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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAPS OF THE CARSON TRADING POST QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

[Report includes 14 plates]

by

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This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

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CARSON TRADING POST 7 1/2-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 Carson Trading Post 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 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 Carson Trading Post 7 1/2-minute quadrangle is located in east-central San Juan County, New Mexico. The area is approximately 17.5 miles (28 km) southeast of Farmington and 68 miles (109 km) northeast of Gallup, New Mexico.

Accessibility

The eastern half of the area is accessible by light-duty roads which converge at Carson Trading Post. Two light-duty roads, one from Carson Trading Post and another in the southeastern corner, connect with State Route 44, 7 miles (11 km) and 10 miles (16 km) east of the area, respectively. The remainder of the area is accessible by numerous light-duty and unimproved dirt roads. The Atchison, Topeka, and Santa Fe Railway operates a route 68 miles (109 km) to the southwest at Gallup, New Mexico, which connects Gallup with Grants and Albuquerque.

Physiography

The quadrangle is located in the Central Basin area (Kelley, 1950) of the San Juan Basin. Total relief in the area is 720 ft (219 m), with elevations which range from 5,940 ft (1,811 m) at the northern extent of Gallegos Canyon to 6,660 ft (2,030 m) in the southeast corner of the quadrangle. The gently-sloping, dissected plains of the Carson Trading Post quadrangle are characteristic of Central Basin topography. The area is drained by intermittent streams; most notable are Gallegos Canyon in the northeast and the West Fork of Gallegos Canyon in the southwest, both of which flow northwest to the San Juan River, 20 miles (32 km) to the north.

Climate

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

Land Status

The quadrangle is in the west-central portion of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 93 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 the Fruitland Formation coals 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.

After the first basin-wide retreat, the Late Cretaceous sea reversed the direction of movement. As a result, the transgressive sequence of paludal 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 Menefee Formation. Subsequently, beach sands of the La Ventana Tongue (Cliff House Sandstone) were deposited over these Menefee deposits in the northeast portion of the quadrangle. Shoreward (southwest) and contemporaneous with the La Ventana beach deposits, swamps (Menefee) developed above the older Menefee deposits in the southwest portion of the quadrangle. Subsequently, coals formed in these deposits which are called the Hogback Mountain Tongue of the Menefee (Beaumont, 1971). Minor fluctuations of the sea resulted in interfingering of the La Ventana (Cliff House) and Hogback Mountain (Menefee) Tongues.

Onlap continued as the sea moved southwestward across the basin area. The transgressing northwest-southeast-trending strandline is represented in the lithologic record by the Chacra Tongue (informal name of local usage) of the Cliff House Sandstone. The marine facies which developed northeast of the strandline is the Lewis Shale. The base of the Lewis is contemporaneous with and grades into the Chacra Sandstone in the southwest portion of the quadrangle. As the sea continued to move to the southwest, the Lewis Shale was deposited over the Chacra. The thick sequence of Lewis Shale thins to the southwest and 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. As the sea retreated, the sediments of the Pictured Cliffs Sandstone and overlying Fruitland Formation were deposited in successively higher stratigraphic positions to the northeast. 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 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 floodplain 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.

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. A significant amount of erosion has occurred, as indicated by the removal of the San Jose Formation and some 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: (two of the three formations of the Mesaverde Group) the Menefee Formation and Cliff House Sandstone; Lewis Shale, Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, and Nacimiento Formation.

A composite columnar section on CRO Plate 3 illustrates the stratigraphic relationship of these formations and is accompanied by lithologic descriptions of the individual formations.

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, an unnamed upper coal-bearing member (Beaumont and others, 1956), and the Hogback Mountain Tongue (Beaumont, 1971). The first three members were grouped together as an undifferentiated member of the Menefee Formation for the purposes of this report only.

The undifferentiated member consists primarily of gray, carbonaceous to noncarbonaceous, flaky shale with local plant fossils and brown siderite stringers, interbedded white to gray, slightly calcareous, micaceous sandstone, and lenticular coal beds. It has a total thickness of approximately 1,050 ft (320 m) in this area. Due to the regional dip of about 1° to the north and northeast, the lower portion of the Menefee Formation is more than 3,000 ft (914 m) below the ground surface (the study limit) throughout the entire quadrangle area. In the northeastern corner of the area (drill hole 29 in section 9, T. 26 N., R. 11 W.) 1,090 ft (332 m) of a total of 1,160 ft (354 m) of the undifferentiated member are deeper than the study limit; however, in the southwestern part (drill hole 26 in section 25, T. 25 N., R. 12 W.) only the lower 614 ft (187 m) have more than 3,000 ft (914 m) of overburden.

