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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE NORTHWEST QUARTER OF THE CASTLE DALE 15-MINUTE QUADRANGLE EMERY COUNTY, UTAH

(Report includes 16 plates)

By

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This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

CONTENTS

ILLUSTRATIONS

(Plates are in pocket)

TABLES

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 Northwest Quarter of the Castle Dale 15-minute quadrangle, Emery County, Utah (U.S. Geological Survey Open-File Report 79-1004).

Published and unpublished public information were used as data sources for this study.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 data were used.

Location

The Northwest Quarter of the Castle Dale 15-minute quadrangle lies in the central part of the Wasatch Plateau coal field in Emery County, Utah. The quadrangle is approximately 6 miles (10 km) west of the town of Castle Dale which is the county seat of Emery County. The town of Orangeville is about 3 miles (5 km) east and the town of Ferron is 2.5 miles (4 km) south of the quadrangle. The nearest railhead on the main line of the Denver and Rio Grande Western Railroad is at the city of Price, approximately 30 miles (48 km) northeast of the quadrangle. The terminus of the Utah Railway line is at Mohrland, about 13 miles (21 km) north and 5 miles (8 km) east of the quadrangle. The Utah Railway line joins the Denver and Rio Grande Western Railroad at the city of Helper 34 miles (55 km) northeast of the quadrangle.

Accessibility

The quadrangle is generally inaccessible because of the high and rugged terrain. An unimproved dirt road in Rock Canyon provides access to several jeep roads in the high plateau area. The Rock Canyon road joins Utah Highway 10 which passes within 2 miles (3 km) of the southeast corner of the quadrangle. Utah Highway 10 is the main road connection between the cities of Price, Castle Dale, Ferron, and other towns along the eastern front of the Wasatch Plateau.

Physiography

The Wasatch Plateau is a highly dissected tableland, whose eastern margin forms a sweeping stretch of barren sandstone cliffs some 80 miles (129 km) in length. Generally the sedimentary strata exhibit a gentle westward dip and the resistant sandstone beds form parallel lines of cliffs and ledges.

North Horn Mountain and South Horn Mountain are capped by gently-sloping surfaces of the plateau upland and are bounded by precipitous slopes of sandstone cliffs and ledges from 1,000 to 2,000 ft (305 to 610 m) high.

A smaller flat-topped mesa called "The Cap" in the northwest corner of the quadrangle rises about 1,000 ft (305 m) above the general elevation of North Horn Mountain. The total relief in the quadrangle area is approximately 3,610 ft (1,100 m) with surface elevations ranging from 6,000 ft (1,829 m) where Rock Canyon Creek leaves the quadrangle to 9,610 ft (2,929 m) at the highest point on The Cap.

The coal beds in the quadrangle crop out in the cliff area at elevations ranging from 7,300 to 7,800 ft (2,225 to 2,377 m) above sea level.

Climate

The Wasatch Plateau coal field is located in the mid-latitude steppe climate with semi-arid conditions prevailing at the lower elevations.

The normal annual precipitation in the quadrangle area ranges from 10 inches (25 cm) in the lowland area below the cliffs to approximately 23 inches (58 cm) in the highest areas in the northwest corner of the quadrangle (U.S. Department of Commerce, (1964)).

The extreme winter and summer temperatures in the highlands area are expected to range from -30 degrees F (-34 degrees C) to 90 degrees F (32 degrees C). The temperature extremes for the lowlands are expected to be similar to those recorded at the town of Ferron with a summer high of 97 degrees F (36 degrees C) and a winter low of -15 degrees F (-26 degrees C).

Land Status

The Northwest Quarter of the Castle Dale 15-minute quadrangle is in the central part of the Wasatch Plateau Known Recoverable Coal Resource Area (KRCRA). Approximately 12,300 acres of the quadrangle area lie within the KRCRA boundary as shown on plate 2. About 500 acres of the KRCRA are non-Federal coal land and 11,800 acres are unleased Federal coal land. There were no Federal coal leases in the quadrangle at the date the land source data was obtained (1977).

GENERAL GEOLOGY

Previous Work

Spieker (1931) mapped the geology and coal outcrop traces of the Wasatch Plateau coal field and his maps are the most detailed original work presently available. The stratigraphy of the area is also described by Hayes and others (1977), Spieker and Reeside (1925), and Katich (1954).

Doelling (1972) has summarized the geology and updated the coal data for the coal field.

