Text to Accompany

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

(Report Includes 13 Plates)

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

By

MEIIJI RESOURCE CONSULTANTS

LAYTON, UTAH

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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 southeast quarter of the Orderville 15-minute 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 southeast quarter of the Orderville 15-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 at the request of 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). Published and unpublished information was used as the data base for the study. Neither new drilling nor field mapping was done, and confidential data were not used.

Location

The southeast Quarter of the Orderville 15-minute quadrangle, hereinafter referred to as the quadrangle, is in southwestern Utah in northwestern Kane County at the west end of the Alton-Kanab KRCRA. The quadrangle is about 27 miles (43 km) north of Kanab, Utah which is three miles north of the Utah-Arizona border. Kanab, Utah is the nearest town with full services. Glendale, Utah is in the west-central part of the quadrangle but has few services. Orderville, a small town similar to Glendale, is just outside of the quadrangle boundary about three miles (5 km) southwest of Glendale, Utah.

Accessibility

The main access to the region is U.S. Highway 89, which runs north from Kanab, Utah through Orderville and Glendale, and continues north from Glendale 270 miles (432 km) to Salt Lake City, Utah. Dirt and gravel roads branch east from U.S. 89, providing access to the coal outcrops in the northeastern part of the quadrangle.

Physiography

The southeast quarter of the Orderville 15-minute quadrangle lies within the High Plateaus section of the Colorado Plateau physiographic province (Sargent and Hansen, 1976). The quadrangle is divided into two unequal sections by the northeast-trending Sevier Fault zone. The Sevier Fault zone is the dividing line between the Markagunt Plateau and Kolob coal field to the northwest and the Paunsaugunt Plateau and Alton-Kanab coal field to the southeast.

The northwest third of the quadrangle, northwest of the fault, is characterized by mountainous relief. Slopes are steep and composed of ledges and cliffs. The streams occupy canyons which frequently have moderate gradients along the valley floors and steep sides dominated by cliffs. Elevations range from 5500 feet (1676 m), where the East Fork of the Virgin River leaves the quadrangle along the southwestern boundary, to nearly 7600 feet (2316 m) in the center of the northern boundary.

The topography southeast of the fault, including the fault zone, is more subdued. It is an area of shallow valleys and low fills, forming a bench-type topography. The bench is dissected in two places. The East Fork of the

Virgin River is incised along the west side of the Sevier Fault zone as much as 1000 feet (305 m) below the level of the bench. Kanab Creek has cut a cliff-bordered canyon as much as 800 feet (244 m) deep at the southeast quadrangle boundary.

Elevations rise gradually on the surface of the bench from 6400 feet (1951 m) in the southeast of the quadrangle to near 7600 feet (2316 m) at the center of the north boundary.

Drainage is into the East Fork of the Virgin River northwest of the fault and southeast to Kanab Creek, southeast of the Sevier Fault. Both streams are perennial and are tributary to the Colorado River to the south.

Climate and Vegetation

The climate is arid, but precipitation depends heavily on elevation. The valley floors are dry, averaging 16 inches (41 cm) or less moisture each year while the higher elevations average as high as 25 inches (64 cm). Temperatures range from an average winter low reading of $16^{o}F$ ($-9^{o}C$) to an average summer high of $90^{o}F$ ($32^{o}C$) at Glendale, Utah. Temperatures at higher elevations are 10^{o} to $15^{o}F$ (6^{o} to $8^{o}C$) cooler.

Five vegetation types are present in the quadrangle. The most widespread vegetation type is an open woodland dominated by Pinyon and Juniper which covers the entire quadrangle except for local areas.

Low valley areas with limited precipitation are covered by a mixture of low scrubs, principally sagebrush and rabbit brush and various grasses. The valleys of the East Fork of the Virgin River and Kanab Creek exhibit this typical vegetation, where not under cultivation.