The informally-named Hogback Mountain Tongue (Beaumont, 1971) of the Menefee Formation represents thick paludal sediments deposited shoreward of the massive marine sands of the La Ventana Tongue. This member is distinguished as a major coal-bearing unit as a result of its depositional environment. The stratigraphic equivalence and complex intertonguing of the Hogback Mountain Tongue with the La Ventana make it distinguishable in the area of intertonguing. The thickness of the Hogback Mountain Tongue varies greatly due to the intertonguing relationship with the La Ventana Tongue; however, it thins in a northeasterly direction and is not present in the northeastern part of the area. Similar in lithology to the underlying undifferentiated member of the Menefee Formation, the Hogback Mountain Tongue is composed of gray, carbonaceous shale with plant fossils and sandy stringers, and random coal beds.

The La Ventana Tongue is the basal member of the Cliff House Sandstone. In the northeastern portion of the quadrangle it is a thick sand unit averaging 600 ft (183 m) in thickness which conformably overlies the undifferentiated member of the Menefee Formation. However, to the southwest the La Ventana splits into two distinct sand wedges divided by a tongue of the Hogback Mountain Tongue of the Menefee Formation. The La Ventana sandstone represents the shoreward edge of a transgressive sequence consisting primarily of light gray, calcareous, silty sandstone with a trace of clay, and interbedded gray, micaceous siltstone and shale.

The uppermost member of the Cliff House Sandstone is the Chacra Tongue (informal name of local usage). It is present in the western and southwestern parts of the area and displays a lithology transitional from massive nearshore sandstone, typical of the type section to the south at Chacra Mesa, to the marine deposits of the Lewis Shale. The deposits are a gray, slightly dolomitic and calcareous siltstone with thinly interbedded gray shale and sandy stringers. This "transition" Chacra is about 360 ft (110 m) thick.

It is not present in the northeastern part of the quadrangle where it grades laterally into the basal portion of the marine Lewis Shale.

The marine Lewis Shale conformably overlies the Mesaverde Group. In contrast to the underlying Cliff House Sandstone, it consists predominantly of gray, flaky shale with local plant fossils, brown siderite stringers, and interbedded thin, white to gray, slightly calcareous, micaceous sandstone. The Lewis averages 290 ft (68 m) in thickness throughout the southwestern part of the quadrangle. The lower contact of the Lewis is 360 ft (110 m) lower stratigraphically in the northeastern part of the area than in the southwest and, consequently, this portion is stratigraphically equivalent to and intertongues with the Chacra Tongue. The upper contact of the Lewis is gradational with the overlying Pictured Cliffs Sandstone, and, therefore, a distinct contact is difficult to establish.

The Pictured Cliffs Sandstone consists of about 160 ft (49 m) of white to cream, calcareous, slightly glauconitic sandstone, commonly interbedded with gray, micaceous shale with plant fossils 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 variations in the formational top and, as a result, local Fruitland coal beds are commonly present in the Pictured Cliffs. Since the Pictured Cliffs is widespread throughout the basin and has a distinctive character on geophysical logs, the authors have used the top of the Pictured Cliffs as a lithologic datum for correlation of the overlying Fruitland Formation coals.

The major coal-bearing unit in the quadrangle is the Fruitland Formation. It has an average thickness of 300 ft (91 m) and consists of gray to brown carbonaceous shale with plant fossils and coal beds of varying thicknesses. The thickest and most continuous coal beds occur near the base of the formation, while discontinuous and lenticular coals are characteristic of the upper portion. The upper contact is gradational from nonmarine lower coastal plain deposits of the Fruitland to upper coastal or alluvial plain deposits of the Kirtland Shale (Molenaar, 1977). Many authors have used various criteria to establish the upper contact, but, in general, for the purposes of this report the uppermost coal was chosen (after Fassett and Hinds, 1971).

