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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE DEER SPRING POINT QUADRANGLE, KANE COUNTY, UTAH

(Report Includes 3 Plates)

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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This report was prepared under contract to the U.S. Geological Survey and has not been edited for conformity with Geological Survey standards and nomenclature. Opinions, and conclusions expressed herein do not necessarily represent those of the Geological Survey.

CONTENTS

ILLUSTRATIONS

Coal resource occurrence maps of the Deer Spring Point quadrangle, Kane County, Utah.

TABLES

Page

INTRODUCTION

Purpose

This report is to be used with the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Deer Spring Point 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 Deer Spring 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 Published and unpublished information was used as the data base for this study.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 Deer Spring Point quadrangle is in southwestern Utah in central Kane County. The quadrangle occupies the southeastern corner of the Alton-Kanab KRCRA. The coal outcrops in the quadrangle are about 26 miles (42 km) northeast of Kanab, Utah. Kanab is the main service center for this part of Utah. The northern boundary of the quadrangle is about 17 miles (27 km) southwest of Cannonville, Utah.

Accessibility

U.S. Highway 89 is the main highway through the region. The highway extends north from Kanab through Glendale, Utah, 26 miles (42 km) to the north. From Kanab the highway runs east toward Page, Arizona. Utah State Route 136, a well maintained gravel road over most of its length, branches eastward from U.S. 89 10.5 miles (17 km) north of Glendale. Utah 136 connects U.S. 89 with Alton, Utah, then proceeds southeast as an unpaved highway to rejoin U.S. Highway 89 nine miles (14 km) east of Kanab, Utah. An unpaved county road branches to the northeast from Utah 136 halfway between Alton and its southern junction with U.S. 89 east of Kanab. The county road starts from a junction near the southwest corner of the adjoining Skutumpah Creek quadrangle and proceeds east and north, where it crosses the northwest corner of the Deer Spring Point quadrangle toward Cannonville, 20 miles (32 km) northeast of the northern quadrangle boundary. A number of jeep roads and dirt trails branching off from this county road provide access to the coal outcrops north of the road and to other parts of the quadrangle. Many of these branching roads become impassable during wet weather.

Physiography

The Deer Spring Point quadrangle lies within the High Plateaus section of the Colorado Plateau physiographic province (Sargent and Hansen, 1976). The northwest corner of the quadrangle is located about 10 miles (16 km) southeast of the Paunsaugunt Plateau. The quadrangle area is characterized by mesas which rise 300 to 900 feet (91 to 274 m) above valleys of various widths, with the exception of the northwest corner of Deer Spring Point quadrangle. Approximately 10 percent, or 3800 acres (1538 ha), in the northwest corner has rounded topography, where steep slopes replace cliffs, and rounded divide areas replace gently sloping mesa tops. Local relief ranges from 200 to 500 feet (61 to 152 m).

Elevations in the quadrangle range from 5700 feet in Park Wash, at the southeast corner, to just over 7300 feet (2225 m) on top of Deer Spring Point and Timber Mountain.

Climate and Vegetation

The climate is arid. Precipitation over most of the quadrangle averages less than 12 inches (30 cm) per year, although the mesas receive slightly more. Temperatures vary from an average winter low temperature of 14^{0} F (-10^{0} C) to an average summer high temperature of 88^{0} F (31^{0} C).

Vegetation is uniform throughout the quadrangle. The low valley areas are covered by sagebrush, grasses, rabbit brush and similar vegetation adapted to very dry conditions. The slopes below the higher elevations and the mesa tops are covered by an open forest of Pinyon and Juniper.

Land Status

The Deer Spring Point quadrangle is located in the southeast corner of the Alton-Kanab KRCRA in central Kane County, Utah. Only 3.1 percent, or about 1200 acres (486 ha), in the northwest corner of the quadrangle is underlain by coal.

Private parties own approximately 620 acres (251 ha) of the land surface within the quadrangle; 380 acres (154 ha) are Federally owned; and 200 acres (81 ha) are owned by the State of Utah. The Federal Government is the primary coal owner, with rights to most of the coal underlying private land as well as the Federal acreages. Only one 40-acre (16 ha) parcel of land is leased.

GENERAL GEOLOGY

Previous Work

G.B. Richardson (1909) completed the first regional investigation of coal in southwestern Utah. His work did not extend east beyond Kanab Creek, which is approximately 11 miles (18 km) west of Deer Spring Point quadrangle, and he reported that the coal did not extend to Deer Spring Point quadrangle (Richardson, 1909). Gregory and Moore (1931) investigated the coal in the upper Paria River valley 25 miles (40 km) northeast of the quadrangle but believed the coal thinned to the west and south and did not extend to the Deer Spring Point quadrangle basin. Gregory (1951) later extended his investigations only as far east as Jackson Valley, six miles (10 km) west of the western boundary of the quadrangle. W.B. Cashion (1961) completed the first extensive report concerned primarily with the Cretaceous coals in the Kolob-Kanab coal field. He may have gone only as far east as Johnson Valley because of a recommendation by Gregory (Doelling and Graham, 1972). Cashion's work (1961, 1967) was of great importance, as it formed the basis for later work by the Utah Geological and Mineralogical Survey, which extended the coal investigations to the east (Robison, 1964, Doelling and Graham, 1972).

