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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE BRYCE POINT QUADRANGLE, KANE AND GARFIELD COUNTIES, UTAH

(Report includes 13 plates)

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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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 Bryce Point quadrangle, Kane and Garfield Counties, 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 Bryce Point 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). Published and unpublished information was used as the data base for this study.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 Bryce Point 7½-minute quadrangle is in the northeastern corner of the Alton-Kanab KRCRA and crosses the Kane County-Garfield County line in southwestern Utah. The central portion of Bryce Canyon National Park crosses the northern half of the quadrangle. The eastern quadrangle boundary is seven miles (11 km) west of Cannonville, Utah and five miles (8 km) south-west of Tropic, Utah. The southern quadrangle boundary is 35 miles (56 km) northeast of Kanab, Utah. Kanab is the nearest town with complete services.

Accessibility

The Bryce Point quadrangle is within a remote and sparsely populated area of Utah. The main highway through the region is U.S. Highway 89 which runs east-west 25 miles (40 km) southwest of the quadrangle. At Kanab, Utah U.S. 89 turns north and passes about 25 miles (40 km) west of the western quadrangle boundary.

Access to the coal resource areas of the Bryce Point quadrangle is from the north or southwest. Utah State Road 12 branches east-southeast off of U.S. 89 about 12 miles (19 km) northwest of the northwestern quadrangle boundary and passes through Cannonville, where a gravel county road branches off to the south. Dirt roads and jeep trails, branching northwest off the county road, lead into the quadrangle. Coal outcrops are usually within a mile of one of these dirt or jeep roads. Many of these roads and trails become impassable during wet weather.

About two miles (3 km) south of the quadrangle, the county road runs northeast to southwest where, 20 miles (32 km) to the southwest, it joins Utah State Road 136, an unpaved road. Utah State Road 136 connects with U.S. 89 at two points, one about 10 miles (16 km) north of Glendale, Utah, and the other nine miles (14 km) east of Kanab, Utah.

Physiography

The Bryce Point quadrangle is within the High Plateaus section of the Colorado Plateau physiographic province (Sargent and Hansen, 1976). The northwest and north-central portions of the quadrangle cover the east side of the Paunsaugunt Plateau, bordered on the southeast by the Pink Cliffs. The remainder of the quadrangle is lower, with elevations decreasing toward the southeast. The entire quadrangle is rugged with steep cliffs, high buttes, narrow canyons and sparse vegetation.

The north and west sections of the quadrangle lie within Bryce Canyon National Park. Plateau elevations are high, ranging from 7800 feet (2377) to 8880 feet (2707 m), but relief on top of the plateau is a moderate 180 feet (55 m).

To the southeast, the lower area is dissected by Sheep Creek, Willis Creek, and their tributaries. Elevations here range from 6380 feet (1945 m) near the southeast corner of the quadrangle to 7800 feet (2377 m) along the base of the Pink Cliffs. The coal outcrops occur in the southeast and south-central protions of the quadrangle at elevations of approximately 6500 feet (1983 m) to 7100 feet (2166 m).

Climate and Vegetation

The climate in the Bryce Point quadrangle is arid, like most of southwestern Utah. Probably not more than 24 inches (61 cm) of precipitation are received annually even on the higher plateau, while the valleys receive less than 10 inches (25 cm). The scant rain and snowfall are the result of a rain shadow formed downwind (to the east) of the Paunsaugunt Plateau rim.

Winters are cold with an average low of 6^{o} F (-14^{o} C), and summers are hot with an average summer high of 85^{o} F (29^{o} C) at Tropic, Utah. The high mountain areas are usually 10^{o} F to 15^{o} F (5.5^{o} C to 8^{o} C) cooler.

The dominant vegetation type is open Pinyon-Juniper Woodland. This type is present throughout the quadrangle to an elevation approaching 8000 feet (2439 m). Higher elevations in the north and southwest support Ponderosa Pine and Conifer-Aspen associations, respectively. The deeper soils of canyon and valley bottoms and well-drained flats support the Sagebrush-Grass vegetation type.

Climate and vegetation information is derived from "Department of Interior, 1975, Part I, p. II-1 to II-4, II-31 to II-35, figure II-11".

