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

[Report includes 11 plates]

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SOUTHEAST 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 the Coal Development Potential (CDP) Map of the southeast quarter of the Nageezi 15-minute quadrangle, Rio Arriba and San Juan 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 southeast quarter of the Nageezi 15-minute quadrangle is located in west-central Rio Arriba County and southeast San Juan County, New Mexico. The area is approximately 44 miles (70 km) southeast of Farmington and 82 miles (132 km) northeast of Gallup, New Mexico.

Accessibility

State Route 44 extends across the southwest corner of the area but provides limited access. In general, unimproved dirt roads allow access to most of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates a route approximately 82 miles (132 km) to the southwest at Gallup, New Mexico, which extends southeast and southwest.

Physiography

The quadrangle is in the Central Basin area (Kelley, 1950) of the San Juan Basin. Total relief in the area is approximately 1,048 ft (319 m). Elevations range from 6,520 ft (1,987 m) in Rockhouse Canyon at the eastern boundary of the quadrangle to 7,568 ft (2,307 m) on Crow Mesa. The area is characterized by a broad, gently-sloping plain which has been dissected by intermittent streams to form finger-like mesas which are separated by wide, steep-walled canyons. The drainage divide is Crow Mesa, with most of the streams in the area draining northeast into Canon Largo or southwest into Blanco Wash.

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

Land Status

The quadrangle is in the south-central part of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 89 percent of the KRCRA land within the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. No Federal coal leases occur in the quadrangle.

GENERAL GEOLOGY

Previous Work

Fassett and Hinds (1971) made subsurface interpretations of Fruitland Formation coal occurrences in the quadrangle area 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, 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.

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 later 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 freshwater sediments then covered this 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 to the northeast 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: the 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 80 ft (24 m) in thickness. Because it is a persistent unit throughout most of the San Juan Basin and easily recognized on geophysical logs, the top was picked as the datum (CRO Plate 3) for Fruitland coal correlations. The formation consists of a white to light gray, friable, slightly calcareous sandstone interbedded with gray to green shale near the base of the unit. Intertonguing with the overlying

Fruitland Formation occurs throughout the entire basin and, consequently, minor Fruitland coal beds are commonly present in the upper portion of the Pictured Cliffs.

The major coal-bearing unit in the quadrangle is the Fruitland Formation. Wide variations in reported thickness are common due to an indistinct upper contact, but the average is about 185 ft (56 m) in this quadrangle. Many authors have used various criteria to establish the upper boundary, but, in general, for this study the uppermost coal was chosen (after Fassett and Hinds, 1971). The formation consists primarily of gray to brown, carbonaceous shale with plant fossils, interbedded kaolinitic siltstone, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 325 ft (99 m) thick in this area. It is predominantly freshwater, gray-green to brown to mottled siltstone with plant fossils, and interbedded white, quartzitic, friable, kaolinitic sandstone. The formation 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 conformably overlies the Kirtland Shale. It is a white to cream, coarse-grained to conglomeratic sandstone with interbedded shale lenses and averages 120 ft (37 m) in thickness.

Approximately 1,390 ft (424 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. These rocks are exposed in the southwestern corner of the quadrangle where they consist of light to dark gray siltstone, interbedded gray shale, and buff to yellow sandstone.

The San Jose Formation of Eocene Age unconformably overlies the Nacimiento Formation and crops out over most of the quadrangle area. It consists of buff to yellow, fine- to very coarse-grained, arkosic sandstone and interbedded gray to green, silty shale.

Structure

The southeast quarter of the Nageezi 15-minute quadrangle is located in the Central Basin area (Kelley, 1950) of the major structural depression known as the San Juan Basin. The axis of the basin is about 20 miles (32 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 approximately 1° to 2° to the northeast.

