UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-149

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE DEADMAN CANYON QUADRANGLE, CARBON COUNTY, UTAH

(Report includes 20 plates)

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INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence and Coal Development Potential Maps of the Deadman Canyon quadrangle, Carbon County, Utah (20 plates; U.S. Geological Survey Open-File Report 79-149). 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 Resource Areas (KRCRA's) in the Western United States. Published and unpublished public information were used as data sources for this study. No new drilling nor field mapping was done to supplement the study. No confidential nor proprietary information was used.

Location

The Deadman Canyon 7½-minute quadrangle (NW¼ of the Wellington 15-minute quadrangle) is located in the north central part of Carbon County in Central Utah and in the western part of the Book Cliffs coal field. The town of Wellington, Utah is about 6 miles (10 km) south of the quadrangle.

Accessibility

The southeastern corner of the quadrangle is accessible by a paved road (Utah Highway 53) which joins U.S. Highway 6-50 east of the town of Wellington. The main line of the Denver and Rio Grande Western Railroad and U.S. Highway 6-50 pass through Wellington. Two light duty roads and numerous unimproved dirt roads cross the foothill area on the south half of the Deadman Canyon quadrangle. A few unimproved roads are present in the canyons and mountainous area to the north.

Physiography

The Book Cliffs form a bold southward-facing escarpment of barren sandstone cliffs from 1,000 to 2,000 feet (305 to 610 m) high. This striking physiographic feature extends eastward and south-eastward to the Utah-Colorado state line. The rock strata in the Book Cliffs dip gently northward and erosion processes have sculptured cliffs and ledges on steep canyon walls. The northern half of the quadrangle is rugged and mountainous while the southern half consists of low hills and shallow washes. The Book Cliffs intersect the north-south trending Wasatch Plateau approximately 20 miles (32 km) west of the Deadman Canyon quadrangle.

The topographic relief in the quadrangle area is approximately 2,920 feet (890 m) with elevations ranging from 4,840 feet (1,780 m) in the southeast corner to 8,760 (2,670 m) in the northwest corner.

Most of the drainage is in a southward direction from off the cliffs and out of the steep canyons. With the exception of Coal Creek and Soldier Creek, the streams in the quadrangle are intermittent. Scattered stands of juniper are present in the foothill area while in the highlands above the cliffs the junipers are intermingled with pinon and Ponderosa pine trees.

Climate

The Book Cliffs coal field is located in a mid-latitude steppe climate and semi-arid conditions prevail. The normal annual precipitation in the Deadman Canyon quadrangle ranges from 9 inches (23 cm) in the lower altitudes to 18 inches (46 cm) in the higher mountainous areas (U.S. Dept. of Commerce, 1964).

Temperatures are also a function of altitude. At the base of the cliffs the temperatures range from a maximum of over 100 degrees F (38 in the summer to a low of -20 degrees F (-29 degrees C) in the winter.

Land Status

The Deadman Canyon quadrangle is located in the northwestern part of the Book Cliffs Known Recoverable Coal Resource Area (KRCRA). Approximately 10,565 acres in this quadrangle lie within the KRCRA which consists of 1,880 acres of non-Federal land, 2,935 acres of Federal coal land under lease (1977), and 5,750 acres of unleased Federal coal land. The outline of the KRCRA, Federal lands, Federal coal leases and non-Federal lands are shown on plate 2.

GENERAL GEOLOGY

Previous Work

Clark (1928) mapped the geology and coal outcrops in the western part of the Book Cliffs coal field and his work is the most detailed original work presently available. Fisher (1936) mapped the area east of Clark's map. The stratigraphy is further described by Abbott and Liscomb (1956), Fisher, Erdmann, and Reeside (1960), Katich (1954), and Young (1955, 1957, and 1966). Doelling (1972) has summarized the geology and updated the coal data described by the earlier workers.

