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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SOUTHWEST QUARTER OF THE NAGEEZI 15-MINUTE QUADRANGLE, SAN JUAN AND RIO ARRIBA COUNTIES, NEW MEXICO

[Report includes 8 plates]

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SOUTHWEST QUARTER OF THE NAGEEZI 15-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps and Coal Development Potential (CDP) Map of the southwest quarter of the Nageezi 15-minute quadrangle, San Juan and Rio Arriba Counties, 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 a 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 southwest quarter of the Nageezi 15-minute quadrangle is located in east-central San Juan County and western Rio Arriba County, New Mexico. The area is approximately 38 miles (61 km) southeast of Farmington and 76 miles (122 km) northeast of Gallup, New Mexico.

Accessibility

State Route 44 extends across the southwestern corner of the quadrangle eastward through the village of Nageezi. South of Nageezi it is outside the quadrangle area, but reenters and crosses the southeastern corner. A single unimproved dirt road extends from State Route 44 in the southeast corner, northwestward across the area. Several dirt roads diverge from this road to provide access to the more remote areas. The nearest railway transportation is the Atchison, Topeka, and Santa Fe Railway which is approximately 76 miles (122 km) to the southwest at Gallup, New Mexico, and connects Gallup with Grants and Albuquerque to the east.

Physiography

The quadrangle is located in the southwestern portion of the Central Basin area (Kelley, 1950) of the larger structural depression known as the San Juan Basin. The total relief in the area is approximately 851 ft (259 m). Elevations range from 6,600 ft (2,012 m) in Blanco Wash to 7,451 ft (2,271 m) on Crow Mesa. The broad, gently-sloping plains of the Central Basin dip to the northeast in this area. Blanco Wash and its tributaries have mildly dissected the plains over the entire quadrangle, excluding the northeast corner at Crow Mesa. Streams on the southwest side of the mesa form a broad floodplain extending to Blanco Wash. However, steep-walled canyons have been carved into the northeast side of Crow Mesa.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than about 10 inches (25 cm), with slight variations across the basin due to elevational differences. Rainfall is rare in the early summer and winter; most precipitation is received in July and August as intense afternoon thundershowers. Annual temperatures in the basin range from 0°F (-18°C) to over 100° (38°C). Snowfall occurs from November to April with an average of 18 inches (46 cm) in the southwestern part of the basin.

Land Status

The quadrangle is in the south-central portion of the San Juan Basin Known Recoverable Coal Resource Area, and the Federal Government owns the coal rights for approximately 86 percent of the KRCRA land as shown on Plate 2 of the Coal Resource Occurrence Maps. No Federal coal leases occur within the quadrangle.

GENERAL GEOLOGY

Previous Work

Reeside (1924) mapped the surficial geology of the quadrangle area on a scale of 1:250,000 as part of a study of the Upper Cretaceous and Tertiary formations of the San Juan Basin. More recently, Fassett and Hinds

(1971) made subsurface interpretations of Fruitland Formation coal occurrences as part of a larger San Juan Basin coal study.

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, lay 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.

The first 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 lithostratigraphically 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 freshwater sediments covered the quadrangle as indicated by the 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 and structural deformation of the basin then ceased, and the warped strata of the San Juan Basin have been exposed 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: Pictured Cliffs Sandstone, Fruitland Formation, 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 95 ft (29 m) in thickness in this quadrangle. Because it is a persistent unit throughout most of the San Juan Basin and easily recognized on geophysical logs, the top of the Pictured Cliffs Sandstone was picked as the datum (CRO Plate 3) for Fruitland coal correlations. The formation consists of a light gray to tan, micaceous friable sandstone with interstitial kaolinite, and interbedded gray-green siltstone and claystone near the base of the unit. Intertonguing with the overlying Fruitland Formation occurs throughout the entire basin, and, consequently, minor Fruitland coal beds commonly are present in the upper portion of the Pictured Cliffs Sandstone.

The major coal-bearing unit in the quadrangle, the Fruitland Formation, conformably overlies the Pictured Cliffs Sandstone. Wide variations in reported thickness are common due to an indistinct upper contact. The Fruitland averages about 245 ft (75 m) in this quadrangle. Many authors have utilized various criteria for establishing the upper Fruitland Formation boundary, but for this study the uppermost coal was generally chosen as the contact (after Fassett and Hinds, 1971). The formation is predominantly a gray, carbonaceous shale with plant fossils, traces of pyrite, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 380 ft (116 m) in thickness in this area. It consists of freshwater, gray-green to purple to brown siltstone, and thin, gray, slightly micaceous, calcareous, kaolinitic sandstone with traces of pyrite. The Kirtland Shale has previously been divided into several members by various authors; however, for the purposes of this report it was not necessary to distinguish between the individual members.