Land Status

In the Bryce Point quadrangle 96.8 percent, or about 36,500 acres (14,770 ha), of the surface land is Federally owned, while private parties own 2.7 percent, or about 1,000 acres (405 ha), and the State of Utah owns 0.5 percent, or about 190 acres (76 ha) (Doelling and Graham, 1972).

The coal in the quadrangle is owned by the Federal Government. Ninety percent of the quadrangle is underlain by coal, but much of this is deeply buried under Bryce Canyon National Park and the Paunsaugunt Plateau. There are no outstanding coal leases.

GENERAL GEOLOGY

Previous Work

The earliest reported geologic investigation in the vicinity of Bryce Point quadrangle was made by Gregory and Moore (1931). They were the first to report the coal potential of the upper Paria River valley, five miles (8 km) to the northeast of the northeast corner of the quadrangle. Gregory later wrote a paper (Gregory, 1951) on the Paunsaugunt Plateau which described the geology of the western half of the quadrangle. His work ended here because he did not believe coal of economic interest occurred in the southern and eastern sides of the plateau.

Cashion (1961, 1967) expanded the work of Gregory (1951) by concentrating on the coal and adjacent stratigraphy around the western and southern sides of the plateau. His investigations extended as far east as Johnson Valley on the Bald Knoll quadrangle, 15 miles (24 km) to the southwest of this quadrangle. His lithologic descriptions, stratigraphic relationships, and measurements of coal outcrops have been used by all subsequent authors. His was the first publication dealing primarily with the coal geology of the area. Robison (1963, 1964, 1966) mapped and described the coal from Johnson Valley east into the Tropic area and provided measurements of coal outcrops along the east side of the Paunsaugunt Plateau.

The coal geology of the Bryce Point quadrangle was investigated by the Utah Geological and Mineralogical Survey and reported by Doelling and Graham (1972). The U.S. Geological Survey completed four drill holes, at depths ranging from 300 feet (91 m) to 500 feet (152 m), to obtain subsurface information for an investigation of the Alton-Kanab KRCRA (Bowers, 1977; drill holes AK-1-BP, AK-2-BP, AK-3-BP, AK-4-BP). In addition, W.E. Bowers (1979) provided a number of unpublished coal outcrop measurements which have aided materially in the preparation of this report.

Stratigraphy

In the Bryce Point quadrangle, sedimentary rocks are 3000 feet (914 m) thick and range in age from Jurassic to Recent. Outcrops of sedimentary formations were briefly described by Doelling and Graham (1972), more fully described southwest of the quadrangle by Goode (1973), and northeast of the quadrangle by Robison (1966). Doelling and Graham informally divided the Jurassic-age rock units, using outcrop data and narrative descriptions from Thompson and Stokes' report (1970) on the San Rafael Group of southern Utah.

The Jurassic-age Navajo Sandstone is a massive, cliff-forming sandstone at least 1000 feet (305 m) thick (Doelling and Graham, 1972). The sandstone is fine-grained, light gray, tan to almost white. The most conspicuous and diagnostic feature is the massive, sweeping crossbeds. The light color and cliff-forming character are responsible for the informal designation "white-cliffs," which is applied to Navajo Sandstone outcrops in southern Utah. The Navajo Sandstone underlies the quadrangle but does not crop out anywhere within the quadrangle, although it does crop out southeast of the quadrangle.

The Jurassic Carmel Formation unconformably overlies the Navajo Sandstone. The Carmel Formation is divided into six members, including the

Thousand Pockets Tongue of the Navajo Sandstone. All six members are present in the subsurface of the Bryce Point quadrangle (Doelling and Graham, 1972). The lowest member of the Carmel Formation is the Kolob Limestone, which correlates with the limestone member described by Cashion (1967). This member is composed of dense, gray to tan, silty limestone, with thin, sandy red shale near th base and thin gypsum interbeds near the top.

The Crystal Creek Member conformably overlies the Kolob Limestone Member. The Crystal Creek Member is a gypsiferous siltstone and fine grained sandstone, with alternating dark reddish-brown and white to light-gray beds which give this member a banded appearance. It contains some minor beds of gypsiferous shale, calcareous shale, and red and green clay-pebble conglomerate. This member corresponds to the banded member reported by Cashion (1967).

