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

(Report includes 8 plates)

By

AAA Engineering & Drafting, Inc.

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 (7 plates) and the Coal Development Potential (CDP) Map (1 plate) of the Southeast Quarter of the Woodside 15-minute quadrangle, Emery County, Utah (U.S. Geological Survey Open-File Report 79-898).

Published and unpublished public information were used as data sources for this study.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 Woodside 15-minute quadrangle is located in the northeast part of Emery County in east central Utah. The quadrangle is approximately 18 miles (29 km) northwest of the town of Green River, and about 28 miles (45 km) southeast of the city of Price, Utah. The city of Castle Dale, the county seat of Emery County is 35 miles (56 km) west of the quadrangle.

Accessibility

U.S. Highway 50-6 cuts diagonally across the west side of the quadrangle and provides the main access route to the quadrangle from Salt Lake City, Utah on the west and Grand Junction, Colorado on the east. The western half of the quadrangle is relatively flat with low hills and shallow washes. This area is crossed by several unimproved dirt roads built on a shale base. When the ground is wet following a rain storm the dirt roads are very slippery and soft. Sometimes after longer periods of precipitation these roads may be almost impassable. There are no roads, other than a jeep trail, on the mountainous east half of the quadrangle which is inaccessible to all but 4-wheel drive vehicles.

A main line of the Denver and Rio Grande Western Railroad crosses the southwest corner of the quadrangle. Rail coal loading facilities are located at Green River (Sphinx station) and at Banning station west of the quadrangle. The railroad provides direct transportation to Salt Lake City, Utah, and Denver, Colorado.

Physiography

The quadrangle lies at the southeastern end of the Book Cliffs Known Recoverable Coal Resources Area (KRCRA), but in the central part of the physiographic feature called the Book Cliffs. This prominent feature forms a great S-shaped escarpment about 180 miles (290 km) long extending from near the 111⁰ meridian just west of Helper, Utah to Grand Junction, Colorado. The Southeastern Quarter of the Woodside 15-minute quadrangle is approximately one-third of that distance from the western end of the Book Cliffs. In the quadrangle the Book Cliffs form a bold westward-facing escarpment of barren sandstone cliffs approximately 1,000 ft. (305 m) high. The line of cliffs extends in a near north-south direction through the central part of the quadrangle.

The area west of the cliffs is a gently-sloping plain of low hills and shallow washes. This area is underlain by the non-resistant Mancos Shale which is partly covered by a gravel layer where remnants of a pediment have been preserved. The area east of the cliffs is rugged and mountainous with surface elevations reaching 8,000 ft. (2,438 m) in the northeast corner of the quadrangle. The lowest elevation is 4,550 ft. (1,387 m) at the southeast boundary where Price River leaves the quadrangle.

Price River flows from the southwest corner and along the south side of the quadrangle in a meandering course toward its confluence with the Green River approximately 10 miles (16 km) southeast of the quadrangle.

Climate

The Book Cliffs coal field is located in a mid-latitude steppe climate. Semi-arid conditions prevail over most of the area below the cliffs. The normal annual precipitation ranges from about 7 inches (18 cm) in the low areas in the west part of the quadrangle to a maximum of 14 inches (36 cm) in the high mountainous area in the northeast corner (U.S. Department of Commerce, 1964). The precipitation at the elevation of the coal outcrops is approximately 8 inches (20 cm) per year.

Temperatures are also a function of altitude and the maximum summer temperature range approximately from about 105 degrees F (41 degrees C) at the lower elevations to 90 degrees F (32 degrees C) in the higher mountainous area. The minimum winter temperatures range from approximately -10 degrees F (-23 degrees C) in the lower elevations to -20 degrees F (-29 degrees C) in the highest areas.

Land Status

Approximately 11,300 acres in the east half of the quadrangle lie within the Book Cliffs Known Recoverable Coal Resources Area (KRCRA). The

areas of unleased Federal Coal Land, leased Federal coal land, and non-Federal land are shown on plate 2 and the approximate acreage distribution of the lands is summarized in table 1.

