Text to Accompany:

Open-File Report 80-105

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SKUTUMPAH CREEK QUADRANGLE, KANE COUNTY, UTAH

(Report includes 9 Plates)

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

By

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

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INTRODUCTION

Purpose

This report is to be used with the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Skutumpah Creek quadrangle, Kane County, Utah. This report was compiled to assist the land planning work of the Bureau of Land Management by providing a systematic coal resource inventory of Federal coal lands for the Skutumpah Creek 7½-minute quadrangle of the Alton-Kanab Known Recoverable Coal Resource Area (KRCRA) in southwestern Utah. This investigation was performed by Meiiji Resource Consultants of Layton, Utah for the U.S. Geological Survey under contract number 14-08-0001-17460. Resource information was gathered for this report in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Both published and unpublished information was used as the data base for this study. Neither new drilling nor field mapping was done, and confidential data were not used.

Location

The Skutumpah Creek quadrangle is in western Kane County in southwestern Utah, in the south-central part of the Alton-Kanab KRCRA. The northwest corner of the quadrangle is ten miles (16 km) southeast of Alton, Utah; the western quadrangle boundary is 15 miles (24 km) east of Glendale, Utah; and the southwest quadrangle boundary is 17 miles (27 km) north of Kanab, Utah, the nearest town with complete services.

Accessibility

U.S. Highway 89, the main highway through the region, runs north and south through Kanab and Glendale and east from Kanab to Page, Arizona. Utah State Route 136, a well maintained gravel road, connects U.S. 89 and the towns of Glendale and Alton, Utah with the southwest corner of the quadrangle via an unpaved county road. This road traverses the central portion of the quadrangle in a roughly east - west direction. Jeep trails provide access to the coal outcrops but are impassable in wet weather.

Physiography

The Skutumpah Creek quadrangle lies within the High Plateaus section of the Colorado Plateau physiographic province (Sargent and Hansen, 1976) and south of the Paunsaugunt Plateau. In the southern half of the quadrangle, the Skutumpah Terrace overlies the Jurassic Carmel Formation. The slopes are gentle. Relief in the southern part of the quadrangle varies from a high of 6846 feet (2087 m) on Jodys Knoll to a low of 6000 feet (1829 m) in Red Wash. In the northern half of the quadrangle, hills and plateaus rise to the north of Red Wash valley, becoming steeper and higher to the north. Along the northern boundary of the quadrangle, elevations are commonly 7300 feet (2225 m) or higher. In the extreme northwest corner the hills become very steep with some cliffs.

Skutumpah Creek flows southward through the center of the quadrangle. This creek is the only perennial stream in the area and at Kanab, flows into Kanab Creek, a tributary of the Colorado River.

Climate and Vegetation

The climate in the Skutumpah Creek quadrangle is arid to semi-arid. Average annual precipitation for the quadrangle is 16 inches (40 cm) but accumulations vary considerably with elevation. Valley areas receive eight to ten inches (20-25 cm) of precipitation, while the hills and terraces accumulate from 25 to 30 inches (64 - 75 cm). Temperatures are cold in winter with hot summers. The average winter temperature is 14^{o} F (-10^{o} C), while the average summer temperature is 88^{o} F (31^{o} C). Higher elevations are normally 10 to 15^{o} F (5.5 - 8^{o} C) cooler than the surrounding lowlands. (See United States Department of the Interior Part I, p. II-1 to II-4).

Vegetation types show little variation. The quadrangle is characterized by open Pinyon-Juniper Woodland in the higher areas, with Sagebrush-Grass type vegetation primarily in the lower areas. (See United States Department of the Interior, 1975 Part I, p. II-33 to II-35, fig. II-11).

Land Status

About 14,000 acres (5666 ha.), all in the northern part of the quadrangle, are within the KRCRA boundary. Approximately 12,000 acres (4856 ha) of this is underlain by coal.

The Bureau of Land Management is the principal coal owner, although the State of Utah owns 800 acres (323 ha) of shallow coal which is now under lease. Both the State of Utah and private parties own coal rights to limited areas with deeply buried coal. Virtually all coal under less than 200 feet (61 m) of overburden is under lease (Doelling and Graham, 1972) (See plate 7).

