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COAL RESOURCE OCCURRENCE MAPS OF THE JOHNSON TRADING POST QUADRANGLE, SANDOVAL COUNTY, NEW MEXICO

[Report includes 6 plates]

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JOHNSON TRADING POST 7 1/2-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps of the Johnson Trading Post quadrangle, Sandoval 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) in the western United States. The work has been 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 Johnson Trading Post 7 1/2-minute quadrangle is in north-central Sandoval County, New Mexico. The area is approximately 64 miles (103 km) northwest of Albuquerque and 76 miles (122 km) southeast of Farmington, New Mexico.

Accessibility

The Johnson Trading Post quadrangle is accessible from New Mexico State Route 44 which is east of the area and State Route 197 which is to the north of the area. From these routes light-duty roads provide further access to the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates a route approximately 64 miles (103 km) southeast of the area which passes through Albuquerque, New Mexico.

Physiography

The quadrangle is in the southeastern corner of the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. Elevations range from 6,520 ft (1,987 m) near San Isidro Wash to 7,200 ft (2,195 m) on Mesa Penistaja. The major topographic features are the Isidro Valley in the central portion of the area, Mesa Aguila to the southwest, Fork Rock Mesa to the southeast, and several other mesas located in the northwest and northeast. Numerous arroyos and washes provide drainage for the area; most notable is San Isidro Wash.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than 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 thunder-

showers. Annual temperatures in the basin range from below 0°F (-18°C) to above 100°F (38°C). 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 77 percent of the quadrangle is in the southeast 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 in 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

Dane (1936) has mapped the Upper Cretaceous and Tertiary strata in the area with emphasis on outcrops of Fruitland Formation coal and clinker. Hinds (1966) has mapped the geology of the quadrangle on a scale of 1:24,000. The following year Baltz (1967) published a Geological Survey Professional Paper on the stratigraphy and regional tectonic implications of the Upper Cretaceous and Tertiary rocks of the east-central San Juan Basin. His report includes the geology of the northern two-thirds of the quadrangle area. More recently, Fassett and Hinds (1971) published subsurface interpretations of the 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.

The first basin-wide retreat of the Late Cretaceous sea is indicated by the nearshore deposits of the Point Lookout Sandstone. These ancient barrier beaches formed a generally east-west-trending strandline in this part of the basin, behind which swamps developed. Organic material accumulated in the swamps and later became coal in the paludal deposits of the lower Menefee Formation. Deposition of materials which formed the coal beds was influenced by the strandline. This is shown by the more consistent thickness and greater lateral extent of the coals parallel to the strandline and also by the lack of continuity perpendicular to it, to the north, where the Menefee and underlying Point Lookout deposits interfinger. Streams which crossed the swamps also influenced deposition of organic matter; stream deposits may terminate even the most continuous coal beds.

During the continued retreat of the sea, the depositional environments in the quadrangle area became more terrestrial. This is evidenced by the transition within the lower Menefee from carbonaceous to noncoal-bearing deposits, in which there is an upward decrease in the occurrence and lateral

continuity of the coals. As the sea retreated, the sediments of the Point Lookout Sandstone and overlying Menefee Formation were deposited in successively higher stratigraphic positions to the northeast.

The sea then reversed the direction of movement, and the transgressive sequence of paludal upper Menefee Formation, nearshore Cliff House Sandstone, and marine Lewis Shale was deposited in the quadrangle. Swamps (Menefee) formed southwest (shoreward) of the transgressing beaches (Cliff House). Organic matter deposited in these swamps ultimately formed coal in the upper part of the Menefee Formation. Subsequently, a thin sand was deposited over the Menefee swamp deposits. Several hundred feet of beach sands of the La Ventana Tongue (Cliff House Sandstone) were then deposited over the basal sand in the southern part of the quadrangle. At the same time in the north, the marine facies, the Lewis Shale, was deposited over the basal Cliff House, and its deposits interfinger with the La Ventana Tongue. The marine shale was then deposited over the La Ventana in the southern part of the area as the sea moved in that direction. Deposition of the Lewis Shale marks the last advance of the Late Cretaceous sea.

