The Spotted Horse Coalfield, Sheridan and Campbell Counties, Wyoming

GEOLOGICAL SURVEY BULLETIN 1050

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By W. W. OLIVE

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A description of the Tertiary stratigraphy and reserves of coal in the Wasatch and Fort Union formations in 24 townships in northern Wyoming

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By WILDS W. OLIVE

ABSTRACT

The Spotted Horse coalfield includes about 725 square miles in Sheridan and Campbell Counties in northeastern Wyoming adjacent to the Montana State line. It is in the northern Great Plains province, midway between the Black Hills and the Bighorn Mountains. The topography is characterized by flat-topped buttes; long, narrow flat divides, and even-crested ridges, rising steeply 100–600 feet above valley bottoms. Altitudes range from 3,395 feet where the Powder River crosses the state line into Montana to about 4,660 feet along the Powder River-Little Powder River divide near the southern boundary of the field. Well-defined erosion surfaces supported by resistant strata and greatly dissected by streams occur at two levels. The higher surface caps high buttes and divides in the southern part of the area at altitudes of about 4,450–4,660 feet, the lower surface occurs on high stream divides and flat-topped buttes elsewhere in the coal field at altitudes of 4,000–4,250 feet. The erosion surfaces bevel successively younger rocks southwestward across the area, owing to the prevailing southwesterly dip of the strata.

The rocks exposed in the Spotted Horse field are of continental origin and range in age from Paleocene to Recent. The oldest, the Tongue River member of the Fort Union formation of Paleocene age, underlies the surface in about two-thirds of the Spotted Horse coal field and consists of about 1,200 to 1,300 feet of sandstone, shale, and coal, but only the upper 900 feet is exposed. Outcrops support an abundant growth of timber. The prevailing color of the rocks is yellowish gray, except where the beds have been baked by burning of underlying coal beds to form conspicuous beds of red, purple, and violet clinker. The Tongue River member is seemingly conformable with the overlying Wasatch formation in the northern part of the field. As much as 220 feet of the uppermost beds of the Tongue River member in the northern part of the coalfield are missing elsewhere as a result either of pre-Wasatch erosion or of nondeposition.

The Wasatch formation of Eocene age is exposed in large areas in the western and southern parts of the field and caps many divides in the north-central part. The Wasatch is similar in lithology to the Tongue River member; but its outcrops are moderate yellowish-brown and characterized by a scarcity of timber. The Wasatch formation is more than 700 feet thick in the western part of the area, but the youngest beds occur in the southern part, where the Wasatch is only 410–600 feet thick. Its strata below the Felix coal bed, thin from about 430 feet in the western part of the field to about 160 feet in the southern part and change from shale, sandstone, and coal to yellowish-gray, friable, crossbedded, coarse-grained sandstone.

Deposits of sand and gravel of Pleistocene(?) age cover small areas at different levels above the Powder River and Clear Creek. The gravel is composed predominantly of rounded to subangular pebbles and cobbles of quartzite, sandstone, and chert derived outside the mapped area. Clinker occurs in gravel deposits less than 100 feet above the Powder River and Clear Creek. Recent alluvial deposits of sand, silt, and clay, with lenses of gravel and rubble surface the floors of the main valleys.

The prevailing dip of the strata is less than 3 degrees southwestward, but reversals of dip suggest shallow synclines and anticlines. Dips of as much as 11 degrees occur near faults. The dominant structural feature is a series of gentle southwesterly plunging folds which trend about N 25° E in a belt about 8 miles wide across Tps. 56 and 57 N., Rs. 76 and 77 W. The folds merge into a shallow syncline which trends easterly across the northern tier of townships. Elsewhere in the area smaller folds trend parallel to this belt, but a few trend about N 45° W.

Faults are concentrated near the mouth of Clear Creek, at the southern part of the main belt of folds; along Fence Creek at the northern end of the fold belt where it merges into the syncline across the northern row of townships; and in T. 54 N., Rs. 74 and 75 W. All but one of the faults are normal; most trend either northeastward or eastward and some can be traced as much as 3 miles. The strata are displaced as much as 300 feet.

Interest in oil and gas possibilities of the Spotted Horse field was stimulated in 1948 by the discovery of oil in the Texas Co. No. 1 Adon well about 7½ miles southeast of the area. However, two deep wildcat wells drilled in 1949 and 1950, one in the northwestern part of the area, the other in the southern part, failed to find commercial quantities of oil and gas. Natural gas, probably derived from coal, flows from several shallow wells in the southeastern part of the coal field and in areas adjacent ot the Powder River and Clear Creek.

Coal beds ranging in thickness from 2½ feet to about 40 feet in the Spotted Horse field contain about 12,060,000,000 short tons of coal: 10,305,000,000 tons in the Tongue River member of the Fort Union formation, 1,755,000,000 tons in the Wasatch formation. About 76 percent of the reserves of the Tongue River member is in the Canyon, Anderson, and Smith coal beds; about 77 percent, (1,356,000,000 tons) of the reserves of the Wasatch formation is in the Felix coal bed.

Construction materials consisting of clinker, sandstone, shale, gravel, and sand occur in many parts of the coalfield; many samples of the material were found unsuited for use as concrete aggregate or riprap.

INTRODUCTION

PURPOSE AND SCOPE OF THE REPORT

The geologic investigation of the Spotted Horse coalfield was undertaken by the U. S. Geological Survey as a part of the Department of the Interior program for the integrated development of the Missouri River basin. The site of the proposed Moorhead dam on the Powder River is 3 miles north of the Spotted Horse field, and the proposed reservoir will extend several miles southward up the Powder River and tributary valleys. The objectives of the investigation were to map the geology and structure of the proposed-reservoir area and to determine the mineral resources and geologic features of the adjacent area.

for use in the classification and administration of public lands. The area contains many coal beds, and much of the field work consisted of mapping and measuring the beds in order to determine the reserves of coal and to locate areas most favorable for mining.

LOCATION

The Spotted Horse coalfield includes about 725 square miles in Sheridan and Campbell Counties in northeastern Wyoming adjacent to the Montana State line. The field is named from Spotted Horse, a post office and general store, near the head of Spotted Horse Creek; its boundaries are the limits of previously mapped adjacent fields. Figure 1 shows the areas included in each of these fields and also other coalfields in adjacent areas.

FIELD WORK AND ACKNOWLEDGMENTS

Field work for this report was done during the summers of 1948 and 1949. The writer was assisted by J. F. Cronin, W. D. Johnson, Jr., J. C. McLachlan, and C. E. Person in 1948 and by W. J. Hail and A. A. Meyerhoff in 1949. Johnson aided in compiling information and data during the winter of 1948–1949.

The writer expresses his appreciation to Prof. Grover E. Murray of Louisiana State University for reading the report and making many helpful suggestions. The ranchers, farmers, and merchants of the Spotted Horse area were very helpful and cooperative in providing campsites, information, and other valuable assistance to the writer and his associates.

LAND SURVEYS

All land within the Spotted Horse coalfield has been subdivided by surveys of the United States General Land Office. About 45 percent of the area was surveyed in 1883, and only a few of the stone markers set during this survey could be found. The township and section lines for these old surveys are shown on the accompanying geologic map (plates 1 and 2) by dashed lines to indicate that their location is uncertain. The rest of the area was surveyed after 1912, and iron pins capped with brass plates mark many of the section and quarter-section corners.

PREVIOUS GEOLOGIC WORK

The general geologic features of the Spotted Horse coalfield have been known from early reconnaissance work in the region and from studies in adjoining coalfields. As early as 1804–1806, members of the Lewis and Clark Expedition (Allen, 1814, p. 391–393) observed coal beds in the bluffs of the Yellowstone River near the mouth of the Tongue River, and further downstream they noted "burnt hills" (buttes capped by clinker formed by the burning of coal beds). F. V. Hayden (1869), a member of Captain W. F. Raynolds' expedi-

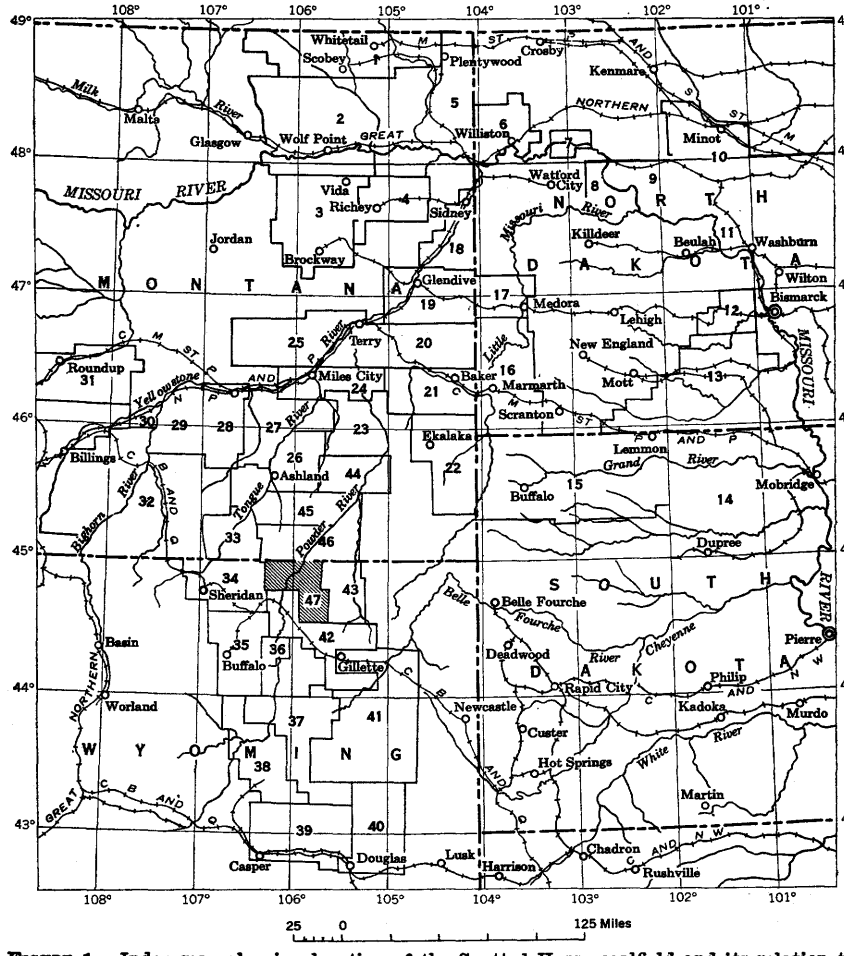


FIGURE 1.—Index map showing location of the Spotted Horse coalfield and its relation to other coalfields in northeastern Wyoming and adjacent States.

tion to explore the Yellowstone River and its tributaries for the War Department in 1859 and 1860, described the geology of the country. N. H. Darton (1905) described the geology and underground water resources of the general region. A map by W. G. Pierce and R. M. Girard (1945) shows the broad structural features of the Powder River Basin. R. W. Brown (1949) published a map showing Paleocene deposits of the Rocky Mountains and Plains which includes the area discussed in this report. A geologic map of the Powder River Basin compiled by J. D. Love and J. L. Weitz (1951) depicts the regional geology.

GEOGRAPHY

SURFACE FEATURES

The Spotted Horse coalfield is in the Great Plains physiographic province and midway between the Black Hills and the Bighorn Mountains. The topography is characterized by flat-topped buttes, long

Coalfields shown on figure 1 and described in Geological Survey bulletins:

Index no. on fig. 1	Coalfield or area	U. S. Geol. Survey Bull.	Author	Date of publication
1	Scobey	751–E	Collier, A. J	1924
2	Fort Peck	381–A	Smith, C. D	1910
3	McCone County	905	Collier, A. J. and Knechtel, M. M.	1939
4	Richey-Lambert	847–C	Parker, F. S	1936
5	Culbertson	471–D	Beekly, A. L	1912
6	Williston	531–E	Herald, F. A	1913
7	Nesson Anticline	691–G	Collier, A. J	1918
8	Fort Berthold	726–D	Bauer, C. M. and Herald, F. A.	1922
9	Fort Berthold	381–A	Smith, C. D	1910
		471–C	Pishell, M. A	1912
10	Minot	906–B	Andrews, D. A	1939
11	Washburn	381–A	Smith, C. D	1910
12	New Salem	726–A	Hancock, E. T	1921
13	Cannonball River	541–G	Lloyd, E. R	1914
14	Standing Rock and Cheyenne Reservations.	575	Calvert, W. R., and others.	1914
15	Northwestern South Dakota.	627	Winchester, D. E., and others.	1916
16	Marmarth	775	Hares, C. J	1928
17	Sentinel Butte	341–A	Leonard, A. G. and Smith, C. D.	1909
18	Sidney	471–D	Stebinger, Eugene	1912
19	Glendive	471–D	Hance, J. H	1912
20	Terry	471–D	Herald, F. A	1912
21	Baker	471–D	Bowen, C. F	1912
22	Ekalaka	751–F	Bauer, C. M	1924
23	Mizpah	906–C	Parker, F. S., and Andrews, D. A.	1939
24	Miles City	341–A	Collier, A. J., and Smith, C. D.	1909
25	Little Sheep Mountain.	531–F	Rogers, G. S	1913
26	Ashland	831–B	Bass, N. W	1932
27	Rosebud	847–B	Pierce, W. G	1936
28	Forsyth	812–A	Dobbin, C. E	1930
29	Tullock Creek	749	Rogers, G. S., and Lee, Wallace.	1923
30	Southwest of Custer	541–H	Rogers, G. S	1914
31	Bull Mountain [1]	647 [1]	Woolsey, L. H., and others.	1917
32	Big Horn County	856	Thom, W. T., Jr., and others.	1935
33	Northward extension of Sheridan.	806–B	Baker, A. A	1929

See footnotes at end of table.

Coalfields shown on figure 1 and described in Geological Survey bulletins—Con.

Index no. on fig. 1	Coalfield or area	U. S. Geol. Survey Bull.	Author	Date of publication
34	Sheridan	341–B	Taff, J. A	1909
35	Buffalo	381–B	Gale, H. S. and Wegemann, C. H.	1910
36	Barber	531–I	Wegemann, C. H	1913
37	Pumpkin Buttes	806–A	Wegemann, C. H., and others.	1928
38	Sussex	471–F	Wegemann, C. H	1912
39	Glenrock	341–B	Shaw, E. W	1909
40	Lost Spring	471–F	Winchester, D. E	1912
41	Gillette	796–A[2]	Dobbin, C. E. and Barnett, V. H.	1927
42	Powder River	381–B	Stone, R. W. and Lupton, C. T.	1910
43	Little Powder River	471–A	Davis, J. A	1912
44	Coalwood	973–B	Bryson, R. P	1952
45	Birney-Broadus	000	Warren, W. C	
46	Moorhead	in preparation	Bryson, R. P	
47	Spotted Horse	1050	Olive, W. W	

[1] Compiled and edited by E. R. Lloyd.

[2] With a section on the Minturn district and the northwestern part of the Gillette field by W. T. Thom, Jr.

narrow and flat divides, and even-crested ridges that rise steeply 100–600 feet above valley bottoms. Altitudes range from 3,395 feet above sea level along the Powder River to about 4,660 feet along the divide between the Powder and Little Powder Rivers.

Badland topography occurs south and west of U. S. Highway 14 and 16, where the maximum local relief is about 450 feet. Valleys and gulches have steep barren walls to within a few hundred feet of their heads. Cottonwoods grow along valley bottoms and sparse stands of pine grow on a few clinker-capped hills. A few straggling junipers grow near the top of buttes and divides.

The Powder River flood plain, which has an average width of about one-half mile, follows a sinuous, northeasterly-trending course across the north-central part of the coalfield. The valley has steep slopes generally rising 100–600 feet above the valley floor, although north of Big Remington Creek and Gray Cabin Draw the slopes are interrupted by a series of benches which have formed on resistant clinker. The flood plain of Clear Creek, about three-eighths of a mile wide, trends northeasterly across T. 56 N., R. 77 W. to join the Powder River flood plain in sec. 31, T. 57 N., R. 76 W. Clear Creek valley closely resem-

bles the valley of the Powder River and has slopes of comparable height and steepness. Most tributaries to Powder River and Clear Creek occupy straight narrow deep valleys.

Well-defined erosion surfaces supported by resistant but deeply dissected strata occur at two levels. The upper surface, which ranges in altitudes from about 4,450 to 4,660 feet, caps high buttes and divides in the area south and west of U. S. Highway 14 and 16. Large areas of the upper erosion surface are preserved on the flat divide between the Powder River and the Little Powder River in T. 53 N., R. 74 W., and in the southern part of T. 53 N., R. 75 W. Smaller areas of this surface remain on a few high clinker-capped buttes in T. 54 N., Rs. 74 and 75 W. Much of this erosion surface is underlain by the resistant clinker formed by the burning of the Ulm No. 2 coal bed, but in the southwestern part of T. 53 N., R. 75 W. it is underlain by a thick bed of sandstone that overlies the Ulm No. 2 bed.

The lower erosion surface is found at altitudes of 4,000–4,260 feet and is preserved on high stream divides and flat-topped buttes in the area north and east of U. S. Highways 14 and 16. The largest areas remain on the divide between the Tongue River and the Powder River in the westernmost tier of townships, and on the divide between the Powder River and the Little Powder River in T. 55 N., Rs. 73 and 74 W. In the north-central part of the Spotted Horse coalfield this surface has been destroyed by erosion, except on some of the high stream divides.

DRAINAGE AND WATER SUPPLY

About three-fourths of the Spotted Horse coalfield is in the Powder River drainage basin. Tributaries of the Little Powder River drain about 145 square miles in the southeastern part of the area, and tributaries of the Tongue River drain about 35 square miles in the northwestern corner.

The Powder River heads in central Wyoming near the town of Powder River, and flows northward to join the Yellowstone River near Terry, Mont. In the Spotted Horse coalfield it has a meandering channel with a gradient of about 5½ feet per mile. Normally the river is wide, shallow, and muddy, but at times it has no surface flow. On the accompanying geologic map (plate 1) the Powder River is shown as a perennial stream north of Clear Creek, but at times the flow of Clear Creek is not sufficient to maintain a surface flow for more than a few miles below the junction of these two streams. The Powder River Valley is subject to flooding during periods of heavy rainfall, generally in the spring and autumn. On September 29, 1923 a flood, remembered by older settlers as the most destructive in the history of the region, swept away homes, equipment, fences, and crops

and destroyed much livestock. This flood was estimated to have attained a maximum flow of 95,000 second-feet near Arvada, Wyo. (Follansbee and Hodges, 1925, p. 119–120.) As the waters receded, the river occupied a channel quite different from that of its earlier course.

Clear Creek heads to the west in the Bighorn Mountains and empties into the Powder River in sec. 31, T. 57 N., R. 76 W. In contrast to the turbid Powder River, the water of Clear Creek is clean, though the creek diminishes to a mere trickle in unusually dry summers or during prolonged drouths. A Geological Survey gauging station near the mouth of Clear Creek recorded a minimum flow of 0.2 second-feet on August 16 and 17, 1940, and a maximum flow of 9,000 second-feet on June 26, 1942 (Paulsen and others, 1950, p. 246). The gradient of the stream is about 6½ feet per mile.

Other streams flow only for short periods after summer rains and during wet seasons. Seepage beneath small earth reservoir dams along stream channels usually is sufficient to cause flow for short distances. Torrential downpours during summer thunder storms produce local flash floods in tributary valleys. However, as the valleys are small and are sparsely settled, the floods generally do not inflict great damage.

In many of the valleys springs flow from the base of coal beds overlying carbonaceous shale, but high alkali content renders much of their water unfit for domestic use. Potable water generally comes from shallow open wells, cisterns, and wells drilled to depths of 100–600 feet. A few artesian wells have been drilled along the Powder River and east of the divide between the Powder River and the Little Powder River south of Recluse. The artesian flows generally are accompanied by natural gas. Most of the drilled wells are pumped by windmills, but several are pumped by gasoline motors. The shallow open wells generally have water which is relatively free from alkali but which has an unpleasant odor. The cisterns are filled with snow during the winter, and the melt water from the snow is pumped as needed.

CLIMATE

The Spotted Horse area has a semiarid climate with large annual ranges in temperature. In 1948 the low temperature was −27° on February 11, and the high was 104° on August 11, as reported by the United States Weather Bureau station three miles north of Arvada, Wyo. During the same year there were 144 days between the last frost of spring and the first frost of fall. Average annual precipitation was 13.32 inches for a ten year period ending January 1, 1949. About three-fourths of the moisture fell during spring and autumn storms, many of which lasted for several days. Summer rainfall is characterized by local thunder-showers.

TIMBER

Scattered stands of western pine and cottonwood constitute almost all the timber resources of the area. North of the valleys of Seventy-Six, Squaw, and Ivy Creeks most of the pines grow on weathered outcrops of clinker and thick beds of sandstone in the Tongue River member of the Fort Union formation. The Wasatch formation which supports only a few widely spaced pines is more extensive south of these three valleys, and there pines are much less abundant.

Where the land has not been cleared for cultivation along the Powder River and Clear Creek flood plains, cottonwoods are interspersed with small clumps of box elder, ash, and willow and undergrowth of small shrubs and brambles. Elsewhere in the area cottonwood trees generally grow in narrow belts, rarely more than 150 feet wide, along stream channels. Junipers grow in widely spaced coppices or as lone trees on and near the tops of stream divides.

POPULATION AND ROUTES OF TRAVEL

The Spotted Horse coal field is a sparsely populated area and contains no incorporated towns. Recluse, with a population of about 25, is the largest settlement. Post offices are located at Recluse, Spotted Horse, and Wild Cat. Two stores, one having the post office, are the only buildings at Moorhead, Mont., on the west bank of the Powder River 3 miles north of the Montana State line. The Moorhead-dam campsite of the United States Bureau of Reclamation is about halfway between the State line and Moorhead. Arvada, which has a population of about 100, is on the Powder River about 9 miles south of the area. The nearest commercial centers are Sheridan, about 40 miles west of the Spotted Horse field, and Gillette, about 17 miles southeast of the field.

U. S. Highway 14 and 16, an all-weather paved road between Sheridan and Gillette, crosses the southern part of the Spotted Horse area. Several graded and clinker-surfaced county roads traverse the area, generally following the main valleys and divides. Several unimproved roads cross the Powder River and Clear Creek at fords that are passable by automobile only during low water or when the streams are frozen.

The line of the Chicago, Burlington & Quincy Railroad between Billings, Mont., and Alliance, Nebr., passes within 2 miles of the southwest corner of the mapped area. Good loading facilities on this are available at Arvada.

LAND USE

Cattle raising is the chief industry of the region. A few herds of sheep are grazed on the higher slopes. The number of cattle that can be grazed on a section of land—about 20–35 head—depends upon the

amount of forage and water available. Marketable stock generally are shipped in autumn to eastern markets. A few horses are raised but mostly for local use.

Dry farming of wheat, barley, oats, and hay is practiced on the high flatlands of the major divides and in the bottom lands bordering Powder River and Clear Creek. Grain is the chief crop on the flatlands of the divides, particularly those in the vicinity of Recluse, Wildcat, and Spotted Horse; and hay, which is used for winter feeding of livestock, is the chief crop in the valleys.

Stock raising and farming are subject to the devastating effects of extremely dry years and of hordes of grasshoppers which frequently plague the area. Agencies of the Federal and State governments in cooperation with the landowners have instituted a program to control the spread of grasshoppers by spraying infested areas with poison.

GEOLOGY

STRATIGRAPHY

Rocks that crop out in the Spotted Horse coalfield range in age from early Tertiary to Recent. The coal-bearing strata are of early Tertiary age and occur in the Tongue River member of the Fort Union formation and in the Wasatch formation. The thicker, more persistent beds have been correlated on plate 5 with beds in adjacent coal fields. Quaternary rocks consist of terrace deposits and alluvium. Small patches of Pleistocene(?) gravel occur at various levels above the Powder River and Clear Creek. Alluvium covers flood plains of the major streams.

TERTIARY SYSTEM

TONGUE RIVER MEMBER OF THE FORT UNION FORMATION (PALEOCENE)

The Tongue River member is defined by Thom and Dobbin (1924, p. 495) as consisting

> of yellow or light-colored strata containing massive sandstones and numerous thick coal beds. . . . The top of the member as here defined is placed beneath bed *K* of the Sidney field, bed *F* of the Sentinel Butte field, and the Roland coal bed of the Sheridan field. The base of the member is placed beneath the light-colored, coal-bearing rocks which characteristically form a marked clinker-capped escarpment rising above lowlands or badlands developed from the somber Lebo shale.

In the Spotted Horse coalfield the Tongue River member is about 1200–1300 feet thick, but only the upper 900 feet is exposed. It is of continental origin, and consists mainly of friable yellowish-gray sandstone, waxy medium-gray shale, coal, and dusky-brown shale. Rocks of the Tongue River member crop out in about two-thirds of the mapped area. The best exposures occur in the north-central and northeastern parts of the area along the Powder River and its tributaries.

The prevailing color of rocks in the Tongue River member is yellowish gray. At many places, however, they have been baked by burning of underlying coal beds to form brittle hard clinker, colored various shades of red, purple, and violet. The clinker is resistant to erosion and underlies many high surfaces on the divides and prominent benches along the ridges (pl. 12, *A*).

Only the upper part of the Tongue River member in the Spotted Horse field was measured, as the base of the mmber is not exposed. In the Sheridan coalfield the Tongue River coal group, correlated with the Tongue River member, is about 800 feet thick (Taff, 1909, p. 129). In the northward extension of the Sheridan coalfield, Baker (1929, p. 27) estimated it to be from 1,626–1,790 feet thick. According to Bass (1932, p. 35), it is 1,150–1,600 feet thick in the Ashland coalfield, although the upper 200–300 feet is missing, owing to post-Paleocene erosion. In the Gillette coalfield the member is 250–400 feet thick (Dobbin and Barnett, 1927, p. 9–10); however, the upper boundary of the member in this coalfield is placed about 350 feet below the upper boundary in the Spotted Horse field. Plate 4, a fence diagram, shows the relationship of the Tongue River rocks to the overlying Wasatch formation and to the underlying Lebo shale member of the Fort Union formation in parts of northeastern Wyoming and southeastern Montana.

