Text to accompany:

Open-File Report 79-107

1979

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

[Report includes 11 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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LYBROOK NW 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 Lybrook NW 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 Lybrook NW 7 1/2-minute quadrangle is in southeastern San Juan County, New Mexico. The area is approximately 44 miles (71 km) southeast of Farmington and 72 miles (116 km) northeast of Gallup, New Mexico.

Accessibility

The area is accessible from New Mexico State Route 44 which extends east to west across the northern portion of the quadrangle. Light duty and unimproved dirt roads provide access to remote areas of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates a route which passes through Gallup about 72 miles (116 km) to the southwest.

Physiography

This quadrangle is in the south-central portion of the Central Basin area (Kelley, 1950) of the larger structural depression known as the San Juan Basin. Elevations range from 6,540 ft (1,993 m) in the stream bed of Escavada Wash to 7,264 ft (2,214 m) in the northeastern corner of the quadrangle. The area in the northeast is characterized by steep-sided mesas which have been highly dissected by numerous intermittent streams. To the west and south the topography grades into gently sloping plains of low relief. Several drainage systems are present, with major intermittent streams draining to the south. Escavada Wash is the major drainage in the south; Kimbeto Wash drains the northern portion, and Betonnie Tsosie Wash drains the central portion of the quadrangle.

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 over 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 southeastern part of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 93 percent of 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

Reeside (1924) mapped the Upper Cretaceous and Tertiary formations of the San Juan Basin. Dane (1936) has mapped the Upper Cretaceous and Tertiary strata as part of a study of the geology and fuel resources of the southern San Juan Basin. A more recent publication by Fassett and Hinds (1971) includes 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 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 coal 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.

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 Cliff House Sandstone, and marks the last advance of the Late Cretaceous sea.

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 later became coals of the Fruitland Formation. Again, deposition of organic material was influenced by the strandline as shown both by 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 northeast of the quadrangle as the regression continued in that direction. Terrestrial freshwater then sediments 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. 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. 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 in age from Late Cretaceous to Paleocene. They are, in order from oldest to youngest: the Menefee Formation (undifferentiated), Cliff House Sandstone, 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 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 the undifferentiated Menefee Formation for the purposes of this report only. The formation consists primarily of dark gray to brown carbonaceous to noncarbonaceous shale, thin, gray sandstone, and lenticular coal beds. It has a total thickness of approximately 900 to 1,000 ft (274-305 m) in this area. Due to the gentle regional dip of 1° to 2° to the northeast, the entire Menefee Formation is overlain by more than 3,000 ft (914 m) of overburden (the study limit) in the northernmost portion of the quadrangle. To the southwest, the entire formation is higher in elevation so that in drill hole 3 (Section 6, T. 22 N., R. 8 W.) the lowermost 200 ft (61 m) of the Menefee are deeper than the study limit. Therefore, the complete section is not shown on Plate 3 of the CRO maps.

The Cliff House Sandstone conformably overlies the Menefee Formation. The basal member is the La Ventana Tongue, which is a 600- to

750-ft (183-229-m) thick, gray, massive, locally calcareous and silty sandstone interbedded with shale and siltstone, which become more common in the lower portion. The upper member, the Chacra Tongue (informal name of local usage), overlies the La Ventana and averages 360 ft (110 m) in thickness. It consists of thinly bedded, gray, argillaceous, calcareous, silty sandstone, and interbedded gray to brown siltstone and shale. This lithology is transitional between the massive sandstone at the type section, Chacra Mesa, to the southwest and the overlying Lewis Shale.

The Lewis Shale, a marine deposit, conformably overlies the Mesaverde Group. In contrast to the underlying Cliff House Sandstone, it is predominantly a gray to brown, locally calcareous shale with limy nodules and plant fossils, and gray to brown sandstone and siltstone. The thickness of the Lewis ranges from 200 to 280 ft (61-85 m) in this area. The upper contact is gradational with the overlying Pictured Cliffs Sandstone and, therefore, it is difficult to determine.

The Pictured Cliffs Sandstone consists of cream to light gray, friable sandstone interbedded with gray to brown, micaceous shale near the base of the formation. 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 the occurrence of local Fruitland coal beds. Since the formation 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 coals.

