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

[Report includes 11 plates]

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KIMBETO 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 Kimbeto 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) 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 Kimbeto 7 1/2-minute quadrangle is located in southeastern San Juan County, New Mexico, about 40 miles (64 km) southeast of Farmington and 66 miles (106 km) northeast of Gallup, New Mexico.

Accessibility

The Kimbeto quadrangle can be reached via State Route 44 to the northeast and also by State Route 56 which cuts across the extreme northwest corner of the area. Light-duty roads and unimproved dirt roads provide access to the interior of the quadrangle. The Atchison, Topeka, and Santa Fe Railway has a route 66 miles (106 km) to the southwest at Gallup, New Mexico, which connects Gallup with Grants and Albuquerque.

Physiography

The quadrangle is in the south-central portion of the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. Elevations range from 6,280 ft (1,884 m) in Betonnie Tsosie Wash to 6,920 ft (2,076 m) in the northeastern corner of the quadrangle. The topography is characterized by gently sloping plains which have been moderately dissected by numerous intermittent streams. Two major washes, Kimbeto Wash and Betonnie Tsosie Wash, drain to the southwest.

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 and winter; most precipitation occurs 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 southern part of the basin.

Land Status

The quadrangle is in the southwest portion of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 94 percent of the KRCRA land as shown on Plate 2 of the Coal Resource Occurrence Maps. Preference Right Lease Applications (NM 3918, NM 3919, NM 6804, NM 8592, and NM 12324) in the southwest corner of the quadrangle cover 7 percent of the KRCRA. No Federal coal leases occur within the quadrangle.

GENERAL GEOLOGY

Previous Work

Reeside (1924) studied the formations exposed in the area as part of a study of the Upper Cretaceous and Tertiary formations of the San Juan Basin. Shomaker (1971a) described in detail the surface occurrences of Fruitland Formation coal south of the area and estimated the strippable reserves of Fruitland coal which would project into the Kimbeto quadrangle. Fassett and Hinds (1971) provided subsurface interpretations of Fruitland Formation coal deposits in the San Juan Basin. The most recent work in the area is by Schneider (1978), and includes the various Fruitland coal zones and clinker mapped at a scale of 1:24,000.

Geologic History

The San Juan Basin, an area of classic transgressive and regresive 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 northwest-southeast-trending strandline, 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 northeast, 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 the coal beds in the upper part of the Menefee Formation. Subsequently, several hundred feet of beach sands of the La Ventana Tongue (Cliff House Sandstone) were deposited over the Menefee across the quadrangle.

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 as it moved to the southwest is the Lewis Shale. This thick sequence, which thins to the southwest, overlies the Chacra and marks the last advance of the Late Cretaceous sea.

Depositional evidence of the final retreat of the Late Cretaceous sea are the nearshore regressive Pictured Cliffs Sandstone and the overlying paludal Fruitland Formation which were deposited in successively higher stratigraphic positions to the northeast. Southwest (shoreward) of the beach deposits, swamps, which were dissected by streams, accumulated organic matter which 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 northwest-southeast strandline and their discontinuity perpendicular to it to the northeast.

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 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, 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 portion 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: (the three formations of the Mesaverde Group), the Point Lookout Sandstone, Menefee Formation, and Cliff House Sandstone; the Lewis Shale, Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, and the 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 Point Lookout Sandstone, the basal formation of the Mesaverde Group, is composed of white to light gray, slightly calcareous sandstone with interstitial kaolinite, interbedded gray shale, and local coal beds. Thin, discontinuous Menefee Formation coal beds occur in the upper portion of the Point Lookout as a result of intertonguing. The sandstone is massive, averages about 144 ft (44 m) in thickness, and possesses a distinctive and consistent character on geophysical logs. Because it is present throughout the basin, the authors used the top of the Point Lookout as a lithologic datum for the correlation of overlying Menefee 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, from the base upward, into the Cleary Coal Member, the barren Allison Member, and an unnamed upper coal-bearing member (Beaumont and others, 1956). These members are designated as the undifferentiated Menefee Formation for the purposes of this report only. The Menefee in this area averages 1,090 ft (332 m) of gray, carbonaceous to noncarbonaceous shale with plant fossils, interbedded light gray sandstone and gray siltstone, and random coal beds.

Conformably overlying the Menefee Formation is the basal member of the Cliff House Sandstone, the La Ventana Tongue. It ranges in thickness from 434 ft (132 m) in the south to 965 ft (294 m) in the northeastern part of the quadrangle. The La Ventana is composed primarily of light gray, slightly calcareous sandstone with interbedded gray shale.