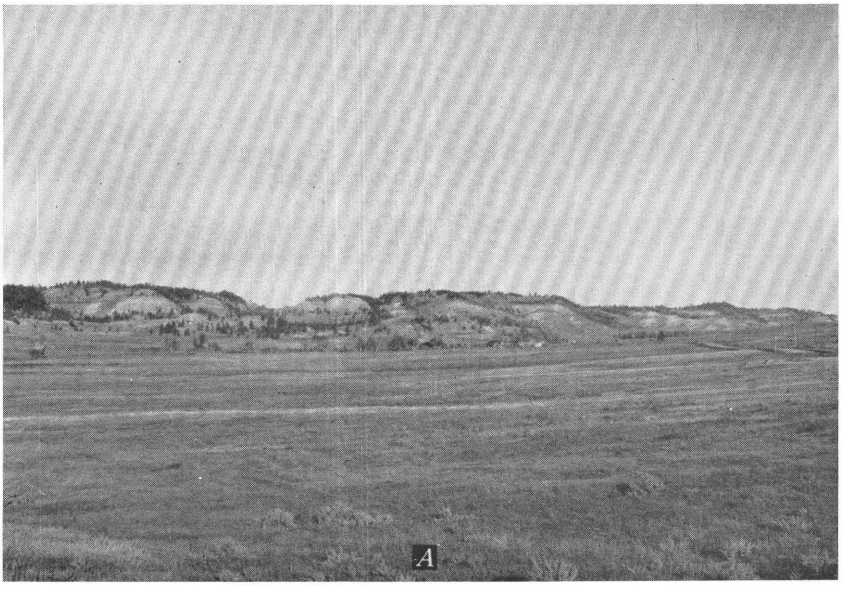
The following detailed section is representative of that part of the Tongue River member which crops out in the Spotted Horse field.

Section measured in sec. 25, T. 57 N., R. 77 W., Wyo.

	Feet	*Inches*
Top of hill.		
Wasatch formation: sandstone, medium-grained, friable, yellowish-gray; contains log-shaped concretions 15–20 ft. long	96	
Fort Union formation:		
Tongue River member:		
Shale, dusky-brown		5
Coal (Roland bed)	2	4
Sandstone, medium-grained, friable, yellowish-gray	15	8
Sandstone, well-indurated, platy, ledge-forming, yellowish gray	2	
Sandstone, medium-grained, friable, yellowish-gray	26	2
Coal (local bed)	1	8
Shale, dusky-brown		8
Shale, gray; interbedded with fine-grained yellowish-gray sandstone	3	9
Shale, dusky-brown and black	2	8
Sandstone, friable, yellowish-gray	42	
Coal (local bed):		
Coal		3
Shale, dusky-brown	1	
Coal	2	6
Sandstone, fine- to medium-grained, friable, yellowish-gray	24	

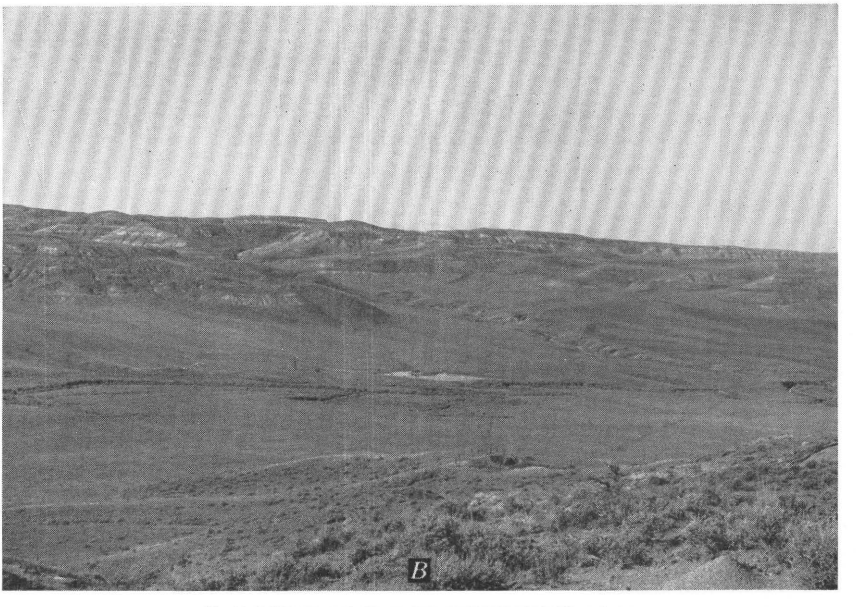
Section measured in sec. 25, T. 57 N., R. 77 W., Wyo.—Continued

	Feet	Inches
Fort Union formation—Continued		
Tongue River member—Continued		
Shale, dusky-brown	3	6
Coal (local bed)	5	7
Shale dusky-brown	3	1
Sandstone, medium-grained, friable, yellowish-gray	28	
Coal (local bed):		
Coal		4
Shale, dusky-brown		10
Coal		5½
Shale, dusky-brown	1½	
Coal	1	4
Shale, dusky-brown	4	4
Sandstone, yellowish-gray; interbedded with light-gray shale	28	
Shale, dusky-brown	7	3
Coal (Smith bed); contains fossilized wood	7	10
Sandstone and shale, interbedded, gray and yellowish gray; fragments of pelecypod shells occur from 30 to 35 feet above base of unit	58	6
Sandstone, fine-grained, well-indurated, orange	1	6
Sandstone, fine-grained, friable, light-gray; contains fragments of pelecypod shells	15	
Sandstone, fine-grained, well-indurated, orange	2	7
Sandstone, friable, yellowish-gray and gray	28	8
Shale, dusky-brown and black	6	
Coal (local bed), contains fossil wood	1	7
Shale, dusky-brown and black	6	6
Sandstone, friable, yellowish-gray; contains indurated sandstone lenses	22	
Coal (Anderson bed):		
Coal	4	6
Shale, black	2	6
Coal	10	1
Shale, dusky-brown	9	6
Sandstone, fine-grained, friable, yellowish-gray, contains thin layers of dusky-brown shale	42	
Coal (local bed)		9
Shale, dusky-brown		2
Sandstone, fine-grained, friable, yellowish-gray; contains ironstone concretions	6	3
Shale, dusky-brown	2	10
Coal (Dietz No. 1 bed)	2	9
Shale, dusky-brown		9
Sandstone, fine-grained, gray	4	8
Sandstone, well-indurated, light-brown, ledge-forming	2	10
Sandstone, fine-grained, gray	3	2
Sandstone, fine-grained, well-indurated, yellowish-brown	1	9
Sandstone, fine-grained, gray; contains ironstone concretions	28	
River level:		
Total, Fort Union formation (Tongue River member)	494	8



A. OUTCROP OF THE TONGUE RIVER MEMBER OF THE FORT UNION FORMATION

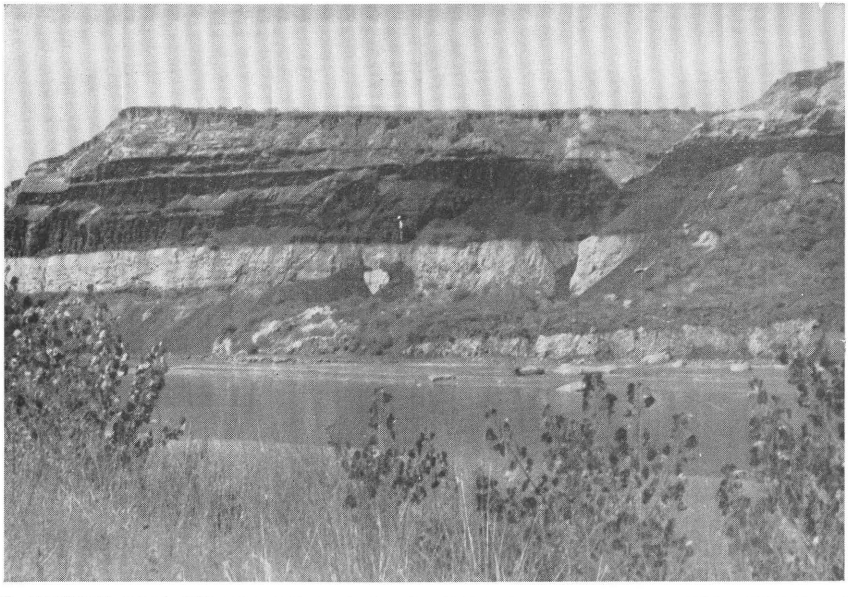
Characteristic topography and vegetation on outcrops of the Tongue River member. The even-topped ridges in the background are held up by clinker of the Anderson bed. View is west across Bitter Creek from the NW¼, sec. 23, T. 75 N., R. 74 W.



B. OUTCROP OF THE WASATCH FORMATION

Characteristic topography of outcrops of the Wasatch formation. The Felix coal bed crops out near the base of the steep slopes that border the valley. View is southwest across Middle Prong of Wildhorse Creek from the NW¼, sec. 11, T. 54 N., R. 75 W.

A. WEATHERED BLOCKS ON COQUINAL LIMESTONE FROM THE FOSSILIFEROUS ZONE NEAR THE TOP OF THE TONGUE RIVER MEMBER IN THE NE¼, SEC. 6 T. 57 N., R. 77 W.



B. CANYON COAL BED EXPOSED IN THE WEST BANK OF THE POWDER RIVER AT LOCALITY 376 IN SEC. 20, T. 57 N., R. 76 W.

In the north-central part of the Powder River Basin the Roland coal bed, which was named in the Sheridan coalfield, Wyo., is the uppermost unit of the Tongue River member as defined by Thom and Dobbin (1924, p. 495) and accepted by the Geological Survey (Wilmarth, 1938, p. 2163). Inasmuch as the Roland bed is not continuous in the Spotted Horse field and its top cannot be used as a convenient mappable horizon; the top of the member was mapped on the top of a persistent, highly fossiliferous unit of shale, sandstone, and limestone which occurs 5–65 feet above the Roland bed. The fossiliferous unit is in the upper part of a transition zone, 150 to 200 feet thick, within which the light-colored beds of the Tongue River member grade into lithologically similar, but darker strata of the Wasatch formation.

At most places the fossiliferous unit is easily recognized because of numerous pelecypod and gastropod shells that litter its outcrops; the most conspicuous components are beds of coquinal limestone that weather into grayish-white ledge-forming blocks (plate 13, *A*). In T. 58 N., R. 78 W. the unit reaches a maximum observed thickness of about 30 feet. Fossils collected from the unit in this township are listed on page 15. The unit thins southward to about 5–10 feet in T. 56 N., Rs. 77 and 78 W. and eastward to 1–2 feet in Tps. 56 and 57 N., R. 76 W., and T. 56 N., R. 75 W. Here it is a ledge-forming, fossiliferous limestone, generally underlain by a few inches of fossiliferous shale. The unit pinches out in the northwestern part of T. 55 N., R. 75 W. It was traced into T. 58 N., R. 77 W. from the Moorhead coalfield, where it is thought by R. P. Bryson (oral communication) to be the same fossiliferous unit that occurs above the Roland coal bed in the northward extension of the Sheridan coalfield. It is also correlated with a fossiliferous unit below the Arvada coal bed in the Powder River coalfield.

In the Gillette coalfield Dobbin and Barnett (1927, p. 10) placed the upper boundary of the Tongue River member at the top of the *D* coal bed, which they believed to be the Roland bed. The *D* bed of the Gillette coalfield is correlated in this report with the Anderson coal bed of the Spotted Horse field and is about 350 feet stratigraphically below the fossiliferous unit used to mark the top of the Tongue River member. Tongue River rocks above the *D* coal bed probably have been removed by pre-Wasatch erosion in the Gillette coalfield. Wegemann (1929, p. 4) placed the top of the Fort Union formation at the top of the *H* coal bed in the Pumpkin Buttes coalfield southwest of Gillette; however, in this same area Brown (1949) showed the top of the Fort Union formation at a somewhat higher level.

Eastward and southeastward of the NW¼ sec. 12, T. 55 N., R. 75 W., strata of the Tongue River member above the Smith coal bed wedge out and the Wasatch formation overlies the Smith coal bed. East of the Powder River-Little Powder River divide the interval between the

Smith coal bed of Tongue River age and the Felix coal bed of Wasatch age is occupied by 160 feet of cross-bedded, coarse-grained sandstone. In places to the west the interval between these two beds is occupied by 670 feet of interbeded sandstone, shale, and coal—225 feet belonging to the Tongue River member and 445 feet to the Wasatch formation (see plate 3). This relationship suggests that the southern part of the mapped area was uplifted slightly at the close of the Paleocene, with a resulting change from deposition to nondeposition or erosion. The sandstone between the Smith and Felix coal beds is assigned to the Wasatch formation and is interpreted as an aeolian deposit that accumulated above the eroded Tongue River member near the eastern margin of a basin in which the Wasatch formation was deposited. While the sandstone was being laid down, shale, sandstone, and coal, indicative of swampy conditions, were accumulating in the west in other parts of the basin during Wasatch time. As the basin filled, swamps encroached eastward and the material of the Felix coal bed accumulated on the sandstone. Owing to this transgression of the basin margin the Felix bed is about 100 feet higher stratigraphically near the eastern margin of the basin than in areas to the west. The stratigraphic position of the Felix coal bed is treated in more detail in the discussion of the Wasatch formation. Throughout the southern part of the field the Wasatch–Fort Union contact is nearly everywhere covered by soil and slope wash derived from the basal Wasatch sandstone and can be only approximately located.

Plant fossils are abundant in the Tongue River member of the Fort Union formation, and invertebrate fossils, chiefly pelecypod and gastropod shells, occur in thin, widely-spaced beds at widely spaced stratigraphic levels. The plant fossils consist of impressions, coalified and carbonized leaves, twigs and stems, and fossil wood. Plant impressions occur chiefly in the medium-gray shale and yellowish-gray sandstone and are best preserved in rocks that have been somewhat hardened by burning of underlying coal beds. Coalified plant material commonly occurs in dusky-brown shale associated with coal beds, but the material is in such small pieces that identification is difficult. Silicified and "ocherized" stumps and pieces of wood are abundant in some coal beds. No plant fossils were collected in the Spotted Horse area.

The following list of fossil leaves from the lower part of the Tongue River member in the Coalwood coal field, Powder River County, Mont., was collected by R. P. Bryson and identified by Roland W. Brown.

Platanus raynoldsi Newberry
Betula sp.
Onoclea sensibilis fossilis Newberry
Cabomba inermis (Newberry) Hollick
Quercus sp.
Viburnum antiquum (Newberry) Hollick
Sapindus grandifoliolus Ward
Corylus fosteri Ward
Equisetum sp.
Viburnum asperum Newberry
Laurus sp.

Two collections of pelecypod and gastropod shells from the fossiliferous unit at the top of the Tongue River member have been identified by Teng-Chien Yen of the U. S. Geological Survey as follows:

Locality: NW¼ sec. 24, T. 58 N., R. 78 W.
Elliptio cf. *E. priscus* (Meek and Hayden)
Viviparus raynoldianus (Meek and Hayden)
Lioplacodes mariana Yen
Lioplacodes? limnaeiformis (Meek and Hayden)
Locality: NW¼ sec. 32, T. 58 N., R. 78 W.
Elliptio cf. *E. priscus* (Meek and Hayden)
Viviparus trochiformis (Meek and Hayden)
Lioplacodes tenuicarinata (Meek and Hayden)
Lioplacodes mariana Yen
Lioplacodes? limnaeiformis (Meek and Hayden)
Pleurocera? warrenanum (Meek and Hayden)
Gyraulus parvulus (Meek and Hayden)
Carinulorbis planospiralis Yen

Yen (1952, personal communication) regards these assemblages as indicating an upper Paleocene age—probably the same as the age of the Roland coal beds. Yen (1948, p. 35–47) has described fossils collected from this and other zones in the Tongue River member of southern Montana.

WASATCH FORMATION (EOCENE)

The Wasatch formation underlies large areas in the western and southern parts of the Spotted Horse coalfield and caps many divides in the north-central part. North of T. 55 N., Rs. 74 and 75 W. it rests conformably on the Tongue River member of the Fort Union formation, but in the southern part of the field it overlies an erosional surface which bevels successively older rocks of the Tongue River member southward. The maximum local thickness of the formation is more than 700 feet in the western part of the mapped area.

The Wasatch formation and the underlying Tongue River member show no marked difference in lithology, inasmuch as the Wasatch also consists of continental deposits of sandstone, shale, and coal. The predominant color of the formation is moderate yellowish-brown. The drab color of the Wasatch and the scarcity of timber that characterizes its outcrops are in strong contrast to the lighter colors and small stands of timber that characterize the outcrops of the Tongue River member (see plate 12*B*).

Although the Wasatch formation is thickest in the western part of the area, the youngest and stratigraphically highest beds occur in the southern part (see plate 5). In the southwestern part of T. 57 N., R. 78 W. a coal bed that is tentatively correlated with the Felix coal bed is about 430 feet above the base of the Wasatch formation. The intervening rocks are shale, sandstone, and a few thin coal beds

which thin eastward and grade laterally into sandstone. In the west-central part of T. 54 N., R. 74 W. the interval is formed by about 160 feet of yellowish-gray friable crossbedded coarse-grained sandstone containing many ironstone concretions.

The easterly decrease in thickness of strata between the Felix and Ulm No. 2 coal beds from about 330 feet in the northeastern part of T. 54 N., R. 74 W. to about 250 feet in the northwestern part of T. 54 N., R. 73 W. is due largely to lensing out of such strata.

The following detailed section shows the composition and character of rocks in the Wasatch formation in the Spotted Horse area.

Section measured in S½ sec. 14, T. 53 N., R. 75 W., Wyo.

Top of Hill.

Wasatch formation:	*Feet*	*Inches*
Sandstone, yellowish-gray	1	6
Shale, pale-brown	8	2
Shale, dusky-brown	1	1
Coal (Ulm no. 1 bed)	10	10
Shale, dusky-brown	2	4
Sandstone, fine-grained, friable, yellowish-gray; contains lenses of well-indurated sandstone	7	3
Shale, dusky-brown	1	
Shale, pale-brown to pale-olive; contains many gypsum crystals	9	5
Shale, dusky-brown	1	8
Sandstone, friable, yellowish-gray	3	10
Shale, dark-yellowish-brown		5
Coal (local bed)	2	4
Shale, dusky-brown	1	2
Shale, silty, yellowish-gray; becomes darker near top	8	11
Sandstone, medium-grained, friable, crossbedded, yellowish-gray	8	7
Sandstone, medium-grained, friable, crossbedded, white	24	10
Unconformity.		
Coal (Ulm No. 2 bed):		
Coal, contains fossil tree stumps	2	11½
Sandstone, fine-grained, light olive-gray		1
Coal		5
Shale, light olive-gray	1	8
Coal	1	4
Sandstone, friable, yellowish-gray to dusky-brown	12	
Shale, light medium-gray	2	11
Coal (local bed):		
Coal		10
Shale, dark-yellowish-brown		7
Coal		6
Shale, dark-yellowish-brown		6
Covered	5	4
Sandstone, medium-grained, well-indurated, yellowish-gray; ledge-forming	2	5
Sandstone, friable, pale yellowish-brown	13	
Shale, light medium-gray	2	4
Siltstone, shaly, pale-yellow; and fine-grained friable sandstone	10	3

Section measured in S½ sec. 14, T. 53 N., R. 75 W., Wyo.—Continued	*Feet*	*Inches*
Shale, light-medium-gray	1	4
Sandstone, fine-grained, friable, pale-yellowish-gray	4	
Shale, medium-light-gray	7	3
Sandstone, coarse-grained, pale-yellowish-gray; contains oval concretions, 6–10 ft. in diameter, of indurated sandstone	36	
Shale, dusky-brown		9
Shale, light-medium-gray	1	
Sandstone, medium- to coarse-grained, friable, pale-yellowish-gray	1	9
Unconformity.		
Coal (local bed)	2	10
Shale, pale-brown to dusky-brown		7
Shale, light-medium-gray		6
Sandstone, friable, pale yellowish-gray; contains lenses of well-indurated sandstone	14	6
Shale, pale-yellowish-brown	3	6
Shale, dusky-brown	1	9
Coal (local bed)	2	6
Shale, dusky-brown		5
Shale, light-olive-gray	1	3
Shale, dusky-yellow		6
Sandstone, friable, pale yellowish-gray	8	5
Shale, medium light-gray	5	
Sandstone, medium-grained, well-indurated, pale-yellowish-gray	1	6
Sandstone, friable, moderate-yellow	10	5
Shale, medium light-gray	1	2
Shale, yellowish-brown		4
Coal (local bed); contains lenses of well-indurated sandstone	2	10
Shale, dusky-brown	5	
Sandstone, friable, pale-yellowish-gray	10	2
Shale and silty shale, light-moderate-gray	2	8
Shale, dusky-brown and pale-yellowish-brown	1	11
Sandstone, friable, pale-yellowish-gray; with dark-yellowish-orange stains	13	7
Shale, olive-gray		2
Coal (local bed):		
Coal	4	2
Shale, dusky-brown	2	4
Coal		5
Shale, dusky-brown	0	5
Sandstone, friable, pale yellowish-gray	5	7
Shale, olive-gray	0	6
Coal (local bed), shaly	0	6
Shale, olive-gray	0	8
Covered	1	8
Siltstone, shaly, light olive-gray	6	
Sandstone, well-indurated, ledge-forming, pale-gray; weathering yellowish-orange	16	2
Shale, dark yellowish-brown		1
Coal (local bed)	1	11
Shale, dusky-brown		2
Shale, olive-gray	1	6
Covered	28	6

Section measured in S½ sec. 14, T. 53 N., R. 75 W., Wyo.—Continued	*Feet*	*Inches*
Sandstone, fine-grained, friable, grayish-yellow; contains lenses of indurated sandstone	30	
Siltstone, shaly, light olive-gray; moderate-yellow stains along bedding planes	2	8
Coal (Felix bed):		
Coal	2	6
Siltstone, shaly, medium-gray	1	3
Coal	2	1
Sandstone, medium-grained, very friable, pinkish-gray, lenticular		11
Coal	1	6
Sandstone, medium-grained, very friable, pinkish-gray, lenticular	3	7
Coal	11	8
Siltstone, shaly, medium-gray		10
Coal	17	6
Shale, dusky-brown		7½
Shale, slightly silty, light olive-gray; contains moderate-yellow vein-like stains	3	1
	442	10

The use of the term Wasatch formation as applied to continental deposits of Eocene age in the northern Powder River Basin has been the subject of considerable discussion. The term Wasatch formation was applied by F. V. Hayden (1869, p. 191, Wilmarth, 1938, p. 2277–2278) to beds of variegated sands, clays, and conglomerates of continental origin well-exposed in Echo and Weber Canyons in the Wasatch Mountains of Utah, about 450 miles from the Spotted Horse coalfield. The name was first used in northeastern Wyoming by Wegemann (1918, p. 57–60) who assigned 2,400 feet of rocks of freshwater origin, exposed between Pumpkin Buttes and Great Pine Ridge, about 50 miles south of the Spotted Horse area, to the Wasatch. This assignment was based principally on the occurrence of the fossil *Coryphodon* in these rocks. Wegemann (1918, p. 60) also expressed the "opinion that the Kingsbury conglomerate[1] is equivalent to part of the Wasatch, and that the unconformity at its base separates that formation, in the Kingsbury region at least, from all older rocks."

As is true for most continental deposits of this type, it is difficult to correlate deposits of one basin of deposition with those of another. Commenting on Wegemann's use of the name Wasatch for rocks in the Pumpkin Buttes area, Nace (1936, p. 131) writes:

> In the present writer's opinion, the paleontologic evidence proffered by Wegemann does not justify use of the name, Wasatch, in the Pumpkin Buttes area. The nearest equivalents of the Pumpkin Buttes "Wasatch" appear to be the Clark Fork and lower Greybull horizons, both of which are definitely older

[1] Exposed on the east flank of the Big Horn Mountains about 50 miles west of the Spotted Horse area.

than the only known mammal-bearing horizon (Knight member) of the typical Wasatch in southwest Wyoming. The Clark Fork and Greybull have been included in the so-called Big Horn Wasatch by some writers, but the legitimacy of this usage is questioned since the Clark Fork horizon has no known equivalent in any part of the typical Wasatch.

In the Sheridan coalfield, which joins the Spotted Horse field on the west, Taff (1909, p. 127–131) divided the coal-bearing rocks, including correlatives to those exposed in the Spotted Horse area, into a lower and upper member, and subdivided the upper member, from bottom to top, into the Tongue River, Intermediate, and Ulm coal groups. Thom and Dobbin (1924, p. 494–496) raised the Tongue River coal group to the rank of member of the Fort Union formation, and correlated the Intermediate coal group with the Sentinel Butte shale of western North Dakota, which they assigned to the Wasatch instead of the Fort Union. They also placed the Ulm coal group in the Wasatch. Nace (1936, p. 104–106, and 131) later proposed that the Intermediate group be designated Sentinel Butte shale and the Ulm group be raised to the rank of formation. These proposals now appear untenable, inasmuch as Brown (1948) has found stratigraphic and paleontologic evidence that suggests the Sentinel Butte shale is Paleocene in age and is equivalent to the upper part of the Fort Union formation.

Although Nace (1936, p. 131) and Wood (1941, p. 35–36) questioned the propriety of the term Wasatch formation as used in northern Powder River Basin, it is retained in this report to conform with long-accepted and widespread usage in the Powder River Basin.

