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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE FORKS RANCH QUARANGLE, BIG HORN COUNTY, MONTANA

(Report includes 59 plates)

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COAL RESOURCE OCCURRENCE

Introduction

Purpose

This text is for use in conjunction with the coal resource occurrence maps (plates 1-58) and the coal development potential map (plate 59) of the Forks Ranch quadrangle, Big Horn County, Montana (U.S. Geological Survey Open-File Report 78-653). The maps are intended to support land-use planning and coal leasing activities of the Bureau of Land Management as required by their Energy Minerals Activities Recommendation System (EMARS), and to provide information leading to a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. The only coal beds included in this resource inventory are those 5 feet (1.5 m) or more thick and under less than 1,000 feet (305 m) of overburden, as specified for Reserve Base calculations for subbituminous coal in the coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey (1976).

Location

The Forks Ranch 7 1/2-minute quadrangle is in the southeastern part of Big Horn County, Montana about 1/2 mile (1 km) north of the Wyoming State Line. It is about 27 airline miles (43 km) northeast of Sheridan, Wyoming and 69 airline miles (111 km) southeast of Hardin, Montana.

Accessibility

An all-weather graveled raod extends the length of the quadrangle, and connects the Forks Ranch with the communities of Decker and Birney, Montana. A graded road extends southeastward from this road along Trail Creek, but the remainder of the quadrangle is accessible only by unimproved roads and trails.

The Burlington Northern Railroad operates an east-west route from Sheridan, Wyoming to Gillette, Wyoming which comes within 19 miles (31 km) of the Forks Ranch quadrangle.

Physiography

The dominant physiographic features of this quadrangle are the broad valleys of the northward-flowing Hanging Woman Creek and its major tributaries, and the series of benches up to the flat-topped narrow ridges between the stream valleys. The ridges are remnants of an old upland surface that was underlain by an extensive, resistant sandstone bed. The valley sides have gentle to moderately steep slopes, with coalescing alluvial fans, footslopes, and stream terraces. The local relief from the valley floor to the ridge tops is as much as 450 feet (137 m). The surface elevations in the quadrangle range from 3,475 feet to 4,055 feet (1,060 m to 1,238 m) above mean sea level.

Climate

Southeastern Montana in the vicinity of the Forks Ranch quadrangle has a semi-arid climate. Average annual precipitation at Decker, Montana, about 18 miles (29 km) to the west, is about 12 inches (30 cm) and the annual variation in temperature is from about 100°F to -40°F (38°C to -40°C).

Land status

The quadrangle lies within the Northern Powder River Basin Known Recoverable Coal Resource Area. The Federal government owns all of the coal within the quadrangle except for the coal in about 6 square miles (16 sq. kms). In 1977, no Federal coal was covered by outstanding Federal coal leases, prospecting permits, or licenses.

General Geology

Sources of data

The coal deposits of the Forks Ranch quadrangle were first mapped by Baker (1929) as part of a study of the northern extension of the Sheridan coal field. In the early 1940's, Bryson and Bass (1973) mapped the eastern margin of the quadrangle as part of their investigation of the Moorhead coal field. The quadrangle was later examined by Matson and others (1973) for strippable coal deposits. In 1976, Culbertson and Klett mapped the geology of the Forks Ranch quadrangle on a topographic base at a scale of 1:24,000, and a report is in preparation. In a small part of the Forks Ranch quadrangle (East Trail Creek valley), the quality and resources of surface-minable coal are discussed in a recent report by Culbertson, Hatch,and Affolter (1978).

Information on coal-bed thicknesses in-and-adjacent to the quadrangle are from measurements at the outcrop, measurements in shallow coal test holes, and measurements derived from interpretation of geophysical logs of oil and gas test wells. The measurements from coal test holes are considered to be accurate to within about 1 foot (0.3 m), and measurements from gamma-ray logs of oil and gas test wells are probably of similar accuracy. Thicknesses obtained only from the resistivity log of oil and gas test wells may be less reliable. Coal beds generally have high resistivity; however, some other types of rocks such as limestone and some kinds of sandstone also have high resistivity, so misinterpretations are possible. The coal beds shown in the well at locality 38 on plates 1 and 3 are interpretations from a resistivity log only.

Stratigraphy

The coal-bearing rocks underlying the Forks Ranch quadrangle are about 2,400 feet (730 m) thick. The upper 300 feet (90 m) are assigned to the Wasatch Formation of Eocene age, the remaining 2,100 feet (640 m) are assigned to the Fort Union Formation of Paleocene age. The lowermost coal-bearing beds probably belong to the Lebo Shale Member (middle member) of the Fort Union Formation, which consists predominantly of shale and siltstone with minor amounts of sandstone, and one or two coal beds.

