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COAL RESOURCE OCCURRENCE MAPS OF THE NORTHWEST QUARTER OF THE LLAVES 15-MINUTE QUADRANGLE, RIO ARRIBA COUNTY, NEW MEXICO

[Report includes 3 plates]

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NORTHWEST QUARTER OF THE LLAVES 15-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps of the northwest quarter of the Llaves 15-minute quadrangle, Rio Arriba County, New Mexico. These maps were compiled to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) of the western United States. The work was performed under contract with the Conservation Division of the U.S. Geological Survey (Contract No. 14-08-0001-17172).

The resource information gathered in this program is in response to the Federal Coal Leasing Amendments Act of 1976 and is part of the U.S. Geological Survey's coal program. The information provides basic data on coal resources for land-use planning purposes by the Bureau of Land Management, state and local governments, and the public.

Location

The northwest quarter of the Llaves 15-minute quadrangle is located in southwest Rio Arriba County. The area is approximately 74 miles (119 km) southeast of Farmington and 94 miles (151 km) north of Albuquerque, New Mexico.

Accessibility

The northwest quarter of the Llaves quadrangle is accessible from New Mexico State Route 112 which is east of the area. Light-duty roads extend into the quadrangle from State Route 112 and provide further access to the area. The Atchison, Topeka, and Santa Fe Railway operates a route 94 miles (151 km) southeast of the area which passes through Albuquerque, New Mexico.

Physiography

The quadrangle is in the east-central portion of the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. Elevations range from 7,020 ft (2,140 m) in Canoncito de las Yequas in the southeastern corner to 8,562 ft (2,610 m) in the east-central part of the area. The Nacimiento Monocline trends north-south across the eastern part of the area. The quadrangle is in the Yequas Mesas physiographic division of Baltz (1967). It is characterized by steep-walled canyons which separate long, narrow mesas. The western Continental Divide extends across both the northwestern and southwestern corners of the area.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than about 10 inches (25 cm) but varies across the basin due to elevational differences. Rainfall is rare in the early summer; most precipitation occurs in July and August as intense afternoon

thundershowers. Annual temperatures range from below 0°F (-18°C) to over 100°F (38°C) in the basin. Snowfall may occur from November to April with an average of 18 inches (46 cm) in the southern part of the basin.

Land Status

Approximately 8 percent of the quadrangle is in the northern portion of this isolated portion of the San Juan Basin Known Recoverable Coal Resource Area, which is located east of the main KRCRA area. The Federal Government owns the coal rights for all of the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps.

GENERAL GEOLOGY

Previous Work

Dane (1948) mapped the geology of the northern part of the area on a scale of 1:63,360. Baltz (1967) has mapped the geology of the entire quadrangle on the same scale. The most recent work in the area is a publication by Fassett and Hinds (1971) which includes subsurface interpretations of Fruitland Formation coal deposits throughout the San Juan Basin.

Geologic History

The San Juan Basin, an area of classic transgressive and regressive sedimentation, provided the ideal environment for formation of coals

during Late Cretaceous time. At that time a shallow epeiric sea, which trended northwest-southeast, was northeast of the basin. The sea transgressed southwesterly into the basin area and regressed northeasterly numerous times; consequently, sediments from varying environments were deposited across the basin. Noncarbonaceous terrestrial deposition predominated during Paleocene and Eocene time.

Depositional evidence of the final retreat of the Late Cretaceous sea is the nearshore regressive Pictured Cliffs Sandstone. Southwest (shoreward) of the beach deposits swamps, which were dissected by streams, accumulated organic matter which became coals of the Fruitland Formation. Deposition of organic material was influenced by the strandline as shown by both the continuity of the coal beds parallel to the northwest-southeast strandline and their discontinuity perpendicular to it to the northeast. The less continuous Fruitland coals appear to be noncorrelative, but are stratigraphically equivalent in terms of their relative position within the Fruitland Formation.

The brackish-water swamp environment of the Fruitland moved farther to the northeast as the regression continued in that direction. Terrestrial sediments covered the quadrangle as evidenced by lacustrine, channel, and floodplain deposits of the Kirtland Shale. This sequence of events is evidenced by both an upward decrease in occurrence and thickness of Fruitland coals and a gradational change to noncarbonaceous deposits of the Kirtland. Continuous deposition during Late Cretaceous time ended with the Kirtland. The sea then retreated beyond the limits of the quadrangle area, and modern basin structure began to develop. An erosional unconformity developed in a relatively short time as part of the Cretaceous Kirtland Shale was removed.

Terrestrial deposition resumed in the Paleocene as represented by the Ojo Alamo Sandstone and the overlying Nacimiento Formation. Alluvial plain and floodplain deposits of the Ojo Alamo were followed by the thick, lithologically varied deposits of the Nacimiento during continuous nonmarine deposition. The Nacimiento was later exposed to erosion.

The Eocene San Jose Formation was subsequently deposited over the Nacimiento erosional surface, reflecting various nonmarine environments which developed across the basin. Deposition in the basin then ceased. Structural deformation related to the Nacimiento uplift subsequently warped the strata in a long narrow belt along the Nacimiento Fault. Tectonic activity then subsided, and the warped strata of the San Juan Basin have been exposed to erosional processes to the present time.