GENERAL GEOLOGY

Previous Work

In 1909, G.B. Richardson investigated the coal in southwestern Utah. He worked within five miles (8 km) of the western boundary of the Skutumpah Creek quadrangle but judged that the coal did not extend as far east as this quadrangle (Richardson, 1909). In 1931, Gregory and Moore investigated coal in the Upper Paria valley twenty-five miles (40 km) northeast of the quadrangle, but reported the coal thinned to the west and did not extend to the Skutumpah Creek drainage basin. Later, Gregory (1965) did further investigations west of the quadrangle, but only as far east as Johnson Valley.

In 1961, W.B. Cashion completed the first extensive report on the Cretaceous coal of the Kolob-Kanab coal fields. He may have gone only as far east as Johnson Valley because of Gregory's conclusion that potentially economic coal did not exist to the east (Doelling and Graham, 1972). The Utah Geological and Mineralogical Survey later compiled the information collected by earlier writers into a monograph on southern Utah coal fields (Robison, 1964; Doelling and Graham, 1972).

H.D. Goode (1973) completed preliminary geologic maps of the Skutumpah Creek quadrangle and the adjacent Bald Knoll quadrangle to the west. This have provided much needed information on the stratigraphy and structure. The U.S. Geological Survey has conducted two drilling programs which included this quadrangle (Bowers, Aigen, and Landis, 1976; Bowers, 1977). Recently, W.E. Bowers (1979) measured additional outcrops. He has not published this material but permitted the writer to use the information in this report.

Stratigraphy

Rock units which crop out in the Skutumpah Creek range in age from the Jurassic Navajo Sandstone to Quaternary gravels. The Jurassic Navajo Sandstone, the oldest formation exposed within the quadrangle, is a massive, cliff-forming sandstone at least 1000 feet (305 m) thick (Doelling and Graham, 1972), fine grained, light gray, tan to almost white. The most conspicuous and diagnostic feature of the Navajo is the massive sweeping crossbeds. The light color and cliff-forming character have led to the informal designation "white cliffs" for Navajo outcrops in southern Utah. The Navajo Sandstone crops out in the southwest corner of the quadrangle where only the upper 200 feet (61 m) is exposed (Goode, 1973a).

The Jurassic Carmel Formation unconformably overlies the Navajo Sandstone. The Carmel Formation is divided into six members, five of which are present in the Skutumpah Creek quadrangle. A sixth member, the Wiggler Wash Member, may be present within a limited area.

The lowest member of the Carmel Formation is the Kolob Limestone, which correlates with the limestone member reported by Cashion (1967). The member is composed of dense gray to tan, silty limestone, with thin, sandy red shale near the base and thin gypsum interbeds near the top. The thickness of this unit in the Skutumpah Creek quadrangle is variable. Goode (1973a) measured 120 feet (36.6 m) along Johnson Canyon and 200 feet (61 m) along Skutumpah Canyon about one mile (1.6 km) to the east. The Kolob Member crops but in a number of areas within about a mile (1.6 km) of the southern quadrangle boundary.

The Crystal Creek Member, a gypsiferous siltstone and fine-grained sandstone, conformably overlies the Kolob Limestone Member. Alternating dark reddish-brown and white to light-gray beds give this member a banded appearance. This member was designated the Banded Member by Cashion (1961). It contains some minor beds of gypsiferous shale, calcareous shale, and red and green clay-pebble conglomerate. It also contains lenses of gravel, boulders of rhyolite and andesite, plus some small lenses of gypsum. The thickness is variable being from 50 to 125 feet (15 - 38 m). East of the Skutumpah Creek quadrangle, the Kolob and Crystal Creek Members thin and merge and are mapped together as the Judd Hollow Member.

The Thousand Pockets Tongue of the Navajo Sandstone is included within the Carmel Formation, where it overlies the Crystal Creek Member. It may be as much as 50 feet (15 m) thick along the eastern quadrangle boundary but thins and pinches out near Skutumpah Creek. It is a yellow to white, faintly cross-bedded sandstone.

The Paria River Member overlies the Crystal Creek Member west of Skutumpah Creek and the Thousand Pockets Tongue of the Navajo Sandstone east of Skutumpah Creek. The Paria River Member, or Gypsiferous Member described by Cashion (1961), is a red gypsiferous sandstone with some interbedded white sandstone and purplish-red mud and siltstones. This member is 150 to 200 feet (46 to 61 m) thick on the west side of the quadrangle but thickens to over 300 feet (91 m) along the east side.