The Tongue River Member (upper member) of the Fort Union Formation is the principal coal-bearing unit in this quadrangle. It consists of interbedded friable yellowish-gray to light-gray siltstone and very fine- to medium-grained sandstone; light- to medium-gray clayey siltstone, gray shale, brown carbonaceous shale, and coal beds. Most of the beds of sandstone and siltstone are lenticular and weakly cemented. However, a 20- to 50-foot (6- to 15-m) thick bed of sandstone near the top of the member is a persistent bed, well cemented in the top part, that caps the high benches in the northern part of the area. Other sandstones and siltstones are locally limy, and locally grade into impure limestone that weathers on the outcrop to form resistant ledges.

The contact between the Fort Union Formation and the overlying Wasatch Formation is placed at the top of the Roland coal bed of Baker (1929) following the practice of Baker (1929) and other workers. The Wasatch Formation is similar lithologically to the Fort Union Formation, but it contains more shale, and several zones of mollusk-bearing shale, sandstone, and limestone, and locally two thin coal beds. A bed of coquinal limestone 1 to 2 feet (0.3 to 0.6 m) thick lies about 30 feet (9 m) above the base of the formation in the southwestern corner of the quadrangle, but it is about 100 feet (30 m) above the base in the southeastern corner.

The Fort Union and Wasatch Formations were deposited during the Paleocene and Eocene epochs in rivers, flood plains, swamps,and small lakes which shifted back and forth on a vast, flat alluvial plain.

The sedimentary rocks overlying and underlying the Anderson coal bed in part of the Forks Ranch quadrangle have been analyzed for their trace element content by the U.S. Geological Survey (Hinkley, 1978). These rocks contain no greater amount of trace elements of environmental concern than do similar rock types found in other coal fields in the Northern Great Plains region.

Structure

The Forks Ranch quadrangle lies on the gently-dipping east flank of the Powder River Basin, near its trough line. The regional dip, which is less than 1/2 degree to the south, has been modified by gentle flexures associated with a series of normal faults. The dips of the strata locally exceed 2 degrees near the faults. The faults generally trend east or northeast, and the strata are displaced downward on the south side of the faults by as much as 240 feet (73 m).

Coal geology

About twenty-seven coal beds, ranging in thickness from about 1 to 34 feet (0.3 to 10.4 m) were identified on the surface or in the subsurface in the Forks Ranch quadrangle (plate 3). Of these, ten coal beds are thick enough and shallow enough to be included in calculations of the Reserve Base. The other seventeen are either too thin or too deeply buried.

The uppermost coal is the Arvada coal bed. This coal is successively underlain by: an interval about 140 feet (43 m) thick containing a local coal bed; the Roland coal bed of Baker (1929); a noncoal interval about 90 feet (27 m) thick; the Trail coal bed; a noncoal interval about 80 feet (24 m) thick; the Waddle coal bed; an interval 40 to 75 feet (12 to 23 m) thick containing a local coal bed; the Smith coal bed; a noncoal interval 85 to 135 feet (26 to 41 m) thick; the Anderson coal bed; an interval 35 to 125 feet (11 to 38 m) thick containing a local coal bed; the Dietz coal bed; a noncoal interval 50 to 125 feet (15 to 38 m) thick; the Cox coal bed; a noncoal interval 50 to 115 feet (15 to 35 m) thick; the Canyon coal bed; an interval 70 to 135 feet (21 to 41 m) thick containing a local coal bed; the White coal bed; a noncoal interval 5 to 75 feet (1.5 to 23 m) thick; the Cook coal bed; a noncoal interval 15 to 70 feet (5 to 21 m) thick; the Otter coal bed; an interval 80 to 165 feet (24 to 50 m) thick containing a local coal bed; the Wall coal bed; an interval 180 to 260 feet (55 to 79 m) thick containing two local coal beds; the Brewster-Arnold coal bed; an interval 140 to 175 feet (43 to 53 m) thick containing the Odell coal bed in the upper part; the King coal bed; a noncoal interval 125 to 170 feet (38 to 52 m) thick; the Knobloch coal bed; a noncoal interval 160 to 200 feet (49 to 61 m) thick; the Roberts coal bed; an interval 240 to 260 feet (73 to 79 m) thick containing a local coal bed; and the Kendrick coal bed.

Coal bed thicknesses that are shown on the coal data map (pl. 1), the coal data sheet (pl. 3), and on the isopached maps are the thicknesses of coal as recorded either at outcrops or in the drill holes, and are rounded to the nearest foot (0.3 m). The coal bed thicknesses exclude partings where they are known to exist; however, the coal beds generally are free of partings.