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. Again, deposition of organic material was influenced by the strandline as shown by both the continuity of the coal beds parallel to the east-west strandline and their discontinuity perpendicular to it to the north. 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 northeast of the quadrangle as the regression continued in that direction. Terrestrial freshwater sediments then covered the area 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 (Powell, 1973). 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 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 three formations of the Mesaverde Group), the Point Lookout Sandstone, Menefee Formation (undifferentiated), and Cliff House Sandstone; the Lewis Shale, Pictured Cliffs Sandstone, 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 Point Lookout Sandstone, the basal formation of the Mesaverde Group, consists of gray to brown fine- to medium-grained sandstone with interbedded shale. It is massive in character, averages 185 ft (56 m) thick, and displays a distinctive character on geophysical logs. This last characteristic was used by the authors in establishing the top of the Point Lookout as a lithologic datum for correlation of the overlying Menefee Formation coals.

The oldest coal-bearing formation in the quadrangle is the Menefee Formation of the Mesaverde Group. In previous studies the Menefee has been divided into the Cleary Coal Member, the barren Allison Member, and an unnamed upper coal-bearing member (Beaumont and others, 1956). These three members are referred to as undifferentiated Menefee Formation for the purposes of this report only. The formation is about 700 ft (213 m) thick in this area, and is predominantly a gray to brown carbonaceous to noncarbonaceous shale with interbedded white to brown, fine- to medium-grained sandstone, interbedded brown siltstone, and random coal beds. In the northern part of the quadrangle the entire Menefee Formation has greater than 3,000 ft (914 m) of overburden (the study limit) due to the regional dip of 1° to 2° to the north. However, the formation is higher in elevation to the south-

east, so that in drill hole 12 (refer to CRO Plate 1) the entire Menefee Formation has less overburden than the study limit.

The Cliff House Sandstone sequence conformably overlies the Menefee Formation. A thin basal sand member, referred to as "the Cliff House Sandstone" by Fassett (1977), correlates with the thin undifferentiated Cliff House Sandstone to the northeast. It consists of 40 ft (12 m) of white to buff sandstone.

Overlying the basal member in the southern half of the area is the La Ventana Tongue (Cliff House Sandstone). This member is a 725-ft (221-m) thick sequence of white to buff sandstone and thinly-interbedded shale and siltstone. The La Ventana is massive in the southern part of the area, but intertongues with the Lewis Shale in a northerly direction, and is absent near the northern edge of the quadrangle.

The marine Lewis Shale conformably overlies the Mesaverde Group. In contrast to the underlying Cliff House Sandstone, it is predominantly a gray calcareous shale with interbedded thin sandstone and siltstone. The Lewis averages 400 ft (122 m) in thickness throughout the southern half of the quadrangle. In the northern part of the area the lower contact of the Lewis is approximately 725 ft (221 m) lower and is stratigraphically equivalent to the La Ventana Tongue of the Cliff House Sandstone. The upper contact of the Lewis Shale is gradational with the overlying Pictured Cliffs Sandstone and, therefore, a distinct contact is difficult to determine.

The Pictured Cliffs Sandstone consists of gray to brown fine-grained sandstone, interbedded with thin gray shale near the base of the formation where it grades into the Lewis. The upper contact is more sharply defined than the basal contact, even though intertonguing with the overlying

Fruitland Formation results in minor fluctuations in the formational top. Since the Pictured Cliffs is present throughout most of the basin and displays a distinctive character on geophysical logs, the authors have used the top of the unit as a lithologic datum for correlation of the overlying Fruitland Formation coals.

Conformably overlying the Pictured Cliffs Sandstone is the undivided Fruitland Formation and Kirtland Shale, the lower portion of which is the major coal-bearing unit in the quadrangle. The combined average thickness is 295 ft (90 m), and the lithology is gray to brown to greenish-brown carbonaceous to noncarbonaceous shale, interbedded sandstone and siltstone, and coal beds of varying thicknesses in the lower portion.