The uppermost unit of the Carmel Formation which crops out in this quadrangle is the Winsor Member. The Winsor Member is a predominantly fine-grained sandstone in shades of white to brown. Thin red siltstones are interbedded within the sandstones. Goode (1973a) reports the upper contact is marked by a white sandstone bed 10 to 20 feet (3 to 6 m) thick.

Doelling and Graham (1972) tentatively identified a sequence of limestone, reddish siltstone, and greenish-white gypsum east of Skutumpah Creek as the Wiggler Wash Member of the Carmel Formation. The strata ranged from 0 to 60 feet (0 to 18 m) thick.

The Jurassic Entrada Formation is absent over the northern and western portion of the quadrangle as the result of a pre-Dakota erosion interval. The Entrada Formation is present in the east and southeast portions of the quadrangle. Two members, the Gunsight Butte Member and the overlying Cannonville Member, are present along the east boundary of the quadrangle. The Gunsight Butte Member is principally a red siltstone with thin, greenish-gray shale interbeds. It reaches a maximum thickness of about 45 feet (14 m). The Cannonville Member attains a thickness of about 70 feet (21 m). This member is a white, very fine-grained sandstone, containing lenses of pebbles and mudstone. Low-angle crossbeds are present near the top. The Entrada thins and becomes discontinuous towards the west. It has not been reported west of Skutumpah Creek (Goode, 1973a; Doelling and Graham, 1972).

The Cretaceous-age Dakota Formation unconformably overlies the Jurassic formations. The Dakota overlies the Winsor Member of the Carmel Formation west of Skutumpah Creek and the Entrada Formation to the east. The lower contact between the Dakota and the Jurassic formations is distinct in color and lithology and is easily located. However, the upper contact with the overlying Tropic Shale has been drawn at widely varying stratigraphic levels by different authors (Gregory and Moore, 1931; Cashion, 1961; Van DeGraff, 1963; Lawrence, 1965; Doelling and Graham, 1972). The division followed here is the same as that advocated by Lawrence (1965) and modified by Utah Geological and Mineralogical Survey practice (Doelling and Graham, 1972), which places the contact at the top of the highest coal bed in the upper or Smirl coal zone in the Alton-Kanab KRCRA.

The Dakota Formation consists of gray to dark gray shale, alternating with yellow-gray to brown, fine-to medium-grained sandstone. Bentonite, carbonaceous shale, and coal are interbedded with the shale and sandstone. Coal beds occur in two zones named the "lower" and "upper" coal zones by Cashion (1961). These lower and upper coal zones were later renamed the Bald Knoll and Smirl coal zones by Deolling and Graham (1972). Both zones are composed of gray to dark gray shale, carbonaceous shale, and coal. The Bald Knoll coal zone is within the lower 50 feet (15 m) of the Dakota Formation, while the Smirl coal zone is within the upper 50 feet (15 m). Although the sandstone beds make up less than half of the section, the upper half to two-thirds of the Dakota Formation is characterized by prominent cliffs up to 30 feet (9 m) high. The sandstone beds are lenticular and grade laterally into shale. Goode (1973a) reports that the base of the coal bed in the Bald Knoll coal zone is within six to ten feet (2 to 3 m) of the base of the Dakota Formation. The total thickness of the Dakota Formation on the Skutumpah Creek quadrangle is about 200 feet (61 m).

The Dakota Formation was deposited over the Upper Jurassic-Lower Cretaceous erosion surface of low relief during a Lower Cretaceous marine transgression. Deposition occurred in a complex environment ranging from fluvial to marine. The basal beds are usually fluvial or near-shore deposits, overlain by a complex interfingering of paludal, lagoonal, near-shore; and marine sediments. The marine advance was generally continuous but was marked by numerous local, or occasionally regional, retreats followed by renewed transgression. There is a gradual change from coarse sandstone, in places conglomeratic, at the base of the Dakota Formation upward through the section to fine-grained sandstone and shale. All lithologies are lenticular and discontinuous. The formation is predominantly shale (Doelling and Graham, 1972) with minor interbedded lenticular, discontinuous beds of sandstone, carbonaceous shale, and coal. The sandstones form prominent ledges and low cliffs, in contrast to the weathered shale and mudstone of the overlying Tropic Shale.