The Kolob Limestone and Crystal Creek Members are each about 120 feet (37 m) thick on the Skutumpah Creek quadrangle southwest of the Bryce Point quadrangle (Doelling and Graham, 1972; Goode, 1973). Doelling and Graham, and Thompson and Stokes (1970) report the two members thin and merge to form the Judd Hollow Member east of Skutumpah Creek. Further, Robison (1966) did not appear to have recognized the two members as distinct units ten miles (16 km) to the east of the Bryce Point quadrangle, suggesting the Crystal Creek and Kolob Limestone Members may be present as the Judd Hollow Member.

The Thousand Pockets Tongue of the Navajo Sandstone overlies the Crystal Creek (Judd Hollow) Member of the Carmel Formation. It thins to the west (Goode, 1973, Doelling and Graham 1972) and may not extend very far beyond the western boundary of the Bryce Point quadrangle. The Thousand Pockets

Tongue is a crossbedded, white to yellowish-buff, fine-grained sandstone. It is 60 to 80 feet (18 to 24 m) thick in the Rainbow Point quadrangle to the south (Doelling and Graham, 1972) and is probably about the same thickness in the Bryce Point quadrangle.

The Paria River Member of the Carmel Formation overlies the Thousand Pockets Tongue of the Navajo Sandstone and corresponds to the gypsiferous member reported by Cashion. It is a red, gypsiferous sandstone with some interbedded white sandstone and purplish-red mud and siltstone.

The Winsor Member overlies the Paria River Member. This unit crops out only in Averett Canyon in the southwest corner of the quadrangle. The Winsor Member is predominantly a fine-grained, buff sandstone but ranges in color from white to brown. Thin red siltstones are interbedded within the sandstones (Goode, 1973).

The Wiggler Wash Member overlies the Winsor Member and is the youngest member of the Carmel Formation. It crops out along Averett Canyon with the Winsor Member. This member is composed of interbedded limestone, red siltstone, and white and greenish-white gypsum. The total thickness of the Carmel Formation, to the south in the Rainbow Point quadrangle, is about 600 feet (183 m).

The youngest Jurassic Formation in the Bryce Point quadrangle is the Entrada Formation, which unconformably overlies the Carmel Formation and is divided into two members. The lower, or Gunsight Butte, member is a fine-to very fine-grained quartz sandstone. The sandstone is medium to dark reddish-brown with minor lighter-colored beds, mainly light gray to white silty sandstone. Robison (1966) reported this unit to be of eolian origin, as indicated by thick, lenticular beds with high angle crossbedding. The middle, or Cannonville, member is a light gray to white, fine-grained sandstone. A few thin interbeds of dark red sandstone, similar to the Gunsight Butte Member, are interbedded near the base of the Cannonville Member. Robison suggests this unit is water-laid because of the thin beds and low angle crossbedding.

The Cannonville Member is a massive white unit which stands out in marked contrast to the overlying dark gray Cretaceous shales. The Entrada Formation crops out diagonally across the southeast corner of the quadrangle. The total thickness of the Entrada Formation in the quadrangle was estimated by Doelling and Graham (1972) to be 400 feet (122 m).

The Cretaceous Dakota Formation unconformably overlies the Jurassic Entrada 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 the Utah Geological and Mineralogical Survey (Doelling and Graham, 1972), which identifies the contact as 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 are confined to 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 Doelling and Graham (1972). Both zones are composed of gray to dark-gray shale, carbonaceous shale, and coal with only thin, rare sandstone beds. 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 Dakota Formation crops out east of the Paunsaugunt Fault in the southeast part of the quadrangle along the sides of the larger canyons, such as Sheep Creek, Indian Hollow, and Willis Creek. The total thickness is reported to be 165 feet (50 m) (Doelling and Graham, 1972).

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 occurred in a dynamic, deltaic environment that varied from fluvial to marine. The basal beds are generally fluvial or near-shore deposits overlain by a complex interfingering of paludal, lagoonal, near-shore, and marine sediments. The marine transgression was generally continuous but was marked by numerous local, or occasionally regional, regressions 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 lithologic units 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, making the Dakota Formation stand out topographically from the uniform shale and mudstone of the overlying Tropic Shale.

The contact between the Cretaceous Tropic Formation and the underlying Dakota Formation is gradational. A number of authors have described the Tropic Shale (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. The sandstones occur near the lower and upper contacts with the underlying Dakota Formation and overlying Straight Cliffs Sandstone.