The Wasatch formation of the Spotted Horse field is correlated with the Intermediate and Ulm coal groups of the Sheridan (Taff, 1909), Barber (Wegemann, 1913), and Powder River (Stone and Lupton, 1910) coalfields. The formation has also been mapped in the Pumpkin Buttes (Wegemann and others, 1929) and Gillette (Dobbin and Barnett, 1927) coalfields and the northward extension of the Sheridan coalfield (Baker, 1929).

Fossil plants and mollusk shells are abundant in some beds of the Wasatch formation. Roland W. Brown visited the Spotted Horse field during the field seasons of 1948 and 1949 and collected the plant *Salvinia preauriculata* in the western part of the area from beds above and below a coal bed which is tentatively correlated with the Felix bed and in the southern part of the area from strata overlying the Felix bed. Brown (1951, written personal communication) considers this species to be definitely of early Eocene age, but as regards other plant fossils he states: "It is plain that many, perhaps most, of the Fort Union species continued into the Wasatch."

Mollusk shells were collected by W. J. Mapel in 1950 from beds of the Wasatch formation near the U. S. Coast and Geodetic Survey

triangulation station in the northern part of sec. 5, T. 55 N., R. 78 W. These were identified by Teng-chien Yen who considers them to be early Eocene in age. His identifications are as follows:

Unio sp. undet.
Valvata sp. undet.
Viviparus paludinaeformis (Hall)
Goniobasis cf. *G. tenera* (Hall)
sp. undet.

QUATERNARY SYSTEM

PLEISTOCENE(?) GRAVELS

Deposits of sand and gravel cover small areas at various heights above the valley floors of the Powder River and Clear Creek. The gravel is composed predominantly of rounded to subangular pebbles and cobbles of quartzite, sandstone, and chert derived from outside the Spotted Horse coalfield. Disc-shaped pebbles of a limestone that closely resembles the Madison limestone (Mississippian) in the Bighorn Mountains, and rounded pebbles of igneous rocks occur in small quantities. Clinker derived from local sources is present in gravel deposits that are less than 100 feet above the Powder River and Clear Creek.

The highest terrace in the Spotted Horse field occurs at altitudes of 3,800–3,960 feet, or 400–425 feet above the Powder River, and is best represented by beds of sand and gravel in sec. 1, T. 57 N., R. 76 W., and near the summit of the Powder River–Clear Creek divide in T. 56 N., R. 77 W. Smaller deposits occur on the divides between Big Remington and Little Remington Creeks, between Short and Fence Creeks, and along the Montana State line in sec. 24, T. 58 N., R. 75 W.

Watson Basin in sec. 10, T. 57 N., R. 75 W. was formed by a meander of the Powder River when the valley bottom was about 150 feet higher. Gravel deposits near the center of the basin are 10–20 feet higher than the surrounding level and represent a lens in the alluvial deposits of the old river bed.

RECENT DEPOSITS

Sand, silt, and clay, with lenses of gravel and rubble, surface the floor of the main valleys in the Spotted Horse area. The gravels come mainly from the terrace gravels, but some were carried from the Bighorn Mountains by the Powder River and Clear Creek during floods. Blocks of angular sandstone and clinker fragments from nearby outcrops comprise the rubble deposits. Borings along a line across the Powder River valley at the proposed Moorhead dam site, where the valley bottom is about 1,700 feet wide, penerated 12–21 feet of alluvium [2] before reaching bedrock.

[2] From unpublished data in the files of the United States Bureau of Reclamation, Region 6, Billings, Mont.

STRUCTURE

The Spotted Horse coalfield is in the north-central part of the Powder River Basin, the major structural depression between the Bighorn Mountains on the west and the Black Hills on the east. The sedimentary rocks in the coalfield dip gently southwestward, but slight reversals of the dip indicate shallow synclines and anticlines in the surface rocks. Dip generally is less than 3 degrees but is as much as 11 degrees near faults.

The structure of surface rocks in the area is shown on plates 1 and 2 by contours drawn on the bases of the Smith and Ulm No. 2 coal beds, and the attitudes and stratigraphic positions of the main coal beds are shown by the cross sections. Most of the elevations used in drawing the contours were measured on coal beds, the most persistent and easily recognized rock units. Some elevations were determined on the bases of persistent beds of sandstone and on the bases of beds of fossiliferous limestone near the top of the Tongue River member of the Fort Union formation. Many intervals between coal beds were determined by hand-leveling, and these were used in reducing the elevations to a common reference plane. For most of the field the contour lines are shown on the base of the Smith coal bed, and on its inferred base in those parts of the field where the Smith bed has been removed by erosion. The base of the Ulm No. 2 coal bed, inferred where absent, represents the reference plane in the southern part of the field, where the Wasatch formation unconformably overlies the Tongue River member. Contour lines were not drawn for parts of Tps. 56 and 57 N., R. 78 W., owing to the inadequacies of correlations.

FOLDS

The dominant structural feature in the area is a belt about 8 miles wide of shallow southwesterly plunging folds trending about N 25° E. across Tps. 56 and 57 N., R. 76 W. and Tps. 56 and 57 N., R. 77 W. These folds merge into a shallow syncline, which trends eastward across the northern row of townships. Elsewhere in the area still less pronounced folds trend parallel to this belt of shallow folds. Other small gentle folds trend about N. 45° W.

FAULTS

Faults in the Spotted Horse field are concentrated in three areas. Six faults were mapped near the southern end of the belt of low folds, and five were mapped near the northern end where the belt merges into the shallow syncline. The third concentration, 5 faults, is in T. 54 N., Rs. 74 and 75 W. Other faults are widely spaced. All but one of the faults are normal. Displacement ranges from about 20 to 300 feet, and fault traces range in length from a fraction of a mile to about 3½ miles. Most of the faults trend either northeastward or eastward.

Strata on the upthrown side of many faults are relatively flat; those on the downthrown side dip steeply toward the fault but flatten a short distance from it, so that the beds are vertically offset only near the fault. This type of faulting occurs near the central parts of Tps. 56 and 58 N., R. 77 W., in the northeastern corner of T. 58 N., R. 76 W., in the south-central part of T. 56 N., R. 76 W., and south of U. S. Highways 14 and 16. Strata along both sides of other faults have relatively steep dips.

A northeasterly trending fault, in the north-central part of T. 58 N., R. 76 W., with the north side downthrown, has a displacement of 100–150 feet in Black Canyon Prong and Red Prong valleys, but on the divide between the two valleys the displacement is only one or two feet.

A graben along the south boundary of T. 58 N., R. 76 W. is bounded on the southeast by a reverse fault and on the northwest by a normal fault. The reverse fault dips 62 degrees and trends northeastward with a throw of 150 feet. The normal fault, parallel to and one-half mile northwest of the reverse fault has a displacement of 100 feet. Another graben, about 1⅓ miles wide, which occurs near the northeastern corner of T. 56 N., R. 77 W. is bounded by two northeastward trending normal faults, each with displacement of about 200 feet.

ECONOMIC GEOLOGY

OIL AND GAS

Interest in the oil possibilities of the Spotted Horse coalfield was stimulated by the discovery of oil in the Texas Company's Adon No. 1 well in sec. 2, T. 52 N., R. 72 W., Campbell County, Wyo. The well, which is about 7½ miles southeast of the Spotted Horse coalfield, was completed in March 1948 with initial production of 204 barrels of oil per day from the Minnelusa sandstone (Pennsylvanian) at a depth of 9,345 feet (Dorn, 1949, p. 830).

After completion of the Adon well, two wildcat wells were drilled in the Spotted Horse area. The first deep test in the north-central Powder River Basin, the Shell Oil Company's Clear Creek No. 1 well [3], was located, on the basis of surface and seismic information in sec. 11, T. 57 N., R. 78 W., Sheridan County. The well was completed June 28, 1949, after reaching a total depth of 12,215 feet below the surface in Cambrian strata. A slight show of oil was obtained from the Mississippian strata (Severy and McLarty, 1950, p. 1039). The Spotted Horse Syndicate's Pringle No. 1 well in sec. 21, T. 55 N., R. 74 W., Campbell County was abandoned April 6, 1950 in the Sundance formation (Jurassic) at a depth of 8,503 feet below the surface. No

[3] Severy and McLarty (1950, p. 1039) refer to this well as Unit No. 1.

shows of oil or gas were reported (Severy and McLarty, 1951, p. 1171).

Natural gas, probably derived from coal, has been found in several shallow wells drilled in the southeastern part of the coal field and in areas adjacent to the Powder River and Clear Creek. The gas occurs in beds of sandstone at different stratigraphic levels of the Tongue River member of the Fort Union formation. Data for three shallow wells in T. 54 N., Rs. 73 and 74 W. are presented in following list:

Well location	*Total depth (feet)*	*Depth of gas sand (feet)*	*Initial daily production (cubic feet)*
SW¼ sec. 8, T. 54 N., R. 73 W.	245	223–229	1, 000, 000
SW¼ sec. 20, T. 54 N., R. 73 W.	415	395–415	1, 000, 000
NW¼ sec. 12, T. 54 N., R. 74 W.	?	263–?	500, 000

Gas from some wells is captured in water-sealed tanks and used for domestic purposes. Gas from a well in the SE¼ sec. 30, T. 58 N., R. 75 W. has been used at the W. F. Dobrenz ranch since 1916. The gas pressure in this well is reported by the owner to be sufficient to lift a weight of 600 pounds.

COAL

Coal beds in the Spotted Horse field occur in the Tongue River member of the Fort Union formation and in the overlying Wasatch formation. The oldest coal beds exposed in the area crop out in the Powder River Valley near the Montana State line; the youngest crop out near the tops of the highest buttes and divides in the southern part of the field. Beds containing 2 or more feet of coal were examined and mapped, and their outcrops are shown on plates 1 and 2; numbered localities along the outcrops indicate points where sections were measured. The sections, arranged in order of townships in which they occur, are shown on plates 6–11.

Coal beds occur in carbonaceous zones in association with carbonaceous shale and carbonaceous sandstone, and within these carbonaceous zones the coal beds show intricate gradations. A coal bed near the middle of a zone at one locality may be in the upper or lower part elsewhere. Thin shale partings in a coal bed may thicken and split the coal into several stringers which may eventually pinch out. Owing to changes in the position of coal beds in the zones and to thickness changes in rocks between carbonaceous zones, intervals between coal beds are not of constant thickness.

In this report, coal beds in the Tongue River member are identified by the names of beds in the nearby northward extension of the Sheridan coalfield in Montana, if they can be correlated, and similarly, such coal beds in the Wasatch formation bear the names of coal beds in the adjoining Powder River coalfield of Wyoming. Plate 5 is a

correlation chart of the principal coal beds of the Spotted Horse and nearby coalfields.

The following generalized section shows the most important coal beds in the Spotted Horse field. Some of the beds are important because they contain large reserves; others, because they can be correlated with coal beds of nearby fields and therefore provide a basis for stratigraphic correlations of other beds. The local beds are discussed in the description of each township.

Generalized section showing the major coal beds in the Spotted Horse coalfield

Intervals were measured from base of a bed to base of the bed above; those marked by asterisk (*) occur only in northern part of coalfield.

	Feet
Wasatch formation:	
Ulm No. 1 bed	
Interval	75
Ulm No. 2 bed	
Interval	65
Scott bed	
Interval	190–280
Felix bed	
Interval*	0–425
Arvada bed	
Interval* (to Roland)	65
Fort Union formation	
Tongue River member:	
Roland bed	
Interval*	180
Smith bed	
Interval	160
Anderson bed	
Interval	75
Dietz No. 1 bed	
Interval	85
Canyon bed	
Interval	290
Wall bed	
Lower part of Tongue River member.	

PHYSICAL PROPERTIES

The coal of the Spotted Horse coalfield is either lignite or subbituminous coal. It generally has a woody texture, conchoidal fracture, and dark-brown streak. When freshly exposed, coal is shiny black and hard, but it rapidly loses moisture and in a relatively short time slakes to fine black dust and irregularly shaped granules. Long-distance shipping is not feasible, but coal stored by ranchers for domestic use can be kept in closed bins for about three months without disintegrating.

Silicified and "ocherized" pieces of wood were noted in the coal beds at many outcrops, and silicified tree stumps, whose roots extend into

the underlying rocks, were found in many coal beds; few stumps extend more than 1½ feet upward from the floor of a coal bed.

CHEMICAL PROPERTIES

No analyses of the coal in the area of this report were available at the time the area was examined and no samples were taken for analyses, because no mines were operating within the area from which unweathered samples of coal could be collected. The general quality of the coal is suggested by the analyses of coal in nearby coal fields shown in table 2.

BURNING OF COAL BEDS

In many parts of the Spotted Horse coalfield coal beds have burned at the outcrop and beneath shallow cover. The distance to which the coal burns from the outcrop depends upon the quality and thickness of the coal, the amount of water in the coal bed, and the porosity and thickness of the overlying rocks. As a result of the burning, the overlying rocks bake or even fuse to produce clinker. The clinker generally is red, but locally, it may be violet or purple. Because of its appearance it is locally called "scoria", "red shale", "lava rock", and "slag." The formation of clinker and the physical and mineralogical changes accompanying the process have been described by Rogers (1918, p. 1–10).

Extensive burning of coal beds has produced abundant clinker that now caps the high, even-crested divides and buttes in the northeastern and south-central parts of the field. The clinker generally forms patches and discontinuous bands along the burnt outcrops of coal beds. Burning of the coal beds probably occurred during Recent time. Coal is still burning in secs. 15 and 16, T. 57 N., R. 76 W.; sec. 6, T. 56 N., R. 76 W.; and sec. 19, T. 57 N., R. 74 W.

The Anderson bed is burning near the site of an abandoned mine in sec. 9, T. 57 N., R. 75 W. A local rancher stated that the fire was started accidentally by explosions set off during mining operations. Reports indicate that the coal has been burning for at least 5 or 6 years (1949). As indicated by slumping of overlying rocks, the bed has burned beneath about 2 acres of overburden which ranges in thickness from about 10 to 150 feet. Vertical downward movement due to slumping is about 40 or 50 feet, most of which is probably due to the filling of the void left by burned coal. Beds at the surface above the burned out area show little evidence of alteration. The Anderson bed is also burning in sec. 10, but the origin of the fire is unknown.

TONGUE RIVER MEMBER OF THE FORT UNION FORMATION

Wall bed.—The Wall bed, oldest coal bed exposed in the Spotted Horse coalfield, occurs about 800 feet below the top of the Tongue

TABLE 1. *Analyses of coal from selected coalfields in northeastern Wyoming and northeastern Montana, by U. S. Bureau of Mines*

[Condition of sample: A, as received; B, moisture-free: C, moisture- and ash-free; Classification by rank: parentheses enclose figures representing determinations made on mineral-matter-free basis, the first determination represents percent fixed carbon in moisture-free sample, reported to the nearest whole number, the second represents Btu to the nearest hundred]

Source of sample	Sample No.	Condition of sample	Air-drying loss	Proximate			Ultimate						Heating value		Classification by rank, According to standards of American Society for Testing Materials
				Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Cal.	Btu	
Wildhorse Mine, sec. 24, T. 54N., R. 77W.; Arvada(?) coal bed.	D-20225	A	13.3	28.6	29.9	33.1	8.4	1.6	6.5	46.0	0.9	36.6	4,439	7,990	Lignite or subbituminous C coal (54-87).
		B	-------	-------	41.9	46.3	11.8	2.2	4.6	64.3	1.3	15.8	6,217	11,190	
		C	-------	-------	47.5	52.5	------	2.5	5.2	73.0	1.5	17.8	7,044	12,680	
Peerless Mine, Campbell County, Wyo.; Roland coal bed.	A-2640	A	18.0	33.3	29.0	31.8	5.9	.5	6.8	45.7	.6	40.5	4,317	7,770	Lignite (53-83).
		B	-------	-------	43.4	47.7	8.9	.8	4.7	68.5	1.0	16.1	6,472	11,650	
		C	-------	-------	47.7	52.3	------	.8	5.2	75.2	1.1	17.7	7,100	12,780	
Monarch Mine, Monarch, Wyo.; Monarch coal bed.	C-11137-C-11139.	A	13.2	21.5	32.1	35.2	11.3	1.3	6.1	49.8	1.1	30.3	7,100	8,740	Subbituminous B coal (54-110).
		B	-------	-------	40.9	44.7	14.4	1.9	4.7	63.3	1.6	14.3	6,183	11,130	
		C	-------	-------	47.7	52.3	------	2.5	5.5	74.0	1.6	16.8	6,944	12,500	
Moorhead Dam Project, Mont. (U. S. Bureau of Reclamation, drill core hole C-3) Broadus(?) bed.	C-92753-92754.	A	15.1	27.9	30.3	35.8	6.7	.9	6.5	49.2	.9	36.6	4,711	8,480	Subbituminous C coal (55-91).
		B	-------	-------	42.0	49.7	8.2	1.1	4.6	68.2	1.2	16.5	6,533	11,760	
		C	-------	-------	45.8	54.1	------	1.2	5.1	74.4	1.4	17.9	7,122	12,820	
Lake De Smet Project, Buffalo, Wyo. (U. S. Bureau of Reclamation Drill core hole No. 7).	C-97450	A	6.7	23.6	31.9	34.8	9.7	1.0	6.1	48.3	.7	34.2	4,594	8,270	Subbituminous C coal (53-92).
		B	-------	-------	41.7	45.6	12.7	1.3	4.6	63.2	1.0	17.2	6,017	10,830	
		C	-------	-------	47.8	52.2	------	1.5	5.2	72.4	1.1	19.8	6,889	12,400	
North Star Mine, Coalwood, Mont. Broadus bed.	C-75924	A	21.7	33.9	28.5	31.5	6.1	.3	6.7	43.2	.7	43.0	4,056	7,300	Lignite (53-78).
		B	-------	-------	43.1	47.7	9.2	.4	4.4	65.4	1.1	19.5	5,778	11,040	
		C	-------	-------	47.5	52.5	------	.5	4.9	72.1	1.2	21.3	6,756	12,160	
Sweat and Smith Mine, NE, ¼ sec. 13, T. 55N., R. 78W, Wyo. Arvada bed.	6798 [1]	A	8.7	18.3	34.6	40.7	6.4	1.2	5.7	53.9	1.1	31.8	5,115	9,207	Subbituminous B coal (55-99).
		B	-------	-------	42.4	49.8	7.8	1.4	4.4	66.0	1.3	19.1	6,261	11,270	
		C	-------	-------	46.0	54.0	------	1.5	4.8	71.6	1.4	20.7	6,791	12,224	

[1] Sample from slightly weathered coal.

River member. Near the north boundary of the area it crops out for a short distance above the flood plain of the Powder River and passes below the alluvium in sec. 30, T. 58 N., R. 75 W. The thickness of the bed could be measured at only two localities. A partly exposed section at locality 315 in sec. 19, T. 58 N., R. 75 W. shows 12 feet 5 inches of coal, not including a 2-inch parting near the top. Eastward the bed splits into two relatively thin benches of coal that are about 12 feet apart at locality 319 in sec. 20.

Canyon bed.—The Canyon coal bed is about 290 feet above the Wall bed and is best exposed in the north-central and northeastern parts of the field. The coal has burned along much of its outcrop to produce thick clinker, which now caps buttes and forms benches on the slopes along the Powder River and Fence, Bitter, and S A Creeks. The Canyon bed passes below the alluvium of the Powder River valley in sec. 30, T. 57 N., R. 76 W. About a mile further southward it is exposed for a short distance along a small normal fault. The Canyon bed is very lenticular and at many places is not mappable. The thickest sections measured are at locality 375 in the NE¼ sec. 29, T. 57 N., R. 76 W., where the bed is 23 feet 1 inch thick, not including a 5-inch shale parting near the middle, and at locality 336 in the SE¼ sec. 28, T. 58 N., R. 75 W., where the bed contains 22 feet 8 inches of coal, which is free of partings. The Canyon is well exposed for several hundred yards along the west bank of the Powder River in the W½ sec. 20, T. 57 N., R. 76 W. (see plate 13, *B*). At locality 376 an incomplete section shows 18 feet 3 inches of coal with an 8-inch parting in the upper 1½ feet. The Canyon coal bed is correlated with *E* bed of the Little Powder River coal field.

Dietz No. 1 bed.—Coal of the Dietz No. 1 bed forms several discontinuous lenses intermediate in position between the Canyon and Anderson beds in the north-central and northeastern parts of the field. Small patches and bands of clinker have been produced by the burning of the coal. The Dietz No. 1 bed in few places exceeds 10 feet in thickness, and in many places it contains partings. The coal bed is thickest and most persistent in the area bordering Buffalo, Fence, and Bitter Creeks and Butte Prong of Bitter Creek in the northeastern part of the coal field.

Anderson bed.—The Anderson bed is about 160 feet above the Canyon bed and 75 feet above the Dietz No. 1 bed. Clinker marks the position of the Anderson bed over much of the north-central and northeastern parts of the Spotted Horse area and in the valleys of Spring, Squaw, Hay, and Horse Creeks near the southeastern border. Clinker produced by burning of the Anderson bed is as much as 100 feet thick. It caps high buttes and even-crested ridges along the Powder River near the Montana State line, and in the vicinity of

Buffalo, Dry, and Bitter Creeks in T. 58 N., R. 74 W. Elsewhere the coal is protected from extensive burning by a thick cover, and clinker occurs only in narrow strips rarely more than 200 yards wide. The Anderson bed is well exposed in the east bank of the Powder River at locality 710 in sec. 18, T. 56 N., R. 76 W. but passes below the surface in sec. 24, T. 56 N., R. 77 W. Unburned coal at the outcrop was found in many parts of the area, but at some of the localities the base of the bed was not exposed. The Anderson bed has an average thickness of about 15 feet and contains the largest reserves of coal for any bed in the Spotted Horse field. The thickest section was measured at locality 557 in the west-central part of sec. 2, T. 57 N., R. 75 W., where 26 feet of coal at the top is separated from 6 feet 8 inches of coal at the base by a 12-foot covered interval. At locality 596, in the SW¼ sec. 26 of the same township, 31 feet of coal is exposed, but at locality 360, about 1½ miles north of locality 557, the bed is only 6 feet 5 inches thick and contains a 10-inch parting near the middle of the section. Along the valley of S A Creek, in secs. 22 and 28, T. 56 N., R. 74 W., the Anderson bed grades into interstratified layers of sandstone and carbonaceous shale, and the coal benches are thin in this vicinity. The only outcrop where the thickness of the coal could be measured near the southeastern border of the area is at locality 1424 in the NE¼ sec. 16, T. 54 N., R. 73 W. There, 18½ feet of coal is split by 3 partings which total 11 inches in thickness.

Smith bed.—The Smith bed, about 160 feet above the Anderson bed, is one of the most persistent beds in the area. It commonly crops out high on the even crested ridges and buttes in the eastern part of the coal field and at lower elevations in steep valley walls in the central and western parts. Throughout the southern half of T. 56 N., R. 75 W. the coal averages about 10 feet in thickness, and in a small area in Tps. 53 and 54 N., R. 73 W. it is about 12 feet thick. Short distances northward and southward from Tps. 53 and 54 N., R. 73 W. the bed thins to less than 5 feet and locally wedges out. Partings were noted in the coal at many localities. In the southwestern half of T. 56 N., R. 77 W. and at several localities in T. 56 N., R. 76 W. the bed splits into two benches of coal separated by 1–25 feet of rocks. The coal thins northwestward and is not mappable in the northern part of T. 57 N., R. 77 W. and in T. 58 N., R. 77 W.

The Smith bed is commonly overlain and underlain by thick beds of massive cliff-forming, yellowish-gray sandstone. In T. 56 N., R. 76 W. the coal is underlain by a thick light-bluish-gray sandstone which forms steep slopes above the mouth of the Spotted Horse Creek. Because of their prominence and color these slopes locally are referred to as "the blue wall." Baker (1929, p. 35) noted the occurrence

of a "soft steel-gray sandstone" at about the same stratigraphic position in the southern part of the northward extension of the Sheridan coal field.

Roland bed.—The Roland bed, the uppermost coal bed of the Tongue River member, is about 180 feet above the Smith bed. A fossiliferous unit, as much as 30 feet thick above the coal is separated from it by an interval ranging from a fraction of an inch to about 30 feet and affords an excellent criterion for identifying the bed. Coal of the Roland bed is lenticular; several lenses crop out near the crests of high divides and tops of buttes, principally in the area west of the Powder River and Clear Creek. To the east the Roland coal occurs in only a few small patches, the easternmost of which is in a small knoll high on the divide between S A Creek and L X Bar Creek in sec. 30, T. 57 N., R. 75 W. The thickest sections of coal, about 6 feet, were found in T. 58 N., R. 77 W. and in the northern part of T. 57 N., R. 77 W. Southward and eastward from this area the coal thins and grades into shale within a few miles.

A coal bed about 3½ feet thick which crops out along Clear Creek in sec. 31, T. 56 N., R. 77 W. was believed by Stone and Lupton (1910, p. 122) to be equivalent to the Roland of the Powder River field. However, it probably is a local bed about 100 feet below the Roland, that is exposed at locality 454.

WASATCH FORMATION

Arvada bed.—The Arvada coal bed is about 65 feet above the Roland bed and a few feet above the base of the Wasatch formation. Except for small patches near the tops of several high buttes and ridges in T. 56 N., R. 76 W., the Arvada bed is limited to small areas on high divides west of the Powder River. In the westernmost row of townships coal of the Arvada bed usually is less than 5 feet thick and contains partings. The coal thickens and becomes cleaner to the east, and in the area of the Powder River and Clear Creek it averages about 7 feet thick and contains few partings. The maximum observed thickness of 11 feet 11 inches of coal is at locality 478 in the NW¼ sec. 35, T. 56 N., R. 77 W.

