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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE MOUNT BARTLES QUADRANGLE CARBON COUNTY, UTAH

(Report includes 16 plates)

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INTRODUCTION

Purpose

This report was compiled to support the land planning work of the Bureau of Land Management and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the Western United States. It supplements the land planning requirements of the Federal Coal Leasing Amendments Act of 1976 (Public Law 94-377) sec. (3)(B) which states, in part, that "Each land-use plan prepared by the Secretary [of the Interior] (or in the case of lands within the National Forest System, the Secretary of Agriculture pursuant to subparagraph (A)(i)) shall include an assessment of the amount of coal deposits in such land, identifying the amount of such coal which is recoverable by deep mining operations and the amount of such coal which is recoverable by surface mining operations."

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) maps (15 plates) and the Coal Development Potential (CDP) map (1 plate) of the Mount Bartles quadrangle (Northwest Quarter of the Sunnyside 15-minute quadrangle), Carbon County, Utah (U.S. Geological Survey Open-File Report 79-490).

Published and unpublished public information were used as data sources for this study. No new drilling nor field mapping were done to supplement this study. No confidential nor proprietary information was used.

Location

The Mount Bartles quadrangle is located in the north central part of Carbon County, Utah. The south boundary of the quadrangle is 5.5 miles (8.8 km) north of the coal mining town of Sunnyside. The town of

Wellington is approximately 14 miles (23 km) southwest of the quadrangle. The city of Price is the county seat of Carbon County and is 16 miles (26 km) west and 1 mile (1.6 km) south of the southwest corner of the Mount Bartles quadrangle.

Accessibility

Mount Bartles quadrangle is in a rugged and remote area and is accessible only by dirt roads and jeep trails. The main access route to the central part of the quadrangle is the gravel and dirt road in Whitmore Canyon whose mouth is at the town of Sunnyside. The canyon splits at Grassy Trail Reservoir on the southeast boundary of the quadrangle. The main road continues northward in the Left Fork of Whitmore Canyon which heads in the center of the quadrangle. The junction of Left Fork and Right Fork of Whitmore Canyon is about 6 miles (10 km) north of Sunnyside. Utah Highway 123 connects Sunnyside to U.S. Highway 50-6 at Sunnyside Junction about 9 miles (14 km) west of Sunnyside. The unimproved road in Rock Canyon in the southwest quarter of the quadrangle also provides access to U.S. Highway 50-6 about 10 miles (16 km) away. The dirt road in Cow Canyon on the north side of the quadrangle joins Utah Highway 53 approximately 2 miles (3 km) to the north. Utah Highway 53 extends from the town of Wellington, 14 miles (23 km) southwest of the quadrangle, to Myton, approximately 37 miles (60 km) northeast of the quadrangle.

A branch line of the Denver and Rio Grande Western Railroad passes through Sunnyside where unit coal trains are loaded. Loading facilities are also located on the main line of the Denver and Rio Grande Western Railroad at Wellington.

Physiography

The Book Cliffs form a bold southward-facing escarpment of barren sandstone cliffs from 1,000 to 2,000 ft (305 to 610 m) high which trend easterly and then southeasterly across eastern Utah. The rock strata dip gently northward and erosional processes have formed steep slopes and canyon walls of parallel cliffs and ledges which are typical of regions of flat-lying beds. The front of the Book Cliffs escarpment crosses the southwest corner of the quadrangle. The rest of the quadrangle lies in the rugged and mountainous area behind the cliffs. Total topographic relief in the quadrangle is over 3,600 ft (1,097 m) with elevations ranging from 6,440 ft (1,963 m) in the southwest corner to 10,047 ft (3,062 m) at the top of Mount Bartles on the northeast side.

Climate

The Book Cliffs coal field is located in a mid-latitude steppe climate and semi-arid conditions prevail in the lower altitudes below the cliffs. The normal annual precipitation in the quadrangle area ranges from 11 inches (28 cm) in the southwest corner to a maximum of about 23 inches (58 cm) in the high areas around Mount Bartles (U.S. Department of Commerce, (1964)). The annual precipitation along the coal outcrops ranges from 11 to 16 inches (28 to 41 cm).