H.D. Goode (1973) completed a preliminary geologic map of the Skutumpah Creek quadrangle, which has provided much needed information on the stratigraphy and structure of the Deer Spring Point quadrangle directly to the east. W.E. Bowers (1979) of the U.S. Geological Survey provided three unpublished measured coal sections from the Deer Spring Point quadrangle for this report.

Stratigraphy

Rock units which crop out in the Deer Spring Point quadrangle include sediments which range in age from Jurassic to Tertiary. The Jurassic Navajo Sandstone is a massive, cliff-forming sandstone at least 1000 ft. (305 m) thick (Doelling and Graham, 1972), which 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 have led to the informal designation "white cliffs" for many of the Navajo outcrops in southern Utah. The Navajo Sandstone crops out over most of the quadrangle and underlies the mesas and Skutumpah Terrace in the Deer Spring Point quadrangle.

Individual mesas and Skutumpah Terrace are capped by the Jurassic Carmel Formation, which unconformably overlies the Navajo Sandstone and is more easily eroded than the Navajo. The Carmel is divided into six members by Thompson and Stokes (1970), all of which are present in this quadrangle.

The lowest member of the Carmel Formation is the Kolob Limestone, which correlates with the limestone member described 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 directly to the west is variable. Goode (1973) measured 120 ft. (36.6 m) of thickness along Johnson Canyon and 200 ft. (61 m) along Skutumpah Canyon about one mile (16. km) east of Johnson Canyon, in the Skutumpah Creek quadrangle.

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, accounting for the designation as banded member, used by Cashion (1961). It contains some minor beds of gypsiferous shale, and red and green clay-pebble conglomerate. It also contains lenses of gravel, and boulders of rhyolite and andesite, plus some small lenses of gypsum. The thickness varies from 50 to 125 ft. (15-38 m).

In the Deer Spring Point quadrangle, the Kolob and Crystal Creek members thin and merge and are mapped together as the Judd Hollow Member. The thickness is 180 ft. (55 m) to 200 ft. (61 m).

The Thousand Pockets Tongue of the Navajo Sandstone is included within the Carmel Formation, where it overlies the Judd Hollow Member. It measures about 50 ft. (15 m) thick along the western quadrangle boundary and averages about 60 ft. (18 km) across the quadrangle. It is a yellow to white, faintly cross-bedded sandstone.

The Paria River Member overlies the Thousand Pockets Tongue of the Navajo Sandstone. The Paria River Member, also described as the gypsiferous member by Cashion, is a red gypsiferous sandstone with some interbedded white sandstone and purplish-red mud and siltstones. This member is 150 to 200 ft. (46 to 61 m) thick within the quadrangle. However, it may be up to 300 ft. (91 m) thick along the western quadrangle boundary (Goode, 1973).

The Winsor Member is predominantly fine-grained sandstone, ranging in color from white through brown. Thin red siltstones are interbedded within the sandstones. Goode (1973) reports the upper contact is marked by a white sandstone bed 10 to 20 ft. (3 to 6 m) thick.

The upper unit of the Carmel Formation is the Wiggler Wash Member. This member is composed of interbedded limestone, red siltstone, and white and greenish gypsum. Doelling and Graham (1972) report a thickness of 49 ft. (15 m).

The Entrada Formation, the youngest Jurassic formation present in the Deer Spring Point quadrangle, is beveled by a pre-Dakota erosion surface. Total thickness of the formation ranges from about 115 ft. (35 m), along the western quadrangle boundary, to 300 ft. (91 m), where the formation crops out about three miles (5 km) east of the western boundary. The Entrada Formation is divided into two members. The lower, or Gunsight Butte Member is approximately 45 feet thick along the western quadrangle boundary, and about 165 feet (50 m) thick three miles (5 km) to the east. The Gunsight Butte Member is principally red siltstone with thin, gray shale interbeds. The upper, or Cannonville, member is about 135 ft. (41 m) thick three miles (5 km) to the east. The Cannonville Member is a white, very fine-grained sandstone containing lenses of pebbles and mudstone. Low angle crossbeds are present near the top.