An area of Mountain Brush covered by Gamble Oak and Mountain Mahogany, with some Sagebrush and Grass, covers the extreme northeast corner of the quadrangle. This vegetation group requires a greater water supply than the Pinyon and Juniper Woodland. A somewhat larger area of about six square miles (15 sq. km) in the northwest corner of the quadrangle is characterized by Ponderosa Pine, although many other species are also present.

The remaining area is agricultural land along the southern two-thirds of the valley of the East Fork of the Virgin River. The main crop is hay, which is grown in small fields along the sides of the river.

Climate and vegetation information was modified from Department of Interior, part I, p. II-1 to II-4, p. II-31 to p. II-35, fig. II-11.

Land Status

The Southeast Quarter of the Orderville 15-minute quadrangle is at the west end of the Alton-Kanab Known Recoverable Coal Resource Area (KRCRA). The quadrangle lies in the western portion of Kane County.

Less than a quarter of the quadrangle is within the KRCRA boundary. This includes a one and a half mile (2.4 km) wide, northeast-trending strip which includes the Sevier Fault zone and a one and a half mile (2.4 km) wide section along the east side of the north quadrangle boundary. The KRCRA includes 8640 acres (3497 ha), of which 1500 acres (607 ha) are not Federally owned. Most of this 1500 acres is concentrated near Glendale, Utah (plate 2). The majority of the coal is Federally owned, with 25 percent of the coal land and virtually all of the coal under less than 200 feet (61 m) of overburden currently under lease.

GENERAL GEOLOGY

Previous Work

The first preliminary report on the coal in southern Utah, which included the southeast quarter of the Orderville 15-minute quadrangle, was prepared by G.B. Richardson (1909). Richardson briefly described coal occurrences in the vicinity of Glendale and Orderville and measured a number of sections containing coal beds. Several of these were outside the quadrangle near the southwest corner, but two measured sections were within the quadrangle near Glendale. These two sections of the Levanger and Glendale Mines (see plate 1) were later discussed by Cashion (1961) in his report.

Later publications of the U.S. Bureau of Mines, Lord (1913), and Spieker (1925), drew heavily on Richardson's work. Gregory and Moore (1931) completed a geographic and geologic reconnaissance of southeastern Utah and northeastern Arizona which outlined the structural and stratigraphic framework of the region. Gregory (1950, 1951) later prepared similar reports for more restricted areas, the Paunsaugunt Plateau to the east and the Zion Park region to the west. These papers did not discuss specifically the southeast quarter of the Orderville quadrangle and only briefly discussed the coal beds. They did, however, relate the Alton-Kanab coal field to the Kolob coal field to the west and the Kaiparowits coal field to the east, within a stratigraphic frame of reference.

The first publication to deal directly with the coal and enclosing sediments in this quadrangle was written by W.B. Cashion (1961) of the U.S. Geological Survey. He prepared a reconnaissance map which included seven

measured sections of coal outcrops (see plate 3). In 1967 he published a geologic map of the Markagunt Plateau (Cashion, 1967) which includes this quadrangle, providing additional detail to his earlier paper. The Utah Geological and Mineralogical Survey (Doelling and Graham, 1972) prepared a monograph on coal in Utah which included this quadrangle. All earlier information was compiled with some original work performed by the U S. Geological Survey.

Stratigraphy

Formations which crop out in the southeast quarter of the Orderville 15-minute quadrangle range in age from the Jurassic Navajo Sandstone to the Eocene Claron Formation. The Navajo Sandstone is approximately 3000 feet (914 m) below the coal bed, exposing a stratigraphic interval of about 6000 feet (1829 m).

The oldest exposed formation is the Jurassic Navajo Sandstone, which is in excess of 1000 feet (305 m) thick. The true thickness of the Navajo in this quadrangle is unknown as the base is not exposed. The Navajo Sandstone underlies the structural terrace or bench covering most of the quadrangle. Presumably, it underlies the entire quadrangle at some depth below the surface.

The Navajo Sandstone is exposed in two places. As much as 1000 feet (305 m) are exposed in cliffs along the east side of the valley of the East Fork of the Virgin River, within the fault slices of the Sevier Fault zone. Between 500 feet (152 m) and 600 feet (183 m) of the Navajo is exposed in the southeast quadrangle corner in cliffs above Kanab Creek.