Unconformably overlying the Upper Cretaceous rocks is the Paleocene Ojo Alamo Sandstone, which consists of about 60 ft (18 m) of brown, medium- to coarse-grained, locally conglomeratic sandstone, with interbedded thin gray to green shale.

The Nacimiento Formation grades into the underlying Ojo Alamo. Approximately 1,200 ft (366 m) of the Nacimiento deposits are present and consist of gray to brown shale and interbedded sandstone and siltstone.

The Eocene San Jose Formation unconformably overlies the Paleocene Nacimiento Formation. It consists of buff to yellow, fine- to coarse-grained, locally conglomeratic, arkosic sandstone with interbedded brown to gray shale.

A total of six formations crop out within the quadrangle. The outcrop pattern trends in a general east-west direction, the formations becoming successively younger to the north. The oldest formation is the Lewis Shale in the southeastern corner of the area. The entire sections of the Pictured

Cliffs Sandstone, the undivided Fruitland Formation and Kirtland Shale, Ojo Alamo Sandstone, and Nacimiento Formation crop out consecutively across the quadrangle in a northerly direction. The San Jose Formation, the youngest unit in the area, is exposed atop Mesa Penistaja in the north-central part of the quadrangle.

Structure

The Johnson Trading Post quadrangle is in the Central Basin area (Kelley, 1950) of the San Juan Basin. The axis of the basin is about 25 miles (40 km) northeast of the quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin (Baltz, 1967). Regional dip within the quadrangle is approximately 1° to 2° to the north. A minor fault of minimal offset occurs in the southwest corner of the quadrangle near isolated outcrops of the Fruitland 1 coal bed.

COAL GEOLOGY

Two coal zones (Menefee and Fruitland) were identified in the subsurface, and one coal bed (Fruitland 1) was mapped on the surface of this quadrangle (CRO Plate 1). The Menefee Formation coals are designated as the Menefee coal zone (Me zone). These coal beds are generally noncorrelative and less than reserve base thickness (5 ft [1.5 m]); an exception is a 5-ft (1.5-m) coal in drill hole 11 (CRO Plate 1).

The Point Lookout Sandstone occasionally contains local (L) Menefee coal beds in the upper portion which are random, discontinuous, and below the reserve base thickness of 5 ft (1.5 m).

Menefee Formation coal beds in the southeastern part of the San Juan Basin vary from subbituminous B to high volatile C bituminous in rank. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values ranging from 9,983 to 11,966 Btu's per pound (23,220-27,833 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 12.1 to 20.0 percent, ash content ranging from 4.9 to 9.9 percent, sulfur content ranging from 0.6 to 2.8 percent, and heating values on the order of 10,343 Btu's per pound (24,058 kj/kg). There is no apparent consistent difference between the various Menefee Formation coal beds (Dane, 1936; Shomaker, 1971). Analyses of several Menefee Formation coal beds were published in a report by Shomaker (1971). The results of these analyses are given in Table 1.

The Fruitland 1 (Fr 1) coal bed is defined by the authors as the lowermost coal bed of the Fruitland Formation; it generally is directly above the Pictured Cliffs Sandstone. The Fruitland 1 coal bed crops out in several isolated areas in the southwestern portion of the quadrangle; however, since the bed is less than the reserve base thickness (5 ft [1.5 m]) in this quadrangle, derivative maps were not constructed.