COAL GEOLOGY

One coal bed (Fruitland 1) and a coal zone (Fruitland) are identified and mapped in the subsurface of this quadrangle (CRO Plate 1). The Fruitland 1 (Fr 1) is defined by the authors as the lowermost coal of the Fruitland Formation; it is generally directly above the Pictured Cliffs Sandstone. Above the Fruitland 1 coal bed is the Fruitland coal zone (Fr zone), extending from the top of the Fruitland Formation to the base of the lowermost coal which is designated (CRO Plate 3) as a Fruitland zone coal bed. The zone consists of several coal beds which are generally noncorrelative and less than reserve base thickness (5 ft [1.5 m]); exceptions are a a 5-ft (1.5-m) bed in drill hole 15 and a 6-ft (1.8 m) bed in drill holes 28, 29, and 30 (CRO Plate 1).

Fruitland Formation coal beds in the southern part of the San Juan Basin are considered borderline high volatile B to high volatile A bituminous in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values ranging from 13,820 to 14,227 Btu's per pound (32,145-33,092 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" analyses indicate moisture content varying from 3.6 to 4.4 percent, ash content ranging from 13.5 to 24.5 percent, sulfur content less than one percent, and heating values on the average of 11,357 Btu's per pound (26,416 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; Fassett and Hinds, 1971).

Fruitland 1 Coal Bed

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

As illustrated by the structure contour map (CRO Plate 5), the coal bed dips approximately 1° to the northeast. Consequently, overburden (CRO Plate 6) increases from less than 2,000 ft (610 m) in the south to greater

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.			Mois-ture	Volatile matter	Fixed Carbon	Ash	Sulfur		
H-22075	Val Reese & Assoc. Bobby "B" No. 2-31	NE¼ 31	24	6	2,070-2,090	A	3.6	41.1	40.6	14.7	0.7	11,840	
						B	---	42.6	42.2	15.2	0.7	12,280	
						C	---	50.2	49.8	----	0.9	14,480	
H-31101	Val Reese & Assoc. Lybrook No. 7-27	NE¼ 27	24	7	2,140-2,150	A	4.4	40.9	41.2	13.5	0.6	11,790	
						B	---	42.8	43.1	14.1	0.6	12,340	
						C	---	49.9	50.1	----	0.7	14,370	
H-37832	Merrion & Associates Federal No. 3-35	SW¼ 35	25	6	2,455-2,465	A	3.6	36.3	35.6	24.5	0.8	10,440	
						B	---	37.7	36.9	25.4	0.8	10,830	
						C	---	50.5	49.5	----	1.1	14,510	

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.

than 2,600 ft (792 m) to the north. As indicated by the isopach map (CRO Plate 4), the coal bed is greater than 5 ft (1.5 m) in parts of the north, central, and southwest quadrangle area. Throughout most of the quadrangle the coal bed is less than 5 ft (1.5 m) thick, and the coal is absent in the northeastern, southeastern, and western parts of the area.

Chemical Analyses of the Fruitland 1 Coal Bed - Analyses of several Fruitland Formation coal beds from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland Coal Zone

The Fruitland coal zone 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. The structure contour map (CRO Plate 9) is drawn using the top of the Fruitland Formation. As illustrated by the map, the coal zone dips approximately 1° to the northeast. Consequently, overburden (CRO Plate 10) increases from less than 1,800 ft (549 m) in the south to greater than 2,500 ft (762 m) in the northeast. Also shown on CRO Plate 10 is the total amount of interburden within the Fruitland coal zone, which is the noncoal-bearing thickness from the top of the Fruitland Formation to the top of the lowermost coal designated (CRO Plate 3) as a Fruitland zone coal bed. The interburden values vary from zero to greater than 200 ft (61 m). The thickness variation is the result of the number of coal beds and their stratigraphic position within the Fruitland zone. The isopach map (CRO Plate 8) shows the total thickness of the coals of the Fruitland zone. The maximum thickness is greater than 15 ft (4.6 m) and occurs in the central and southwestern portions of the quadrangle. The total thickness decreases to zero in the eastern, northern, and southwestern parts of the map.

Chemical Analyses of the Fruitland Zone Coal Beds - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

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 coals in this quadrangle. All of the coals studied in the southeast quarter of the Nageezi 15-minute quadrangle are more than 200 ft (61 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, 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. This 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 66.8 million short tons (60.6 million metric tons).

