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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SOUTHWEST QUARTER OF THE HIAWATHA 15-MINUTE QUADRANGLE EMERY COUNTY, UTAH

(Report includes 8 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 (7 plates) and the Coal Development Potential (CDP) Map (1 plate) of the Southwest Quarter of the Hiawatha 15-minute quadrangle, emery County, Utah (U.S. Geological Survey Open-File Report 79-900).

Published and unpublished public information were used as data sources for this study.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 Southwest Quarter of the Hiawatha 15-minute quadrangle is located in the central part of the Wasatch Plateau coal field in Emery County in central Utah. The town of Huntington is 8.5 miles (13.7 km) east of the quadrangle. The town of Orangeville is 4.0 miles (6.4 km) southeast, and Castle Dale, the county seat of Emery County, is approximately 6 miles (10 km) southeast of the quadrangle. The city of Price is 23 miles (37 km) northeast of the quadrangle.

Accessibility

Utah Highway 29 passes through the south part of the quadrangle in Cottonwood and Straight canyons. This highway provides access from Castle Dale and Orangeville on the east side of the Wasatch Plateau to the town of Ephraim and the Sanpete Valley area on the west side. The highway is paved to Joes Valley Reservoir and is a light-duty graveled road from there to Ephraim. Utah Highway 10 extends from the city of Price southward through Huntington, Castle Dale, and other cities and towns along the base of the east side of the Wasatch Plateau.

The nearest railhead is at the terminus of the Utah Railway Company line in the old coal mining town of Mohrland approximately 7 miles (11 km) northeast of the quadrangle. The Utah Railway line makes connection with a main line of the Denver and Rio Grande Western Railroad at the city of Helper 26 miles (42 km) northeast of the quadrangle. There are also rail loading facilities on the Denver and Rio Grande Western Railroad at the city of Price and the town of Ephraim. These railroads provide transportation to Salt Lake City, Utah and Denver, Colorado.

Physiography

The Wasatch Plateau is a high and deeply dissected tableland, the eastern margin of which forms a sweeping stretch of barren sandstone cliffs about 80 miles (129 km) in length. The cliffs rise sharply above the flat, dry land of Castle Valley below. Elevations in the quadrangle range from about 6,050 ft (1,844 m) where Cottonwood Creek leaves the southeast corner of the quadrangle to 10,150 ft (3,094 m) on East Mountain on the north side of the quadrangle. The topographic relief is approximately 4,100 ft (1,250 m).

The two main canyons in the quadrangle, Cottonwood and Straight, are bounded by steep precipitous sandstone cliffs and ledges. There are small areas on the high ridges of East Mountain and Trail Mountain that are flat

or gently sloping. The main drainage system in the quadrangle is Cottonwood Creek and its tributaries. Cottonwood Creek flows into the San Rafael River about 14 miles (23 km) east of the quadrangle.

The coal beds in the quadrangle crop out in the irregular line of steep sandstone cliffs at elevations ranging from about 6,500 ft (1,981 m) to 7,800 ft (2,377 m).

Climate

The climate in the quadrangle ranges with altitude from semi-arid in the lower elevations to alpine in the highest. The normal annual precipitation ranges from 10 inches (25 cm) in the southeast corner of the quadrangle to 30 inches (76 cm) at the north edge of the quadrangle on East Mountain (U.S. Department of Commerce, (1964)). Much of the precipitation falls as snow during the winter months. Occasional late summer thunderstorms may produce flash floods in the steep narrow canyons and washes.

Temperatures in the high mountainous country are generally cold in winter with warm days and cool nights during the summer. In the high areas on the north side of the quadrangle the summer temperatures may reach 85 degrees F (29 degrees C) while the minimum winter temperatures could drop to -30 degrees F (-34 degrees C). At the lower elevations in the southeast corner of the quadrangle summer temperatures may reach 100 degrees F (38 degrees C) and the winter temperatures may drop as low as -20 degrees F (-29 degrees C).

Land Status

The Southwest Quarter of the Hiawatha 15-minute quadrangle is located in the central part of the Wasatch Plateau Known Recoverable Coal Resource Area (KRCRA). The KRCRA covers approximately 30,300 acres of the quadrangle. The Federal coal lands within the KRCRA boundary include about 19,100 acres

of unleased Federal coal land and 9,600 acres of Federal coal leases. Approximately 1,600 acres in the KRCRA boundary of the quadrangle are non-Federal lands. The areas of Federal coal lands, coal leases, non-Federal lands, and the KRCRA boundaries are shown on plate 2.