The sandstone is fine-grained, light gray, tan to off-white. The most conspicuous features are the massive, cliff-forming weathering style and the large, sweeping crossbeds. The light color and cliff-forming character have led to the informal designation "white cliffs" for Navajo Sandstone outcrops in southern Utah. The upper 90 feet (27 m) are separated from the main part of the formation by red shale and siltstone. This upper section is designated the Temple Cap Member.

The Jurassic Carmel formation overlies the Navajo. This formation is easily eroded and commonly surfaces benches which have developed on top of the Navajo, such as the surface of the large bench covering the southeast section of this quadrangle.

Four members of the Carmel Formation are present in this quadrangle. The lowest member is the Kolob Limestone, which correlates with the limestone member described by Cashion (1967). It 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 quadrangle is about 300 feet (91 m).

The Crystal Creek Member conformably overlies the Kolob Limestone Member. This is a gypsiferous siltstone and fine-grained sandstone. Alternating dark reddish-brown and white to light-gray beds give this member a banded appearance. It contains some minor beds of gypsiferous shale, calcareous shale, and red and green clay-pebble conglomerate. The thickness is estimated to be about 190 feet (55 m) in the quadrangle area. This member corresponds to the banded member described by Cashion (1967).

The Paria River Member overlies the Crystal Creek Member and corresponds to the gypsiferous member described by Cashion (1967). This member varies between 55 feet (17 m) and 95 feet (29 m) in thickness. The Paria River

Member consists of light gray, interbedded gypsiferous limestone, sandstone and shale. Some light-reddish colored beds are present. This unit is somewhat resistant to erosion and often forms ledges.

The youngest member of the Carmel within the quadrangle is the Winsor Member. This is a fine to very fine-grained, gray to light brown, friable sandstone. It is interbedded in the lower quarter with some thin, red silt or mudstone beds. The upper surface was truncated by erosion before the overlying Cretaceous strata were deposited. The thickness varies between 180 feet (55 m) and 400 feet (122 m).

The Cretaceous Dakota Formation unconformably overlies the Jurassic Carmel Formation. The lower contact is distinct in color and lithology and is easily located. However, the upper contact is gradational with the overlying Tropic Shale. As a result, the contact of the Dakota with the overlying Tropic 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 that advocated by Lawrence (1965) and modified by Utah Geological and Mineralogical Survey practice (Doelling and Graham, 1972). Accordingly, the contact is designated 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 five feet (11.5 m) or more in thickness 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 by Doelling 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). The total thickness of the Dakota Formation on this quadrangle is about 400 feet (122 m).

The Dakota Formation was deposited over an Upper Jurassic-Lower Cretaceous erosion surface of low relief during a Lower to Upper Cretaceous marine transgression. Deposition occured in a complex environment varying 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 beds. The marine advance was generally continuous but was marked by numerous local, or occasionally regional, retreats followed by renewed transgression.

There is a gradual fining upward from coarse sandstone, in places conglomeratic, at the base of the Dakota Formation to fine-grained sandstone and shale. All lithologies are lenticular and discontinuous. The formation is predominately 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, below the shale and mudstone of the overlying Tropic Shale.

The Dakota Formation crops out in two areas within this quadrangle. One area is in fault blocks within the Sevier Fault zone. These strata are frequently steeply-dipping, near fault surfaces. The second area is one of nearly flat-lying strata in the northeast corner of the quadrangle. The Dakota Formation crops out along the southern edge of this area and underlies approximately 4480 acres (188 ha).

The contact between the Cretaceous Tropic Shale and the underlying Dakota Formation is gradational. The Tropic Shale 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, respectively.

The Tropic Shale is predominantly marine shale in this 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 interbedded sandstones and coal beds within the quadrangle suggest the Tropic Shale was deposited in a shallow marine environment. Total thickness of the Tropic Shale on this quadrangle was estimated to be approximately 1000 ft. (305 m) by Doelling and Graham (1972).