In the past, several of the thicker coal beds have caught fire at the outcrop and have burned back under shallow cover for varying distances, some for nearly a mile (1.6 km). The heat from the burning coal has baked and fused the overlying rocks to form a resistant reddish-colored rock called clinker (also locally called scoria, or red shale). Clinker resulting from near-surface burning of the Anderson coal bed may be more than 50 feet (15 m) thick and caps a large area in the northern part of the quadrangle.

The apparent rank of the coal in the Forks Ranch quadrangle is subbituminous C, as calculated from twelve analyses of core of the Anderson bed and two analyses of core of the Smith bed (table 1 and table 2). These coals are similar in chemical composition to other coal beds in the Powder River region, and the content of elements of environmental concern are generally low when compared to coals in the Interior province of the United States (Culbertson, Hatch, and Affolter, 1978, p. 28).

Table 1.--Proximate, ultimate, heating value, and forms-of-sulfur analyses of cores of the Anderson and Smith coal beds, Forks Ranch quadrangle, Big Horn County, Montana.

[All analyses except heating value are in percent. Forms of analyses: 1, as received; 2 moisture-free; 3 moisture and ash free. All analyses by Coal Analysis section, U.S. Bureau of Mines, Pittsburgh, Pennsylvania. 1 foot = 0.305 m.]

Locality No. (Plate 1)	Hole Name	Depth Interval (feet)	Lab. No.	Form of Analysis	Proximate				Ultimate					Forms of Sulfur			Heating Value (Btu/lb)
					Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Sulfur	Oxygen	Sulfate	Pyritic	Organic	
Anderson Bed																	
49	HWC-21	114.0 to 116.5	D186443	1	26.7	28.4	38.8	6.1	6.3	50.5	1.1	.3	35.7	.01	.20	.07	8612
	HWC			2		38.8	52.9	8.3	4.5	68.9	1.5	.4	16.4	.01	.27	.10	11743
				3		42.3	57.7		4.9	75.1	1.6	.4	17.9	.01	.29	.11	12811
		116.5 to 141.0	D186444	1	27.9	28.6	38.2	5.3	6.3	50.0	1.0	.4	36.9	.02	.20	.19	8536
				2		39.7	52.9	7.4	4.4	69.4	1.4	.6	16.8	.03	.28	.26	11842
				3		42.9	57.1		4.8	75.0	1.5	.6	18.1	.04	.31	.28	12728
34	HWC-27	230.5 to 233.0	D186454	1	27.9	27.6	40.5	4.0	6.4	50.9	1.0	.3	37.5	.01	.14	.13	8667
				2		38.3	56.2	5.5	4.5	70.6	1.4	.4	17.6	.01	.19	.18	12028
				3		40.5	59.5		4.8	74.7	1.5	.4	18.6	.01	.20	.19	12731
		233.0 to 259.2	D186455	1	28.8	28.7	38.8	3.7	6.6	50.2	1.1	.2	38.2	.01	.08	.13	8659
				2		40.3	54.5	5.2	4.8	70.6	1.5	.3	17.6	.01	.11	.19	12166
				3		42.5	57.5		5.1	74.5	1.6	.3	18.6	.01	.12	.20	12835
45	HWC-23	138.0 to 166.7	D186456	1	27.4	29.8	37.3	5.5	6.4	49.8	1.0	.5	36.6	.01	.22	.28	8522
				2		41.0	51.4	7.6	4.6	68.6	1.4	.7	16.9	.01	.30	.39	11872
				3		44.4	55.6		5.0	74.3	1.6	.8	18.3	.01	.33	.42	12851
Smith Bed																	
34	HWC-27	101.5 to 105.0	D186453	1	27.0	28.1	36.3	8.6	6.2	47.5	1.2	.9	35.6	.02	.28	.59	8214
				2		38.4	49.8	11.8	4.4	65.0	1.6	1.2	15.9	.02	.39	.81	11247
				3		43.6	56.4		5.0	73.7	1.8	1.4	18.0	.03	.44	.92	12479

Table 2.--Proximate, heating value, and forms-of-sulfur analyses of cores of the Anderson and Smith coal beds, Forks Ranch quadrangle, Big Horn County, Montana.

[All analyses except heating value in percent. Forms of analyses: A, as received; B, moisture-free; C, moisture and ash free. 1 foot = 0.305 m. From Matson, Blumer, and Wegelin, 1973, p. 51-53.]