The Fruitland Formation is the major coal-bearing unit in the quadrangle. It has an average thickness of 271 ft (83 m) and consists of gray to green to brown, carbonaceous, locally calcareous shale with plant fossils, interbedded with sandstone and siltstone, and coal beds of varying thicknesses. The thickest and most continuous coal beds occur near the base of the formation, while discontinuous and lenticular coal beds are characteristic of the upper portion. The upper contact of the formation is gradational from nonmarine, lower coastal plain deposits of the Fruitland to upper coastal or alluvial plain deposits of the Kirtland Shale (Molenaar, 1977).

The freshwater deposits of the Kirtland Shale average 255 ft (78 m) thick and consist of medium gray to green to brown shale with interbedded thin sandstone and siltstone beds. The formation has previously been divided nto several members by various authors; however, for the purposes of this report it was not necessary to distinguish between the individual members.

Unconformably overlying the Upper Cretaceous rocks is the Paleocene Ojo Alamo Sandstone. It consists of about 210 ft (64 m) of white to light gray, coarse-grained to conglomeratic, arkosic, friable sandstone, and thin interbedded gray to brown shale.

Approximately 600 to 1,200 ft (183-366 m) of the nonmarine Nacimiento Formation conformably overlie the Ojo Alamo Sandstone in this area. In contrast to the Ojo Alamo, the Nacimiento consists primarily of medium gray to brown sandy shale, thinly bedded, coarse-grained to conglomeratic sandstone, and interbedded siltstone.

Surface exposures in the quadrangle are influenced by the regional dip of 1° or more to the northeast, which exposes consecutively younger strata in a northeasterly direction. The Cretaceous Kirtland Shale, the oldest unit exposed, is in the extreme southwestern corner. The Ojo

Alamo Sandstone crops out in a thin band across the southwest portion. The youngest formation is the Tertiary Nacimiento Formation, which is exposed over the majority of the quadrangle area.

Structure

The axis of the San Juan Basin is about 35 miles (56 km) northeast of the Lybrook NW quadrangle and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Regional dip measured within the quadrangle varies from 1°4' to 1°20' (Reeside, 1924) to the northeast.

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.

Two coal zones (Menefee, Fruitland) and a coal bed (Fruitland 1) were identified in the subsurface of this quadrangle. The coals of the Menefee Formation have been designated as the Menefee coal zone (Me zone). These coals are generally discontinuous, noncorrelative, and less than reserve base thickness (5 ft [1.5 m]), as specified by the U.S. Geological Survey; an exception is a 9-ft (2.7-m) coal in drill hole 4. Due to these characteristics, derivative maps were not constructed.

No published analyses of the quality of Menefee Formation coals are available for this quadrangle. However, information on the quality of coals from surrounding areas is assumed to be similar to that of the coals from this quadrangle. There is no apparent consistent difference between the various Menefee Formation coals. The Menefee Formation coals in the southern part of the San Juan Basin vary from subbituminous B to high volatile C bituminous. The rank 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) (American Soc. for Testing 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, sulfur content ranging from 0.6 to 2.8 percent, ash content ranging between 4.9 and 9.9 percent, and heating values on the order of

10,325 Btu's per pound (24,016 kj/kg) (Bauer and Reeside, 1921; Dane, 1936; Shomaker and Lease, 1971). Analyses of several Menefee Formation coals are included in reports by Lease (1971) and Shomaker (1971). The results of these analyses are given in Table 1.

The Pictured Cliffs Sandstone occasionally contains random Fruitland coal beds in the upper portion, where the formations interfinger. They have been designated as local beds because they are random, discontinuous, and generally less than the reserve base thickness of 5 ft (1.5 m).

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 remaining Fruitland coals are designated as the Fruitland coal zone (Fr zone). These coals are generally noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5 m]).

