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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SOUTHEAST QUARTER OF THE SCOFIELD 15-MINUTE QUADRANGLE, CARBON AND EMERY COUNTIES, UTAH

(Report includes 28 plates)

By

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

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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 (27 plates) and the Coal Development Potential (CDP) Map (1 plate) of the Southeast Quarter of the Scofield 15-minute quadrangle, Carbon and Emery Counties, Utah (U.S. Geological Survey Open-File Report 79-486).

Published and unpublished public information were used as data sources for this study.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 Southeast Quarter of the Scofield 15-minute quadrangle is located near the northern end of the Wasatch Plateau in central Utah. The southwestern corner area of the quadrangle lies in Emery County and the remainder of the quadrangle is in Carbon County. The eastern edge of the quadrangle is 10 miles (16 km) due west of the city of Price, the county seat of Carbon

County. The small coal mining town of Wattis is located in the southeastern corner of the quadrangle.

Accessibility

The quadrangle area is generally inaccessible to vehicular traffic. However, jeep trails provide some accessibility into the rugged mountainous terrain for cattle and sheep ranchers. There are several light-duty dirt roads which penetrate one or two miles into the quadrangle. A paved road, Utah Highway 50, provides access to the town of Wattis which is about one mile (1.6 km) inside the quadrangle boundary.

Railroad loading facilities exist on the end of a spur of the Utah Railway Company line at Wattis. The railroad delivers coal to a rail connection with a main line of the Denver and Rio Grande Western Railroad at the city of Helper 15 miles (24 km) northeast of Wattis.

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 6,500 ft (1,981 m) near the northeast corner on the South Fork of Gordon Creek to 10,101 ft (3,079 m) on Gentry Mountain in the southwest corner.

The low area below the cliffs in the northeast quarter of the quadrangle consist of dissected pediments locally referred to as "benches." The west edge of the quadrangle is marked by Castle Valley Ridge which divides the Huntington Creek drainage from the streams which flow eastward into Castle Valley and the Price River. The ridge is also the boundary between Emery and Carbon Counties.

Most of the drainages north of Wattis flow northeastward into the South Fork of Gordon Creek. The major canyons which head in the high plateau area all contain perrennial streams. The rugged mountainous area is characterized by steep-walled V-shaped canyons with steep stream gradients. Flash flooding often follows the late summer thunderstorms.

Climate

The climate in the quadrangle varies with altitude from alpine to semi-arid with normal annual precipitation ranging from about 28 inches (71 cm) in the uplands to less than 13 inches (33 cm) in the lowlands below the cliffs (U.S. Department of Commerce, 1964).

Temperatures in the high plateau country are generally cold in winter with warm days and cool nights during the summer. On the plateau summer temperatures may reach 90 degrees F (32 degrees C) while the minimum winter temperatures could reach -30 degrees F (-34 degrees C). At the lower elevations below the mountain front summer temperatures may reach 100 degrees F (38 degrees C) and the winter temperatures may drop to -20 degrees F (-29 degrees C).

Land Status

The Southeast Quarter of the Scofield 15-minute quadrangle is located in the northeast part of the Wasatch Plateau Known Recoverable Coal Resource Area (KRCRA). The KRCRA covers approximately 15,900 acres of this quadrangle. Some 13,600 acres of Federal coal lands lie within the KRCRA boundary. About 10,100 acres are unleased Federal coal land and 3,500 acres are covered by Federal coal leases. Approximately 2,300 acres in the KRCRA boundary of the quadrangle are non-Federal lands. The areas of Federal 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 is further 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.

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 four formations which are, 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 is the youngest formation in the quadrangle and overlies the Mesaverde Group. The North Horn is the lowest member of the Wasatch Group which is more prevalent toward the north end of the Wasatch Plateau. The North Horn Formation forms the upper part of Gentry Mountain in the southwest corner of the quadrangle.