Felix bed.—The Felix bed was traced from the Powder River coalfield into the southern part of the Spotted Horse coalfield. South and west of U. S. Highways 14 and 16 the Felix bed crops out near stream levels. In T. 55 N., R. 74 W., coal and clinker of the bed crop out on several small buttes and ridges. The Felix is about 160–180 feet above the base of the Wasatch formation in the area east of the Powder River-Little Powder River divide, but this interval increases to as much as 400 feet westward due to thickening of strata below the Felix bed. Throughout most of the area the Felix bed is overlain by a

thick cover and is thus protected from burning. The Felix coal bed has an average thickness of about 15 feet and contains most of the coal reserves in the Wasatch formation. At many places the coal contains partings, some of which are persistent. Bony coal occurs near the base of several measured sections in T. 54 N., Rs. 74 and 75 W. The thickest sections were measured at locality 1322 in the SW¼ sec. 14, T. 53 N., R. 75 W. where the bed contains 35 feet 3 inches of coal and 4 partings totaling 6 feet 7 inches in thickness. At locality 1162 in sec. 35, T. 54 N., R. 75 W. the coal is 28 feet 4 inches thick with no partings.

Scott bed.—The Scott coal bed is so named because it is well exposed at locality 1502 in the NE¼ sec. 14, T. 53 N., R. 74 W., about one mile northwest of the Harold W. Scott homestead. Here the bed is 190 feet above the Felix bed; the interval between the beds increases westward, however, and is 280 feet in the western parts of Tps. 53 and 54 N., R. 75 W. The bed is confined to the area south and west of U. S. Highway 14 and 16. It is persistent but generally is less than 4 feet thick. At a few places, however, it is as much as 10 feet thick. The coal commonly contains partings, and at some places it contains fossil wood.

Ulm No. 2 bed.—The Ulm No. 2 coal bed, which is about 65 feet above the Scott bed, crops out near the tops of divides south and west of U. S. Highway 14 and 16. The coal has burned at many places to form a thick bed of clinker which caps the highest buttes and ridges. The largest areas of unburned coal are in the southern parts of T. 53 N., Rs. 74 and 75 W. where the coal is overlain by 30–60 feet of cover. The maximum observed thickness of the coal is about 22 feet at locality 1517 in sec. 27, T. 53 N., R. 74 W. East of Windmill Draw the average thickness is about 12 feet. The coal thins to about 4½ feet in the western part of T. 53 N., R. 75 W. where it commonly contains partings and much fossil wood.

Ulm No. 1 bed.—The Ulm No. 1 coal bed, 75 feet above the Ulm No. 2 bed, is found only in an area of about 1 acre at the summit of a small, high butte in sec. 14, T. 53 N., R. 75 W. The coal is 10 feet 10 inches thick at locality 1316 and is overlain by 9 feet of rock. Elsewhere in the Spotted Horse field the bed has been removed by erosion.

ESTIMATES OF RESERVES[4]

Parts of coal beds that are 2½ feet or more in thickness in the Spotted Horse field contain an estimated 12,060 million short tons of coal. About 10,305 million tons occur in the Tongue River member of the Fort Union formation and 1,755 million in the Wasatch formation. About 76 percent of the reserves of the Tongue River member,

[4] Calculated by Henry L. Berryhill and Dorothy A. Taylor, U. S. Geol. Survey.

or 7,802 million tons, is in 3 beds: the Canyon bed, with 2,296 million tons; the Anderson bed, with 3,861 million tons; and the Smith bed, with 1,645 million tons. Nearly 77 percent, or 1,356 million tons, of reserves of the Wasatch formation is in the Felix coal bed. Local beds of the two formations contain approximately 1,600 million tons.

Coal reserves in tables 2 and 3 are shown by beds, townships, formations, and counties. Measured and indicated reserves include coal for which tonnage has been computed from thicknesses measured at intervals of 1½ miles or less along the outcrop. They include reserves limited in underground extent to areas whose outer limit is a line drawn parallel to and 2 miles from the outcrop. Inferred reserves include coal which is in areas beyond this limit. The estimates for infered reserves are based on geologic evidence for assumed subsurface continuity of the coal beds.

Measured and indicated, and infered coal reserves are further subdivided into the following categories according to thickness of the coal beds exclusive of partings: (1) 2½–5 feet, (2) 5–10 feet, and (3) more than 10 feet. Where partings were thicker than either the overlying or underlying bench of coal the two benches were treated as separate beds. The areal extent of coal beds was measured on the map by planimeter, and the tonnage was calculated by assuming that the weight of 1 acre-foot of subbituminous coal and lignite is 1,770 short tons (Combo and others, 1949, p. 1).

CONSTRUCTION MATERIALS

The only mineral resources other than coal in the area are construction materials: clinker, sandstone, shale, gravel, and sand, which occur in many parts of the coal field. Clinker, abundant in most parts of the area, is used as road metal and railroad ballast. A well-indurated standstone which crops out in secs. 13, 14, and 24, T. 57 N., R. 76 W. was used in the early 1900's to construct stone buildings. Beds of medium-gray waxy silt-free hackly shale, as much as 4 feet thick that occur beneath many coal beds in various parts of the area may be suited for use as fire clay.

An investigation of rocks for suitability of use as riprap and concrete aggregate in the construction of the proposed Moorhead dam was made in August 1950 by the United States Bureau of Reclamation.[5] Many rock samples were collected and tested to determine their composition, specific gravity, absorptive capacity, resistance to abrasion, resistance to weathering, and durability under freezing and thawing conditions. Clinker collected along the Powder River and Bitter Creek, short distances south of the Montana line, has a low density,

[5] Inventory of sand, gravel, and riprap deposits of the Yellowstone District (unpublished), in the files of the United States Bureau of Reclamation, Region 6; Billings, Montana.

variable hardness, and low resistance to abrasion. Its quality ranges from poor to fair for use as riprap, and it is unsuitable for use as a concrete aggregate. Samples of sandstone collected near the dam site show little variation in composition but under tests show wide variation in physical qualities. The quality of sandstone ranges from inferior to fair for use as riprap. Some is suitable for use as a concrete aggregate provided it is properly graded and an air-entraining agent is used. Gravel deposits near the Jackson ranch in sec. 31, T. 56 N., R. 76 W. are unsuitable for use as concrete aggregate because they contain about 6–26 percent of weak material, although the deleteriously reactive portion is insignificant. Other gravel deposits in the Spotted Horse area were not tested by the Bureau of Reclamation. Concrete cylinders made from gravel collected from the bed of Powder River about 3 miles north of the Montana line showed poor durability when subjected to freezing and thawing conditions.

DESCRIPTION OF COAL BEDS, BY TOWNSHIPS

The topography and coal beds of each of the 21 full and 3 partial townships are discussed in the rest of this report. Townships are described from north to south in the western tier and then in the same order for successive tiers to the east. Graphic sections of the thicker coal beds in each township are shown in the plate indicated below the heading of each township's description.

T. 58 N., R. 78 W.

Plate 6

The Tongue River-Powder River divide, roughly delineated by a county road, passes through the southeastern part. Runoff from most of the township flows into the Tongue River by way of the northeasterly flowing intermittent Seventy Six and Trail Creeks, and Iron Springs and Logs Draws. A small area in the southeastern part is drained by Cabin Creek. In general, summit areas of the divides are narrow, gently rolling and covered with grass and brush. Streams which head in the Tongue River-Powder River divide have incised their channels 150–200 feet below summit levels in the central and western parts of the township and occupy narrow valleys bordered by steep slopes on which grow sparse stands of pine. About 150 feet of the Tongue River member of the Fort Union formation and 150 feet of the Wasatch formation are exposed in the township.

The Roland bed.—The Roland bed was traced into secs. 23 and 24 from the Moorhead coalfield. The coal maintains a mappable thickness for only a short distance and grades into carbonaceous shale in sec. 24. At locality 26 the bed contains 2 feet 2 inches of coal, and at locality 24, 4 feet 4½ inches of coal and 2 shale partings that total

2 feet 7 inches in thickness. A local bed with an average thickness of about 4 feet is exposed about 50 feet below the Roland. The lowest coal bed which crops out in the township is another local bed about 100 feet below the Roland. Sections measured on this bed show from about 2½ to 4½ feet of coal.

Arvada bed.—A coal bed about 75 feet stratigraphically above the Roland bed and 20–35 feet above the base of the Wasatch formation is correlated with the Arvada bed of the Powder River coalfield. The Arvada bed crops out along the rims of high buttes and near the tops of divides in many parts of the township. Coal ranges in thickness from about 2–6 feet. At many of these localities the coal is split by a parting.

In sec. 27, three small, isolated clinker-capped buttes afford evidence of a coal bed about 130 feet above the Arvada bed and which was probably once extensive over much of the northern part of the Spotted Horse coalfield.

Other beds.—The Anderson, Dietz No. 1, Canyon, and Wall coal beds crop out in townships to the east at stratigraphic intervals of about 340, 415, 500, and 790 feet, respectively, below the Roland bed and also occur to the west and northwest in the Sheridan coalfield or its northward extension. Thickness measurements in the Spotted Horse coalfield indicate these beds have the following estimated average thicknesses in T. 58 N., R. 78 W.: Anderson, 6.6 feet; Dietz No. 1, 3.8 feet; Canyon, 5.0 feet; and Wall, 3.6 feet. Lower coal beds of considerable thickness are exposed near Birney, Mont., in the northward extension of the Sheridan field; however, information as to their presence in this township is lacking.

T. 57 N., R. 78 W.

Plate 7

This township is drained by intermittent tributaries of the Tongue and Powder Rivers. The divide between the two rivers extends from near the northeast corner of the township to the southwest corner. The topography of most of the township is characterized by a moderately dissected, gently rolling surface with long, narrow, low, grass- and brush-covered ridges that parallel the northwesterly alignment of the larger streams. In the southwestern corner of the township several buttes rise 100–275 feet above the general level of the Tongue River-Powder River divide. Near the margins of the township, streams have incised their valleys 100–200 feet below upland levels.

Rocks of the Tongue River member of the Fort Union formation and the Wasatch formation are exposed in the township. The Tongue River member has a thickness of about 275 feet. The Wasatch for-

mation is about 725 feet thick and underlies the surface of most of the township but is poorly exposed, owing to soil cover.

Smith bed.—The lowest coal bed exposed in the township is the Smith bed, which crops out only near the valley bottom of Squaw Creek at locality 108. At this locality the bed contains 3 feet 3½ inches of coal and 2 shale partings which total 7½ inches in thickness.

Roland bed.—The Roland bed, about 160 feet stratigraphically above the Smith bed, crops out near the head of Cabin Creek in the northeastern part of the township, although it probably occurs, beneath a soil cover, near the stream level of North Buffalo Creek in the southeastern part. The bed contains 2½ feet of coal at locality 91, and an incomplete section measured at locality 104 shows 3 feet 9 inches of coal. A local bed, about 50 feet below the horizon of the Roland, contains 2 feet of coal at locality 81.

Arvada bed.—The Arvada bed, about 40–75 feet stratigraphically above the Roland bed, is well exposed near the tops of divides in the northern part of the township, and, owing to a southwesterly dip, occurs at lower elevations in the southern part. The coal has an average thickness of about 4 feet at the outcrop.

Felix(?) bed.—A thin lenticular coal bed, tentatively correlated with the Felix bed of the Powder River field, crops out in the southwestern part of the township, about 425 feet stratigraphically above the Arvada bed. Sections on the bed were measured at localities 93, 94, and 99.

A local bed about 45 feet above the Felix(?) contains approximately 8 feet of coal at locality 98; however, a short distance westward and southward the coal grades into carbonaceous shale. Another local bed crops out 95 feet above the Felix(?) bed. The coal is thin and commonly contains partings and fragments of fossil wood.

Other beds.—In townships to the east the Anderson, Dietz No. 1, Canyon, and Wall coal beds crop out at stratigraphic intervals of about 180, 255, 340, and 630 feet, respectively, below the Smith bed; they also occur in the Sheridan coal field or its northward extension to the west and northwest. Thickness measurements in the Spotted Horse coal field indicate these beds have the following estimated average thickness in T. 57 N., R. 78 W.; Anderson, 4.7–6.2 feet; Dietz No. 1, 3.8 feet; Canyon, 5.0 feet; and Wall, 3.6 feet. Lower coal beds of considerable thickness are exposed near Birney, Montana, in the northward extension of the Sheridan field; however, information as to their presence in this township is lacking.

T. 56 N., R. 78 W.

Plate 8

Most of T. 56 N., R. 78 W. is drained by Buffalo Creek an intermittent, easterly flowing tributary of Clear Creek. North of Buffalo

Creek the surface is characterized by long narrow straight, southeasterly trending stream valleys and narrow grass- and brush-covered ridges. The stream valleys, which in the eastern part of the township are about 150–300 feet deep, head northwestward in divide areas having a gently undulating surface. South of Buffalo Creek the surface is rugged and many short streams having steep gradients flow in a general northerly direction. Several high, isolated buttes in secs. 6, 7, 31, and 32 rise above surrounding levels. Maximum relief in the township is about 750 feet.

About 150 feet of rocks of the Tongue River member of the Fort Union formation and 750 feet of rocks of the Wasatch formation are exposed in the township. The Tongue River member is well exposed in steep slopes in the eastern part of the township. The Wasatch formation underlies the surface of much of the township, but owing to soil cover the formation is poorly exposed.

Roland bed.—The Roland bed is exposed in the northeast corner of the township along the valley walls of North Buffalo Creek. At locality 276 the bed is split into two benches, each less than 5 feet thick, separated by 17 feet 8 inches of sand and shale. A short distance eastward, at locality 277, the upper bench is somewhat thinner, and the lower bench is represented by bony coal and shale. Southward from Buffalo Creek the coal grades into shale.

Arvada bed.—The Arvada bed, about 75 feet stratigraphically above the Roland, is well exposed near the tops of divides in the eastern part of the township and crops out near stream level in the central part. The thickest sections measured are at locality 312, where the bed contains 7½ feet of coal and a 4-inch parting, and at locality 310, where the bed contains 6 feet 10 inches of coal and a 6-inch parting. Within a short distance from these localities the coal grades into bone and bony coal. At other measured outcrops the bed ranges in thickness from 4 feet to 5 feet 3 inches of coal. The bed thins northward and grades into shale in the north-central part of the township. A highly fossiliferous limestone that overlies the coal at localities 281 and 293 closely resembles limestone of the unit that marks the contact of the Wasatch and Fort Union formations.

Felix(?) bed.—A thin coal bed near the top of a high butte in sec. 31 occurs about 400 feet above the Arvada bed and is tentatively correlated with the Felix bed of the Powder River coalfield. At locality 301, the only locality observed where the bed is of mappable thickness, there is 3 feet of coal and 7 inches of partings. About 45 feet above the horizon of the Felix(?) bed a local coal bed less than 3 feet thick is exposed at localities 275, 302 and 303. At locality 272 a bed containing 7 feet 4 inches of coal and 1 foot of partings, crops out about 90 feet above the horizon of the Felix(?) bed. The bed is thinner at

localities 269 and 274, and partings comprise a thicker portion of the section. The highest coal bed exposed in the township, a local bed about 140 feet above the Felix(?), is exposed at localities 268, 270, 271, and 273. Its maximum observed thickness, 2 feet 10 inches, was measured at locality 273.

Other beds.—The Smith, Anderson, and Canyon coal beds, which commonly occur at stratigraphic intervals of 160, 340, and 500 feet, respectively, below the Roland bed, probably occur beneath the surface of the township and may contain considerable reserves. The Smith bed where measured in east adjoining T. 56 N., R. 77 W. is commonly more than 5 feet thick, and the Anderson and Canyon coal beds are as much as 20 feet thick in T. 56 N., R. 76 W. The Dietz No. 1 bed, if present, is probably represented by a series of discontinuous lenses of coal. Information is insufficient to indicate the presence of coal below the Anderson bed.

T. 58 N., R. 77 W.

Plate 6

Most of this township is in the Powder River drainage basin; however, a small part west of the county road that passes through secs. 19, 30, and 31 is drained by tributaries of the Tongue River. Fence Creek, a southeasterly flowing intermittent stream, and its tributaries drain about three-fourths of the township. In the central and eastern parts valleys are narrow and are bordered by steep walls that rise 100–250 feet above stream levels to grass- and brush-covered buttes and narrow ridges fringed with sparse stands of pine. Westward the gradient of Fence Creek steepens, and the valley bottom merges with the treeless Tongue River–Powder River divide. Maximum relief in the township is about 385 feet.

About 280 feet of the upper part of the Tongue River member of the Fort Union formation and 155 feet of the Wasatch formation are exposed in the township. The Tongue River member is best exposed in the central and eastern parts of the township, where it crops out in steep valley walls and high buttes. The Wasatch formation forms the surface of the divide areas and caps several high buttes in the central and eastern parts.

Anderson bed.—The Anderson bed, the lowest coal bed exposed in the township, is near the valley bottom of Fence Creek in the east-central part of the township, but owing to soil cover, the coal is poorly exposed. At locality 64, the only place in the township where the bed was found, measurements show 6 feet 7 inches of coal. Coal sections measured in east adjoining T. 58 N., R. 76 W. indicate that the coal thickens eastward.

Roland bed.—The Roland coal bed about 265 feet stratigraphically above the Anderson bed, crops out beneath high buttes and divides in the central and southeastern parts of the township and underlies the Tongue River–Powder River divide. The bed is identified by the highly fossiliferous unit which crops out above the coal at an interval ranging from a fraction of an inch to about 35 feet. Local burning of the coal has produced small patches of clinker along the outcrop. The bed is thickest at locality 42, where it contains 10 feet of coal and a parting 1 foot 1 inch thick. The thickness of the coal, free of partings, ranges from 5 feet 2 inches to 7 feet 10½ inches. The thinnest sections measured are in the central part of the township. A thin local bed, about 100 feet below the Roland bed, is exposed in the valleys of Fence Creek and its tributaries. Measurements show about 2–3 feet of coal.

Arvada bed.—The Arvada bed, the highest coal bed exposed in the township, crops out about 65–70 feet stratigraphically above the Roland bed and about 25–35 feet above the Wasatch–Fort Union contact. It underlies the Tongue River–Powder River divide, and occurs as narrow bands and small patches along the Little Remington–Fence Creek divide. The coal ranges in thickness from about 4 to 7 feet.

Other beds.—The Dietz No. 1, Canyon, and Wall coal beds which occur at stratigraphic intervals of about 75, 160, and 450 feet, respectively, below the Anderson bed probably occur beneath the surface of the township and may contain important reserves. The Dietz No. 1 and Canyon beds are as much as 8 feet thick to the east in adjoining T. 58 N., R. 77 W., and the Wall bed is about 12 feet thick in the W½, sec. 19, T. 58 N., R. 75 W. Information is insufficient to indicate the presence of coal beds below the Wall bed.

T. 57 N., R. 77 W.

Plate 7

This township is drained by the intermittent, southeasterly flowing Little Remington, Big Remington, Cabin, and Squaw Creeks and their tributaries. The topography is characterized by straight, narrow, grass- and brush-covered stream valleys which are bordered by steep slopes that rise 150–575 feet to the tops of long, narrow, straight, even-crested ridges that parallel the main stream.

The Tongue River member of the Fort Union formation makes up the lower 480 feet of the section, and the Wasatch formation, the upper 100 feet.

Anderson bed.—The Anderson coal bed is exposed in the eastern part of the township near the stream levels of Big Remington, Little Remington, and Cabin Creeks. In sections 1, 12, and 25, burning of the coal has produced small patches of clinker that mark the outcrop.

The bed is thickest at locality 214, where it contains 19 feet 3 inches of coal; it thins to 6 feet at localities 196 and 241. A shale parting 1½–2½ feet thick splits the coal into two benches at localities 252, 253, and 265. A local coal bed crops out about 80 feet stratigraphically above the Anderson bed in the eastern part of the township. The bed reaches a maximum thickness at locality 203 where it contains 7 feet 10 inches of coal and a 7-inch sandstone parting near the middle.

Smith bed.—The Smith bed, about 150–180 feet stratigraphically above the Anderson bed, is well exposed in steep valley walls in the eastern part of the township and crops out near stream levels in the western part. The bed is about 6–7½ feet thick. At locality 250 the coal is 7 feet 10 inches thick but contains much fossil wood. The bed thins toward the northwestern part of the township, where it grades into thin stringers of coal and carbonaceous shale. A local bed about 35 feet stratigraphically below the Smith bed contains 2 feet 1½ inches–3 feet 9 inches of coal. Many sections were measured on a thin local bed that crops out about 35 feet stratigraphically above the Smith bed. The coal of this bed reaches a maximum observed thickness of 4 feet at localities 194 and 206. At other localities it is 3 feet or less thick and commonly contains partings.

Roland bed.—The Roland coal bed, about 195–220 feet above the Smith bed, crops out near the tops of divides in the northern part of the township and in secs. 25 and 26. Throughout most of its extent the bed is overlain by a highly fossiliferous unit at an interval ranging in thickness from a few inches to as much as 30 feet. The coal is best developed along the divide between Big and Little Remington Creeks, where it has an average thickness of about 6 feet, reaching a maximum observed thickness of 8 feet 2½ inches at locality 175. Southward the coal grades into shale. A local bed about 145 feet below the Roland bed is exposed at localities 193 and 219; and a higher local bed about 125 feet below the Roland bed is exposed at localities 247 and 248, where it contains about 5½ feet of coal. A local bed, about 100 feet below the Roland bed is exposed in the eastern part of the township, where the coal ranges in thickness from about 2 to 3 feet.

Arvada bed.—The Arvada bed is the highest exposed in the township and is about 60 feet stratigraphically above the Roland bed. It crops out beneath the highest buttes and ridges. Measurements show about 5½–6½ feet of coal. South of Cabin Creek and North Cabin Creek the coal commonly contains a parting about 1–2 feet thick. For a short distance in sec. 8 the coal is less than 2 feet thick and was not mapped.

Other beds.—The Dietz No. 1, Canyon, and Wall coal beds, about 75, 160, and 450 feet, respectively, below the Anderson bed probably occur beneath the surface of the township and may contain considerable reserves. Based on measurements in townships to the east and north

these beds are estimated to have about the following thicknesses in T. 57 N., R. 77 W.: Dietz No. 1, 2½–4½ feet; Canyon, 5 feet; and Wall, 3½ feet. Information is insufficient to indicate the presence of coal beds below the Wall bed.

T. 56 N., R. 77 W.

Plate 8

The Powder River and Clear Creek flow northeasterly and join a short distance northeast of the township. Both streams meander and occupy broad valleys which in the southern part of the township are bordered by badlands. In the northeastern part their valley bottoms are bordered by relatively gentle, grass- and brush-covered slopes that rise to the bases of high, steep-sided, narrow ridges and buttes. Squaw Creek and Buffalo Creek extend short distances across the western part of the township.

About 700 feet of strata are exposed in the township. The lower 550 feet belong to the Tongue River member of the Fort Union formation and the upper 150 feet to the Wasatch formation. Rocks of the Wasatch formation form the surface of the high divide areas.

Canyon bed.—Clinker produced by the burning of the Canyon bed is exposed for a short distance along the valley wall of the Powder River in the NE¼, sec. 1, where the bed crops out in the upthrown side of a normal fault. No other coal or clinker of the Canyon bed was recognized in the township. Incomplete sections measured in east adjoining T. 56 N. R. 76 W. at localities 629 and 642, near the eastern boundary of sec. 12, indicate that the coal, where present beneath the surface, may have a thickness of more than 10 feet.

Dietz No. 1 bed.—The Dietz No. 1 bed was not recognized in the township; however, a short distance east of the township east boundary 4½ feet of coal of the Dietz No. 1 bed is exposed at locality 630. The bed is believed to extend into the eastern part of sec. 12, but owing to a cover of alluvium and soil, its presence was not ascertained.

Anderson bed.—Coal of the Anderson bed is exposed along the valley of Clear Creek and is believed to lie near river level in parts of secs. 1, 12, 13, and 24 beneath soil and alluvium in the bed of the Powder River. The bed ranges in thickness from 3 feet 9 inches at locality 435 to 12 feet 8 inches at locality 448; it probably is at least 10 feet thick in most of the township, as suggested by measurements in adjoining areas. A thin uncorrelated bed crops out between the Anderson and the Smith beds at localities 438 and 475.

Smith bed.—The Smith bed crops out about 130 feet above the Anderson and is one of the most persistent mappable units in the township. East of Clear Creek the bed consists of two benches of coal separated by rocks ranging in thickness from 8 feet (locality 458) to 27 feet 8 inches (locality 471). The lower bench reaches a maxi-

mum observed thickness of 4 feet 10 inches at locality 483; the upper bench is thickest at locality 449, where 6 feet 9½ inches of coal is exposed. West of Clear Creek, except at locality 421, the Smith bed is represented by a single bed of coal which has an average thickness of about 5 feet. In the northeastern and southern parts of the township a local coal bed crops out about 50 feet above the Smith bed. The bed reaches a maximum observed thickness of 5 feet 3 inches at locality 455.

Roland bed.—The Roland coal bed crops out near the mouth of North Buffalo Creek. The bed contains 2 feet 6½ inches of coal at locality 409, and 2 feet 2 inches at locality 416. Local coal beds crop out at intervals of 65, 80, and 100 feet below the horizon of the Roland bed in different parts of the township. Where measured the lowest two beds each have an average thickness of about 2½ feet. The upper bed has a maximum observed thickness of 7 feet 8 inches at locality 468 and is about 4 feet thick at localities 415 and 473.

Arvada bed.—The Arvada bed is the highest coal bed exposed in the township and crops out near the tops of divides in the southern part. Along Clear Creek and the Powder River it occurs about 215 feet above the Smith bed. Coal at locality 478 is 11 feet 11 inches thick; the thickest observed exposure of the Arvada bed measured in the coal field. The bed is commonly more than 6 feet thick, but owing to its small areal extent, it does not contain a large part of the reserves of the township.