GENERAL GEOLOGY

Previous Work

Spieker (1931) mapped the geology and coal occurrences in the Wasatch Plateau and his work is the most detailed presently available. The stratigraphy of the area has also been described by Lupton (1916), Spieker and Reeside (1925), Katich (1954), and Hayes and others (1977). Doelling (1972) has summarized the geology and updated the coal data. Reports on recent drilling in the area have been prepared by Blanchard, Ellis, and Roberts (1977) and Davis and Doelling (1977).

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. The Mesaverde consists of the following four formations in ascending order: the Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and Price River Formation. The Upper Cretaceous Mancos Shale underlies the Mesaverde Group and consists of three shale members and two sandstone members. The Tunuk Shale Member at the base is succeeded upward by the Ferron Sandstone Member, Blue Gate Shale Member, Emery Sandstone Member, and the Masuk Shale Member.

The North Horn Formation of Upper Cretaceous and Paleocene ages overlies the Mesaverde Group and the North Horn is overlain by the Flagstaff Limestone of Paleocene age.

The oldest stratigraphic unit exposed in the quadrangle is the Emery Sandstone Member of the Mancos Shale. The Emery Sandstone crops out along

Cottonwood Creek in the southeast corner of the quadrangle and is composed of yellowish-gray littoral sandstone with some shaly partings. The overlying Masuk Member, a gray marine shale, is about 1,300 ft (396 m) thick and crops out over a large area below the steep sandstone cliffs of the Mesaverde Group in Cottonwood and Straight canyons. Some pediments in the southeast corner of the quadrangle are developed on the Masuk Shale.

The Star Point Sandstone forms a cliff above the Masuk Shale. It consists of massive yellowish-gray to white sandstone with interbedded subordinate shale and is approximately 300 ft (91 m) thick.

The Blackhawk Formation overlies the Star Point Sandstone and consists of approximately 700 ft (213 m) of alternating shale, sandstone, and coal. The coal beds occur in the lower 200 to 300 ft (61 to 91 m) of the formation.

In this area the Blackhawk is unconformably overlain by the Castlegate Sandstone. The unconformity represents a change from the lagoonal and littoral environments of the Blackhawk to fluvial continental of the Castlegate which occurs as a massive cliff of coarse gritty sandstone and minor shale partings. The Castlegate is from 250 to 350 ft (76 to 107 m) thick and the overlying Price River Formation of similar lithology is about 500 ft (152 m) thick. The Price River is not massive appearing and is less resistant than the Castlegate Sandstone.

The North Horn Formation and Flagstaff Limestone overlie the Price River Formation and cap the high ridges on East and Trail mountians. The North Horn is composed of variegated shale, sandstone, and limestone and the Flagstaff consists of yellowish-gray to cream colored, evenly bedded, resistant limestone.

Structure

Except for one fault cutting through Meetinghouse Canyon in the northeast corner of the quadrangle little deformation of strata is evident. This fault

represents the south end of the Pleasant Valley fault zone. The displacement of the fault is approximately 250 ft (76 m) and would limit mining.

The structure contour map of the Hiawatha coal bed (plate 5) is based on the structure map of Spieker (1931) and the limited data from drill holes and outcrop measured sections. The coal-bearing strata in the south half of the quadrangle dip gently to the west and southwest. The dips of the beds range between 3 and 6 degrees. The strata on the north side of the quadrangle have a southward dip of less than 4 degrees and a very gentle synclinal trough lies in the northeast quarter of the quadrangle.

COAL GEOLOGY

Seven named and several unnamed local coal beds occur in the quadrangle. The local beds are generally thin and lenticular. In ascending order the named coal beds are the Hiawatha, Upper Hiawatha, Cottonwood, Blind Canyon, Bear Canyon, Upper Bear Canyon, and Upper Grimes Wash.

Hiawatha Coal Bed

The Hiawatha coal bed is the most persistent and well-developed coal bed known in the explored areas of the quadrangle. It ranges from 1.1 to 18.4 ft (0.3 to 5.6 m) thick in measured sections. The isopach map of this bed (plate 4) shows a general thickening in the east central part of the quadrangle where the bed is more than 15 ft (4.6 m) thick at two points on the east side. The isopach lines on the north and west sides of the quadrangle were projected from the outcrop areas to the widely spaced drill holes on the map and from control points in adjoining quadrangles. In Cottonwood Canyon the bed is from 5 to 11 ft (1.5 to 3.4 m) thick except where it was found to be 3.8 and 2.3 ft (1.2 and 0.7 m) thick at two locations. The bed thins southward but is over 5 ft (1.5 m) thick in one small area in Straight Canyon. The Hiawatha coal bed is being produced in the Trail Mountain mine in Cottonwood Canyon.