The uppermost member of the Cliff House Sandstone, the Chacra Tongue (informal name of local usage), is about 370 ft (113 m) thick and overlies the La Ventana Tongue. It is transitional from the massive sandstone, typical of the type section at Chacra Mesa south of the area, to the marine deposits of the Lewis Shale to the northeast. In this area the Chacra is composed of gray, slightly calcareous siltstone beds with interbedded sandstone and shale.

The marine Lewis Shale conformably overlies the Mesaverde Group. In contrast to the underlying Cliff House Sandstone, it is predominantly a gray, slightly calcareous shale with interbedded siltstone. The Lewis is generally 200 ft (61 m) thick throughout the quadrangle. 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 approximately 140 ft (43 m) of light to medium gray sandstone commonly 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 variations in the formation 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 as a lithologic datum for correlation of the overlying Fruitland coals.

The Fruitland Formation, which overlies the Pictured Cliffs, is the major coal-bearing unit in the quadrangle. It is composed of an average of 310 ft (94 m) of gray to gray-brown, carbonaceous, calcareous shale with local plant fossils, interbedded thick, gray, slightly calcareous sandstone and siltstone with interstitial clay, and coal beds of varying thickness. 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 to upper coastal or alluvial plain deposits of the Kirtland Shale (Molenaar, 1977). Many authors have used various criteria in establishing the top of the Fruitland Formation but, in general, for the purposes of this report the uppermost coal in the formation was chosen (after Fassett and Hinds, 1971).

The freshwater deposits of the Kirtland Shale are the youngest Cretaceous strata in the area. The unit consists of about 268 ft (82 m) of gray to gray-brown shale with local 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 Kirtland Shale, the oldest formation exposed in this area, is present in the southwestern part of the quadrangle.

Unconformably overlying the Upper Cretaceous rocks is the Paleocene Ojo Alamo Sandstone. It is composed of about 130 ft (40 m) of light gray, locally conglomeratic sandstone with interbedded thin, gray to brown siltstone and claystone. The Ojo Alamo crops out in a thin belt extending across the central part of the quadrangle from the northwest to the southeast.

The Nacimiento Formation gradationally overlies the Ojo Alamo. It is predominantly gray shale and interbedded claystone. The lower part of the formation is present in the area, and crops out over the northeastern half of the quadrangle.

Structure

The axis of the San Juan Basin is about 38 miles (61 km) northeast of the Kimbeto quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Measured regional dips within the quadrangle range from 1° 15' to 2° to the northeast (Reeside, 1924).

COAL GEOLOGY

Individual coal beds are not continuous across the San Juan Basin because the coal-related strata are progressively younger from southwest to northeast; the strata rise in steps due to minor transgressions which occurred during the overall retreat of the sea. However, for the exclusive purpose of reserve and reserve base calculations, the Fruitland 1 coal bed has been correlated and mapped as if it were a single bed, continuous throughout the basin.

A lithologic datum was used for correlation of the coals (CRO Plate 3). The primarily marine sandstone units (Point Lookout, Pictured Cliffs) which underlie the coal-bearing formations (Menefee, Fruitland) were used as datums since they represent a more laterally continuous boundary than any of the overlying paludal, fluvial, and lacustrine deposits of the coal-bearing formations. Also, the sandstone units are generally more easily recognized on geophysical logs. As shown on CRO Plate 3, the tops of the sandstone units have been used as datums for each drill hole and the coals have been plotted in the column and correlated based upon their position relative to the datum.

One coal bed (Fruitland 1) and two coal zones (Menefee and Fruitland) were identified in the subsurface of this quadrangle (CRO Plate 1). The Menefee Formation coal beds are designated 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 coal beds are generally noncorrelative and less than reserve base thickness (5 ft [1.5 m]) as specified by the U.S. Geological Survey.

The upper portion of the Point Lookout Sandstone contains Menefee coal beds which are the result of intertonguing with the Menefee Formation. These coals have been designated as local beds because they are random, discontinuous, and less than reserve base thickness (5 ft [1.5 m]).

Menefee Formation coal beds in the southern part of the San Juan Basin are considered to be subbituminous A in rank. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values averaging 11,166 Btu's per pound (25,972 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 averaging 15.7 percent, ash content ranging from 7.5 to 10.2 percent, sulfur content varying from 0.6 to 2.2 percent, and heating values on the order of 10,053 Btu's per pound (23,383 kj/kg). Analyses of several Menefee Formation coal beds are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; Lease, 1971; Shomaker, 1971b).

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. The upper Fruitland Formation coal beds were designated as the Fruitland coal zone (Fr zone) since these coals are not extensive and are generally less than the reserve base thickness of 5 ft (1.5 m) (an exception is a 7-ft [2.1-m] coal in drill hole 1). Due to these characteristics, derivative maps were not constructed.