Other beds.—The Wall and several higher local coal beds crop out beneath the Canyon bed along valley slopes in the northern part of the coal field and may occur at depth in this township. These beds, although locally thick, are lenticular and because of lack of information, they are not included in reserve estimates.

T. 58 N., R. 76 W.

Plate 6

Most of the township is drained by Fence Creek and its tributaries. A small area in the northeastern part is drained by Short Creek. In the eastern half of the township Fence Creek occupies a narrow valley that is bordered by steep slopes which rise 150–350 feet to flat-topped buttes and divide areas, capped with clinker produced by the burning of the Anderson and Canyon coal beds. The clinker of the Canyon bed caps low buttes and forms a prominent bench on the slopes, and the clinker of the Anderson bed caps the highest buttes and ridges. In the western half of the township Fence Creek is bordered by a moderately rolling surface, one-half to 1 mile wide, which rises to the base of sharp-crested ridges and flat-topped buttes, 100–200 feet high.

The Tongue River member of the Fort Union formation is composed of about 730 feet of sandstone, shale, and coal beds. Most of the thick coal beds of the Tongue River member occur in the lower part of the exposed section. Above the Anderson coal bed the member is composed dominantly of sandstone and contains only one coal bed, the Roland, that is more than 2 feet thick. About 20 feet of sandstone and shale at the base of the Wasatch formation is exposed at the top of a small butte in sec. 31.

Canyon bed.—Coal of the Canyon bed has burned along much of its outcrop, producing a prominent clinker that caps low buttes and forms a bench on slopes in the eastern part of the township. The bed is faulted below the level of Fence Creek in secs. 29 and 31. Incomplete sections at localities 114 and 126 contain at least 7 feet 9 inches of coal. At localities 117, 121, 132, and 136 the coal is split into 2 benches separated by about 1½–5 feet of shale. At locality 121, where the bed is thickest, each bench contains about 5 feet of coal. A local bed that crops out about 70 feet above the Wall bed in T. 58 N., R. 75 W. probably occurs beneath a cover of soil near the mouth of Fence Creek in sec. 36. The coal of this bed is more than 11 feet thick at locality 330 in sec. 31, T. 58 N., R. 75 W. The lowermost coal exposed in the township is a local bed about 170 feet below the Canyon bed. Coal at this horizon crops out near the valley bottoms of Short and Fence Creeks and their tributaries. The thickest section was measured at locality 142 where the coal is 9 feet 4 inches thick. The clinker of a local bed that occurs about 100 feet below the Canyon bed is very prominent near the valley bottom of Fence Creek in the central part of the township. Incomplete sections measured on this bed at localities 116, 122, and 134 show about 11–19 feet of coal that is free of partings. The coal thins eastward to 4 feet 4 inches at locality 133 and is less than 2 feet thick in sec. 35.

Dietz No. 1 bed.—The Dietz No. 1 coal bed occurs as a series of lenses which crop out about 75 feet above the Canyon bed and about 100 feet below the Anderson bed. The coal ranges in thickness from 2 feet to 4 feet 9 inches at localities 120, 127, 128, and 135, and at localities 118 and 129 it is about 6–7½ feet thick but is split by a shale parting, 3–7 inches thick. At locality 137 the coal is split into three benches which range in thickness from about 1 to 4½ feet.

Anderson bed.—In the eastern part of the township the Anderson coal bed has burned along most of its outcrop producing a prominent clinker which rims the highest ridges and caps the highest buttes. In the western part burning of the coal has locally produced a conspicuous bed of clinker which crops out near the level of Fence Creek and, where not burned, is generally concealed by soil cover. Coal measured at localities 113 and 115 is 21–28 feet thick but is bony in the upper 2–3 feet.

Roland bed.—The Roland coal bed crops out about 25 feet below the top of a small butte at the southwest corner of the township. No sections on the bed were measured in this township; however, at locality 73, a short distance from the western boundary, the coal is 6 feet thick and is overlain by a highly fossiliferous limestone.

Other beds.—The Wall coal bed about 290 feet below the Canyon bed, is exposed along the Powder River a short distance east of the township. An incomplete section measured about a mile east of section 25 shows 11 feet 10 inches of coal. This bed is probably at depth in the township and may contain considerable reserves.

T. 57 N., R. 76 W.

Plate 7

In this township the Powder River follows a sinuous northeasterly trending course over a broad alluvial valley bottom bordered by steep slopes that rise in steps or benches supported by clinker of the Anderson and Canyon beds. Watson basin in secs. 8 and 9 is an old meander scar which now stands about 100–160 feet above river level. The rocks of the township are deeply dissected and its surface is characterized by narrow southeasterly trending valleys whose steep slopes rise 100–400 feet to high, narrow ridges and buttes. Maximum relief in the township is about 625 feet.

Most of the rocks exposed in the township belong to the Tongue River member of the Fort Union formation, which here is 700 feet thick. About 25 feet of the Wasatch formation crops out at the top of a high butte in sec. 34.

Canyon bed.—Along most of its outcrop the Canyon coal bed has burned, producing a thick clinker which forms a prominent bench along slopes in the northeastern and central parts of the township. The bed passes below stream level in section 30 and its reappearance east of the county road in sec. 31 is due to uplift caused by faulting in adjoining T. 56 N., R. 76 W. The bed is thickest at localities 375, 378, and 385, where it contains about 21–23 feet of coal and a parting from 5 inches to 1 foot 10 inches thick. The lowest coal bed exposed in the township is about 265 feet stratigraphically below the Canyon bed and is correlated with a local bed that crops out about 35 feet above the Wall bed in T. 58 N., R. 75 W. At locality 382 this bed contains 2½ feet of coal. A local coal bed, about 225 feet below the Canyon bed and 70 feet above the Wall bed, contains 12 feet 5 inches of coal at locality 379 and 10 feet 8 inches of coal at locality 380. A local bed 170 feet below the Canyon bed, contains about 3½–9½ feet of coal. A local bed 100 feet below the Canyon bed, contains about 2–4½ feet of coal, and a measurement at locality 384 shows 7 feet 4 inches of coal and 2 feet of partings.

Dietz No. 1 bed.—The Dietz No. 1 coal bed crops out as discontinuous lenses about 65–90 feet below the Anderson bed. At localities 369 and 371 the coal bed is split into two benches, each about 3½ feet thick. Measurements at localities 377 and 386 show 2 feet 9 inches to 3 feet of coal; and 2 feet 1 inch of clean coal, overlain by 8 inches of bony coal, is exposed at locality 394.

Anderson bed.—The Anderson coal bed is exposed above the Canyon bed at a stratigraphic interval ranging from about 150 to 175 feet. The Anderson coal underlies high divide areas near the margins of the township, and its clinker caps several high buttes and ridges. Clinker borders much of the outcrop and only a few localities were found where the complete bed is exposed. The thickest section was measured at locality 391, where the bed contains 23 feet 4 inches of coal and an 8-inch parting near the base. The bed reaches a minimum observed thickness of 7 feet 8 inches of coal at locality 393. A local bed occurs 50 feet above the Anderson at locality 392; and at locality 363 a local bed is exposed about 130 feet above the Anderson bed. A thin bed of coal exposed at locality 367 is correlated with a local bed, which in the southern adjoining township crops out about 35 feet above the Smith coal bed.

Roland bed.—The Roland bed, the highest exposed in the township, crops out in secs. 4, 5, and 34. The coal is thin and the bed is of little importance except as a horizon marker. The bed contains 2 feet 2 inches–3 feet 6 inches of coal overlain by a fossiliferous limestone. Thin local beds occur about 110 feet and 145 feet below the Roland bed.

Other beds.—The Wall coal bed, about 290 feet below the Canyon bed, probably occurs at shallow depth in the northeastern part of the township and may contain economically important reserves.

T. 56 N., R. 76 W.

Plate 8

The Powder River flows northward across secs, 6, 7, and 18, and most of the township is drained by Spotted Horse, Ivy, L X Bar, and Joe Creeks and by other but unnamed intermittent tributaries. The western part of the township contains typical badland topography and is the most rugged area in the coal field. Valleys are narrow and are bordered by steep, bare slopes that rise 300–500 feet to sharp-crested ridges and divides. Steep cliffs near the mouth of Spotted Horse Creek have developed on a light bluish-gray sandstone and are locally known as the "blue wall." The eastern and southern parts of the township are characterized by broad, moderately rolling divides that stand 300–350 feet above stream levels.

The Tongue River member of the Fort Union formation is composed dominantly of sandstone, shale, and coal beds and comprises a

section ranging in thickness from about 500 to 600 feet. Thinning of strata above the Smith bed accounts for the greater part of the thickness change. About 100 feet of the Wasatch formation remains on the major stream divides.

Canyon bed.—The Canyon bed, the lowest coal bed cropping out in the township, is exposed in sections 7 and 8 on the upthrown sides of normal faults. At locality 629 the bed contains a partly exposed lower bench of coal 2 feet 8 inches thick and an upper bench 11 feet thick separated by 1 foot 4 inches of shale. A measurement of a partly exposed section at locality 642 shows 11 feet of coal that is free of partings.

Dietz No. 1 bed.—The Dietz No. 1 coal bed is exposed for a short distance near the mouth of Spotted Horse Creek. The bed contains about 2–4½ feet of coal. The coal grades into shale near the SE¼ sec. 8.

Anderson bed.—The Anderson bed crops out near the western and northern margins of the township and along Spotted Horse Creek. Elsewhere scattered patches of clinker mark the zone. The coal is thickest in the northern and western parts of the township where at locality 617 it reaches a maximum thickness of 17 feet, not including a 6-inch parting. Coal exposed at localities 631 and 710 is split into two benches separated by a shale parting 1½–3 feet thick. The lower bench, partly exposed, is 11–13 feet thick and the upper bench 3–4½ feet. The bed thins toward the central part of the township and is only 3 feet thick at locality 698. An incomplete section measured at locality 657 shows 15 feet 8 inches of bony coal and partings. Wagon mines at localities 631 and 710 are operated by local ranchers to provide coal for domestic use. In sec. 6, near the mouth of a small tributary of the Powder River, the Anderson coal is burning at a very slow rate at the outcrop and beneath 10–40 feet of overburden. As indicated by slumping of overburden and the amount of clinker, the coal is burned out in an area of about one acre or less. A few hundred feet south of this area a fault, north side dropped, which cuts across the Anderson bed will probably limit the burning of the coal in this direction. An uncorrelated coal bed 2 feet 2 inches thick crops out above the Anderson bed at locality 616 but grades into shale a few hundred yards.

Smith bed.—The Smith coal bed crops out above the Anderson bed at a stratigraphic interval ranging from about 130 feet in the central and northeastern parts of the township to about 175 feet in the northwestern part. The bed is thickest in the southern part of the township, where the coal is commonly split into two benches, separated by rock ranging in thickness from a few inches to as much as 20 feet. The lower bench reaches a maximum observed thickness of 6 feet 2 inches at locality 706, and the upper bench, 10 feet 10 inches

at locality 659. The bed thins northward and grades into shale at places. In the northwestern and north-central parts of the township the bed is less than 3 feet thick. At locality 706 an adit has been driven about 30 feet into the hillside, and coal is mined for domestic use. Some coal has been mined at locality 682. A local bed, about 35 feet stratigraphically above the Smith bed, contains about 2–3 feet of coal. A still higher local bed, about 75 feet above the Smith bed contains 4–7 feet of coal at localities 621, 624, and 626, but is thinner elsewhere and commonly contains one or more partings.

Roland bed.—Sections on the Roland bed, measured at localities 660 and 708, show 4½ feet and 2 feet of coal, respectively. A short distance along the outcrop from these localities the coal grades into shale. A local coal bed occurs about 125 feet below the horizon of the Roland bed. The bed is thickest at locality 674, where 3 feet of coal is exposed.

Arvada bed.—The Arvada bed, the highest exposed in the township, crops out at a position ranging from 200 to 290 feet above the Smith bed. It is exposed near the tops of high buttes and flat divide areas in the southwestern part of the township and in sections 11 and 14. Elsewhere coal of the Arvada bed is less than 2 feet thick and was not mapped. In the southwestern part of the township the coal ranges in thickness from 4 feet 9 inches to 9 feet 3 inches. The coal thins northward and is 2 feet 5½ inches thick at locality 676. A measurement made about one half mile south of the coalfield boundary shows 5 feet 9 inches of coal. Some coal has been mined at locality 676.

Other beds.—Strata below the Canyon bed are not exposed in the township. In areas to the north, the Wall bed and several higher local coal beds crop out below the Canyon bed within an interval of about 300 feet. It is not known if any of these beds are present in the township.

T. 58 N., R. 75 W.

Plate 6

The Powder River flows northward across the western part of the township and is bordered by steep slopes that rise 300–500 feet to tree-covered, flat-topped buttes and ridges capped with the clinker of the Anderson bed. At places the slopes are broken by benches formed on the resistant clinker of the Canyon bed. Bitter Creek, an intermittent tributary of the Powder River, extends across the eastern part of the township. The divide area between the two streams is a high, broad, moderately rolling meadow land fringed with pine trees.

Strata exposed in the township make up about 600 feet of the Tongue River member of the Fort Union formation. Burning of the Anderson coal and, to a lesser extent, of the Canyon and lower coal beds has produced an abundance of clinker in all parts of the township.

Wall bed.—The Wall bed is stratigraphically the lowest coal bed exposed in the township. It crops out for a short distance along the Powder River and passes below alluvium in secs. 29 and 30. An incomplete section measured at locality 315 shows 11 feet 10 inches of coal, and at locality 319 the coal is split into two benches, each less than 4 feet thick, separated by 12 feet of strata. A local bed occurs about 35 feet above the Wall bed. Incomplete measurements at localities 324 and 329 show 2½–5 feet of coal. A higher, local bed, 70 feet above the Wall bed, crops out along the Powder River and Bitter Creek and contains about 2½–13½ feet of coal.

Canyon bed.—The Canyon coal bed occurs about 295 feet, stratigraphically above the Wall bed. In most parts of the township the Canyon bed has burned at the outcrop, producing a prominent bench of clinker on the slopes along the Powder River and Bitter Creek. A few measurements at widely spaced localities indicate that the coal is more than 10 feet thick throughout most of its extent. In section 31 and 32 the coal is less than 2 feet thick and was not mapped. The coal reaches a maximum observed thickness of 22 feet 8 inches at locality 336. A local bed, about 170 feet stratigraphically below the Canyon bed, crops out along the Powder River and Bitter Creek. The coal has an average thickness of about 8 feet where measured and reaches a maximum observed thickness at locality 349, where the bed contains 21 feet of coal underlain by 5 feet of interbedded shale and coal. Southward from this locality the coal in the lower part of the bed grades into bone. A section measured at locality 339 shows 10 feet of coal underlain by 2½ feet of shale and 9 feet of bone. In secs. 19 and 20 the coal is less than 2 feet thick and was not mapped. A local bed, about 90 feet below the Canyon bed, is exposed at many places east of the Powder River. At localities 337, 350, and 356 the bed contains from 11 feet 7 inches to 19 feet 9 inches of coal. At other localities the coal is about 3–8 feet thick. The coal is less than 2 feet thick in sections 19, 25, 30, and 31.

Dietz No. 1 bed.—Where observed in the township, the coal of this bed is not of mappable thickness. Small patches of clinker from the burning of the coal are exposed in secs. 19 and 30. The bed was not recognized east of the Powder River because the clinker formed by the burning of the coal cannot be distinguished from that of the overlying Anderson bed. Hence the mapped base of the Anderson bed may at places represent the outcrop of the base of clinker of the Dietz No. 1 bed.

Anderson bed.—Almost everywhere in the township the Anderson bed has burned, forming a thick clinker that underlies the highest ridges. Only 3 localities were found at which the thickness of the coal could be determined. A section at locality 335 contains 13 feet 10 inches of coal with a shale parting 7 inches thick near the base.

This measurement is believed to approximate the average thickness before burning of the Anderson coal in this township.

Other beds.—A thick coal bed may occur at depth in this township. A bed, estimated to be about 150 feet below the Wall coal bed, was reached in several holes drilled at the Moorhead dam site, about 3 miles to the north. The top of the bed is about 70 feet below river level. The coal occurs in two benches, 4 feet apart. The upper bench is about 16 feet thick and the lower about 3 feet.

T. 57 N., R. 75 W.

Plate 7

Most of the township is drained by the L X Bar, S A, and Dead Horse Creeks, intermittent tributaries of the Powder River. A small area in the northeastern part drains into Bitter Creek. Except for the broad, nearly flat valley of the Powder River in secs. 6 and 7, the surface of the township is rugged and is characterized by narrow northwesterly trending stream valleys and high, narrow, parallel divide areas. Extensive burning of the Canyon and Anderson coal beds has produced abundant clinker which forms prominent benches in valley walls and caps many low buttes and ridges. Maximum relief in the township is about 750 feet.

Most of the rocks exposed are included in the Tongue River member of the Fort Union formation, here about 900 feet thick. About 25 feet of basal strata of the Wasatch formation caps a small knoll in sec. 30.

Canyon bed.—The Canyon coal bed crops out near stream level along Dead Horse and L X Bar Creeks. Along the Powder River and S A Creek the coal has burned at the outcrop, producing a prominent bench of clinker in the valley walls. The coal varies considerably in thickness within short distances. The coal reaches a maximum observed thickness of 16 feet 3 inches at locality 534 in the northern part of sec. 8 and thins within a mile northward to less than 2 feet. A similar change takes place in secs. 1 and 2, where the coal thins from more than 12 feet at locality 569 to about 3 feet at locality 555. At several localities the coal is bony and split by partings. Coal at locality 587 is split into 4 benches ranging in thickness from about 2 to 8 feet. The lowest bench is not completely exposed. The benches of coal and associated beds of carbonaceous shale comprise a zone that is about 60 feet thick. The top of the zone is about 55 feet below the Anderson bed. The upper bench of coal, which is about 75 feet below the Anderson bed, may be the Dietz No. 1 bed.

The lowest coal bed exposed in the township, a local bed about 210 feet below the Canyon bed, is exposed along the east bank of the Powder River and is the bed that occurs about 70 feet above the Wall

coal bed in T. 58 N., R. 75 W. (p. 46). A local bed about 170 feet stratigraphically below the Canyon bed crops out in the northwestern part of the township, where measurements show about 3–9 feet of coal. A local bed about 100 feet below the Canyon bed is exposed along the valleys of the Powder River, S A, and Dead Horse Creeks and for a short distance in sec. 12. The coal averages about 5 feet in thickness, reaching a maximum observed thickness of 13 feet 7 inches at locality 561.

Dietz No. 1 bed.—The Dietz No. 1 coal bed occurs as a series of discontinuous lenses which crop out in various parts of the township about halfway between the Canyon and Anderson beds. The thickest section was measured at locality 544, where the bed contains 8 feet 9 inches of coal. A short distance from this exposure the coal grades into shale. At other measured outcrops the coal ranges in thickness from about 3½ to 4 feet.

Anderson bed.—The Anderson coal bed crops out at a stratigraphic position ranging from about 120 feet above the Canyon bed in the northern and southeastern parts of the township to 185 feet above it in the central and southwestern parts. The coal has burned beneath broad areas and at the outcrop, producing abundant clinker which caps ridges and buttes in the northern part of the township and forms a conspicuous bench along steep slopes in the southern part. The bed has a maximum thickness of 44 feet 8 inches at locality 557, where the section consists of 6 feet 8 inches of coal at the base, a 12-foot covered interval, and 26 feet of coal at the top. The coal is 31 feet thick at locality 596 and is 20–25½ feet thick at localities 549, 564, 579, and 611. Throughout most of the township the coal maintains a thickness of more than 10 feet.

Smith bed.—The Smith coal bed, about 165 feet above the Anderson bed, crops out near the tops of the highest divides. The coal is less than 5 feet thick at most localities and commonly contains partings. At places the bed grades into carbonaceous shale. Four local beds, each about 2–3 feet thick, are exposed between the Smith and Roland coal beds along the ridge between L X Bar and S A Creeks and in sec. 13.

Roland bed.—The Roland coal bed, about 245 feet above the Smith bed, crops out near the top of a small knoll high on the L X Bar—S A Creek divide. At locality 568 the bed contains 4 feet 2 inches of coal split by a parting 1½ feet thick. The coal is overlain by a bed of highly fossiliferous limestone.

Other beds.—The Wall coal bed crops out about 295 feet below the Canyon bed in northern adjoining T. 58 N., R. 75 W. It is not exposed in T. 57 N., R. 75 W., but may underlie the surface and contain additional reserves.

T. 56 N., R. 75 W.

Plate 8

About two-thirds of the township is drained by L X Bar Creek which flows northwestward across the central part of the township; the rest is drained by Spotted Horse and S A Creeks and their tributaries. The narrow, straight valley bottoms of the larger streams are bordered by gentle slopes which rise to flat-crested, grass- and brush-covered divides, many of which are under cultivation. Maximum relief in the township is about 500 feet.

The Tongue River member of the Fort Union formation, here about 400 feet thick, is exposed over most of the township. A remnant, about 100 feet thick, of the Wasatch formation, covers an area of about 3 square miles along the S A–Spotted Horse Creek divide.

Canyon bed.—The Canyon bed, the lowest coal bed that crops out in the township, is exposed along the valleys of L X Bar and S A Creeks. Sections measured at localities 814, 821, and 826 show 5 feet 3 inches to 8 feet of coal, and an incomplete section measured at locality 832 is 3 feet 9 inches thick. The bed probably extends under most of the township and may contain considerable reserves.

Dietz No. 1 bed.—The Dietz No. 1 coal bed is 5 feet thick at locality 840 in the NE¼ sec. 2. No other outcrops of the bed were found in the township.

Anderson bed.—In T. 56 N., R. 75 W. the Anderson bed is about 130 feet above the Canyon bed and is best exposed in the northern part of the township between S A and L X Bar Creeks. Along the south side of L X Bar Creek exposures are rare, owing to soil cover, and few measurements of the coal could be made. The thickest sections measured are in the northwestern part of the township. The bed has a maximum observed thickness at locality 839, where 20½ feet of coal is exposed. At localities 812, 817, 822, and 828 the bed is split into two benches of coal separated by 2 feet 7 inches–9 feet of rock. The upper bench has a thickness of about 2–3 feet, and the lower bench is 6 feet 4 inches–9½ feet thick. At locality 828 the lower bench is composed of bony coal. In the northeastern part of the township the Anderson bed has an average thickness of about 5½ feet. A thick, crossbedded sandstone, exposed at the horizon of the Anderson bed in sec. 9 and near the southeast corner of sec. 11, suggests that the coal is absent, owing to stream channeling.

Smith bed.—The Smith coal bed is one of the most persistent mappable units in the township and constitutes a very large part of its coal reserves. The bed is from 100 to 130 feet above the Anderson bed. In the central and eastern parts of the township, scattered patches of clinker mark the outcrop. The coal has a maximum ob-

served thickness of 15 feet 2 inches at locality 865. Sections which contain more than 10 feet of coal, free of partings, were measured at localities 851, 856, 872, 873, 880, 895, 899, and 907. Thinnest sections measured are the northern half of the township, where the coal ranges in thickness from about 2½ to 4 feet. For a short distance in sec. 8 the coal is not of mappable thickness. Some coal has been mined from the Smith bed at localities 895 and 899. A local bed is exposed about 48 feet above the Smith bed. A second local bed, about 75 feet above the Smith bed, crops out near the rims of the divides in most parts of the township. This bed has an average thickness of about 4 feet but usually contains a 5- to 8-inch parting near the middle of the section. At locality 816 the bed is split into 2 benches, about 2–3⅓ feet thick, separated by 6 feet 7 inches of rock. At locality 860, 2 feet 10 inches of coal is exposed about 120 feet above the Smith bed and 2 feet of bony coal is exposed at locality 886 at the same horizon. No coal of mappable thickness was found above this zone.

Other beds.—A local coal bed, about 100 feet below the Canyon bed, crops out in S A Creek valley about 1½ miles north of sec. 4. In northern adjoining T. 57 N., R. 75 W. the bed is fairly persistent and ranges in thickness from about 3½ to 13½ feet. It probably underlies the surface of T. 56 N., R. 75 W. and may contain considerable reserves. Information is insufficient to indicate the presence of lower coal beds.

T. 55 N., R. 75 W.

Plate 9

Spotted Horse Creek and its tributaries drain most of the township. About 4 square miles in the northeastern corner is drained by L X Bar Creek, and about one-half square mile in sec. 31 is drained by North Prong of Wild Horse Creek. The long, straight, narrow valley bottom of Spotted Horse Creek is bordered by steep slopes that rise 150–300 feet to broad, undulating, grass- and brush-covered upland surfaces. A small area of high relief in the southern part of the township has been deeply dissected by headward erosion of tributaries of Spotted Horse and North Prong of Wild Horse Creeks.

The upper part of the Tongue River member of the Fort Union formation underlies broad surfaces in the northern part of the township. This part of the member is about 175 feet thick in the northwestern part of the township, where it is conformably overlain by the Wasatch formation. Elsewhere the Tongue River member is truncated by a pre-Wasatch erosion surface which bevels successively older strata eastward. Near the southeastern corner about 60 feet of section has been removed from the top of the Tongue River member by pre-Wasatch erosion. The Wasatch formation forms most of the surface south of Spotted Horse Creek and underlies high

areas along the L X Bar Creek-Spotted Horse Creek divide. Below the Felix coal bed the formation is composed predominantly of sandstone, with a few thin beds of shale. This sandy interval, which is about 325 feet thick in sec. 31, thins eastward to about 225 feet in secs. 35 and 36. The 200 feet of rocks which crops out above the Felix bed of the Tongue River in the southern tier of sections include sandstone, shale, and coal. The Wasatch-Fort Union contact is not clearly defined, except in secs. 6, 7, and 8. In other part of the township it is placed above the uppermost coal bed of the Tongue River member and below the thick basal sandy section of the Wasatch formation.