The Tropic Shale is predominantly marine in the Bryce Point quadrangle. To the west, the Tropic Shale interfingers with the nearshore Straight Cliffs Sandstone (Cashion, 1961; Lawrence, 1965; Doelling and Graham, 1972), while to the east it is correlated with the marine Tununk Member of the Mancos Shale of eastern and central Utah. The close proximity of the time-equivalent, nearshore Straight Cliffs Sandstone to the west, and interbedded sandstones and coal beds of the underlying Dakota Formation within the Bryce Point area, suggest the Tropic Shale was deposited in a shallow marine environment. The total thickness of Tropic Shale present in this quadrangle was estimated at about 700 feet (213 m) by Doelling and Graham (1972).

Upper Cretaceous formations cropping out in the Bryce Point quadrangle have not received extensive study. The Straight Cliffs and Wahweap Sandstones are very similar and are mapped together by Doelling and Graham (1972) and by Gregory and Moore (1931). The sandstones are fine-to medium-grained, tan to yellow-gray, and thin to thick-bedded. Occasional thin coal beds are present and concentrated toward the center of the section. The sandstones were deposited in the nearshore environment as the Cretaceous sea retreated to the east (Van DeGraff, 1963).

The Kaiparowits Formation, the youngest Cretaceous formation exposed in the quadrangle, 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 dark gray to gray-green, fine-to medium-grained sandstone. Some thin conglomerate beds are also present. The total thickness of the Upper Cretaceous formations present in the Bryce Point quadrangle is estimated to be about 1500 feet (457 m) (Doelling and Graham, 1972).

The Upper Cretaceous sandstones crop out in a belt about a mile wide, running from the southwest to the northeast corner of the quadrangle. The eastern boundary of the outcrop area is the Paunsaugunt Fault, and the western boundary is the base of the Pink Cliffs, which forms a canyonland topography characterized by moderate to steep canyon walls, cliffs and ledges.

The youngest formation exposed within the quadrangle, the Eocene Claron Formation, caps the Paunsaugunt Plateau to the west. The Claron unconformably overlies the Cretaceous Kaiparowits Formation. The Claron Formation is predominantly pink to red, arenaceous limestone with some gray limestone and sandstone beds. The lower portion is characterized by abundant calcareous conglomerates and sandstones. This formation has the widest geographic distribution of any formation in the quadrangle, cropping out over 40 percent of the entire quadrangle in the northwest, west central, and north central areas. The total thickness of the Claron Formation is approximately 800 feet (244 m), though before erosion the formation may have been 1200 to 1400 ft. (366 to 427 m) thick.

Large areas of the Tropic Formation and the Dakota Formation have been beveled and covered by gravel derived from the Claron Formation. These gravel-covered terraces form a conspicuous part of the topography in the southeast portion of the quadrangle.

Structure

Folds

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

The Bryce Point quadrangle lies on the east side of the Paunsaugunt Syncline (Doelling and Graham, 1972) which plunges north. Dips do not exceed 3^{o} on either limb. Dips in the Bryce Point quadrangle generally are 1^{o} to 2^{o} west.

Faults

The Paunsaugunt Fault is the only major fault through the quadrangle. It is the easternmost fault of three major north-south faults that separate major tectonic blocks in southern Utah. The other major faults, in order from east to west, are the Sevier Fault and the Hurricane Fault.

The Paunsaugunt Fault and associated minor faults comprise a fault zone which separates the Paunsaugunt Plateau to the west from the Kaiparowits Plateau to the east. The Paunsaugunt Fault is a normal fault which dips 70° to 90° to the west. The west block is downthrown more than 500 feet (152 m). Robison (1966) reports greater movement north of the quadrangle at Tropic Canyon, where more than 1500 feet (457 m) of displacement has occurred. Dips steepen to the west near the branch faults off of the Paunsaugunt Fault. Grose, Hileman and Ward (1967) reported that major deformation was confined within 100 to 500 feet (30 to 152 m) of the major fault branches.

COAL GEOLOGY

General

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

Thirty-one measured sections and four drill holes are available for use in evaluating the coal resources within the Bryce Point quadrangle. Twenty-one measured sections and the four drill holes provide information on the Bald Knoll coal zone, while eleven measured sections and the four drill holes are within the Smirl coal zone. Six of the measured sections and all four drill holes within the Smirl coal zone include the Middle

Smirl coal bed. Six coal analyses are available for the Bryce Point quadrangle from the Bald Knoll coal zone.