The Cretaceous Straight Cliffs Formation conformably overlies the Tropic Shale. The base of the Straight Cliffs is the first massive sandstone above the transitional sandstone and shale of the Tropic Shale (Goode, 1973). This formation consists of massive, cliff-forming, tan or buff, fine-grained marine sandstone with some thin beds of shale or siltstone. The sandstones were deposited in a near-shore environment as the Cretaceous sea retreated to the east (Van DeGraff, 1963).

The Wahweap Sandstone conformably overlies the Straight Cliffs Sandstone and is similar to the Straight Cliffs. The Wahweap is fine to very fine-grained tan sandstone. The sandstone is slightly feldspathic and silty with interbeds of blue-gray, green, and tan shale as well as some lenses and

cross-beds of fine pebbles. The Wahweap Sandstone weathers to a topography dominated by ledges and low cliffs, separated by small slopes. The weathering style contrasts somewhat with the underlying, more massive, cliff-forming Straight Cliffs Sandstone.

The Kaiparowits Formation is the youngest Cretaceous formation present within the quadrangle. It is a weak, friable sandstone, poorly cemented by calcite. The weathering style is more typical of a shale than a sandstone. The Kaiparowits Formation is a dark-gray to gray-green, fine to medium-grained sandstone. Some thin conglomerate beds are also present. Total thickness of the upper most Cretaceous formations above the Tropic Shale on this quadrangle is estimated to be about 1600 feet (488 m) (Cashion, 1961).

The Tertiary Claron Formation is the youngest consolidated sedimentary formation present within the quadrangle, unconformably overlying the Cretaceous Kaiparowits Formation. The formation is predominantly pink to red, sandy limestone with some gray limestone and sandstone beds. The lower portion is characterized by abundant calcareous conglomerates and sandstones. There is a general gradation upward from sandy and conglomeratic beds at the base to finer-grained material higher in the section. Probably less than 500 feet (152 m) of the Claron Formation is present in one small outcrop area in the middle of the northern boundary of this quadrangle.

Olivine basalt has been extruded from two cinder cones, Buck Knoll and Black Knoll, along the eastern boundary of the quadrangle. The flows partially fill the valley of Kanab Creek and are contemporaneous with alluvium (Goode, 1973), indicating a recent origin. The two cinder cones are only slightly affected by erosion, again suggesting a young age. The basalt is composed of minor olivine phenocrysts in a groundmass of labradorite, augite and iron-titanium oxides.

STRUCTURE

Folds

The southeast quarter of the Orderville 15-minute quadrangle lies west of the Paunsaugunt Plateau. Regional structure in this area is characterized by broad, open folds with an occasional north-trending normal fault, which is typical of the Colorado Plateau province.

The quadrangle lies on the west side 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 coal outcrop on the quadrangle are east to northeast at about 2^{o}.

Faults

The Sevier Fault zone trends N. 30^{o} E. across the quadrangle. It is a zone approximately a mile wide, composed of numerous subparallel, en echelon, and crossfaults. Total displacement across the fault zone has been 1000 feet (305 m) to 2000 feet (610 m) with the west side downthrown. Grose, Hileman and Ward (1967) found that the Sevier Fault generally had a moderate effect on the coal beds and then only within 100 feet (31 m) to 500 feet (152 m) of a major branch. No other faults are known within the quadrangle.

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 coal beds, normally the result of deposition in deeper parts of an oxbow lake, swamp or lagoon.

Eight measured sections are available for use in evaluating the quadrangle: five in the Bald Knoll coal zone and three in the Smirl coal zone. Coal crops out in two contrasting structural settings within this quadrangle. The structure of the western portion is dominated by the Sevier Fault zone, and many coal outcrops lie within the various fault blocks. It is within some of these fault blocks at Glendale, Utah that the only coal has been mined from within this quadrangle. The structure east of the fault is characterized by almost flat-lying beds and minor faulting. No prospects or mines are known in the eastern coal area.

Only one coal analysis is available from the quadrangle.