The freshwater deposits of the Kirtland Shale are the youngest Cretaceous strata in the San Juan Basin. They consist of an average of 620 ft (189 m) of tan to gray-brown claystone with local plant fossils and interbedded gray-green, arkosic, micaceous, slightly calcareous sandstone. The formation has previously been divided into several members by various authors; however, for the purposes of this report the individual members were not differentiated.

Unconformably overlying the Upper Cretaceous strata is the Paleocene Ojo Alamo Sandstone. It consists primarily of about 120 ft (37 m) of white to cream, coarse-grained to conglomeratic sandstone with interbedded thin, gray shale.

The Nacimiento Formation gradationally overlies the Ojo Alamo Sandstone. The basal few hundred feet are present in this area and consist of gray to brown, locally silty shale and interbedded buff to yellow sandstone and gray siltstone.

A total of two formations crop out within the quadrangle. The outcrop pattern trends in a general north-south direction, with the formations becoming successively younger to the east. The oldest formation exposed is the upper portion of the Ojo Alamo Sandstone which is present in the west-central part of the quadrangle. The lowermost beds of the Nacimiento Formation, the youngest formation in the area, are exposed over the remainder of the quadrangle.

Structure

The Carson Trading Post 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 23 miles (37 km) north of the quadrangle area near Farmington, New Mexico, and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Regional dip, measured south of the quadrangle in Ojo Alamo Arroyo, is 1° 20' to the north and northeast (Reeside, 1924).

COAL GEOLOGY

Two coal zones (Menefee, Fruitland) and two coal beds (Fruitland 1, Fruitland 2) were identified in the subsurface of this quadrangle (CRO Plate 1). The Menefee Formation coal beds are grouped together as the Menefee coal zone (Me zone) which extends from the top of the La Ventana Tongue to the base of the Menefee Formation. These coals are generally noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5 m]). Several drill holes include Menefee zone coal beds of greater than reserve base thickness: a 12-ft (3.7-m) coal bed in drill hole 9; a 7-ft (2.1-m) coal bed in drill hole 12; a 6-ft (1.8-m) and an 11-ft (3.4-m) coal bed in drill hole 18; a 5-ft (1.5-m) and a 7-ft (2.1-m) coal bed in drill hole 24; an 8-ft (2.4-m), a 9-ft (2.7-m), and a 10-ft (3.0-m) coal bed in drill hole 25; and a 6-ft (1.8-m) coal bed in drill hole 34 (CRO Plate 1).

Menefee Formation coals in the central portion of the San Juan Basin are considered subbituminous A in rank. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values averaging 11,179 Btu's per pound (26,002 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 (Bauer and Reeside, 1921; Dane, 1936). The "as received" analyses indicate moisture content averaging 16.9 percent, ash content ranging from 6.6 to 13.0 percent, sulfur content varying from 0.6 to 1.4 percent, and heating values on the order of 9,947 Btu's per pound (23,137 kj/kg). Analyses of several Menefee coals from the outcrop area west of this quadrangle are given in Table 1 (Shomaker, 1971). These coals are assumed to be similar in quality and character to the coals of this quadrangle since no published analyses of Menefee coals from this area are known to be available.

The Fruitland 1 (Fr 1) coal bed is defined by the authors as the lowermost coal of the Fruitland Formation. The Fruitland 2 (Fr 2) bed is above the Fruitland 1 in the western part of the quadrangle. However, since the datum (the top of the Pictured Cliffs Sandstone) is higher in stratigraphic position to the northeast, the Fruitland 2 (Fr 2) coal bed is the basal coal in the eastern part of the quadrangle where the Fruitland 1 pinches out. In areas where the Fruitland 1 is present, it is less than reserve base (5 ft [1.5 m]) thickness; therefore, 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
J-52142	Channel, Open Pit	SW¼ 27	25	17	-------------	A	17.4	35.5	40.5	6.6	0.6	10,410	Noncaking.
						B	----	43.0	49.1	7.9	0.7	12,600	Coal may have
						C	----	46.7	53.3	----	0.8	13,680	been slightly weathered.
J-61758	Core Sample	SW¼ 36	25	17	-------------	A	15.8	31.6	39.6	13.0	1.2	9,700	
						B	----	37.5	47.1	15.4	1.4	11,510	
						C	----	44.3	55.7	----	1.6	13,610	
J-61759	Core Sample	SW¼ 36	25	17	-------------	A	17.4	31.5	40.4	10.7	1.4	9,730	
						B	----	38.1	48.9	13.0	1.7	11,780	
						C	----	43.8	56.2	----	2.0	13,540	

To convert Btu's/lb to kj/kg, multiply Btu's/lb by 2.326.