Upper Hiawatha Coal Bed

The Upper Hiawatha coal bed is thin and lenticular in the outcrop area of the quadrangle. The bed occurs from 15 to 30 ft (4.6 to 9.1 m) above the Hiawatha bed, and it generally consists of two or more thin sub beds separated by rock partings or interbeds. The bed is Reserve Base thickness at index number 26 on plate 1 where the main sub bed is 6.0 ft (1.8 m) thick. Because of the limited occurrence and thinness of the coal bed, an isopach map of the bed was not made. The Reserve Base tonnage for non-isopached coal beds includes the Upper Hiawatha bed at the location of index number 26 (plate 1).

Cottonwood Coal Bed

The Cottonwood coal bed occurs as a thin and lenticular bed in measured sections 10 and 11, and in the drill hole at index number 2 in the upper Cottonwood Canyon area. The bed is less than 5 ft (1.5 m) thick and occurs about 30 ft (9.1 m) above the Hiawatha bed. The Cottonwood bed "may be contiinous with the Upper Hiawatha bed, and it is here separately identified largely because of its consistent and apparently restricted appearance in Cottonwood Canyon" (Spieker, 1931, p. 154).

Blind Canyon Coal Bed

The Blind Canyon coal bed occurs from 55 to 70 ft (16.8 to 21.3 m) above the Hiawatha coal bed and is lenticular in the Cottonwood Canyon area. It is not known to be continuous with the Blind Canyon bed of Huntington Canyon to the northeast. The bed is generally thin and includes rock partings in the quadrangle area. However, at the locations of index numbers 2 and 43 (plate 1) the coal is 6.0 and 7.5 ft (1.8 and 2.3 m) thick. Spieker (1931) suggests that the bed at index number 43 is part of a lens which probably extends under the eastern edge of North Horn Mountain.

Bear Canyon Coal Bed

The Bear Canyon coal bed occurs in several measured sections and two drill holes in the quadrangle. The bed lies from 90 to 110 ft (27 to 34 m) above the Hiawatha coal bed and is generally thin in this area. The bed may be represented in outcrop burned areas in Grimes Wash and is probably continuous between Grimes Wash and Cottonwood Canyon (Spieker, 1931, p. 156). The bed is Reserve Base thickness in the drill hole at index number 42 on plate 1 where it is 6.6 ft (2.0 m) thick.

Upper Bear Canyon Coal Bed

The Upper Bear Canyon coal bed occurs from 120 to 150 ft (37 to 46 m) above the Hiawatha bed in this quadrangle. In the Cottonwood Canyon area the Upper Bear Canyon bed is thin and is not known to be more than 3.5 ft (1.1 m) thick.

Upper Grimes Wash Coal Bed

The Upper Grimes Wash coal bed is generally less than 3 ft (0.9 m) thick and occurs about 190 ft (58 m) above the Hiawatha coal bed. The bed is present on the east side of Cottonwood Canyon but is apparently absent on the west side.

Intervals reported as "bony coal", "bone", or "shaly coal", 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

Doelling (1972, p. 207) tabulated the ranges and the averages of coal analyses of samples from the Hiawatha coal bed in the quadrangle. The summary of the analyses is shown in the following table.

Table 1. Average coal analyses, Southwest Quarter of the Hiawatha 15-minute quadrangle, Emery County, Utah*

	No. Analyses	Percent as-received	
		Average	Range
Moisture	27	4.7	1.5-13.2
Volatile matter	16	41.6	37.9-43.7
Fixed carbon	16	46.4	43.2-48.7
Ash	20	6.5	4.2-8.8
Sulfur	18	0.57	0.38-0.7
Btu/lb**	23	12,905	11,376-13,452

*Doelling (1972, p. 207)
**To convert Btu/lb to Kj/kg multiply by 2.326

Based on the average analysis shown above, the Hiawatha coal is ranked as high volatile B bituminous (American Society of Testing and Materials, 1977).

Mining Operations

Coal has been produced from several mines in the quadrangle at various times since 1898. At the time of this writing (1979) one mine, the Trail Mountain mine, was active. Table 2 lists the active and inactive mines in the quadrangle, their approximate locations, and the years in which the mines were active.