Smith bed.—The Smith bed is the lowest coal bed exposed in the township. It crops out in the valley of Spotted Horse Creek and in sec. 1 along the south side of L X Bar Creek. Along much of its outcrop the coal has burned and produced a conspicuous clinker. Where the coal has not burned, the bed is generally concealed by soil. Only two exposures were found where the total thickness of the coal could be measured. At locality 911 the bed contains 14 feet 3 inches of coal and a 1-inch shale parting; at locality 960 the coal is 7 feet 2½ inches thick. A local bed about 85 feet stratigraphically above the Smith bed crops out along Spotted Horse Creek and ranges in thickness from 2 to 12 feet. Coal of this bed exposed at locality 940 consists of an upper bench 13 feet thick and a lower bench 2 feet 11 inches thick separated by about 20 feet of shale which contains an 8-inch lens of coal. The upper bench is probably equivalent to a higher local bed elsewhere. A local bed 125 feet above the Smith contains about 2½–5¼ feet of coal. Another local bed, exposed about 150 feet above the Smith bed, contains about 2½–4½ feet of coal.

Felix bed.—The Felix coal bed crops out near the base of steep slopes in the southern part of the township. The coal averages about 11–12 feet in thickness, reaching a maximum observed thickness of 21 feet at locality 959. A local coal bed is exposed about 50 feet below the Felix bed at localities 942 and 958, where the bed contains about 2½–4½ feet of coal. An incomplete section on a local bed 40 feet above the Felix bed shows 4½ feet of coal at locality 928. A thin local bed correlated with a bed in T. 54 N., R. 75 W. that occurs about 140 feet below the Scott bed is about 2½–4 feet thick and is split by partings. An uncorrelated local coal bed is about 2½ feet thick including a 2-inch parting at locality 931.

Other beds.—The Anderson coal bed, about 160 feet below the Smith bed, may lie beneath the surface of the township and contain considerable reserves. Evidence for its presence in the subsurface is indicated by exposures to the north in T. 56 N., R. 75 W., where the coal is as much as 20 feet thick. Information is insufficient to indicate the presence of lower coal beds.

T. 54 N., R. 75 W.

Plate 10

Most of the surface of T. 54 N., R. 75 W. is dissected by deep valleys which head against the high narrow ridge forming the divide between Spotted Horse Creek and Middle Prong of Wild Horse Creek. Gently sloping grasslands, part of which are under cultivation, border the wide, open valley of Middle Prong of Wild Horse Creek on the south boundary of the township and the tributary valleys of Spotted Horse Creek in the northeastern part. Maximum relief is about 600 feet.

About 100 feet of the Tongue River member of the Fort Union formation underlie gently sloping grasslands in the northeastern corner of the township. The member is unconformably overlain by the Wasatch formation, about 500 feet thick, which underlies most of the township. Below the Felix coal bed, the formation is composed predominantly of sandstone and contains one thin local coal bed in secs. 19 and 20. This basal sandy section is about 165 feet thick in the northeastern part of the township.

Smith bed.—The Smith bed is not exposed in this township but is believed to lie beneath soil cover near the level of Spotted Horse Creek in the NE¼ sec. 1. Coal sections measured at nearby localities in adjoining areas show 2 feet 8 inches–7 feet 2½ inches of coal. The lowest coal bed cropping out in the township is a local bed about 85 feet above the Smith. This bed crops out in the valley walls of Spotted Horse Creek and its tributaries in the northeastern part of the township. An incomplete section measured at locality 1092 contains 3 feet of coal; at locality 1093 the coal is 2 feet 7½ inches thick.

Felix bed.—The Felix coal bed is well exposed near the base of steep slopes in most parts of the township. Locally, the coal has burned, producing a conspicuous clinker. The coal bed averages about 15 feet in thickness and has the largest part of the coal reserves of the township. The coal reaches a maximum observed thickness of 28 feet 4 inches at locality 1162, and is more than 20 feet thick at localities 1098, 1109, 1111, and 1155. Bone and bony coal make up a considerable part of the section at localities 1114, 1124, and 1158; and many sections contain one or more partings, generally less than a foot thick. Crossbedded sandstone, believed to be a channel sandstone, occurs at the horizon of the Felix bed in the E½ sec. 20. A local bed, 2 feet 9 inches thick, is exposed 75 feet below the Felix bed at locality 1091. At locality 1070, a local bed having 2 feet of coal is exposed 70 feet above the Felix bed and about 4 feet of coal is exposed in a local bed 85 feet above the Felix bed at localities 1046, 1060, and 1075.

Scott bed.—The Scott coal bed occurs about 270 feet stratigraphically above the Felix bed. It is exposed in small areas near the tops

of divides. The bed rarely contains more than 5 feet of workable coal, and where more than 4 feet thick it commonly contains one or more partings. A local bed about 140 feet below the Scott bed contains about 2–5 feet of coal at localities 1071, 1074, and 1077. A coal bed of local extent crops out about 115 feet below the Scott bed in the northwestern and southeastern parts of the township and in sec. 21, and contains about 3–5 feet of workable coal. A lenticular local bed which crops out about 90 feet below the Scott bed contains about 2–3 feet of coal. Another local bed, about 55 feet below the Scott bed, contains about 2½–6 feet of coal.

Ulm No. 2 bed.—Several small clinker-capped buttes and unburned patches of coal that underlie the highest parts of the divide between Spotted Horse Creek and Middle Prong of Wild Horse Creek are evidence that the Ulm No. 2 coal bed at one time extended over the entire township. At locality 1157 in sec. 25 the bed contains 17 feet of coal with no partings.

Other beds.—The Anderson coal bed, about 160 feet below the Smith bed, may lie beneath the surface of the township and contain considerable reserves. The Anderson coal is as much as 20 feet thick at many places in the northern part of the Spotted Horse field and is about 18 feet thick in sec. 16, T. 54 N., R. 73 W. Information is insufficient to indicate the presence of lower coal beds.

T. 53 N., R. 75 W.

Plate 11

The surface of most of T. 53 N., R. 75 W. is rugged; maximum relief in the township is about 650 feet. Middle Prong of Wild Horse Creek, with a valley one-fourth to three-fourths of a mile wide, drains most of the township. The gently sloping valley floor is bordered by steep slopes that rise to narrow ridges and hills. A high, flat-topped, narrow divide between Middle and South Prongs of Wild Horse Creek trends northwesterly across the southern part of the township. Streams which head on the divide occupy steep-sided, narrow valleys 100–300 feet deep. Windmill Lake and two smaller undrained depressions on the divide near the head of Windmill Draw are the sites of ephemeral lakes that contain water for short periods after heavy rains and during the spring thaw.

Rocks of the Wasatch formation form the surface of most of the township and have a thickness of about 625 feet. No coal beds of mappable thickness occur below the Felix coal bed which is stratigraphically about 225 feet above the lowest exposed rocks.

Felix bed.—The Felix bed is the lowest coal bed exposed in the township, and its outcrop is marked by scattered patches of clinker. The Felix coal averages about 15 feet in thickness and has about

two-thirds of the total coal reserves of the township. The bed reaches a maximum thickness at locality 1322, where the lower part is composed of 29 feet 2 inches of coal split by a 10-inch sandstone parting, and the upper part is composed of 11 feet 10 inches of interbedded coal and sandstone. Local lenses of coal, about 45 feet above the Felix bed, crop out in section 10 and in the south of section 35. At locality 1281 the coal is split into a lower bench, 8 feet 5 inches thick, and an upper bench, 2 feet 1 inch thick, separated by 9 feet 5 inches of rock. A local bed, about 65 feet above the Felix bed, ranges in thickness from 2 feet 7 inches to 4 feet 9 inches.

Scott bed.—The Scott coal bed is made up of a series of thin lenses that crop out above the Felix bed at an interval ranging from about 235 feet in the eastern part of the township to about 280 feet in the western part. The coal rarely exceeds a thickness of 3 feet and grades into shale at places. A local bed, about 3–4½ feet thick, crops out about 45 feet below the Scott bed. Many measurements were made on a local bed which crops out about 85 feet below the Scott bed. At most localities the coal is less than 3 feet thick, and at several localities it is split into benches that range in thickness from about 1½ to 3½ feet. The coal reaches a maximum thickness of 5½ feet at locality 1323. A local coal bed about 140 feet below the Scott bed averages approximately 4–5 feet in thickness. At locality 1260 there is 7 feet 4 inches of bony coal. A lenticular coal bed that crops out about 170 feet below the Scott bed contains about 3–4½ feet of clean coal.

Ulm No. 2 bed.—The Ulm No. 2 bed, the highest persistent coal bed in the Spotted Horse field, crops out near divide levels in many parts of the township. Along the divide between Windmill Draw and Middle Prong of Wild Horse Creek, local burning of the coal has produced a conspicuous bed of clinker. The thickest sections measured are in the eastern part of the township, where the coal ranges in thickness from 9 feet to 3 inches to 11½ feet. At several localities the coal is split into two benches. Coal exposed at localities 1304 and 1355 is about 40 feet below the Ulm No. 2 bed and is contained in several benches, from 1 foot 4 inches to 3 feet 4 inches thick. A local bed 45 feet above the Ulm No. 2 bed is about 2½–5 feet thick at localities 1315 and 1317.

Ulm No. 1 bed.—A coal bed that crops out about 75 feet above the Ulm No. 2 bed is considered to be the Ulm No. 1 bed. It underlies a small, high butte near the center of sec. 14 and has been removed by erosion from other parts of the coal field. The coal at locality 1316 is 10 feet 10 inches thick.

Other beds.—The Smith coal bed in T. 53 N., R. 74 W., occurs about 180 feet below the Felix coal bed and a few feet beneath the unconformable Wasatch-Fort Union contact. Further to the east, in T. 53 N., R. 73 W., the Anderson bed crops out about 160 feet below

the Smith bed. Both of these beds probably are present beneath the surface of T. 53 N., R. 75 W. and may contain considerable reserves. Where exposed in areas to the east the Smith bed averages about 6–8 feet in thickness; and the Anderson bed is about 18 feet thick in sec. 16, T. 54 N., R. 73 W. Information is insufficient to indicate the presence of coal beds beneath the Anderson bed.

T. 58 N., R. 74 W.

Plate 6

This township is drained by Buffalo, Dry, and Bitter Creeks and their tributaries. The major streams occupy straight, narrow valleys with steep slopes that are broken at places by benches developed on the resistant clinker of the Dietz No. 1 and Canyon beds. Divide areas are high, even-topped, narrow and are generally capped by the clinker of the Anderson bed. Maximum relief in the township is about 700 feet.

All rocks which crop out in the township belong to the Tongue River member of the Fort Union formation, which here is about 700 feet thick.

Canyon bed.—The Canyon coal bed is correlated with the *E* bed of the Little Powder River coalfield. Local burning of the coal has produced a thick clinker that crops out in narrow bands and small patches. The coal occurs as a series of lenses, which grade into shale at places. The bed reaches a maximum observed thickness at locality 485, where it contains 18 feet of coal with a 2-inch parting near the middle; however, this does not represent the total thickness, as the base of the coal is not exposed. At locality 490 the coal is split into 3 widely spaced benches 1 foot, 3 feet 8 inches, and 4 feet 3 inches thick. Other sections average about 4–8 feet of coal. At locality 500 the bed is composed of 5 feet of bone and bony coal. The lowest coal bed that crops out in the township is poorly exposed near the valley bottom of Bitter Creek and it is correlated with a local bed which occurs about 70 feet above the Wall bed in the western adjoining township, T. 58 N., R. 75 W. At locality 489, the only observed outcrop of the bed in the township, the coal is 3 feet 1½ inches thick. A higher local coal bed crops out about 100 feet below the Canyon bed and ranges in thickness from about 3 to 8 feet. At locality 488 a local bed 45 feet below the Canyon bed is 2 feet 6 inches thick.

Dietz No. 1 bed.—The Deitz No. 1 coal bed, about 60 feet stratigraphically above the Canyon bed, crops out in steep valley walls in most parts of the township. Local burning of the coal has produced a conspicuous clinker. The coal is generally more than 5 feet thick but grades into shale in the western row of sections. The bed is commonly split into benches of coal; most of the coal occurs in the thick middle

bench which reaches a maximum thickness of 9 feet at locality 487. About 7 inches to 2 feet above this bench is generally a thin layer of coal less than 1 foot thick, and at localities 496 and 505 it is underlain by a lower bench about 2½ feet thick.

Anderson bed.—The Anderson coal bed occurs above the Dietz No. 1 bed at intervals ranging from about 60 to 85 feet. Throughout most of its extent the coal has burned, producing abundant clinker. About one square mile of unburned coal occurs beneath the surface of the Buffalo Creek–Dry Creek divide. In other parts of the township unburned coal is limited to small, isolated patches surrounded by clinker. Measured sections contain 6–10 feet of coal, but, except at locality 521, the base of the coal is not exposed and the total thickness could not be obtained. At locality 510, the coal is bony and is split into a lower bench 2 feet 7 inches thick, and an upper bench 22 feet 4 inches thick, separated by 2 feet 8 inches of shale.

Other beds.—The Wall coal bed, tentatively correlated with the *J* bed of the Little Powder River coal field, occurs about 300 feet stratigraphically below the Canyon bed and may lie beneath the surface of the township. Measurements at 2 localities in T. 58 N., R. 75 W., and many measurements on the *J* bed in the Little Powder River field (Davis, 1912, p. 423–440) indicate that the coal is lenticular. In the Little Powder River field it increases in thickness from about 2 or 3 feet to as much as 13 feet within 1½ miles. Because of the uncertain correlation with the *J* bed and the lenticularity of the Wall bed it was not included in the reserve estimate of the township.

T. 57 N., R. 74 W.

Plate 7

Most of the township is drained by Bitter Creek and its tributaries. About 4 square miles in the northeastern corner and 2 square miles in the southwestern corner are drained by Dry and S A Creeks, respectively. Even-topped, pine-covered ridges and buttes, capped with clinker of the Anderson bed, stand 350–450 feet above stream level in the northwestern part of the township. Southeastward the divide areas are lower, moderately rolling, and generally underlain by sandstone. Several small clinker-capped knolls rise 50–100 feet above the level of the divides in secs. 10 and 11 and in the southwestern part of the township. Maximum relief is about 700 feet. About 650 feet of the Tongue River member of the Fort Union formation is exposed in the township.

Canyon bed.—The Canyon coal bed crops out in the slopes along Bitter Creek and its tributaries. The coal occurs as a series of discontinuous lenses which ordinarily contain partings. Commonly, where the coal is more than 2 feet thick it has burned at the outcrop, producing clinker which marks the position of the bed. The bed

averages about 5–6 feet in thickness. A local coal bed about 230 feet below the Canyon bed and 70 feet above the Wall bed is exposed at locality 731, where it is 4 feet 3 inches thick. A local bed about 100 feet below the Canyon bed is well exposed in the valley walls of Bitter Creek. This bed reaches a maximum observed thickness of 7 feet 7 inches at locality 809. An uncorrelated coal bed below the Canyon bed contains about 2–4½ feet of coal at localities 732 and 742.

Dietz No. 1 bed.—The Dietz No. 1 coal bed crops out about 55–80 feet stratigraphically above the Canyon bed in the valley of Bitter Creek and at locality 728 near the head of Dry Creek. The coal is bony at places and commonly contain partings. In the southeastern part of the township the coal is less than 2 feet thick along much of its outcrop. The thickest section measured is at locality 728, where the bed contains a lower bench of coal 7 feet thick separated by 9 inches of sandstone from an upper bench of coal 8 inches thick. At localities 719, 724, and 805 the bed contains benches of coal, free of partings, that are about 5 feet thick.

Anderson bed.—The largest areas of Anderson coal underlie thick cover in the eastern and southern parts of the township. At most of the outcrops visited, the bed is not completely exposed and its total thickness could not be determined. Incomplete sections show about 4½–15 feet of coal. The thickest complete section was measured at locality 765, where the coal is split into a lower bench 22 feet 4 inches thick and an upper bench 3 feet thick separated by about 10 feet of rock.

Smith bed.—The Smith bed underlies the high divide area between S A and Bitter Creeks and several high buttes in secs. 2, 3, 10, and 11. Small patches of clinker which do not extend far back from the outcrop commonly mark its position. The coal is generally split into two benches separated by a parting ½–1½ feet thick. The coal ranges in thickness from 2 feet 2 inches at locality 796 to 10 feet 4 inches—with a 9-inch parting—at locality 763. A local bed about 4 feet thick crops out at localities 783, 784, and 794 about 80 feet above the Smith bed. The clinker capping several high buttes in secs. 32 and 33 is evidence that a higher bed once was probably extended over much of the township.

Other beds.—The Wall coal bed, tentatively correlated with the *J* bed of the Little Powder River coal field, occurs about 300 feet stratigraphically below the Canyon bed and may be beneath the surface. Many measurements on the *J* bed in the Little Powder River field (Davis, 1912, p. 423–440) indicate that the coal of the bed is lenticular, ranging in thickness from about 2 or 3 feet to as much as 13 feet within 1½ miles. Because correlation with the *J* bed is uncertain, and the coal is lenticular, the Wall bed was not included in the reserve estimates of the township.

T. 56 N., R. 74 W.

Plate 8

Most of T. 56 N., R. 74 W. is drained by S A Creek and its tributaries. The eastern and north-central parts are drained by Butte Prong which flows northward into Bitter Creek. Parts of secs. 19, 30, 31, and 32 are drained by tributaries of L X Bar Creek. The main stream valleys are straight and narrow; the valley bottoms are bordered by moderate slopes which rise with increasing steepness to high divides. The Butte Prong–S A Creek divide is a narrow, grass- and brush-covered ridge that roughly parallels S A Creek. The surface along the divide between L X Bar and S A Creeks is broad and flat and is rimmed by pine-covered patches of clinker.

All exposed rocks belong to the Tongue River member of the Fort Union formation, which here is about 350 feet thick.

Dietz No. 1 bed.—The lowest coal bed that crops out in the township is the Dietz No. 1 bed which is exposed in secs. 1, 12, and 13 along Butte Prong. The thickness of the coal ranges from 8 to 13½ feet. In other parts of the township, coal at this horizon is less than 2 feet thick and was not mapped.

Anderson bed.—Scattered patches of clinker produced by the burning of the Anderson coal mark the outcrop of the bed at many places along the valleys of S A Creek and Butte Prong of Bitter Creek. A cover of soil conceals the bed in secs. 11, 14, 23, and in the northern part of sec. 24. In the SE¼ sec. 24 and NE¼ sec. 25 the bed is exposed for a short distance on the upthrown side of a normal fault that crosses Butte Prong. The thickest observed section was measured at locality 969, where 23 feet of coal is exposed. At locality 980 the bed contains a lower bench of bony coal 9½ feet thick separated by a 6-inch parting from an upper bench of clean coal 11 feet thick. Elsewhere the bed contains from 2 feet 2 inches to 14 feet 2 inches of coal; the thinnest sections measured are along S A Creek in the central and southwestern parts of the township. In secs. 21 and 28 the bed grades into carbonaceous shale and sandstone. A local bed, about 60 feet above the Anderson bed contains from 2 feet 3 inches to 4 feet 9 inches of coal.

Smith bed.—The Smith coal bed, about 130–160 feet stratigraphically above the Anderson bed, crops out near the top of the divide between S A Creek and Butte Prong, and at lover elevations, on the broad flat divide between L X Bar and S A Creeks where the bed has burned, leaving a conspicuous clinker along much of its outcrop. The coal reaches a maximum thickness of 11½ feet at locality 976 and is more than 5 feet thick at many localities. At localities 974, 982, and 1005 the bed contains 2 feet 9 inches–4½ feet of bony coal. In

the NE¼ sec. 4 the coal is less than 2 feet thick and was not mapped. A local coal bed 35 feet above the Smith bed is about 3–5 feet thick. About 60 feet above the Smith bed a local bed contains about 2–4 feet of coal.

Other beds.—The Canyon coal bed, which is about 160 feet below the Anderson bed, probably occurs beneath the surface of the township and may contain additional reserves. Measurements in T. 57 N., R. 74 W. and T. 57 N., R. 75 W. indicate that the bed is lenticular, containing as much as 16 feet of coal at some places but absent at others. About 2 miles northeast of T. 56 N., R. 74 W. the coal is split into 3 benches which range in thickness from 2½ to about 4 feet.

In T. 57 N., R. 72 W. of the Little Powder River field the *E* bed, correlated with the Canyon bed, is about 3–6 feet thick (Davis, 1912, Pl. XXXIII, op. p. 437). Because the Canyon coal bed is lenticular, a very conservative estimate of the thickness and extent beneath T. 56 N., R. 74 W. is given in the table showing the estimated reserve of this township. A local bed crops out about 100 feet below the Canyon bed in T. 57 N., Rs. 74 and 75 W., where the coal ranges in thickness from about 2 to 13½ feet. This bed probably underlies much of the surface of T. 56 N., R. 74 W. with an average thickness of about 3–4 feet of coal.

T. 55 N., R. 74 W.

Plate 9

The treeless divide between the Powder River and the Little Powder River follows an irregular northeasterly course across the eastern part of T. 55 N., R. 74 W. The surface of the township is that of an upland of moderate relief trenched by deep valleys near its margins. A great part of the area is under cultivation. In the southern part of the township several buttes and narrow ridges, capped by coal and clinker of the Felix bed, rise 175–200 feet above the general level. The S A lakes in the NW¼ sec. 14 occupy an undrained depression that contains water for short periods after heavy rains and during the spring thaw. Two smaller undrained depressions are in the SW¼ sec. 4.

The Tongue River member of the Fort Union formation, about 275 feet thick, is exposed in the northern part of the township and near the heads of Chicken, Hay and Squaw Creeks in the southern part. About 350 feet of the Wasatch formation is exposed in the southern part of the township. The basal 180–220 feet of the formation, or that part below the Felix coal bed, is composed of a thick crossbedded, coarse-grained, yellowish-gray sandstone well exposed in deep gullies that head on the buttes and ridges southwest of Recluse. The

Wasatch-Fort Union contact is an unconformable surface which bevels progressively older rocks of the Tongue River member southeastward. It is about 175 feet above the Smith coal bed in the northwestern part of the township and 10 or 15 feet, in the southeastern. Owing to poor exposures, the contact was only approximately located.

Smith bed.—The Smith coal bed crops out in stream valleys near the borders of the township and along the Powder River-Little Powder River divide in its north-central part. In the northern part of the township the coal is split into two benches, separated by about 1–7 feet of strata. The lower bench ranges in thickness from about 6 to 7 feet and the upper bench is about 1–2 feet thick. About 250 yards west of sec. 31 at locality 960 the bed contains 7 feet 2½ inches of coal. In sec. 2 a local coal bed about 100 feet below the Smith bed is concealed by slope wash. At locality 1017, about 400 yards north of the township boundary, this bed contains 4 feet 9 inches of coal. A local bed about 60 feet above the Smith bed is exposed in the nothern and southwestern parts of the township; the thickness of coal ranges from about 5 to 6 feet. The coal is split into two benches, each about 2½–3½ feet thick, at localities 1022 and 1033, and at locality 1024 it is split into 3 benches, each about 2½ to 6 feet thick. Another local coal bed is poorly exposed in the western part of the township about 150 feet above the Smith bed. At locality 1027 the bed contains 8½ feet of coal.

Felix bed.—The Felix coal bed crops out near the tops of several high buttes and ridges in the southern part of the township. Locally the coal has burned to produce conspicuous clinker. At locality 1042 the coal is 14 feet 10 inches thick, and at locality 1034 it is split into two benches about 1½ feet apart. The lower bench is 5 feet 5 inches thick and the upper bench is 9 feet 7 inches thick. The coal thins eastward and at locality 1043 is about 3 feet thick, with an 8-inch shale parting. A local coal bed, about 115 feet above the Felix bed, contains 3 feet 2 inches of coal at locality 1039.

Other beds.—The Anderson coal bed, about 160 feet below the Smith bed, probably occurs beneath the surface of the township and is believed to contain large reserves. About one-fourth mile north of sec. 2 the Anderson coal is 2 feet 2 inches thick, and in other parts of the township it is as much as 23 feet thick. Near the eastern boundary of the coal field the bed has burned, forming a thick clinker. Sections of coal measured in the southern part of the Little Powder River coalfield (Davis, 1912, p. 423–440) are generally more than 10 feet thick, and in sec. 4, T. 55 N., R. 72 W. the coal is about 25 feet thick (Davis, 1912, loc. 20, pl. 32, pl. XXXII, op. p. 436). The Anderson coal in T. 55 N., R. 74 W. is estimated to range in thickness from about 3½ to 7½ feet.

T. 54 N., R. 74 W.

Plate 10

The narrow, treeless, Powder River–Little Powder River divide, surmounted by several clinker-capped buttes, follows a sinuous, northerly trending course across the township. Most of the area west of the divide is drained by Spotted Horse Creek and its tributaries. About 2 square miles near the southwest corner are drained by tributaries of Middle Prong of Wild Horse Creek. The area east of the divide is drained by Hay and Horse Creeks and their tributaries. Broad, gently sloping areas of grassland, much of which is under cultivation, occur in the northwestern and eastern parts of the township. The rest of the township is rugged and is characterized by deep narrow valleys and high divides. Horse Creek Butte, a clinker-capped erosional remnant rising about 350 feet above the surrounding area, is one of the most prominent topographic features in the Spotted Horse coalfield. Maximum relief in the township is about 650 feet.