Although there are no published analyses for the Fruitland Formation coal beds in this quadrangle, analyses of Fruitland coals in the surrounding area are assumed to be similar to those of coals from this quadrangle. The Fruitland Formation coal beds in the southern part of the San Juan Basin are considered high volatile C bituminous in rank, although they vary from subbituminous A to high volatile A bituminous. The rank has been determined on a moist, mineral-matter-free basis with calorific values ranging from 11,207 to 14,102 Btu's per pound (26,067-32,081 kj/kg) (American Soc. for Testing Materials, 1977). The coal is hard, brittle, and black with a bright luster. The coal readily decomposes with exposure to weather; however, it stocks fairly well when protected. The "as received" analyses indicate moisture content varying from 3.9 to 13.6 percent, sulfur content generally less than 1 percent, ash content ranging from 13.5 to 30.5 percent,

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 Mois- ture	Volatile matter	Fixed Carbon	Ash	Sulfur	Heating Value (Btu)	Remarks
A47085	Mine Sample	SW¼ 31	19	1	----	A	15.8	34.5	43.8	5.9	0.6	10,900	Cleary Member
	San Juan Mine					B	----	41.0	52.0	7.0	0.7	12,950	
A46366	Mine Sample	SW¼ 31	19	1	----	A	15.7	32.0	45.1	7.2	0.6	10,790	Cleary Member
	San Juan Mine					B	----	38.0	53.5	8.5	0.7	12,800	
						C	----	41.5	58.5	----	0.8	13,990	
A47084	Prospect Pit Wilkins No. 2 Prospect	SW¼ 26	19	1	----	A	18.2	34.4	40.8	6.6	0.9	10,280	Cleary Member
						B	----	42.0	49.9	8.1	1.0	12,570	
A60026	Mine Sample	SE¼ 19	19	1	----	A	12.1	35.8	44.5	7.6	2.8	10,940	Allison Member
	Rio Puerco Mine					B	----	40.7	50.6	8.7	3.2	12,460	
						C	----	44.6	55.4	----	3.5	13,640	
A64268	Mine Sample	SE¼ 35	19	2	----	A	20.0	32.5	42.6	4.9	0.7	10,240	Allison Member
	Anderson Mine					B	----	40.7	53.2	6.1	0.8	12,790	
						C	----	43.3	56.7	----	0.9	13,630	
A46367	Prospect Drift	35	19	2	----	A	14.8	33.9	41.4	9.9	1.2	8,910	Allison Member; sample may have been somewhat weathered
						B	----	39.8	48.6	11.6	1.4	10,460	
						C	----	45.1	54.9	----	1.6	11,840	
3823	Mine Sample	14	20	11	----	A	17.5	32.9	41.2	8.4	2.2	----	
23004	Outcrop Sample	14	20	11	----	A	14.4	34.8	42.3	7.5	1.5	10,220	
						B	----	40.7	50.5	8.8	1.8	11,940	

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

and heating values on the order of 9,850 Btu's per pound (22,911 kj/kg) (Dane, 1936; Fassett and Hinds, 1971; Shomaker and Lease, 1971).

Fruitland 1 Coal Bed

As illustrated by the structure contour map (CRO Plate 5), the coal bed dips from less than 1° to approximately 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 6) varies from less than 600 ft (183 m) in the southwest to over 2,000 ft (610 m) in the northeast. The isopach map (CRO Plate 4) shows the coal bed is greater than 15 ft (4.6 m) thick in a small portion of the southeast. In general, the thickness decreases from this area.

Chemical Analyses of the Fruitland 1 Coal Bed - No published chemical analyses of the Fruitland coals are available for this quadrangle. However, Fassett and Hinds (1971) and Shomaker and Lease (1971) published analyses of undesignated Fruitland coals from the surrounding area. These analyses are given in Table 2.

