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GEOLOGICAL SURVEY

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1979

COAL RESOURCES

OF THE MINNIE MAUD CREEK EAST QUADRANGLE

CARBON AND DUCHESNE COUNTIES, UTAH

By

AAA Engineering and Drafting, Inc.

This report has not been edited for conformity
with U.S. Geological Survey editorial standards
of 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 in-
ventory of Federal coal lands in Known Recoverable Coal Resource Areas
(KRCRA's) in the Western United States. It supplements the land plan-
ning 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."

Published and unpublished public information were used as data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 Minnie Maud Creek East quadrangle is located on the north central side of
Carbon County and the south central side of Duchesne County, Utah about
16 miles (26 km) northeast of the town of Wellington, and 15 (24 m)
northwest of East Carbon City and the town of Sunnyside. The city of
Price is the county seat of Carbon County and is 14 miles (23 km) southwest
of the quadrangle. The city of Duchesne, the county seat of Duchesne
County, is approximately 20 miles (32 km) northeast of the quadrangle.

Accessibility

Utah Highway 53, a gravel road, crosses the southeast corner of the quadrangle in Nine Mile Canyon. This highway connects the town of Wellington, 16 miles (26 km) southwest of the quadrangle, to the town of Myton, 33 miles (53 km) northeast of the quadrangle. Dirt roads provide accessibility into Minnie Maud Creek Canyon and Argyle Canyon. A road also runs along Big Sulphur Ridge which crosses the northern third of the quadrangle in an east-west direction. Several jeep trails provide access into some of the more rugged areas.

A main line of the Denver and Rio Grande Western Railroad passes through the town of Wellington and a branch line of the railroad extends to the coal-loading facilities at Sunnyside.

Physiography

The Book Cliffs form a bold southward-facing escarpment of barren sandstone cliffs from 1,000 to 2,000 ft (305 to 610 m) high trending easterly and southeasterly across eastern Utah to the Utah-Colorado state line and beyond. The rock strata dip gently northward to north-eastward and erosion processes have sculptured precipitous cliffs and ledges on steep canyon walls. The east-west trending Book Cliffs' escarpment lies approximately 5 miles (8 km) south of the Minnie Maud Creek East quadrangle in the adjoining Pine Canyon quadrangle. Whitmore Park in the southwest corner of the Minnie Maud Creek East quadrangle is an upland valley bounded on the north by an upper line of steep hills called the Roan Cliffs.

The major drainage system in the quadrangle consists of Nine Mile Creek. All but the southwest corner of the quadrangle drains into Nine Mile Creek and its tributaries, Minnie Maud Creek and Argyle Creek.

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The southwest corner of the quadrangle drains into Soldier Creek, a tributary of Price River. Both Nine Mile Creek and Price River drain into the Green River.

The total relief in the quadrangle area is approximately 2,484 ft (757 m). The lowest elevation 6,890 ft (2,100 m) is in the southeast corner of the quadrangle on Nine Mile Creek. The highest point is 9,374 ft (2,857 m) on Argyle Ridge in the northwest quarter of the quadrangle.

Climate

The Book Cliffs 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 approximately 14 inches (36 cm) in the southeast corner to 21 inches (53 cm) on the northwest end of Argyle Ridge (U.S. Department of Commerce, (1964)).

Nearly the entire quadrangle area is over 7,000 ft (2,133 m) in elevation above sea level. The maximum summertime temperature is approximately 90 degrees F (32 degrees C) and the minimum wintertime temperature may reach as low as -30 degrees F (-34 degrees C).

Land Status

The Minnie Maud Creek East quadrangle is located on the north side of the central part of the Book Cliffs Known Recoverable Coal Resource Area (KRCRA). Only a small part of the KRCRA lies in the quadrangle area as shown on plate 1 and includes approximately 150 acres (61 ha) of unleased Federal land and 75 acres (30 ha) of non-Federal land.