Stratigraphy

The coal beds of economic importance in the Book Cliffs 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 Price River Formation. The Upper Cretaceous Mancos Shale underlies the Mesaverde Group and consists of gray marine shale with some interfingering sandstone members.

The oldest rocks exposed in the quadrangle are beds of the Mancos Shale which consists of dark bluish-gray shale which is sandy in the

upper part. In this area the lowest formation of the Mesaverde Group, the Star Point Sandstone, consists of several sandstone tongues which interfinger with the Mancos Shale. These tongues all thin eastward and pinch out in the Mancos shale.

The Blackhawk Formation overlies the Star Point Sandstone and contains the important coal beds. The main coal-bearing part of the Blackhawk consists of approximately 1,000 ft (305 m) of massive gray to buff sandstone, sandy shale, shale, and coal beds. In this quadrangle the Aberdeen Sandstone is the basal member of the Blackhawk Formation.

The Castlegate Sandstone overlies the Blackhawk Formation and is about 250 ft (76 m) thick. It is composed of massive gray to yellowish-gray, brown-weathering resistant sandstone.

The Castlegate Sandstone is overlain by 900 to 1,000 ft (274 to 305 m) of Price River Formation. This formation consists of alternating resistant gray to yellowish-gray sandstone and non-resistant gray to olive-green shale.

The Upper Cretaceous-Tertiary North Horn Formation unconformably overlies the Price River Formation and consists of variegated shale, yellowish-gray sandstone, and subordinate conglomerate and freshwater limestone. This formation is approximately 600 ft (183 m) thick in the Deadman Canyon quadrangle.

The Flagstaff Limestone overlies the North Horn Formation and is composed of thin-bedded limestone, shale, and minor sandstone. The shale is variegated and the sandstone is reddish-brown. The thickness of the formation is approximately 300 ft (91 m).

Structure

The Book Cliffs of east central Utah lie on the gently north-dipping south flank of the Uinta Basin. The Upper Cretaceous strata in the

Deadman Canyon quadrangle display this regional north to northeastward dip of from 4 to 6 degrees.

The structure contours of the main coal beds are shown on plates 5, 9, 13, and 17. The few faults which occur within the quadrangle have small displacements.

COAL GEOLOGY

At least nine coal beds have been named in the Deadman Canyon quadrangle. Only four, the Castlegate "A", Castlegate "B", Gilson, and Lower Sunnyside beds reach the reserve base thickness of 5 ft (1.5 m). The Kenilworth bed, which is the most important coal bed in the Helper quadrangle immediately to the west, is thin and lenticular in the Deadman Canyon quadrangle where thicknesses average about 2 ft (0.6 m).

The Castlegate "A" coal bed rests upon the Aberdeen Sandstone, the basal member of the Blackhawk Formation in this area. It is separated from the Castlegate "B" coal bed by a non-coal interval from 7 to 35 ft (2 to 10 m) thick.

The Gilson coal bed lies from 162 to 210 ft (49 to 64 m) above the Castlegate "B". The interval between these beds includes the Royal Blue and the Kenilworth beds which are very thin. An interval 125 to 235 ft (38 to 71 m) thick separates the Gilson bed from the Lower Sunnyside bed and includes two very thin coal beds, the Fish Creek and Rock Canyon beds.

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.

Castlegate "A" Coal Bed

The Castlegate "A" coal bed is more than 5 ft (1.5 m) thick in a very limited area in the western part of the Deadman Canyon quadrangle. As shown on the coal isopach map (plate 16) the bed exhibits a local lenticular thickening that reaches 5.8 ft (1.8 m). The bed at most of the points of measurement along the cliffs is less than 4 ft (1.2 m) thick.