The coal development potential for the Fruitland 1 bed was 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 southeast quarter of the Nageezi 15-minute quadrangle has development potential for subsurface mining methods only (CDP Plate 11).

COAL DEVELOPMENT POTENTIAL

Coal beds of 5 ft (1.5 m) or more in thickness which are overlain by 200 to 3,000 ft (61-914 m) 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.

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE SOUTHEAST QUARTER OF THE NAGEEZI 15-MINUTE QUADRANGLE, RIO ARRIBA AND SAN JUAN 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	--	10,270,000	56,530,000	66,800,000
TOTAL	--	10,270,000	56,530,000	66,800,000

Development Potential for Surface Mining Methods

All coals studied in the southeast quarter of the Nageezi 15-minute quadrangle occur more than 200 ft (61 m) below the ground surface and, thus, they have no coal development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

Underground coal of the Fruitland 1 bed has moderate development potential in the south-central and southwestern parts of the quadrangle (CDP Plate 11) where the coal bed thickness varies from 5 to 8 ft (1.5-2.4 m) (CRO Plate 4), and the overburden thickness is approximately 1,950 to 2,000 ft (594-610 m) (CRO Plate 6). The Fruitland 1 has low potential in the north-central, central, south-central, and southwestern parts of the quadrangle. Coal bed thickness for these areas ranges from 5 to 7 ft (1.5-2.1 m), and the overburden thickness increases from 2,000 ft (610 m) in the south to approximately 2,600 ft (792 m) in the north. Most of the quadrangle area has unknown development potential where the Fruitland 1 coal bed is less than the reserve base thickness of 5 ft (1.5 m). Isolated areas in the northeast, west-central, and east-central to southeast have no Fruitland 1 coal and, thus, have no development potential.

REFERENCES

American Soc. for Testing and Materials, 1977, Gaseous fuels; coal and coke; atmospheric analysis, in Annual book of ASTM standards, part 26: p. 214-218.

Baltz, E.H., Jr., 1967, Stratigraphy and regional tectonic implications of part of Upper Cretaceous and Tertiary rocks, east-central San Juan Basin, New Mexico: U.S. Geol. Survey Prof. Paper 552, p. 12.

Bauer, C.M., and Reeside, J.B., Jr., 1921, Coal in the middle and eastern parts of San Juan County, New Mexico: U.S. Geol. Survey Bull. 716-G, p. 177-178.

Dane, C.H., 1936, The La Ventana - Chacra Mesa coal field, pt. 3 of Geology and fuel resources of the southern part of the San Juan Basin, New Mexico: U.S. Geol. Survey Bull. 860-C, p. 137-138, [1937].

El Paso Natural Gas Co., Well log library, Farmington, New Mexico.

Fassett, J.E., and Hinds, J.S., 1971, Geology and fuel resources of the Fruitland Formation and Kirtland Shale of the San Juan Basin, New Mexico and Colorado: U.S. Geol. Survey Prof. Paper 676, 76 p.

Kelley, V.C., 1950, Regional structure of the San Juan Basin in New Mexico Geol. Soc. Guidebook of the San Juan Basin, New Mexico and Colorado, 1st Field Conf., p. 102.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geol. Survey Bull. 1450-B, 7 p.

U.S. Department of the Interior, 1949, Map of portion of San Juan and Rio Arriba Counties, New Mexico: U.S. Geol. Survey Oil and Gas Operations Map Roswell 66, revised 1974, 1:31,680.

________, 1951, Map of portion of Rio Arriba County, New Mexico: U.S. Geol. Survey Oil and Gas Operations Map Roswell 67, revised 1974, 1:31,680.

________, 1955, Map of portion of Rio Arriba and Sandoval Counties, New Mexico: U.S. Geol. Survey Oil and Gas Operations Map Roswell 75, revised 1975, 1:31,680.

________, 1955, Map of portion of Rio Arriba, Sandoval, and San Juan Counties, New Mexico: U.S. Geol. Survey Oil and Gas Operations Map Roswell 76, revised 1974, 1:31,680.