RB R(50%)   RB R(50%)

19
0.1 <0.1   0.3 0.2   20   21

30   KRCRA   28
5   29   Minnie Maud Creek E. Quad.
          Inf   3000   Pine Canyon Quad.

T. 12 S., R. 12 E.

Lower Sunnyside coal bed
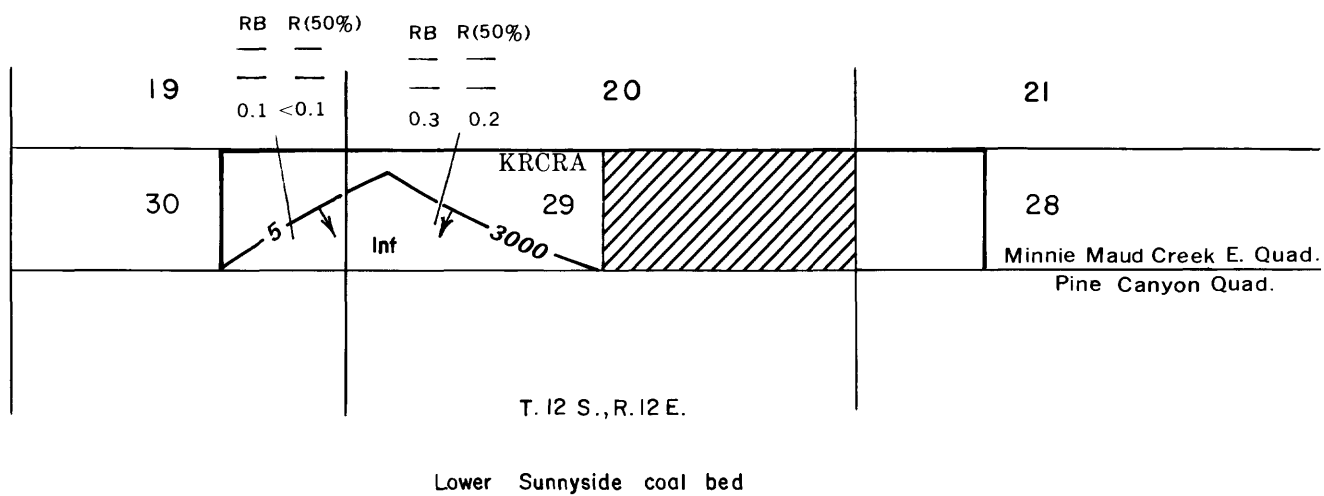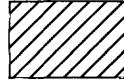
0   1/4   1/2
                              Mile

PLATE Ia. Boundary data and areal distribution and identified resources map of the
          KRCRA area in the Minnie Maud Creek East Quadrangle, Carbon and
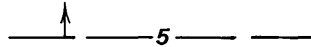   Duchesne Counties, Utah.

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EXPLANATION

KRCRA

KNOWN RECOVERABLE COAL RE-
SOURCES AREA BOUNDARY – Label
within KRCRA boundary.

NON-FEDERAL COAL LAND – Land
within the KRCRA boundary for which
the Federal Government does not own
the coal rights.

ISOPACH–Showing thickness of coal, in
feet. Arrow points toward area where coal
bed is 5 feet or more thick. Dashed where
inferred by present authors.

OVERBURDEN ISOPACH– Showing
thickness of overburden, in feet. Arrow
points toward area where coal bed is less
than 3,000 feet below surface.

RB	R(50%)	
—	—	(Measured)
—	—	(Indicated)
0.3	0.2	(Inferred)

IDENTIFIED COAL RESOURCES–Show-
ing totals for Reserve Base (RB) and
Reserves (R), in millions of short tons, for
each section or part of section of non-leased
Federal coal land within the KRCRA.
Reserve (R) tonnage is calculated by mul-
tiplying the Reserve Base (RB) tonnage
by the appropriate recovery factor. Dash
indicates no resource in that category.

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SECTION OF LAND

NOTE: BLM Coal Ownership Data current as
of September 22, 1977.

To convert short tons to metric tons, multiply
short tons by 0.9072.

To convert feet to meters, multiply feet
by 0.3048

REFERENCE

U.S. Bureau of Mines and U.S. Geological Survey,
1976, Coal resource classification system of
the U.S. Bureau of Mines and U.S. Geological
Survey: U.S. Geol. Survey Bull. 1450-B, 7p.

PLATE Ib. Boundary data and areal distribution and identified resources map explanation.