Table 1. Approximate distribution of coal lands within the KRCRA in the Southeast Quarter of the Woodside 15-minute quadrangle, Emery County, Utah

Category	Approximate Area (acres)	Percent of KRCRA (%)
Non-Federal land	600	5
Leased Federal coal land	2,400	21
Unleased Federal coal land	8,300	74
Total	11,300	100

GENERAL GEOLOGY

Previous Work

Clark (1928) mapped the geology and coal outcrops in the western part of the Book Cliffs coal field from the Standardville 7½-minute quadrangle on the west to the Patmos Head quadrangle on the east. The Patmos Head quadrangle joins the north side of the Northeast Quarter of the Woodside 15-minute quadrangle. Fisher (1936) mapped the area south and east of Clark's map along the Book Cliffs to the Utah-Colorado state line. The geology and coal deposits in the area have also been described by Abbot and Liscomb (1956), Fisher, Erdmann, and Reeside (1960), Hayes and others (1977), and Young (1955, 1957, and 1966). Doelling (1972) has summarized and updated the geology and coal information reported in earlier writings. Osterwald and Mayberry (1974) closely examined the faults and prepared engineering geologic maps of the quadrangle.

Stratigraphy

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 in the quadrangle area consists of three formations which are, in ascending order, the Blackhawk Formation, Castlegate Sandstone, and the Price River Formation. The Upper Cretaceous Mancos Shale underlies and intertongues with the Blackhawk Formation. The Mancos Shale was deposited in an offshore marine environment and the Blackhawk Formation in a mixed marine and continental environment. The Castlegate Sandstone and the Price River Formation were formed in a continental environment.

The bluish-gray shale of the Mancos Shale crops out on the west half of the quadrangle and several hundred feet are exposed in the slope above the base of the Book Cliffs. Sandstone beds of the Blackhawk Formation crop out in steep and precipitous cliffs and ledges above the Mancos Shale.

Fisher (1936, p. 22) divided the Blackhawk Formation into the following four members in ascending order: the Lower Sandstone Member 221 ft. (67 m) thick; the Middle Shale Member 121 ft. (37 m) thick; the Middle Sandstone Member $165 \pm$ ft ($51 \pm$ m) thick; and the Upper Member (complete member not measured, but Fisher (1936, p. 14) estimated that it ranges from 70 to 230 ft (21 to 70 m) in thickness.

The Lower Sandstone Member is correlated with the Kenilworth sandstone to the west (Doelling, 1972) but thins eastward and cannot be traced east of Green River. The Middle Shale Member is apparently a tongue of the Mancos Shale and cannot be distinguished from the Mancos east of Green River. The Sunnyside coal zone lies in the upper part of the Middle Sandstone Member. Young (1955) delineates the Grassy and Desert members of the Blackhawk Formation above the Middle Sandstone Member. These two members are probably

equivalent to the Upper Member of Fisher (1936) and consists of sandstone, shale, and lenticular coal beds.

The Castlegate Sandstone thins eastward from 500 ft (152 m) of conglomeratic sandstone in the northern part of the Wasatch Plateau to a feather edge of siltstone near the Utah-Colorado state line (Fisher, 1936). In this quadrangle the Castlegate is approximately 100 ft (30 m) thick. Fisher (1936) referred to the Castlegate as a member of the Price River Formation. The Castlegate is overlain by the Buck Tongue of the Mancos Shale which is poorly developed in the quadrangle area, but which thickens eastward toward the Utah-Colorado state line where it is 350 ft (107 m) thick. The Price River Formation lies above the Castlegate Sandstone where the Buck Tongue is not present. Fisher (1936) described three members of the Price River Formation above the Buck Tongue in the eastern part of the Book Cliffs, but which are not recognized northwest of the Beckwith Plateau. In this quadrangle the Price River Formation consists of interbedded sandstone, shale, carbonaceous shale, and coal streaks.