Past Production

Three mines and one prospect have been opened in the quadrangle. These are the Glendale, Lavenger, and Foote mines and the Glendale prospect (see plate 1). Two of these, the Glendale and Lavenger mines, were present when Richardson visited the area in 1907. There is no record of production.

Bald Knoll Coal Zone

The Bald Knoll coal zone crops out within the fault blocks of the Sevier Fault zone and in the northeast corner of the quadrangle. Five

coal outcrop measurements are within the zone. The limited information and fault disruption within the Sevier Fault zone make it impossible to determine if one coal bed is continuous over large areas, although the lack of correlation among the available sections make such continuity appear unlikely. The total coal within the zone decreases to the east, from greater than six feet (1.8 m) to approximately five feet (1.2 m) as the eastern boundary of the quadrangle is approached. The amount of shale and bone which is included also increases to the east.

One mine, the Levanger, is believed to be within the Bald Knoll coal zone. No coal analyses are available for the Bald Knoll coal zone. Coal reserves were calculated for only a limited area because of the lack of data.

Smirl Coal Zone

Three coal outcrop measurements are available for the Smirl coal bed within the Smirl coal zone. The limited available measurements indicate the Smirl coal bed may have a uniform thickness of about eight feet (2.4 m) across the quadrangle. The only coal analysis available for the quadrangle is from the Glendale mine (table 1). It shows a sub-bituminous "B" rank, with medium sulfur (1.2%) and low ash (6.2%).

Coal reserves have been calculated only for limited areas because of the lack of data.

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 were used to construct outcrop, coal isopach, and structure contour maps for both the Smirl coal zone and the Bald Knoll coal zone. 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 maps (plates 4 and 8) and the areal distribution and identified resources maps (plates 7 and 11). 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 plates 7 and 11 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 20,460,000 short tons

(18,560,000 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 ft. (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

is shown below:

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

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 areas with mining ratio values over 15, but under less than 200 ft. (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 12 and table 2. Fifty percent of the coal tonnage is rated high, 18 percent is rated moderate, and 32 percent is rated low. The total surface development potential for this quadrangle is 7,510,000 short tons of coal.

Development Potential for Subsurface Mining Methods

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

An unknown development potential is assigned to areas under less than 3000 ft. (914.4 m) of overburden, where coal data are absent or very limited. Where coal is beneath 3000 ft. (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 13 and table 3.

The coal designated for subsurface development potential totals 12,950,000 short tons. All subsurface coal (within the "Limit of Data" line) on this quadrangle is given a high development potential rating.

An unknown development potential is assigned to large areas within the KRCRA. The remaining portion is divided with 75% of the coal rated high and 25% given a moderate rating. The total subsurface development potential for this quadrangle is 12,950,000 short tons of coal.

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Table 1. Chemical analyses of coal in southeast quarter of the Orderville 15-minute quadrangle.

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
N.SE.NW.Sec.24, T40S, R7W	Smirl	A	20.56	32.43	40.79	6.22	1.19	6.08	57.11	1.01	28.39	-	9,794
		C	-	40.82	51.35	7.83	1.50	4.78	71.89	1.27	12.73	-	12,329

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 southeast quarter of the Orderville 15-minute Quadrangle, Kane County, Utah.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Bald Knoll	210,000	160,000	350,000	720,000
Smirl	3,530,000	1,180,000	2,080,000	6,790,000
Total	3,740,000	1,340,000	2,430,000	7,510,000

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 southeast quarter of the Orderville 15-minute Quadrangle, Kane County, Utah.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Bald Knoll Zone	1,620,000	-	-	1,620,000
Smirl Zone	11,330,000	-	-	11,330,000
Total	12,950,000	-	-	12,950,000

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

Table 4. Sources of data on plate 1.

Plate 1 Index Numbers	Source	Data Base
1	Doelling and Graham, 1972, after Cashion, 1961, U.S.G.S., Coal Inventory Map C-49	Measured Outcrop
2	"	Measured Section
3	"	"
4	"	"
5	"	"
6	"	"
7	"	"
8	"	"