The remaining coals of the Fruitland Formation are 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. These coals are generally noncorrelative and less than reserve base thickness (5 ft [1.5 m]); exceptions are a 5-ft (1.5-m) coal in drill holes 5 and 28, and a 6-ft (1.8-m) coal in drill hole 27 (CRO Plate 1).

Fruitland Formation coals in the central portion 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 14,366 Btu's per pound (33,415 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 (Bauer and Reeside, 1921; Dane, 1936). The "as received" analyses indicate moisture content averaging 2.7 percent, ash content ranging from 12.0 to 19.3 percent, sulfur content less than 1 percent, and heating values on the order of 12,002 Btu's per pound (27,917 kj/kg). Analyses of several Fruitland Formation coals are given in Table 2 (Fassett and Hinds, 1971).

Menefee Coal Zone

The structure contour map of the Menefee coal zone was drawn using the top of the La Ventana Tongue of the Cliff House Sandstone. The La Ventana Tongue is contemporaneous with the coal-bearing Hogback Mountain Tongue of the Menefee Formation (Beaumont, 1971) and exhibits a distinctive

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			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-12706	Southwest Production Ted Henderson No. 1	NE¼ 5	26	11	1,700-1,705	A	3.6	40.6	39.3	16.5	0.7	11,540	
						B	---	42.1	40.8	17.1	0.7	11,970	
						C	---	50.8	49.2	----	0.8	14,430	
H-3031	Southwest Production Cambell No. 2	NE¼ 26	27	12	1,900-1,910	A	2.6	41.2	40.5	15.7	0.6	11,810	
						B	---	42.3	41.6	16.1	0.6	12,120	
						C	---	50.4	49.6	----	0.7	14,440	
H-5021	British-American Oil Fullerton No. 8	NE¼ 14	27	11	1,920-1,930	A	3.3	40.8	43.9	12.0	0.6	12,370	
						B	---	42.2	45.4	12.4	0.6	12,790	
						C	---	48.1	51.9	----	0.7	14,600	
H-15776	Aztec Oil & Gas Hanka No. 14-D	SW¼ 12	27	10	1,900-1,905	A	2.2	40.4	44.0	13.4	0.6	12,520	
						B	---	41.3	45.1	13.6	0.6	12,790	
						C	---	47.9	52.1	----	0.7	14,820	
H-5472	Aztec Oil & Gas Caine No. 13	NW¼ 16	28	10	1,842-1,853	A	1.6	38.4	40.7	19.3	0.6	11,760	
						B	---	39.0	41.4	19.6	0.6	11,950	
						C	---	48.5	51.5	----	0.8	14,870	
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	

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.

character on geophysical logs. When present, it portrays the upper boundary of the coal-bearing Menefee zone more consistently than the randomly-occurring uppermost Menefee coal in the Hogback Mountain Tongue. Consequently, the structure contour map of the Menefee zone (CRO Plate 5) was drawn using the top of the La Ventana.

As illustrated by the structure contour map (CRO Plate 5), the coal zone dips approximately 1° in a northerly direction. Consequently, overburden (CRO Plate 6) ranges from less than 1,800 ft (549 m) in the west to greater than 2,400 ft (732 m) in the northeast part of the quadrangle. Also shown on CRO Plate 6 is the total amount of interburden, which is the non-coal-bearing portion of the zone. The interburden thickness varies from less than 1,550 ft (472 m) to greater than 1,750 ft (533 m). These large values are the result of the stratigraphic spread of the coal beds and reflect the thickness of the formation including the tongues of the La Ventana. The isopach map (CRO Plate 4) shows the total thickness of the individual coal beds of the zone, except those coals with more than 3,000 ft (914 m) of overburden (the study limit). The greatest combined coal thickness is more than 40 ft (12.2 m) in the southwest part of the map. The thickness decreases in all directions, and is less than 5 ft (1.5 m) throughout most of the northern portion of the quadrangle and in parts of the southeast and southwest.