Coal outcrops are restricted to the southeast portion of the quadrangle on the east side of the Paunsaugunt Fault. Coal is presumed to be present west of the fault under the Pausaugunt Plateau. No coal resource data is available beyond 4,000 feet (1,219 m) downdip from the coal bed outcrop. Furthermore, the distance, which the available coal data may be reasonably projected, is limited. A "Limit of Data" line has been drawn to reflect the 4,000-foot distance limitation for projecting coal data (plates 7 and 11). The Paunsaugunt Fault roughly follows this line so, as a practical guide, the fault may be used as the limit line for information.

Past Production

There are no known mines or prospects in the Bryce Point quadrangle.

Bald Knoll Coal Zone

The Bald Knoll coal zone is located near the base of the Cretaceous-age Dakota Formation. The base of the lowest coal bed varies from ten feet (3 m) above the base of the Dakota Formation near the south end of the quadrangle (data points 25 and 26, plate 3-C), to 50 feet (15 m) above the base of the Dakota at the north edge of the coal bearing area, east of the fault (plate 3-B). The Bald Knoll coal zone is composed of one to five coal beds separated by interbeds of thin shale or bony coal.

The Bald Knoll coal zone is present throughout the outcrop area in the Bryce Point quadrangle. Coal thickness is irregular and ranges from two and a half feet (0.8 m) to over 12 feet (3.6 m) in thickness (plate 4). The coal is deposited in a number of small, scattered basins. The average thickness is probably eight to nine feet (2.4 to 2.7 m) between the outcrop and the "Limit of Data" line. About 40 percent of the coal area east of Paunsaugunt Fault contains some coal under less than 200 feet (61 m) of overburden (plate 7).

Six coal analyses are available for the Bald Knoll coal zone. Four analyses from outcrops (Doelling and Graham, 1972), and two from drill cores (Affolter and Hatch, 1980), indicate a coal rank of lignite A to sub-bituminous C. The subsurface samples tend to have a higher rank than the outcrop samples, as would be expected. Ash content is moderate and averages 16.2 percent, while sulfur is moderate with an average of 0.85 percent, ranging from 0.5 percent to 1.6 percent. The Bald Knoll coal zone contains over 90 percent of the coal reserves in the Bryce Point quadrangle (tables 2 and 3).

Smirl Coal Zone

The Smirl coal zone is composed of a number of thin, lenticular, discontinuous coal beds that occur over a wide stratigraphic interval (see plate 3). Two of the most continuous beds are the Middle Smirl coal bed in the northern part of the coal outcrop area and the Lower Smirl coal bed in the southern portion. Coal reserve figures were prepared for the Middle Smirl coal bed (tables 2 and 3), but not for the Lower Smirl coal bed, because the latter measures less than three feet (1 m) thick in outcrop.

The Middle Smirl coal bed averaged two to three feet (0.6 to 1.0 m) in thickness at the outcrop and reached a maximum of three and a half feet (1.1 m) at outcrop data point 6 on plate 1. Five feet (1.5 m) of Middle Smirl coal was encountered in drill holes AK-1-BP and AK-4-BP (Bowers, 1977), as shown on plate 1 as data points 1 and 8. A small area of coal reserves is calculated on the east side of the Paunsaugunt Fault, based on the drill hole information (plates 7 and 8).

No coal analyses are available for the Middle Smirl coal bed.

Coal Resources

Coal reserves are calculated by multiplying the total tons of coal in place (the reserve base) by a recovery factor, which is based on 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 and drill hole 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 shown 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 83,230,000 short tons (75,510,000 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 higher 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 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 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 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 12 and table 2. Twenty-six percent of the coal is rated high; seventeen percent is rated moderate; and 57 percent is rated low. Approximately 40 percent of the area within the "Limit of Data" line is classified as having a surface development potential. The total surface development potential for this quadrangle is 29,470,000 short tons of coal.

Development Potential for Subsurface Mining Methods

Areas in which 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 13 and table 3.

Calculated tonnage values of the coal, between 200 feet (61 m) and 3000 feet (914.4 m) of overburden, total 53,750,000 short tons. All of this coal has been assigned a high development potential.