Stratigraphy

The formations studied in this quadrangle range from Late Cretaceous to Eocene in age. They are, in order from oldest to youngest: the Pictured Cliffs Sandstone, the undivided Fruitland Formation and Kirtland Shale, Ojo Alamo Sandstone, Nacimiento Formation, and San Jose Formation. A composite columnar section on CRO Plate 3 illustrates the stratigraphic relationships of these formations and is accompanied by lithologic descriptions of the individual formations.

The Pictured Cliffs Sandstone averages 150 ft (46 m) thick. Because the unit is present throughout most of the San Juan Basin and displays a distinctive character on geophysical logs, the top was picked as the datum (CRO Plate 3) for Fruitland coal correlations. The formation consists

of a light brown to gray sandstone, with interbedded gray shale near the base. Interfingering with the overlying Fruitland Formation occurs throughout the basin and, consequently, minor Fruitland coals are often present in the upper portion of the Pictured Cliffs.

The major coal-bearing unit in the quadrangle is the Fruitland Formation. Due to an indistinct upper contact with the Kirtland Shale the two formations are not divided in the area. The average combined thickness is 130 ft (40 m) in this quadrangle. The deposits consist primarily of dark gray, carbonaceous to noncarbonaceous shale, interbedded white to brown sandstone, and lenticular coal beds.

The Paleocene Ojo Alamo Sandstone, which unconformably overlies the Kirtland Shale, is a buff to light brown, locally conglomeratic sandstone with interbedded gray to olive-gray shale. It averages 90 ft (27 m) in thickness.

Approximately 1,050 ft (320 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. Nacimiento rocks are exposed in the northeastern and southeastern corners of the quadrangle where they consist of gray to olive-gray shale, buff to tan, locally conglomeratic sandstone, and a thin (0.6-ft [0.2-m], Fassett and Hinds, 1971), local coal bed.

The San Jose Formation of Eocene age unconformably overlies the Nacimiento Formation. It is predominately red to brown to variegated shale, interbedded buff to tan to red, locally conglomeratic sandstone and interbedded red to brown siltstone. The San Jose Formation crops out across much of the quadrangle. Baltz (1967) has mapped the individual members of the San Jose Formation, but for the purpose of this report it was not necessary to distinguish between them.

Structure

The northwest quarter of the Llaves quadrangle is in the Central Basin area (Kelley, 1950) of the San Juan Basin. The axis of the basin is about 3 miles (5 km) southwest of the quadrangle area and trends northward in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). The Nacimiento Hogback trends north-south across the eastern half of the quadrangle. Dips along the Nacimiento Monocline average 15° to 17° to the west, with the angle decreasing westward to 2° (Baltz, 1967).

COAL GEOLOGY

One coal bed (Fruitland 1) was identified in the subsurface of this quadrangle (CRO Plate 1). The Fruitland 1 (Fr 1) coal bed is defined by the authors as the lowermost coal of the Fruitland Formation, which is generally directly above the Pictured Cliffs Sandstone. Since the coal bed is less than reserve base thickness (5 ft [1.5 m]) within the 3,000-foot (914-m) overburden study limit and is absent in several areas, derivative maps were not constructed.

Fruitland Formation coal in the eastern part of the San Juan Basin is considered high volatile A bituminous. The rank has been determined on a moist, mineral-matter-free basis with a calorific value of 14,545 Btu's per pound (33,832 kj/kg) (Amer. Soc. for Testing and Materials, 1977). The coal is hard, brittle, and black with a bright luster. The coal readily slakes with exposure to weather; however, it stocks fairly well when protected. The "as received" analysis indicates moisture content of 2.1 percent, a sulfur

content of 0.7 percent, an ash content of 22.5 percent, and a heating value of 10,990 Btu's per pound (25,563 kj/kg) (Dane, 1936; Fassett and Hinds, 1971). An analysis of an undesignated Fruitland Formation coal bed was included in the report by Fassett and Hinds (1971) and is given in Table 1.

COAL RESOURCES

Coal resources were not calculated for the Fruitland 1 coal bed within the 3,000-foot (914-m) overburden study limit because the coal is discontinuous and less than the reserve base thickness of 5 ft (1.5 m).

COAL DEVELOPMENT POTENTIAL

Coal development potential maps were not constructed for this quadrangle because Fruitland 1 coal within the 3,000-foot (914-m) overburden study limit is discontinuous and less than the reserve base thickness (5 ft [1.5 m]) and, therefore, has unknown coal development potential.

TABLE 1

Analyses of coal samples from the Fruitland Formation

(Form of analysis: A, as received; B, moisture free, C, moisture and ash free)

U.S. Bureau Mines Lab No.	Well or Other Source	Location Section	T.N.	R.W.	Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur	Heating Value (Btu)	Remarks
H-32405	El Paso Nat. Gas Lindrith No. 42	NE¼ 22	24	3	3,194-3,205	A	2.1	38.7	36.7	22.5	.7	10,990	
						B	----	39.5	37.5	23.0	.7	11,230	
						C	----	51.3	48.7	----	1.0	14,580	

To convert Btu's/lb to kj/kg, multiply Btu's/lb by 2.326.
To convert feet to meters, multiply feet by 0.3048.

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