusive.	
Interval	40
Chandler (?) (Ma) coal bed, No. 15.	
Interval	220
C A or De Bore (Na) coal bed, Nos. 1 to 14, inclusive.	

The Dougherty bed, on account of its thickness, is the most important, but it underlies a comparatively small area in the northwestern part of the township. All the coal is of the same high-grade subbituminous quality as the coal in other parts of the Bull Mountain field.

C A (Na) coal bed.—The lowest coal bed in the township is the C A bed, called the De Bore bed, in the township to the east. It outcrops in the southwestern part around the head of Cow Gulch and its tributaries, where it is characterized by a persistent parting of shale. Its average thickness is about 2 feet. North of the divide between Cow Gulch and Hibbard Creek the bed is thin and was not mapped. It outcrops on the steep slopes bordering the plateaus and can be examined at almost any place desired. The sections shown graphically in Plate XXVII and those in the following list were measured in the southwestern part of the township.

Coal sections on the C A (Na) coal bed in T. 6 N., R. 29 E.

[See also Pl. XXVII.]

No. on map, Pl. XXVII	Location.	Section.	Ft.	in.
1	Sec. 30, NW. ¼...	Coal		10
		Parting		1½
		Coal	1	5
		Total coal.	2	3
3	Sec. 30, SE. ¼...	Coal		10
		Parting		1½
		Coal	1	6
		Total coal.	2	4
4	Sec. 30, NE. ¼...	Coal		9
		Parting		1½
		Coal	1	5
		Total coal.	2	2
6	Sec. 20, SW. ¼...	Coal		6
		Parting		½
		Coal	1	5
		Total coal.	1	11
8	Sec. 20, SE. ¼...	Coal		5½
		Parting		2
		Coal	1	6
		Total coal.	1	11½
9	Sec. 20, SE. ¼...	Coal	1	10
10	Sec. 21, SW. ¼...	Coal	1	9
13	Sec. 27, SW. ¼...	Coal	1	5
14	Sec. 34, NE. ¼...	Coal		9½
		Parting		2
		Coal	1	2
		Total coal.	1	11½

Chandler (Ma), Dougherty (M), and Ostrander (La) coal beds.—The Chandler, Dougherty, and Ostrander beds underlie a high narrow ridge which extends eastward in secs. 5, 6, 7, and 8 along the divide between Hawk Creek and Dry Fork of Hawk Creek. The Chandler bed, the lowest of the three, is probably lenticular in character and was examined at only one place (No. 15), where the following section is exposed:

Section on the Chandler (Ma) coal bed (No. 15), SW. ¼ sec. 6, T. 6 N., R. 29 E.

	Ft.	in.
Coal	1	4½
Parting		1
Coal		1½

Complete measurements of the Dougherty bed were made at only three places (Nos. 16, 17, and 18, Pl. XXVII) which show thicknesses of 3 feet 5 inches to 4 feet 3 inches. In the NE. ¼ sec. 5 (No. 19) 5 inches of ash was found at this horizon.

The Ostrander bed, 60 feet higher in the same ridge, has an average thickness of about 2 feet. It was measured at two places (Nos. 21 and 22, Pl. XXVII). In the NE. ¼ sec. 4 (No. 20) 8 inches of ash is exposed at the horizon. Both the Dougherty and Ostrander beds have been burned to some extent along the outcrop in secs. 5 and 6, where their horizons are shown by bands of reddened clinker.

All the complete measurements on the Dougherty and Ostrander beds are shown graphically in Plate XXVII.

Development.—No coal is known to have been mined from this township, but small quantities may have been removed from surface prospects by ranchers for domestic use. The first coal to be mined on a commercial scale probably will be the Dougherty bed in the northwest part of the township, as it contains the thickest and presumably the best coal. The most feasible route for a railroad spur to this locality is along the valley of Hawk Creek from the Chicago, Milwaukee & St. Paul Railway on the north, or along the valley of Buffalo Creek from the Northern Pacific Railway at the south. The spur could cross from the Buffalo Creek drainage to the Hawk Creek drainage most easily in sec. 31, T. 7 N., R. 30 E., about a mile northeast of the northeast corner of the township.

T. 7 N., R. 29 E.

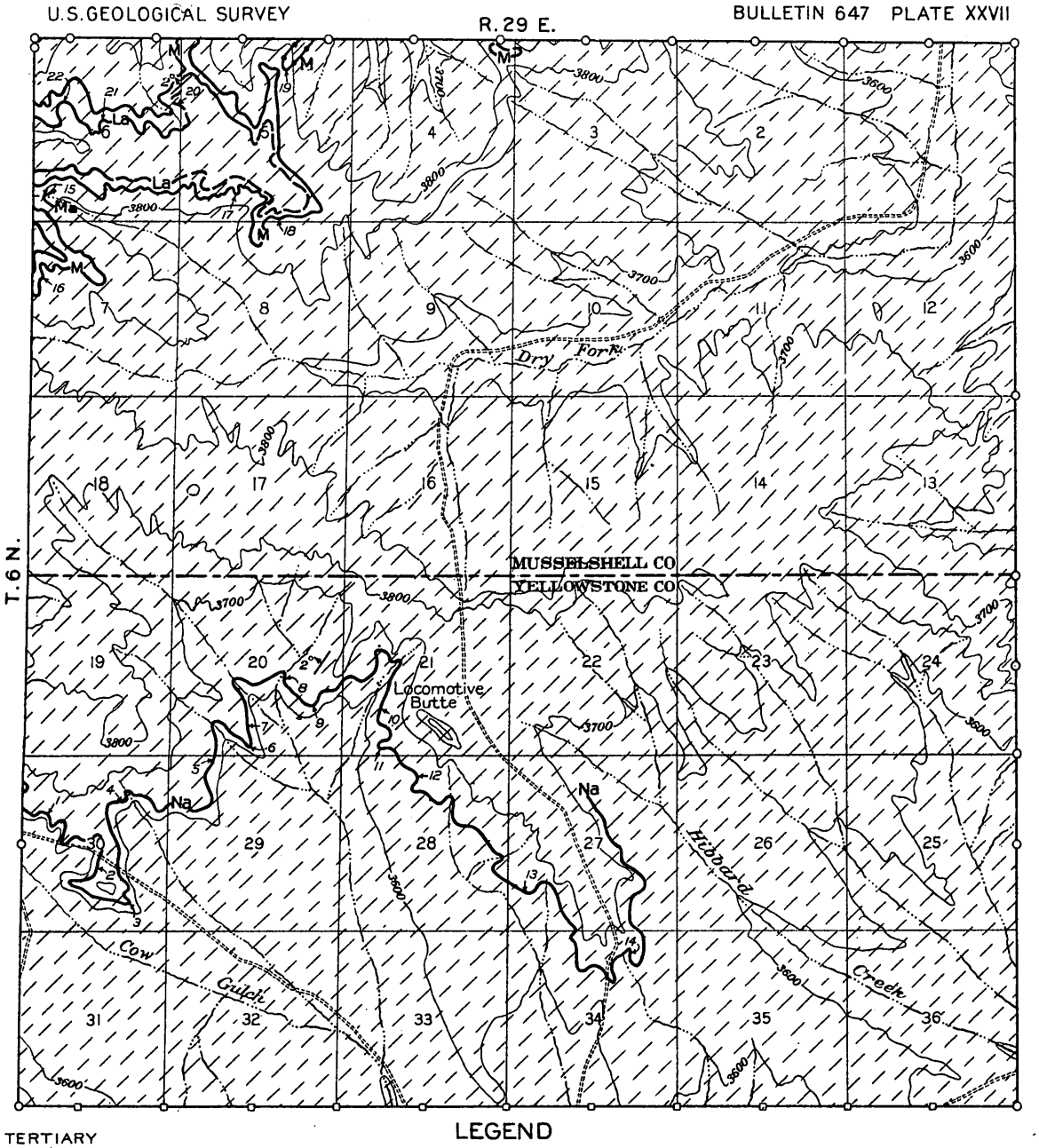
GEOGRAPHY.

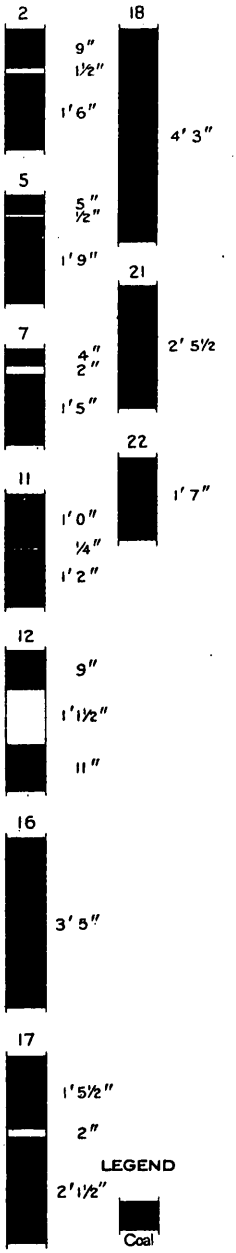
T. 7 N., R. 29 E., lies in the east-central part of the Bull Mountain field, northeast of the Bull Mountains proper. The plateau which surrounds the high Bull Mountain mesas and extends northeastward has in this township been maturely dissected by numerous streams, of which Hawk Creek and its tributaries (Schauber, Anderson, and Fishel creeks) and Carter Coulee, a tributary of Fattig Creek, are the largest. All these valleys are walled on the northern sides by characteristic rim rocks. Narrow spurs or ridges extend into the southwestern part of the township from the higher land to the west and are underlain by some of the more important coal beds.

Hawk Creek contains running water throughout the year for short distances below the springs at the several ranches. Water holes supply the rest of the township. Small areas are adapted for dry farming and for cutting wild hay, and the hills carry a moderate growth of pine, the best of which has been cut.

GEOLOGY.

All the rocks outcropping in the township belong to the upper or coal-bearing portion of the Fort Union formation. They consist of





LEGEND

TERTIARY
Eocene

Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Strike and dip

Land corner found

Private land corner

Names and symbols of coal beds and numbers of coal sections

Ostrander (La) 20-22
Dougherty (M) 16-19
Chandler (Ma) 15
CA, DeBore (Na) 1-14

SECTIONS

Scale 1/62,500

1 0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 6 N., R. 29 E., MONTANA

alternating beds of sandstone, clay shale, and coal, of which the sandstones are the most prominent, forming the rugged scarps or rim rocks of the valley walls and mesas. The beds are practically horizontal.

COAL.

Stratigraphic relations.—Only the Dougherty and Ostrander coal beds have been mapped in this township. (See Pl. XXVIII.) A few isolated coal exposures in the central and southern parts of the township are believed to be on the Buckey bed, the approximate outcrop of which is shown on Schauber and Fishel creeks. The McCleary coal bed, which outcrops in the townships to the north and east, probably underlies the northern half of the township. Its thickness in the northeast corner of the township is estimated to be 3 feet 6 inches. Thin local coal beds also were found in the interval between the Buckey and Dougherty. The following table shows the stratigraphic relations of the coal beds which are exposed in the township and also those which from their outcrops in adjoining townships may be expected to underlie parts of this township. The stratigraphic relations of these beds are as follows:

Stratigraphic relations of coal beds in T. 7 N., R. 29 E., and the numbers of the sections measured on each.

	Feet.
Top.	
Ostrander (La) coal bed, Nos. 15 to 18, inclusive.	
Interval	60
Dougherty (M) coal bed, Nos. 8 to 14, inclusive.	
Interval, containing local coal beds, Nos. 4 to 7, inclusive	200
Buckey (N) coal bed, Nos. 1 to 3, inclusive.	
Interval	175±
McCleary (Ob) coal bed, no measurements.	

The coal in these beds is high-grade subbituminous, similar in all respects to the coal in other parts of the Bull Mountain field.

Buckey (N) coal bed.—Two exposures, Nos. 1 and 2, on Hawk Creek, sec. 28, are doubtfully referred to the Buckey bed. At the first (No. 1), in the SW. ¼, the thickness is 6 inches, but half a mile farther east (No. 2), in the SE. ¼, it is 1 foot 11 inches. Another section, approximately 1 foot in thickness, was measured on Schauber Creek in the SW. ¼ sec. 14 (No. 3). The outcrop is for the most part concealed by surface material and could be followed for a short distance only. North of the township line the bed was measured on a branch of Anderson Creek in sec. 36, T. 8 N., R. 29 E., where it has a thickness of 2 feet 8 inches. The bed probably has an average thickness of 2 feet under the northern third of the township.

Local coal beds between Buckey and Dougherty coal beds.—The locations and thicknesses of coal beds exposed in the northwestern part

of the township between the Buckey and the Dougherty are given below. As the most important of these is only 1 foot 2 inches thick, they need no further mention.

Coal sections on local coal beds between the Buckey and Dougherty coal beds in T. 7 N. R. 29 E.

No. on map, Pl. XXVIII.	Location.	Section.		No. on map, Pl. XXVIII.	Location.	Section.	
			Ft. in.				*Ft. in.*
4	Sec. 6, NW.¼...	Coal.....	9	6	Sec. 19, NE.¼...	Coal.....	11
5	Sec. 18, NE.¼..	Coal.....	5	7	Sec. 19, SW.¼...	Coal.....	1 2

Dougherty (M) and Ostrander (La) coal beds.—The Dougherty and Ostrander coal beds, separated by about 60 feet, outcrop in the sides of the high hills around the head of Hawk Creek in the southwestern part of the township and in the adjoining township to the west. They underlie small areas in secs. 19, 20, 30, and 31. Both beds are fairly well exposed in the steep bluffs but are burned at the outcrop to such an extent that in only a few places could a satisfactory measurement be obtained. The average thickness of each bed is about 3 feet. The graphic sections in Plate XXVIII and the following list show the character of the exposure at each place where the beds were examined:

Coal sections on the Dougherty (M) and Ostrander (La) coal beds in T. 7 N., R. 29 E.

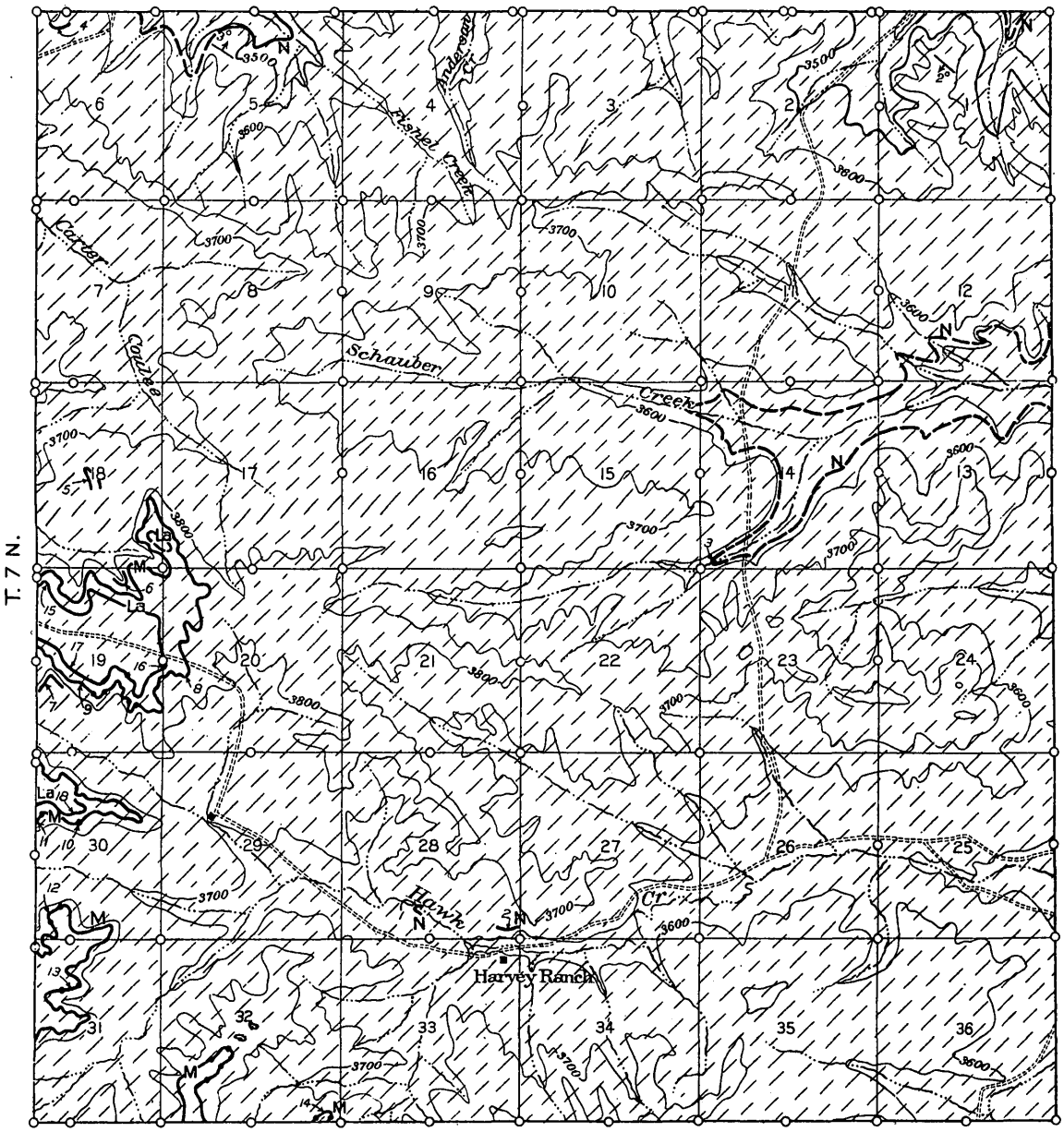
[See also Pl. XXVIII.]

Dougherty (M) coal bed.

No. on map, Pl. XXVIII.	Location.	Section.		No. on map, Pl. XXVIII.	Location.	Section.	
			Ft. in.				*Ft. in.*
10	Sec. 30, NE.¼...	Ash.....	3±	13	Sec. 31, NE.¼...	Coal.....	2
		Parting....	1			Shale.....	1½
		Coal.....	1 4			Coal.....	2
						Sandstone.	4 0
11	Sec. 30, NW.¼..	Ash.....	4			Ash.....	4
		Parting....	2			Coal.....	1 9
		Coal.....	1 8				
		Ash.....	3	14	Sec. 32, SE.¼....	Coal.....	1 2
12	Sec. 30, SW.¼...	Shale.....	7				
		Ash.....	4				
		Coal.....	10				

Ostrander (La) coal bed.

15	Sec. 19, NW.¼...	Ash.....	9	18	Sec. 30, NE.¼...	Coal.....	1 9
		Coal.....	9			Interval.....	19 0
17	Sec. 19, SW.¼...	Coal.....	1 8			Coal.....	1 1
		Ash.....	3				
		Shale.....	1				
		Coal.....	10				



LEGEND

TERTIARY
Eocene
Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Strike and dip

Land corner found

Names and symbols of coal beds and numbers of coal sections

Ostrander (La)	15-18
Dougherty (M)	8-14
Local	4-7
Buckey (N)	1-3
McCleary (Ob)	No measurement

Scale 1/62,500

1 0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 7 N., R. 29 E., MONTANA

Development.—No coal has been mined in this township except possibly a few wagonloads from surface prospects for domestic use by ranchers. As only a comparatively small area in the township is underlain by minable coal beds perhaps no commercial mines and probably few country banks will be opened within its limits. The most feasible route for a spur from the Chicago, Milwaukee & St. Paul Railway to the north is along the course of Hawk Creek and up the tributaries of that creek to the coal beds at the heads of the coulees. The McCleary coal bed, which underlies the township at an average depth of about 200 feet, may be of importance in this region, and if so it could be most advantageously mined by shafts in the deeper valleys.

T. 8 N., R. 29 E.

GEOGRAPHY.

T. 8 N., R. 29 E., is in the north-central part of the field, northeast of the main Bull Mountain mesas. Its surface is characterized by nearly level uplands interrupted by numerous valleys. Hawk Creek, which drains the greater part of the township, flows northwest across the northeastern part of the township and is joined in sec. 3 by Fishel Creek, which drains the western part. Anderson Creek, another tributary of Hawk Creek, drains the southeastern part. These streams flow through wide, level valleys in sharp contrast with the narrow, rugged valleys of the smaller tributaries. High scarps or cliffs of massive sandstone rim rocks separate the valleys sharply from the uplands. The heads of the gulches and the steep valley walls are clothed with a moderate growth of small pine and cedar. Grass is abundant on the uplands and is utilized chiefly for winter pasture.

A fairly abundant supply of water is furnished by Hawk Creek, which is a perennial stream, and by a few springs near the heads of ravines. Water can be reached by shallow wells at most places in the valley bottoms. Artesian water flows from a well directly north of the township in the SE. ¼ sec. 32, T. 9 N., R. 29 E. It seems probable from the structure in this part of the field that the center of this artesian basin is near the mouth of Hawk Creek and that artesian water may be reached by deep wells as far south as the central part of the township. The larger valley bottoms and some of the uplands are adapted for dry farming.

The stage road between Junction City and Musselshell follows the valley of Hawk Creek across the northeastern part of the township from southeast to northwest. There is no town or post office in the township, but there are several ranches on Hawk and Fishel creeks. Musselshell, at the mouth of Hawk Creek, is only 2 miles north of the north township line.

GEOLOGY.

The rocks that outcrop in this township all belong to the upper part of the Fort Union formation and have a total thickness of about 325 feet. They consist of sandstone, clay, shale, and coal beds, of which the massive buff to yellowish-gray sandstones are predominant and form the prominent rim rocks of the valley walls. These sandstone beds, however, are very irregular in thickness and are represented locally by grayish thin-bedded sandstone with intercalated clay and shale. The strata in the greater part of the township are practically level, but in the west-central part they are domed, so that the McCleary coal bed is exposed for a short distance in sec. 29 in the valley of Fishel Creek. The stratigraphic section (J in Pl. VI, p. 34), measured by Lupton near Grant's prospect in secs. 28 and 29, shows the character of the rocks and the stratigraphic interval between the coal beds. It will be observed that the interval between the McCleary and Buckey coal beds in this township is 185 feet. In the Musselshell Valley, 4 miles north of the township (F in Pl. VI), the same interval is about 225 feet and on Hibbard Creek (L in Pl. VI) in the southern part of the field it is only 90 feet. This shows a decided decrease in thickness of the intervening sediments from the north to the south.

COAL.

Stratigraphic relations.—Four coal beds, the McCleary (Ob), the De Bore (Na), the Buckey (N), the Kuchta (Mc), and one or more local lenses of coal outcrop in the township. (See Pl. XXIX.) The stratigraphic intervals between these beds are shown by the graphic section J in Plate VI. Two samples of coal were collected and analyzed from this township. One of them (laboratory No. 9129), from a small mine on the Kuchta bed in lot 23, sec. 2 (No. 108, Pl. XXIX), shows a heating value of 11,430 British thermal units for the air-dried sample. The other sample (laboratory No. 7195), obtained from a small opening on the Buckey bed in the NE. ¼ sec. 29 (No. 18, Pl. XXIX), shows a heating value of 11,020 British thermal units for the air-dried sample. These analyses and the physical character of the coal show that it is high-grade subbituminous, corresponding in character with the coal in other parts of the field. (For complete discussion of physical and chemical characters see pp. 48–59.)

In addition to the coal beds which outcrop in the township the Carpenter bed, which in T. 9 N., R. 29 E., lies stratigraphically about 50 feet below the McCleary, probably underlies all of this township, although at the time of examination no drill-hole records were available to prove the assumption. It is estimated from the charac-

ter and thickness of the coal at the outcrop in the townships to the north and the east that the Carpenter coal bed is about 3½ feet thick in the northeast corner of the township, but that it thins rather sharply to the southwest.

McCleary (Ob) coal bed.—The McCleary coal bed outcrops only a short distance on Fishel Creek in sec. 29, where it has a thickness of 3 feet 3½ inches (No. 1, Pl. XXIX). It is exposed in the townships to the east and to the north, and from the exposures in these townships it is estimated to have a thickness of 3 to 3½ feet over the greater part of the township but to thin toward the northwest—probably to not over a foot in the northwest corner.

