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

[Report includes 8 plates]

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NORTHEAST 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) Maps of the northeast 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 northeast quarter of the Nageezi 15-minute quadrangle is located in west-central Rio Arriba and eastern San Juan Counties, New Mexico. The area is approximately 38 miles (61 km) southeast of Farmington, New Mexico, and 110 miles (177 km) northwest of Albuquerque, New Mexico.

Accessibility

A light-duty road along Canon Largo connects with State Route 17, 20 miles (32 km) northwest of the area, and is the major access route into the area. Several unimproved dirt roads extend southward from Canon Largo and parallel Big Rincon, Palluche, and Cibolo washes. The nearest railway transportation is the Atchison, Topeka, and Santa Fe Railway which is approximately 38 miles (61 km) to the southwest at Gallup, New Mexico, and heads southeast and southwest from Gallup.

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. Total relief in the area is approximately 1,024 ft (312 m). Elevations range from 6,110 ft (1,862 m) in the bottom of Canon Largo to 7,134 ft (2,174 m) on top of Smouse Mesa. Broad, gently-sloping plains in this part of the Central Basin area were once graded to the level of Canon Largo. Subsequently, the tributaries carved steep-sided mesas from these plains. Most of the streams in the area are intermittent and drain northeastward into Canon Largo, which flows intermittently into the San Juan River.

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° (38°C) in the basin. 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 east-central portion of the San Juan Basin Known Recoverable Coal Resource Area, and the Federal Government owns the coal rights for approximately 91 percent of the KRCRA land within the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. No Federal coal leases occur within 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 located 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 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 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 by removal of part of the Cretaceous Kirtland Shale.

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 the 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 is a regressive sandstone of near-shore marine origin which averages 75 ft (23 m) in thickness in this area. 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 cream to light gray, calcareous, kaolinitic, slightly micaceous, friable sandstone, interbedded with gray shale near the base of the unit. Intertonguing with the overlying Fruitland Formation occurs throughout the entire basin and, consequently, minor Fruitland coal beds commonly occur in the upper portion of the Pictured Cliffs.

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 220 ft (67 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 taken as the upper contact (after Fassett and Hinds, 1971). The formation consists primarily of gray to brown, carbonaceous shale with plant fossils, interbedded siltstone, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 335 ft (102 m) in thickness in this area. It is predominantly freshwater, gray-green to brown shale with plant fossils, and gray-green siltstone with plant fossils. 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 tan to gray, slightly arkosic, locally conglomeratic, silty sandstone with interbedded gray shale. It averages 170 ft (52 m) in thickness.

Approximately 1,100 ft (335 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. Nacimiento Formation rocks consist of gray-green to brown shale, tan to gray, silty sandstone, and tan to gray-green, micaceous siltstone.

The San Jose Formation of Eocene age unconformably overlies the Nacimiento Formation and crops out over the entire quadrangle area. It consists of tan to gray-green, locally conglomeratic, arkosic, slightly micaceous, friable sandstone; gray-green to brown, occasionally sandy shale; and gray-green to maroon siltstone.

Structure

The northeast 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 17 miles (27 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 a coal zone (Fruitland) were identified and mapped in the subsurface of this quadrangle (CRO Plate 1). The Fruitland 1 (Fr 1) coal bed is herein defined as the lowermost coal of the Fruitland Formation; it generally lies 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 (5 ft [1.5 m]) thickness. However, there are several coals of greater than reserve base (5 ft [1.5 m]) thickness within the zone: a 5-ft (1.5-m) bed in drill holes 10, 19, and 21; two 5-ft (1.5-m) beds in drill hole 18; and a 6-ft (1.8-m) bed in drill hole 11 (CRO Plate 1). Since these coals are noncorrelative and discontinuous, derivative maps were not constructed.

Fruitland Formation coal beds in the southern part of the San Juan Basin are considered high volatile A bituminous in rank. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values averaging 14,824 Btu's per pound (34,481 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 farily well when protected (Bauer and Reeside, 1921; Dane, 1936). The "as-received" analyses indicate moisture content ranging from 1.3 to 3.6 percent, ash content varying from 14.8 to 30.5 percent, sulfur content less than one percent, and heating values averaging 11,234 Btu's per pound (26,130 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (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 Picured 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.