Stratigraphy

The coal beds of economic importance in the Wasatch Plateau field are Upper Cretaceous in age, and are confined to the Blackhawk Formation of the Mesaverde Group. This group includes, in ascending order, the Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and the Price River Formation. The Upper Cretaceous Mancos Shale underlies the Mesaverde Group and consists of the Tunuk Shale Member at the base succeeded by the Ferron Sandstone Member, Blue Gate Shale Member, Emery Sandstone Member, and the Masuk Shale Member. Only the Blue Gate, Emery, and Masuk members are exposed on the east side of the quadrangle below the cliffs of the Mesaverde Group.

The Tertiary strata in the quadrangle which overlie the Mesaverde Group consist of two formations of the Wasatch Group, the North Horn Formation and the Flagstaff Limestone. The North Horn Formation is Upper Cretaceous and Paleocene in age and the Flagstaff Limestone is Paleocene.

The oldest stratigraphic unit exposed in the quadrangle is the Blue Gate Shale Member of the Mancos Shale. The overlying Emery Sandstone Member is 250 to 350 ft (76 to 107 m) thick and consists of two 50 ft (15 m) thick sandstone tongues separated by a thick blue-gray shale interval. The Masuk Shale Member is about 750 ft (229 m) thick and overlies the Emery Sandstone Member.

The Star Point Sandstone is about 400 ft (122 m) thick and in the northern part of the quadrangle it is a well-defined, massive, cliff-forming, yellowish-gray sandstone. However, in the southern part it is well bedded and is less easily distinguished from the overlying Blackhawk Formation. The Blackhawk consists of sandstone interbedded with shale and coal beds. It forms step-like outcrops and is 750 ft (229 m) or more in thickness.

The Castlegate Sandstone is from 150 to 200 ft (46 to 61 m) thick and consists of massive white to gray coarse-grained and gritty sandstone with some conglomerate. It generally forms a prominent cliff. The overlying Price River Formation has a similar sandstone lithology, but contains some interbedded shale and does not form cliffs. The Price River Formation is 250 to 350 ft (76 to 107 m) thick and makes up the entire upper surface of South Horn Mountain.

In the quadrangle area the North Horn Formation and the Flagstaff Limestone are present only on North Horn Mountain. The lower unit consists of about 1,250 ft (381 m) of variegated shale with subordinate amounts of sandstone, conglomerate, and freshwater limestone. The Flagstaff forms "The Cap" of North Horn Mountain and consists mostly of yellowish-gray, resistant, ledge-forming limestone.

Structure

The strata within the quadrangle area dip gently northwestward and westward with dips ranging from less than one degree to 6 degrees. Except in the southwest corner of the quadrangle no other faults occur. In this sector the Biddlecomb Hollow fault is the easternmost fault of the Joes Valley fault zone and has a displacement of at least 100 ft (30 m).

COAL GEOLOGY

Bear Canyon Coal Bed

The Bear Canyon bed is the uppermost named coal bed in the quadrangle and has been measured at a number of points both on the surface and in drill holes. The bed is generally thin and most thickness measurements are less than 5 ft (1.5 m). See plate 4. The bed is 5.5 ft (1.7 m) thick at two closely-spaced measurements on an outcrop and in a prospect pit in the central part of the west half of Section 5, T. 19 S., R. 7 E. A hole drilled in the NW¼ Section 28, T. 18 S., R. 7 E. encountered the Bear Canyon bed as three splits 3.0, 2.0, and 6.0 ft (0.9, 0.6, and 1.8 m) thick separated by rock intervals 4.0 ft (1.2 m) and 2.0 ft (0.6 m) thick. The coal isopach map, plate 4, shows the combined coal thickness of 11.0 ft (3.4 m) for the Bear Canyon bed at that point. The extent of the thicker coal in this area is not known because of insufficient data.

The Bear Canyon coal bed is separated from the underlying Blind Canyon coal bed by a 40 to 60 ft (12 to 18 m) noncoal interval.

Blind Canyon Coal Bed

The Blind Canyon coal bed has been measured in outcrops and drill holes in the northern half of the quadrangle where its thickness ranges from 1.0 to 13.5 ft (0.3 to 4.1 m). The sparcity of thickness measurements makes it difficult to get an accurate picture of thickening and thinning trends of the bed. Some closely-spaced measurements of the coal bed in Section 5, T. 19 S., R. 7 E. ranging from 1.0 to 13.5 ft (0.3 to 4.1 m), suggest that the bed is lenticular in that area (plate 8). A drill hole at the north edge of the quadrangle in Section 20, T. 18 S., R. 7 E. encountered a 9.0 ft (3.7 m) thick Blind Canyon bed. The coal bed was also encountered in another drill hole a little over a mile away in Section 28 of the same township where the bed was 4.5 ft (1.4 m) thick. This suggests a northward thickening of the bed on the north side of the quadrangle.