De Bore or C A (Na) coal bed.—The De Bore or C A coal bed was measured at several places in the township, but as its maximum thickness is only 1 foot 3 inches it was not mapped continuously. It is stratigraphically 30 feet below the Buckey coal bed and outcrops approximately parallel to the outcrop of that bed. The following sections have been measured:

Coal sections on the De Bore (Na) coal bed in T. 8 N., R. 29 E.

No. on map, Pl. XXIX.	Location.	Section.	Ft.	in.	No. on map, Pl. XXIX.	Location.	Section.	Ft.	in.
2	Sec. 20, NW.¼...	Coal.....	1	3	7	Sec. 25, SW.¼....	Bone.....		1
							Coal.....		10
3	Sec. 3, lot 20.....	Coal.....		6	8	Sec. 11, NE.¼....	Coal.....	1	1
4	Sec. 11, NW.¼...	Coal.....		10	9	Sec. 1, lot 21.....	Coal.....		10
5	Sec. 11, SW.¼....	Coal.....	1	0	10	Sec. 3, lot 3.....	Coal.....	1	1½
6	Sec. 12, SW.¼....	Coal.....	1	0					

Buckey (N) coal bed.—The Buckey coal bed, about 30 feet above the De Bore and 185 feet above the McCleary, is the most persistent of the lower group of coal beds in the Bull Mountain area. It is well exposed along the valleys of Hawk and Anderson creeks, near the bottom of Roan Horse Coulee in secs. 21 and 22, and in an irregular line extending from secs. 32 and 33 northward to Fishel Creek, in sec. 16, and from there northwest across secs. 17, 18, and 7.

Fifty-seven sections of the Buckey coal bed in this township show an average thickness of 2 feet 3 inches. The maximum thickness of 4 feet was measured in lot 4, sec. 31 (No. 12), but sharp variations are shown by the fact that only 6 feet away the bed measures only 1 foot 11 inches (No. 11, Pl. XXIX). An analysis of a sample from Grant's prospect (No. 18) in sec. 29 is shown on page 53 (laboratory No. 7195). A selected number of coal sections are shown graphically in Plate XXIX and illustrate in general the variations in thickness

throughout the township. Additional details are furnished by the following list of sections:

Coal sections on the Buckey (N) coal bed in T. 8 N., R. 29 E.

[See also Pl. XXIX.]

No. on map, Pl. XXIX.	Location.	Section.	Ft.	in.
15	Sec. 33, SW. ¼...	Bone, purplish brown.....		3
		Coal.....	2	2
		Shale, brown.		
16	Sec. 33, NW. ¼..	Coal, bright..	2±	
17	Sec. 29, SE. ¼...	Coal.....	2	3
20	Sec. 21, NW. ¼..	Clay, drab.		
		Bone.....		4
		Coal.....	2	1
		Shale, yellowish brown.		
24	Sec. 17, NE. ¼...	Bone.....		5
		Coal.....	2	0
28	Sec. 7, SE. ¼....	Shale, drab.		
		Ash.....		1½
		Coal.....		9
		Shale, brown.		
29	Sec. 7, lot 3.....	Shale, drab.		
		Coal.....		1
		Ash.....		2½
		Shale, brown.		
31	Sec. 22, NW. ¼..	Sandstone, massive.....	6+	
		Clay shale.....	1	0
		Coal, bony...		3
		Coal.....	2	1
		Shale, clayey..	1	6
		Sandstone, light yellow.		
32	Sec. 21, NE. ¼...	Sandstone, massive.....	6+	
		Clay shale.....	1	0
		Coal, bony...		3
		Coal.....	2	2
		Shale, drab, clayey.....	1	6
		Sandstone, light yellow.		
34	Sec. 3, lot 11.....	Coal, hard and firm...	2	5
35	Sec. 3, lot 14.....	Coal, upper 6 inches shaly.....	2	5
36	Sec. 3, lot 20.....	Coal, weathered.....	2	7
38	Sec. 3, SE. ¼....	Coal.....	2	5
39	Sec. 11, SE. ¼...	Ash.....		3
		Coal.....		6
42	Sec. 24, NW. ¼..	Shale, drab.		
		Shale, purplish black.....		6
		Coal, weathered.....	2	2
		Shale, brown.		
44	Sec. 13, NW. ¼..	Ash.....		3½
45	Sec. 13, SE. ¼...	Sandstone, massive...	7	0
		Ash, dark, maroon....		4
47	Sec. 25, SE. ¼...	Ash, bright colored		3
50	Sec. 34, NE. ¼...	Shale, brown.		
		Coal.....		5
		Shale, drab to purple.....		10
		Coal.....		10
		Shale.		
		Total coal. Horizon questioned.	1	3
51	Sec. 35, NW. ¼..	Alluvium.		
		Coal.....	2	2+
		Shale. Top eroded away.		
55	Sec. 11, NE. ¼...	Coal.....	2	3
60	Sec. 3, lot 17.....	Coal.....	2	6
62	Sec. 3, lot 9.....	Coal..... Base not exposed.	2	4+
63	Sec. 3, lot 7.....	Coal..... Top of coal eroded.	2	3+

Kuchta (Mc) coal bed.—The Kuchta coal bed, 25 to 40 feet above the Buckey, outcrops extensively along Hawk Creek valley but is apparently of little value south of a line drawn approximately parallel to Hawk Creek and a mile south and west of it. The average of 53 sections measured is 1 foot 5 inches, the maximum (No. 107) being 2 feet 10 inches. In secs. 3 and 4, on the west side of Hawk Creek, the Kuchta bed is less than 1 foot 2 inches thick for about

a mile along the outcrop. A remarkable feature is that a coal bed about 12 feet above the horizon of the Kuchta is of importance only where the Kuchta is thin. This upper bed was observed in different parts of the field examined in 1909 but only in this township did it reach 1 foot 2 inches. An analysis of a sample collected from the Kuchta bed at the Todd mine on Hawk Creek in sec. 2 (No. 108) is shown on page 53 (laboratory No. 9129). The sections measured on these two beds are shown graphically in Plate XXIX or are listed in the following table.

Coal sections on the Kuchta (Mc) coal bed in T. 8 N., R. 29 E.

[See also Pl. XXIX.]

No. on map, Pl. XXIX.	Location.	Section.	Ft.	in.
65	Sec. 28, SW. ¼...	Coal.....		8
66	Sec. 21, SW. ¼...	Coal.....	1	0
67	Sec. 3, lot 5.....	Ash.....		3
		Coal, impure.		3
68	Sec. 3, lot 20....	Coal.....		10
71	Sec. 11, NW. ¼..	Coal.....	2	2
76	Sec. 13, NW. ¼..	Coal.....	1	4
77	Sec. 23, NE. ¼...	Coal.....		11
83	Sec. 25, NE. ¼...	Shale and sandstone, alternating.....	4	4
		Shale, brown..		1½
		Coal.....		11
		Shale, brown.		
84	Sec. 25, NE. ¼...	Bone.....		5½
		Coal.....		11
		Shale, brown..		1
85	Sec. 25, NW. ¼..	Shale and bone, purple.....		7
		Coal.....		9
		Shale, brown.		
86	Sec. 25, NW. ¼..	Coal.....		7
		Parting.....		6
		Coal.....		7
87	Sec. 25, SW. ¼...	Shale, brown.		
		Coal.....		¾
		Shale, brown		1
		Bone, purplish.....		5
		Coal.....		6
		Bone, hard....		3
88	Sec. 26, SE. ¼...	Shale, brown..		1½
		Coal.....		9
		Shale, brown to drab.....		6
89	Sec. 26, SW. ¼...	Shale and sandstone, alternating.		
		Shale, brown..		1
		Coal, poor...		5
		Shale, brown..		1
		Bone.		
91	Sec. 34, NE. ¼...	Coal.....		8+
		Shale.		
		Top not exposed.		
92	Sec. 36, NW. ¼..	Sandstone, massive, ledge maker.....	6	0
		Sandstone, massive, in part shaly.....	5	0
		Sandstone and shale, thin bedded.....	3	3
		Shale, brown..		1
		Coal.....		2
		Bone, purplish.....		4
		Coal.....		6
		Shale.		
		Total coal		8
93	Sec. 36, NW. ¼..	Sandstone, ledge maker.	3	0
		Sandstone and shale.....	6	0
		Shale, brown..		1½
		Coal.....		1½
		Bone, with coal streaks.		4
		Coal.....	1	1
		Shale, brown to drab.		
94	Sec. 36, NE. ¼...	Sandstone, massive.....	5	0
		Sandstone and shale.....	4	0
		Shale, brown..		1
		Coal.....		1
		Bone, purple.		6
		Coal.....	1	
		Shale, brown to drab.		½
95	Sec. 36, SW. ¼...	Sandstone, ledge maker.	6	0
		Sandstone and shale.....	6	0
		Shale, brown..		1
		Coal.....		2
		Bone.....		2½
		Coal.....		9
		Shale, drab.		
		Total coal..		11
96	Sec. 36, SE. ¼....	Shale and sandstone, alternating.		
		Coal.....		7½
		Shale, purplish		7

Coal sections on the Kuchta (Mc) coal bed in T. 8 N., R. 29 E.—Continued.

[See also Pl. XXIX.]

No. on map, Pl. XXIX.	Location.	Section.	Ft	in.
97	Sec. 36, SE. ¼....	Shale, purplish		6
		Coal.....		5
		Shale, drab.		
98	Sec. 36, NE. ¼...	Sandstone, thin bedded.....	2	1
		Bone.....		7
		Ash, mixed with purple and black shale.....		1
		Coal, good...		7
		Sandstone, brown, shaly.		
100	Sec. 12, NE. ¼...	Coal.....	1	10
101	Sec. 12, NW. ¼..	Shale, carbonaceous.....		7
		Coal.....	1	11
104	Sec. 11, NE. ¼...	Ash.....		6
105	Sec. 2, SE. ¼.....	Coal.....	2	4
109	Sec. 2, lot 19.....	Coal, hard and firm...	2	7
111	Sec. 3, lot 7.....	Sandstone.		
		Ash.....		2½
		Coal.....		6

Coal sections on a local coal bed above the Kuchta in T. 8 N., R. 29 E.

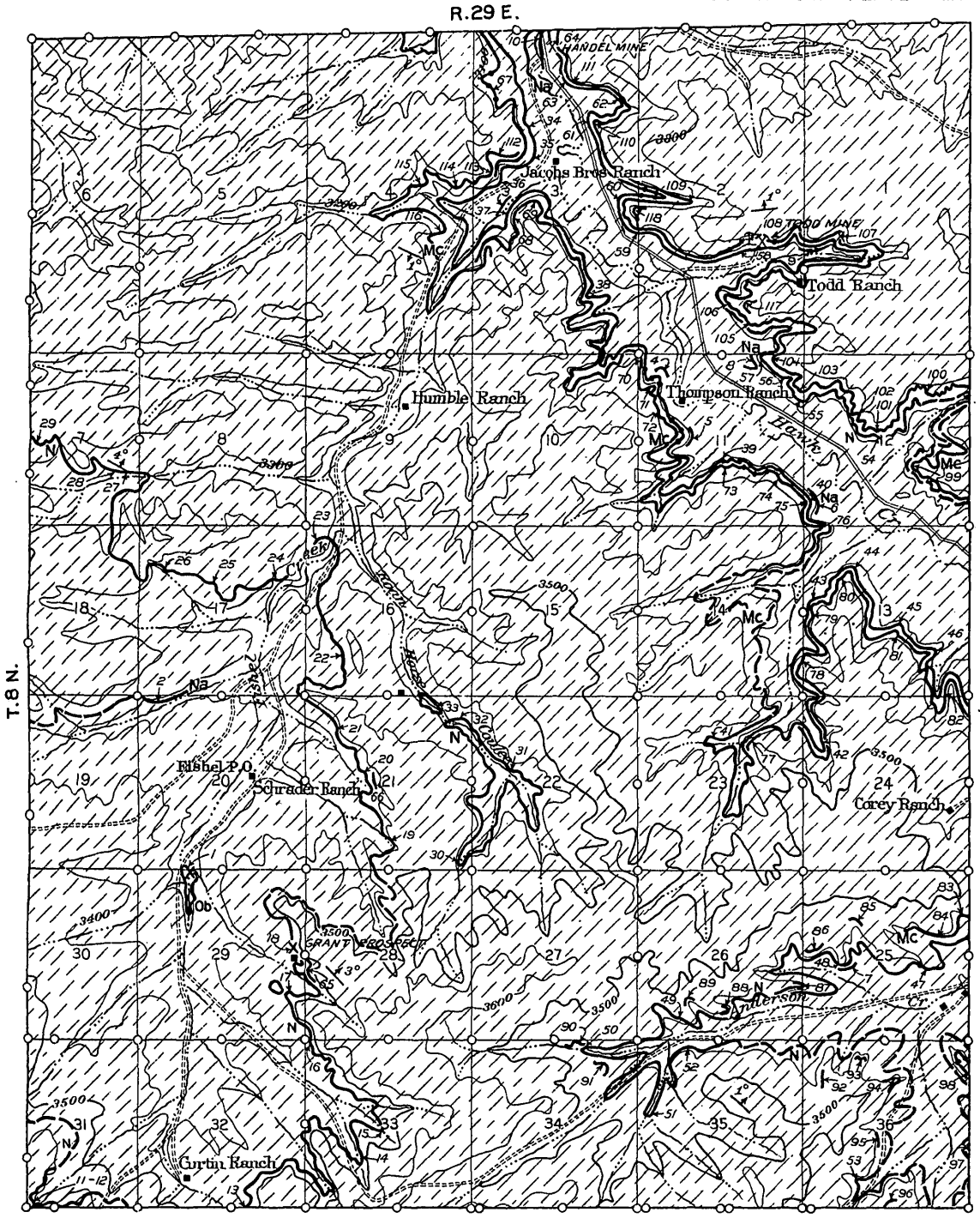
[See also Pl. XXIX.]

No. on map, Pl. XXIX.	Location.	Section.	Ft.	in.
113	Sec. 3, lot 13....	Coal.....	1	6
114	Sec. 4, lot 17.....	Coal, weathered.....	1	3
115	Sec. 4, lot 18.....	Clay shale, gray.		
		Coal.....	1	5
		Clay shale, brown.		
117	Sec. 2, SE. ¼.....	Coal.....		10
118	Sec. 3, lot 17.....	Sandstone.		
		Coal.....		11
		Shale, black, carbonaceous.		

Development.—No mining on a commercial scale has been attempted in this township, but considerable coal has been removed for domestic use by ranchers and others. In sec 1 (No. 107, Pl. XXIX) there is a small prospect on the Kuchta bed. About one-half mile east, in sec. 2, is the Todd mine, opened in 1909 by Neborvig & Todd. Several hundred tons of coal have been removed and sold to ranchers and at Musselshell, about 4 miles to the north. The analysis of a sample of coal (laboratory No. 9129) collected at this place is given on page 53.

In the northern part of sec. 3, at location 64, a country bank, locally known as Handel mine, was opened by Ben Linsebigler, of Musselshell, about 1911 on the Buckey bed. The entry is more than 100 feet long, and is under 10 to 40 feet of cover. In July, 1913, it was estimated that 1,600 tons of coal had been mined.

A small prospect drift, known as Grants prospect, was opened on the Buckey coal bed in the NE. ¼ sec. 29, and the coal was hauled to Musselshell. When this locality was last visited a small cabin and a bin to receive the coal had been built, but the mine was not in opera-



LEGEND

TERTIARY
Eocene
Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Mine

Local mine

Prospect

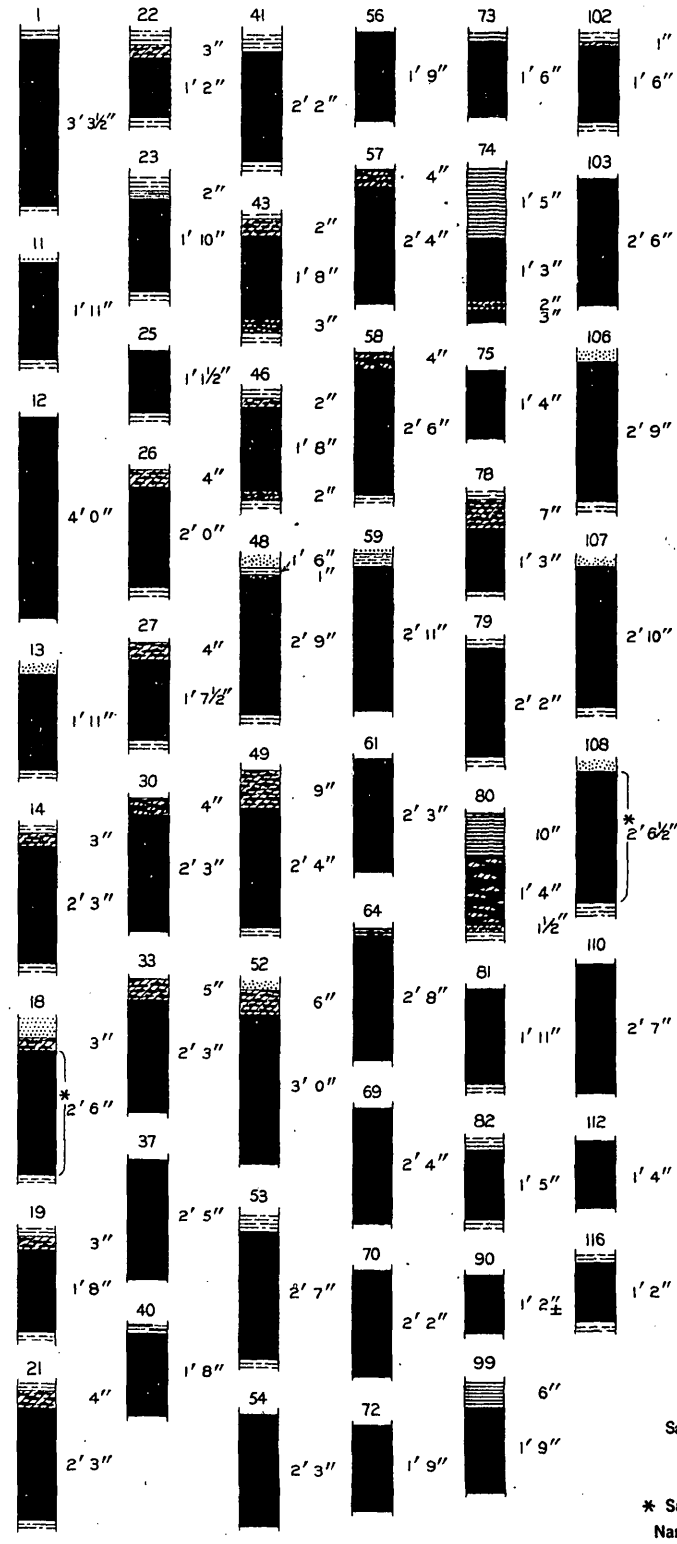
Strike and dip

Land corner found

Scale 1/62,500

0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 8 N., R. 29 E., MONTANA



LEGEND

Sandstone
Coal
Bony coal
Shaly coal
Bone
Carbonaceous shale
Shale and coal
Shale
Sandstone and shale or sandy shale

* Sampled for analysis

Names and symbols of coal beds and numbers of coal sections

Local	112-118
Kuchta (Mc)	65-111
Buckey (N)	11-64
DeBore (Na)	2-10
McCleary (Ob)	1

SECTIONS

tion. Probably 600 tons of coal have been removed from this place. The analysis of a sample (laboratory No. 7195) collected here is given on page 53. A few tons of coal have been removed from a surface prospect on the McCleary coal bed in the NW. ¼ sec. 29, on the east side of Fishel Creek, about one-half mile southwest of August Schrader's ranch.

Possibly a few tons of coal may have been removed from surface prospects in other parts of the township for domestic use, but the quantity is small.

The valleys of Hawk and Fishel creeks and their tributaries are excellent natural routes for railroad spurs to any mines that may be located on the outcrops of any of the coal beds exposed in this township. In mining the coal beds underlying the surface of the township shafts should be sunk in the valley bottoms. Water and timber for mining use are fairly plentiful.

The roof of the McCleary coal bed is good, consisting of 4 feet of hard drab sandy shale overlain by a massive gray sandstone. The roof of the Kuchta is also good in most places, but that of the Buckey will probably prove troublesome.

T. 9 N., R. 29 E.

GEOGRAPHY.

T. 9 N., R. 29 E., lies near the northeast corner of the Bull Mountain coal field, on both sides of the valley of Musselshell River, which flows northeast across the central part of the township, its flood plain ranging in width from one-half mile to nearly 2 miles. North of the river the surface is comparatively smooth, except along the outcrop of the Lance formation, where the relatively resistant beds of sandstone form a series of rough hogback ridges. South of the river the topography is characterized by narrow upland ridges, the remnants of an old plateau surface, dissected by numerous intermittent valley streams, whose walls are formed in many places by almost vertical scarps or rim rocks. The uplands are fringed with a scanty growth of pine and cedar, and cottonwoods are numerous along Musselshell River. The township is drained by Musselshell River and Hawk Creek, which are the only perennial streams in the township. A number of drill holes in the vicinity of Musselshell, reaching a depth of 200 to 300 feet, penetrate a sandstone which carries a presumably abundant supply of artesian water. Near Hawk Creek, in the SE. ¼ sec. 32, the water flows from a well and is the principal supply in lower Hawk Creek during the dry season. In many other wells the water rises nearly to the surface. The center of this artesian basin is near the mouth of Hawk Creek.

Musselshell, a town of about 300 inhabitants, is at the mouth of Hawk Creek, on the Chicago, Milwaukee & St. Paul Railway, which follows along the north side of Musselshell River. Ranches are

numerous on the alluvial bottom lands along the river and in the principal tributary valleys. The old stage road between Fort McGinnis and Junction City crosses the township from northwest to southeast, but the stage has been discontinued south of the Musselshell since the advent of the railway. A well-traveled road connecting Roundup and Melstone follows the south side of Musselshell Valley, and from Musselshell a good road extends along the north side of the valley to Melstone. Secondary roads and trails make the entire township accessible.

GEOLOGY.

The rocks which outcrop in this township belong to the Bearpaw, Lance, and Fort Union formations. The bluish-gray marine Bearpaw shale outcrops in the northern part of the township. (See map, Pl. XXX.) The dip of the beds at the top of the Bearpaw is 15°–35° S., but farther north—that is, lower in the stratigraphic succession—the dip is less. South of its outcrop the Bearpaw shale is overlain by about 700 feet of sandstone, clay, and shale, which make up the Lance formation. These strata dip even more steeply than the underlying Bearpaw, especially in the eastern part of the township, where they are tilted 25° to 40°. The Lance formation is overlain by about 200 feet of dark sandy shale and thin-bedded sandstone of the Lebo shale member of the Fort Union and this in turn is overlain by the sandstone, clay shale, and coal of the upper part of the Fort Union. The lower beds of the Fort Union are sharply tilted, like those of the underlying formations. On the south side of the township, however, the beds dip gently north. As indicated by these facts the township is crossed by an asymmetric syncline, whose axis extends nearly east and west across its central part. The dips are greater on the north than on the south, being at a maximum at about the line of outcrop of the lower coal beds.

COAL.

Stratigraphic relations.—Seven coal beds—Spendiff (Od), Carpenter (Oc), McCleary (Ob), C A (Na), Buckey (N), Kuchta (Mc), and a local bed above the Kuchta, all belonging to the upper part of the Fort Union formation—have been examined and mapped in the township. (See Pl. XXX.) Other less important beds in the Fort Union and Lance formations outcrop in places, but were not considered sufficiently valuable to warrant mapping. The Big Dirty coal bed lies stratigraphically near the middle of the Lebo shale member. It is about 10 feet thick, and consists of alternating beds of dark thin-bedded carbonaceous sandstone, sandy shale, and fairly good coal in places as much as a foot in thickness. The approximate stratigraphic relations of the coal beds of the upper part of the Fort

Union and the numbers of the sections examined on each bed are shown below.

Stratigraphic relation of coal beds in T. 9 N., R. 29 E., and the numbers of the sections measured on each.

	Feet.
Top.	
Local coal bed—Nos. 43 to 50, inclusive.	
Interval not measured.	
Kuchta (Mc) coal bed—Nos. 25 to 42, inclusive.	
Interval	25–40
Buckey (N) coal bed—Nos. 20 to 24, inclusive.	
Interval	25–40
De Bore (Na) coal bed—Nos. 14 to 19, inclusive.	
Interval	200
McCleary (Ob) coal bed—Nos. 12 and 13.	
Interval	50
Carpenter (Oc) coal bed—Nos. 6 to 11, inclusive.	
Interval	8–30
Spendiff (Od) coal bed—Nos. 1 to 5, inclusive.	
Interval	430
Top of Lebo shale.	