Castlegate "B" Coal Bed

The only evidence that the Castlegate "B" coal bed attains reserve base thickness in the area is the log of a hole drilled in the northwest corner of the quadrangle (SE 1/4 SE 1/4 Sec. 1, T. 13 S., R. 10 E., index no. 4). At that point the drill encountered the Castlegate "B" as two coal beds 4.0 ft (1.2 m) and 13.0 ft (4.0 m) thick separated by a 6.0 ft (1.8 m) thick rock interval. The extent of this thick coal bed on the north side of the quadrangle is unknown because of the lack of non-proprietary drilling data in that area. Outcrop measurements of this bed in the west half of the quadrangle range from 0.3 to 4.3 ft (0.1 to 1.3 m).

Gilson Coal Bed

The Gilson coal bed has been termed by Doelling (1972) as "perhaps the most valuable bed in the quadrangle." The bed is over 7 ft (2.1 m) thick in two areas where it exhibits a lenticular shape. However, the acreage is not large where the bed is reserve base thickness (plate 8). Doelling (1972) reports a thickness of 9.5 ft (2.9 m) in the area where the Gilson has been mined but that bony seam splits and the steep pitches of the coal beds have made mining difficult and costly.

Lower Sunnyside Coal Bed

The Lower Sunnyside coal bed is generally less than 5 ft (1.5 m) thick in the outcrop area of the quadrangle. One surface section has a thickness

of 5.1 ft (1.5 m). A drill hole in the northwest part of the quadrangle (index no. 4) encountered a thickness of 7.4 ft (2.2 m) with a 0.3 rock split. The bed may thicken in a northerly direction.

Kenilworth Coal Bed

The Kenilworth bed is present across the entire outcrop area of the quadrangle. It reaches a thickness of 5 ft (1.5 m) or more at only one locality (index nos. 7 and 8) in the northwest part of the quadrangle. Two surface sections (index nos. 7 and 8) very close to each other show thicknesses of 6.7 and 6.8 ft (2.0 and 2.1 m). Isopach and structure contour maps were not made for this coal bed because of the very limited area in which the bed has a reserve base thickness.

Chemical Analyses of the Coal

The number of available analyses of coal from the Deadman Canyon quadrangle totals 137. Most of the coal samples came from the Gilson bed in the Coal Creek Canyon area. Doelling (1972) has averaged and listed the ranges of the proximate analyses in the following table.

Table 1. Average proximate analyses of coal, Deadman Canyon quadrangle, Carbon County, Utah (Doelling, 1972)

	No. Analyses	Percent	
		Average	Range
Moisture	136	4.8	2.2-8.4
Volatile matter	124	38.6	30.9-45.7
Fixed carbon	124	48.7	44.0-52.6
Ash	128	7.5	3.4-12.6
Sulfur	110	0.49	0.3-1.0
Btu/lb*	132	12,451	11,700-13,000

*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 bituminous B rank. (American Society for Testing and Materials, 1977).

Mining Operations

Most of the mining in this quadrangle has taken place in the Coal Creek Canyon area and has generally been confined to the Gilson bed. By the early 1900's practically the entire Book Cliffs had been prospected, but mines in the Deadman Canyon quadrangle did not become significantly productive until the 1940's. In 1970 all mines with portals in the quadrangle were closed. Total production from the quadrangle has been estimated to be from 2 to 3 million short tons (1.8 to 2.7 million metric tons) (Doelling, 1972). The Coal Creek mines produced 1,680,000 short tons (1,524,000 metric tons) of coal from the Gilson bed and the rest of the production came from mines in the Deadman Canyon area operating in the Gilson and Castlegate "A" beds.

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 Clark (1928). Nearly all recent drilling in the area is classified as proprietary and was not available to the present authors.

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, 12 and 16) 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 Castlegate "A", Castlegate "B", Gilson, and Lower Sunnyside beds are shown on plates 7, 11, 15, and 19, 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 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 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 4.7 million short tons (4.3 million metric tons) for the unleased Federal coal lands within the KRCRA boundary in the Deadman Canyon quadrangle. Reserve Base tonnages in the various development potential categories for subsurface mining methods are shown in Table 2.