GENERAL GEOLOGY

Previous Work

Clark (1928) mapped the geology and coal outcrops in the western part of the Book Cliffs coal field and Fisher (1936) investigated the area lying east of Clark's map. Anderson (1978) made a comprehensive study of the coal deposits in the adjoining Pine Canyon quadrangle and included the results of recent core drilling in his report. The stratigraphy of the area has also been described by Abbott and Liscomb (1956), Fisher, Erdmann, and Reeside (1960), Hayes and others (1977), and Young (1955, 1957, and 1966). Doelling (1972) summarized the geology and updated the coal data for the coal field.

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. This group includes the following formations in ascending order: the Blackhawk Formation, Castlegate Sandstone, and the Price River Formation. The Mancos Shale of Upper Cretaceous age underlies the Blackhawk Formation.

The Mancos Shale is a bluish-gray marine shale and is overlain by the Aberdeen Sandstone Member of the Blackhawk Formation. The Aberdeen is split into two parts by an eastward-projecting tongue of the Mancos Shale up to 275 ft (84 m) thick.

In the adjoining quadrangle (Pine Canyon) on the south the coal-bearing part of the Blackhawk Formation above the Aberdeen Sandstone consists of massive yellowish-gray sandstone alternating with beds of shaly sandstone, sandy shale, gray shale, carbonaceous shale, and coal.

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Some of the sandstone beds are as prominent as the Aberdeen and the better

coal beds usually lie immediately above these sandstone beds or are

separated from them by thin layers of shaly sandstone or shale. Six

coal beds have been recognized and named in the Pine Canyon quadrangle

area (Anderson, 1978). The Blackhawk Formation is about 750 ft (229

m) thick and thins eastward.

The Blackhawk Formation and the overlying Castlegate Sandstone form

the major part of the Book Cliffs. The Castlegate ranges up to 225 ft

(69 m) in thickness. It forms a vertical cliff above the Blackhawk and

consists of gray to yellowish-gray, brown-weathering sandstone.

The Price River Formation is composed of two or more thick beds of

sandstone interbedded with thin-bedded shale and sandy shale. In the

Pine Canyon quadrangle the thick sandstones form cliffs up to 100 ft (30

m) high, and the formation ranges from 150 ft (46 m) to about 500 ft

(152 m) in thickness in that quadrangle (Doelling, 1972).

The Tertiary strata overlying the Price River Formation consist of

the Wasatch Group and the Green River Formation. The Wasatch Group in-

cludes the North Horn Formation (Upper Cretaceous and Paleocene age) at

the base, the Flagstaff Limestone (Paleocene age), and the Colton For-

mation (Eocene age). The Green River Formation is Eocene in age.

The North Horn Formation overlies the Price River Formation and

consists of variegated shale, tan to yellowish-gray sandstone, and tan

argillaceous limestone with minor amounts of conglomerate. The forma-

tion is around 500 ft (152 m) thick in the Pine Canyon quadrangle and

thickens westward.

SYSTEM	SERIES	FORMATION	COAL BED NAME			LITHOLOGIC DESCRIPTION

SYSTEM	SERIES	FORMATION	COAL BED NAME
TERTIARY	EOCENE	GREEN RIVER FM.	
		COLTON FORMATION	
	?		
	PALEOCENE	FLAGSTAFF FORMATION	
	DANIAN	NORTH HORN FORMATION	
CRETACEOUS	MAESTRICHTIAN	PRICE RIVER FORMATION	
		CASTLEGATE S.S.	
	CAMPANIAN	BLACKHAWK FORMATION	Upper Sunnyside, Lower Sunnyside, Rock Canyon, Fish Creek, Gilson, Kenilworth
		MANCOS SHALE	

LITHOLOGIC DESCRIPTION

1. Shale and mudstone interbedded; greenish gray and white, high in organic matter near base; minor sandstone.

2. Sandstone, siltstone, and mudstone interbedded; sandstone, reddish-brown, light-gray, purplish-gray, fine-grained, calcareous, lenticular; siltstone, reddish-tan; mudstone, variegated, calcareous.

3. Sandstone, limestone, and mudstone, interbedded; sandstone, greenish-gray, tan, fine-grained, calcareous; limestone, gray, silty; fossiliferous; mudstone, grayish-green to brown, fossiliferous.

4. Mudstone, sandstone, and minor limestone, interbedded; mudstone, gray, yellowish-tan, some thin bedded, calcareous; sandstone, tan to gray, fine-to medium-grained, conglomeratic; limestone, gray to tan.

