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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAPS OF THE FLORA VISTA QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

[Report includes 8 plates]

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FLORA VISTA 7 1/2-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 Flora Vista quadrangle, San Juan 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 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 Flora Vista 7 1/2-minute quadrangle is located in north-central San Juan County, New Mexico. The area is approximately 8 miles (13 km) northeast of Farmington. Aztec, New Mexico, is located on the east-central border of the quadrangle.

Accessibility

The Flora Vista quadrangle is accessible by New Mexico State Route 550 which passes northeast-southwest through the area. Light-duty roads which extend across State Route 550 provide access to other parts of the quadrangle. The Atchison, Topeka, and Santa Fe Railroad operates a route which is 96 miles (154 km) to the southwest at Gallup, New Mexico, and extends southeast and southwest.

Physiography

This quadrangle is in the northwestern portion of the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. Elevations range from 5,448 ft (1,661 m) in the Animas River Valley in the west to 6,282 ft (1,915 m) in the northwest. The Animas River flows northeast-southwest through the quadrangle and is surrounded by low hills which are dissected by numerous arroyos. The Beeline Reservoir is north of the Animas River in the western part 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) 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 below 0°F (-18°C) to over 100° (38°C) in the basin. Snowfall may occur from November to April.

Land Status

The quadrangle is in the northern part of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 68 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

Reeside (1924) mapped the surficial geology of the area 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 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 north-south strandline in this quadrangle and their discontinuity perpendicular to it to the east. 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 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. A significant amount of erosion has occurred, as indicated by the removal of the San Jose Formation and the upper part of the Nacimiento Formation from the area.

Stratigraphy

The formations studied in this quadrangle range from Late Cretaceous to Paleocene in age. They are, in order from oldest to youngest: Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, and Nacimiento 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 120 ft (37 m) thick in the area. Because the unit is persistent 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 light gray to tan, friable, kaolinitic, slightly glauconitic sandstone, and

interbedded gray siltstone with sandy stringers 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.

The major coal-bearing unit in the quadrangle, the Fruitland Formation, conformably overlies the Pictured Cliffs Sandstone. Wide variations in reported thickness of the Fruitland are common due to an indistinct upper contact with the Kirtland Shale, but the average is about 350 ft (107 m) in this quadrangle. Many authors have utilized various criteria to establish the upper contact, but, in general, for this study the uppermost coal was chosen (after Fassett and Hinds, 1971). The formation consists primarily of gray, carbonaceous shale with plant fossils and siderite nodules, interbedded light gray, calcareous sandstone with interstitial kaolinite, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 1,060 ft (323 m) thick in this area. It is predominantly freshwater, gray-green to brown siltstone with sandy stringers and plant fossils, interbedded buff, slightly calcareous sandstone, and interbedded gray shale. 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, which unconformably overlies the Kirtland Shale, is a light gray, locally conglomeratic sandstone with interstitial kaolinite, and interbedded gray shale near the base of the formation. It averages 110 ft (34 m) in thickness and is exposed in the southwestern corner of the area in the Animas River Valley.

The Paleocene Nacimiento Formation is exposed across most of the quadrangle. It consists of gray to gray-green shale, interbedded gray to green siltstone and claystone, and interbedded white to tan sandstone.

Structure

The Flora Vista quadrangle is in the Central Basin area (Kelley, 1950) of the major structural depression known as the San Juan Basin. The axis of the basin is in the east-central part of the quadrangle area and trends eastward in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Reeside (1924) stated that the rocks in this area are "nearly horizontal".

COAL GEOLOGY

Four coal beds (Fruitland 1, Fruitland 2, Fruitland 3, Fruitland 4) and a coal zone (Fruitland) are 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; it is generally directly above the Pictured Cliffs Sandstone. However, occasionally there is a local (L) coal bed. Above the Fruitland 1 (when present) is the Fruitland 2 (Fr 2) coal bed; the two are separated by a rock interval averaging 8 ft (2.4 m); above the Fruitland 2 is the Fruitland 3 (Fr 3) coal bed; they are separated by a rock interval of 41 to 62 ft (12.5-18.9 m); stratigraphically above the Fruitland 3 is the Fruitland 4 (Fr 4) coal bed (these two coal beds are not present together in any drill hole within this quadrangle). Although

these coal beds have been correlated as consistent horizons, they may actually be several different coal beds that are lithostratigraphically equivalent but not laterally continuous. Since the Fruitland 2, 3, and 4 coal beds are less than reserve base thickness (5 ft [1.5 m]), derivative maps were not constructed.

The remaining coals of the Fruitland Formation are grouped together as the Fruitland coal zone (Fr zone). These coals are generally noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5m]). Therefore, derivative maps were not constructed.

Fruitland Formation coals in the northwest part of the San Juan Basin are considered high volatile A to high volatile B bituminous in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values averaging 14,258 Btu's per pound (33,164 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 1.8 to 5.7 percent, ash content averaging 13.7 percent, sulfur content less than one percent, and heating values on the order of 12,131 Btu's per pound (28,217 kj/kg). Analyses of several Fruitland coals are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; Fassett and Hinds, 1971).