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-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	
H-32698	Caulkins Oil State "A" MD No. 62	NE¼ 2	26	6	3,184-3,200	A	1.3	38.9	41.4	18.4	0.7	12,130	
						B	----	39.4	41.9	18.7	0.7	12,290	
						C	----	48.4	51.6	----	0.9	15,120	
H-5020	Kay Kimbell Leiberman No. 5	SW¼ 19	26	7	2,105-2,150	A	2.5	38.1	41.2	18.2	0.6	11,760	
						B	----	39.1	42.2	18.7	0.6	12,060	
						C	----	48.1	51.9	----	0.8	14,830	
H-33317	El Paso Nat. Gas S.J.U. 27-5 No. 74	SE¼ 23	27	5	3,250-3,260	A	3.1	34.4	39.5	23.0	0.8	11,080	
						B	----	35.6	40.7	23.7	0.9	11,440	
						C	----	46.6	53.4	----	1.1	15,010	
H-33643	El Paso Nat. Gas Rincon Unit No. 171	SW¼ 21	27	6	3,165-3,180	A	1.4	39.3	44.5	14.8	0.9	12,690	
						B	---	39.8	45.2	15.0	0.9	12,870	
						C	----	46.9	53.1	----	1.1	15,150	
H-35788	El Paso Nat. Gas Rincon Unit No. 177	SE¼ 13	27	7	3,130-3,140	A	2.3	32.9	34.3	30.5	0.8	9,900	
						B	----	33.7	35.1	31.2	0.8	10,130	
						C	----	48.9	51.1	----	1.2	14,720	
H-7224	El Paso Nat. Gas S.J.U. 28-5 No. 50	SW¼ 28	28	5	3,323-3,345	A	2.6	31.6	39.0	26.8	0.6	10,640	
						B	----	32.5	40.0	27.5	0.6	10,920	
						C	----	44.8	55.2	----	0.9	15,070	

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

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 2,100 ft (640 m) in the southwest to greater than 2,800 (853 m) in the northeast portion of the quadrangle. The isopach map (CRO Plate 4) shows the greatest thickness of the Fruitland 1 coal bed occurs in the north-central part of the map where the coal is greater than 20 ft (6.1 m) thick. The coal decreases in thickness in all directions, and is absent in areas of the southwest, southeast, and eastern portions of the quadrangle.

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).

COAL RESOURCES

Coal resource data from oil and gas wells and pertinent publications were utilized in the construction of isopach and structure contour maps for this quadrangle. All of the coals studied in the northeast quarter of the Nageezi 15-minute quadrangle lie more than 2,000 ft (610 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, yielding 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. However, in areas of underground coal exceeding 12 ft (3.6 m) in thickness, the Reserves (mineable coal) were calculated on the basis of a maximum coal bed thickness of 12 ft (3.6 m) which represents the maximum economically mineable thickness for a single coal bed in this area by current underground mining technology.

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 388 million short tons (352 million metric tons).

The coal development potential for the Fruitland 1 bed is calculated in a similar manner to the Reserve Base, from planimetered measurements, in acres, for areas of high, moderate, and low potential for subsurface mining methods. The northeast 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 (306-610 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 northeast quarter of the Nageezi 15-minute quadrangle occur more than 2,000 ft (610 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 coal bed has low development potential throughout most of the northern and central parts of the quadrangle (CDP Plate 8). The coal thickness in these areas ranges from 5 to 20 ft (1.5-6.1 m) (CRO Plate 4) and the overburden increases from approximately 2,100 ft (64 m) in the northwest to almost 3,000 ft (914 m) near the center of the quadrangle area (CRO Plate 6).

The remaining areas with Fruitland 1 coal (west, southwest, east and southeast) have unknown development potential because the coal is less

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE NORTHEAST 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	--	--	388,640,000	388,640,000
TOTAL	--	--	388,640,000	388,640,000

than the reserve base thickness of 5 ft (1.5 m). Areas with no Fruitland 1 coal in the extreme southeast, and in the southwest and northeast, have no development potential for subsurface mining methods.

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.