The oldest stratigraphic unit exposed in the quadrangle is the Emery Sandstone Member of the Mancos Shale. The Emery is 550 ft (168 m) thick and crops out in Corner Canyon and several shallow washes in the northeast quarter of the quadrangle. It consists of yellowish-gray littoral sandstone with some shaly partings. The overlying Masuk Member, a gray marine shale,

is more than 1,000 ft (305 m) thick and crops out over a large area in the north half of the quadrangle. The Star Point Sandstone forms a cliff above the Masuk Shale. It consists of massive yellowish-gray to white sandstone with interbedded shale tongues of the Masuk. The shale tongues diminish in thickness toward the south. The type section of the Star Point Sandstone is in this quadrangle and consists of the following three members in ascending order: the Panther Tongue, Storrs Tongue, and Spring Canyon Tongue.

The Blackhawk Formation is an important stratigraphic unit because of the coal beds it contains. The formation consists of approximately 1,000 ft (305 m) of alternating shale, sandstone, and coal beds. The coal beds generally occur in the lower 400 ft (122 m) of the formation. The Blackhawk is successively overlain by the Castlegate Sandstone and the Price River Formation. These two units have similar lithologies in that they consist largely of coarse-grained, gray to brown sandstone with interbeds of hard sandy shale. The Castlegate Sandstone is more massive and cliff-forming than the Price River Formation which contains more shale beds. The combined thickness of the two formations ranges from 700 to 1,000 ft (213 to 305 m).

The North Horn Formation caps the Price River Formation on Gentry Mountain and consists of about 600 ft (183 m) of variegated shale, sandstone, and limestone.

Structure

The principal structural features are the faults in the northwest and central parts of the quadrangle. These are extensions of components of the North Gordon fault zone in the adjoining quadrangle to the north. The westernmost faults cut the coal beds along the spurs of cliffs. The faults decrease in displacement southward and most of them become indistinguishable on the south side of the quadrangle.

The sedimentary strata exhibit gentle dips which range from 2 degrees to 8 degrees.

COAL GEOLOGY

The main coal beds in the quadrangle area are, in ascending order, the Hiawatha, Second Bed, Third Bed, Wattis, Upper Wattis, Castlegate "A", Royal Blue, and Bob Wright. The Bob Wright, Royal Blue, and Castlegate"A" beds are important in the northwest corner and along the west edge of the quadrangle, while the other coal beds are significant in the southern half of the quadrangle.

In the south half of the quadrangle the Hiawatha coal bed is successively overlain by a 20 to 40 ft (6 to 12 m) noncoal interval, the Second coal bed, a 25 ft (8 m) noncoal interval, the Third coal bed, a 30 to 70 ft (9 to 21 m) noncoal interval, the Wattis coal bed, a 20 to 60 ft (6 to 18 m) noncoal interval, and the Upper Wattis coal bed which is overlain by 200 ft (61 m) of rock interbedded with thin uncorrelatable local coal beds.

The dominant coal bed in the northwest quarter of the quadrangle is the Castlegate "A" bed which is overlain by a 60 to 70 ft (18 to 21 m) noncoal interval, the Royal Blue coal bed, a 25 to 100 ft (8 to 30 m) noncoal interval, the Bob Wright coal bed or zone, and an upper section containing several uncorrelatable local coal beds. The Hiawatha coal bed is thin but continuous and correlatable in the northwest quarter of the quadrangle.

The thickness and characteristics of each individual coal bed are discussed in a separate section below.

The relationship of the various coal beds within the quadrangle are shown in the Composite Columnar Section and coal bed correlation columns on plate 3. No drill hole data was available and the coal information was derived entirely from outcrop measured sections reported in the cited references.

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

Doelling (1972) reports 49 analyses of coal samples taken in the quadrangle from the Wattis bed and perhaps the Hiawatha bed. All but one of the 49 samples came from the Wattis mine. The results of the analyses of coal samples from the Wattis mine are summarized in the following table taken from Doelling (1972, p. 230).

Table 1. Average coal analyses, Wattis mine, Southeast Quarter of the Scofield 15-minute quadrangle.

	No. Analyses	As-received (percent)	
		Average	Range
Moisture	49	6.5	2.7-11.1
Volatile matter	44	40.8	37.3-43.6
Fixed carbon	44	46.0	39.8-48.9
Ash	46	6.3	2.6-9.8
Sulfur	34	0.85	0.59-1.2
Btu/lb*	45	12,286	11,206-12,860

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

On the basis of the above average analysis, the coal is classified as high volatile B bituminous coal (American Society of Testing and Materials, 1977).