No sample for chemical analysis was obtained from any of the beds in this township, but the appearance of the coal shows that it is of fairly uniform grade in all the beds. Analyses of samples obtained in other parts of the field show that the coal is high-grade subbituminous. (See pp. 51–53.)

The character and distribution of each coal bed will be described, beginning with the lowest—the Spendiff (Od). Selected coal sections from each bed are represented graphically in Plate XXX.

Spendiff (Od) coal bed.—The Spendiff coal bed lies from 8 to 30 feet stratigraphically below the relatively more important Carpenter bed. Its outcrop is along a nearly straight easterly line from the southwest corner of sec. 7 to the center of the east side of sec. 13. It was mapped, however, in three localities only—near the south line of sec. 8 (Nos. 1 and 2); on the Musselshell-Melstone road in sec. 15 (No. 3); and east of the river, in sec. 13 (No. 5). The coal sections measured at these points are as follows:

Coal sections on the Spendiff (Od) coal bed in T. 9 N., R. 29 E.

No. on map, Pl. XXX.	Location.	Section.	Ft.	in.
1	Sec. 8, SW. ¼...	Coal	1	1½
		8 to 10 feet below Carpenter bed.		
2	Sec. 8, SW. ¼...	Coal	1	1
		8 to 10 feet below Carpenter bed.		
3	Sec. 15, NW. ¼..	Coal		3
		Shale		5
		Coal		11
		Total coal.	1	2
5	Sec. 13, NW. ¼...	Shale, brown and drab	1	0
		Coal		6
		Shale		½
		Coal		3½
		Shale, brown		3
		Coal		7
		Shale, drab and brown		6
		Total coal.	1	4½

Carpenter (Oc) coal bed.—The Carpenter coal bed, which is about 450 feet above the top of the Lebo shale, probably corresponds to the Snyder coal bed found by Richards on Fattig Creek, in T. 8 N., R. 28 E. Its outcrop in T. 9 N., R. 29 E., is along an easterly line from the southwest corner of sec. 7 to the center of the east side of sec. 13. Six sections (Nos. 6–11) show a range in thickness from about 4 feet to 5 feet 10½ inches. None of these exposures, however, is near the west border of the township, and a section measured near the west line of T. 9 N., R. 28 E., where the bed is only 1 foot 6 inches thick, shows that there is a decided decrease in thickness in that direction. All the coal sections are shown graphically on Plate XXX.

McCleary (Ob) coal bed.—The McCleary coal bed, which lies about 50 feet stratigraphically above the Carpenter bed, probably corresponds to the Snelling coal bed found by Richards on Fattig Creek in T. 8 N., R. 28 E. It was measured at only two places in the township, near the center of the north side of sec. 15 and in sec. 13 (Nos. 12 and 13, Pl. XXX), at both of which the Carpenter bed is also exposed (Nos. 9 and 11, Pl. XXX). The measurements on the McCleary bed at these places are shown in Plate XXX.

De Bore or C A (Na) coal bed.—The De Bore coal bed is approximately 200 feet above the McCleary in this township. North of Musselshell River its thickness ranges from 5 inches to 1 foot, and it has been mapped at only two localities, in sec. 17 (Nos. 14, 15, and 16) and in sec. 15 (No. 17). The bed outcrops also at the south side of the township in the valley of Hawk Creek, where it dips gently north and disappears beneath the floor of the valley less than half a mile north of the township line. Two exposures were examined on the east side of the creek in sec. 33 (Nos. 18 and 19). The following sections were measured in this township:

Coal sections on the De Bore or C A (Na) coal bed in T. 9 N., R. 29 E.

No. on map, Pl. XXX.	Location.	Section.	Ft.	in.	No. on map, Pl. XXX.	Location.	Section.	Ft.	in.
14	Sec. 17, NW. ¼..	Shale, brown...		8	17	Sec. 15, NE. ¼...	Coal, shaly, weathered.	1	0
		Coal.....		5					
15	Sec. 17, NW. ¼..	Coal.....	1	0	18	Sec. 33, SW. ¼...	Sandstone, gray.....	6–8	
16	Sec. 17, NW. ¼..	Shale, brown, soft.....		7			Shale, carbonaceous.....		3
		Coal, bright..		7½			Coal, bright.	2	0
		Shale and clay, drab.....		2	19	Sec. 33, SW. ¼...	Coal.....	1	1½

Buckey (N) coal bed.—The Buckey coal bed, 25 to 40 feet stratigraphically above the De Bore, was not observed north of Musselshell River. East of the river, in sec. 13, it is practically worthless. In Hawk Creek valley, in secs. 32 and 33, the bed dips north, disap-

pearing below the valley floor about half a mile north of the township line. The three coal sections shown in Plate XXX and the additional two listed below, all measured in this vicinity, show thicknesses of 1 foot 7 inches to 2 feet 10 inches. The bed is overlain by a massive sandstone, and the top of the coal is irregular.

Coal sections on the Buckey (N) coal bed in T. 9 N., R. 29 E.

[See also Pl. XXX.]

No. on map, Pl. XXX.	Location.	Section.		No. on map, Pl. XXX.	Location.	Section.	
			Ft. in.				*Ft. in.*
21	Sec. 33, SW. ¼...	Sandstone, massive	5 0	23	Sec. 33, SW. ¼...	Clay.	
		Bone	3			Coal	1 7
		Coal	1 6				

Kuchta (Mc) coal bed.—The Kuchta coal bed, 25 to 40 feet above the Buckey, is the topmost bed of economic importance in this part of the field. Its outcrop on the north side of the syncline is roughly parallel to that of the lower beds, but as it dips south much less steeply its outcrop is to a greater extent affected by the topography, extending some distance south along the streams. The bed was measured at 13 places on the north side of the syncline and was found to range in thickness from less than a foot to about 2 feet. (See Pl. XXX and table below.) In the valley of Hawk Creek the bed outcrops well up on the sides of the valley at the south edge of the township, but it dips north and disappears below the valley floor just south of Musselshell. The bed was measured at seven places on Hawk Creek, where it has an average thickness of 1 foot 6 inches. All these sections are either shown in Plate XXX or are given in the list below.

Coal sections on the Kuchta (Mc) coal bed in T. 9 N., R. 29 E.

[See also Pl. XXX.]

No. on map, Pl. XXX.	Location.	Section.	*Ft.*	*in.*
25	Sec. 17, NW. ¼.....	Clay, sandy	6–8	
		Clay, drab and brown		4
		Coal	1	½
		Shale, black, carbonaceous		4
27	Sec. 17, NE. ¼.....	Clay, drab, sandy	8	0
		Shale, black, carbonaceous		1½
		Coal		5½
		Ash, brown		4½
		Coal		7
		Clay, drab.		
28	Sec. 17, NE. ¼.....	Coal, powdery	1	0
29	Sec. 16, NE. ¼.....	Sand and sandstone, gray	5	0
		Shale, brown, carbonaceous		2½
		Coal		8½
		Shale, carbonaceous.		

Coal sections on the Kuchta (Mc) coal bed in T. 9 N., R. 29 E.—Continued.

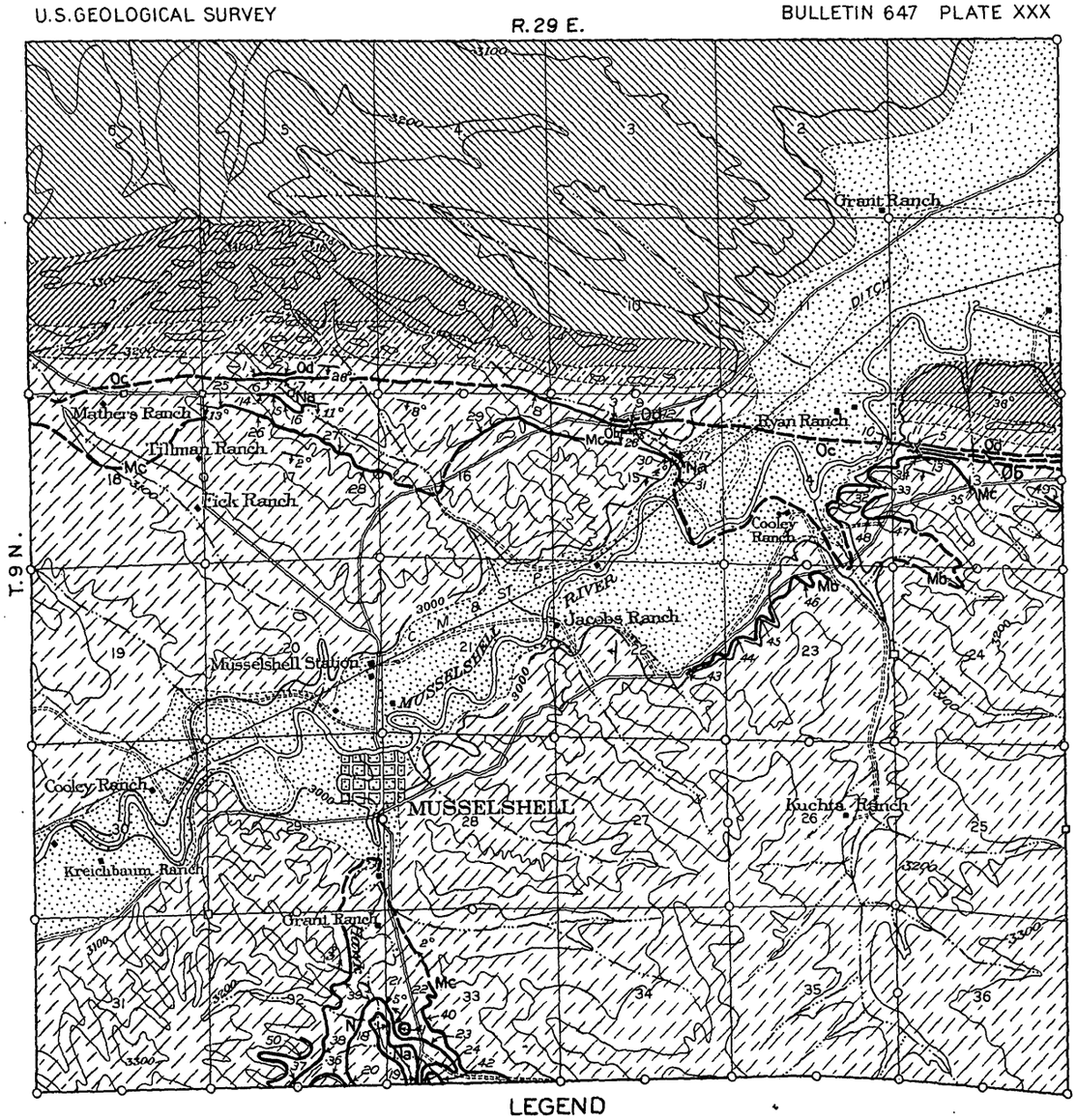
[See Pl. XXX.]

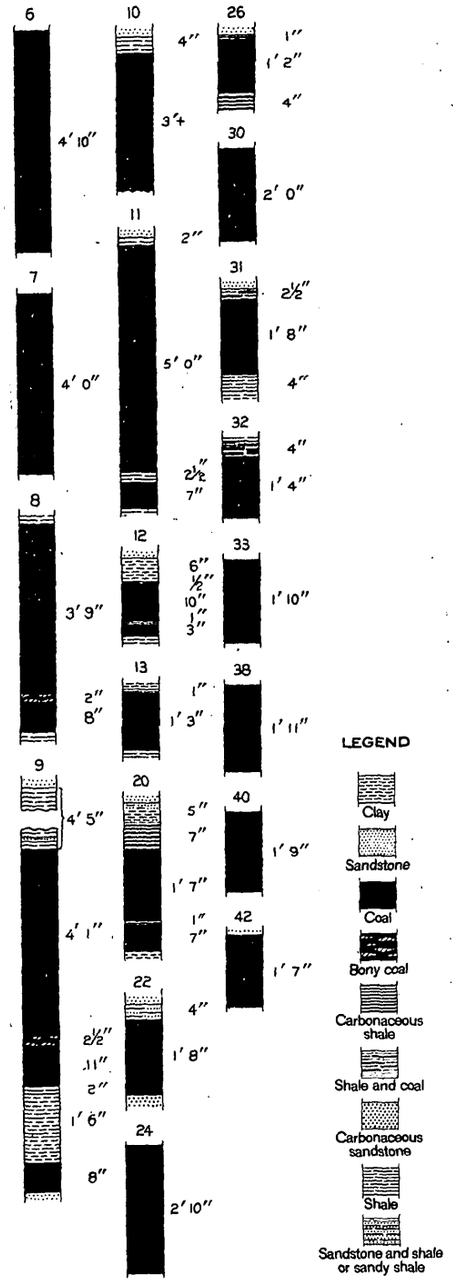
No. on map, Pl. XXX.	Location.	Section.	Ft.	in.
34	Sec. 13, NW. ¼	Sandstone, yellowish gray, shaly.		
		Shale, black and brown, carbonaceous		4
		Coal	1	½
		Shale, brownish drab, carbonaceous.		
35	Sec. 13, SW. ¼	Sandstone, brown		6–12
		Shale, carbonaceous		5
		Coal		11
a		Shale, yellow and brown.		
36	Sec. 32, SE. ¼	Coal	1	11
37	Sec. 32, SW. ¼	Sandstone, thin bedded	3	0
		Coal	1	10
		Shale, drab	1	
		Overlying sandstone, rim rock is absent.		
39	Sec. 32, NE. ¼	Sandstone, yellowish gray, massive	30–35	
		Sandstone and clay, alternating	40–50	
		Shale, brown, carbonaceous		2
		Coal	1	3
		Shale, brown, carbonaceous		10+
41	Sec. 33, SW. ¼	Coal, bright	1	5

Local coal bed.—A thin coal bed outcrops a short distance above the Kuchta in the bluffs south of Musselshell River in secs. 22, 23 and 13 and west of Hawk Creek near the south line of sec. 32. At only one place (No. 50, sec. 32) was a thickness noted greater than 1 foot. The sections are as follows:

Sections on local coal bed above the McCleary in T. 9 N., R. 29 E.

No. on map, Pl. XXX.	Location.	Section.	Ft.	in.
43	Sec. 22, SE. ¼	Coal		7
44	Sec. 23, NW. ¼	Shale, drab.		
		Clay, brown		3
		Shale, brown, carbonaceous		1½
		Coal		7
		Shale, black, carbonaceous, hard		2
45	Sec. 23, NW. ¼	Sandstone, gray, massive.		
		Coal		9
46	Sec. 23, NW. ¼	Sandstone, yellowish gray, containing leaf impressions	1	4
		Clay, with carbonaceous streak		4½
		Shale, brown		2½
		Coal		10
		Shale, brown, carbonaceous		1±
47	Sec. 14, SE. ¼	Sandstone, yellowish gray	25–40	
		Shale, brown, carbonaceous		4
		Coal, good		10
		Bone, with coal streaks		4
48	Sec. 14, SE. ¼	Shale, brown, carbonaceous		3
		Coal		3
		Ash		1
		Coal		8
		Shale, brown, carbonaceous, hard		4
49	Sec. 13, SE. ¼	Coal		9
50	Sec. 32, SE. ¼	Coal		8
		Shale, drab and brown	1	3
		Coal		7





SECTIONS

LEGEND

QUATERNARY — Alluvium

TERTIARY — Eocene — Fort Union formation with Lebo shale member at base

TERTIARY(?) — Eocene ? — Lance formation

CRETACEOUS — Upper Cretaceous — Bearpaw shale

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed concealed at outcrop

× Prospect

Strike and dip

○ Land corner found

□ Private land corner

Scale 1/62,500 — 0 — 1 — 2 MILES

Names and symbols of coal beds and numbers of coal sections

Local	43-50
Kuchta (Mc)	25-42
Buckey (N)	20-24
DeBore (Na)	14-19
McCleary (Ob)	12-13
Carpenter (Oc)	6-11
Spendiff (Od)	1- 5

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 9 N., R. 29 E., MONTANA

Developments.—Possibly as much as 200 tons of coal had been mined from the Carpenter bed in the NW. ¼ sec. 15 (No. 9, Pl. XXX) of this township prior to 1914—the greater part of it at about the time the Chicago, Milwaukee & St. Paul Railway was being constructed (1906 and 1907). A few tons of coal have been removed from the same bed in the small prospect slope in the NW. ¼ sec. 13 (No. 11, Pl. XXX) on the south side of the river. In addition possibly a few tons of coal may have been removed from surface prospects in different parts of the township by ranchers and others for domestic use.

It is reported that a shaft was sunk to the Carpenter bed in the NE. ¼ sec. 15 on the north side of the river by a local company under lease from the Northern Pacific Railway Co. to mine the coal under sec. 15. Grading operations were in progress in June, 1914. It is quite probable the mining of the underlying coal beds near the river will be handicapped by water seeping into the mine workings from the river. The presence of an artesian basin in the vicinity of Musselshell will possibly prove an additional handicap.

The Kuchta, Buckey, and De Bore coal beds are best exposed along Hawk Creek south of Musselshell and will probably be first developed in this locality. As these beds are comparatively thin in this township it is doubtful if they will be mined on a commercial scale until the thicker beds, such as the Carpenter, McCleary, Roundup, Mammoth, and other important beds of the field, are fairly well mined out. These thinner beds will probably continue to furnish a considerable supply of fuel for local domestic use.

The valley of Hawk Creek and the rather broad coulee in the eastern part of the township joining Musselshell River from the south will prove excellent sites for shaft mines for the removal of coal from the Carpenter and McCleary beds. The Carpenter and McCleary coal beds can be most advantageously mined in that part of the township where the strata are flat. Only a comparatively narrow strip along the outcrop of these beds in secs. 7, 8, 9, 13, 14, 15, 16, 17, and 18 is included with the belt of steeply dipping strata, and throughout the southern half of the township they lie nearly horizontal. Timber and water for use in mining are plentiful in this township.

T. 5 N., R. 30 E.

GEOGRAPHY.

T. 5 N., R. 30 E., lies in the southeast corner of the Bull Mountain coal field and, with the west half of T. 5 N., R. 31 E., contains the southeastward terminations of three of the long steep-sided flat-topped ridges which radiate from the plateau region in the central part of the field. The southern slopes of these ridges are very

steep, in places vertical, but the northern slopes are comparatively gentle. The broad smooth valleys of Mill and Hibbard creeks cross the township from northwest to southeast and contrast markedly with the intervening ridges. Castle Butte, at the end of one of these ridges in sec. 34, is a prominent landmark. The erosion of the Lebo shale in the southern part of the township has given rise locally to badlands topography.

At the time of survey there were no ranches in the township, but it is reported that several homesteaders have recently located along Hibbard Creek. Secondary roads and the character of the topography render all parts of the township accessible. In 1909 the township was used entirely for grazing, but undoubtedly the valley bottoms and uplands are adapted to dry farming. The more broken parts of the township are clothed with a scanty growth of small pine and cedar.

McCormick Springs on Hibbard Creek in sec. 20 is the most important source of water in the township. On Mill Creek in sec. 11 there is a small seep. It is probable that comparatively shallow wells would reach water in the valley of Hibbard Creek.

GEOLOGY.

The lowest rocks outcropping in the township are the yellowish gray sandstones and intercalated beds of shale of the Lance formation. Overlying these are the yellow, brown, olive-green, and dark shale and thin-bedded sandstone of the Lebo shale member of the Fort Union formation. The thickness of the Lebo is about 200 feet. Above this is the upper coal-bearing portion of the Fort Union, which outcrops over the greater part of the township and consists of alternating beds of sandstone, clay shale, shale, and coal. The buff to yellowish-gray sandstone is predominant and forms the almost vertical scarps or rims of the valleys. These beds of sandstone are irregular in thickness and locally end abruptly by merging into grayish thin-bedded sandstones with intercalated beds of clay shale and shale. The stratigraphic section (L, in Pl. VI) was measured on the north side of Hibbard Creek in this township, where the thickness of the upper part of the Fort Union is 440 feet. Comparison of this section with sections measured near Musselshell (Pl. VI, p. 34) shows that this part of the Fort Union is 300 feet thinner here than on Musselshell River. The strata in this township dip very slightly north and northwest.

COAL.

Stratigraphic relations.—All the coal beds of economic importance in this township, as in other parts of the Bull Mountain coal field, lie within the upper part of the Fort Union formation.

The Big Dirty coal bed, which lies near the middle of the Lebo shale, consists mainly of dark thin-bedded carbonaceous sandstone, which weathers light gray, and of layers of fairly good coal 2 to 12 inches thick. The bed ranges in thickness in the whole field from 5 to 20 feet. Under present mining conditions it has no economic value and has not been mapped.

In the upper part of the Fort Union five coal beds have been studied and mapped. (See Pl. XXXI.) Their stratigraphic relations and the number of sections measured on each bed are shown in the following table:

Stratigraphic relations of coal beds in T. 5 N., R. 30 E., and the numbers of the sections measured on each.

Top.	
Local coal bed, Nos. 41 and 42.	
Interval not determined.	
Buckey (N) coal bed, Nos. 31 to 40, inclusive.	
Interval	130
McCleary (Ob) coal bed, Nos. 11 to 30, inclusive.	
Interval	50
Carpenter (Oc) coal bed, No. 10.	
Interval	195
Perry (Oe) coal bed, Nos. 1 to 9, inclusive.	
Interval to top of Lebo shale member	20

The character of the coal as inferred from its physical similarity to coal which has been analyzed from other parts of the field is high-grade subbituminous. (See pp. 48–59.) No sample for analysis was obtained in this township.

The Perry (Oe) coal bed.—The lowest coal bed of the upper part of the Fort Union is the Perry, which outcrops about 20 feet above the top of the Lebo shale member of the Fort Union formation. The outcrop of this coal bed extends northwestward for about 4 miles from the SE. ¼ sec. 25 to the vicinity of McCormick Springs, where it crosses Hibbard Creek, and thence extends southeast along the south side of the valley. The bed exceeds 1 foot 2 inches in thickness along the course above described to a point within a mile of Castle Butte, in the SE. ¼ sec. 34, except in secs. 25 and 28, where for short distances it falls below that thickness. South and west of the NW. ¼ sec. 34 this coal bed is practically worthless. In its best development in this township it ranges from 1 foot 3 inches to 1 foot 9 inches and averages 1 foot 4 inches in thickness. The Perry coal is valuable principally for local use. The variations in thickness are shown by the graphic sections in Pl. XXXI and by the following table.

Coal sections on the Perry (Oe) coal bed in T. 5 N., R 30 E.

[See also Pl. XXXI.]

No. on map, Pl. XXXI.	Location.	Section.			No. on map, Pl. XXXI.	Location.	Section.	
			Ft.	*in.*				*Ft.*	*in.*
3.....	Sec. 28, SE. ¼....	Coal.....	1	1	9.....	Sec. 25, SE. ¼...	Sandstone, gray, massive...	4–6	
4.....	Sec. 28, SE. ¼....	Coal.....	1	1			Shale, brown....	1	6
5.....	Sec. 28, SE. ¼....	Coal.....	1	3			Sandstone, gray, thin-bedded.	1	6
8.....	Sec. 23, SE. ¼....	Sandstone, gray, massive....	3–5				Coal.....	1	1½
		Coal.....	1	9			Shale, yellowish brown.....	1	1½

Carpenter (Oc) coal bed.—The Carpenter coal bed, stratigraphically 195 feet above the Perry, was not considered of sufficient importance in this township to warrant its mapping. It outcrops for a short distance in the SE. ¼ sec. 15, where the following section was measured:

Coal section on the Carpenter (Oc) coal bed in the SE. ¼ sec. 15, T. 5 N., R. 30 E. (No. 10).

	Inches.
Shale, brown.....	7
Coal, weathered dull.....	11
Shale, brown.	