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

Table 2. Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Deadman Canyon quadrangle, Carbon County, Utah.

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

Coal bed name	High development potential	Moderate development potential	Low development potential	Total
Lower Sunnyside	1,100,000	-0-	-0-	1,100,000
Gilson	900,000	-0-	-0-	900,000
Castlegate "B"	2,100,000	-0-	-0-	2,100,000
Castlegate "A"	100,000	-0-	-0-	100,000
Kenilworth*	500,000	-0-	-0-	500,000
Total	4,700,000	-0-	-0-	4,700,000

*A coal isopach map was not made for this coal bed because of insufficient data. An areal distribution and identified resources map was prepared for file reference only.

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 Gasification

The coal development potential for the subsurface mining of coal is shown on plate 20. In this quadrangle, the areas where coal beds 5 ft (1.5 m) or more in thickness are overlain by less than 1000 ft (305 m) of overburden are considered to have a high development potential for subsurface mining.

Areas where such beds are overlain by 1,000-2,000 ft (305-610 m) and 2,000-3,000 ft (610-914 m) of overburden are rated as having a moderate and a low development potential respectively. 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 Deadman Canyon quadrangle are known to fall within the "moderate", "low", or "no" development potential classifications.

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 Deadman Canyon quadrangle approximately 395 acres of unleased Federal land have a high development potential rating and 5,750 acres have an unknown development potential.

The in situ gasification methods of development potential classification are based on the dip and depth of coal beds having a minimum thickness of 5 ft (1.5 m). There are only two development potential classifications--moderate and low. The criteria for in situ classification include coal bed dips of 15 to 90 degrees and coal bed depths of 200-3,000 ft (61-914 m). Inasmuch as the dip of the coal beds is less than 15 degrees in the Deadman Canyon quadrangle, the in situ coal gasification methods of development potential classification do not apply.

Table 3. Sources of data used on plate 1.

Source	Plate 1 Index Number	Data Base: Measured Section No.	Data Base: Plate or Page No.
Clark, F.R., 1928, Economic geology of the Castlegate, Wellington, and Sunnyside quadrangles, Carbon County, Utah: U.S. Geol. Survey Bull. 793	1	base sec. 1	pl. 5
	2	base sec. 2	pl. 5
	5	base sec. 3	pl. 5
	6	4	pl. 6
	7	base sec. 5	pl. 5
	8	48	pl. 6
	10	base sec. 6	pl. 6
	11	base sec. 7	pl. 5
	12	base sec. 8	pl. 5
	13	28	p. 39
	14	base sec. 9	pl. 5
	15	base sec. 10	pl. 5
	16	base sec. 11	pl. 5
	17	12	pl. 6
	18	base sec. 13	pl. 5
	19	14	pl. 6
	20	base sec. 32	pl. 5
	21	72	pl. 5
	22	74	pl. 6
	23	15 and 56	p. 42 and pl. 6
	24	base sec. 33	pl. 5
	25	base sec. 16	pl. 5
	26	35 and 58	pl. 6
	28	base sec. 18	pl. 5
	29	37	pl. 6
	30	base sec. 19	pl. 5
	31	base sec. 39	pl. 5
	32	40, 62, and 90	p. 42 and 45; and pl. 6
	33	41	pl. 6
	34	base sec. 63	pl. 5
	35	base sec. 64	pl. 5
	37	43	p. 40
	38	44, 65 and 92	p. 40 and 45; and pl. 6
	39	45	pl. 6
Doelling, H.H., 1972, Book Cliffs coal field, in Doelling, H.H., Central Utah coal fields: Utah Geol. and Min. Survey Mon. Ser. no. 3.	3	4	p. 392
	9	2 and 6	p. 392
	24	11	p. 392 and 393
	27	97 and 132	p. 393
	36	15, 62 and 103	p. 392 and 393
Independent Coal Co.	4	Drill Hole No. 6	

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