Bob Wright Coal Bed

The Bob Wright bed in some places occurs as two or more closely separated sub-beds. The main bed is locally up to 10 ft (3.0 m) thick (index number 3). It has been mined at the Clear Creek No. 4 mine in the northwest

corner of the quadrangle and adjoining quadrangles. Other sub-beds are up to 4 ft (1.2 m) thick but are generally thinner. Spieker (1931, p. 107) reported that the middle bed of the Bob Wright group is highly resinous.

Royal Blue Coal Bed

The Royal Blue bed was measured in three sections (index numbers 1, 6, and 7) in the northern part of the quadrangle. The coal thicknesses ranged from 3.5 to 5.5 ft (1.1 to 1.7 m). This coal bed is more important in the quadrangles to the north and east where it has been mined in the western part of the Book Cliffs coal field. Because of the limited occurrence of the coal bed in this quadrangle no derivative maps were made for the bed. However Reserve Base tonnages were calculated for the bed and included in the figures for non-isopached coal beds shown in table 3.

Castlegate "A" Coal Bed

The Castlegate "A" bed is of importance in the north half of the quadrangle where it ranges from 15 ft (4.6 m) thick down to a 4 ft (1.2 m) thick split. The Clear Creek No. 3 mine at the head of Bob Wright Canyon in the adjoining quadrangles to the north and northwest operated on it. The bed is thickest in the northwest corner of the quadrangle where, at one point, it is 15 ft (4.6 m) thick. The Castlegate "A" bed thins eastward and thickens northward and westward in the quadrangle area. The bed pinches out and does not occur south of Corner Creek unless one of the local coal beds in the vicinity of Mud Water Canyon is equivalent to it.

Upper Wattis Coal Bed

The Upper Wattis bed occurs in a limited area in the south central part of the quadrangle. Four measurements of the bed are available and the thickest of these is 9 ft (2.7 m). The coal isopach map, plate 12, suggests a southeastward thickening of the bed.

Wattis Coal Bed

The Wattis bed is an important bed in the southern half of the quadrangle where it has been extensively mined. The bed exhibits a wide range of thicknesses from 0.8 to 11.0 ft (0.2 to 3.4 m). The bed pinches out a short distance south of the quadrangle. The extent of the bed is shown on plate 16.

Third Coal Bed

The Third Bed occurs in the southern half of the quadrangle where it exhibits thicknesses ranging from 1.8 to 13.7 ft (0.5 to 4.2 m). The isopach map of the bed (plate 20) indicates a thickening of the bed toward the southwest corner of the quadrangle. This is not definite, however, inasmuch as the coal isopach lines cannot be drawn into the corner area because of insufficient data.

Hiawatha Coal Bed

The Hiawatha bed has been extensively mined in the south central part of the quadrangle, but the exact configuration of mining is not known. The maximum measured thickness of the bed is 11.5 ft (3.5 m) in the south central part of the map area. Spieker (1931) shows a continuous outcrop trace of the bed across the quadrangle but no thickness measurements were available for the north half of the quadrangle. The bed thickens southward into the adjoining quadrangle where it reaches thicknesses up to 28 ft (9 m).

Other Coal Beds

There are several other coal beds in the quadrangle that were not discussed above. They are the Second Bed and several local coal beds of small areal extent. The Second Bed is approximately 30 ft (9 m) above the Hiawatha and is up to 6.8 ft (2.1 m) thick. It is 5 ft (1.5 m) or more thick between Mud Water Canyon and Wattis Canyon (Doelling, 1972).

The Reserve Base tonnages for the coal beds of limited occurrence are grouped together and shown in table 3 as "non-isopached coal beds".

Mining Operations

The presently active (1979) coal mines in the quadrangle are operated by Plateau Mining Company, a subsidiary of United Nuclear Corporation and include the mines listed in the following table.

Table 2. Active coal mines in the Southeast Quarter of the Scofield 15-minute quadrangle, Carbon and Emery Counties, Utah.