Locality No. (Plate 1)	Hole Name	Depth Interval (in feet)	Form of Analysis	Proximate				Form of Sulfur				Heating Value (Btu/lb.)
				Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
Anderson bed												
12	SH-13	86 to 96	A	22.550	32.810	38.548	3.092	.211	.008	.000	.202	8696
			B		44.076	51.777	4.153	.283	.011	.000	.272	11949
			C		45.979	54.021		.295	.012	.000	.283	12467
		96 to 102	A	28.530	29.500	38.588	3.382	.097	.000	.000	.097	8506
			B		41.276	53.992	4.732	.136	.000	.000	.136	11902
			C		43.326	56.674		.142	.000	.000	.142	12493
13	SH-14	160 to 167	A	27.540	25.919	43.016	3.524	.065	.000	.000	.065	8595
			B		35.771	59.366	4.863	.090	.000	.000	.090	11862
			C		37.599	62.401		.095	.000	.000	.095	12468
20	SH-15	104 to 113	A	27.300	30.446	38.752	3.502	.106	.008	.000	.098	8615
			B		41.880	53.303	4.817	.146	.011	.000	.135	11850
			C		43.999	56.001		.154	.012	.000	.142	12450
23	SH-22	93 to 98	A	26.190	29.039	40.146	4.625	.075	.000	.000	.075	8521
			B		39.343	54.391	6.266	.102	.000	.000	.102	11544
			C		41.973	58.027		.109	.000	.000	.109	12316
28	SH-21	63 to 73	A	26.130	29.702	40.778	3.390	.109	.034	.017	.059	8901
			B		40.209	55.202	4.589	.148	.045	.023	.080	12050
			C		42.143	57.857		.155	.048	.024	.083	12630
35	SH-119	110 to 119	A	27.130	29.418	40.379	3.073	.148	.000	.000	.148	8657
			B		40.370	55.413	4.217	.203	.000	.000	.203	11880
			C		42.147	57.853		.212	.000	.000	.212	12403
39	SH-23	130 to 140	A	24.540	29.824	41.474	4.162	.196	.017	.017	.162	8685
			B		29.523	54.962	5.515	.260	.023	.023	.215	11510
			C		41.830	58.170		.275	.024	.024	.227	12182
40	SH-20	110 to 119	A	25.850	29.469	41.647	3.034	.141	.000	.000	.141	8893
			B		39.742	56.166	4.092	.191	.000	.000	.191	11993
			C		41.438	58.562		.199	.000	.000	.199	12505
46	SH-16	63 to 70	A	26.530	29.719	39.972	3.778	.225	.042	.058	.125	8726
			B		40.451	54.406	5.143	.306	.057	.079	.170	11877
			C		42.644	57.356		.322	.060	.084	.179	12521
Smith bed												
44	SH-24	95 to 101	A	23.710	28.182	36.014	12.094	.787	.052	.199	.536	7877
			B		36.941	47.207	15.853	1.031	.068	.261	.703	10325
			C		43.900	56.100		1.225	.081	.310	.835	12270

Roland coal bed of Baker (1929)

[pls. 4-8]

The Roland coal bed was named by Taff (1909) in the Sheridan coal field, Wyoming. A coal assumed to be the same bed was called the Roland bed in the northern extension of the Sheridan coal field, Montana by Baker (1929). Subsequent work in the Sheridan coal field has shown that the Roland bed of Baker (1929) lies about 125 feet (38 m) above the original Roland bed of Taff (1909).

The top of the Roland bed of Baker (1929) is generally used in southern Montana as the contact between the Fort Union and overlying Wasatch Formations.

The Roland bed of Baker (1929) crops out extensively in higher hills in the southern part of the Forks Ranch quadrangle (pl. 1). It ranges in thickness from 3 feet (0.9 m) to about 13 feet (4.0 m) with a 3-foot (0.9-m) shale parting and locally splits into two or more beds (pls. 1 and 4). Interburden is 3 to 20 feet (0.9 to 6.1 m) thick where the bed is split into two beds more than 5 feet (1.5 m) thick (pl. 6). In most of the area of occurrence the bed is under less than 200 feet (61 m) of overburden and has potential for recovery by surface mining methods.

Chemical analyses have not been made of the Roland coal bed of Baker (1929) in this quadrangle.

Smith coal bed

[pls. 9-13]

The Smith coal bed was named by Taff (1909) in the Sheridan coal field, Wyoming, and was traced into the area of the Forks Ranch quadrangle by Baker (1929). A distinctive feature of the bed in this quadrangle is the abundant petrified wood that weathers out from this bed on the outcrop.

The coal bed ranges in thickness from 2 to 7 feet (0.6 to 2.1 m) (pl. 9). It is thickest in the southwestern part of the quadrangle where it contains a thick shale parting, and thins generally northeastward. Overburden is less than 200 feet (61 m) in about half of the area of occurrence of the coal bed where it is more than 5 feet (1.5 m) thick and reaches a maximum thickness of slightly more than 400 feet (122 m) along the southern margin of the quadrangle (pl. 11).