Temperatures are also a function of altitude and the winter low may reach -30 degrees F (-34 degrees C) in mountainous areas while the summer highs may approach 90 degrees F (32 degrees C). The temperatures in the lower parts of the quadrangle are approximately 10 to 15 degrees F (5.6 to 8.3 degrees C) warmer than in the high elevations.

Land Status

The Mount Bartles quadrangle is located in the central part of the Book Cliffs Known Recoverable Resource Area (KRCRA). Approximately

8,800 acres in the quadrangle are within the KRCRA boundary. The Federal coal leases, non-Federal lands, unleased Federal lands, and the boundary of the KRCRA are shown on plate 2. Within the KRCRA boundary in the quadrangle, 25 percent of the land is non-Federal, 54 percent is covered by Federal coal leases, and the remaining 21 percent is unleased Federal land.

GENERAL GEOLOGY

Previous Work

Clark (1928) mapped the geology and coal outcrops in the western part of the Book Cliffs coal field including the Mount Bartles quadrangle. Fisher (1936) mapped most of that portion of the coal field lying south and east of the area mapped by Clark. The stratigraphy of the Book Cliffs has also been discussed by Abbott and Liscomb (1956), Fisher, Erdmann, and Reeside (1960), Hayes and others (1977), Katich (1954), and Young (1955, 1957, and 1966). Doelling (1972) has summarized the geology and updated the coal data.

Stratigraphy

Rock units exposed in the Mount Bartles quadrangle range from the Mancos Shale of Upper Cretaceous age to the Green River Formation of Eocene age. The coal beds of economic importance in the Book Cliffs coal field are Upper Cretaceous in age and are confined to the Blackhawk Formation of the Mesaverde Group. The Mesaverde consists of three formations which are, in ascending order, the Blackhawk Formation, Castlegate Sandstone, and Price River Formation.

The Aberdeen Sandstone Member of the Blackhawk Formation is a sandstone tongue within the Mancos Shale about 275 ft (84 m) from the top of the Mancos. The Aberdeen Sandstone is about 100 ft (30 m) thick in Rock Canyon and thickens westward.

The main body of the Blackhawk Formation overlies the uppermost part of the Mancos which consists of gray marine shale. The Blackhawk consists of massive gray to yellowish-gray cliff-forming sandstone beds, shaly sandstone, shale, and coal beds. The formation is approximately 750 ft (229 m) thick in the Mount Bartles quadrangle.

Overlying the Blackhawk Formation is the Castlegate Sandstone which forms near-vertical cliffs and is about 150 ft (46 m) thick. The sandstone is light gray to yellowish-gray in color and weathers brown. The Castlegate is overlain by the Price River Formation which is composed of two or more thick beds of sandstone interbedded with thinner beds of shale and sandy shale. The Price River Formation is approximately 500 ft (152 m) thick. A disconformity was created during a period of post depositional subaerial erosion of the Price River beds and before the North Horn Formation was laid down.

The North Horn Formation of Upper Cretaceous and Paleocene ages overlies the Price River Formation and consists of interbedded shale, sandstone, and minor amounts of conglomerate and freshwater limestone. Its total thickness is about 500 ft (152 m). The Flagstaff Limestone pinches out just west of the quadrangle so that the Colton Formation of Eocene age rests directly on the North Horn Formation. The lower part of the Colton consists of thin-bedded limestone, variegated shale, and calcareous reddish-brown sandstone. The upper part is composed of lenticular reddish-brown shale and sandstone beds. The formation thins westward and has a minimum thickness within the quadrangle of around 1,000 ft (305 m).

The youngest unit represented in the Mount Bartles quadrangle is the Green River Formation of Eocene age which is composed mainly of greenish-gray to white claystone and shale. Minor amounts of sandstone, marlstone, and algal reef limestone are also present. In some areas the shale is rich in organic material and has a brown to black color. The Green River Formation section is incomplete in the quadrangle and no estimate of thickness is available.