McCleary (Ob) coal bed.—The McCleary, the thickest and most important coal bed in the township, is about 50 feet above the Carpenter. Twenty measured sections (Nos. 11–30) show an average thickness of about 2 feet 4 inches. The minimum thickness exposed is less than 1 foot 2 inches and the maximum thickness 4 feet 4 inches. On the ridge between Hibbard and Mill creeks in sec. 14 and in the northern part of sec. 23 the bed is from 3 feet 6 inches to 3 feet 9 inches thick. It is thinner to the northwest, showing less than 1 foot 2 inches on the south side of the ridge in the W. ½ sec. 9 and on the north side in sec. 4. The outcrop was not traced farther northwest. North of Mill Creek, in the SW. ¼ sec. 1, the bed has a total thickness of 4 feet 4 inches of coal, with a 5-inch parting of bone (No. 29, Pl. XXXI). In secs. 2 and 3, however, it is much thinner, and in sec. 2 is cut out for a short distance by sandstone. A selected number of coal sections are shown in Plate XXXI, and the remainder are included in the following table:

Coal sections on the McCleary (Ob) coal bed in T. 5 N., R. 30 E.

[See also Pl. XXXI.]

No. on map, Pl. XXXI.	Location.	Section.	Ft.	in.
15	Sec. 23, NW. ¼...	Shale, brown...		6
		Coal.....	1	0
		Bone.....		4
		Coal, bright...	2	7
		Shale, brown.		
		Total coal..	3	7
20	Sec. 10, SE. ¼.....	Shale, brown...	1	0
		Bone, black....		3
		Coal, bright...	2	1
		Shale, brown.		
21	Sec. 10, NW. ¼...	Shale, brown...	2	6
		Coal, bright...	2	2
		Shale, brown...	3+	
22	Sec. 10, NW. ¼...	Shale, brown and drab.		
		Coal, bony....		3
		Coal, bright, lignitic.....	2	0
		Shale, brown.		
		Total coal..	2	3
24	Sec. 4, SE. ¼.....	Shale and bone, carbonaceous.....	3	0
25	Sec. 3, NW. ¼....	Shale and bone, carbonaceous.....	3	0
26	Sec. 3, NE. ¼....	Sandstone, buff, massive, cutting out upper part of coal bed..	15±	
		Coal, impure..	1	8
30	Sec. 1, SW. ¼....	Coal.....		9
		Bone, hard...		5
		Coal, impure.		10
		Coal, good....	2	5
		Total coal..	4	0

De Bore (Na) coal bed.—The De Bore coal bed, which in adjoining townships occupies a position stratigraphically about 100 feet above the McCleary, was not found in the township.

Buckey (N) coal bed.—The Buckey coal bed, probably the most persistent of all the beds of the lower group in the Bull Mountain area, is stratigraphically about 130 feet above the McCleary. It outcrops on both sides of the divide, between Hibbard and Mill creeks in secs. 4, 5, 9, 10, and 15, but in sec. 9 and part of sec. 4, on the north side of the divide, it has a thickness of less than 1 foot 2 inches and is in large part covered by grass. The maximum thickness measured is 1 foot 6 inches (No. 35, sec. 9), and the 10 sections average 1 foot 3½ inches. Four sections of the Buckey bed are shown graphically in Plate XXXI and the remainder with two thin sections measured on a local coal bed in sec. 5, are included in the following tables:

Coal sections on the Buckey (N) coal bed and on a local bed in T. 5 N., R. 30 E.

[See also Pl. XXXI.]

Buckey (N) coal bed.

No. on map, Pl. XXXI.	Location.	Section.	Ft.	in.	No. on map, Pl. XXXI.	Location.	Section.	Ft.	in.
32	Sec. 5, NE. ¼....	Shale, carbonaceous.			36	Sec. 9, SE. ¼.....	Sandstone, gray.	1	0
		Coal, bright....	1	3			Shale, brown and drab.....		6
		Shale, brown.					Coal, bright..	1	5
33	Sec. 5, SE. ¼.....	Sandstone, gray, soft.					Bone.		
		Coal, bright....	1	1	39	Sec. 15, NW. ¼...	Sandstone, gray.		
		Shale, brown.					Coal, good.....	1	3
34	Sec. 9, NW. ¼...	Sandstone, gray.			40	Sec. 4, SE. ¼.....	Sandstone, yellowish gray.		
		Coal, bright....	1	5			Coal.....	1	1
		Bone.							

Local coal bed.

41	Sec. 5, lot 2.....	Shale, brown.			42	Sec. 5, NE. ¼....	Shale, brown.		
		Coal, bright....		4			Coal, bright....		4
		Shale, brown.					Shale, carbonaceous.		

Development.—No coal has been mined in this township except possibly a few tons from surface prospects by ranchers for domestic use. The Perry and Buckey coal beds are generally thin and probably will never be mined on a commercial scale. The McCleary bed is thick enough to be of commercial importance, but on account of its comparatively small area the expense of constructing 20 or more miles of railroad to mine it would probably be prohibitive. However, should a railroad spur be constructed to this general locality, the McCleary bed in this township may interest coal operators. The valleys of Mill and Hibbard creeks are excellent natural routes for railroad spurs that may be constructed from the Northern Pacific Railway 15 to 20 miles to the south. Timber and water for mining are rather scarce.

The roofs of all the coal beds are in most places clays and shales and would require propping. Mining operations will probably not be hindered by underground waters.

T. 6 N., R. 30 E.

GEOGRAPHY.

T. 6 N., R. 30 E., lies on the southern side of the Musselshell-Yellowstone divide. The upland plateau is well preserved in the western part of the township, but in the northern, eastern, and

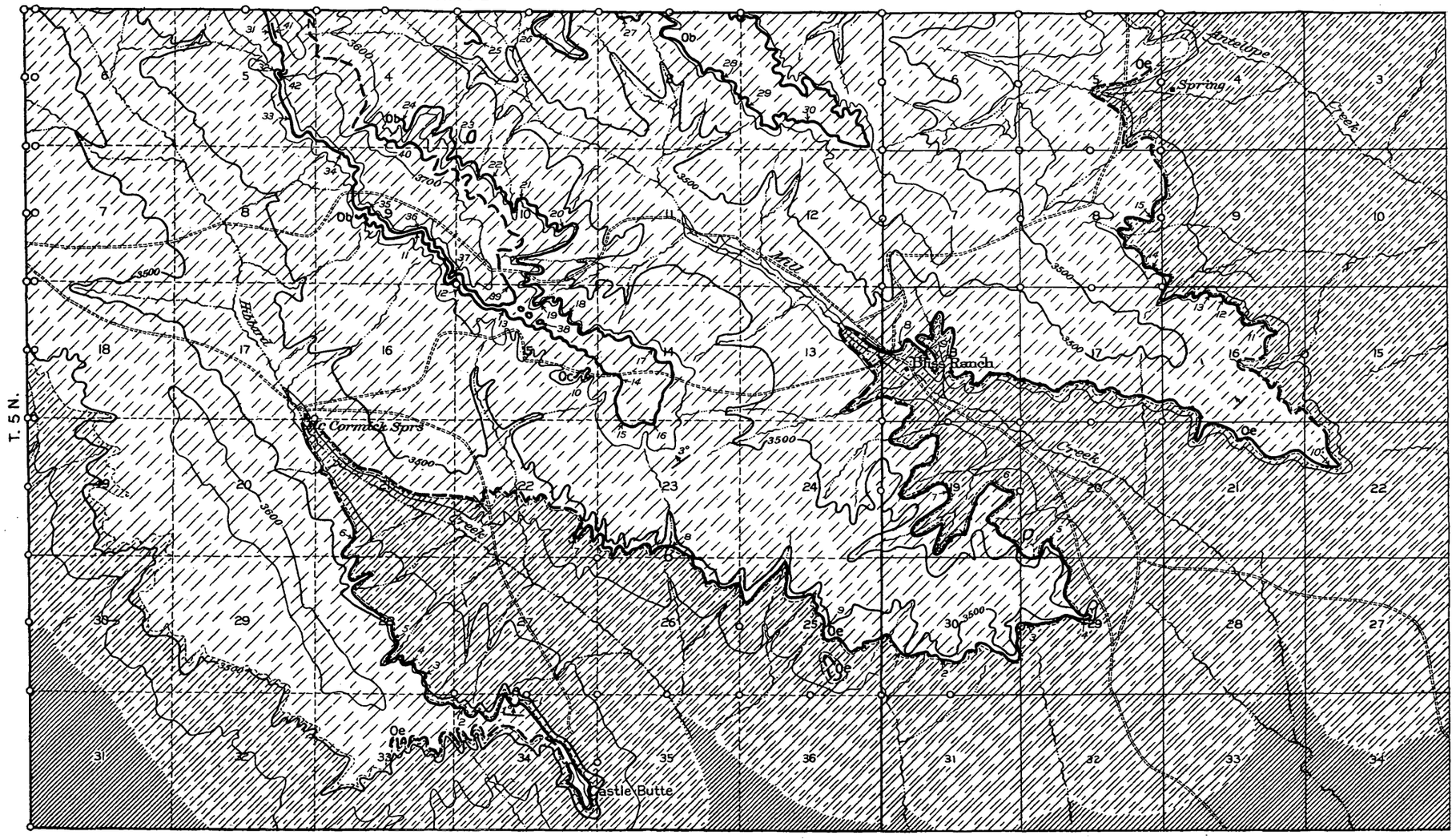
U.S. GEOLOGICAL SURVEY

BULLETIN 647 PLATE XXXI

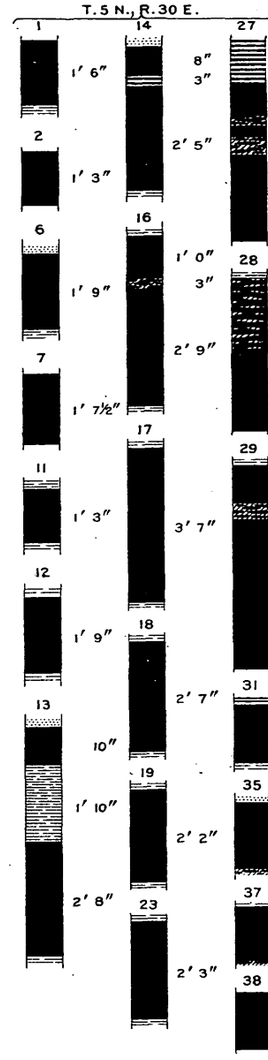
R.30 E.

R.31 E.

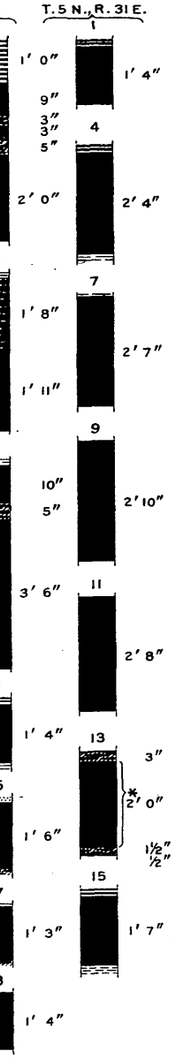
T. 5 N.



T. 5 N., R. 30 E.



T. 5 N., R. 31 E.



LEGEND

Clay
Sandstone
Coal
Bony coal
Bone
Carbonaceous shale
Shale

SECTIONS

Names and symbols of coal beds and numbers of coal sections

	T. 5 N., R. 30 E.	R. 31 E.
Local	41-42	
Buckey (N)	31-40	
McCleary (Ob)	11-30	
Carpenter (Oc)	10	
Perry (Oe)	1-9	1-15

* Sampled for analysis

LEGEND

TERTIARY — Eocene — Fort Union formation with Lebo shale member at base

TERTIARY(?) — Eocene ? — Lance formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500

1 0 1 2 MILES

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 5 N., R. 30 E., AND WESTERN PART OF T. 5 N., R. 31 E., MONTANA

southern parts it has been almost entirely destroyed by stream erosion, the area being now occupied by the broad smooth valleys of Antelope and Buffalo creeks. The heads of these valleys are steep-sided gulches, bordered by rugged rim rocks.

No first-class roads cross the township, but secondary roads and the character of the topography make all parts easily accessible. The only ranch within the township in 1909 was situated on Buffalo Creek in sec. 2. The township was at that time utilized wholly for grazing, furnishing excellent range throughout the year. The uplands are sparsely clothed with small pines and cedars. Practically all the permanent water in the township is along Buffalo Creek, where there are a number of seep springs. The greater part of the valley of Buffalo Creek and the uplands are suitable for dry farming.

GEOLOGY.

The rocks that outcrop in this township belong to the upper or coal-bearing portion of the Fort Union formation. They consist of sandstone, clay, shale, and coal beds, of which the massive buff to yellowish-gray sandstone is predominant and forms the prominent rim rocks of the valley walls. The massive sandstone beds, however, are not regular in thickness and are represented locally by grayish thin-bedded sandstone with intercalated clay and shale.

The strata are practically level but locally dip 1° to 5° slightly east of north.

COAL.

Stratigraphic relations.—The coal beds of T. 6 N., R. 30 E., are practically confined to the southeastern third of the township, where only two beds, the McCleary and Buckey, have a thickness greater than 1 foot 2 inches. (See Pl. XXXII.) Isolated outcrops were observed in other parts of the township, but on account of the thinness of the coal beds no attempt was made to trace them.

The coal in the McCleary and the Buckey beds is of practically the same grade—fair subbituminous. No sample for chemical analysis was obtained, but the character of the coal can be inferred from the analyses of coal from adjoining townships. A sample from the McCleary bed (laboratory No. 8578) was taken on Alkali Creek, in sec. 32, T. 8 N., R. 31 E., about 8 miles north and slightly east of this township, and a sample from the Buckey coal (laboratory No. 8464) was taken in sec. 36, T. 9 N., R. 30 E., about 13 miles to the north. (See pp. 51–53.)

McCleary (Ob) coal bed.—The lowest coal bed in the township, the McCleary, outcrops on both sides of the divide between Antelope Creek on the north and Mill Creek on the south, at elevations ranging from about 3,400 feet on Antelope Creek to nearly 3,600 feet on the south side of the township in sec. 35. It also outcrops on the

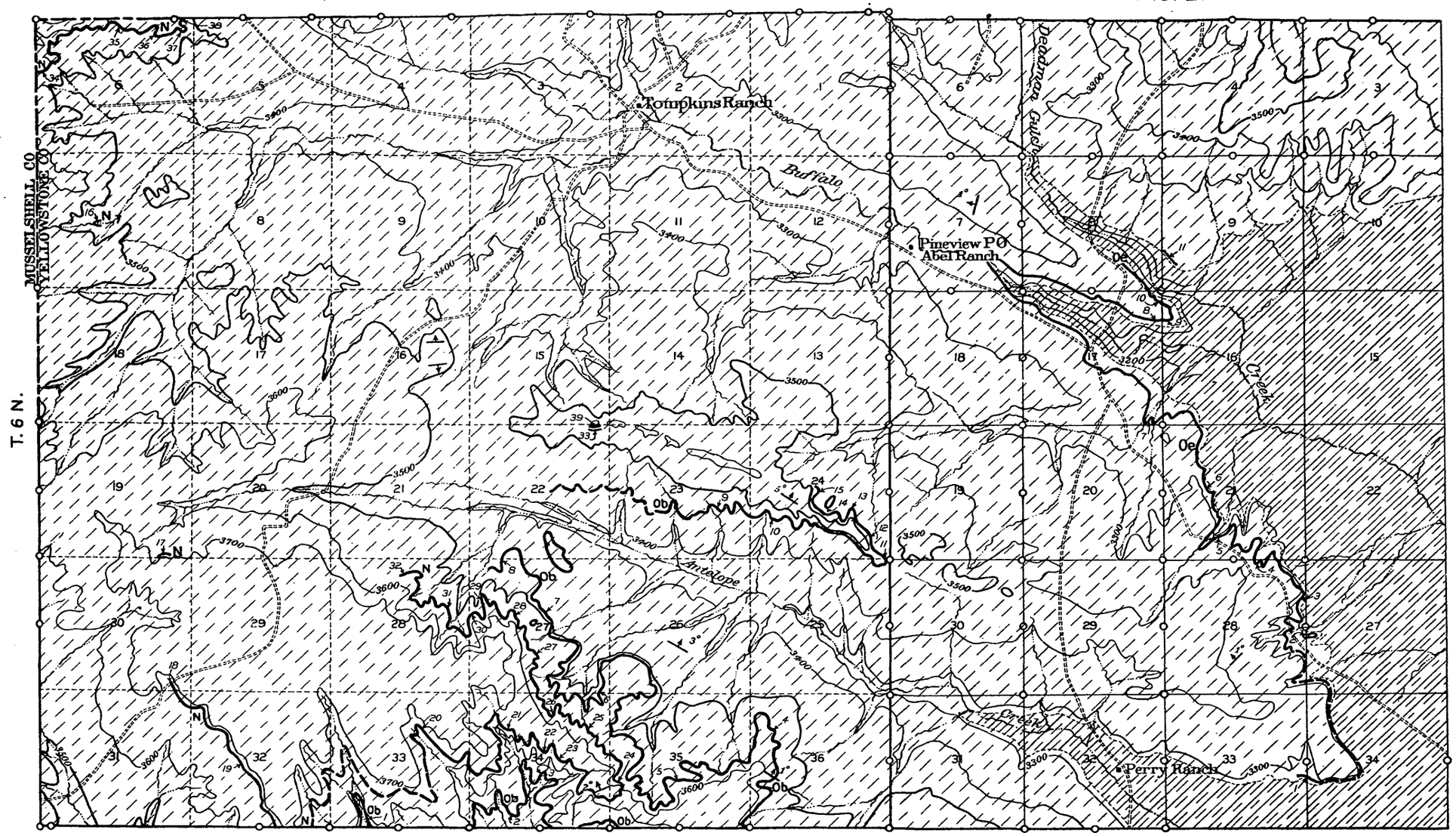
north side of Antelope Creek in secs. 22, 23, 24, and 25. These outcrops have not been connected with those of the McCleary coal bed in the township to the north on account of the thinness of the coal bed and the presence of grassy slopes that covered all outcrops in the broad valley of Buffalo Creek. There is, however, little doubt of the correlation. Sixteen sections measured in this township show an average thickness of 1 foot 6 inches. The variations are shown by the detailed sections in Plate XXXII and in the following list:

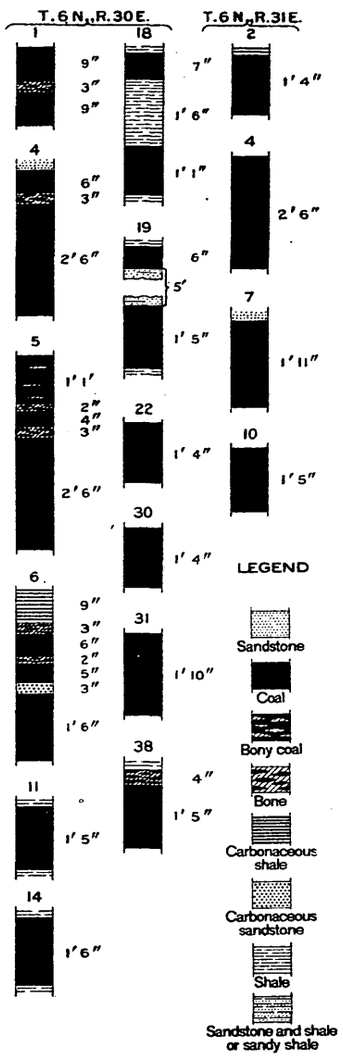
Coal sections on the McCleary (Ob) coal bed in T. 6 N., R. 30 E.

[See also Pl. XXXII.]

No. on map, Pl. XXXII.	Location.	Section.	Ft.	in.
2	Sec. 34, SW. ¼...	Shale, carbonaceous	1	6
		Coal, impure.	1	8
3	Sec. 34, SE. ¼...	Shale, carbonaceous	3	0
		Coal	1	4
7	Sec. 27, NE. ¼...	Shale, brown, carbonaceous.		
		Coal	1	7
8	Sec. 27, NW. ¼..	Coal		10
9	Sec. 23, SE. ¼...	Sandstone, massive.		
		Shale, brown...		2
		Coal	1	3
		Shale, brown.		
10	Sec. 24, SW. ¼...	Sandstone, buff, massive.		
		Sandstone, thin bedded		5
		Shale, brown...		6
		Coal		4
		Interval	14	0
		Shale, brown.		
		Bone		2
		Coal, bright..	1	4
		Shale, brown.		
12	Sec. 24, SE. ¼...	Sandstone, yellowish, soft.		2
		Coal	1	3
		Shale, yellowish brown.		
13	Sec. 24, SE. ¼...	Bone, purplish.		3
		Coal	1	6
		Shale, brown.		
15	Sec. 24, NW. ¼..	Sandstone, yellowish gray.	30±	
		Coal, bright..	1	1
		Shale, brown.		
16	Sec. 7, SW. ¼....	Sandstone, gray, massive.		
		Coal		10

Buckey (N) coal bed.—The Buckey coal bed, which outcrops around the head of Mill Creek and northward toward Antelope Creek, has been mapped in secs. 19, 27, 28, 30, 31, 32, 33, 34, and 35 and also from the township on the north into sec. 6, but has not been traced between these places. The correlation of the beds on the south with those on the north has been made on the basis of the elevation and the character of the coal. A section of a coal bed, without doubt the Buckey, measured in sec. 13, T. 6 N., R. 29 E., resembles those measured in secs. 19 and 30 of this township. The Buckey bed in this township averages about 1 foot 3 inches in thickness, the maximum thickness being 1 foot 10 inches in the NE. ¼ sec. 28 (No. 31). In all, 22 sections were measured, which are presented in detail either graphically in Plate XXXII or in the following list:





LEGEND

TERTIARY

Eocene

Fort Union formation with Lebo shale member at base

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500

1 0 1 2 MILES

Names and symbols of coal beds and numbers of coal sections

Buckey (N)	17-38
McCleary (Ob)	1-16
Perry (Oe)	1-10

SECTIONS

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 6 N., R. 30 E., AND WESTERN PART OF T. 6 N., R. 31 E., MONTANA

Coal sections on the Buckey coal bed (N) in T. 6 N., R. 30 E.

[See also Pl. XXXII.]

No. on map, Pl. XXXII.	Location.	Section.	Ft.	in.
17	Sec. 19, SE. ¼...	Shale, sandy.		
		Coal.....		7
		Shale, brown....	1	0
		Coal.....	1	½
		Shale, brown.		
20	Sec. 33, NE. ¼...	Coal.....	1	2
21	Sec. 34, NW. ¼..	Coal.....	1	2
23	Sec. 34, NE. ¼...	Coal.....	1	3
		Shale, carbonaceous.		
24	Sec. 35, SW. ¼...	Coal.....	1	0
25	Sec. 34, NE. ¼...	Coal.....	1	3
		Shale, carbonaceous.		
26	Sec. 34, NE. ¼...	Coal.....	1	4
		Shale, carbonaceous.		
27	Sec. 27, SW. ¼...	Coal.....	1	2½
28	Sec. 27, NW. ¼..	Sandstone, massive.....	3	0
		Coal.....	1	3
29	Sec. 27, NW. ¼..	Sandstone, massive.....	3	0
		Coal.....	1	3
32	Sec. 28, NE. ¼...	Coal, impure..	1	0
33	Sec. 22, NE. ¼...	Coal.....		4
		Shale.....		4
		Coal.....		8
		Total coal..	1	0
34	Sec. 6, NW. ¼...	Bone.....		4
		Coal.....		9
35	Sec. 6, NE. ¼....	Sandstone, gray, massive.		
		Clay.....		2
		Shale, light brown		4½
		Coal, weathered	1	½
		Bone.....		1½
36	Sec. 6, NE. ¼....	Sandstone, massive.		
		Bone.....		2½
		Coal, bright...	1	½
		Bone.....		1
37	Sec. 6, NE. ¼....	Sandstone.		
		Bone.....		2½
		Coal.....	1	2½
		Shale.		

Kuchta (Mc) coal bed.—The Kuchta coal bed was measured at but one place in this township, in the NE. ¼ sec. 22 (No. 39), where 1 foot of coal is exposed.

Development.—No coal is known to have been mined in this township, but small quantities may have been removed from surface prospects by ranchers for domestic purposes. As the coal beds are irregular in thickness and comparatively thin in most places (maximum 3 feet) it seems very doubtful if they will ever furnish commercial mines. The ranchers of the neighborhood will probably open a few country banks on the thicker beds as the demand for fuel becomes greater by the increase in population and the depletion of the wood supply.