The Tertiary strata successively overlying the Price River Formation include the Tuscher, North Horn, and Wasatch formations. The basal part of the Wasatch Formation caps a small peak in the northeast corner of the quadrangle and consists of variegated shale, sandstone, and limestone.

Structure

The strata dip generally eastward from less than 4 degrees to 6 degrees except in the vicinity of some faults and in local areas where the dips may be as much as 12 degrees (Doelling, 1972).

Numerous east-west trending normal faults occur in the quadrangle. These were mapped and studied by Osterwald and Mayberry (1974) who measured the dip and displacement on many of the faults (plate 1). Generally the

fault planes are steeply dipping and the displacements range from a few feet up to 150 ft (46 m). The faults with the larger displacements will probably be a detriment to mining.

COAL GEOLOGY

Two coal zones, the Beckwith and the Sunnyside, occur in the Blackhawk Formation in the quadrangle area. Fisher (1936, p. 45) reports that "On the basis of age of coal, as well as other features, the Book Cliffs coal field of Utah may be divided conveniently into two subfields. The Sunnyside subfield includes the part west of the Green River; it carries no Price River coals but contains essentially all the coals in the Blackhawk Formation. The Thompsons subfield lies east of the river; it carries all the Price River coals but only very minor amounts of the older Blackhawk coals." This quadrangle lies on the west side of the Green River and on the east side of Clark's "Sunnyside subfield." In this area the Blackhawk coals are thinner and more lenticular than in the quadrangle to the north and west.

Beckwith Coal Zone

The Beckwith coal zone is at least 70 ft (21 m) thick and usually contains several lenticular coal beds. In the quadrangle area the measured coal bed thicknesses range from less than 1 ft (0.3 m) to 6.5 ft (2.0 m) and a 7.0 ft (2.1 m) bed with three rock partings (index numbers 11 and 12; plate 1). These are the only two coal bed measurements in the Beckwith zone in the quadrangle where the coal is over 5 ft (1.5 m) thick. Therefore a coal isopach map was not made for these beds because of insufficient data. An isolated data map was prepared for the coal at index numbers 11 and 12 and is kept in U.S. Geological Survey files. The Reserve Base tonnages have been calculated for these beds where they are more than 5 ft (1.5 m) thick.

The tonnages are shown separately by section on plate 2 and are listed in table 2 as non-isopached coal beds under unknown development potential. Because of the sparsity of data, thickness trends for beds in the Beckwith zone cannot be determined.

Sunnyside Coal Zone

The Sunnyside coal zone is approximately 60 ft (18 m) below the Beckwith coal zone. The Sunnyside coal beds, although somewhat lenticular, are the most persistent beds in the quadrangle. The coal zone occurs in the Middle Sandstone Member of the Blackhawk Formation. In the north half of the quadrangle the zone generally consists of two or more beds which range in thickness from 0.3 to 8.0 ft (0.1 to 2.4 m) or more. In the south half of the quadrangle the zone is represented by a single bed except at the location of index number 19.

The coal isopach map (plate 4) indicates that the Sunnyside zone is continuous, but variable in thickness. The thickest point on the isopach map is 12.0 ft (3.7 m) which is the total thickness of two closely spaced beds 3.8 and 8.2 ft (1.2 and 2.5 m) thick. At the south edge of the quadrangle the coal thins to less than 3.0 ft (0.9 m). The lack of non-proprietary drilling behind the coal outcrop prevents a discussion of thickening or thinning in an eastward direction.

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 map.

Chemical Analyses of the Coal

Doelling (1972, p. 323) reports one coal analysis from the quadrangle area. The sample was taken from the Beckwith coal zone exposed in the

Peterson prospect on the south side of the quadrangle. The results of the as-received proximate analysis are:

	Percent
Moisture	4.7
Volatile matter	33.58
Fixed carbon	50.24
Ash	11.43
Sulfur	1.15

No calorific value was reported. Without additional analyses of the Beckwith coal, the above analysis cannot be regarded as typical for the zone.