5. Sandstone and shale interbedded; sandstone, light gray, medium- to coarse-grained, carbonaceous; shale, gray, partly sandy, thin-bedded.

6. Sandstone, gray to light-brown, medium-grained, massive.

7. Sandstone, mudstone, siltstone, and shale interbedded; sandstone, gray, light-brown, buff, fine-grained, local coal streaks; mudstone, gray to black, fossiliferous; siltstone, gray to tan, carbonaceous; shale, gray, sandy, carbonaceous; several coal beds.

8. Shale, gray to dark gray.

Meters   Feet
0 ┬ 0
50 ┤ ┌ 200
100 ┤
      ├ 400
150 ┤
      ├ 600
200 ┤
250 ┤ ├ 800
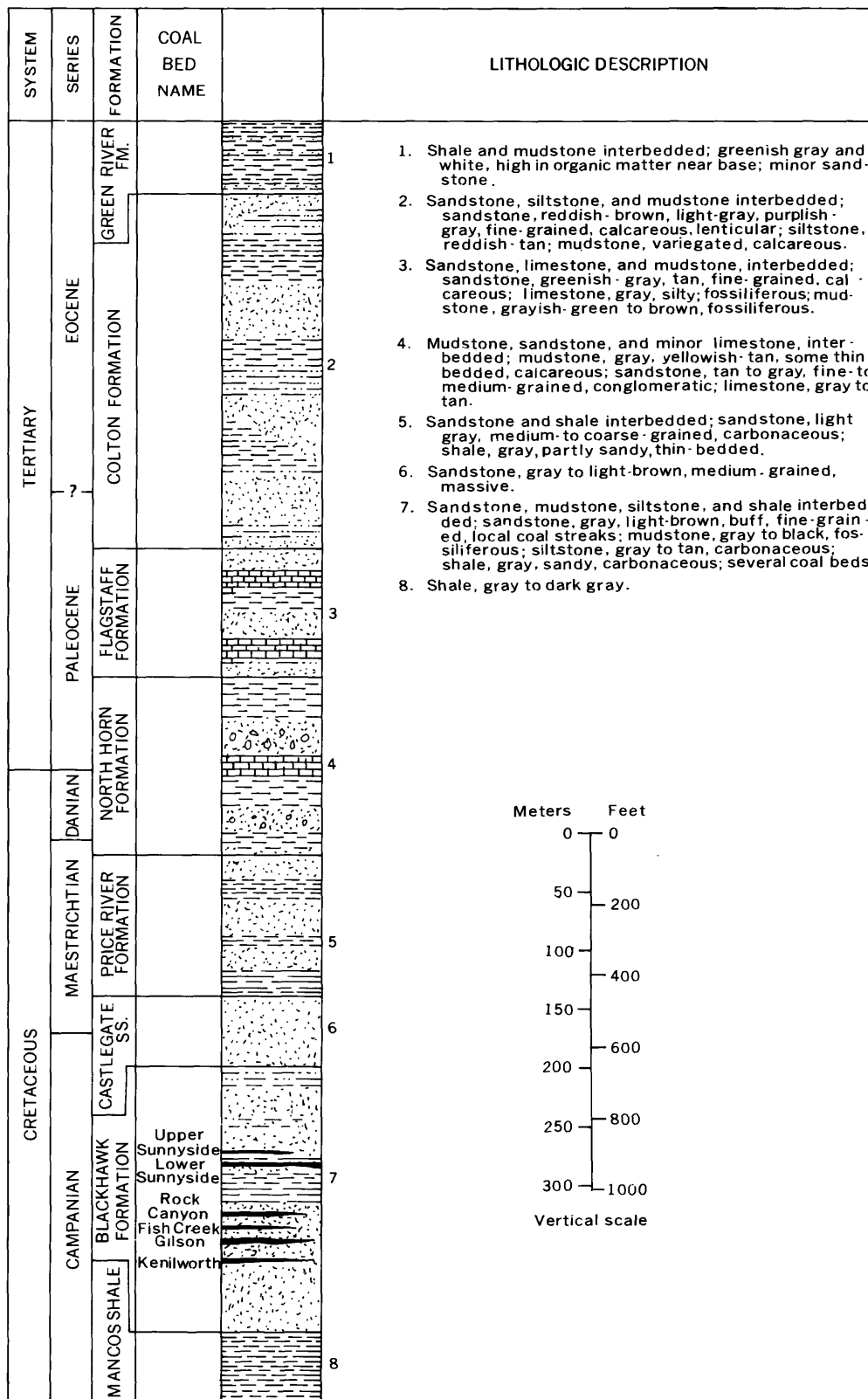300 ┴ └ 1000

Vertical scale

PLATE 2. Composite columnar section, Minnie Maud Creek East Quadrangle, Carbon and Duchesne Counties, Utah.