The valley of Buffalo Creek is a natural route for a railroad spur from the Northern Pacific Railway to the outcrops of the higher coal beds in the township to the west. Water and timber for mining are fairly plentiful.

T. 7 N., R. 30 E.

GEOGRAPHY.

The chief topographic feature of T. 7 N., R. 30 E., is a broad upland plateau, which forms the Musselshell-Yellowstone divide and which has been maturely dissected by Hawk and Buffalo creeks and their tributaries. The walls of the valleys are in many places formed by

almost vertical scarps or rim rocks. North of the divide a good spring in the NW. ¼ sec. 17 and a few seep springs along Hawk Creek furnish a meager water supply. South of the divide a good spring flows in Deadman Gulch in the NE. ¼ sec. 24 and a seep spring in the SE. ¼ sec. 32. The uplands are fringed by a scanty growth of pine and cedar.

The De Bore ranch on Hawk Creek near the center of sec. 30 was the only one in the township at the time of examination by the United States Geological Survey. There were a few cabins along Hawk Creek and one at each of the springs on the south side of the divide. Secondary roads and trails make all parts of the township easily accessible. The broad valleys of Hawk and Buffalo creeks and their tributaries and some of the uplands are adapted for dry farming.

GEOLOGY.

All the rocks which outcrop in the township belong to the upper portion of the Fort Union formation. They consist of alternating beds of buff to yellowish-gray sandstone, clay shale, and coal, of which the sandstones are most prominent, forming the steep scarps or rim rocks of the valley walls. The beds are practically level, although slight irregularities were observed.

COAL.

Stratigraphic relations.—Four coal beds—the McCleary (Ob), De Bore (Na), Buckey (N), and Kuchta (Mc)—have been studied in this township. (See Pl. XXXIII.) The three upper beds lie 15 to 32 feet apart in a group about 700 feet above the top of the Lebo shale member of the Fort Union formation. The McCleary bed is less than 100 feet below the upper group in this township and 225 feet below it on the north side of the field, showing a marked decrease in the thickness of the intervening sandstones and shales from north to south.

The coal in these beds is regarded as high-grade subbituminous from its apparent physical similarity to coals which have been sampled for analysis in other parts of the field. No sample was obtained in this township.

McCleary (Ob) coal bed.—The McCleary coal bed outcrops around the head of Deadman Gulch in secs. 13, 14, 23, and 24. In the NW. ¼ sec. 24 (No. 4) it has a thickness of 2 feet 8 inches, but it thins to the west and in the SE. ¼ sec. 23 (No. 2) shows only 7½ inches of coal. The bed was not traced farther. The outcrops in the northwestern part of the township to the east (T. 7 N., R. 31 E.) show that the coal bed probably has a thickness of about 4 feet in the northeast part of the township, and that it gradually decreases to about 1 foot south of a line through the middle of the township from east to west.

Two coal sections on the McCleary bed are shown graphically on Plate XXXIII, and two additional sections are given in the following list, where is included one section on a local coal bed in sec. 23 (No. 5).

Coal sections on the McCleary (Ob) coal bed and on a local coal bed in T. 7 N., R. 30 E.

[See also Pl. XXXIII.]

No on map, Pl. XXXIII.	Location.	Section.	No. on map, Pl. XXXIII.	Location.	Section.
	McCleary (Ob) coal bed.	Ft. in.		**Local coal bed.**	Ft. in.
1	Sec. 25, NW. ¼...	Coal..... 11	5	Sec. 23, NE. ¼....	Limestone, concretionary layers.. 10–15 Sandstone, thin bedded..... 5 0 Clay and shale, drab and gray with coal streak.. 4 0 Coal..... 1 1 Clay, gray, sandy.. 12 0
2	Sec. 23, SE. ¼.....	Sand, yellowish gray....10+ Coal..... 7½ Shale, brown.. 1 0 Sandstone, soft..... 11 0 Sandstone, brown, hard, ledge maker... 2–4			

De Bore (Na) coal bed.—A coal bed 10 to 13 inches thick, probably the De Bore (Na) bed, was found on the divide between Deadman Gulch and Hawk Creek in secs. 13 and 14. The bed was found also on a branch of Hawk Creek in the SW. ¼ sec. 2, where it locally reaches a thickness of 1 foot 5 inches (No. 7). The sections measured on this bed are as follows:

Coal sections on the De Bore (Na) coal bed in T. 7 N., R. 30 E.

No. on map, Pl. XXXIII.	Location.	Section.	No. on map, Pl. XXXIII.	Location.	Section.
		Ft. in.			Ft. in.
6	Sec. 3, NE. ¼.....	Coal..... 10	16	Sec. 27, NW. ¼...	Coal, poor quality... 11
7	Sec. 2, SW. ¼.....	Coal..... 1 5	17	Sec. 22, NE. ¼....	Wash..... 5 0 Sandstone, gray, thin bedded... 2 0 Shale, brown and drab. 2 Coal..... 7½ Shale, drab... 3 0
8	Sec. 2, NE. ¼.....	Coal..... 1 1			
9	Sec. 2, NE. ¼.....	Coal..... 8			
10	Sec. 2, NE. ¼.....	Coal..... 6			
11	Sec. 11, NW. ¼...	Coal..... 6			
12	Sec. 14, NE. ¼....	Coal..... 1 1			
13	Sec. 14, NE. ¼....	Coal..... 10			
14	Sec. 30, SW. ¼....	Coal..... 1 0			
15	Sec. 27, NW. ¼...	Coal..... 10			

Buckey (N) coal bed.—The Buckey (N) coal bed outcrops high on the plateau on both sides of Hawk Creek and around the headwaters of the streams which flow southeast. Throughout the greater part of the township its outcrop is concealed by grassy slopes and in many places the coal is burned. Owing to its position on the uplands the bed is in most places thinly covered for a considerable distance from the outcrop. The bed ranges in thickness from 10 inches to 2 feet 3 inches, its greatest thickness being in the northwestern part of the township in the SW. ¼ sec. 5 (No. 24). Its average thickness in the central part of the township is about 1 foot 6 inches and in the southwest corner about 1 foot. The sections in Plate XXXIII and in the following table show the different thicknesses.

Coal sections on the Buckey (N) coal bed in T. 7 N., R. 30 E.

[See also Pl. XXXIII.]

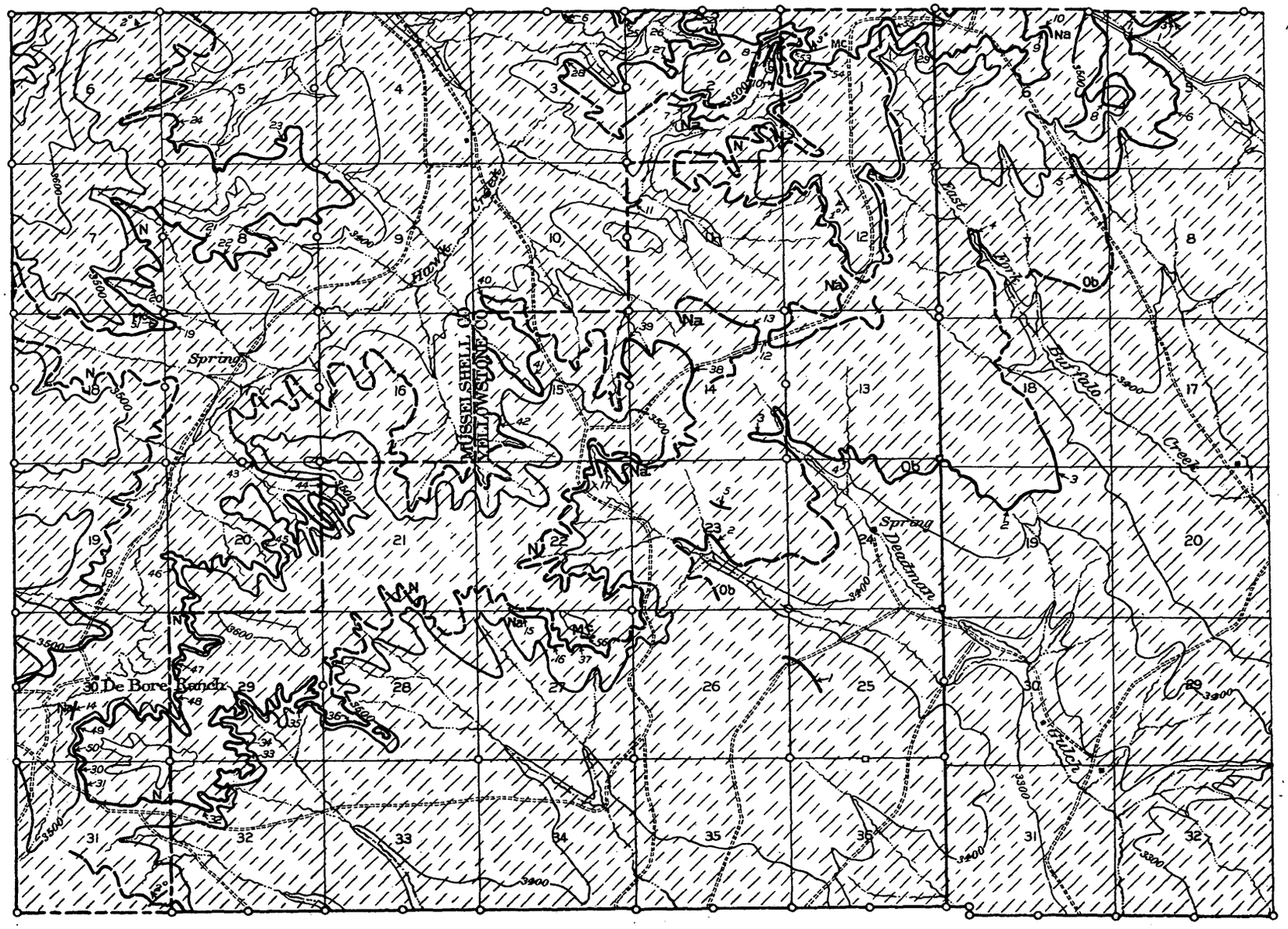
No. on map, Pl. XXXIII.	Location.	Section.	Ft.	in.
20	Sec. 7, SE. ¼	Shale, carbonaceous		6
		Coal	1	10
		Shale.		
21	Sec. 8, SW. ¼	Coal	1	4+
		Shale.		
		Top not exposed.		
22	Sec. 8, SW. ¼	Coal	1	9
		Shale.		
23	Sec. 5, SE. ¼	Coal	1	10
		Shale, brown.		
26	Sec. 2, NW. ¼	Coal	1	0
27	Sec. 2, NW. ¼	Ash, red and yellow		7
		Coal, good, hard		7
28	Sec. 3, NE. ¼	Ash		3
		Coal		10
30	Sec. 31, NW. ¼	Coal, bony		5
		Coal, good	1	8
		Total coal	2	1
34	Sec. 29, SW. ¼	Sandstone, gray.		
		Bone		3
		Coal, black, bright	1	6
		Shale, brownish.		
36	Sec. 28, SW. ¼	Coal, bony		4
		Coal, good	1	6
		Total coal	1	10
39	Sec. 15, NE. ¼	Ash and coal		10
40	Sec. 10, SW. ¼	Sandstone, massive.		
		Ash		4
		Coal		1
		Shale, brown	1	5
42	Sec. 15, SW. ¼	Sandstone, massive.		
		Shale, brown and drab.		
		Bone		8
		Coal	1	10½
43	Sec. 20, NE. ¼	Coal	1	½
		Shale, brown.		
46	Sec. 20, SW. ¼	Coal, bony		3
		Coal, good	1	6
		Total coal	1	9
47	Sec. 29, NW. ¼	Coal, bony		3
		Coal, good	1	7
		Total coal	1	10
50	Sec. 30, SW. ¼	Coal, bony		4
		Coal, good	1	7
		Total coal	1	11

Kuchta (Mc) coal bed.—The Kuchta coal bed underlies only a small area in the northern part of secs. 1 and 2, where its average thickness is 1 foot 10 inches. On the uplands in other parts of the township the bed is present 25 or 30 feet above the Buckey bed but is so thin as to be worthless. The graphic sections in Plate XXXIII and the sections given in the following table include all detailed sections measured in the township.

R.30 E.

R.31 E.

T.7 N.



LEGEND

TERTIARY

Eocene

Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

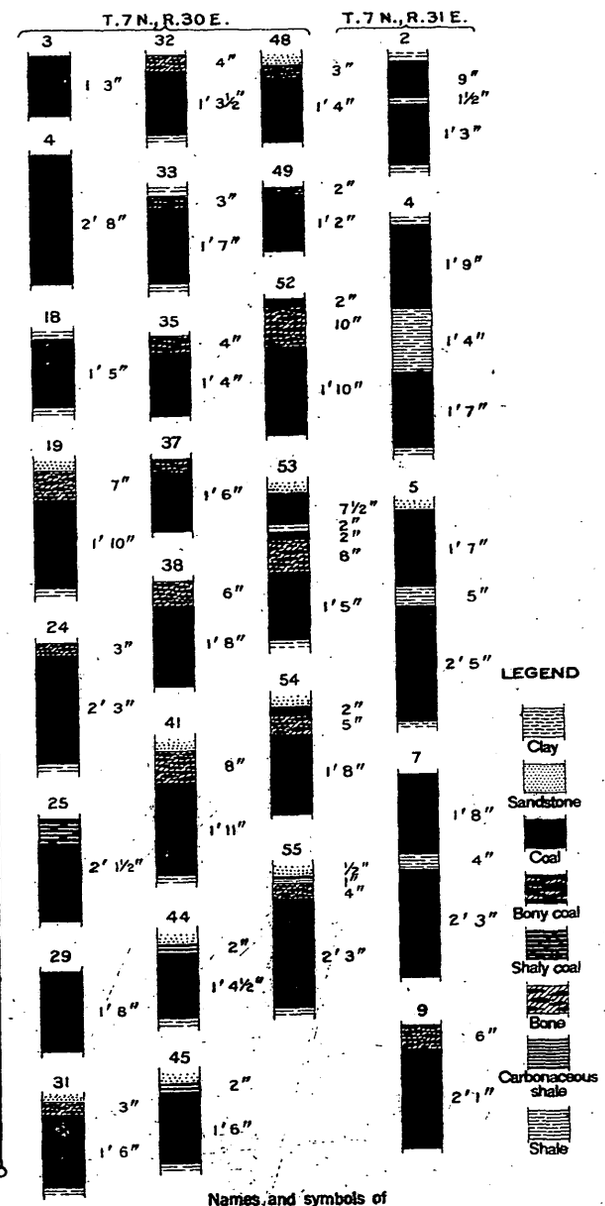
Strike and dip

Land corner found

Private land corner

Scale 1/62,500

1 0 1 2 MILES



Names and symbols of coal beds and numbers of coal sections

T. 7 N., R. 30 E.

Kuchita (Mc)	51-56
Buckey (N)	18-50
DeBore (Na)	6-17
Local	5
McCleary (Ob)	1-4

T. 7 N., R. 31 E.

Buckey (N)	9
DeBore (Na)	10
Local	8
McCleary (Ob)	2-7
Carpenter (Oc)	1

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 7 N., R. 30 E., AND WESTERN PART OF T. 7 N., R. 31 E., MONTANA

SECTIONS

Coal sections on the Kuchta (Mc) coal bed in T. 7 N., R. 30 E.

[See also Pl. XXXIII.]

No. on map, Pl. XXXIII.	Location.	Section.	No. on map, Pl. XXXIII.	Location.	Section.
		Ft. in.			*Ft. in.*
51	Sec. 18, NE. ¼.	Coal, bony..... 1 0	56	Sec. 27, NE. ¼.	Coal..... 6

Development.—No coal is known to have been mined in this township, but a few tons may have been removed from surface prospects by ranchers for domestic use. The valleys of Hawk Creek and Deadman Gulch and their tributaries are natural routes for railroad spurs to any coal mine that may be opened. Owing to the fact, however, that the exposed coal beds are comparatively thin it seems doubtful if the southern part of this township will ever contain commercial mines. In the northwestern part, along Hawk Creek, shaft mines may be opened on the Carpenter or McCleary beds if these should prove of importance in this part of the field. Water and timber for mining uses are fairly plentiful. The upper coal beds (Kuchta, Buckey, and De Bore) will probably be mined from country banks for domestic use.

T. 8 N., R. 30 E.

GEOGRAPHY.

The surface of T. 8 N., R. 30 E., is a broad upland plateau dissected by Hawk and Carpenter creeks and their tributaries. The sides of the valleys are formed in most places by almost vertical scarps or rim rocks. Hawk Creek contains running water along the greater part of its course in this township throughout the year and, together with numerous seep springs along its banks and in the lower course of Coulee Creek and a good spring on Carpenter Creek in lot 10, sec. 1, furnishes the water supply. The uplands are fringed with a scanty growth of small pine and cedar, and the ridge separating Hawk and Coulee creeks bears a few pines large enough to furnish considerable lumber.

Several important ranches are located in the valleys of Hawk and Coulee creeks. The more level portions of the uplands and valley bottoms are adapted for dry farming but had not been cultivated to any extent at the time of examination by the United States Geological Survey. The old stage road between Fort McGinnis and Junction City follows the valleys of Hawk and Coulee creeks across the township and with secondary roads and trails renders the greater part of the township accessible.

GEOLOGY.

All the rocks outcropping in the township belong to the upper portion of the Fort Union formation. They consist of alternating beds of buff to yellowish-gray sandstone, clay shale, and coal, of which the sandstones are most prominent. The strata dip gently but persistently north throughout the greater part of the township.

COAL.

Only two important coal beds, the Buckey and Kuchta, outcrop within the township. (See Pl. XXXIV.) Their stratigraphic position is about 700 feet above the top of the Lebo shale member of the Fort Union formation, and the interval between them ranges from 15 to 32 feet, with an average of 22 feet. The De Bore coal bed, 20 to 30 feet below the Buckey, is exposed at several places in the township but is so thin as to be of little value. The Carpenter and McCleary coal beds, which are 100 to 200 feet lower stratigraphically, in all probability underlie the whole township. It is estimated that the Carpenter bed has a thickness of 4 to 5 feet along the north line of the township but that it decreases markedly to the south and that within 2 or 3 miles south of the township line measures less than 1 foot. The McCleary bed probably has a thickness of 3 to 5 feet under the whole township.

Both the Buckey and Kuchta coal beds outcrop high on the bluffs or scarps along the valleys of Hawk Creek and its tributaries and about the head of Carpenter Creek in the northeast corner of the township. In the southwest corner of the township the outcrops are so concealed by grass that they could be mapped only approximately. Farther north the beds are somewhat lower and are well exposed in the steep valley walls. Throughout the greater part of the township good exposures could be found easily. Owing to a slight trough or syncline, the axis of which runs nearly north about a mile west of the east range line, the Buckey coal bed. disappears beneath the bed of the two branches of Coulee Creek in secs. 14 and 23 and reappears again in the valleys of the same streams on the east side of the syncline in secs. 24 and 36, respectively. Along the main south branch of Coulee Creek the Kuchta bed also lies below the bed of the creek for a short distance in the SW. ¼ sec. 25.

Of the 116 coal sections measured in this township, 56 are on the upper or Kuchta bed, 39 on the Buckey, and 21 on the De Bore. The Kuchta coal bed ranges in thickness from 5 inches to 3 feet 3 inches and averages about 1 foot 8 inches. The lower or Buckey coal bed ranges in thickness from 5 inches to 4 feet 5 inches and averages about 2 feet 2 inches. This coal bed is not so well exposed as the Kuchta on account of the presence of talus and of a sandstone ledge directly below, which hinders undercutting by streams.

Both beds are very persistent. The Kuchta bed is capped by 5 to 7 inches of bone, and the Buckey has a 5-inch parting of bone near its top. The De Bore coal bed has a maximum thickness of only 1 foot 3½ inches. Two sections a few feet apart in the SW. ¼ sec. 27 (Nos. 7 and 8) illustrate the irregularities caused in this bed by the undulating sandstone roof.

The burning of these upper coal beds does not form slag or baked clay above, but simply leaves a layer of unconsolidated pink, red, yellow, and grayish ash, with a streak of coal at the base.

The coals are regarded as high-grade subbituminous from their apparent physical similarity to coals sampled for analysis in other parts of the field. (See pp. 51–53.) No sample was obtained in the township. A number of coal sections showing the variations in thickness on each bed are shown graphically in Plate XXXIV. All the others are included in the following tables.

Coal sections on the De Bore (Na), Buckey (N), and Kuchta (Mc) coal beds in T. 8 N., R. 30 E.

[See also Pl. XXXIV.]

De Bore (Na) coal bed.

No. on map, Pl. XXXIV.	Location.	Section.	Ft.	in.
1	Sec. 29, NW. ¼	Coal		9
2	Sec. 30, SE. ¼	Shale, brown		1
		Coal, bright		11½
		Shale, brown to drab		1
3	Sec. 32, NW. ¼	Shale, brown.		
		Coal		1
		Shale and bone		3
		Coal.		
		Shale.		
4	Sec. 34, SE. ¼	Coal	1	
5	Sec. 34, NW. ¼	Coal	1	1
6	Sec. 27, SE. ¼	Coal	1	
7	Sec. 27, SW. ¼	Coal	1	½
8	Sec. 27, SW. ¼	Sandstone, gray massive		2
		Coal, bright	1	3½
		Sandstone, gray, massive	8	
9	Sec. 28, NW. ¼	Coal	1	1½
10	Sec. 21, SW. ¼	Coal and shale alternating		1½
		Coal, good	1	
11	Sec. 17, SW. ¼	Coal, good	1	1½
12	Sec. 17, SE. ¼	Coal	1	1½
13	Sec. 16, SW. ¼	Coal	1	1½
14	Sec. 16, SE. ¼	Coal	1	1
15	Sec. 22, NE. ¼	Coal	1	1
16	Sec. 15, SE. ¼	Coal	1	
17	Sec. 17, NE. ¼	Coal	1	
18	Sec. 18, NW. ¼	Coal	1	
19	Sec. 18, NW. ¼	Coal		10

Coal sections on the De Bore (Na), Buckey (N), and Kuchta (Mc) coal beds in T. 8 N., R. 30 E.—Continued.

Buckey (N) coal bed.

No. on map, Pl. XXXIV.	Location.	Section.	Ft.	in.
22	Sec. 19, NE. ¼	Sandstone, massive	8	
		Shale, brown and drab.		
		Shale, carbonaceous		3
		Ash, red, yellow		3
		Coal, bright		5
		Shale.		
23	Sec. 19, NE. ¼	Ash, red, yellow		4
24	Sec. 19, NE. ¼	Ash		4
25	Sec. 19, SE. ¼	Ash, brick red		3
		Coal, bright		5
		Shale.		
27	Sec. 19, SE. ¼	Ash		4
28	Sec. 30, SE. ¼	Ash, dark maroon		4
		Coal, bright		4
		Shale, drab.		
30	Sec. 31, NE. ¼	Shale, drab.		
		Bone		7
		Coal	2	2½
		Shale, brown.		
34	Sec. 28, NW. ¼	Coal, much weathered	1	5
35	Sec. 28, NE. ¼	Coal	2	6
36	Sec. 21, SW. ¼	Coal, bony		3
		Coal, excellent	2	7
		Total coal	2	10
37	Sec. 17, SW. ¼	Bone, very carbonaceous		6
		Coal, excellent	2	5
38	Sec. 17, SW. ¼	Shale, light drab.		
		Shale, dark		3
		Bone		3
		Coal, excellent	2	5½
43	Sec. 22, NE. ¼	Coal, weathered	1	1½
44	Sec. 24, NE. ¼	Sandstone, reddish yellow	5+	
		Coal and bone		8
		Coal, excellent	2	8
		Total coal	3	4
45	Sec. 24, NE. ¼	Sandstone, massive	6	
		Shale, white, sandy		3
		Coal, bony		4
		Coal, excellent	2	7
		Total coal	2	11
50	Sec. 17, NE. ¼	Shale, drab, "paper"		2
		Bone, black		4
		Coal, good	2	2
52	Sec. 17, NW. ¼	Shale, "paper"		½
		Bone with coal streaks		5
		Coal, poor at top	2	3
53	Sec. 18, NE. ¼	Bone, drab and black		4
		Coal, good, except at top	2	
		Shale, yellowish.		
54	Sec. 18, NE. ¼	Bone		4
		Coal	1	10
55	Sec. 18, NW. ¼	Bone		5
		Coal, good	2	2
59	Sec. 1	Bone		4
		Coal	1	5

Coal sections on the De Bore (Na), Buckey (N), and Kuchta (Mc) coal beds in T. 8 N., R. 30 E.—Continued.