Chemical analyses have been made of cores of the Smith coal bed collected from the drill holes at localities 34 and 44 (pl. 1). The samples contained 0.8 to 0.9 percent sulfur; 8.6 to 12.1 percent ash; and had a heat value of 7,877 to 8,214 Btu/lb (4,376 to 4,563 Kcal/kg) on the as-received basis (table 1 and table 2).

Anderson coal bed

[pls. 14-18]

The Anderson coal bed was named by Baker (1929), probably for outcrops along Anderson Creek about 10 miles (16 km) west of the Forks Ranch quadrangle. It crops out extensively in the northern part of the Forks Ranch quadrangle and ranges in thickness from 15 to 34 feet (4.6 to 10.4 m) (pl. 14) locally containing a shale parting near its base (pl. 3).

The Anderson bed is the most favorable coal bed for surface mining in the Forks Ranch quadrangle, because it is the thickest bed and is under less than 200 feet (61 m) of overburden in large areas in the quadrangle (pl. 16). Overburden reaches a maximum thickness of slightly more than 400 feet (122 m) in the southern part of the quadrangle.

In the northern part of the quadrangle the Anderson bed has burned extensively back from the outcrop (pl. 1). Locally, as in secs. 4 and 5, T. 9 S., R. 43 E., the extent of burning is uncertain, so additional exploration is needed to determine the actual amount of unburned coal.

Only partial thicknesses of the Anderson coal bed were found at drill holes at localities 5 and 9 (pl. 1), because the top of the bed had been eroded. The coal at these two localities, and underlying the valley south of locality 9 (pls. 1 and 14) is assumed to be weathered and therefore of poor quality. Consequently no Reserve Base coal was calculated in these areas.

At locality 6, a small area of unclinkered rocks surrounded by massive clinker indicates that there may be some unburned Anderson coal at the locality. However, the hole at locality 6 found only 6 feet (1.8 m) of coal beneath clinker, indicating that most of the coal had burned. It is assumed that the remaining coal in this small area is of poor quality because of the adjacent burning, so no Reserve Base coal was calculated for this area (pl. 14). The upper few feet of coal has burned at locality 8 (pl. 3), but 21 feet (6.4 m) of coal remain. Because only a minor amount of coal burned, the remaining 21 feet (6.4 m) is assumed to be of good quality.

In a small area in sections 32 and 33, T. 8 S., R. 43 E. that straddles a fault, a coal bed was found underneath the clinker of the Anderson coal bed (pl. 1). It was determined to be 11 and 16 feet (3.4 and 4.9 m) thick at two localities by use of a portable auger. This coal bed is interpreted to be a lower split of the Anderson which lies from 5 feet (1.5 m) to about 20 feet (6.1 m) below the clinker of the upper Anderson. On the north side of this area the coal can be traced northward into the clinker bed, thinning rapidly as it does so. The areal extent of this lower bench could not be determined on the south side of the fault, but it apparently is of small extent. A small area in the NE 1/4 section 32 is inferred to contain coal in both splits of the Anderson (pl. 14).

Chemical analyses have been made of cores of the Anderson coal bed collected from the drill holes at localities 12, 13, 19, 20, 23, 28, 34, 35, 39, 40, 45, and 46 (pl. 1). The samples contained 0.1 to 0.5 percent sulfur; 3 to 6 percent ash; and had a heat value of 8,500 to 8,900 Btu per pound (4,720 to 4,940 kcal per kg) on the as-received basis (table 1 and table 2).

Dietz coal bed

[pls. 19-23]

The name Dietz is used in this report as it was applied by Baker (1929) in the northern extension of the Sheridan coal field. The name is from the adjacent Sheridan coal field where Taff (1909) recognized and named, in descending order, the Dietz 1, 2, and 3 coal beds. Baker (1929, p. 35-36) correlated his Dietz bed with the Dietz 1 bed of Taff (1909). The stratigraphic relations of coal in the Dietz interval within the two coal fields are still being worked out, and the exact correlation is uncertain.

The bed here recognized as the Dietz ranges in thickness from less than 5 feet (1.5 m) to 13 feet (4.0 m) locally containing a shale parting (pl. 3), and is thickest in the northern part of the quadrangle (pl. 19). A shale parting splits the coal into two beds in the western and southern parts of the quadrangle. West of the split line, the upper split is everywhere less than 5 feet (1.5 m) thick and the lower split is 5 to 7 feet (1.5 to 2.1 m) thick.

Large areas of the Dietz bed and of the lower split of the Dietz are under less than 200 feet (61 m) of overburden and have potential for surface mining (pl. 21). Overburden reaches a maximum of slightly more than 800 feet (244 m) thick along the southern margin of the quadrangle.