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The Flagstaff Limestone is a resistant unit and caps the dip-slope on the south side of Whitmore Park. The formation consists of thin-bedded limestone, shale, and sandstone. The limestone is yellowish-gray, the shale is variegated, and the sandstone is generally reddish-brown. The formation is several hundred feet thick on the west side of the Pine Canyon quadrangle, but it thins rapidly eastward and pinches out at the east edge of that quadrangle.

The Colton Formation forms the Roan Cliffs and is exposed in the southwest corner of the quadrangle. It consists of reddish and brownish lenticular sandstone, shale, and siltstone and has a total thickness of at least 1,000 ft (305 m). The Green River Formation caps the Colton Formation in the Roan Cliffs and is exposed over the northern two-thirds of the quadrangle. The Green River is composed of greenish-gray and white claystone, shale, marlstone, and oil shale.

Structure

The Book Cliffs area of east central Utah lies on the gentle north-ward-dipping south flank of the Uinta Basin. The strata dip gently northward from 4 to 7 degrees. There are very few faults in the area and these generally have small displacements. There are no known faults in the KRCRA of the Minnie Maud Creek East quadrangle.

COAL GEOLOGY

Six main coal beds have been mapped and described in the adjoining Pine Canyon quadrangle (AAA Engineering and Drafting, Inc., 1979). These occur in the Blackhawk Formation and include the following beds in ascending order: the Kenilworth, Gilson, Fish Creek, Rock Canyon, Lower Sunnyside, and Upper Sunnyside coal beds.

The Kenilworth and Gilson beds are separated by a non-coal interval of approximately 50 ft (15 m). The Gilson and Fish Creek beds are separated by a non-coal interval ranging from 25 to 60 ft (8 to 18 m) with an average of 42 ft (13 m). The Fish Creek bed is successively overlain by: a non-coal interval approximately 50 ft (15 m) thick; the Rock Canyon coal bed; a non-interval ranging from 55 to 180 ft (17 to 59 m) thick; the Lower Sunnyside coal bed; a non-coal interval about 175 to 250 ft (53 to 76 m) thick; and the Upper Sunnyside coal bed.

The Kenilworth, Gilson, Fish Creek, and Rock Canyon coal beds apparently occur at depths greater than 3,000 ft (914 m) in the Minnie Maud Creek East quadrangle based on structure contour maps of the coal bed in the Pine Canyon quadrangle (AAA Engineering and Drafting, Inc., 1979). The Lower and Upper Sunnyside beds have less than 3,000 ft (914 m) overburden only in the southwest corner of the quadrangle.

Kenilworth Coal Bed

The Kenilworth coal bed is the lowest coal bed exposed in the Pine Canyon quadrangle. Although it is a thin coal bed, it is fairly constant in thickness averaging about 2 ft (0.6 m) thick in that quadrangle. Generally, the Kenilworth coal bed is overlain by a shale or sandy shale and a sandstone bed. In some areas the sandstone lies directly on the coal. There are no indications that this coal bed thins or thickens northward toward the Minnie Maud Creek East quadrangle where the bed is apparently greater than 3,000 ft (914 m) in depth.

Gilson Coal Bed

The Gilson coal bed is the thickest bed in the Pine Canyon quadrangle although the thickness varies considerably because of the lenticularity of the bed. The thickness ranges from less than 2 ft (0.6 m)

in Sec. 18, T. 13 S., R. 12 E. to 12.9 ft (3.9 m) in Sec. 24, T. 13 S.,

R. 12 E. and 16 ft (4.9 m) in a drill hole located in Sec. 28, T. 12 S.,

R. 12 E. An isopach map of the coal bed in that quadrangle (AAA Engi-

neering and Drafting, Inc., 1979) indicates that it thickens northward

on the west side of the quadrangle. The bed is apparently greater than

3,000 ft (914 m) in depth in the Minnie Maud Creek East quadrangle.