Fruitland Formation coal beds in the southern part of the San Juan Basin are considered to be high volatile C bituminous in rank, although the coals vary from borderline subbituminous A - high volatile C bituminous 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 11,246 to 14,102 Btu's per pound (26,158 to 32,801 kj/kg) (Amer. Soc. for Testing and Materials, 1977). The coal is hard, brittle, and black with a bright luster. The coal readily slakes with exposure to weather; however, it stocks fairly well when protected. The "as received" analyses indicate moisture content varying from 3.9 to 14.6 percent, ash content ranging from 13.65 to 35.14 percent, sulfur content generally less than one percent, and heating values varying from 7,740 to 11,035 Btu's per pound (18,003-25,667 kj/kg). Analyses of several Fruitland Formation coal beds are given in Table 2 (Dane, 1936; Fassett and Hinds, 1971; Shomaker, 1971a).

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-63534	Core Sample	NE ¼ 36	17	10	----	A	16.5	33.4	40.4	9.7	0.6	10,070	
						B	----	40.0	48.3	11.7	0.7	12,060	
						C	----	45.3	54.7	----	0.8	13,650	
3823	Mine Sample	14	20	11	----	A	17.5	32.9	41.2	8.4	2.2	----	
23004	Pueblo Bonito Mine	14	21	11	----	A	14.4	34.8	43.3	7.5	1.54	10,220	Allison Member
						B	-----	40.7	50.5	8.8	1.80	11,940	
						C	-----	44.6	55.4	----	1.97	13,090	
J-57562	Pit Sample	SW ¼ 11	22	13	----	A	14.4	32.6	42.8	10.2	0.9	9,870	
						B	----	38.1	50.0	11.9	1.0	11,530	
						C	----	43.3	56.7	----	1.2	13,090	

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

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 Mois-ture	Volatile matter	Fixed Carbon	Ash	Sulfur	Heating Value (Btu)	Remarks
*29	Drill Cuttings	NW¼ 5	22	10	----	A	4.52	-----	-----	13.65	0.59	11,035	
						B	-----	-----	-----	14.30	0.62	11,577	
						C	-----	-----	-----	-----	----	13,485	
*34	Drill Cuttings	SE¼ 9	22	10	----	A	9.28	29.26	38.42	23.04	0.54	9,240	
						B	-----	32.25	42.35	25.40	0.60	10,185	
						C	-----	-----	-----	-----	----	13,653	
J-63526	Core Sample	NE¼ 15	22	10	269.0-290.2	A	12.4	33.9	37.6	16.1	0.49	9,630	
						B	-----	38.7	42.9	18.4	0.56	10,990	
						C	-----	47.5	52.5	-----	0.68	13,470	
*27	Drill Cuttings	NW¼ 12	22	11	104-110	A	5.01	-----	-----	35.14	0.44	7,740	May be
						B	-----	-----	-----	36.99	0.46	8,148	weathered
						C	-----	-----	-----	-----	----	12,931	sample
*	Drill Cuttings	NW¼ 12	22	11	155-159	A	5.42	-----	-----	19.41	0.66	10,427	
						B	-----	-----	-----	20.52	0.70	10,835	
						C	-----	-----	-----	-----	----	13,634	
J-63220	Core Sample	NE¼ 29	23	11	252.5-283.0	A	12.7	31.9	34.3	21.2	0.3	8,680	
						B	-----	36.5	39.3	24.2	0.4	9,940	
						C	-----	48.2	51.8	-----	0.5	13,120	
J-61645	Core Sample	NE¼ 29	23	11	321.5-330.0	A	14.6	30.8	38.6	16.0	0.34	9,440	
						B	-----	36.1	45.2	18.7	0.40	11,050	
						C	-----	44.4	55.6	-----	0.49	13,600	
H-5022	Dorfman Production Nancy Fed. No. 1	SE¼ 12	24	8	2,525-2,535	A	3.9	35.4	33.7	27.0	1.1	9,960	
						B	-----	36.8	35.1	28.1	1.1	10,370	
						C	-----	51.2	48.8	-----	1.5	14,410	

*New Mexico State Bureau of Mines and Mineral Resources

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.

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. The correlation of the top of the La Ventana with the top of the Menefee zone was established for use in the surrounding quadrangles and has been continued into this quadrangle for the purpose of consistency. The structure contour map of the Menefee coal zone (CRO Plate 5), therefore, was constructed using the top of the La Ventana. The map shows that the coal zone dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 6) increases from less than 800 ft (244 m) in the southwest to greater than 1,900 ft (579 m) in the northeast part of the quadrangle. Also shown on CRO Plate 6 is the total amount of interburden which is the noncoal-bearing portion of the coal zone. The interburden thickness varies from less than 1,600 ft (488 m) in the southeast to greater than 1,700 ft (518 m) in the northeastern part of the quadrangle. These large interburden values are the result of the stratigraphic spread of the coal beds and reflect the thickness of the Menefee Formation plus the La Ventana. The isopach map (CRO Plate 4) illustrates the total combined thicknesses of the individual coal beds of the Menefee zone. The greatest combined thickness occurs in the southern and northwestern portions of the quadrangle where the coals total over 20 ft (6.1 m). The thickness decreases to less than 5 ft (1.5 m) in the northeast.