The contact between the Cretaceous Tropic Formation and the overlying Dakota Formation is gradational. The Tropic Formation has been described by a number of authors (Gregory and Moore, 1931; Van DeGraff, 1963). This slope-forming unit consists predominantly of light-to medium-gray shale and claystone, with minor carbonaceous shale and an occasional thin, lenticular coal bed. Some thin, brown sandstone and thicker, yellow-gray sandstone beds of near-shore origin are also present. The sandstones are concentrated toward the lower and upper contacts with the underlying Dakota Formation and overlying Straight Cliffs Sandstone.

The Tropic Shale is predominantly marine shale in the Skutumpah Creek quadrangle. To the west, the Tropic Shale interfingers with the Straight Cliffs Sandstone (Cashion, 1961; Lawrence, 1965; Doelling and Graham, 1972), while to the east it is correlated with the Tununk Member of the Mancos Shale of eastern and central Utah. The close proximity of the time-equivalent, near-shore Straight Cliffs Sandstone to the west and underlying interbedded sandstones and coal beds within the Skutumpah Creek quadrangle area suggest the Tropic Shale was deposited in a shallow marine environment. Total thickness of the Tropic Shale in this quadrangle was measured at 650 feet (198 m) to 700 feet (213 m) by Goode (1973a).

The Cretaceous Straight Cliffs Formation conformably overlies the Tropic Shale. The base of the Straight Cliffs Formation is the first massive sandstone above the transitional sandstone and shale of the Tropic Formation (Goode, 1973a). The formation consists of massive, cliff-forming, tan or buff, fine-grained marine sandstone with some beds of shale and siltstone. Occasional thin coal or lignite beds are present and concentrated toward the center of the section. The sandstones were deposited in a near-shore environment as the Cretaceous sea retreated to the east (Van DeGraff, 1963). The Straight Cliffs Formation is 200 feet (61 m) to 250 feet (76 m) thick in this area.

The Upper Cretaceous Wahweap Formation is differentiated from the underlying Straight Cliffs Formation by the silty and feldspathic nature of the sandstone. It also contains lenses and cross-beds of fine pebbles and interbeds of blue-gray, green and tan shale. The lower contact is conformable and placed by Goode at the boundary between a cross-bedded, iron-stained, coarse-grained sandstone, and an underlying white, fine-grained sandstone bed at the top of the Straight Cliffs Formation. Only the lower portion of the Wahweap Formation is exposed on this quadrangle.

Quaternary pediment gravels are found from near stream level to 700 feet (213 m) above present stream levels. Most commonly, they have been deposited on the Tropic Shale or Winsor Member of the Carmel Formation. The gravels and cobbles are derived primarily from the Eocene Claron Formation, which crops out several miles north of the Skutumpah Creek quadrangle.

Alkaline olivine basalt caps a ridge above Tenny Creek, in the center of the northern boundary of the quadrangle. The flow source is located about one mile (1.6 km) north of the boundary, and the flow is characterized by abundant augite phenocrysts.

STRUCTURE

Folds

Regional structure of the Skutumpah Creek quadrangle area is characterized by broad, open folds and an occasional north-trending normal fault, frequently with large displacement. The structure of the Skutumpah Creek quadrangle is typical of the Colorado Plateau province as a whole.

The Skutumpah Creek quadrangle lies in the center of the Paunsaugunt Syncline (Doelling and Graham, 1972). The structure plunges north, and dips do not exceed 3^{o} on either limb. Dips at the outcrop on the Skutumpah Creek quadrangle are north at 1^{o} to 3^{o}.

Faults

Goode (1973a) has mapped a number of normal faults trending northeast and northwest, all of which appear to have small displacement. Doelling and Graham (1972) report that none appear to offset the coal to any degree.

COAL GEOLOGY

General

Coal deposition occurred near the beginning and end of deposition of the Dakota Formation, with some minor deposition in between. The coal was deposited over broad areas as thin to moderately thick, discontinuous and sometimes overlapping beds. Localized areas of greater than normal deposition are found within some beds, possibly the result of deposition in deeper parts of an oxbow lake, swamp or lagoon.