The Paleocene Ojo Alamo Sandstone, which unconformably overlies the Kirtland Shale, is a white to light gray, medium- to very coarse-grained, locally conglomeratic, friable, micaceous, kaolinitic sandstone with interbedded gray-green to purple to brown siltstone. It averages 230 ft (70 m) in thickness in this area.

Approximately 1,120 ft (341 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. Nacimiento Formation rocks are exposed in all of the quadrangle area, excluding the northeastern corner. They consist of tan to gray to maroon siltstone with traces of pyrite, and light gray, fine-grained to conglomeratic, slightly micaceous sandstone with pink and white feldspar grains and scattered chert pebbles.

The San Jose Formation of Eocene age unconformably overlies the Nacimiento Formation and crops out over the northeastern part of the quadrangle area. It consists of buff to yellow, fine- to coarse-grained, locally conglomeratic, arkosic sandstone, brown to gray shale, and their lithologic gradations.

Structure

The southwest quarter of the Nageezi 15-minute quadrangle is located in the Central Basin area (Kelley, 1950) of the major structural depression, the San Juan Basin. The axis of the basin is about 29 miles (47 km) northeast of the quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Regional dip within the quadrangle is to the northeast at approximately 1° to 2°.

COAL GEOLOGY

One coal bed (Fruitland 1) and one coal zone (Fruitland) were identifed in the subsurface of this quadrangle (CRO Plate 1). The Fruitland 1 (Fr 1) coal bed is defined as the lowermost coal of the Fruitland Formation; it lies directly above the Pictured Cliffs Sandstone. The upper Fruitland Formation coal beds were grouped together as the Fruitland coal zone (Fr zone) which extends from the top of the Fruitland Formation to the base of the lowermost coal designated on CRO Plate 3 as a Fruitland zone coal bed. Since these coals are not extensive and are less than reserve base thickness (5 ft [1.5 m]), derivative maps were not constructed.

Fruitland Formation coal beds in the southern part of the San Juan Basin are considered to be high volatile B to A bituminous in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values ranging from 13,820 to 14,102 Btu's per pound (32,145-32,801 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; however, it stocks fairly well when protected. The "as-received" analyses indicate moisture content averaging 4.2 percent, sulfur content ranging from 0.6 to 1.1 percent, ash content varying from 13.5 to 31.0 percent, and heating values on the order of 10,343 Btu's per pound (24,058 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; Fassett and Hinds, 1971).

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			Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent					Heating Value (Btu)	Remarks
		Section	T.N.	R.W.			Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur		
H-31101	Val Reese & Assoc.	NE¼ 27	24	7	2,140-2,150	A	4.4	40.9	41.2	13.5	0.6	11,790	
	Lybrook No. 7-27					B	----	42.8	43.1	14.1	0.6	12,340	
						C	----	49.9	50.1	----	0.7	14,370	
H-5022	Dorfman Production	SE¼ 12	24	8	2,525-2,535	A	3.9	35.4	33.7	27.0	1.1	9,960	
	Nancy Fed. No. 1					B	----	36.8	35.1	28.1	1.1	10,370	
						C	----	51.2	48.8	----	1.5	14,410	
H-16695	Century Exploration	SW¼ 21	25	9	1,620-1,625	A	4.2	31.5	33.3	31.0	0.9	9,280	
	Mobil-Rudman No. 2					B	----	32.8	34.8	32.4	0.9	9,680	
						C	----	48.6	51.4	----	1.4	14,310	

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.

Fruitland 1 Coal Bed

The Fruitland 1 coal bed, informally named by the authors, represents the lowermost coal bed which occurs near the base of the Fruitland Formation. Although the Fruitland 1 coal bed is correlated and mapped as a continuous horizon it may, in fact, be several different beds that are lithostratigraphically equivalent but not laterally continuous.

As illustrated by the structure contour map (CRO Plate 5), the Fruitland 1 coal bed dips approximately 1° to the northeast. Consequently, overburden increases from less than 1,400 ft (427 m) in the southwest to over 2,200 ft (671 m) in the northeast (CRO Plate 6). The isopach map (CRO Plate 4) illustrates a westward trend of increasing thickness: the Fruitland 1 is absent in portions of the northern and southeastern parts of the quadrangle; however, to the west the coal bed is greater than 10 ft (3.0 m) thick.