About 100 feet of the Tongue River member of the Fort Union formation is exposed in the township. The Wasatch formation is about 460 feet thick. The basal 180 feet of the formation, or that part below the Felix coal bed, is composed of a thick bed of crossbedded, coarse-grained, yellowish-gray sandstone. The Wasatch-Fort Union contact is an unconformable surface which bevels successively older Tongue River rocks southeastward. It is about 100 feet above the Smith coal bed in the northeastern part of the township, and 10 or 15 feet, in the southeastern part. Owing to poor exposures, the contact was only approximately located.

Smith bed.—The Smith coal bed is exposed along the valley walls of Hay, Grass, and Horse Creeks in the eastern part of the township, and crops out for a short distance along Spotted Horse Creek in the extreme northwestern part. The bed averages about 4 feet in thickness. An incomplete section at locality 1250 shows 7 feet of coal. A measurement about one-half mile northwest from the northwest corner of sec. 6 shows 7 feet 2½ inches of coal. Much of the coal in the eastern part of the township occurs at shallow depth. A local coal bed, about 45 feet below the Smith bed crops out in the valleys of Grass and Horse Creeks and averages more than 7 feet in thickness. An incomplete section of coal, 3 feet 3 inches thick, was measured on a local bed, about 85 feet above the Smith bed at locality 1180.

Felix bed.—The Felix coal bed crops out near the base of steep slopes on the high divides. Locally the coal has burned, producing a conspicuous clinker that marks the outcrop. The coal has an average thickness of about 16 feet and commonly contains one or more thin partings. The thickest section was measured at locality 1209, where

the bed contains 21 feet 3 inches of coal and 6½ inches of partings. Bony coal, ranging in thickness from 3 feet 4 inches to 10 feet 4 inches, makes up the lowest part of the section at several localities. The coal thins to less than 4 feet in the SE ¼ sec. 19 and the NE ¼ sec. 30. Some coal has been mined from a small open pit at locality 1234.

Scott bed.—The Scott coal bed occurs above the Felix bed separated by an interval ranging from about 265 feet near the southwest corner of the township to 170 feet in the east-central part. It occurs in small areas near the highest divides in the township. The thickest section was measured at locality 1197 where the bed contains 9 feet 3½ inches of coal and 8 inches of partings. The coal thins southward and grades into shale in the southwestern part of the township. Local beds of coal exposed in the southwestern part of the township 180 and 110 feet below the Scott bed reach a maximum thickness of about 4 feet. A local coal bed, about 65 feet below the Scott bed, is well exposed in many parts of the township, and many measurements of its thickness were made. The coal has an average thickness of about 3½ feet. At several places in the southwestern part of the township the coal is less than 2 feet thick and was not mapped. Some coal has been mined from this bed at locality 1223.

Ulm No. 2 bed.—Most of the Ulm No. 2 coal bed has burned, producing a thick clinker which caps the highest points in the township, but unburned patches of coal underlie the summits of three small buttes in the southwestern corner of the township. A measurement of the bed at locality 1229 shows 16 feet 2 inches of coal with a 3-inch parting near the top.

Other beds.—The Anderson coal bed, about 160 feet below the Smith bed, probably is beneath the surface of the township and contains large reserves. At an outcrop in sec. 16, of the eastern T. 54 N., R. 73 E, the bed, partly exposed, contains 18½ feet of coal and about 1 foot of partings. According to Davis (1912, p. 423–440) the C bed, correlated with the Anderson coal of this report, is about 9–21 feet thick in the southern part of the Little Powder River field. For the purpose of reserve calculation the thickness of the Anderson bed beneath the township here described is estimated to range from about 3½ to 7½ feet.

T. 53 N., R. 74 W.

Plate 11

The northern and eastern parts of T. 53 N., R. 74 W. are drained by Horse, Lone, and Wildcat Creeks, tributaries of the Little Powder River. The western part is drained by Middle Prong of Wild Horse Creek, a tributary of the Powder River. The Powder River-Little Powder River divide, which follows an arcuate course across the western part of the township, is an intricately dissected plateau remnant

bordered by cliffs and precipitous slopes descending 300–400 feet. Clinker produced by the burning of the Ulm No. 2 bed underlies much of the plateau surface. Maximum relief in the township is about 550 feet.

The Tongue River member of the Fort Union formation is poorly exposed in small areas near the eastern township boundary. Rocks of the Wasatch formation, about 340–420 feet thick, are exposed in most parts of the township. The basal 180 feet of the formation, or that part below the Felix coal bed, is composed of a thick bed of cross-bedded, coarse-grained, yellowish-gray sandstone.

Felix bed.—The Felix bed, the lowest coal bed that crops out in the township, is exposed near the base of steep slopes on the high divides, owing largely to initial dip, but in part to structural dip, the Felix bed crops out west of the Powder River-Little Powder River Divide at elevations about 100 feet lower than east of the divide. Scattered patches of clinker produced by the burning of the coal mark the outcrop. The coal has an average thickness of about 14 feet. At many localities the coal is split by a parting which ranges in thickness from 2 inches to about 12½ feet. The thinnest section was that measured at locality 1528, where the coal is about 4 feet thick.

Scott bed.—The Scott coal bed, named from the H. W. Scott ranch in sec. 13 of this township, crops out near divide levels. The interval between the Scott and Felix beds ranges in thickness from about 190 feet in the eastern part of the township to about 280 feet in the western part. Locally the Scott bed has burned, producing clinker which at places has merged with the clinker of the overlying Ulm No. 2 bed. The Scott coal is lenticular and is generally broken by partings. At localities 1511, 1524, and 1526 the coal is split into 2 benches by a parting ranging from about 4 inches to 6½ feet in thickness; the upper bench is 5 feet 3 inches–5 feet 9½ inches thick, and the lower bench is about 1–1½ feet. Measurements at localities 1457, 1484, and 1529 show about 5½ feet of coal; elsewhere the bed is less than 5 feet thick. It was not mapped for a short distance in the northwestern corner of the township where it is less than 2 feet thick.

A local coal bed 50 feet below the Scott bed contains about 2–3 feet of coal. A lower uncorrelated coal bed about 2 feet thick is exposed at localities 1449 and 1463. Many sections were measured of a local coal bed which crops out about 90 feet below the Scott bed. The coal is about 4–5 feet thick. At locality 1521 it is split into two benches, 2½ and 3½ feet thick, separated by 13 feet 5 inches of shale. A lenticular coal bed, 115 feet below the Scott bed ranges in thickness from about 2–3½ feet. At locality 1490 it is represented by 2 benches of coal, 2½ and 3 feet thick, separated by 16 feet 3 inches of rock. A local coal bed crops out about 150 feet below the Scott bed. A section measured on this bed at locality 1508 shows 12 feet 7½ inches of coal

and a 2-inch parting. At other localities the bed is less than 4 feet thick.

Ulm No. 2 bed.—The Ulm No. 2 coal bed, about 50 feet stratigraphically above the Scott bed, crops out near the summits of the highest divides and buttes. Owing to poor exposures, its thickness was determined at only 4 localities. The thickest section was measured at locality 1517, where the bed contains 21 feet of coal, overlain by 11½ inches of shale, which is overlain by 1 foot 8 inches of coal. Measurements at localities 1495 and 1518 indicate that the lower part of the bed thins and grades into carbonaceous shale eastward.

Other beds.—Where exposed in eastern adjoining T. 53 N., R. 73 E., the Tongue River member of the Fort Union formation contains several thick coal beds that probably underlie the surface of T. 53 N., R. 74 W.; the outcrop of the Smith coal bed was traced westward for short distances across the township border into secs. 1 and 24, where it is concealed. Measurements on the Smith bed at nearby localities show 3½–6 feet of coal, and the bed is estimated to have about the same thickness range in this township. On the basis of measurements in eastern adjoining township, T. 53 N., R. 73 W., two local beds, one 45 feet below and the other 75 feet below the Smith bed are estimated to have an average thickness of about 4 and 3½ feet, respectively. According to Davis (1912, p. 423–440) the *C* bed, correlated with the Anderson coal bed of this report, is about 9–21 feet thick at measured outcrops in the southern part of the Little Powder River coalfield. For the purpose of reserve calculation the thickness of the Anderson bed beneath T. 53 N., R. 74 W. is estimated to range from about 3½–7½ feet.

T. 55 N., R. 73 W. (WESTERN HALF)

Plate 9

Most of the runoff from the western half of T. 55 N., R. 73 W. drains into the Little Powder River by way of Spring and Squaw Creeks and their tributaries. About 2 square miles in the northwestern part is drained by tributaries of the Powder River. The surface of the westernmost part is a rolling prairie, bordered on the east by a low escarpment. Sand blown from upland levels has accumulated in dunes at the base of the escarpment in the SW¼ sec. 29. East of the escarpment the relief is moderate. Stream bottoms are narrow and are bordered by slopes that rise 150–200 feet.

The exposed rocks represent about 225 feet of the Tongue River member of the Fort Union formation. An inlier of the member is exposed in an undrained depression in sections 30 and 31. About 50–75 feet of coarse-grained sandstone of the Wasatch formation is poorly exposed in the western part of the township.

Anderson bed.—The Anderson coal bed is not exposed in the western half of T. 55 N., R. 73 W. Its outcrop in secs. 9, 16, and 28 is covered by soil and alluvium. Clinker produced from the burning of the Anderson coal underlies a small area in the southeastern corner of sec. 28 and forms conspicuous ledges along Spring and Squaw Creeks short distances east of the coalfield boundary. According to Davis (1912, p. 434), the *C* bed, correlated with the Anderson bed of this report, ranges in thickness from 13 to 16 feet in the eastern half of the township and 10 to 17 feet in the northern adjoining township.

Smith bed.—The Smith coal bed was mapped where it crops out near the base of the low escarpment in the western part of the township and at an isolated locality in sec. 16. In other parts of the township the coal is less than 2 feet thick and was not mapped. An incomplete section measured at locality 1171 shows 7 feet 5 inches of coal which represents the maximum observed thickness. Elsewhere the coal ranges in thickness from about 2 to 4½ feet. At several localities the coal is bony and split by partings. An uncorrelated bed below the Smith bed is exposed at locality 1165, where it contains 5 feet 8 inches of coal.

Other beds.—In Tps. 55 N., Rs. 71 and 72 W. of the Little Powder River coal field the *E* (correlated with the Canyon bed), *F*, and *H* coal beds crop out below the Anderson bed at intervals of about 165, 185, and 240 feet (Davis, 1912, p. 428–429), respectively. All are 4 feet or less thick (Davis, 1912, p. 433–434) and grade into shale in the southern part of T. 55 N., R. 72 W. These beds may underlie the surface of T. 55 N., R. 73 W., but are not included, because they are thin and lenticular.

T. 54 N., R. 73 W. (WESTERN HALF)

Plate 10

The run-off flows into the Little Powder River by way of Horse and Hay Creeks. Bottomlands bordering the streams are narrow and are bordered by slopes which rise with increasing gradients to broad, flat, grass- and brush-covered divides. Maximum relief in the township is about 275 feet.

The exposed Tongue River member of the Fort Union formation is about 275 feet thick. A basal, coarse-grained, moderate-brown-weathering sandstone of the Wasatch formation caps broad, flat divides in the west-central and northern parts of the township. The Wasatch-Fort Union contact is an unconformable surface which occurs about 10–15 feet above the Smith coal bed in the northern part of the area and as much as 100 feet above the Smith bed in the southern part.

Anderson bed.—Small patches of clinker produced by the burning of the Anderson coal bed occur in secs. 16, 21, 28, and 29 near the valley bottoms of Hay and Horse Creeks. Where the coal is not burned, its outcrop is generally concealed. A single measurement in an abandoned prospect pit at locality 1424, where the bed is partly exposed, shows 18 feet 6 inches of coal and 11 inches of partings. Davis (1912, p. 433) estimates that the *C* bed, correlated with the Anderson bed, ranges in thickness from 9–13 feet in the eastern half of the township. An uncorrelated bed above the Anderson bed is partly exposed at locality 1418, where 3 feet of coal was measured.

Smith bed.—The Smith coal bed crops out near the tops of divides. The coal has burned along much of its outcrop, producing discontinuous bands and patches of clinkers. The thickest sections on the bed were measured in the southern part of the township. At locality 1420 the coal is 13 feet thick, and at locality 1426 the bed contains 12 feet of coal overlain by 2 feet of shale, above which is 1 foot of coal. Northeastward the coal becomes impure and grades into shale in secs. 4, 5, 6, 8, and 9. Bony coal constitutes all or a considerable part of the sections measured at several localities. A lenticular local coal bed crops out about 60 feet below the Smith in many parts of the township. Commonly the coal is broken by partings, and at several localities it is bony. The bed reaches a maximum observed thickness at locality 1401, where 10½ feet of bony coal is exposed. A second local bed, 95 feet above the Smith bed, is exposed in secs. 32 and 33. At locality 1423 it contains 14 feet 2½ inches of coal.

T. 53 N., R. 73 W. (western half)

Plate 11

The western half of T. 53 N., R. 73 W. is in the Little Powder River drainage area. It is drained, for the most part, by Lone Tree and Wild Cat Creeks and their tributaries. About 2 square miles in the northern part is drained by tributaries of Horse Creek. West of U. S. Highway 14, and 16, streams occupy narrow valleys bordered by steep slopes rising 100–250 feet to broad, moderately rolling, grass- and brush-covered divides that in many places are rimmed by clinker of the Smith and a lower, local coal bed. West of the highway streams are bordered by gentle slopes which rise 250–450 feet to narrow divides and clinker-capped buttes. Maximum relief is about 600 feet.

The exposed Tongue River member of the Fort Union formation is about 250 feet thick. The Wasatch formation (Eocene) forms much of the surface west of the highway. The lower 160–180 feet of formation is composed of cross-bedded, coarse-grained, yellowish-gray sandstone. The Wasatch-Fort Union contact is an unconformable

surface which bevels successively older Tongue River rocks southward. It occurs about 100 feet above the Smith coal bed in the northern part of the township and from 10 to 15 feet above the Smith bed in the southern part. Owing to poor exposures, the contact was only approximately located.

Smith bed.—East of U. S. Highway 14 and 16 only clinker produced by the burning of the Smith coal is visible, and west of the highway the bed is poorly exposed, owing to soil cover. The coal reaches a maximum observed thickness of 12 feet 7 inches at locality 1542. It gradually thins southward and at locality 1557 is about 3½ feet thick. A local bed, possibly a lower bench of the Smith bed, crops out about 30 feet below the Smith bed in many parts of the township. The bed contains about 5½–13½ feet of coal. For a short distance in sec. 9 the coal is less than 2 feet thick and was not mapped. A local coal bed about 75 feet below the Smith bed crops out in the valleys of Lone Tree and Wild Cat Creeks and Jamison Prong of Wild Cat Creek. The bed is thickest at locality 1543, where it contains 14 feet 4 inches of coal and a 2-inch parting. The coal thins toward the center of the township and is 2 feet 5 inches thick at locality 1562. A local coal bed about 30 feet above the Smith bed contains 5 feet 2 inches of coal at locality 1545. In secs. 3 and 9 a second local coal bed, about 6½–8½ feet thick, is exposed about 90 feet above the Smith bed.

Felix bed.—The Felix coal bed underlies several small areas in secs. 6, 7, 18, and 31. Locally, the coal has burned and its clinker caps low buttes. At locality 1564 the bed is composed of a partly exposed lower bench of coal, 12 feet 8 inches thick; an upper bench, 2 feet 2 inches thick, separated by about 6 feet of shale.

Scott bed.—The Scott coal bed, about 200 feet above the Felix bed, crops out near the tops of two small high knolls in the SW¼ sec. 31. A short distance from the southwest corner of the township, the coal is 4 feet 10 inches thick and contains numerous fragments of fossil wood.

Ulm No. 2 bed.—Small patches of clinker produced by the burning of the Ulm No. 2 coal bed cap two high buttes in the SW¼ sec. 31 and are the only indications of the Ulm No. 2 bed in the township.

Other beds.—The Anderson coal bed probably lies below the surface of the western half of T. 53 N., R. 73 W. and is estimated to range in thickness from about 7½ to 13 feet. In sec. 3 of the eastern half of the township, included in the Little Powder River coalfield, "the bed [the C bed, which is correlated with the Anderson bed of this report] has 2 benches of coal, 10 and 13 feet thick, separated by 4 feet of shale." (Davis, 1912, p. 431.)

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TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 58 N., R. 78 W.											
WASATCH FORMATION											
Arvada bed	3.6	2,798	18.06			18.06					18.06
	5.5	300		2.92		2.92					2.92
Total			18.06	2.92		20.98					20.98
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	2.5	226	1.00			1.00					1.00
Local bed 50 ft. below Roland bed	4.0	5,665	39.88			39.88					39.88
	5.4	302		2.92		2.92					2.92
Local bed 100 ft. below Roland bed	3.6	2,704	17.11			17.11					17.11
Anderson bed	6.6	10,726						125.30		125.30	125.30
Dietz No. 1 bed	3.8	10,624					71.46			71.46	71.46
Canyon bed	5.0	10,691						94.62		94.62	94.62
Wall bed	3.6	10,742					68.45			68.45	68.45
Total			57.99	2.92		60.91	139.91	219.92		359.83	420.74
Grand total, T. 58 N., R. 78 W.			76.05	5.84		81.89	139.91	219.92		359.83	441.72

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								
			Measured and indicated				Inferred				Grand total
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 57 N., R. 78 W.											
WASATCH FORMATION											
Local bed 45 ft. above Felix (?)	3.1	114	0.62			0.62					0.62
	6.4	64		0.73		.73					.73
Felix (?) bed	2.6	5	.02			.02					.02
Arvada bed	3.3	13,265	76.07			76.07					76.07
Total			76.71	0.73		77.44					77.44
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	2.6	376	1.73			1.73					1.73
Local bed 50 ft. below Roland bed	2.5	109	.48			.48					.48
Smith bed	3.3	3,933	22.97			22.97					22.97
	3.3	509					2.97			2.97	2.97
Anderson bed	4.7	2,485					20.67			20.67	20.67
	6.2	20,411						223.99		223.99	223.99
Dietz No. 1 bed	3.8	22,795					153.32			153.32	153.32
Canyon bed	5.0	22,843						202.16		202.16	202.16
Wall bed	3.6	16,438					104.74			104.74	104.74
Total			25.18			25.18	281.70	426.15		707.85	733.03
Grand total, T. 57 N. R. 78 W			101.89	0.73		102.62	281.70	426.15		707.85	810.47
T. 56 N., R. 78 W.											
WASATCH FORMATION											
Local bed 140 ft. above Felix (?) bed	2.7	15	0.07			0.07					0.07
Local bed 95 ft. above Felix (?) bed	4.9	6	.05			.05					.05
	6.6	136		1.61		1.61					1.61
Local bed 45 ft. above Felix (?) bed	3.3	10	.06			.06					.06
Felix (?) bed	3.0	3	.02			.02					.02
Arvada bed	3.5	1,653	10.25			10.25					10.25
	7.0	2.35		2.90		2.90					2.90
Total			10.45	4.51		14.96					14.96
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	3.2	1,171	6.68			6.68					6.68
Local bed 35 ft. below Roland bed	3.4	13	.08			.08					.08
Local bed 50 ft. below Roland bed	2.7	710	3.39			3.39					3.39
Local bed 100 ft. below Roland bed	3.1	115	.63			.63					.63
Local bed 50 ft. above Smith bed	3.2	93	.53			.53					.53
Smith bed	2.9	2,552	13.24			13.24					13.24
	2.9	1,942					9.97			9.97	9.97
Anderson bed	4.3	23,768					180.90			180.90	180.90
	5.0	283						2.50		2.50	2.50
Canyon bed	5.0	24,045						212.80		212.80	212.80
Total			24.55			24.55	190.87	215.30		406.17	430.72
Grand total, T. 56 N., R 78 W			35.00	4.51		39.51	190.87	215.30		406.17	445.68

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 58 N., R. 77 W.											
WASATCH FORMATION											
Arvada bed	4.2	4.96	3.70			3.70					3.70
	5.9	13.79		14.42		14.42					14.42
Total			3.70	14.42		18.12					18.12
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	3.6	3,385	22.58			22.58					22.58
	6.5	1,245		14.33		14.33					14.33
Local bed 100 ft. below Roland bed	2.7	1,538	7.33			7.33					7.33
Anderson bed	6.6	4,549		53.14		53.14					53.14
	6.6	4,269						49.87		49.87	49.87
	13.3	1,170			27.54	27.54					27.54
Dietz No. 1 bed	3.8	10,195					68.57			68.57	68.57
Canyon bed	5.0	10,219						90.44		90.44	90.44
Wall bed	3.6	10,227					65.17			65.17	65.17
Total			29.91	67.47	27.54	124.92	133.74	140.31		274.05	398.97
Grand total, T. 58 N., R 77 W			33.61	81.89	27.54	143.04	133.74	140.31		274.05	417.09
T. 57 N., R. 77 W.											
WASATCH FORMATION											
Arvada bed	4.1	819	5.94			5.94					5.94
	6.2	225		2.36		2.36					2.36
Total			5.94	2.36		8.30					8.30
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	3.6	950	6.42			6.12					6.12
	6.2	502		5.51		5.51					5.51
Local bed 100 ft. below Roland bed	2.7	841	4.02			4.02					4.02
Local bed 125 ft below Roland bed	3.8	26	.18			.18					.18
	5.5	13		.13		.13					.13
Local bed 145 ft. below Roland bed	3.1	109	.60			.60					.60
Local bed 35 ft. above Smith	3.0	1,569	8.20			8.20					8.20
Smith bed	3.6	6,018	38.69			38.69					38.69
	5.8	3,467		35.34		35.34					35.34
Local bed 35 ft. below Smith bed	3.1	448	2.46			2.46					2.46
Local bed 85 ft. above Anderson bed	3.5	576	3.58			3.58					3.58
	5.8	124		1.27		1.27					1.27
Anderson bed	7.1	9,672		121.55		121.55					121.55
	7.1	10,622						133.49		133.49	133.49
	14.2	2,026			51.11	51.11					51.11
Dietz No. 1 bed	2.6	32	.15			.15					0.15
	3.8	15,182					102.11			102.11	102.11
Canyon bed	5.0	683	6.04			6.04					6.04
	5.0	22,550						199.57		199.57	199.57
Wall bed	3.6	11,043					70.37			70.37	70.37
Total			70.04	163.80	51.11	284.95	172.48	333.06		505.54	790.49
Grand total, T. 57 N., R. 77 W			75.98	166.16	51.11	293.25	172.48	333.06		505.54	798.79

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								
			Measured and indicated				Inferred				Grand total
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 56 N., R. 77 W.											
WASATCH FORMATION											
Arvada bed	4.1	546	3.91			3.91					3.91
	7.1	6,373		15.80		15.80					15.80
	11.0	19			0.37	.37					.37
Total			3.91	15.80	.37	20.08					20.08
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	2.5	275	1.22			1.22					1.22
Local bed 65 ft. below Roland bed	3.3	968	5.57			5.57					5.57
	6.4	18		0.20		.20					.20
Local bed 80 ft. below Roland bed	2.7	1,272	6.15			6.15					.15
Local bed 100 ft. below Roland bed	3.2	197	1.11			1.11					1.11
Local bed 50 ft. above Smith bed	3.2	664	3.81			3.81					3.81
	5.3	11		.10		.10					.10
Smith bed	3.5	7,765	46.53			46.53					46.53
	5.8	7,019		71.55		71.55					71.55
Local bed	2.9	138	.71			.71					.71
Anderson bed	4.3	8,483	64.55			64.55					64.55
	4.3	9,610					73.14			73.14	73.14
	5.0	526						4.66		4.66	4.66
	7.4	9,437		28.91		28.91					28.91
	11.7	259			5.35	5.35					5.35
Canyon bed	5.0	21,168						187.34		187.34	187.34
	7.5	2,256		29.95		29.95					29.95
	10.0	152			2.69	2.69					2.69
Total			129.65	130.71	8.04	268.40	73.14	192.00		265.14	533.54
Grand total, T. 56 N., R. 77 W.			133.56	146.51	8.41	288.48	73.14	192.00		265.14	553.62
T. 58 N., R. 76 W.											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	6.0	21		0.22		0.22					0.22
Local bed 100 ft. below Roland	2.7	27	0.13			.13					.13
Anderson	19.2	3,084			104.92	104.92					104.92
Dietz No. 1 bed	3.3	639	3.70			3.70					3.70
	4.0	3,850					26.95			26.95	26.95
	6.1	405		4.37		4.37					4.37
Canyon bed	3.7	1,813	11.80			11.80					11.80
	5.0	1,053						9.32		9.32	9.32
	6.1	5,029		54.51		54.51					54.51
	12.6	15			.34	.34					.34
Local bed 100 ft. below Canyon bed	3.7	1,801	11.71			11.71					11.71
	7.4	1,245		16.26		16.26					16.26
	14.7	1,120			29.14	29.14					29.14
Local bed 170 ft. below Canyon bed	3.3	850					6.24			6.24	6.24
	3.8	4,145	27.91			27.91					27.91
	6.5	890		10.21		10.21					10.21
Local bed 70 ft. above Wall bed	3.2	146					.83			.83	.83
	3.8	242	1.63			1.63					1.63
	3.6	797	5.08			5.08					5.08
Wall bed	3.6	8,824					56.23			56.23	56.23
	7.5	210		2.79		2.79					2.79
Total			61.96	88.36	134.40	284.72	90.25	9.32		99.57	384.29
Grand total, T. 58 N., R. 76 W.			61.96	88.36	134.40	284.72	90.25	9.32		99.57	384.29