Forty-two measured sections and four drill holes are available for use in evaluating the coal resources within the Skutumpah Creek quadrangle (see table 1). Outcrop measurements are almost equally divided between the two coal zones, but only one of the drill holes penetrates the Bald Knoll coal zone. Additional information is available from fifteen coal analyses, of which thirteen are from the lower Smirl coal bed (table 1). In addition, one drill hole on the Bald Knoll quadrangle to the west (Bowers, Aigen and Landis, 1976, drill hole no. 105) and one drill hole on Podunk Creek quadrangle to the north (Bowers, 1977, drill hole no. AK-2-PC) were within a mile (1.6 km) of the respective quadrangle boundaries and were used to evaluate the coal geology.

Coal rank is determined accordingly to ASTM Standard Specification D388-77 (American Society for Testing and Materials, 1977).

Past Production

No coal is known to have been mined from within the Skutumpah Creek quadrangle.

Bald Knoll Coal Zone

The Bald Knoll coal zone is within the basal 50 feet (15 m) of the Lower Cretaceous Dakota Formation. Goode (1973a) reports the coal bed on the Skutumpah Creek quadrangle to be six to ten feet (2 to 3 m) above the base of the Dakota. The coal bed is discontinuous and may not be present throughout the outcrop area, notably Table Mountain near the center of the quadrangle (Doelling and Graham, 1972). The coal bed is thin where it has been reported. It is best developed along the western side of the quadrangle, where thickness approaches 4 ft. (1.2 m). The thickness is between two and three feet (0.6 - 0.9 m) where measured along the remainder of the outcrop area.

Only two (2) analyses of the Bald Knoll coal zone are available. One outcrop sample has a rank of sub-bituminous C, while the core sample from DH-104 (Bowers, Aigen and Landis, 1976) yields a rank of lignite A. The sulfur content of both samples is low, while ash content is moderate to high. The coal in outcrop shows thin, interfingering coal, bony coal, and shale beds. As a result of the thin, discontinuous, and dirty coal beds, no additional maps were prepared for the Bald Knoll coal zone.

Smirl Coal Zone

The upper 50 feet (15 m) of the Dakota Formation comprises the Smirl coal zone. The lower Smirl coal bed is the only coal bed greater than five feet (1.2 m) in thickness on the Skutumpah Creek quadrangle. This bed is well developed and appears to maintain its thickness throughout most of the outcrop area.

Twenty-three measured sections and four drill holes provide information on the lower Smirl coal bed. This bed is best developed along the western quadrangle boundary, where it averages over 10 feet (3 m) in thickness and reaches a maximum of 18 feet (5.5 m). The bed thins gradually to the east, and then appears to split and become much thinner within one mile (1.6 km) of the eastern quadrangle boundary.

Thirteen analyses are available within the lower Smirl coal bed. These indicate an average rank of sub-bituminous C coal with medium sulfur (1.0%) and low ash (7.7%) content. The variation in quality is fairly wide, ranging from lignite B to sub-bituminous B, suggesting some caution in interpretation is warranted. This suggestion is supported by a comparison between the analyses in the Doelling and Graham report and the analyses of core samples reported by Bowers and others (1976) and Affolter and Hatch (1980). The outcrop samples average lignite A, while the core samples average a high sub-bituminous C coal rank.

Coal Resources

Coal reserves are calculated by multiplying the total tons of coal in place (the reserve base) by a recovery factor which takes into account losses experienced under similar circumstances in other areas, to arrive at an assumed recoverable coal tonnage (the reserve). The recovery factors used, 0.85 for surface mining and 0.50 for subsurface mining, were provided by the U.S. Geological Survey and are based on economic and technical criteria. Reserve base and reserve tonnages are listed in tables 2 and 3.

Data from outcrop measurements and drill holes were used to construct outcrop, coal isopach and structure contour maps for the lower Smirl coal bed. The source of each indexed data point shown on plate 1 is on table 4.

Coal reserves for Federal land were calculated using data obtained from the coal isopach map (plate 4) and the areal distribution and identified resources map (plate 7). The coal zone acreage (measured by planimeter), multiplied by the average thickness of the coal zone, and by a conversion factor of 1770 short tons of coal per acre-foot (13,017 metric tons per hectare-meter) for sub-bituminous coal, yields the coal resources in short tons of coal for each coal zone. Coal beds thicker than five feet (1.5 m), which lie less than 3,000 feet (914 m) below the ground surface, are included. These criteria were provided by the U.S. Geological Survey.

Reserve base and reserve tonnages for the isopached coal zones are shown on plate 7 and are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal reserve base tonnages for each Federally owned section are shown on plate 2 and total approximately 28,420,000 short tons

(25,780,000 metric tons) for the entire quadrangle.