Chemical Analyses of the Menefee Zone Coal Beds - No analyses of Menefee coal within this quadrangle are known to be available. However, analyses for several Menefee Formation coals in the surrounding area have been published by Bauer and Reeside (1921), Lease (1971), and Shomaker (1971b) and these are assumed to be similar for the coals of this quadrangle. The results of these analyses are given in Table 1.

Fruitland 1 Coal Bed

As illustrated by the structure contour map of the Fruitland 1 coal bed (CRO Plate 8), the bed dips less than 1° to the northeast. Due to topography and dip, overburden (CRO Plate 9) varies from less than 400 ft (122 m) in the southwest to greater than 1,400 ft (427 m) in the northeastern part of the quadrangle. The isopach map (CRO Plate 7) indicates a maximum coal thickness of greater than 20 ft (6.1 m) in the northwest and southwest. The coal bed thins from these areas and is absent in the two portions in the south and east.

Chemical Analyses of the Fruitland 1 Coal Bed - No analyses of Fruitland coal within this quadrangle are known to be available. However, analyses for several Fruitland coals were published by Fassett and Hinds (1971) and Shomaker (1971a) and these coals are assumed to be similar to the coals of this quadrangle. The results of these analyses are given in Table 2.

COAL RESOURCES

Coal resource data for oil and gas wells (El Paso Natural Gas Co., 1978, unpublished data in well log library, Farmington, New Mexico) were utilized in the construction of isopach and structure contour maps of coals in this quadrangle. All of the coal beds studied in the Kimbeto quadrangle are more than 200 ft (61 m) below the ground surface and, thus, have no outcrop or surface development potential.

The U.S. Geological Survey designated the Fruitland 1 coal bed for the determination of coal resources in this quadrangle. Coals of the Menefee Formation were not evaluated because the thickness of the coal beds is less than reserve base thickness (5 ft [1.5]). In addition, the Menefee zone coals are discontinuous and noncorrelative.

For Reserve Base and Reserve calculations, the Fruitland 1 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. Coal located outside the 3-mile (4.8-km) inferred radius is designated as a hypothetical resource, however, Reserves were not calculated for hypothetical coal resources.

Data for calculation of Reserve Base and Reserves for each category were obtained from the coal isopach (CRO Plate 7) and areal distribution maps (CRO Plate 10). The surface area of the isopached Fruitland 1 bed was measured by planimeter, for each category, in acres, 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 each coal bed.

In order to calculate Reserves for measured, indicated, and inferred resources, 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 each category of coal for the Fruitland 1 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 336.5 million short tons (305.3 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 Kimbeto quadrangle has development potential for subsurface mining methods only (CDP Plate 11).

COAL DEVELOPMENT POTENTIAL

Coal beds of 5 ft (1.5 m) or more in thickness which are overlain by 200 to 3,000 ft (61-914 m) of overburden are considered to have potential for underground mining and are designated as having high, moderate, or low development potential according to the overburden thickness; 200 to 1,000 ft (61-305 m), high; 1,000 to 2,000 ft (306-610 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 1 coal bed.

TABLE 3

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS
(in short tons) IN THE KIMBETO 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	201,990,000	134,680,000	--	336,670,000
TOTAL	201,990,000	134,680,000	--	336,670,000

Development Potential for Surface Mining Methods

All coals studied in the Kimbeto quadrangle occur more than 200 ft (61 m) below the ground surface and, thus, they have no coal development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

Underground coal of the Fruitland 1 bed has high development potential in much of the northern half of the quadrangle and in the southwest and southeast (CDP Plate 11). The coal bed thickness is 5 to 20 ft (1.5-6.1 m) in the north, 10 to 20 ft (3.0-6.1 m) in the southwest, and approximately 5 ft (1.5 m) in the southeast (CRO Plate 7). Overburden thickness increases from less than 400 feet (122 m) in the southwest to 1,000 ft (305 m) in the north (CRO Plate 9).

Coal of the Fruitland 1 has moderate development potential along the northern border of the quadrangle where the coal thickness ranges from 5 to 20 ft (1.5-6.1 m), and the overburden increases from 1,000 to 1,400 ft (305-427 m) in the northeast corner of the area.

Most of the central and southern parts of the quadrangle have unknown development potential where the Fruitland 1 is less than the reserve base thickness of 5 ft (1.5 m). Two small areas with no coal development potential occur in the south and east; there is no Fruitland 1 coal in these areas.

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