Kuchta (Mc) coal bed.

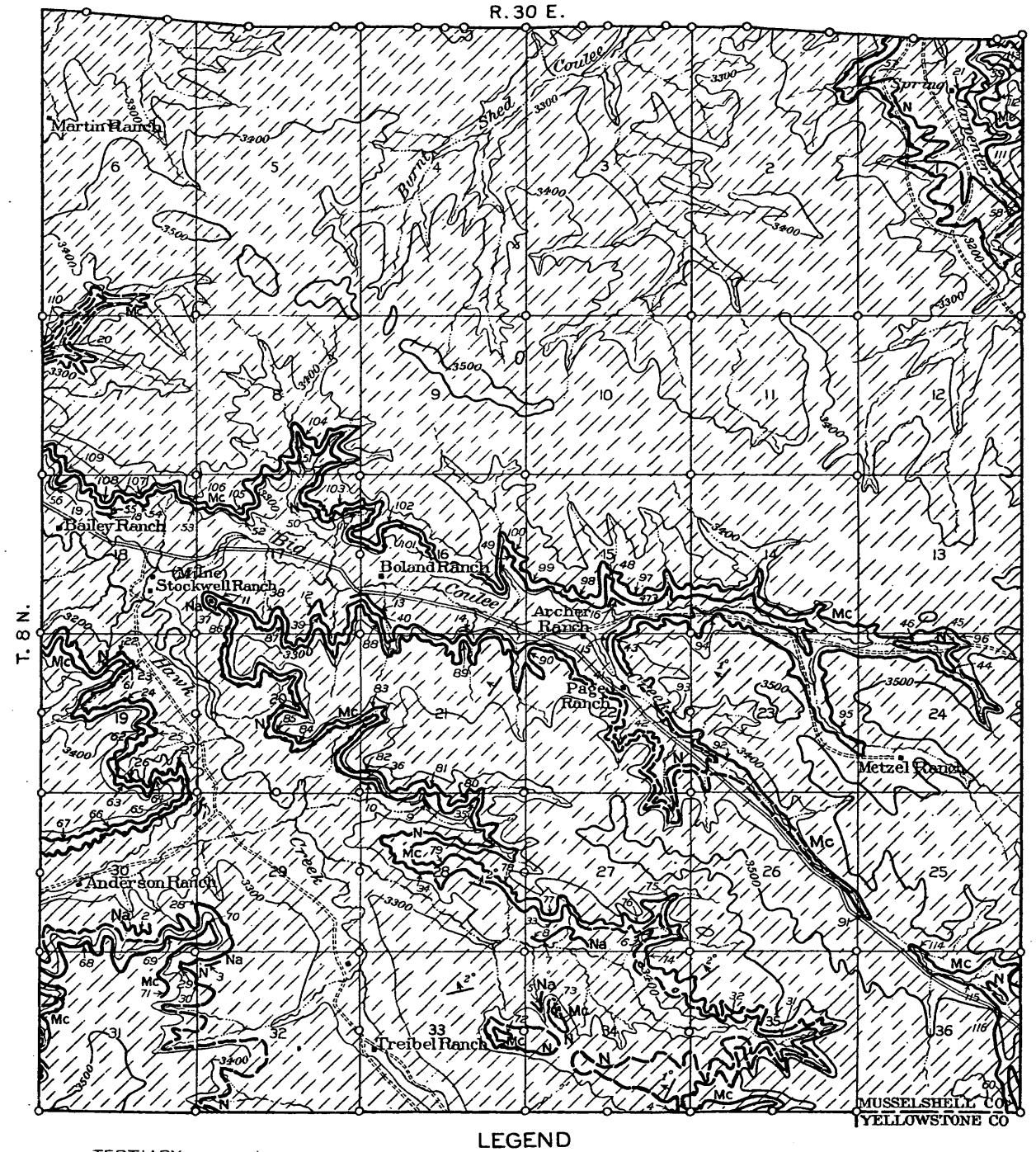
No. on map, Pl. XXXIV.	Location.	Section.	Ft.	in.
65	Sec. 30, NE. ¼	Shale, brown.		
		Bone		7½
		Coal	1	3
67	Sec. 30, NW. ¼	Shale, drab		4
		Shale, brown		1
		Bone, purple		7
		Coal, dull		9
		Shale, brown, with coal streak		2
		Coal		2½
		Shale, brown		
		Total coal		11½
69	Sec. 30, SE. ¼	Sandstone, massive		
		Sandstone and shale, alternating	12–15	
		Shale, brown		1½
		Bone, purple		6
		Coal	1	0
		Shale, brown.		
70	Sec. 29, SW. ¼	Sandstone and shale, alternating		
		Shale, brown		1
		Coal, poor		5
		Shale, brown		1
		Bone, purplish.		
71	Sec. 31, NE. ¼	Shale, brown.		
		Coal		1
		Bone		3
		Coal		9
		Shale.		
74	Sec. 34, NE. ¼	Coal		2
		Bone		7
		Coal	1	3
76	Sec. 27, SE. ¼	Coal		2
		Bone, hard		7
		Coal	1	4
77	Sec. 27, SW. ¼	Coal		5
		Bone		7
		Coal, good	1	6
81	Sec. 21, SW. ¼	Coal		2
		Bone, black, hard		6
		Coal	1	5
83	Sec. 21, NW. ¼	Coal	1	8
84	Sec. 20, SE. ¼	Coal		2
		Bone, light drab, hard		4
		Coal	1	7
85	Sec. 20, SW. ¼	Coal		2
		Bone, light drab, hard		5
		Coal	1	5
86	Sec. 17, SW. ¼	Coal		2
		Bone, very hard		3
		Coal, good	1	6
89	Sec. 21, NE. ¼	Coal, bony		6
		Coal	1	4
		Total coal	1	10
91	Sec. 25, SW. ¼	Coal, bony, weathered		8
		Coal, good	1	6
		Total coal	2	2
		Outcrops 3 feet above Coulee Creek.		
92	Sec. 23, SW. ¼	Bone		7
		Coal, bony near top	2	0

Coal sections on the De Bore (Na), Buckey (N), and Kuchta (Mc) coal beds in T. 8 N., R. 30 E.—Continued.

Kuchta (Mc) coal bed—Continued.

No. on map, Pl. XXXIV.	Location.	Section.	Ft.	in.
95	Sec. 23, SE. ¼	Coal		2
		Shale		2
		Bone, with coal streaks		5
		Coal, somewhat impure	1	8
98	Sec. 15, SW. ¼	Coal, streak.		
		Shale, light		8
		Coal		3
		Bone, hard, massive		4
		Coal, good	2	0
		Clay shale, yellowish drab.		
		Total coal	2	3
99	Sec. 15, SW. ¼	Shale and sandy shale	10±	
		Coal		3
		Bone, hard, drab		4
		Coal, hard, firm	2	0
		Clay, drab.		
		Total coal	2	3
101	Sec. 16, SW. ¼	Bone		7
		Coal	1	10
102	Sec. 16, NW. ¼	Coal		1½
		Bone, hard		8
		Coal, with streaks of bone	1	9
103	Sec. 17, NE. ¼	Coal		2
		Bone, black, hard		7
		Coal, good	2	2
107	Sec. 18, NE. ¼	Sandstone, massive	4±	
		Sandstone, irregular	3	0
		Coal		2½
		Shale, yellowish drab		4
		Coal, with much bone	1	5
109	Sec. 7, SW. ¼	Coal		½
		Bone, hard		5
		Coal	1	5
111	Sec. 1	Coal dust and red ash		3
		Bone, altered by burning		5½
		Coal dust with red ash above		5
113	Sec. 1	Sandstone, massive	2	0
		Shale, light, sandy	3	0
		Coal		7
		Bone		7
		Coal	2	8
		Total coal	3	3
114	Sec. 25, SW. ¼	Gravel	5+	
		Coal, impure		4
		Coal, good, fairly clean	1	8

No coal is known to have been mined in this township, although small quantities may have been removed from surface prospects by ranchers for domestic use. The necessary sites for mines on the upper coal beds are in the heads of the tributaries of Hawk, Coulee, and Carpenter creeks, all of which furnish natural routes for spurs that may be built from the Chicago, Milwaukee & St. Paul Railway, a few miles north of the township. The Carpenter and McCleary coal beds can be mined from shafts approximately 200 feet deep



LEGEND

TERTIARY
Eocene
Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

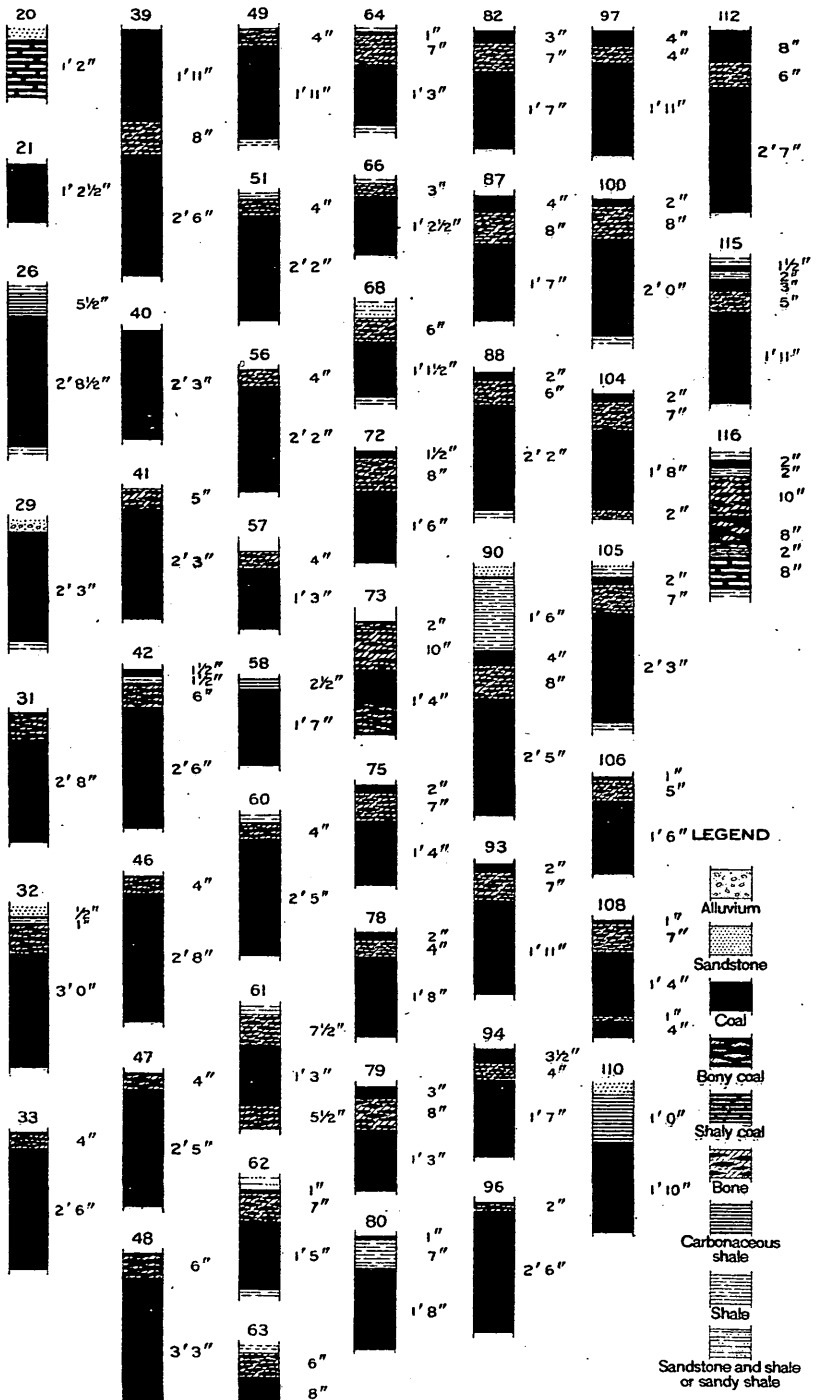
Coal bed burned at outcrop.

Coal bed concealed at outcrop

Strike and dip

Land corner found

Scale 1/62,500
1 0 1 2 MILES



Names and symbols of coal beds and numbers of coal sections

Kuchta (Mc)	61-116
Buckey (N)	22-60
DeBore (Na)	1-21

SECTIONS

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 8 N., R. 30 E., MONTANA

in the main valleys. Water and fuel for mining use are plentiful in parts of this township.

T. 9 N., R. 30 E.

GEOGRAPHY.

T. 9 N., R. 30 E. is in the northeastern part of the Bull Mountain coal field in and south of the valley of Musselshell River. The northern third of the township, which includes the flood plain of the river, is comparatively level. The remainder consists of hilly country except in the fairly smooth valleys of Carpenter Creek and its tributaries. Extensive rims or scarps of sandstone 30 to 70 feet high separate the valleys from the uplands. Near the river the most conspicuous topographic features are the hogbacks formed by the upturned edges of the south-dipping sandstone of the Lance formation. The surface of this township ranges in elevation from 2,900 feet to 3,350 feet above sea level.

The Chicago, Milwaukee & St. Paul Railway crosses the township on the north side of the river, and from it a spur a little over 2 miles in length has recently been constructed to the Carpenter Creek coal mine in sec. 20. Two main wagon roads, one on each side of the Musselshell, and numerous secondary roads and trails make the greater part of the township easily accessible.

Ranches are fairly numerous near the river, whose wide bottom lands have been irrigated to a large extent. Some cabins stand along the creek valleys in the central and southern parts of the township, but only a few of them are occupied. Japan, a little hamlet consisting of Absher post office and a few houses, is on the railroad in secs. 7 and 8. Melstone, a railroad town of about 100 persons, is about 3 miles northeast of the township.

GEOLOGY.

The Bearpaw shale, Lance formation, Lebo shale member of the Fort Union formation, and the upper part of the Fort Union all outcrop in this township. The greater part of the Bearpaw shale is covered by alluvium in the Musselshell Valley and outcrops only in small areas along the south side of the valley, for the most part in secs. 12, 13, 14, 15, and 16. The massive yellow sandstone and shale of the Lance formation outcrop in an irregular area in the north-central part of the township and form a range of rugged hills nearest the river on the south side. The dark shale and thin bedded sandstone of the Lebo shale member of the Fort Union formation outcrop in a narrow strip south of these hills and owing to their lack of resistance to weathering form a valley between the ridges of the more resistant adjacent formations. The important coal beds occur in the upper part of the Fort Union formation,

which outcrops in the southern part of the township, and are included in a stratigraphic distance of approximately 300 feet.

The township lies on the northeast limb of the eastern Bull Mountain syncline and the strata dip southwest toward the axis. In the southern part of the township the dips are slight, but farther north they become steeper and are at a maximum at approximately the outcrop of the Lebo shale, where in sec. 18 angles as high as 35° were observed.

COAL.

Stratigraphic relations.—Six coal beds in the upper part of the Fort Union formation have been studied and mapped in the township. (See Pl. XXXV.) The stratigraphic relations of these beds with one another and with the Big Dirty bed in the Lebo shale member and the numbers of coal sections measured in each bed are shown in the following table:

Stratigraphic relations of coal beds in T. 9 N., R. 30 E., and the numbers of the sections measured on each.

	Feet.
Top of Fort Union formation.	
Kuchta (Mc) coal bed Nos. 40 to 57, inclusive.	
Interval	36
Buckey (N) coal bed, Nos. 20 to 39, inclusive.	
Interval	17
De Bore (Na) coal bed, Nos. 17 to 19, inclusive.	
Interval	165
McCleary (Ob) coal bed, Nos. 10 to 16, inclusive.	
Interval	50
Carpenter (Oc) coal bed, Nos. 5 to 9, inclusive.	
Interval	20
Spendiff (?) (Od) coal bed, Nos. 1 to 4, inclusive.	
Interval	460
Top of Lebo shale member.	
Interval	100±
Big Dirty coal bed.	
Interval to base of the Fort Union formation	100±
Total	980

The Carpenter coal bed is undoubtedly the most valuable in this township. It ranges in thickness from 4 feet 4 inches to 8 feet, and in most places where observed has a very good roof of sandstone. Second in importance is the McCleary coal bed, which ranges in thickness from 3 feet to 4 feet 2 inches but whose roof is not so substantial as that of the Carpenter. The Kuchta coal bed ranks third in value if the average thickness of 1 foot 8 inches and the persistence indicated along its outcrop is a criterion. Twenty sections of the Buckey coal bed show 7 inches to 2 feet 7 inches and average 1 foot 4 inches. The De Bore and Spendiff (?) coal beds are of about equal importance. The Big Dirty coal bed is of no economic value at present. The coal in all the beds belongs to the subbituminous class and where un-

weathered has a calorific value of approximately 12,000 British thermal units. A complete description of the physical and chemical characters is given on pages 48–59. Five samples, the analyses of which are given on pages 51–53, were obtained in this township.

Big Dirty coal bed.—The Big Dirty coal bed probably attains its maximum thickness for the Bull Mountain field in this township. In sec. 18 this bed consists of 27 feet of carbonaceous sandstone broken by a 1 foot 6 inch bed of yellowish sandstone 12 feet from the bottom. The bed also was measured in sec. 22, where only 11 feet of carbonaceous sandstone and thin coal beds are exposed. This, however, probably represents only the lower bench. The bed contains so much sandy material that it is in most places more resistant than the overlying and underlying strata, thus forming a ledge at the outcrop where the beds are flat and a small low rounded hog-back where they are tilted. The bed is considered to be of no economic value and was not mapped in this township.

Spendiff (Od) coal bed.—The Spendiff coal bed is about 460 feet stratigraphically above the top of the Lebo shale. It is apparently of little value at the outcrop and is exposed at only four localities (Nos. 1–4 on Pl. XXXV). The maximum thickness of coal, 1 foot 9½ inches, was found in sec. 16 (No. 2).

Carpenter (Oc) coal bed.—The Carpenter bed, about 20 feet above the Spendiff, is exposed in the western part of the township in sec. 18 (No. 5), where 4 feet 4 inches of good coal broken by a 5-inch bone parting has been uncovered in a prospect just north of the main road. The dip in this locality is approximately 35° S. The outcrop of this coal bed is covered almost completely in the western two-thirds of the township. In sec. 17 (No. 6) Walter Robbins opened a prospect in which 5 feet 3 inches of good coal is exposed. This is probably only the upper bench of this coal bed, because one-quarter of a mile southwest, in the Carpenter Creek Coal Co's. shaft in the NE. ¼ NE. ¼ sec. 20 (No. 7), it is reported to consist of 8 feet of coal, broken by a 2-inch shale parting 2 feet from the bottom. An air-dried sample of the somewhat weathered coal from the Robbins prospect (laboratory No. 7197) yielded 10,250 British thermal units; fresh coal would probably make a much better showing. The bed is well exposed in W. C. Grant's prospect in sec. 26 (No. 9), where the strata dip approximately 3° S. A weathered sample for analysis taken from this prospect yielded 8,900 British thermal units (laboratory No. 8466). In the NW. ¼ sec. 26 (No. 8) 1 foot of ash and coal is exposed.

It was not possible to obtain other coal sections of this bed in this township without a good deal of labor, but from sections in the township to the east it is evident that the bed thins rapidly in that direction. The coal sections at locations 5, 6, 7, and 9 are shown in Plate XXXV.

McCleary (Ob) coal bed.—The McCleary coal bed, 50 feet above the Carpenter, thickens rapidly from west to east. The westernmost exposure in the township is in sec. 21 (No. 10) where the bed is 3 feet thick, but exposures in the adjoining township to the west indicate that the bed thins to as little as 1 foot 3 inches in sec. 18. Further exposures along the outcrop show that the bed thickens to as much as 4 feet 2 inches in sec. 25 (No. 15) and to a still greater thickness in the township to the east. A weathered sample for chemical analysis obtained in the McCleary and Oker prospect in sec. 26 (No. 14), where the bed is 3 feet 7 inches thick, shows a heating value of 8,880 British thermal units (laboratory No. 8465), which is probably 3,000 units less than a fresh sample would show. All the complete sections (Nos. 10, 12, 14, and 15) on this bed are shown graphically in Plate XXXV. The data obtained at locations 11, 13, and 16 are as follows:

Coal sections on the McCleary (Ob) coal bed in T. 9 N., R. 30 E.

[See also Pl. XXXV.]

No. on map, Pl. XXXV.	Location.	Section.	No. on map, Pl. XXXV.	Location.	Section.
		Ft. in.			*Ft. in.*
11	Sec. 27, NW.¼.	Coal..... 1+	16	Sec. 25, SE.¼...	Ash.
		Base not exposed.			Coal..... 5
13	Sec. 26, NW.¼.	Ash.			
		Coal..... 6			

De Bore (Na) coal bed.—The De Bore coal bed is of very little importance at the outcrop in this township and is mapped only in secs. 26, 35, and 36 (Nos. 17, 18, and 19). The average of the three sections measured is 1 foot 3 inches.

Coal sections on the De Bore (Na) coal bed in T. 9 N., R. 30 E.

No. on map, Pl. XXXV.	Location.	Section.	No. on map, Pl. XXXV.	Location.	Section.
		Ft. in.			*Ft. in.*
17	Sec. 28, NW.¼..	Ash, white, brownish and red..... 4	18	Sec. 36, SW.¼..	Shale, brown.
					Coal 1 2
		Coal, weathered 4	19	Sec. 35, NE.¼...	Coal 11

Buckey (N) coal bed.—The Buckey coal bed is about 180 feet above the McCleary. It is of little value along the outcrop through secs. 18, 19, 20, and 21 to a place in sec. 21 (No. 21), where the section shows 1 foot 4 inches of good coal. Southward from this place the bed gradually thickens, as shown by an exposure measured in sec. 29 (No. 24), where it is 2 feet 1 inch thick. Eastward, the coal bed continues to thicken to a point in the NE. ¼ sec. 28

(No. 26), where it attains its known maximum thickness (2 feet 7 inches) in the township. Southeastward, along the outcrop through secs. 28, 27, 33, and 34 the bed thins and at a point in the NW. ¼ sec. 34 (No. 31) only 1 foot 1½ inches of coal is present. For perhaps one-half mile through the northern part of sec. 34 this condition prevails. A section measured in the SE. ¼ sec. 34 (No. 32) shows 1 foot 4 inches of coal. In secs. 26, 35, and 36 the bed ranges from 1 foot 2 inches to 1 foot 6 inches. Near the center of sec. 26 there is an outlier, but its outcrop is completely burned and no good section of it is obtainable. Signs of burning were also observed in the northeastern part of sec. 36. Analysis of a sample collected at the outcrop in the NW. ¼ sec. 36 (No. 35) is shown on page 53 (laboratory No. 8464). The graphic sections in Plate XXXV and the sections given in the following table include all sections measured in the township.

Coal sections on the Buckey (N) coal bed in T. 9 N., R. 30 E.

[See also Pl. XXXV.]