No attempt has been made by Meiiji Resource Consultants to determine the economic recoverability of coal described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential maps are drawn, at the request of the BLM, using the boundaries of the smallest legal land division shown on plate 2 as boundaries for the coal development potential areas. These divisions contain approximately 40 acres (16 ha) each. In portions of Federally owned sections containing no surveyed divisions, parcels of approximately 40 acres (16 ha) have been constructed and used as the development potential area boundaries. When a number of development potential areas are present in the same 40-acre (16 ha) parcel, the highest development potential is assigned to the entire 40-acre (16 ha) parcel in accordance with BLM guidelines.

Development Potential for Surface Mining Methods

Areas between the coal outcrop and 200 feet (61 m) of overburden are designated as surface mining areas. The divisions between high, moderate, and low development potential areas for surface mining methods are based on a calculated mining ratio. This ratio is defined as the cubic yardage of overburden overlying each ton of recoverable coal, assuming an 85 percent recovery. The formula used to calculate mining ratios for surface mining of coal is shown below:

$$MR = \frac{t_o\ (cf)}{t_c\ (rf)}$$

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal: 0.911 for sub-bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

A high development potential ranking is applied to those areas between the coal outcrop and a line representing a mining ratio value of 10. A moderate development potential is applied to areas which have mining ratio values between 10 and 15. A low development potential ranking is assigned to areas with mining ratio values over 15, but under less than 200 feet (61 m) of overburden. These mining ratio values for each development potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey. The surface development potential for this quadrangle is shown on plate 8 and table 2. Nineteen percent of the coal tonnage is rated high, 37 percent is rated moderate, and 44 percent is rated low. The total surface development potential for this quadrangle is 2,500,000 short tons of coal.

Development Potential for Subsurface Mining Methods

Areas where coal is overlain by more than 200 feet (61 m) but less than 3000 feet (914.4 m) of overburden are considered potentially minable by conventional subsurface mining methods. Coal with 200 feet (61 m) to 1000 feet (304.8 m) of overburden is rated as having a high potential. Coal with 1000 feet (304.8 m) to 2000 feet (609.6 m) of overburden is rated as moderate, while that under more than 2000 feet (609.6 m) of overburden is rated low.

An unknown development potential is assigned to areas under less than 3000 feet (914.4 m) of overburden, where coal data are absent or very limited. Where coal is beneath 3000 feet (914.4 m) or more of overburden, a ranking of no development potential is assigned. The subsurface development potential for this quadrangle is shown on plate 9 and table 3.

Most of the land within the KRCRA is presently under lease. All of the remaining area containing coal under more than 200 feet (61 m) of overburden is given a high development potential rating. The total subsurface development potential for this quadrangle is 25,920,000 short tons of coal.

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Table 1. Chemical analyses of coal in the Skutumpah Creek quadrangle, Kane County, Utah.

Location	Coal Bed Name or Zone	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/lb
SE¼Sec.13, T40S, R5W	Smirl	A	17.3	39.1	37.8	5.8	1.0	-	-	-	-	-	9,627
		C	-	47.4	45.6	7.0	1.3	-	-	-	-	-	11,758
C.Sec.7, T40S, R5W	Smirl	A	24.3	38.9	37.6	9.2	2.0	-	-	-	-	-	9,627
		C	-	45.4	43.9	10.7	2.3	-	-	-	-	-	11,231
C.Sec.7, T40S, R5W	Smirl	A	28.1	31.5	34.7	5.7	0.7	-	-	-	-	-	8,258
		C	-	43.8	48.2	8.0	0.9	-	-	-	-	-	11,486
C.Sec.7, T40S, R5W	Smirl	A	28.3	32.8	30.6	9.3	1.3	-	-	-	-	-	7,577
		C	-	45.5	42.6	12.9	1.8	-	-	-	-	-	10,566
Sec.7, T40S, R5W	Smirl	A	15.2	35.2	45.6	4.0	-	-	-	-	-	-	-
		C	-	41.2	53.8	4.7	0.52	-	-	-	-	-	11,400
Sec.9, T40S, R4¼W	Smirl	A	23.5	34.2	31.2	11.1	0.5	-	-	-	-	-	7,923
		C	-	44.7	40.7	14.6	0.7	-	-	-	-	-	10,342