No chemical analyses have been made of the Dietz coal bed in the Forks Ranch quadrangle.

Canyon coal bed

[pls. 24-28]

The Canyon coal bed was named by Baker (1929) for outcrops in the northern extension of the Sheridan coal field. The same coal bed is referred to as the Upper Canyon coal bed by Culbertson and others (1976) in the Stroud Creek quadrangle adjacent to the Forks Ranch quadrangle to the north.

The Canyon bed is 15 to 21 feet (4.6 to 6.4 m) thick (pl. 24) and is under less than 200 feet (61 m) of overburden in only a small area in the northwestern part of the quadrangle (pl. 26). Overburden is more than 800 feet (244 m) thick in the southern part of the quadrangle.

Chemical analyses have not been made of the Canyon coal bed in the Forks Ranch quadrangle.

White coal bed

[pls. 29-33]

The White coal bed is named for a coal bed encountered at a depth of 470 feet (143 m) in the oil and gas test hole at locality 14 (pl. 1), the Samuel Gary 30-3 Federal White. It probably is not correlative with any named bed on the outcrop.

The White coal bed ranges from less than 5 feet (1.5 m) to 9 feet (2.7 m) thick (pl. 29). Where the White bed is more than 5 feet (1.5 m) thick, the overburden ranges in thickness from about 300 feet (90 m) in the northern part of the quadrangle to slightly more than 800 feet (244 m) in the middle of the quadrangle (pl. 31).

Chemical analyses have not been made of the White coal bed in the Forks Ranch quadrangle.

Cook coal bed

[pls. 34-38]

The Cook coal bed was named by Bass (1932) for coal outcrops in the Cook Creek Mountains about 40 miles (64 km) northeast of the Forks Ranch quadrangle. It was mapped southwestward by Warren (1959) in the Birney-Broadus coal field and south along Hanging Woman Creek by Culbertson and others (1976) to a point 4 miles (6.4 km) north of the Forks Ranch quadrangle.

The Cook coal bed ranges from 10 to 17 feet (3 to 5.1 m) thick in the quadrangle (pl. 34). Overburden ranges in thickness from less than 400 feet (122 m) in the northern part of the quadrangle to more than 1,000 feet (305 m) in the southern part of the quadrangle (pl. 36).

Chemical analyses have not been made of coal in the Cook bed in the Forks Ranch quadrangle.

Otter coal bed

[pls. 39-43]

The Otter coal bed was named by Bryson and Bass (1973) for exposures along Otter Creek about 15 miles (24 km) northeast of the Forks Ranch quadrangle. The Otter bed is less than 5 feet (1.5 m) thick in the eastern part of the quadrangle and thickens generally westward to as much as 12 feet (3.6 m) (pl. 39). Where it is more than 5 feet (1.5 m) thick its overburden ranges in thickness from about 400 feet (122 m) in the north to more than 1,000 feet (305 m) in the southern part of the quadrangle (pl. 41).

Chemical analyses have not been made of coal in the Otter coal bed in the Forks Ranch quadrangle.

Wall coal bed

[pls. 44-48]

The Wall coal bed was named by Baker (1929) for exposures of the coal along Wall Creek, about 15 miles (24 km) northwest of the Forks Ranch quadrangle. The Wall ranges from less than 5 feet (1.5 m) thick in the north to 7 feet (2.1 m) in the southwest part of the quadrangle (pl. 44). Where it is more than 5 feet (1.5 m) thick its overburden ranges from less than 700 feet (215 m) to more than 1,000 feet (305 m) thick (pl. 46).

Chemical analyses have not been made of coal from the Wall coal bed in the Forks Ranch quadrangle.

Local bed No. 1 below the Wall coal bed

[pls. 49-53]

A thin unnamed coal bed 35 to 70 feet (10.7 to 21 m) below the Wall ranges in thickness from 3 to 6 feet (0.9 to 1.8 m) (pl. 3). Only in a small area in the northeast part of the quadrangle is it more than 5 feet (1.5 m) thick (pl. 49). The overburden in this area is about 650 to 900 feet (198 to 275 m) thick (pl. 51).

Chemical analyses have not been made of coal from this coal bed in the Forks Ranch quadrangle.

Local bed No. 2 below the Wall coal bed

[pls. 49-53]

An unnamed coal bed 100 to 170 feet (30 to 52 m) below the Wall coal bed ranges in thickness from 2 to 7 feet (0.6 to 2.1 m) in the southern part of the quadrangle (pl. 3 and 49). Where it is more than 5 feet (1.5 m) thick, the overburden ranges from about 900 feet (275 m) to more than 1,000 feet (305 m) thick.