The Blind Canyon bed is separated from the underlying Hiawatha coal bed by an interval of 50 to 70 ft (15 to 21 m) of rock and thin local coal beds.

Hiawatha Coal Bed

The Hiawatha bed is the most prominent and widespread coal bed in the quadrangle. The outcrop trace of this bed was mapped by Spieker (1931) and extends from the north boundary of the quadrangle to the south boundary.

Generally the bed is less than 5 ft (1.5 m) thick in the south half of the quadrangle but the coal isopach map for the bed (plate 12) shows a large area of Reserve Base thickness in the north half. Thicknesses of the Hiawatha bed range from less than 1 ft (0.3 m) to 13.3 ft (4.1 m) in the quadrangle.

The Hiawatha is the lowest coal bed in the Blackhawk Formation and generally occurs at the base of the formation on or near the top of the Star Point Sandstone.

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 three chemical analyses of coal samples from the quadrangle area are available (Spieker, 1931, p. 71). Two of these analyses (lab. nos. 86403 and 86404) are of coal from the Hiawatha bed and the third (lab no. 87022) is an analysis of a thin 1.0 to 1.5 ft (0.3 to 0.5 m) layer of bright coal above the Hiawatha bed. All three coal samples came from Rock Canyon in the central part of the quadrangle.

Table 1: Proximate coal analyses, Northwest Quarter of the Castle Dale 15-minute quadrangle, Emery County, Utah.

	As Received (percent)		
Laboratory No.*	(86403)	(86404)	(87022)
Moisture	6.8	6.4	9.8
Volatile matter	41.0	41.0	34.4
Fixed carbon	47.0	46.3	54.4
Ash	5.2	6.3	1.4
Sulfur	0.6	0.8	0.9
Btu/lb**	12,490	12,270	12,400

*Spieker, 1931, p. 71
**To convert Btu/lb to Kj/kg multiply by 2.326

Based on the ASTM classification of coal (American Society for Testing and Materials, 1977) the coal of laboratory no. 86403 sample is ranked as high volatile B bituminous and the laboratory samples numbered 86404 and 87022 are high volatile C bituminous rank.

Mining Operations

Most of the coal beds in the quadrangle crop out on high, inaccessible cliffs which has made mining difficult. There were no active coal mines in the quadrangle area at the date of this report (1979). Two mines in the Rock Canyon area, the Killpack mine and the Axel Anderson mine, operated in the early 1900's and supplied the local communities with domestic fuel. The mines were accessible by steep, narrow wagon roads. The Axel Anderson mine used a steep tramway to lower the coal from the mine mouth to the loading station. Both mines produced coal from the Hiawatha bed.

Doelling (1972, p. 158) reports that the main tunnel in the Axel Anderson mine was 900 ft (274 m) long and that the production from the mine is estimated to be 5,000 short tons (4,536 metric tons). Spieker (1931, p. 167, 168) notes that the Killpack mine had a 250-ft (76-m) main entry and two 100-ft (30-m) side entries. The Ferron mine in Olsen Hollow is reported (Doelling, 1972, p. 158) to be in 8 ft (2.4 m) of Hiawatha coal.

The following table lists the mines in the quadrangle.

Table 2: Mines and their locations in the Northwest Quarter of the Castle Dale 15-minute quadrangle, Emery County, Utah.*

Mine	Location	Remarks
Axel Anderson mine (Rock Canyon, Clawson, Peterson)	SE¼ NE¼ Sec. 7, T. 19 S., R. 7 E.	1906 - 1932
Killpack mine	SE¼ NW¼ Sec. 5, T. 19 S., R. 7 E.	
Ferron Mine	SW¼ Sec. 19, T. 19 S., R. 7 E.	Active 1901 - 1906

*After Doelling (1972)

Total coal production from the quadrangle has been estimated to be approximately 8,000 short tons 7,258 metric tons) (Doelling, 1972).

COAL RESOURCES

The principal sources of data used in the construction of the coal isopach maps, structure contour maps, and coal data maps were Doelling (1972), Spieker (1931), Blanchard, Ellis, and Roberts (1977) and Davis and Doelling (1977).