Structure

The structure of the Book Cliffs coal field is homoclinal with the beds dipping 6 to 7 degrees northward toward the axis of the Uinta Basin. In the Mount Bartles quadrangle the structure contours of the coal beds are oriented northwest-southeast and the beds dip to the northeast. In the west central part of the quadrangle several north- by northwest-trending faults cut coal beds, but they have not been described in detail. Displacements are assumed to be small (Doelling, 1972) and local shear zones will undoubtedly cut down on the recoverable coal reserves.

COAL GEOLOGY

The coal beds of economic importance in the quadrangle are Upper Cretaceous in age and are confined to the Blackhawk Formation. The coal beds, in ascending order, are the Kenilworth, Gilson, Rock Canyon, Lower Sunnyside, and Upper Sunnyside. Another coal bed, the Rider Seam, lies above the Upper Sunnyside bed, but is thin and probably does not have a great lateral extent. In some places the coal beds are extensively burned.

Kenilworth Coal Bed

The youngest named coal bed in the quadrangle is the Kenilworth which is less than 2 ft (0.6 m) thick where it has been measured. Because of its thinness and irregular occurrence, the Kenilworth bed has not been considered to be economically important in the Mount Bartles quadrangle.

Gilson Coal Bed

The lowest coal bed of economic importance in the quadrangle is the Gilson bed which lies 30 to 40 ft (9 to 12 m) above the Kenilworth bed. The Gilson bed is best developed on the western side of the quadrangle where it is over 6 ft (2 m) thick (plate 12). Although Clark (1928, p. 57) states that the average thickness for the bed in this area is about 7 ft (2 m), the maximum thickness obtained from available data is 6.3 ft (1.9 m). The bed thins eastward and southward on the coal isopach map, plate 12, but the available data are insufficient to indicate trends in other areas.

Rock Canyon Coal Bed

The Rock Canyon coal bed lies from 40 to 75 ft (12 to 23 m) above the Gilson bed and reaches a thickness of over 6 ft (2 m) in the southwest corner of the quadrangle. The bed thins eastward from that area as shown on plate 8. It is believed, however, that the thinning is local since the bed is persistent and of good thickness for some distance to the southeast of the quadrangle (Clark, 1928, p. 58).

Lower Sunnyside Coal Bed

The Lower Sunnyside bed is continuous in the limited outcrop area of the Mount Bartles quadrangle and occurs about 135 ft (41 m) above the Rock Canyon coal bed. The coal isopach map (plate 4) suggests a thinning of the Lower Sunnyside bed in a northeastward direction and a thickening in a southeastward direction. The isopach lines on the south side of the quadrangle are projected from points of measurement in the adjoining Sunnyside quadrangle where the bed is over 9 ft (3 m) thick. Because of insufficient data the extent and character of the bed in a large part of the Mount Bartles quadrangle could not be determined. Doelling (1972, p. 369) reports that the bed has been extensively burned in outcrop and that the zone of burning is thick. Clark (1928, p. 59) estimates that the Lower Sunnyside bed will yield a greater tonnage than either the Gilson or Rock Canyon beds because the Lower Sunnyside bed underlies a greater area than the Rock Canyon bed and the area of thicker coal is larger than that of the Gilson bed.

Upper Sunnyside Coal Bed

The Upper Sunnyside bed is more irregular in its occurrence than the Lower Sunnyside bed and there is no evidence that it reaches Reserve Base thickness in the quadrangle area. It is generally burned at the surface. Its outcrop trace is more uncertain than those of the other beds and little is known of its character and thickness under cover. Clark (1928, p. 59) states that tentative correlations indicate a fairly persistent coal bed, increasing in thickness to the south and east but decreasing to the west. The Upper Sunnyside bed may be of more value than the Kenilworth bed, but it is generally thin and likely to be split by partings (Clark, 1928, p. 60).

Rider Seam

A thin local coal bed 1.7 ft (0.5m) thick was encountered about 33 ft (10 m) above the Upper Sunnyside bed in a hole (index no. 20 on plates 1 and 3) drilled by Kaiser Steel Corporation. The bed was named the Rider Seam and no other correlatable occurrences of it in the quadrangle are known.

The stratigraphic positions of the coal beds within the Blackhawk Formation are shown in the composite columnar section of plate 3.