Chemical analyses have not been made of coal from this coal bed in the Forks Ranch quadrangle.

Brewster-Arnold coal bed

[pls. 54-59]

The Brewster-Arnold coal bed was named by Bass (1924) for coal at the Brewster-Arnold mine about 12 miles (19 km) northwest of the Forks Ranch quadrangle. The coal bed ranges in thickness from 4 to 10 feet (1.2 to 3.1 m) (pl. 54). The overburden ranges in thickness from about 700 feet (214 m) in the northwest to more than 1,000 feet (305 m) in the southern part of the quadrangle (pl. 56).

Chemical analyses have not been made of coal from the Brewster-Arnold coal bed in the Forks Ranch quadrangle.

Coal resources

Coal resource estimates in this report are restricted to the Reserve Base part of the Identified Coal Resource, which is the part most likely to be developed in the foreseeable future (see U.S. Geol. Survey Bull. 1450-B for a discussion of these terms). The Reserve Base for subbituminous coal is coal that is more than 5 feet (1.5 m) thick, under less than 1,000 feet (305 m) of overburden, and within 3 miles (4.8 km) of a complete measurement of the coal bed. Reserve Base coal is further subdivided into resource categories according to its nearness to a measurement of the coal bed. Measured coal is coal within ¼ mile (0.4 km) of a measurement, Indicated coal extends ½ mile (0.8 km) beyond Measured coal to a distance of 3/4 mile (1.2 km) from the measurement, and Inferred coal extends 2 ¼ miles (3.6 km) beyond Indicated coal to a distance of 3 miles (4.8 km) from the measurement.

The total Reserve Base for federally owned coal in the Forks Ranch quadrangle is estimated to be about 3.9 billion short tons (3.5 billion metric tons). Table 3 shows the Reserve Base subdivided according to coal bed, resource category, and thickness of overburden; plate 2 shows the total Reserve Base for each section of federally owned coal land. The Identified Resources plate of each coal bed shows the Reserve Base coal in that bed for each section of federally owned land. About 9 percent of the total Reserve Base is classified as measured; 39 percent as indicated; and 52 percent as inferred. About 22 percent is under less than 200 feet (61 m) of overburden; the remainder is under 200-1,000 feet (61 to 305 m) of overburden.

Table 3.--Coal Reserve Base for surface-mining methods (0-200 feet overburden) and underground-mining methods (200-1,000 feet overburden) in Federal coal lands in the Forks Ranch quadrangle, Big Horn County, Montana

[In millions of short tons. To convert short tons to metric tons, multiply by 0.907]

Coal bed name	Overburden 0-200 feet (0-61 m)				Overburden 200-1,000 feet (61-305 m)				Grand Total
	Measured	Indicated	Inferred	Total	Measured	Indicated	Inferred	Total	
Roland of Baker (1929)-	7.85	16.00	2.79	26.64	0.30	0.13	0.26	0.69	27.33
Smith----------	2.57	9.79	14.74	27.10	0.65	6.71	27.60	34.96	62.06
Anderson----------	145.07	423.07	80.10	648.24	35.57	219.95	328.76	584.28	1,232.52
Dietz----------	35.11	103.38	14.68	153.17	9.70	69.40	65.02	144.12	297.29
Canyon----------	-----	0.40	0.64	1.04	66.71	362.86	450.35	879.92	880.96
White----------	-----	-----	-----	-----	5.61	35.02	171.27	211.90	211.90
Cook----------	-----	-----	-----	-----	21.77	151.03	541.82	714.62	714.62
Otter----------	-----	-----	-----	-----	10.59	75.70	200.67	286.96	286.96
Wall----------	-----	-----	-----	-----	3.74	28.20	19.42	51.36	51.36
Local #1----------	-----	-----	-----	-----	1.26	6.13	1.82	9.21	9.21
Local #2----------	-----	-----	-----	-----	0.76	3.63	2.63	7.02	7.02
Brewster-Arnold--------	-----	-----	-----	-----	3.34	17.90	114.77	136.01	136.01
Total	190.60	552.64	112.95	856.19	160.00	976.66	1,924.39	3,061.95	3,917.24

Coal Reserves are defined as the economically minable part of the Reserve Base. In this quadrangle, only coal recoverable by surface-mining methods is considered to be economically minable. Reserves for this quadrangle are determined by multiplying the amount of Reserve Base coal under less than 200 feet (61 m) of overburden by a recovery factor of 85 percent. The total Reserves for federally owned coal in the Forks Ranch quadrangle is estimated to be 727 million short tons (660 million metric tons) of which 76 percent is in the thick Anderson coal bed. Reserves for the five coal beds containing surface-minable coal are shown by section of federally owned coal on the Identified Resources plate of these coal beds (pls. 8, 13, 18, 23, and 28).