TABLE 1

Analyses of coal samples from the Menefee 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
A-47085	Mine Sample San Juan Mine	SW¼ 31	19	1	----	A B	15.8 ----	34.5 41.0	43.8 52.0	5.9 7.0	0.6 0.7	10,900 12,950	Cleary Member
A-46366	Mine Sample San Juan Mine	SW¼ 31	19	1	----	A B C	15.7 ---- ----	32.0 38.0 41.5	45.1 53.5 58.5	7.2 8.5 ----	0.6 0.7 0.8	10,790 12,800 13,990	Cleary Member.
A-47084	Prospect Pit Wilkins No.2 Prospect	SW¼ 26	19	1	----	A B	18.2 ----	34.4 42.0	40.8 49.9	6.6 8.1	0.9 1.0	10,280 12,570	Cleary Member
A-60026	Mine Sample Rio Puerco Mine	SE¼ 19	19	1	----	A B C	12.1 ---- ----	35.8 40.7 44.6	44.5 50.6 55.4	7.6 8.7 ----	2.8 3.2 3.5	10,940 12,460 13,640	Allison Member
A-64268	Mine Sample Anderson Mine	SE¼ 35	19	2	----	A B C	20.0 ---- ----	32.5 40.7 43.3	42.6 53.2 56.7	4.9 6.1 ----	0.7 0.8 0.9	10,240 12,790 13,630	Allison Member
A-46367	Prospect Drift	35	19	2	----	A B C	14.8 ---- ----	33.9 39.8 45.1	41.4 48.6 54.9	9.9 11.6 ----	1.2 1.4 1.6	8,910 10,460 11,840	Allison Member; Sample may have been somewhat weathered

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.

The upper Fruitland Formation coal beds are designated as the Fruitland coal zone (Fr zone). Since Fruitland zone coal is present in a single drill hole (11) (CRO Plate 1), and it is of less than reserve base thickness, derivative maps were not constructed.

Fruitland Formation coal beds in the southeastern part of the San Juan Basin are considered high volatile C bituminous in rank, although the coals vary from subbituminous A to high volatile A bituminous. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values ranging from 11,358 to 14,545 Btu's per pound (26,419-33,832 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" analyses indicate moisture content varying from 2.1 to 13.48 percent, ash content ranging from 19.86 to 30.49 percent, sulfur content less than one percent, and heating values on the order of 8,888 Btu's per pound (20,673 kj/kg). Analyses of several Fruitland Formation coal beds are given in Table 2 (Dane, 1936; Fassett and Hinds, 1971; Shomaker and Lease, 1971).

Menefee Coal Zone

The Menefee coal zone extends from the top of the La Ventana Tongue (Cliff House) to the base of the Menefee Formation. Correlation of the top of the La Ventana, which is easily recognized on geophysical logs, with the top of the Menefee Formation was established for use in the surrounding quadrangles, where the two units interfinger and are contemporaneous. The correlation has been continued into this quadrangle for the purpose of consistency.

TABLE 2

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
+TH-55298	Core Sample	-------	19	3	----	A	9.44	27.40	32.67	30.49	0.57	8,161	
						B	-----	30.26	36.07	33.67	0.63	9,012	
+TH-55672	Core Sample	-------	19	4	----	A	11.50	36.57	32.07	19.86	0.67	9,473	
						B	-----	41.32	36.24	22.44	0.76	10,704	
+TH-57167	Core Sample	-------	19	5	----	A	13.13	32.63	32.46	21.75	0.49	9,003	
						B	-----	37.56	37.37	25.07	0.56	10,364	
+TH-57168	Core Sample	-------	19	5	----	A	12.05	30.39	27.96	29.60	0.59	7,870	
						B	-----	34.55	31.79	33.66	0.67	8,948	
+TH-57166	Cuttings Sample	-------	19	5	----	A	13.48	29.55	28.05	28.92	0.50	7,829	
						B	-----	34.15	32.42	33.43	0.58	9,049	
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	0.7	10,990	
						B	-----	39.5	37.5	23.0	0.7	11,230	
						C	-----	51.3	48.7	-----	1.0	14,580	

+analysis by Commercial Testing and Eng. Co.