Intervals reported as "bony coal," "bone," "shaly coal," or other similar terms in the data sources are shown as "rock" intervals in this report on plates 1 and 3. These intervals were not included in the coal thicknesses used to construct the coal isopach maps.

Chemical Analyses of the Coal

Only 6 analyses of coal samples are available for the quadrangle. The samples were taken from the Rock Canyon mine and probably came from the Rock Canyon coal bed (Doelling, 1972). The ranges and averages of the analyses are given in the following table from Doelling (1972, p. 372).

Table 1. Average Proximate Analyses of Coal, Mount Bartles quadrangle, Carbon County, Utah.

	No. Analyses	Percent Average	Range
Moisture	6	5.2	3.1 - 7.9
Volatile Matter	6	38.8	37.2 - 40.0
Fixed Carbon	6	49.0	48.4 - 49.7
Ash	6	7.0	5.2 - 7.9
Sulfur	6	1.82	1.0 - 2.4
Btu/Lb.*	6	12,512	11,880 - 12,940

*To convert Btu/lb to Kj/kg multiply by 2.326.

Based on the above average analysis the Rock Canyon bed is ranked as high volatile B bituminous coal (American Society for Testing and Materials, 1977).

The high-sulfur content of the Rock Canyon coal in the above analyses is unusual. Doelling (1972, p. 372) points out that the average sulfur content of washed coal from the general Sunnyside area has the following approximations: "Upper Sunnyside 0.60 percent, Lower Sunnyside 0.85 percent, Rock Canyon 0.94 percent and Gilson 0.68 percent." Much of the sulfur is believed to be in pyritic form.

Mining Operations

Prospected first in 1906, the area was not mined until the 1950's, and then only intermittently. The Rock Canyon mine was operated by Heiner Coal Company from 1950 to 1960 when it was taken over by Pacific Steel Corporation. It was later transferred to Kaiser Steel Corporation but the mine has not been active since 1960. Nothing is known about the Bear Canyon mine except that Doelling (1972) shows its location in the NW¼ of Section 10, T. 14 S., R. 13 E.

COAL RESOURCES

The principal sources of data for the construction of the isopach maps, structure-contour maps, and for the coal-outcrop measurement maps of the coal beds were Doelling (1972) and Clark (1928).

Coal resource tonnages were calculated for measured, indicated, and inferred categories in unleased areas of Federal coal land within the KRCRA boundary. Data obtained from the coal isopach maps (plates 4, 8, and 12) were used to calculate the Reserve Base values. The coal-bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed times a conversion factor of 1,800 short tons of coal per acre-foot of bituminous coal yields the coal resources in short tons of coal for each isopached coal bed. Reserve Base and Reserve values for the Lower Sunnyside, Rock Canyon, and Gilson beds are shown on plates 7, 11, and 15, respectively, and are rounded to the nearest tenth of a million short tons. The Reserve values are based on a subsurface mining recoverability factor of 50 percent.

"Measured resources are computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced and the thickness and extent of coals are so well defined that the tonnage is judged to be accurate within 20 percent of true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of the coal differs from region to region according to the character of the coal beds, the points of observation are no greater than 1/2 mile (0.8 km) apart. Measured coal is projected to extend as a 1/4 mile (0.4 km) wide belt from the outcrop or points of observation or measurement.

"Indicated resources are computed partly from specified measurements and partly from projection of visible data for a reasonable distance on the basis of geologic evidence. The points of observation are 1/2 (0.8 km) to 1 1/12 miles (2.4 km) apart. Indicated coal is projected to extend as a 1/2-mile (0.8 km) wide belt that lies more than 1/4 mile (0.4 km) from the outcrop or points of observation or measurement.

"Inferred quantative estimates are based largely on broad knowledge of the geologic character of the bed or region and where few measurements of bed thickness are available. The estimates are based primarily on an assumed continuation from Demonstrated coal for which there is geologic evidence. The points of observation are 1 1/2 (2.4 km) to 6 miles (9.6 km) apart. Inferred coal is projected to extend as a 2 1-4 miles (3.6 km) wide belt that lies more than 3/4 mile (1.2 km) from the outcrop or points of observation or measurement." (U.S. Bureau of Mines and U.S. Geological Survey, 1976).

Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 2.7 million short tons (2.4 million metric tons) for the unleased Federal coal lands within the KRCRA boundary. The Reserve Base tonnages are also shown in the following tabulation.

Table 2. Coal Reserve Base Data for Subsurface Mining Methods for Federal Coal Lands (in short tons) in the Mount Bartles quadrangle, Carbon County, Utah

(To convert short tons to metric tons, multiply by 0.9072)

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Lower Sunnyside	-0-	-0-	100,000	100,000
Rock Canyon	1,000,000	-0-	-0-	1,000,000
Gilson	100,000	1,400,000	100,000	1,600,000
Total	1,100,000	1,400,000	200,000	2,700,000

AAA Engineering and Drafting, Inc. has not made any determination of economic mineability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Development Potential for Surface Mining Methods

No development potential for surface mining methods exists in the area of this quadrangle because of the rugged topography, steep-sided canyons, extreme relief, and thick overburden. There may be very small areas where some rim stripping could be done, but in general the area is not conductive to surface mining methods.

Development Potential for Subsurface Mining Methods and In Situ Gasification

The coal development potential for the underground mining of coal is shown on plate 16. In this quadrangle the areas where coal beds 5 ft (1.5 m) or more in thickness are overlain by less than 1000 ft (305 m) of overburden are considered to have a high development potential for underground mining.

Areas where such beds are overlain by 1,000-2,000 ft (305-610 m) and 2,000-3,000 ft (610-914 m) of overburden are rated as having a moderate and a low development potential respectively. Areas that contain no known coal in beds 5 ft (1.5 m) or more thick, but coal-bearing units are present at depths of less than 3,000 ft (914 m) are classified as areas of unknown coal development potential. Areas where no coal beds are known to occur or where coal beds are present at depths greater than 3,000 ft (914 m) have no coal-development potential.

The designation of a coal development potential classification is based on the occurrence of the highest-rated coal-bearing area that may occur within any fractional part of a 40-acre BLM land grid area or lot area of unleased Federal coal land. For example, a certain 40-acre area is totally underlain by a coal bed with a "moderate" development potential. If a small corner of the same 40-acre area is also underlain by another coal bed with a "high" development potential, the entire 40-acre area is given a "high" development potential rating even though most of the area is rated "moderate" by the lower coal bed. Another possibility is a 40-acre area devoid of any coal except a small corner where a 5-ft (1.5 m) coal bed crops out. In this case the 40-acre area will have a "high" development potential rating.

The in situ gasification methods of development potential classification are based on the dip and depth of coal beds having a minimum thickness of 5 ft (1.5 m). There are only two development potential classifications -- moderate and low. The criteria for in situ classification include coal bed dips of 15 to 90 degrees and coal bed depths of 200-3,000 ft (61-914 m).

Inasmuch as the coal beds dip less than 15 degrees in the Mount Bartles quadrangle, the in situ coal gasification methods of development potential classification do not apply.

Table 3. Source of Data Used on Plate 1.

Source	Plate 1 Index Number	Data Base: Drill Hole No. Measured Section No.	Data Base: Page or Plate No.
Clark, F.R., 1928	3	213	pl. 8
	4	214	58
	5	205	pl. 8
	6	196, 206, 215, and 219	58 and pl. 8
	7	203	pl. 8
	8	204, 207, 216, and 220	pls. 5 and 8
	9	208	pl. 8
	10	197	pl. 8
	12	228, 243, 255, and 271	63, pls. 6 and 9
	14	229	pl. 9
	15	244	pl. 9
	17	230, 245, and 273	pl. 5
	18	246	pl. 9
	22	221, 232, and 248	pl. 9
	24	233, 250, and 256	pls. 5 and 9
	25	234, 251, and 274	64 and pl. 9
	27	253	pl. 9
Doelling, H.H., 1972	1	8, 15, and 31	372
	2	32	372
	13	5	372
	21	24 and 25	372
	26	29 and 72	372
Kaiser Steel Corp., 1965	11	DDH4	
	16	DDH3	
	19	DDH1	
	20	DDH2	