Fruitland 1 Coal Bed

As shown by the structure contour map (CRO Plate 5), the Fruitland 1 coal bed dips less than 1° in a northeasterly direction. As a result of

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-12704	Redfern & Herd Redfern & Herd No. 5	SW¼ 10	28	11	1,490-1,500	A	2.1	39.8	43.4	14.7	0.6	12,190	
						B	---	40.7	44.3	15.0	0.6	12,460	
						C	---	47.9	52.1	----	0.7	14,670	
H-24567	Sunray Mid-continent Gallegos No. 122	NW¼ 18	28	12	1,305-1,315	A	3.0	38.9	44.4	13.7	0.6	12,010	
						B	---	40.1	45.8	14.1	0.6	12,390	
						C	---	46.8	53.2	----	0.7	14,430	
H-7225	Pan American Holder No. 7	NW¼ 16	28	13	1,705-1,715	A	4.1	39.4	42.8	13.7	0.6	11,740	
						B	---	41.1	44.6	14.3	0.6	12,240	
						C	---	47.9	52.1	----	0.7	14,290	
H-3028	International Oil Fogelson No. 1-9	NW¼ 9	29	11	1,905-1,910	A	1.8	39.9	43.9	14.4	0.7	12,360	
						B	---	40.6	44.8	14.6	0.7	12,590	
						C	---	47.6	52.4	----	0.8	14,750	
H-13060	Tidewater N.M.-Fed. No. 12-E	SE¼ 12	29	11	2,065-2,070	A	2.1	38.7	47.9	11.3	0.6	12,830	
						B	---	39.5	48.9	11.6	0.6	13,100	
						C	----	44.7	55.3	----	0.7	14,820	
H-3030	Tennessee Oil & Gas Cornell Gas Unit A No. 1	NW¼ 10	29	12	1,740-1,750	A	2.1	40.0	44.8	13.1	0.5	12,340	
						B	---	40.9	45.7	13.4	0.5	12,600	
						C	---	47.2	52.8	----	0.6	14,560	
H-8360	Aztec Oil & Gas Hagood No. 21-C	SW¼ 20	29	13	1,125-1,140	A	5.6	39.0	41.3	14.1	0.6	11,580	
						B	---	41.3	43.8	14.9	0.6	12,260	
						C	---	48.5	51.5	----	0.7	14,420	
H-4052	Aztec Oil & Gas Hagood No. 13-C	SE¼ 34	29	13	1,635-1,640	A	3.5	39.6	43.2	13.7	0.5	11,910	
						B	---	41.0	44.8	14.2	0.6	12,330	
						C	---	47.8	52.2	----	0.6	14,370	
H-13062	Aztec Oil & Gas Ruby Jones No. 1	NE¼ 7	30	11	2,020-2,030	A	1.4	37.2	44.1	17.3	0.6	12,010	
						B	---	37.7	44.8	17.5	0.6	12,180	
						C	---	45.7	54.3	----	0.7	14,770	
H-15140	Southwest Production Sullivan No. 1	NE¼ 22	30	12	1,713-1,742	A	2.2	38.8	45.3	13.7	0.6	12,370	
						B	---	39.7	48.3	14.0	0.6	12,640	
						C	---	46.1	53.9	----	0.7	14,700	
H-16308	R&G Drilling Lunt No. 62	NW¼ 18	30	13	1,425-1,440	A	2.8	40.4	44.7	12.1	0.6	12,390	
						B	---	41.6	45.9	12.5	0.6	12,750	
						C	---	47.5	52.5	----	0.7	14,570	
H-19399	Compass Exploration Fedaral No. 1-31A	NE¼ 31	30	13	1,070-1,080	A	5.7	38.8	43.0	12.5	0.6	11,840	
						B	--	41.2	45.5	13.3	0.6	12,540	
						C	---	47.4	52.6	----	0.7	14,460	

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

topography and dip, the overburden (CRO Plate 6) varies in thickness from less than 1,500 ft (457 m) in the southwest in the Animas River Valley to more than 2,400 ft (732 m) at the northern edge of the quadrangle. The isopach map (CRO Plate 4) shows the coal bed is more than 15 ft (4.6 m) thick in several areas in the quadrangle and thins in all directions. It is absent in the extreme northwest corner and in a portion in the east-central part of the quadrangle.

Chemical Analyses of the Fruitland 1 Coal Bed - 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 for this quadrangle. All of the coals studied in the Flora Vista quadrangle are more than 1,190 ft (363 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 2, Fruitland 3, and Fruitland 4 beds and 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, the Fruitland zone 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 catego-

ries (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. However, in areas of underground coal exceeding 12 ft (3.7 m) in thickness, the Reserves (mineable coal) were calculated on the basis of a maximum coal bed thickness of 12 ft (3.7 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 503 million short tons (456 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 Flora Vista 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 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 (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 Flora Vista quadrangle occur more than 1,190 ft (363 m) below the ground surface and, thus, they have no coal development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

The underground coal of the Fruitland 1 coal bed has moderate development potential in the west-central and southern half of the quadrangle (CDP Plate 8) where the coal bed thickness varies from 5 to 18 ft (1.5-5.5 m) (CRO Plate 4), and the overburden thickness increases from approximately 1,600 ft (488 m) in the southwest to 2,000 ft (610 m) across the center of the quadrangle (CRO Plate 6). Low development potential occurs in the southwest and northern half of the quadrangle where the Fruitland 1 coal bed has overburden thickness increasing from 2,000 ft (610 m) in the center of the

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS
(in short tons) IN THE FLORA VISTA QUADRANGLE,
SAN JUAN COUNTY, 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	--	202,210,000	300,310,000	502,520,000
TOTAL	--	202,210,000	300,310,000	502,520,000

area to more than 2,400 ft (732 m) in the north. The coal bed thickness ranges from 5 to 19 ft (1.5-5.8 m) in this area. The Fruitland 1 coal bed has unknown development potential in the northwest and south-central areas where it is less than the reserve base thickness of 5 ft (1.5 m). A small area in the extreme northwest corner of the quadrangle has no Fruitland 1 coal and, thus, has no development potential.

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