Analyses of coal samples from the Lower Sunnyside coal bed in the adjoining quadrangle to the north show the coal is ranked as high volatile B bituminous. The Lower Sunnyside coal bed is probably equivalent to the Sunnyside coal zone of this quadrangle (Fisher, 1936).

Mining Operations

Doelling (1972) reports that the only known effort to mine coal in this quadrangle was at Peterson's prospect high on the cliff on the north side of Price River Canyon. A coal bed in the Beckwith zone was prospected through two adits located approximately at the location of the Beckwith zone at index numbers 12 and 13 on plate 1. The prospect was active before 1905 and as far as is known, little coal was produced.

COAL RESOURCES

The principal sources of data used in the construction of the coal isopach, structure contour, and coal data maps were Doelling (1972), Fisher (1936), and Osterwald and Mayberry (1974).

Coal resource tonnages were calculated for measured, indicated, and inferred categories in unleased areas of Federal coal land within the KRCRA boundary where the coal is 5 ft (1.5 m) or more thick. Data obtained from

the coal isopach map (plate 4) was 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 Sunnyside coal zone are shown on plate 7 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 $\frac{1}{2}$ mile (0.8 km) apart. Measured coal is projected to extend as a $\frac{1}{4}$ -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 $\frac{1}{2}$ (0.8 km) to $1\frac{1}{2}$ miles (2.4 km) apart. Indicated coal is projected to extend as a $\frac{1}{2}$ -mile (0.8 km) wide belt that lies more than $\frac{1}{4}$ 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 a 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 $1\frac{1}{2}$ (2.4 km) to 6 miles (9.6 km) apart. Inferred coal is projected to extend as a $2\frac{1}{4}$ -mile (3.6 km) wide belt that lies more than $\frac{3}{4}$ 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 21.8 million short tons (19.8 million metric tons) for the unleased Federal coal lands within the KRCRA boundary in the Southeast Quarter of the Woodside 15-minute quadrangle. These Reserve Base figures are summarized in the following tabulation.

Table 2. Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Southeast Quarter of the Woodside 15-minute quadrangle, Emery County, Utah.

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

Coal Bed Name	High development potential	Moderate and Low development potential	Unknown development potential	Total
Sunnyside Zone	20,900,000	-0-	-0-	20,900,000
Non-isopached coal beds	-0-	-0-	900,000	900,000
Total	20,900,000	-0-	900,000	21,800,000

AAA Engineering & 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 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 areas of unleased Federal coal land within the KRCRA in the Southeast Quarter of the Woodside 15-minute quadrangle fall within the "high," "unknown," and "no" development potential classifications.

The designation of a coal development potential classification is based on the occurrences of the highest-rated coal-bearing area that may occur

within any fractional part of a 40-acre (16-ha) BLM land grid area or lot area of unleased Federal coal land. For example, a certain 40-acre (16-ha) area is totally underlain by a coal bed with a "moderate" development potential. If a small corner of the same 40-acre (16-ha) area is also underlain by another coal bed with a "high" development potential, the entire 40-acre (16-ha) 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 (16-ha) 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 (16-ha) 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 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 coal beds dip less than 15 degrees in the Southeast Quarter of the Woodside 15-minute quadrangle, the in situ coal gasification methods of development potential classification do not apply.

Table 3. Sources of data used on plate 1.

<u>Source</u>	Plate 1	Data Base	
	<u>Index Number</u>	<u>Measured Section No.</u>	<u>Page or Plate</u>
Fisher, 1936	1	14a	p1.12
	3	15	p1.12
	4	15a	p1.12
	5	16	p1.12
	6	17a	p1.12
	7	18	p1.12
	8	19a	p1.12
	9	20	p1.12
	10	21	p1.12
	14	25	p1.12
Doelling, 1972	2	1 and 13	412
	11	5 and 21	412
	12	6 and 22	412
	13	7 and 23	412
	15	9 and 24	412
	16	10 and 25	412
	17	26	412
	18	27	412
	19	11	412
Osterwald and Mayberry, 1974	20		

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