Chemical Analyses of the Fruitland 1 Coal Bed - Several analyses of Fruitland Formation coals from this quadrangle and the surrounding area were published by Fassett and Hinds (1971). The results of these analyses are given in Table 1.

COAL RESOURCES

Coal resource data from oil and gas wells and pertinent publications were utilized in the construction of isopach and structure contour maps of the coal in this quadrangle. All of the coals studied in the southwest quarter of the Nageezi 15-minute quadrangle are more than 1,390 ft (424 m) below the ground surface and, thus, have no outcrop or surface development potential.

The U.S. Geological Survey designated the Fruitland 1 coal bed for the determination of coal resources in this quadrangle. Coals of the Fruitland zone were not evaluated because the thickness of the coal beds is generally less than the reserve base thickness (5 ft [1.5 m]). In addition, these coals are irregular, noncorrelative, and limited in areal extent.

For Reserve Base and Reserve calculations, the Fruitland 1 coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plate 7) according to criteria established in U.S. Geological Survey Bulletin 1450-B. Data for calculation of Reserve Base and Reserves for each category were obtained from the coal isopach (CRO Plate 4) and areal distribution maps (CRO Plate 7). The surface area of the isopached Fruitland 1 bed was measured by planimeter, for each category, in acres. The number was then multiplied by the average isopached thickness of the coal bed and 1,800 short tons of coal per acre-foot (13,239 tons/hectare-meter), the conversion factor for bituminous coal, which yields the Reserve Base coal, in short tons, for the Fruitland 1 coal bed. In order to calculate Reserves, a recovery factor of 50 percent was applied to the Reserve Base tonnages for underground coal.

Reserve Base and Reserve values for measured, indicated, and inferred categories of coal for the Fruitland 1 coal bed are shown on CRO Plate 7, and are rounded to the nearest hundredth of a million short tons. The total coal Reserve Base, by section, is shown on CRO Plate 2 and totals approximately 197.5 million short tons (179.1 million metric tons).

The coal development potential for the Fruitland 1 bed is calculated in a manner similar to the Reserve Base, from planimetered measurements, in acres, for areas of high, moderate, and low potential for subsurface mining methods. The southwest quarter of the Nageezi 15-minute quadrangle has development potential for subsurface mining methods only (CDP Plate 8).

COAL DEVELOPMENT POTENTIAL

Coal beds of 5 ft (1.5 m) or more in thickness which are overlain by 200 ft (61 m) or more of overburden are considered to have potential for underground mining and are designated as having high, moderate, or low development potential according to the overburden thickness: 200 to 1,000 ft (61-305 m), high; 1,000 to 2,000 ft (305-610 m), moderate; and 2,000 to 3,000 ft (610-914 m), low. Table 2 summarizes the coal development potential, in short tons, for underground coal of the Fruitland 1 coal bed.

Development Potential for Surface Mining Methods

All coals studied in the southwest quarter of the Nageezi 15-minute quadrangle occur 1,390 ft (424 m) or more below the ground surface and, therefore, they have no coal development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

Underground coal of the Fruitland 1 coal bed has moderate development potential in the western, central, and southeastern parts of the area (CDP Plate 8); the coal bed thickness increases from 5 ft (1.5 m) in the

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE SOUTHWEST QUARTER OF THE NAGEEZI 15-MINUTE QUADRANGLE, SAN JUAN AND RIO ARRIBA COUNTIES, NEW MEXICO

(To convert short tons to metric tons, multiply by 0.9072)

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Fruitland 1	--	180,090,000	17,530,000	197,620,000
TOTAL	--	180,090,000	17,530,000	197,620,000

southwest corner and at the center of the quadrangle to more than 10 ft (3.0 m) at the western border (CRO Plate 4), and overburden ranges from less than 1,400 ft (427 m) in the southwest to 2,000 ft (610 m) in the center of the area (CRO Plate 6). Overburden in the southeast corner of the quadrangle is approximately 1,800 ft (549 m). The Fruitland 1 has low development potential in several small areas adjacent to the northern boundary of the zone of moderate development potential (CDP Plate 8). Coal thickness in this narrow band is 5 to 6 ft (1.5-1.8 m), and overburden is approximately 2,050 ft (625 m) thick.

Most of the eastern and northern parts of the quadrangle have unknown coal development potential because the coal of the Fruitland 1 is less than the reserve base thickness of 5 ft (1.5 m) in those areas. Areas with no development potential occur in the northeast and in the east-central to south-central parts of the quadrangle, where the Fruitland 1 coal bed is not present.

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