COAL DEVELOPMENT POTENTIAL

Development potential of coal recoverable by surface-mining methods

Areas where the coal beds are more than 5 feet (1.5 m) thick and are overlain by 200 ft (61 m) or less of overburden are considered to have potential for surface mining and are assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden removed per short ton of coal recovered). The formula used to calculate the mining ratio for subbituminous coal is as follows:

$$MR = \frac{t_o\ (0.911)}{t_c\ (rf)}$$

where MR = mining ratio

t_o = thickness of overburden, in feet

t_c = thickness of coal, in feet

rf = recovery factor (0.85)

Areas of high, moderate, and low development potential are here defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15, as shown on plates 6, 11, 16, 21, and 26. The mining-ratio values for each development-potential category are based on economic and technological criteria, and were derived in consultation with A. F. Czarnowsky, Area Mining Supervisor, U.S. Geologiccal Survey.

In the Forks Ranch quadrangle, the amount of Reserve Base coal in the high development potential category is 706 million short tons (640 million metric tons), of which 92% is the Anderson coal bed (table 4). Reserve Base coal in the moderate and low development potential categories are, respectively, 62 and 87 million short tons (56 and 79 million metric tons). Plate 59 shows the areas underlain by coal beds having high, moderate, and low development potential for recovery by surface-mining methods.

Table 4.--Coal Reserve Base for surface-minable coal according to its development potential, in Federal coal lands in the Forks Ranch quadrangle, Big Horn County, Montana

[In millions of short tons. To convert short tons to metric tons, multiply by 0.907. Development potentials are based on mining ratios expressed as cubic yards of overburden per short ton of recoverable coal. To convert cubic meters per metric ton, multiply by 0.843. To convert Reserve Base to Reserves multiply by 0.85]

Coal bed	High development potential (0-10 mining ratio)	Moderate development potential (10-15 mining ratio)	Low development potential (>15 mining ratio)	Total
Roland of Baker (1929)-	15.13	5.95	5.56	26.64
Smith---------	0.61	2.39	24.10	27.10
Anderson------	648.24	-----	-----	648.24
Dietz---------	42.67	53.13	57.37	153.17
Canyon--------	-----	1.04	-----	1.04
Total	706.65	62.51	87.03	856.19

Development potential of coal recoverable by underground-mining methods

The Reserve Base for federally owned coal beneath 200-1,000 feet (61-305 m) of overburden is estimated to be about 3.1 billion short tons (2.8 billion metric tons) as shown in table 3. Coal at these depths would be recoverable only by underground-mining methods. Coal is not now being mined underground in the Powder River Basin and recovery factors have not been established so the development potential of this coal was not evaluated.

REFERENCES CITED

Baker, A. A., 1929, The northward extension of the Sheridan coal field, Big Horn and Rosebud Counties, Montana: U.S. Geological Survey Bulletin 806-B, p. 15-67.

Bass, N. W., 1924, Coal in the Tongue River valley, Montana: U.S. Geological Survey Press Memorandum 16748, Feb. 12, 1924.

_____1932, The Ashland coal field, Rosebud, Powder River, and Custer Counties, Montana: U.S. Geological Survey Bulletin 831-B, p. 19-105.

Bryson, R. P., and Bass, N. W., 1973, Geology of the Moorhead coal field, Powder River and Rosebud Counties, Montana: U.S. Geological Survey Bulletin 1338, 116 p. [1974].

Culbertson, W. C., Hatch, J. R., and Affolter, R. H., 1978, Geology and coal resources of the Hanging Woman Creek study area, Big Horn and Powder River Counties, Montana: U.S. Geological Survey Open-File Report 78-506, 37 p.

Culbertson, W. C., Mapel, W. J., and Klett, M. C., 1976, Geologic map and coal sections of the Stroud Creek quadrangle, Rosebud and Big Horn Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-822.

Hinkley, T. K., Ebens, J., and Boerngen, J. G., 1978, Overburden chemistry and mineralogy at Hanging Woman Creek, Big Horn County, Montana: U.S. Geological Survey Open-File Report 78-393.

Matson, R. E., Blumer, J. W., and Wegelin, L. A., 1973, Quality and reserves of strippable coal, selected deposits, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 91, 135 p.

Taff, J. A., 1909, The Sheridan coal field, Wyoming: U.S. Geological Survey Bulletin 341, p. 123-150.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

Warren, W. C., 1959, Reconnaissance geology of the Birney-Broadus coal field, Rosebud and Powder River Counties, Montana: U.S. Geological Survey Bulletin 1072-J, p. 561-585.