Continued on next page

Table 1 - Continued

Location	Coal Bed Name or Zone	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/lb
SE¼Sec.9, T40S, R4¼W	Smirl	A	17.3	37.0	38.2	7.5	-	-	-	-	-	-	-
		C	-	44.7	46.2	9.1	0.7	-	-	-	-	-	9,000
SW¼Sec.18, T40S, R4¼W	Smirl	A	15.9	38.4	40.2	5.5	-	-	-	-	-	-	-
		C	-	45.7	47.8	6.5	1.63	-	-	-	-	-	9,320
Sec.18, T40S, R4W	Bald Knoll	A	12.5	34.3	42.6	10.6	-	-	-	-	-	-	-
		C	-	39.2	48.7	12.1	0.90	-	-	-	-	-	8,880

Form of Analysis: A, as received
C, moisture free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. Coal reserve base data for surface mining methods for Federal coal lands (in short tons) in the Skutumpah Creek quadrangle, Kane County, Utah.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Lower Smirl Bed	480,000	920,000	1,100,000	2,500,000
Total	480,000	920,000	1,100,000	2,500,000

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

Table 3. Coal reserve base data for subsurface mining methods for Federal coal lands (in short tons) in the Skutumpah Creek quadrangle, Kane County, Utah.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Lower Smirl Bed	25,920,000	-	-	25,920,000
Total	25,920,000	-	-	25,920,000

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

Table 4. Sources of data used on Plate 1.

Plate 1 Index Number	Source	Data Base
1	Bowers, 1977, U.S.G.S., Open-File Report 77-43	Coal drill hole no. AK-1SC
2	Doelling and Graham, 1972, U.G.&-M.S. Monograph Series No. 1	Measured Section
3	" "	" "
4	Bowers, Aigen, and Landis, 1976, U.S.G.S. Open-File Report 76-386	Test Trench
5	Doelling and Graham, 1972, U.G.& - M.S. Monograph Series No. 1	Measured Section
6	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Thickness
7	Doelling and Graham, 1972, U.G.&-M.S. Monograph Series No. 1	Measured Section
8	" "	" "
9	Bowers, Aigen, and Landis, 1976, U.S.G.S. Open-File Report 76-386	Outcrop Thickness
10	" "	Measured Section
11	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Thickness
12	Bowers, Aigen, and Landis, 1976, U.S.G.S. Open-File Report 76-386	Coal Drill Hole No. 104
13	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Thickness
14	Doelling and Graham, 1972, U.G.&-M.S. Monograph Series No. 1	Measured Section
15	" "	" "
16	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Thickness
17	Bowers, Aigen, and Landis, 1976, U.S.G.S. Open-File Report 76-381	Coal Drill Hole No. 103

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Table 4. Continued

Plate 1 Index Number		
18	Doelling and Graham, 1972, U.G.&-M.S., Monograph Series No. 1	Measured Section
19	" "	" "
20	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Thickness
21	Bowers, Aigen, and Landis, 1976, U.S.G.S., Open-File Report 76-386	Coal Drill Hole No. 101
22	" "	" "
23	Doelling and Graham, 1972, U.G.&-M.S., Monograph Series No. 1	Measured Section
24	" "	" "
25	Bowers, Aigen, Landis, 1976, U.S.G.S., Open-File Report 76-386	Outcrop Thickness
26	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	Measured Section
27	" "	" "
28	" "	" "
29	" "	" "
30	" "	" "
31	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Thickness
32	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	Measured Section
33	Robison, 1964, U.G.&M.S., Intermountain Association of Petroleum Geologists, 12th Annual Field Conference	" "
34	Bowers, 1979, U.S.G.S., Unpublished field notes	" "

Table 4. Continued

Plate 1 Index Number	Source	Data Base
35	Doelling and Graham, 1977, U.G.&M.S., Monograph Series No. 1	Measured Section
36	" "	" "
37	" "	" "
38	Bowers, 1979, U.S.G.S., Unpublished field notes	" "
39	" "	" "
40	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	" "
41	Bowers, 1979, U.S.G.S., Unpublished field notes	" "
42	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	" "
43	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Thickness
44	Doelling and May, 1970, U.G.&M.S., Unpublished data	Measured Section
45	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	" "
46	Bowers, 1979, U.S.G.S., Unpublished field notes	" "

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