No. on map, Pl. XXXV.	Location.	Section.	Ft.	in.
20	Sec. 21, SW. ¼	Coal		7
22	Sec. 20, SE. ¼	Coal	1	3
23	Sec. 28, NW. ¼	Sandstone.		
		Bone and shale		4
		Coal	1	5
		Shale, dark.		
25	Sec. 28, NW. ¼	Bone		10
		Coal, much weathered	1	6
28	Sec. 28, SE. ¼	Sandstone, massive	6+	
		Shale, sandy, light		3
		Shale, dark, carbonaceous		5
		Coal, good	1	4
		Shale, dark.		
29	Sec. 28, SE. ¼	Ash		3
		Coal, weathered	1	1
30	Sec. 33, NE. ¼	Shale, carbonaceous.		
		Bone		4
		Coal	1	4
		Clay, drab.		
31	Sec. 34, NW. ¼	Shale, light.		
		Bone		1
		Coal	1	1½
33	Sec. 36, SW. ¼	Coal	1	3
34	Sec 36, SE. ¼	Sandstone, massive	10–15	
		Shale, brown		3
		Coal	1	2
35	Sec. 36, NW. ¼ (Laboratory No. 8464)	Sandstone, massive	15–20	
		Shale, drab		½
		Coal	1	2
		Shale, brown.		
38	Sec. 26, SE. ¼	Bone		½
		Coal	1	3
39	Sec. 36, NE. ¼	Ash		1

Kuchta (Mc) coal bed.—Because of its thinness the Kuchta coal bed was not mapped continuously in section 18. In section 20, six coal sections range in thickness from 1 foot 2 inches to 2 feet and average 1 foot 5 inches. Through secs. 20, 21, 28, and 29 the thickness of the bed gradually increases southward to the SE. ¼ sec. 29 (No. 52), where 2 feet 10 inches of coal was observed. In sections 28, 33, 34, and 36 the coal has been burned at the outcrop and exposures are scarce, but it seems quite probable that its thickness ranges from 2 to 3 feet in localities where the burning is pronounced. Analysis of a somewhat weathered sample collected from the Kuchta bed in the Kuchta prospect in section 28 (No. 53) is shown on page 53 (laboratory No. 8467). The graphic sections in Plate XXXV and the sections given in the following table include all sections measured in this township.

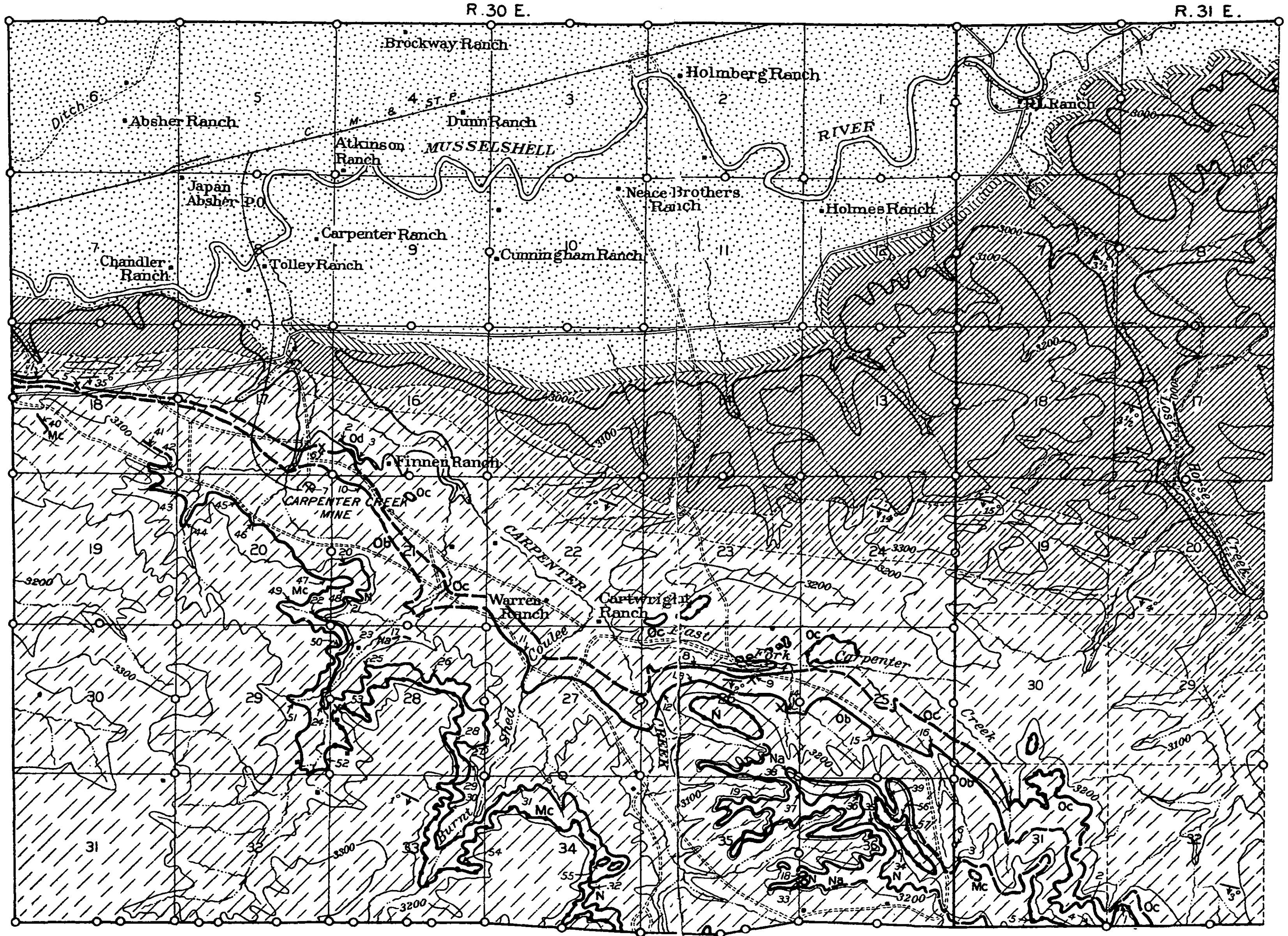
Coal sections on the Kuchta (Mc) coal bed in T. 9 N., R. 30 E.

[See also Pl. XXXV.]

No. on map, Pl. XXXV.	Location.	Section.	Ft.	in.
40	Sec. 18, SW. ¼...	Coal.....		4
41	Sec. 18, SE. ¼....	Coal.....		8
43	Sec. 20, NW. ¼..	Sandstone, light.....		3
		Coal, bony...	1	2½
		Clay, brown.		
44	Sec. 20, NW. ¼..	Sandstone, light brown	10	0
		Coal.....	1	5
		Shale, light brown.....	3	0
45	Sec. 20, NW. ¼..	Bone.....		3
		Coal.....	1	4
48	Sec. 21, SW. ¼...	Coal, weathered	1	2
54	Sec. 33, SE. ¼....	Ash.....		3
		Coal.....	1	0
55	Sec. 34, SE. ¼....	Coal.....		10
		Ash.....		2½
56	Sec. 36, NE. ¼...	Coal.....	1	2+
		Top and bottom not exposed.		
57	Sec. 36, NE. ¼...	Ash.....		4

Development.—At the time of field examination the coal beds of this township were practically undeveloped. A small quantity of coal has been removed for ranch use from several small prospects.

The only mine in the township, formerly owned by the Carpenter Creek Coal Co. but now reported to be held by the Republic Coal Co., is in section 20 (No. 7). The mining equipment is modern and the coal is brought to the surface through a shaft 138 feet deep, which cuts two coal beds of importance (the Carpenter and McCleary). The uppermost or the McCleary coal bed, 83 feet from the surface, is reported to be 2 feet 10 inches thick, and the Carpenter coal bed, 55 feet lower down, to be 8 feet thick. During the winter months 600 to 700 tons of coal are mined here daily, but during the summer its output is small.



LEGEND

QUATERNARY — Alluvium

TERTIARY — *Eocene* — Fort Union formation with Lebo shale member at base

TERTIARY(?) — *Eocene ?* — Lance formation

CRETACEOUS — *Upper Cretaceous* — Bearpaw shale

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

Mine

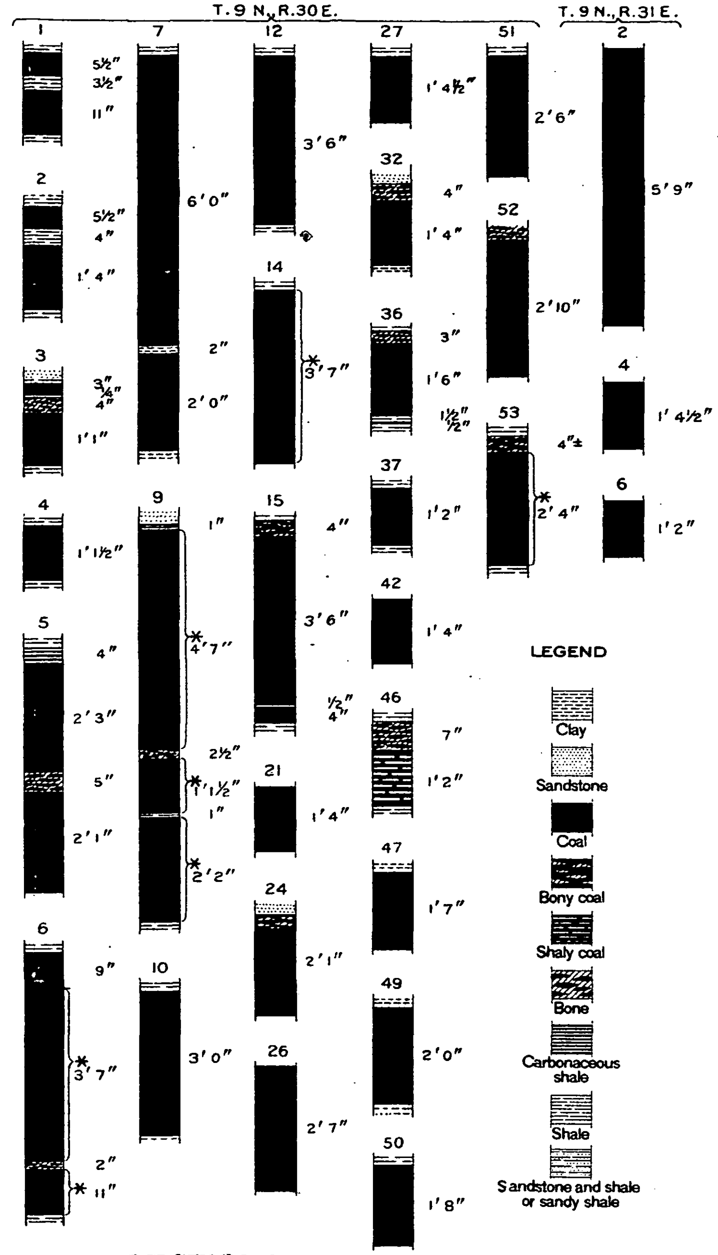
Prospect

Strike and dip

Land corner found

Scale $\frac{1}{62,500}$

1 0 1 2 MILES



SECTIONS

* Sampled for analysis

Names and symbols of coal beds and numbers of coal sections

T. 9 N., R. 30 E.

Kuchta (Mc)	40-57
Buckey (N)	20-39
DeBore (Na)	17-19
McCleary (Ob)	10-16
Carpenter (Oc)	5-9
Spendiff(?) (Od)	1-4

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 9 N., R. 30 E., AND WESTERN PART OF T. 9 N., R. 31 E., MONTANA

A railroad spur has been constructed from a point near Japan connecting the mine with the Chicago, Milwaukee & St. Paul Railway. Another shaft is reported to have been sunk about 1,200 feet west of the old one. A number of houses, stables, blacksmith shops, stores, and other buildings have been built. It is reported that the equipment formerly used at mine No. 4 (now abandoned) of the Davis Coal Co. near Roundup has been installed here.

In the SE. ¼ sec. 17 (No. 6) Walter Robbins has exposed the Carpenter coal bed at the end of a slope about 100 feet long, driven mostly through alluvium, slag, and baked clay, products of the burning of this coal bed. Only the upper bench (6 feet thick) of this coal bed seems to have been uncovered.

A prospect on the Carpenter coal bed in the NW. ¼ sec. 18, exposes approximately 4½ feet of coal (No. 5). The slope is about 20 feet long and was well timbered at the time this field was examined in 1909.

W. C. Grant has opened a prospect 15 feet long on the Carpenter coal bed in the NE. ¼ sec. 26 (No. 9). The coal bed here is approximately 8 feet thick and is somewhat weathered, as shown by the analysis (laboratory No. 8466). The roof consists of a sandstone bed 6 feet thick and will not require much support.

In the SE. ¼ sec. 26 (No. 14) a prospect on the McCleary coal bed has been opened. The slope is about 40 feet long and exposes 3 feet 7 inches of coal. On account of the thinness of the overlying strata the coal is much weathered, as may be seen by comparing its analysis (laboratory No. 8465, p. 51) with analyses of samples collected near Roundup where the coal is unweathered.

A prospect 15 feet long on the Kuchta coal bed has been opened in the SW. ¼ sec. 28 (No. 53) by B. F. G. Kuchta. The coal bed is 2 feet 8 inches thick, the top 4 inches of which is somewhat bony. A sample for analysis (laboratory No. 8467) was collected from this prospect.

The coal of the township can be mined most easily by locating the mine shafts and slopes in Carpenter Creek valley or in the valleys of tributary streams. A railroad switch can easily be extended farther up the main valley of Carpenter Creek from the Chicago, Milwaukee & St. Paul Railway. The Carpenter and McCleary coal beds can be mined either by shafts or slopes, but the Kuchta and Buckey coals outcropping on the sides of the hills must be removed by slopes.

The township has sufficient water for mining use. Underground water probably would not be troublesome in mining. The axis of a northwesterly plunging syncline, carrying the coal-bearing rocks, crosses the southwest corner of this township in a southeasterly

direction and crosses Carpenter Creek about a mile south of this township. Shafts sunk along this axis would have advantages over any at either side of the axis, because little work would be required to move the loaded cars from north, east, and south of the mine to the foot of the shaft, and because mine water would flow naturally to the base of the shaft or into a nearby sump, from which it could easily be pumped to the surface. The upgrade haul would, however, probably make it inadvisable to mine much coal northwest and west of the base of the shaft.'

Pine is plentiful on the uplands of this township and would supply practically all the considerable mine timbering that would be required. The roofs of most of the beds would need support, the Carpenter probably requiring less than the other beds.

Adjoining townships contain coal of the same quality and in larger quantities, but the favorable location makes it very probable that further commercial mining of coal in the eastern part of the Bull Mountain coal field will be continued in this township. It seems entirely probable to the writers that within a few years a mining community equal to or greater than that at Roundup will be developed here.

T. 5 N., R. 31 E.

GEOGRAPHY.

The topography of the western part of T. 5 N., R. 31 E., which was examined in 1909, is characterized by upland ridges separated from each other by the broad valley of Mill Creek and from the lower country to the east and south by almost vertical rim rocks. The erosion of the Lebo shale member of the Fort Union formation in the eastern and southern part of the township gives rise locally to badlands topography.

In 1909 there were no ranches in the township. A cabin on Mill Creek in the SW. ¼ sec. 18 was the only building, and this was occupied for only part of the year. No part of the township was cultivated, but portions of the lowland adjacent to stream courses and some of the upland are adapted for dry farming. A considerable amount of small pine and cedar fringe the upland ridges. Two springs, one in the SW. ¼ sec. 4 and the other on Mill Creek in the SW. ¼ sec. 18 furnish a very meager water supply. It is doubtful if deep drilling would reach a water-bearing sandstone.

GEOLOGY.

The rocks outcropping in the township belong to the Lance and Fort Union formations.

The Lance formation, consisting of alternating beds of gray sandstone, clay, and shale, with streaks of coal, outcrops over a considerable part of the eastern half of the township but has not been mapped. It is overlain by the dark clays and thin-bedded sandstones of the Lebo shale member of the Fort Union, which is about 200 feet thick. The Lebo shale is in turn overlain by the alternating sandstone, clay shale, and thin coal beds of the upper portion of the Fort Union, about 300 feet of which outcrops in this township. The strata are nearly horizontal with slight local dips to the northwest.

COAL.

The coals of the township are confined chiefly to its western half and only this part is mapped on a larger scale. (See Pl. XXXI, p. 180).

The Big Dirty bed lies stratigraphically near the middle of the Lebo shale and consists of 15 to 20 feet of alternating bands of thin-bedded carbonaceous sandstone, sandy shale, and coal. It has no economic value and was not mapped.

The Perry (Oe) coal bed is stratigraphically the lowest coal in the upper part of the Fort Union and is the only coal bed of any importance in this township. It outcrops about 20 feet above the top of the Lebo shale. In the SE. ¼ sec. 8 (No. 15) the bed is 1 foot 7 inches thick, but the coal is brown and lignitic and apparently of low grade. It increases in thickness southeastward to the NE. ¼ sec. 16 (No. 11), where it is 2 feet 8 inches thick. From this place for one-third mile southward along the outcrop it remains practically constant in quality and thickness, then gives way abruptly to a dark carbonaceous shale. The amount of ash and baked clay at the outcrop indicates that the bed may be valuable in the SW. ¼ sec. 16. At the end of the ridge in the NW. ¼ sec. 22 (No. 10) it is represented by 10 inches of dark carbonaceous shale, and it reaches its maximum thickness of 2 feet 10 inches on the north side of Mill Creek in the NW. ¼ sec. 18 (No. 9). From this place the outcrop crosses Mill Creek within half a mile, bears southwestward nearly to the center of sec. 29, then swings west and leaves the township in the SW. ¼ sec. 30, where it is 1 foot 4 inches thick. Considerable burning has occurred in the southwestern part of the township and exposures are not plentiful.

The chemical analysis of a sample obtained in the NW. ¼ sec. 16 (No. 13) shows a heating value of 9,330 British thermal units (laboratory No. 9130).

Selected sections on the Perry coal bed are shown graphically in Plate XXXI (p. 180), and all others measured are given in the following list.

Coal sections on the Perry (Oe) coal bed in T. 5 N., R. 31 E.

[See also Pl. XXXI.]

No. on map, Pl. XXXI.	Location.	Section.	Ft.	in.
2	Sec. 30, SW. ¼	Shale, brown, carbonaceous.		
		Coal	1	6
3	Sec. 29, NW. ¼	Shale, brown, carbonaceous.		
		Coal	2	2
5	Sec. 20, SW. ¼	Shale.		
		Coal	2	2
		Shale.		
6	Sec. 19, NE. ¼	Shale, drab	2+	
		Shale, brown, carbonaceous, with coal streaks		8
		Coal, bright, black	1	10
		Shale, brown, carbonaceous	1	0
		Sandstone, gray	2+	
8	Sec. 18, NW. ¼	Sandstone, gray	3	0
		Shale, brown, carbonaceous, with coal streaks	3	0
		Shale and sandstone, gray and brown, carbonaceous	7±	
		Coal, good	2	5
10	Sec. 22, NW. ¼	Shale, carbonaceous		10
12	Sec. 16, NW. ¼	Coal	2	7
14	Sec. 8, SE. ¼	Shale, brown, carbonaceous		4
		Coal	2	0
		Shale and clay, brown and drab	10±	

No coal is known to have been mined in this township, but possibly a few loads have been removed from surface prospects by ranchers for domestic use. The absence of coal beds of much economic importance in this township renders it doubtful if it will ever be the site of coal mines on a commercial scale. The Perry coal bed will undoubtedly be mined for local use as the country becomes more thickly populated and the wood supply is depleted.

T. 6 N., R. 31 E.

GEOGRAPHY.

The topography of the western part of T. 6 N., R. 31 E., which was examined in 1909, is characterized by upland ridges separated by the broad valleys of Buffalo and Antelope creeks. The uplands are sharply separated from the lower country to the east by almost vertical rim rocks. The erosion of the Lebo shale member of the Fort Union formation in the eastern half of the township gives rise locally to badlands topography. A considerable amount of small pine and cedar clothe the sides of the upland ridges. Several seep springs along Buffalo Creek and a small spring on Antelope Creek in the SE. ¼ sec. 32 furnish a meager water supply.

GEOLOGY.

The rocks outcropping in the township belong to the Lance and Fort Union formations.

The Lance formation, consisting of alternating beds of gray sandstone, clay, and shale, with streaks of coal, outcrops over much of the eastern half of the township but has not been mapped. It is overlain by the dark clay and thin-bedded sandstone of the Lebo shale member of the Fort Union, which is about 200 feet thick. The Lebo shale is in turn overlain by the alternating beds of sandstone, clay shale, and thin coal beds of the upper part of the Fort Union, about 300 feet of which outcrops in this township. The strata are nearly horizontal, with only slight local northwest dips.

COAL.

The coals of the township are confined chiefly to its western half, and only this part is mapped on a large scale. (See Pl. XXXII, p. 182.)

The Big Dirty bed lies stratigraphically near the middle of the Lebo shale and consists of 15 to 20 feet of alternating bands of thin-bedded carbonaceous sandstone, sandy shale, and coal. It has no economic value and was not mapped in this township.

The Perry (Oe) coal bed is stratigraphically the lowest coal bed in the upper part of the Fort Union and the only bed of any importance in this township. The northernmost place at which it is thick enough to attract attention is in the NE. ¼ sec. 17 (No. 10), where 1 foot 5 inches of good coal is exposed. It thickens toward the south as far as the NE. ¼ sec. 28 (No. 4), where 2 feet 6 inches of good coal outcrops. One and three-fourths miles farther southeast, in the SE. ¼ sec. 33 (No. 1), the bed is less than 1 foot thick and is about the same thickness throughout the southern part of the township.

The detailed coal sections are shown in Plate XXXII (p. 182) and in the following list.

Coal sections on the Perry (Oe) coal bed in T. 6 N., R. 31 E.

[See also Pl. XXXII.]

No. on map, Pl. XXXII.	Location.	Section.	Ft.	in.
1	Sec. 33, SE. ¼	Shale, carbonaceous		3
		Coal		11
3	Sec. 28, NE. ¼	Shale, carbonaceous		2
		Coal	2	0
5	Sec. 21, SW. ¼	Coal	2	3
6	Sec. 21, NW. ¼	Coal	2	1
8	Sec. 17, NE. ¼	Coal	1	10
9	Sec. 16, NW. ¼	Coal	1	4
11	Sec. 9, SW. ¼	Coal, shaly		1½
		Coal	1	1

No coal is known to have been mined in this township, but it is probable that as the population increases and the supply of fuel wood becomes exhausted country banks may be opened on the Perry bed which underlies the western half of the township. The coal beds of this township are too thin to be mined on a commercial scale.

T. 7 N., R. 31 E.

TOPOGRAPHY.

The greater part of T. 7 N., R. 31 E., is comparatively smooth, although the erosion of the Lebo shale member of the Fort Union formation gives rise locally to badlands topography, especially in the eastern part. There are no perennial streams in the township. Wolf Spring in sec. 9 and a few small seep springs along the eastern part of Buffalo Creek and Deadman Gulch furnish a meager water supply. In 1909 only a small area in the vicinity of Wolf Spring was cultivated, but a large part of the township is adapted to dry farming. The main wagon road from Musselshell to the Northern Pacific Railway at Custer crosses the northeastern part of the township. The two western tiers of sections which contain the principal coal beds are shown on the same map as T. 6 N., R. 30 E. (See Pl. XXXIII.)

GEOLOGY.

The rocks outcropping in the township belong to the Lance and Fort Union formations. The Lance is exposed only in the southeastern part of the township. The Lebo shale member of the Fort Union consists of about 200 feet of dark sandy shale and thin-bedded sandstone and is overlain by the alternating buff to yellowish-gray sandsones, clay shale, and coal beds of the upper part of the Fort Union, of which from 300 to 400 feet outcrop in this township. The sandstone is most prominent, forming locally nearly vertical scarps or rim rocks. The strata are practically horizontal throughout the township.

COAL.

The valuable coals of the township are confined to the western half, and only this part is mapped on a large scale. (See Pl. XXXIII, p. 186.)

The Big Dirty bed lies stratigraphically near the middle of the Lebo shale and consists of 15 to 25 feet of alternating bands of thin-bedded carbonaceous sandstone, sandy shale, and coal. It has no economic value and was not mapped. An analysis of a sample from this bed collected from a surface outcrop in sec. 10 is shown on page 51 (laboratory No. 8621). The sample represents the whole of the bed, which is at this place 15 or 16 feet thick and has a heating value of only 4,300 British thermal units in the air-dried state.

Five coal beds—the Carpenter (Oc), McCleary (Ob), De Bore (Na), Buckey (N), and Kuchta (Mc)—outcrop in the northwestern part of the township. The Kuchta coal bed underlies only a small area of the township in lot 4, sec. 6. Its thickness, one-fourth mile west of the range line, is 2 feet 3 inches. The Buckey bed contains 2 feet 1 inch of good coal in the NE. ¼ sec. 6 (No. 9) but one-fourth mile west of the range line it thins to 1 foot 8 inches. The De Bore bed is only 8 inches thick in lot 2, sec. 6 (No. 10). Six sections measured on the McCleary bed show a variation in thickness from 1 foot 10 inches to 4 feet, with an average of about 3 feet. A shale parting thickens toward the south for a mile or more from the north border, then thins and disappears entirely in the township to the west. The Carpenter bed in sec. 5 (No. 1) is only 8 inches thick.