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

The structure contour map of the Menefee coal zone (CRO Plate 5) was constructed using the top of the La Ventana Tongue of the Cliff House Sandstone. It shows that the Menefee coal zone dip ranges from less than 1° to approximately 3° to the northwest. As a result of dip and topography, overburden (CRO Plate 6) varies from less than 400 ft (122 m) in the southeast to greater than 2,000 ft (610 m) to the northwest. The total amount of interburden, which is the noncoal-bearing portion of the zone, is also shown on CRO Plate 6. The interburden thickness varies from less than 1,300 ft (396 m) in the southwest and northeast to over 1,550 ft (472 m) in the western part of the quadrangle. The large values are the result of the stratigraphic spread of the coal beds and reflect the thickness of the Menefee Formation plus the La Ventana Tongue. The isopach map (CRO Plate 4) illustrates the total combined thickness of the individual coal beds of the Menefee zone. The greatest combined thickness occurs in the southwest of the quadrangle where the coals total more than 20 ft (6.1 m). In general, the thickness decreases from this area, and the coal is absent in small portions of the southeast, southwest, and northwest.

Chemical Analyses of the Menefee Zone Coal Beds - No published analyses of the quality of Menefee Formation coals are available for this quadrangle. However, information from surrounding areas is assumed to be similar to that for the coals from this quadrangle. Analyses of several Menefee Formation coals were published in a report by Shomaker (1971). The results of these analyses are given in Table 1.

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, 101 p.

Beaumont, E.C., 1971, Stratigraphic distribution of coal in San Juan Basin in Shomaker, J.W., and others, eds., Strippable low-sulfur coal resources of the San Juan Basin in New Mexico and Colorado: New Mexico Bur. of Mines and Mineral Resources Memoir 25, p. 15-30.

Beaumont, E.C., Dane, C.H., and Sears, J.D., 1956, Revised nomenclature of Mesaverde Group in San Juan Basin, New Mexico: Assoc. of Petroleum Geologists Bull., v. 40, no. 9, p. 2160.

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. 81-166, [1937].

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

Fassett, J.E., 1966, Geologic Map of the Mesa Portales quadrangle, Sandoval County, New Mexico: U.S. Geol. Survey Geologic Quadrangle Map GQ-590, 1:24,000.

Fassett, J.E., 1977, Geology of the Point Lookout, Cliff House and Pictured Cliffs Sandstones of the San Juan Basin, New Mexico and Colorado in New Mexico Geol. Soc. Guidebook of the San Juan Basin III, Northwestern New Mexico, 28th Field Conf., p. 193-197.

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.

Hinds, J. S., 1966, Geologic map of the Johnson Trading Post quadrangle, Sandoval County, New Mexico: U.S. Geol. Survey Geologic Quadrangle Map GQ-591, 1:24,000.

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.

Molenaar, C.M., 1977, Stratigraphy and depositional history of Upper Cretaceous rocks of the San Juan Basin area, New Mexico and Colorado, with a note on economic resources in New Mexico Geol. Soc. Guidebook of the San Juan Basin III, Northwestern New Mexico, 28th Field Conf., p. 165.

COAL RESOURCES

Coal resources were not calculated for the Fruitland and Menefee coal beds within the quadrangle because the coals are discontinuous, noncorrelative, and generally less than the reserve base thickness of 5 ft (1.5 m).

COAL DEVELOPMENT POTENTIAL

Coal development potential maps were not developed for this quadrangle because the coal beds within the KRCRA are generally less than the reserve base thickness (5 ft [1.5 m]) and, therefore, have unknown coal development potential.

Powell, J.S., 1973, Paleontology and sedimentation of the Kimbeto Member of the Ojo Alamo Sandstone in Fassett, J.E., ed., Cretaceous and Tertiary rocks of the southern Colorado Plateau: Memoir of the Four Corners Geological Society, p. 111-122.

Shomaker, J.W., 1971, La Ventana Mesaverde field in Shomaker, J.W., and others, eds., Strippable low-sulfur coal resources of the San Juan Basin in New Mexico and Colorado: New Mexico Bur. of Mines and Mineral Resources Memoir 25, p. 97.

Shomaker, J.W., and Lease, R.C., 1971, Star Lake Fruitland area in Shomaker, J.W., and others, eds., Strippable low-sulfur coal resources of the San Juan Basin in New Mexico and Colorado: New Mexico Bur. of Mines and Mineral Resources Memoir 25, p. 117-123.

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.