Fish Creek Coal Bed

In the Pine Canyon quadrangle the Fish Creek coal bed is mainly con-

fined to T. 13 S., R. 12 E. It is believed to be a "split" from the Rock

Canyon coal bed (Clark, 1928). The correlation is based on the strati-

graphic position and thickness of the coal bed. The distance between the

Gilson and the Fish Creek coal bed ranges from 26 ft (7.9 m) to 60 ft

(18.3 m) and averages about 45 ft (13.7 m). The thickness of the coal

bed in the Pine Canyon quadrangle ranges from 0.8 ft (0.2 m) in Sec. 17,

T. 13 S., R. 12 E. to 5.2 ft (1.6 m) near Fish Creek Canyon and averages

about 3.3 ft (1 m). The bed is apparently greater than 3,000 ft (914 m) in

depth in the Minnie Maud Creek East quadrangle.

Rock Canyon Coal Bed

The Rock Canyon coal bed is one of the most valuable coal beds in

the Pine Canyon quadrangle. It exhibits a wide range of thicknesses,

but averages about 5 ft (1.5 m) thick over much of the quadrangle. The

bed ranges in thickness from 1 ft (0.3 m) to 11 ft (3.4 m) in surface

measured sections to 9 ft (2.7 m) in a drill hole located in Sec. 32,

T. 12 S., R. 12 E. The Rock Canyon coal bed has few outcrop exposures

because of extensive burning of the coal at the surface. The bed apparently

thins northward from the Pine Canyon quadrangle where it is 4.0 ft (1.2 m)

thick in the northwest quarter of that quadrangle. This bed is also apparently greater than 3,000 ft (914 m) in depth in the Minnie Maud Creek East quadrangle.

Lower Sunnyside Coal Bed

The Lower Sunnyside coal bed is relatively thin throughout much of the Pine Canyon quadrangle but was found to be over 11 ft (3.4 m) thick in one of the holes drilled in the northern half of that quadrangle (AAA Engineering and Drafting, Inc., 1979). Mapping the position of this coal bed is considered more reliable than mapping some of the other beds because it rests on the Sunnyside Sandstone which is easily traced. However, there are few good exposures of the coal because it has been extensively burned. The stratigraphic distance between the Rock Canyon and Lower Sunnyside coal beds ranges from 55 ft (16.8 m) to about 180 ft (54.9 m). The measured thickness of the coal bed ranges from less than 1 ft (0.3 m) to 4.8 ft (1.5 m) at the surface to 11.5 ft (3.5 m) in a hole drilled in Sec. 4, T. 13 S., R. 12 E. The bed is 8.0 ft (2.4 m) thick in a drill hole approximately 0.6 mile (1.0 km) south of the Minnie Maud Creek East quadrangle boundary. The bed may be less than 3,000 ft (914 m) in depth only in a very small area in the southwest corner of Minnie Maud Creek East quadrangle.

Upper Sunnyside Coal Bed

The Upper Sunnyside coal bed is thin where exposed and may be absent in some places. No exposures were found west of Sec. 21, T. 13 S., R. 12 E., and no estimates can be made regarding the thickness and continuity of this bed in the western part of the quadrangle.

The thickness of the Upper Sunnyside coal bed in the Pine Canyon quadrangle ranges from 1 ft (0.3 m) in Sec. 21, T. 13 S., R. 12 E., to 6.0 ft (1.8 m) excluding partings in Sec. 25, T. 13 S., R. 12 E. The rock interval between the Upper and Lower Sunnyside coal beds averages about 20 ft (6.1 m). Except for a very small area in the southwest corner, the bed is apparently overlain by more than 3,000 ft (914 m) of overburden elsewhere in the Minnie Maud Creek East quadrangle.

Chemical Analyses of the Coal

Doelling (1972) reports the analyses of 97 coal samples from the adjoining Pine Canyon quadrangle. The coal samples were taken from several mines and coal beds. The values of the proximate analyses of the samples have been summed and averaged together in the following table from Doelling (1972, p. 400).

Table 1. Average proximate analysis of coals, Pine Canyon quadrangle, Carbon County, Utah.