Table 2. Mines and their locations, Southwest Quarter of the Hiawatha 15-minute quadrangle, Emery County, Utah*

Mine Name(s)	Approximate Location	Period of Activity
Black Diamond mine (Fox)	NW¼ NW¼ Sec. 12, T. 18 S., R. 6 E.	1898-1950's
Cottonwood Canyon prospects	SW¼ SE¼ Sec. 25, T. 17 S., R. 6 E. SE¼ NE¼ Sec. 31, T. 17 S., R. 6 E.	1946-1948
Johnson mines (Twin City, Shumway Cottonwood)	SW¼ NE¼ Sec. 25, T. 17 S., R. 6 E.	1909-1948

Mine Name(s)	Approximate Location	Period of Activity
Oliphant mine	NE¼ NE¼ Sec. 11, T. 18 S., R. 6 E.	1906-1950's
Sitterud mine	Cottonwood Can., 10 mi (16 km) NW of Orangeville, exact location unknown	1946-1952
Trail Mountain mines (No. 1, No. 2, No. 3)	NW¼ SE¼ Sec. 25, T. 17 S., R. 6 E.	1946-1967 1977-

*After Doelling, 1972, p. 208

Little is known about the operation and production of the older mines. The boundaries of mined-out areas were not available nor were total production figures. However Doelling (1972) estimated the coal production from the mines in the quadrangle as follows:

Mine	Estimated Production (Short tons)	(Metric tons)
Black Diamond mine	10,000	9,072
Oliphant mine	34,000	30,845
Trail Mountain mines (does not include production from latest operation)	25,000	22,680
Other mines and prospects	27,000	24,494
Total	96,000	87,091

COAL RESOURCES

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

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 map (plate 4) 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 the isopached coal bed. Reserve Base and Reserve values for the Hiawatha coal bed are shown on plate 7. The values are rounded to the nearest tenth of a million short tons and the Reserve values are based on a subsurface mining recoverability factor of 50 percent.

Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 180.3 million short tons (163.6 million metric tons) for the isopached coal bed and 1.7 million short tons (1.5 million metric tons) for the non-isopached coal beds in the unleased Federal coal lands within the KRCRA boundary in the Southwest Quarter of the Hiawatha 15-minute quadrangle. These data are summarized in the following tabulation.

Table 3. Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Southwest Quarter of the Hiawatha 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
Hiawatha	69,300,000	90,700,000	20,300,000	180,300,000
Non-isopached coal beds	1,700,000	-0-	-0-	1,700,000
Total	71,000,000	90,700,000	20,300,000	182,000,000

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 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 8. 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 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 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 coal gasification 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 coal beds dip less than 15 degrees in the Southwest Quarter of the Hiawatha 15-minute quadrangle, the criteria for the classification of in situ coal gasification methods of development potential do not apply.

Table 4. Sources of data used on plate 1.

Source	Plate 1 Index Number	Data Base: Measured Section No.	Data Base: Page or Plate No.
Spieker, 1931	3	308	pl. 23
	5	305	pl. 23
	6	304	pl. 23
	7	303	pl. 23
	8	302	pl. 23
	9	309	pl. 23
	10	301a and 301b	pl. 23
	11	300	pl. 23
	12	310	pl. 23
	13	311	pl. 23
	14	312	pl. 23
	15	313	pl. 23
	16	314	pl. 23
	17	299	pl. 23
	18	298	pl. 23
	19	291	pl. 23
	20	292	pl. 23
	21	293a and 293b	pl. 23
	22	294a and 294b	pl. 23
	23	295	pl. 23
	24	296	pl. 23
	25	297	pl. 23
	26	315a and 315b	pl. 23
	27	316	pl. 23
	28	317a and 317b	pl. 23
	29	319	pl. 23
	31	320	pl. 23
	32	321	pl. 23
	33	322	pl. 23
	34	323	pl. 23
	35	324	pl. 23
	36	325	pl. 23
	37	326	pl. 23
	38	327	pl. 23
	39	328	pl. 23
	40	329	pl. 23
	41	330	pl. 23
	43	331	pl. 23
	44	332	pl. 23
Davis and Doelling, 1972	1	Dairy Canyon D.H. 3	35-43
	2	Roans Canyon D.H. 4	44-48
	30	Straight Canyon D.H. 5	49-54
Blanchard, Ellis, and Roberts, 1977	42	D.H. W-NH-6-H	

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