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 57 N., R. 76 W.											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	2.7	16	0.05			0.05					0.05
Local bed 110 ft. below Roland	2.7	199	.95			.95					.95
Local bed 145 ft. below Roland	2.7	317	1.52			1.52					1.52
Local bed 35 ft. above Smith bed	3.1	104	.56			.56					.56
Smith bed	3.1	3	.02			.02					.02
	5.4	3		0.04		.04					.04
	4.0	5	.04			.04					.04
Anderson bed	8.5	1,668		25.42		25.42					25.42
	15.2	3,640			97.94	97.94					97.94
Dietz No. 1 bed	2.5	344	2.04			2.04					2.04
	3.3	616					2.73			2.73	2.73
	4.1	386	2.80			2.80					2.80
Canyon bed	5.0	395						3.55		3.55	3.55
	7.6	9,179		123.54		123.54					123.54
	10.0	5							0.09	.09	.09
	16.2	7,163			204.70	204.70					204.70
Local bed 100 ft. below Canyon bed	3.4	2,515	15.16			15.16					15.16
	5.7	203		2.04		2.04					2.04
Local bed 170 ft. below Canyon bed	3.3	424					2.46			2.46	2.46
	3.9	4,630	31.68			31.68					31.68
	6.3	1,130		12.63		12.63					12.63
Local bed 70 ft. above Wall bed	3.2	1,339					7.58			7.58	7.58
	3.4	353	2.10			2.10					2.10
	7.5	397		5.27		5.27					5.27
	11.0	114			2.22	2.22					2.22
Wall bed	3.6	6,238					39.75			39.75	39.75
Total			56.92	168.94	304.86	530.72	52.52	3.55	0.09	56.16	586.88
Grand total, T. 57 N., R. 76 W.			56.92	168.94	304.86	530.72	52.52	3.55	0.09	56.16	586.88
T. 56 N., R. 76 W.											
WASATCH FORMATION											
Arvada	2.5	66	0.29			0.29					0.29
	6.7	466		5.52		5.52					5.52
Total			.29	5.52		5.81					5.81
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	3.2	118	0.67			0.67					0.67
Local bed 175 ft. below Arvada	2.7	590	2.87			2.87					2.87
Local bed 210 ft. below Arvada	3.3	2,319	13.74			13.74					13.74
	6.0	6		0.06		.06					.06
Local bed 35 ft. above Smith	2.8	390	1.91			1.91					1.91
Local bed	2.9	19	.10			.10					.10
Smith bed	2.8	2,605	17.04			17.04					17.04
	6.5	6,411		73.59		73.59					73.59
	11.5	1,442			29.35	24.35					29.35
Anderson bed	3.5	10,627	66.80			66.80					66.80
	3.6	3,079					19.68			19.68	19.68
	8.0	5,856		83.02		83.02					83.02
	13.5	804			79.22	19.22					19.22
Dietz No. 1 bed	3.1	430	2.39			2.39					2.39
Canyon bed	6.5	16,654						192.18		192.18	192.18
	7.6	5,376		72.56		72.56					72.56
	12.3	3,587			78.30	78.30					78.30
Total			105.52	229.23	126.87	461.62	19.68	192.18		211.86	673.48
Grand total, T. 56 N., R. 76 W.			105.81	234.75	126.87	467.43	19.68	192.18		211.86	679.29

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 58 N., R. 75 W.											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Anderson bed	3.8	93	0.62			0.62					0.62
	5.6	10		0.10		.10					.10
	13.8	2			0.05	.05					.05
Canyon bed	4.3	696	5.28			5.28					5.28
	6.9	819		9.98		9.98					9.98
	13.1	1,782			41.46	41.46					41.46
Local bed 90 ft. below canyon bed	4.3	319	2.41			2.41					2.41
	7.1	4,580		57.63		57.63					57.63
	13.7	618			15.01	15.01					15.01
Local bed 170 ft. below Canyon bed	3.8	922	6.20			6.20					6.20
	7.6	4,856		65.23		65.23					65.23
	15.0	570			15.13	15.13					15.13
Local bed 70 ft. above Wall bed	3.2	1,277					7.23			7.23	7.23
	3.7	1,223	8.07			8.07					8.07
	7.4	1,060		13.93		13.93					13.93
	10.9	155			2.98	2.98					2.98
Local bed 35 ft. above Wall bed	3.8	1,285	8.63			8.63					8.63
Wall bed	3.6	2,645	16.85			16.85					16.85
	3.6	154					.98			.98	.98
	7.5	422		5.60		5.60					5.60
	11.2	310			6.15	6.15					6.15
Total			48.06	152.47	80.78	281.31	8.21			8.21	289.52
Grand total, T. 58 N., R. 75 W.			48.06	152.47	80.78	281.31	8.21			8.21	289.52
T. 57 N., R. 75 W.											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Roland bed	4.2	6	0.04			0.04					0.04
Smith bed	3.4	1,011	6.01			6.01					6.01
	6.5	522		6.01		6.01					6.01
	10.0	2			0.04	.04					.04
Local bed 40 ft. above Anderson bed	2.7	32	0.15			.15					.15
Anderson bed	8.4	2,890		42.08		42.08					42.08
	17.9	4,130			131.21	131.21					131.21
Dietz No. 1 bed	3.6	2,641	16.98			16.98					16.98
	6.9	22		.27		.27					.27
Canyon	3.4	5,046	30.24			30.24					30.24
	7.2	7,302		93.43		93.43					93.43
	11.8	2,380			50.68	50.68					50.68
Local bed 100 ft. below Canyon bed	4.0	2,539					17.98			17.98	17.98
	4.1	11,549	83.81			83.81					83.81
	6.4	4,579	51.49			51.49					51.49
	11.7	202			4.20	4.20					4.20
Local bed 170 ft below Canyon bed	3.5	5,493	34.06			34.06					34.06
	6.6	1,984		23.32		23.32					23.32
	15.0	86				2.28					2.28
Local bed 70 ft. above Wall bed	3.0	3,051					16.23			16.23	16.23
	3.4	1,048	6.36			6.36					6.36
	7.5	650		8.63		8.63					8.63
	11.0	10			.19	.19					.19
Wall bed	3.6	355					2.26			2.26	2.26
Total			177.65	225.23	188.60	591.48	36.47			36.47	627.95
Grand total, T. 57 N., R. 75 W.			177.65	225.23	188.60	591.48	36.47			36.47	627.95

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 56 N., R. 75 W.											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed 120 ft. above Smith bed	2.6	248	1.14			1.14					1.14
Local bed 75 ft. above Smith bed	3.5	8,729	54.50			54.50					54.50
	5.0	5		0.04		.04					.04
Local bed 48 ft. above Smith bed	2.6	171	.79			.79					.79
Smith bed	3.4	1,016	6.10			6.10					6.10
	7.7	8,925		121.46		121.46					121.46
	12.1	2,453			51.90	51.90					51.90
Local bed	3.0	576	3.06			3.06					3.06
Anderson bed	3.3	6,659	38.99			38.99					38.99
	3.3	7,222					42.18			42.18	42.18
	6.6	3,680		43.02		43.02					43.02
	17.0	67			2.07	2.07					2.07
Dietz No. 1 bed	3.5	91	.56			.56					.56
Canyon bed	3.8	1,526					10.26			10.26	10.26
	3.9	462	3.20			3.20					3.20
	5.7	10,954						110.52		110.52	110.52
	6.4	8,853		100.29		100.29					100.29
Local bed 100 ft. below Canyon bed	2.5	11	.05			.05					.05
	3.3	254					1.48			1.48	1.48
Total			108.39	264.81	53.97	427.17	53.92	110.52		164.44	591.61
Grand total 56 N., R. 75 W.			108.39	264.81	53.97	427.17	53.92	110.52		164.44	591.61
T. 55 N., R. 75 W.											
WASATCH FORMATION											
Local bed 140 ft. below Scott bed	4.0	112	0.79			0.79					0.79
	5.1	21		0.19		.19					.19
Local bed 40 ft. above Felix bed	3.5	59	.37			.37					.37
Felix bed	7.2	422		5.38		5.38					5.38
	13.2	470			10.97	10.97					10.97
Local bed 50 ft. below Felix bed	4.2	346	2.56			2.56					2.56
Total			3.72	5.57	10.97	20.26					20.26
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed 150 ft. above Smith bed	3.6	1,705	11.12			11.12					11.12
Local bed 125 ft above Smith bed	3.4	4,259	25.62			25.62					25.62
	5.1	26		0.24		.24					.24
Local bed 85 ft. above Smith bed	3.9	1,933	13.22			13.22					13.22
	6.4	866		9.79		9.79					9.79
	11.8	131			2.74	2.74					2.74
Smith bed	3.7	7,397	48.18			48.18					48.18
	3.7	1,614					10.57			10.57	10.57
	6.4	10,642		120.55		120.55					120.55
	11.1	211			4.15	4.15					4.15
Anderson bed	3.6	22,339					142.34			142.34	142.34
Total			98.14	130.58	6.89	235.61	152.91			152.91	388.52
Grand total, T. 55 N., R. 75 W.			101.86	136.15	17.86	255.87	152.91			152.91	408.78

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 54 N., R. 75 W.											
WASATCH FORMATION											
Ulm No. 2	3.9	95	0.65			0.65					0.65
1 bed	14.5	11			0.28	.28					.28
Scott bed	3.3	465	2.74			2.74					2.74
	6.0	149		1.60		1.60					1.60
Local bed 55 ft.	2.8	173	.85			.85					.85
below Scott bed	6.2	6		.07		.07					.07
Local bed 90 ft. below Scott bed	3.0	330	1.78			1.78					1.78
Local bed 115 ft.	3.5	1,263	7.78			7.78					7.78
below Scott bed	5.7	14		.14		.14					.14
Local bed 140 ft. below Scott bed	3.6	206	1.31			1.31					1.31
Local bed 85 ft. above Felix bed	2.9	226	1.17			1.17					1.17
Felix bed	7.2	2,942		37.49		37.49					37.49
	15.8	8,632			241.40	241.40					241.40
Local bed 50 ft. below Felix bed	2.6	88	.41			.41					.41
Local bed 75 ft. below Felix bed	2.6	45	.21			.21					.21
Total			16.90	39.30	241.68	297.88					297.88
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed 85 ft. above Smith bed	2.9	259	1.33			1.33					1.33
Smith bed	3.7	3,155	20.66			20.66					20.66
	3.7	19,819					129.79			129.79	129.79
	6.4	139		1.58		1.58					1.58
Anderson bed	3.8	23,178					155.89			155.89	155.89
Total			21.99	1.58		23.57	285.68			285.68	309.25
Grand total, T 54 N., R. 75 W.			38.89	40.88	241.68	321.45	285.68			285.68	607.13

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 53 N., R. 75 W.											
WASATCH FORMATION											
Local bed 47 ft. above Ulm No. 2	3.3	24	0.14			0.14					0.14
Ulm No. 2 bed	2.9	917	4.71			4.71					4.71
	7.5	158		1.59		1.59					1.59
	11.1	568			11.16	11.16					11.16
Local bed 40 ft. below Ulm No. 2 bed	3.0	293	1.54			1.54					1.54
Scott bed	2.8	933	4.62			4.62					4.62
Local bed 45 ft. below Scott bed	2.7	190	.91			.91					.91
Local bed 85 ft. below Scott bed	2.9	2,504	13.23			13.23					13.23
Local bed 140 ft. below Scott bed	3.9	2,610	18.11			18.11					18.11
Local bed 170 ft. below Scott bed	3.4	1,490	8.89			8.89					8.89
	6.1	136		1.48		1.48					1.48
Local bed 65 ft. above Felix bed	3.7	341	2.23			2.23					2.23
Local bed 45 ft. above Felix bed	3.5	467	2.88			2.88					2.88
	6.4	14		.15		.15					.15
Felix bed	17.6	17,168			534.82	534.82					534.82
Total			57.26	3.22	545.98	606.46					606.46
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Smith bed	3.7	21,426					140.32			140.32	140.32
Anderson bed	3.8	21,960					147.70			147.70	147.70
Total							288.02			288.02	288.02
Grand total, T. 53 N., R. 75 W.			57.26	3.22	545.98	606.46	288.02			288.02	894.48
T. 58 N., R. 74 W.											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Anderson bed	6.0	259		2.76		2.76					2.76
	10.0	456			8.07	8.07					8.07
Dietz No. 1 bed	3.6	1,295	8.33			8.33					8.33
	7.9	2,746		38.38		38.38					38.38
Canyon bed	4.0	1,995	14.08			14.08					14.08
	7.8	272		3.75		3.75					3.75
	13.0	696			16.02	16.02					16.02
Local bed 45 ft. below Canyon bed	2.6	69	.32			.32					.32
Local bed 100 ft. below Canyon bed	2.5	45					0.20			0.20	.20
	4.2	1,896	13.94			13.94					13.94
	7.0	558		6.86		6.86					6.86
Local bed 70 ft. above Wall bed	2.7	4,008					19.15			19.15	19.15
	2.9	1,094	5.62		5.62	5.62					5.62
	7.5	728		9.66		9.66					9.66
	11.2	85			1.69	1.69					1.69
Total			42.29	61.41	25.78	129.48	19.35			19.35	148.83
Grand total, T. 58 N., R. 74 W.			42.29	61.41	25.78	129.48	19.35			19.35	148.83

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								
			Measured and indicated				Inferred				Grand total
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 57 N., R. 74 W.											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed 80 ft. above Smith bed	4.0	69	0.49			0.49					0.49
	5.8	16		0.16		.16					.16
Smith bed	3.9	104	.71			.71					.71
	7.2	1,698		21.52		21.52					21.52
	10.6	18			0.34	.34					.34
Anderson bed	3.3	179	1.04			1.04					1.04
	7.7	3,633		49.48		49.48					49.48
	15.1	3,576			95.76	95.76					95.76
Dietz No. 1 bed	3.7	2,845	18.56			18.56					18.56
	6.1	990		10.70		10.70					10.70
Canyon bed	3.2	1,670	9.78			9.78					9.78
	6.3	1,259		14.04		14.04					14.04
Local bed	3.5	150	.93			.93					.93
Local bed 100 ft. below Canyon bed	3.7	5,157					34.04			34.04	34.04
	3.8	12,632	85.99			85.99					85.99
	6.8	3,205		38.34		38.34					38.34
Local bed 70 ft. above Wall bed	2.7	4,643					22.19			22.19	22.19
	3.1	358	1.96			1.96					1.96
Total			119.46	134.24	96.10	349.80	56.23			56.23	406.03
Grand total, T. 57 N., R. 74 W.			119.46	134.24	96.10	349.80	56.23			56.23	406.03
T. 56 N., R. 74 W.											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed 60 ft. above Smith bed	3.5	70	0.44			0.44					0.44
Local bed 35 ft. above Smith bed	4.5	795	6.33			6.33					6.33
	6.4	387		4.38		4.38					4.38
Smith bed	3.8	2,605	17.66			17.66					17.66
	6.7	1,509		17.96		17.96					17.96
	11.2	178			3.54	3.54					3.54
Local bed 60 ft. above Anderson bed	3.9	368	2.55			2.55					2.55
Anderson bed	2.9	600					3.08			3.08	3.08
	3.5	7,579	47.43			47.43					47.43
	7.6	6,544		88.02		88.02					88.02
	19.3	1,552			51.29	51.29					51.29
Dietz No. 1 bed	3.8	1,728	11.61			11.61					11.61
	8.1	1,187		17.02		17.02					17.02
	11.2	34			.67	.67					.67
Canyon bed	2.5	139	.62			.62					.62
	2.5	595					2.63			2.63	2.63
Local bed 100 ft. below Canyon bed	3.3	2,611					15.25			15.25	15.25
	3.8	349	2.35			2.35					2.35
Total			88.99	127.38	55.50	271.87	20.96			20.96	292.83
Grand total, T. 56 N., R. 74 W.			88.99	127.38	55.50	271.87	20.96			20.96	292.83

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 55 N., R. 74 W.											
WASATCH FORMATION											
Local bed 115 ft. above Felix	3.2	26	0.15			0.15					0.15
Felix	6.7	80		0.95		.95					.95
	14.9	422			11.13	11.13					11.13
Total			.15	.95	11.13	12.23					12.23
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed	3.1	976	5.36			5.36					5.36
	6.2	80		0.35		.35					.35
Local bed 60 ft. above Smith bed	2.9	5,717	29.68			29.68					29.68
	5.3	143		1.34		1.34					1.34
Smith bed	3.7	8,651	56.66			56.66					56.66
	6.4	6,685		75.73		75.73					75.73
Anderson bed	3.3	14,570					85.10			85.10	85.10
	3.6	2,867	18.27			18.27					18.27
	7.5	458		6.08		6.08					6.08
	7.5	4,818						63.96		63.96	63.96
Total			109.97	83.50		193.47	85.10	63.96		149.06	342.53
Grand total, T. 55 N., R. 74 W.			110.12	84.45	11.13	205.70	85.10	63.96		149.06	354.76
T. 54 N., R. 74 W.											
WASATCH FORMATION											
Ulm No. 2 bed	2.9	22	0.11			0.11					0.11
	14.5	43			1.10	1.10					1.10
Scott bed	3.6	155	.95			.95					.95
	6.6	42		0.48		.48					.48
Local bed 40 ft. below Scott bed	3.3	83	.48			.48					.48
Local bed 65 ft. below Scott bed	3.5	2,117	13.23			13.23					13.23
Local bed 110 ft. below Scott bed	3.2	498	2.82			2.82					2.82
Local bed 170 ft. below Scott bed	3.8	725	4.88			4.88					4.88
Felix bed	3.3	277	1.62			1.62					1.62
	7.7	1,431		19.39		19.39					19.39
	16.0	4,696			132.99	132.99					132.99
Total			24.09	19.87	134.09	178.05					178.05
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed 85 ft. above Smith bed	2.9	275	1.41			1.41					1.41
Smith bed	3.7	13,264	86.87			86.87					86.87
	3.7	6,171					40.41			40.41	40.41
	5.8	2,971		30.50		30.50					30.50
	10.0	45			0.80	.80					.80
Local bed 45 ft. below Smith bed	3.8	1,651	11.10			11.10					11.10
	7.0	993		12.30		12.30					12.30
Anderson bed	3.8	15,002					100.90			100.90	100.90
	7.5	1,376		18.27		18.27					18.27
	7.5	6,496						86.23		86.23	86.23
Total			99.38	61.07	0.80	161.25	141.31	86.23		227.54	388.79
Grand total, T. 54 N., R. 74 W.			123.47	80.94	134.89	339.30	141.31	86.23		227.54	566.84

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 53 N., R. 74 W.											
WASATCH FORMATION											
Ulm No. 2 bed	3.6	80	0.51			0.51					0.51
	7.2	226		2.88		2.88					2.88
	11.2	836			16.52	16.52					16.52
Scott bed	3.6	3,837	24.45			24.45					24.45
	6.4	106		1.20		1.20					1.20
Local bed 50 ft. below Scott bed	3.0	1,546	8.16			8.16					8.16
Local bed 90 ft. below Scott bed	3.2	7,014	39.82			39.82					39.82
	5.3	14		.13		.13					.13
Local bed 115 ft. below Scott bed	2.8	2,554	12.45			12.45					12.45
Local bed 140 ft. below Scott bed	3.2	114	.65			.65					.65
Local bed 150 ft. below Scott bed	3.3	1,260	7.27			7.27					7.27
	12.7	2			.04	.04					.04
	4.5	69	.55			.55					.55
Felix bed	8.2	989		14.27		14.27					14.27
	13.9	13,976			343.52	343.52					343.52
Total			93.86	18.48	360.08	472.42					472.42
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Smith bed	3.7	6,210	40.67			40.67					40.67
	3.7	13,227					86.62			86.62	86.62
	5.8	1,997		20.50		20.50					20.50
Local bed 30 ft. below Smith bed	3.8	3,718	25.01			25.01					25.01
	7.2	230		2.93		2.93					2.93
	10.1	30			0.54	.54					.54
Local bed 45 ft. below Smith bed	3.8	347	2.33			2.33					2.33
	5.0	5		.04		.04					.04
Local bed 75 ft. below Smith bed	3.6	1,416	9.02			9.02					9.02
	3.6	1,144					7.29			7.29	7.29
Anderson bed	3.8	16,704					112.35			112.35	112.35
	7.5	5,200						69.03		69.03	69.03
Total			77.03	23.47	.54	101.04	206.26	69.03		275.29	376.33
Grand total, T. 53 N., R. 74 W.			170.89	41.95	360.62	573.46	206.26	69.03		275.29	848.75
T. 55 N., R. 73 W. (western half)											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Smith bed	3.3	2,896	16.92			16.92					16.92
	6.4	1,029		11.62		11.62					11.62
Local bed	3.8	115	.77			.77					.77
	5.4	24		.23		.23					.23
Anderson bed	7.5	1,069		14.19		14.19					14.19
	7.5	1,982						26.31		26.31	26.31
	12.8	7,893			178.82	178.82					178.82
	12.8	64							1.45	1.45	1.45
Total			17.69	26.04	178.82	222.55		26.31	1.45	27.76	250.31
Grand total, T. 55 N., R. 73 W. (western half)			17.69	26.04	178.82	222.55		26.31	1.45	27.76	250.31

TABLE 2.—*Estimated reserves of coal in the Spotted Horse coalfield, Campbell and Sheridan Counties, Wyo., by townships*—Continued

Coal bed	Average thickness (feet)	Area (acres)	Reserves (millions of short tons)								Grand total
			Measured and indicated				Inferred				
			In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	In beds 2½–5 feet thick	In beds 5–10 feet thick	In beds more than 10 feet thick	Total	
T. 54 N., R. 73 W. (western half)											
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed 95 ft. above Smith bed	3.8	8	0.05			0.05					0.05
	5.0	2		0.02		.02					.02
	14.2	19			0.48	.48					.48
Smith bed	3.6	211	1.34			1.34					1.34
	5.8	2,046		21.00		21.00					21.00
	11.3	439			8.75	8.75					8.95
Local bed 60 ft. below Smith bed	3.8	1,243	8.32			8.32					8.32
	6.0	792		8.42		8.42					8.42
Local bed	2.8	310	1.54			1.54					1.54
Anderson bed	7.5	3,253		43.18		43.18					43.18
	7.5	304						4.04		4.04	4.04
	12.8	7,024			159.14	159.14					159.14
Total			11.25	72.62	168.37	252.24		4.04		4.04	256.28
Grand total, T. 54., N., R. 73 W. (western half)			11.25	72.62	168.37	252.24		4.04		4.04	256.28
T. 53 N., R. 73 N. (western half)											
WASATCH FORMATION											
Local bed 90 ft. below Scott bed	4.0	16	0.11			0.11					0.11
Felix bed	4.5	6	.05			.05					.05
	8.4	24		0.36		.36					.36
	13.0	56			1.29	1.29					1.29
Total			.16	.36	1.29	1.81					1.81
TONGUE RIVER MEMBER OF FORT UNION FORMATION											
Local bed 90 ft. above Smith	8.0	43		9.61		0.61					0.61
Local bed 30 ft. above Smith bed	5.2	38		.35		.35					.35
Smith bed	3.7	1,603	10.50			10.50					10.50
	5.8	1,778		18.25		18.25					18.25
	11.7	1,328			27.50	27.50					27.50
Local bed 30 ft. below Smith bed	4.0	3,899	26.31			26.31					26.31
	7.2	2,321		29.57		29.57					29.57
	10.1	450			8.06	8.06					8.06
Local bed 60 ft. below Smith bed	3.8	323	2.17			2.17					2.17
	5.2	26		.24		.24					.24
Local bed	2.7	72	.34			.34					.34
Local bed 75 ft. below Smith bed	3.6	7,243	46.15			46.15					46.15
	7.5	2,013		26.72		26.72					26.72
	12.1	120			2.57	2.57					2.57
Anderson bed	7.5	6,811						90.42		90.42	90.42
	10.0	24		.42		.42					.42
	12.8	989			22.41	22.41					22.41
	12.8	3,702							83.87	83.87	83.87
Total			85.47	76.16	60.54	222.17		90.42	83.87	174.29	396.46
Grand total, T. 53 N., R. 73 W.			85.63	76.52	61.83	223.98		90.42	83.87	174.29	398.27

TABLE 3.—*Estimated reserves of coal in the Spotted Horse Coalfield, Wyo., by beds*

Coal bed	Reserves (millions of short tons)								
	Measured and indicated			Total measured and indicated	Inferred			Total inferred	Total measured and indicated and inferred
	2½–5 ft.	5–10 ft.	More than 10 ft.		2½–5 ft.	5–10 ft.	More than 10 ft.		
WASATCH FORMATION									
Ulm No. 2	5.98	4.47	29.06	39.51					39.51
Scott	32.76	3.28		36.04					36.04
Felix	2.26	77.84	1,276.12	1,356.22					1,356.22
Arvada	118.22	43.92	.37	162.51					162.51
Local beds	155.98	4.54		160.52					160.52
Total	315.20	134.05	1,305.55	1,754.80					1,754.80
TONGUE RIVER MEMBER OF FORT UNION FORMATION									
Roland	40.31	19.84		60.15					60.15
Smith	450.77	647.20	126.37	1,224.34	420.65			420.65	1,644.99
Anderson	237.74	619.64	954.90	1,812.28	1,083.93	879.80	85.32	2,049.05	3,861.33
Dietz No. 1	64.32	70.74	.67	135.73	425.14			425.14	560.87
Canyon	83.84	502.05	394.19	980.08	12.89	1,302.50	.09	1,315.48	2,295.56
Wall	21.93	8.39	6.15	36.47	407.95			407.95	444.42
Local beds	768.57	424.13	87.23	1,279.93	158.15			158.15	1,438.08
Total	1,667.48	2,291.99	1,569.51	5,528.98	2,508.71	2,182.30	85.41	4,776.42	10,305.40
Grand total	1,982.68	2,426.00	2,875.10	7,283.78	2,508.71	2,182.30	85.41	4,776.42	12,060.20

Estimate of Reserves in the Spotted Horse Coalfield, by Counties

Campbell County ..... 7,972,090,000 short tons
Sheridan County ..... 4,268,110,000 short tons

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