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Table 1. Chemical analyses of coals in the Bryce Point quadrangle, Kane and Garfield Counties, 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, T37S, R3W	Bald Knoll[1]	A	21.7	-	-	-	-	-	-	-	-	-	7,620
		C	-	40.7	43.5	15.8	0.8	-	-	-	-	-	9,723
SE¼Sec.31, T37S, R3W	Bald Knoll[1]	A	21.6	-	-	-	-	-	-	-	-	-	6,307
		C	-	36.5	37.8	25.7	0.7	-	-	-	-	-	8,085
SE¼Sec. 36, T37S, R4W	Bald Knoll[1]	A	10.9	31.6	37.8	19.7	-	-	-	-	-	-	-
		C	-	35.5	42.4	22.1	0.78	-	-	-	-	-	8,080
SE¼Sec.28, T37S, R3W	Bald Knoll[1]	A	8.8	35.3	38.9	17.0	-	-	-	-	-	-	-
		C	-	38.7	42.7	18.6	1.20	-	-	-	-	-	8,230

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

[1] Outcrop sample

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

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
SE¼, NE¼, Sec. 30, T37S, R3W	Bald Knoll	A C	25.9 -	26.7 36.0	37.2 50.2	10.2 13.8	1.6 2.2	6.2 4.5	48.9 66.0	0.9 1.2	32.3 12.5	4710 6360	8,480 11,440
SE¼, SW¼, Sec. 30, T37S R3W (DH AK-2BP)	Bald Knoll	A C	24.4 -	27.7 36.6	29.7 39.3	18.2 24.1	0.6 0.8	5.8 4.1	42.9 56.7	0.8 1.1	31.7 13.2	4130 5460	7430 9830

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 Bryce Point quadrangle, Kane and Garfield Counties, Utah.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Bald Knoll Zone	7,600,000	5,120,000	16,410,000	29,130,000
Middle Smirl Bed	-	-	340,000	340,000
TOTAL	7,600,000	5,120,000	16,750,000	29,470,000

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 Bryce Point Quadrangle, Kane and Garfield Counties, Utah.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Bald Knoll Zone	46,860,000	-	-	46,860,000
Middle Smirl Bed	6,900,000	-	-	6,900,000
TOTAL	53,760,000	-	-	53,760,000

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-1BP
2	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	Measured Section
3	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Measurement
4	Doelling and Graham, 1972, U.G.&M.S., Mongraph Series No. 1	Measured Section
5	Bowers, 1977, U.S.G.S., Open-File Report 77-43	Coal Drill Hole No. AK-2BP
6	Bowers, 1979, U.S.G.S., Unpublished field notes	Measured Section
7	Doelling and Graham, 1972 U.G.&M.S., Mongraph Series No. 1	Measured Section
8	Bowers, 1977, U.S.G.S., Open-File Report 77-43	Coal Drill Hole No. AK-4BP
9	Doelling and Graham, 1972, U.G.&M.S., Mongraph Series No. 1	Measured Section
10	Bowers, 1977, U.S.G.S., Open-File Report 77-43	Coal Drill Hole No. AK-3BP
11	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Measurement
12	"	Measured Section
13	"	Outcrop Measurement
14	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	Measured Section
15	"	"

Table 4 - Continued

Plate 1 Index Number	Source	Data Base
16	Bowers, 1979, U.S.G.S., Unpublished field notes	Measured Section
17	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	"
18	Gregory and Moore, 1931, U.S.G.S., Professional Paper 164	"
19	Bowers, 1979, U.S.G.S., Unpublished field notes	"
20	"	Outcrop Measurement
21	"	"
22	"	"
23	"	"
24	"	"
25	May, (unp.) 1970, in Doelling and Graham, 1972, U.G. & M.S., Monograhp Series No. 1	Measured Section
26	Bowers, 1979, U.S.G.S., Unpublished field notes	"
27	"	"
28	Doelling and Graham, 1972, U.S.&M.S., Monograph Series No. 1	"
29	"	"
30	Bowers, 1979, U.S.G.S., Unpublished field notes	"
31	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	"
32	"	"

Table 4 - Continued

Plate 1 Index Number	Source	Data Base
33	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No.1	Measured Section
34	Bowers, 1979, U.S.G.S., Unpublished field notes	"
35	Doelling and Graham, 1972, U.G.&M.S., Monograph Series No. 1	"