Mine	Portal Location	Coal Bed Mined	Active Periods
Star Point No. 1	NW¼ SE¼ Sec. 16, T. 15 S., R. 8 E.	Hiawatha	1967-
Star Point No. 2	SE¼ NW¼ Sec. 16, T. 15 S., R. 8 E.	Wattis	1968-
Lion Coal	NE¼ NE¼ Sec. 17, T. 15 S., R. 8 E.	Third Bed	1917-1964 1977-

Mines in this area formerly called Wattis No. 1, Wattis No. 2, and the Lion were operated by the Lion Coal Company up to 1964. The properties were taken over by Plateau Limited in 1967 and then by United Nuclear Corporation and its operating subsidiary, Plateau Mining Company, in 1971.

Doelling (1972) reports that from 1917 to 1964 between 7,737,000 and 7,784,150 short tons (7,019,006 and 7,061,781 metric tons) of coal were produced from the Wattis mines. Plateau Mining Company (personal communication) estimates that the annual production from the mines between 1967 and 1972 was approximately 300,000 short tons (272,160 metric tons) which has increased to an annual production rate of about 1,200,000 short tons (1,088,640 metric tons) in 1978.

The history and operation of the Miller Creek Right Fork Mine located in the SE¼ Sec. 19, T. 15 S., R. 8 E. is unknown. Also, the extent of mining

is uncertain, but Doelling (1972) states that the area around the portal is partly mined out.

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). No non-proprietary drill hole data were available, and all information was either from surface outcrop measurements or underground mine sections.

Coal resource tonnages were calculated for measured, indicated, and inferred categories in unleased areas of Federal coal lands within the KRCRA boundary. Data obtained from the coal isopach maps (plates 4, 8, 12, 16, 20, and 24) were used to calculate the Reserve Base values. The coal bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal 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. The Reserve Base and Reserve values for all coal beds on this quadrangle 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 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.

"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 73.4 million short tons (66.6 million metric tons) for the unleased Federal coal lands within the KRCRA boundary in the quadrangle.

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

Table 3. Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Southeast Quarter of the Scofield 15-minute quadrangle, Carbon and Emery Counties, 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
Bob Wright	1,400,000	-0-	-0-	1,400,000
Castlegate "A"	17,600,000	-0-	-0-	17,600,000
Upper Wattis	4,200,000	-0-	-0-	4,200,000
Wattis	11,600,000	-0-	-0-	11,600,000
Third Bed	16,600,000	-0-	-0-	16,600,000
Hiawatha	20,600,000	-0-	-0-	20,600,000
Non-Isopached Coal Beds	1,400,000	-0-	-0-	1,400,000
Total	73,400,000	-0-	-0-	73,400,000

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 subsurface mining is shown on plate 28. 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 moderate and low development potentials 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.

In the quadrangle approximately 7,000 acres of unleased Federal land are classified as having a high coal development potential rating, 3,000 acres are classified as having an unknown coal development potential, and 100 acres have no coal 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 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 this quadrangle, the in situ coal gasification methods of development potential classification do not apply.

Table 4. Source of data used on plate 1.

Source	Plate 1 Index Number	Data Base	
		Measured Section No.	Page or Plate No.
Spieker, E. M., 1931	1	108 a, b, and c	pl. 16
	2	110 a, b, and c	pl. 16
	3	113 a and c	pl. 16
	4	114 a and b	pl. 16
	6	116 a, b, c, and d	pl. 16
	8	118 a and b	pl. 16
	11	121 a and b	pl. 16
	12	122 a, b, and c	pl. 18
	13	124 a, b, and c	pl. 18
	14	123 a, b, c, and d	pl. 18
	15	127 a and b	pl. 18
	16	125 a, b, c, and d	pl. 18
	17	128 a, b, c, and d	pl. 18
	18	129 a, b, c, and d	pl. 18
	19	130 a and b	pl. 18
	20	131 a, b, c, and d	pl. 18
	21	137 a, b, c, and d	pl. 18
	22	138 a, b, c, and d	pl. 18
	24	136 a and b	pl. 18
	25	135 a and b	pl. 18
	26	134 a and b	pl. 18
Doelling, H. H., 1972	5	28	226
	7	20	226
	9	31	226
	10	32	226
	23	50	227
	27	75	227

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