The Cretaceous Dakota Formation unconformably overlies the Jurassic Entrada Formation. The lower contact of the Dakota is distinct in color and lithology from underlying units and is easily located. However, the upper contact between the Dakota and 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 the same as that advocated by Lawrence (1965) and modified by Utah Geological and Mineralogical Survey practice (Doelling and Graham, 1972). Thus, 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 crops out only within the KRCRA in the northwest corner of the Deer Spring Point quadrangle.

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), which 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.

The Bald Knoll coal zone is within the lower 50 ft. (15 m) of the Dakota Formation while the Smirl coal zone is within the upper 50 ft. (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 ft. (9 m) high. The sandstone beds are lenticular and grade laterally into shale. Goode (1973) reports that the base of the coal bed in the Bald Knoll coal zone is within six to ten ft. (2 to 3 m) of the base of the Dakota Formation. The coal thickness of the Dakota Formation on the Podunk Creek quadrangle is about 200 ft. (61 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 complex environment ranging from fluvial to marine. The basal beds are generally of fluvial or near-shore origin, 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,regressions followed by renewed transgression.

There is a gradual fining upward from coarse sandstone, in places even conglomeratic, at the base of the Dakota Formation 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 underlying 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 of the formation.

The Tropic Shale is predominantly marine shale in the Deer Spring Point 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 area suggest that the Tropic Shale was deposited in a shallow marine environment.

The upper portions of a number of hills within the quadrangle are capped by Tertiary gravels. The gravels cover the upper portion of the Dakota Formation, including most outcrops of the Smirl coal zone, raising doubt as to whether either the upper part of the Dakota Formation or the lower part of the Tropic Shale is present in the quadrangle.

STRUCTURE

Folds

Regional structure in the Deer Spring Point quadrangle area is characterized by broad open folds and an occasional north-trending normal fault, frequently with large displacement. The structure of the Deer Spring Point quadrangle is typical of the Colorado Plateau province.

The Deer Spring Point quadrangle lies in the southeast portion of the Paunsaugunt Syncline (Doelling and Graham, 1972). The structure plunges north, and dips do not exceed 4^{o} on either limb. Dips at outcrops measure 2^{o} to 4^{o} to the northwest.

Faults

The Paunsaugunt Fault is the only known fault which significantly affects the Jurassic and Cretaceous strata on this quadrangle. The Paunsaugunt Fault zone has many minor faults and a few major faults associated with it. The Paunsaugunt Fault separates the Paunsaugunt Plateau to the west from the Kaiparowits Plateau to the east. It is a normal fault which dips 70^{o} to 80^{o} to the west, and movement across the fault varies from 200 ft. (61 m) to 500 ft. (152 m) (Doelling and Graham, 1972). Robison (1966) reported greater movement north of the quadrangle at Tropic Canyon, where more than 1500 ft. (457 m) of displacement was recognized. Locally, dips steepen to the west near the main faults within the fault zone. However, Grose, Hileman and Ward (1967) reported that major deformation was confined within 100 ft. (30 m) to 500 ft. (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 deposition in between. The coal was deposited as thin, discontinuous, and sometimes overlapping beds. Beds thicken locally, possibly because they were deposited in the deeper parts of an oxbow lake, swamp or lagoon.

Five measured sections of coal outcrops are available for this quadrangle. Two of these were published in Doelling and Graham (1972), and the other three were obtained from W.E. Bowers (1979). All of the sections were from the Smirl coal zone. There are no coal analyses.

Bald Knoll Coal Zone

The Bald Knoll coal zone thins as it approaches the Deer Spring Point quadrangle from the west or north (see Open-File Reports 80-105 and 80-107). Exposures are very poor, and it is possible that the Bald Knoll coal zone is absent. No coal sections have been measured in an identified Bald Knoll outcrop, and Doelling and Graham (1972) report the coal is thin and badly split.

Smirl Coal Zone

Coal beds within the Smirl coal zone have been measured in several outcrop areas (plate 1, table 1). The coal is present in a number of thin beds, but only one section (plate 3, no. 2) reaches a thickness of five ft. (1.5 m). The overlying gravel deposits make location and correlation of the Smirl beds difficult. Information currently available is insufficient to determine the amount and condition of coal which may be present within the Smirl coal zone.

Coal data on the adjacent Skutumpah Creek and Rainbow Point quadrangles suggest that any coal present in this quadrangle will be thin and erratically distributed (see Open-File Reports 80-105 and 80-107).

Coal Resources

Coal development potential and reserve base data were not determined due to lack of adequate information.

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Table 1. Sources of data used on Plate 1.

Plate 1 Index Number	Source	Data Base
1	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Measurement
2	" "	" "
3	Doelling and Graham, 1972, UG. & M.S., Monograph Series No. 1	Measured Section
4	Bowers, 1979, U.S.G.S., Unpublished field notes	Outcrop Measurement
5	Doelling and Graham, 1972, U.G. & M.S., Monograph Series No. 1	Measured Section