<u>Chemical Analyses of the Menefee Zone Coal Beds</u> - Analyses of several Menefee Formation coals from the area surrounding this quadrangle are given in Table 1 (Shomaker, 1971).

Fruitland 2 Coal Bed

The Fruitland 2 coal bed, informally named by the authors, has been correlated and mapped as a consistent horizon, although it may actually be several different coal beds that are lithostratigraphically equivalent but not laterally continuous.

As illustrated by the structure contour map (CRO Plate 8), the coal bed dips approximately 1° to the northeast. Consequently, overburden (CRO Plate 9) increases from less than 1,100 ft (335 m) in the west-southwest to greater than 1,600 ft (488 m) in the northeast part of the quadrangle. The isopach map (CRO Plate 7) shows that the coal bed is greater than 15 ft (4.6 m) thick in the western and central portions of the map. The thickness decreases in all directions, and the coal is absent in a portion of the south and the east.

Chemical Analyses of the Fruitland 2 Coal Bed - Analyses of several Fruitland Formation coals from the area surrounding this quadrangle are given in Table 2 (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 12) was, therefore, drawn using the top of the Fruitland Formation and it indicates that the zone dips approximately 1° to the northeast. Consequently, overburden (CRO Plate 13) increases from less than 800 ft (244 m) in the southwest to greater than 1,400 ft (427 m) in the northeast part of the quadrangle. Also shown on CRO Plate 13 is the total amount of interburden, which is the noncoal-bearing portion of the zone. The thickness varies from zero to greater than 300 ft (91 m) and reflects the stratigraphic spread of the coals within the zone. The isopach map (CRO Plate 11) shows that the greatest total thickness of zone coals is more than 15 ft (4.6 m) in parts of the northeast and southeast. The thickness decreases in all directions, and no Fruitland zone coals are present in an area extending from the northwest to the southeast and in another portion in the southeast part of the quadrangle.

Chemical Analyses of the Fruitland Zone Coal Beds - Analyses of several Fruitland Formation coals from the area surrounding this quadrangle are given in Table 2 (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 Carson Trading Post 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 2 coal bed for the determination of coal resources in this quadrangle. Coals of the Fruitland 1 bed and Menefee and Fruitland zones were not evaluated because they are generally discontinuous, noncorrelative, and less than the reserve base thickness (5 ft [1.5 m]). In addition, the coals of the Fruitland 1 bed, though correlative, are less than reserve base thickness.

For Reserve Base and Reserve calculations, the Fruitland 2 coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plate 10) 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 respective coal isopach (CRO Plate 7) and areal distribution maps (CRO Plate 10). The surface area of the isopached Fruitland 2 bed was measured by planimeter, in acres, for each category, then multiplied by both 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 2 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 2 coal bed are shown on CRO Plate 10 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 680 million short tons (617 million metric tons).

The coal development potential for the Fruitland 2 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 Carson Trading Post quadrangle has development potential for subsurface mining methods only (CDP Plate 14).

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 3 summarizes the coal development potential, in short tons, for underground coal of the Fruitland 2 coal bed.

Development Potential for Surface Mining Methods

All coals studied in the Carson Trading Post 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 2 coal bed has moderate development potential over most of the quadrangle, with the exception of the southern border area and the southeast quadrant (CDP Plate 14). The coal bed increases in thickness from 5 to 18 ft (1.5-5.5 m) (CRO Plate 7), and the overburden thickness ranges from approximately 1,050 ft (320 m) in the

TABLE 3

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE CARSON TRADING POST 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 2	--	680,090,000	--	680,090,000
TOTAL	--	680,090,000	--	680,090,000

southwest to 1,600 ft (488 m) in the northeast (CRO Plate 9). The area of moderate potential along the southern border of the quadrangle (southeast corner) is the result of the Fruitland 1 coal bed in the Alamo Mesa East quadrangle to the south. The south-southeastern part of the area has unknown development potential where the coal is less than the reserve base thickness of 5 ft (1.5 m).

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