	No. Analyses	Percent Average	Range
Moisture	97	4.9	3.1-8.5
Volatile matter	94	38.6	37.4-40.1
Fixed Carbon	94	50.1	45.2-52.9
Ash	97	6.4	3.7-11.5
Sulphur	96	0.49	0.3-0.82
Btu/lb*	93	12,645	11,390-13,390

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

Based on the ASTM system of classification, the average analysis shown in Table 1 indicates that the coal mined in the Pine Canyon quadrangle (primarily, the Gilson and Rock Canyon beds) has an average classification of high volatile bituminous B rank (American Society for Testing and Materials, 1977).

Mining Operations

No coal mining has taken place in the Minnie Maud Creek East quadrangle, but active coal mining in the Pine Canyon quadrangle began around 1906. Although several mines have produced coal since then, only the California Portland Cement Company is producing the Rock Canyon coal bed in the Soldier Creek mine (1979).

Most of the coal mined in the Pine Canyon quadrangle has come from the Gilson and Rock Canyon coal beds. Doelling (1972) reported that the total coal production from that quadrangle amounted to a little less than 2.6 million short tons (2.4 million metric tons) and that overall recoverability had been about 50 percent.

COAL RESOURCES

The only coal bed of Reserve Base thickness (5.0 ft or 1.5 m) with apparently less than 3,000 ft (914 m) of overburden that can be projected into the KRCRA area in the Minnie Maud Creek East quadrangle from the adjoining Pine Canyon quadrangle is the Lower Sunnyside coal bed (see plate 1a). The coal bed is 8.0 ft (2.4 m) thick in a hole drilled 0.6 mile (1.0 km) south of the quadrangle boundary and apparently thins northward into the Minnie Maud Creek East quadrangle. The projected 5-ft (1.5-m) coal isopach line passes through the KRCRA area. The 3,000-ft (914-m) overburden isopach line, shown on plate 1a, was drawn from a projection of the structure contour lines of the coal bed from the Pine Canyon quadrangle (AAA Engineering and Drafting, Inc., 1979).

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

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coal resources in short tons of coal from the isopached coal bed. Reserve Base and Reserve values for the Lower Sunnyside bed per Federal section are shown on plate 1a and rounded to the nearest tenth of a million short tons. Reserve values are based on a subsurface mining recoverability factor of 50 percent.

The resources for the Lower Sunnyside coal bed in the Minnie Maud Creek East quadrangle are classified as "inferred" resources because the point of observation from which the resources are projected is more than 3/4 mile (1.2 km) and less than 3 miles (5 km) from the KRCRA area in the quadrangle (U.S. Bureau of Mines and U.S. Geological Survey, 1976). The coal Reserve Base tonnages per Federal section are shown on plate 1a and total 400,000 short tons (362,880 metric tons) for the unleased Federal coal lands within the KRCRA boundary in the Minnie Maud Creek East quadrangle.

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.

Development Potential for Subsurface Mining Methods
and In-Situ Gasification

The coal development potential for the subsurface mining of coal is determined by the thickness of overburden under which a coal bed lies. Areas where coal beds 5 ft (1.5 m) or more in thickness are overlain by

more than 2,000 ft (610 m) and less than 3,000 ft (914 m) of overburden
are rated as having a "low" development potential. In the Minnie Maud
Creek East quadrangle KRCRA the following areas of unleased Federal coal
land have a low development potential rating:

T. 12 S., R. 12 E.
Sec. 29:   N½ NW¼
Sec. 30:   NE¼ NE¼

The only other unleased Federal coal land in the KRCRA of the quadrangle
is the NW¼ NW¼ Section 28, T. 12 S., R. 12 E. Inasmuch as the Upper and
Lower Sunnyside coal beds are apparently overlain there by more than 3,000 ft
(914 m) of overburden, that part of the KRCRA is classified as having no
development potential.

The designation of a coal development potential rating is based on
the occurrence of the highest-rated coal-bearing area that may occur with-
in any fractional part of a 40-acre BLM land grid area or lot area of un-
leased 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 clas-
sification is based on the dip and depth of coal beds having a minimum
thickness of 5 ft (1.5 m). There are two development potential

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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 Minnie Maud Creek East quadrangle, the in-situ coal gasification methods of development potential classification does not apply.

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