The coals of the Fort Union formation in this township are regarded as high-grade subbituminous, from their physical similarity to coals sampled for analysis in other parts of the field. (See pp. 48–59.) No sample for analysis was obtained in this township.

The section measured on the Buckey bed and four sections on the McCleary bed are shown graphically in Plate XXXIII. All other coal sections measured in the township are included in the following list.

Coal sections in T. 7 N., R. 31 E.

[See also Pl. XXXIII.]

Carpenter (Oc) coal bed.

No. on map, Pl. XXXIII.	Location.	Section.	Ft.	in.
1	Sec. 5, NW. ¼	Coal		8

McCleary (Ob) coal bed.

3	Sec. 19, NE. ¼	Coal		9
		Shale, brown		2
		Coal	1	1
		Total coal	1	10
6	Sec. 5, SW. ¼	Coal	1	3½+
		Base not exposed.		

Local coal bed.

8	Sec. 6, SE. ¼	Coal		8½

De Bore (Na) coal bed.

10	Sec. 6, NE. ¼	Coal		8

Practically no coal has been mined from the beds exposed in this township, although a few tons may have been removed from surface prospects by ranchers for domestic use. Owing to the small area underlain by the coal beds and the thinness of the coal it is doubtful if this township will ever contain any commercial mines. The maximum coal measurement is on the McCleary bed in the NE. ¼ sec. 7 (No. 5), where about 4 feet of coal is present. The greater amount of mining in the future will probably be in country banks. Timber for mining is fairly plentiful, but water is scanty.

T. 8 N., R. 31 E.

GEOGRAPHY.

The upland plateau that forms the Mussellshell-Yellowstone divide extends in a comparatively narrow belt across the northwestern part of T. 8 N., R. 31 E. Its sides have been deeply incised by the canyon-like gulches at the heads of Carpenter and Alkali creeks and their tributaries. This roughly dissected upland contrasts rather sharply with the low and rolling surface of the eastern part of the township. A good spring on Carpenter Creek in the NW. ¼ sec. 7 and a few seep springs along Alkali Creek and its tributaries afford a meager supply of water. The uplands are fringed with a scanty growth of small pines and cedars, and a few pines valuable for lumber stand in the northwestern part of the township.

In 1909 there were only two ranches in this area, both located near the east border. Since that time, however, it is reported that the eastern half of the township, where the land is most valuable for dry farming, has been settled by a number of homesteaders. Secondary roads and trails make the greater part of the township accessible.

GEOLOGY.

All the rocks that outcrop in the township belong to the upper part of the Fort Union formation. They consist of alternating, practically horizontal beds of buff to yellowish-gray sandstone, clay shale, and coal, of which the sandstone is most prominent.

COAL.

Stratigraphic relations.—Six coal beds—the Spendiff (Od), Carpenter (Oc), McCleary (Ob), De Bore (Na), Buckey (N), and Kuchta (Mc)—have been studied in this township. (See Pl. XXXVI.) The two principal lower beds, the Carpenter and McCleary, are about

50 feet apart stratigraphically and about 450 feet above the top of the Lebo shale member of the Fort Union. The Buckey and Kuchta beds are 25 to 40 feet apart, and the Buckey is about 225 feet above the McCleary. The De Bore coal bed, 25 to 40 feet below the Buckey, and the Spendiff coal bed, about 25 feet below the Carpenter, are unimportant in this township.

A slightly weathered sample (laboratory No. 8578), taken from the McCleary bed in the NW. ¼ sec. 32 (No. 13, Pl. XXXVI), shows on analysis a heating value (for the air-dried sample) of 10,250 British thermal units. This analysis (see p. 51) and other analyses made from samples collected in adjoining townships show that the coals are high-grade subbituminous.

Spendiff (Od) coal bed.—The Spendiff coal bed was measured at two widely separated localities, in secs. 3 and 32.

Coal sections on the Spendiff (Od) coal bed in T. 8 N., R. 31 E.

No. on map, Pl. XXXVI.	Location.	Section.	No. on map, Pl. XXXVI.	Location.	Section.
		Ft. in.			*Ft. in.*
1	Sec. 32, NE. ¼.	Sandstone, massive.	2	Sec. 3.....	Shale, sandy..... 1 4
		Coal..... 9			Coal, bright, 6 inches to..... 1 3
					Clay, drab.

Carpenter (Oc) coal bed.—In the northern part of secs. 2, 3, and 4 and in the township to the north (T. 9 N., R. 31 E.) the Carpenter coal bed is so burned at the outcrop that no satisfactory sections could be found. Although the amount of burning in this part of the field suggests that the coal bed is thick, a partial section measured in sec. 3 (No. 12) shows approximately the true character.

The bed was measured in two places in sec. 2 about three-fourths mile south and slightly east of location 12. The northern of the two exposures (No. 11) shows 1 foot 9 inches of good coal. Approximately 200 feet southeast of this place (No. 10) the thickness is only 10 inches. It is believed, however, that these two sections represent only a part of the bed. From this place the outcrop extends generally southwestward and throughout the remainder of this township the bed is practically worthless at the outcrop. In the NE. ¼ sec. 32 (No. 3) it ranges from 11½ inches to 15 inches in thickness, but a mile to the south it shows only 8 inches of coal. The following table includes all the sections and partial sections measured.

Coal sections on the Carpenter (Oc) coal bed in T. 8 N., R. 31 E.

No. on map, Pl. XXXVI.	Location.	Section.	Ft.	in.
3	Sec. 32, NE. ¼	Sandstone, massive.		
		Coal, 11½ inches to	1	3
4	Sec. 33, NE. ¼	Coal		11
5	Sec. 28, SE. ¼	Coal		2
		Bone		5
		Coal		7
6	Sec. 26, NW. ¼	Shale, drab.		
		Coal	1	3
7	Sec. 15, SE. ¼	Shale, drab.		
		Coal		10
		Shale, brown	4–5	0
		Coal		4½
		Clay, drab.		
8	Sec. 11, SW. ¼	Shale, brown		6–8
		Coal		6
		Shale, brown and drab	5	0
		Coal		7
		Shale, brown		8
9	Sec. 11, SW. ¼	Shale, brown		6
		Coal, bright, weathered		7
		Shale, brown		10
10	Sec. 2	Coal		10
11	Sec. 2	Coal	1	9
12	Sec. 3	Sandstone, gray	1	0
		Clay, sandy	10	0
		Ash and baked clay	1	3
		Coal	1	4
		Clay, drab	1	0
		Shale, brown		6
		Coal, bright		10
		Shale, brown		2
		Clay, drab	2	6
		Sandstone, gray, massive	4	8

McCleary (Ob) coal bed.—The outcrop of the McCleary coal bed, like that of the Carpenter, extends southeast from the north side of sec. 4 across sec. 3, into sec. 2, where it swings south and outcrops about the heads of the southeastward-flowing streams across the central and southern parts of the township. Nine sections measured on the bed show a variation in thickness from 2 feet 5 inches in the SW. ¼ sec. 28 to a maximum of 8 feet 8 inches in the NE. ¼ sec. 15 (No. 18). Analysis of a badly weathered sample from an open prospect in sec. 32 (No. 13) is given on page 51. This coal bed is the most important in the township and will probably be the first to be mined. A selected number of coal sections are shown graphically in Plate XXXVI, and all others measured are included in the following list.

Coal sections on the McCleary (Ob) coal bed in T. 8 N., R. 31 E.

[See also Pl. XXXVI.]

No. on map, Pl. XXXVI.	Location.	Section.	Ft.	in.
16	Sec. 28, NE. ¼	Sandstone, grayish, thin bedded	6	0
		Shale, yellowish brown		6
		Sandstone, drab, carbonaceous		2
		Shale, brown		1
		Coal, bright		2
		Shale, blackish gray		3
		Coal	1	9
		Bone, black		4½
		Coal, bright, hard	1	11+
		Base not exposed.		
17	Sec. 28, NE. ¼	Shale, yellowish.		
		Shale, brown		10
		Coal, bright	2	8+
		Base not exposed.		
21	Sec. 3	Sandstone, yellowish gray, soft	4+	
		Shale, black, carbonaceous		2
		Coal, bright	3	0
		Clay, drab, brown		

De Bore (Na) coal bed.—The De Bore coal bed was examined at one place in sec. 30 and at five places on a tributary of Carpenter Creek in the northern tier of sections. In sec. 30 (No. 22) it is 1 foot 1 inch in thickness. The measurements made in secs. 3, 4, and 5 show that the bed is lenticular in character in that locality, having a variation in thickness from 6 inches to 1 foot 10 inches. Two of these sections are shown in Plate XXXVI and the remainder are as follows:

Coal sections on the De Bore (Na) coal bed in T. 8 N., R. 31 E.

[See also Pl. XXXVI.]

No. on map, Pl. XXXVI.	Location.	Section.	Ft.	in.
22	Sec. 30, NE. ¼	Coal	1	1
23	Sec. 3	Coal		6
24	Sec. 4	Shale, carbonaceous.		
		Coal		6
		Shale, carbonaceous.		

No. on map, Pl. XXXVI.	Location.	Section.	Ft.	in.
25	Sec. 4	Shale		6
		Coal		8

Buckey (N) coal bed.—The Buckey coal bed lies 25 to 40 feet above the De Bore and has been traced about the head of Carpenter Creek in secs. 5 and 6 and across the divide into sec. 4. Its average thickness is about 1 foot 2 inches.

Southwestward from a point near the center of sec. 4 the outcrop is covered with grass and the bed is in most places thin. In a coulee in the SE. ¼ sec. 17 (No. 34) 1 foot 10 inches of good coal is exposed,

but the bed thins to 9 inches within one-third mile to the southeast (No. 33). For a short distance in the NW. ¼ sec. 29 (No. 30) it thickens to 1 foot 2 inches. Near the south side of sec. 31 it is thicker and one-fourth mile south of the township line in T. 7 N., R. 31 E., it is 2 feet 1 inch thick. The graphic sections on Plate XXXVI and the sections given in the following list include all the sections measured on the Buckey coal bed in this township.

Coal sections on the Buckey (N) coal bed in T. 8 N., R. 31 E.

[See also Pl. XXXVI.]

No. on map, Pl. XXXVI.	Location.	Section.	Ft.	in.
28	Sec. 31, NE. ¼	Coal		10
29	Sec. 30, SE. ¼	Coal	1	1
31	Sec. 19, NE. ¼	Coal	1	1
32	Sec. 21, SW. ¼	Coal		11½
33	Sec. 17, SE. ¼	Coal		9
35	Sec. 16, NW. ¼	Coal		9
36	Sec. 3	Shale, black		3½
		Coal	1	½
38	Sec. 4	Shale, carbonaceous		5
		Coal	1	4
39	Sec. 4	Bone		
		Coal	1	7
40	Sec. 4, SW. ¼	Sandstone, massive	25	0
		Shale, sandy		3
		Bone		3
		Coal	1	6
41	Sec. 5	Coal		1½
		Shale, yellow		3
		Shale, carbonaceous		4
		Coal	1	5
		Shale, brownish drab		
		Total coal	1	6½
43	Sec. 5, SW. ¼	Bone		4
		Coal	1	8
44	Sec. 6	Bone		5
		Coal	1	9

Kuchta (Mc) bed.—The Kuchta coal bed outcrops about the head of Carpenter Creek in secs. 4, 5, and 6. Near the center of sec. 4 the outcrop crosses the divide and extends generally southwest to the southwest corner of the township, with a few small outliers in the northern part of secs. 4 and 5. Its average thickness is about 2 feet. In the southern part of the township exposures are scarce on account of the heavy covering of grass. The graphic sections in Plate XXXVI and the sections given in the following list show the variations in thickness.

Coal sections on the Kuchta (Mc) coal bed in T. 8 N., R. 31 E.

[See also Pl. XXXVI.]

No. on map, Pl. XXXVI.	Location.	Section.	Ft.	in.
50	Sec. 31, NE. ¼	Coal		2
		Shale, gray, drab		3
		Coal		2
		Bone, with coaly streaks		8
		Coal, excellent	1.	4
51	Sec. 31, NW. ¼	Sandstone, argillaceous	10+	
		Coal		2
		Shale, gray		6
		Coal		2
		Bone, hard, with bony coal		7
		Coal, excellent	1	10
54	Sec. 30, NE. ¼	Coal		2
		Bone		7
		Coal	2	0
55	Sec. 21, SW. ¼	Coal	2	1
57	Sec. 9, SE. ¼	Coal		4
		Bone		3
		Coal	2	0
58	Sec. 9, NE. ¼	Coal		3
		Bone		5
		Coal	2	7
		Total coal	2	10
59	Sec. 9, NE. ¼	Coal		½
		Bone, drab		1
		Coal, bony		6
		Coal	2	0
60	Sec. 9, NE. ¼	Coal		2
		Bone, hard, sandy, compact		8
		Coal, excellent	2	8
61	Sec. 4, SE. ¼	Coal, bony		1
		Bone		4
		Coal	2	6
62	Sec. 4	Ash		3
64	Sec. 4	Ash, various colors		3
		Shale, carbonaceous		5
67	Sec. 5	Ash, light yellow		3
		Coal		9
68	Sec. 5, SW. ¼	Clay shale	3	0
		Coal		2½
		Bone, hard, sandy		3½
		Coal	3	5
		Total coal	3	7½
70	Sec. 4	Coal	2	7

Development.—A few tons of coal have been removed from a surface prospect on the McCleary bed in the NE. ¼ sec. 32 by ranchers for domestic use. Since this part of the field was examined in 1909 other surface prospects may have been opened for fuel by the settlers in the locality. A sample (laboratory No. 8578) was collected from this prospect and was shown by analysis to be much weathered. (See p. 51.)

The valleys of Carpenter and Alkali creeks are natural routes for railroad spurs from either north or south. Coal from the thickest bed in the field (the McCleary in the east-central part of the township) can most easily be removed to the Chicago, Milwaukee & St. Paul Railway, even though a rather high divide intervenes between it and the head of Horse Creek, in the valley of which the spur from the railroad must be constructed.

Water and timber for mining use are fairly plentiful in this township as a whole, the timber being more plentiful in the western and the water in the eastern part.

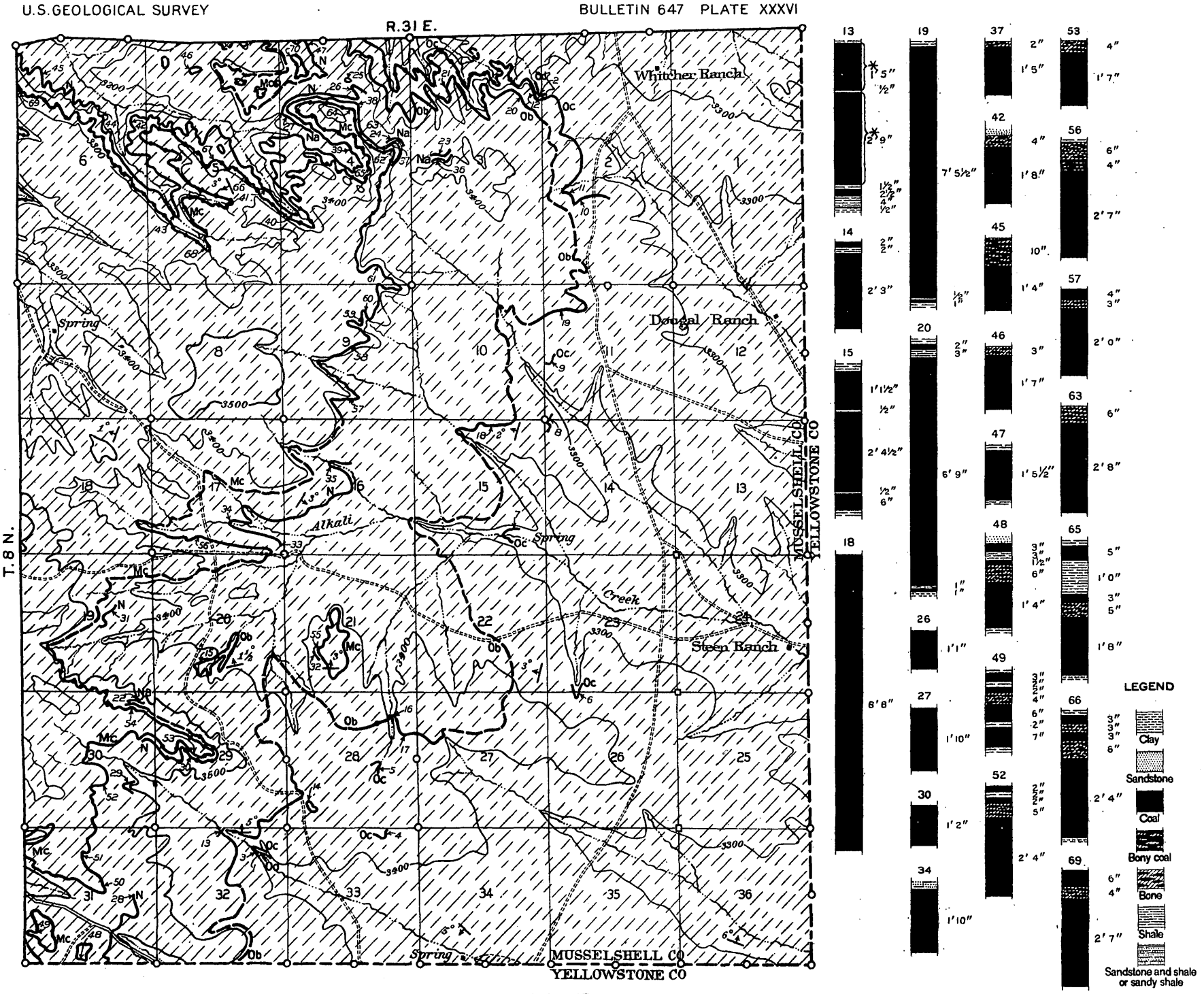
T. 9 N., R. 31 E.

GEOGRAPHY.

Musselshell River crosses the northwest corner of T. 9 N., R. 31 E., and its flood plain is one-half to 1½ miles in width. Several intermittent streams have completely dissected the original upland surface of the township and flow through broad valleys which are locally separated from the uplands by rim rocks. The R. L. ranch in the SW. ¼ sec. 6 was the only one of importance in the township in 1909. The only other house in the township was in sec. 12. Much of the valley of Lost Horse Creek and of the lands bordering the flood plain of Musselshell River is adapted to dry farming, and practically all of the flood plain of the river can be irrigated. A road following Lost Horse Creek is the main route of travel from this part of Musselshell Valley to the Yellowstone Valley in the vicinity of Custer. An interesting case of recent stream piracy has occurred in the north half of sec. 25, where the drainage of the upper part of Lost Horse Creek has been directed into Horse Creek. (See Pl. I.) A few seep springs along the lower course of Lost Horse Creek, a good spring in the SW. ¼ sec. 12, and Musselshell River furnish the water supply of the township. The uplands are clothed with a scanty growth of small pine and cedar, and cottonwood is plentiful along the river. Only the two western tiers of sections, which contain the principal coal beds, are shown in Plate XXXV (p. 198) with T. 9 N., R. 30 E.

GEOLOGY.

The rocks which outcrop in the township belong to the Bearpaw, Lance, and Fort Union formations. The Bearpaw shale outcrops in a narrow strip along the south side of the flood plain of the Musselshell, by which the greater part of it is concealed. The Lance formation consists of 700 to 800 feet of grayish sandstone and shale with thin streaks of coal near the top. It outcrops in a broad belt across the north-central part of the township with an increase in width toward the east due to a decrease in the dip of the strata. Overlying



LEGEND

TERTIARY
Eocene

Fort Union formation

Outcrop of coal bed. Number indicates section described in text or shown to right of map. Letter designates bed

Coal bed burned at outcrop

Coal bed concealed at outcrop

× Prospect.

Strike and dip

Scale 1/62,500
1 0 1 2 MILES

SECTIONS

○ Land corner found

□ Private land corner.

* Sampled for analysis

Names and symbols of coal beds and numbers of coal sections

Kuchta (Mc)	48-70
Buckey (N)	28-47
DeBore (Na)	22-27
McCleary (Ob)	13-21
Carpenter (Oc)	3-12
Spendiff (Od)	1-2

MAP SHOWING TOPOGRAPHY AND ECONOMIC GEOLOGY OF T. 8 N., R. 31 E., MONTANA

the Lance formation is the Lebo shale member of the Fort Union formation, which consists of about 200 feet of yellow, brown, and dark sandy shale and thin-bedded sandstone. The coal-bearing upper portion of the Fort Union outcrops in the southern part of the township and consists of alternating beds of sandstone, shale, clay, and coal.

The township lies on the north flank of the main eastern syncline of the Bull Mountains, and all the beds dip south. The maximum dips range from 15° in the western part of the township to 4° in the eastern part and lie roughly along a line corresponding to the outcrop of the top of the Lance formation. The dip is less both to the north and south of this line.

COAL.

The valuable coal beds—Carpenter (Oc), McCleary (Ob), Buckey (N), and Kuchta (Mc)—belong to the upper portion of the Fort Union and lie practically horizontal in the southwest corner of the township, mainly in sec. 31. (See Pl. XXXV.)

It was impossible to obtain good sections of any except the McCleary bed on account of the burned outcrops and the scarcity of exposures. The Carpenter (Oc) bed is extensively burned on the outcrop. Brick-red baked clay caps many of the small buttes in the vicinity. Although the presence of a large amount of baked clay along the outcrop suggests a thick bed of coal, the sections measured a mile or more to the southeast seem to prove that it is comparatively thin. No measurement was obtained in this township. The McCleary (Ob) coal bed, which is 4 feet 2 inches thick one-half mile west of this township (No. 15, T. 9 N., R. 30 E.), is 5 feet 9 inches thick in sec. 31 of this township (No. 2, Pl. XXXV). In sec. 32 it exposes (No. 1) 3 feet of coal and ash. In the township to the south it is the main bed and has a maximum thickness of over 8 feet. The Kuchta (Mc) coal bed is represented only by a small outlier in the SW. ¼ sec. 31. It averages 1 foot 6 inches in thickness in the township to the west, where the Buckey averages 1 foot 4 inches. Two sections on the Buckey bed in sec. 31 (Nos. 4 and 6) of this township are shown in Plate XXXV. At another location (No. 5) in the same section, 4 inches of ash is exposed. The De Bore (Na) coal bed is unimportant in this township, being only 6 inches thick in the SW. ¼ sec. 31 (No. 3).

The coals are regarded as high-grade subbituminous, from the apparent physical similarity to coals sampled for analysis in other parts of the Bull Mountain field. (See pp. 48–59.) No sample was obtained in this township.

No coal is known to have been mined in this township, but a few tons may have been removed from surface prospects by ranchers for domestic use. So small a part of the township is underlain by eco-

nomically important coal beds that it seems doubtful if it will ever be the site of mines of importance. However, it may seem desirable to locate on the Carpenter and McCleary beds in the southwestern part of the township, in which case the valley of Horse Creek would be the natural route for a spur from the Chicago, Milwaukee & St. Paul Railway.

T. 8 N., R. 32 E.

T. 8 N., R. 32 E., lies at the extreme eastern side of the area included in the map of the Bull Mountain coal field. (See Pl. I, in pocket.) The surface is gently rolling prairie except in the eastern part, where shallow steep-sided gulches are developed.

There are a few seep springs in the western part near the cabin in sec. 31 and along Alkali Creek and its northern tributary, which flows through secs. 7, 17, 18, and 20. Water could probably be reached in shallow wells along the principal stream courses. The greater part of the township is adapted to dry farming. It is practically treeless. The only ranch in the township in 1909 was that of J. Heide in the NW. ¼ sec. 18, but since that time a number of homesteaders have settled there.

The surface rocks of the township include the upper part of the Lance formation, the Lebo shale member of the Fort Union formation, and the lower few hundred feet of the upper part of the Fort Union. These strata are practically flat or have a slight westward dip.

No coal beds of importance outcrop in this township. The Big Dirty coal bed, which occurs about the middle of the Lebo shale, is of no economic value.

INDEX.