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 Bear Canyon, Blind Canyon, and Hiawatha beds are shown on plates 7, 11, and 15, 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 well defined that the tonnage is judged to be accurate within 20 percent of true tonnage. Although the spacing of 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 not 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 1/2 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 quantitative 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 mile (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 140 million short tons (127 million metric tons) for the unleased Federal coal lands within the KRCRA boundary in the Northwest Quarter of the Castle Dale 15-minute quadrangle. Reserve Base tonnages in the various development potential categories for subsurface mining methods are shown in Table 3.

Table 3: Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Northwest Quarter of the Castle Dale 15-minute quadrangle, Emery 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
Bear Canyon	1,800,000	-0-	-0-	1,800,000
Blind Canyon	69,000,000	14,000,000	-0-	83,000,000
Hiawatha	47,000,000	8,200,000	-0-	55,200,000
Total	117,800,000	22,200,000	-0-	140,000,000

AAA Engineering and Drafting, Inc. has not made any determination of economic recoverability 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 conducive to surface mining methods.

Development Potential for Subsurface Mining and In Situ Coal Gasification Methods

The coal development potential for the subsurface 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 1,000 ft (305 m) of overburden are considered to have a high development potential for subsurface mining.

Areas where such beds are overlain by 1,000 to 2,000 ft (305 to 610 m) and 2,000 to 3,000 ft (610 to 914 m) of overburden are rated as having a moderate and a low development potential respectively. Those areas classified as having an unknown coal development potential are areas that contain no known coal in beds 5 ft (1.5 m) or more thick, but where coal-bearing units are present at depths of less than 3,000 ft (914 m). 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. No areas of unleased Federal coal land within the KRCRA in the quadrangle are known to fall within the "low" development potential classification.

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 tract may be totally underlain by a coal bed with a "moderate" development potential. If a small corner of the same 40-acre tract is also underlain by another coal bed with a "high" development potential, the entire 40-acre tract is given a "high" development potential rating even though most of the tract is rated "moderate" by the lower coal bed. Another possibility is a 40-acre area with no coal present except in a small corner area 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 even though most of the 40-acre area contains no coal.

In the quadrangle approximately 5,890 acres of unleased Federal coal land have a "high" development potential rating; 1,460 acres are rated "moderate"; 4,370 acres are rated "unknown"; and 80 acres have "no" development potential.

The in situ coal 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 to 3,000 ft (61 to 914 m). Inasmuch as the dip of the coal beds is less than 15 degrees in the Northwest Quarter of the Castle Dale 15-minute quadrangle, the in situ coal gasification methods of development potential classification do not apply.

Table 4. Sources of data used on plate 1.

Source Reference	Plate 1 Index Number	Data Base: Drill Hole or Measured Section No.	Data Base: Page or Plate No.
Doelling, 1972	6	6	156
	8	8	156
	9	9	156
	14	11	156
	15	12	156
	17	4	156
	18	14 and 14a	156
	19	15	156
	20	18	156
	22	19	156
	23	21	156
	24	22	156
	25	24	156
	26	26	156
	27	28	156
	28	29	156
	29	30	156
	30	31	156
	31	32	156
	32	33	156
	33	34	156
	34	35	156
	35	37	156
	36	38	156
	38	40	156
	39	41	156
	41	43	156
	42	44	156
	43	45	157
	44	46	157
	45	47	157
	46	48	157
	47	50	157
	48	51	157
	49	52	157
	50	53	157
	51	54	157
	52	55	157
	53	56a	156
	54	57	157
	55	58	157
	56	59	157
	57	60	157
	58	61	157
	59	62	157
	60	63	157
	62	65	157
	64	67	157
	65	68	157

Source Reference	Plate 1 Index Number	Data Base: Drill Hole or Measured Section No.	Data Base: Page or Plate No.
Doelling, 1972	66	69	157
	67	70	157
	68	71	157
	69	72	157
	70	73	157
	71	74 and 74a	156 and 157
Spieker, 1931	7	337	pl. 23
	12	343	pl. 23
	13	342	pl. 23
	16	346	pl. 23
	21	350	pl. 23
	37	371	pl. 23
	40	374	pl. 23
	61	396	pl. 23
	63	398	pl. 23
Blanchard, Ellis, and Roberts, 1977	2	d.h. W-NH-1-CD	
	3	d.h. W-NH-2A-CD	
	4	d.h. W-NH-3-CD	
	5	d.h. W-NH-7-CD	
Davis and Doelling, 1977	1	d.h. 6	55-69

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