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. Therefore, the structure contour map (CRO Plate 9) was drawn using the top of the Fruitland Formation. As illustrated by this map, the coal zone dips approximately 1° to the northeast. Due to topography and dip, overburden (CRO Plate 10) varies from less than 400 ft (122 m) in

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-31101	Val Reese & Assoc Lybrook No. 7-27.	NE¼ 27	24	7	2,140-2,150	A	4.4	40.9	41.2	13.5	0.6	11,790	
						B	----	42.8	43.1	14.1	0.6	12,340	
						C	----	49.9	50.1	----	0.7	14,370	
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	
H-16309	Val Reese & Assoc Betty "B" No. 1-15.	NW¼ 15	23	7	2,180-2,195	A	5.7	39.3	40.8	14.2	0.6	11,410	
						B	----	41.7	43.3	15.0	0.7	12,100	
						C	----	49.1	50.9	----	0.8	14,240	
J-62557	Core Sample	SW¼ 26	21	8	----	A	13.6	33.4	35.4	17.6	0.53	9,110	
						B	----	38.6	41.0	20.4	0.62	10,540	
						C	----	48.5	51.5	----	0.77	13,240	
J-62604	Core Sample	SW¼ 26	21	8	----	A	12.6	28.7	28.2	30.5	0.49	7,510	
						B	----	32.8	32.4	34.8	0.56	8,590	
						C	----	50.3	49.7	----	0.86	13,180	
*TH-53400 (analysis by Commercial Testing & Eng. Co.)	Core Sample	----	20	6	----	A	12.44	34.95	34.05	18.56	0.56	9,499	
						B	----	39.91	38.89	21.20	0.64	10,848	
*C-14108 (Analysis by Illinois Geological Survey)	Core Sample	----	20	6	----	A	10.7	33.4	37.5	18.4	0.65	9,667	
						B	----	37.4	42.0	20.6	0.72	10,826	
						C	----	47.1	52.9	----	0.91	13,637	

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 southwest to greater than 1,600 ft (488 m) in the northeast. Also shown on CRO Plate 10 is the interburden, the noncoal portion of the zone. The interburden thickness varies from zero to greater than 200 ft (61 m); these values reflect the stratigraphic spread of the coals within the Fruitland. The isopach map (CRO Plate 8) shows the total thickness of the coals. In the northeast, the coals total more than 20 ft (6.1 m) thick. From this area the coals thin, and there is no coal in a small part of the west and southeast.

Chemical Analyses of the Fruitland Zone Coal Beds - No published chemical analyses of Fruitland coals from the quadrangle are available. However, Fassett and Hinds (1971) and Shomaker and Lease (1971) published analyses of several Fruitland coals from the surrounding area. These analyses are given in Table 2.

COAL RESOURCES

Coal resource data from 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 the coals in this quadrangle. All of the coal beds evaluated in the Lybrook NW 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 and Fruitland zone were not evaluated because the thickness of these coals is generally less than the reserve base thickness (5 ft [1.5 m]). In addition, the Menefee zone coals are irregular and noncorrelative, and the Fruitland zone coals are limited in areal extent.

For Reserve Base and Reserve calculations, the Fruitland 1 coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plate 7) according to criteria established in U.S. Geological Survey Bulletin 1450-B. Data for calculation of Reserve Base and Reserves for each category were obtained from the coal isopach (CRO Plate 4) and areal distribution maps (CRO Plate 7). The surface area of the isopached Fruitland 1 bed was measured by planimeter, for each category, in acres, then multiplied by 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, 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 401 million short tons (364 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 Lybrook NW 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 (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 1 coal bed.

Development Potential for Surface Mining Methods

All coal beds evaluated in the Lybrook NW 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 coal bed has high development potential in most of the southern half of the quadrangle (CDP Plate 11),where the coal bed thickness ranges from 5 to 15 ft (1.5-4.6 m), and the overburden varies from approximately 600 ft (183 m) in the southwest to 1,000 ft (305 m) near the center of the quadrangle area (CRO Plates 4 and 6).

The remainder of the Fruitland 1 coal bed of greater than reserve base thickness (5 ft [1.5 m]) has moderate development potential in the northwest, central, and southeast parts of the area. Coal bed thickness in

TABLE 3

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE LYBROOK NW 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	234,150,000	166,960,000	--	401,110,000
TOTAL	234,150,000	166,960,000	--	401,110,000

these areas varies from 5 to 15 ft (1.5-4.6 m), and the overburden ranges from 1,000 ft (305 m) in the west to 2,000 ft (610 m) in the northeast.

The Fruitland 1 coal bed has unknown development potential in the southwest, north, and eastern parts of the quadrangle where the coal is less than the reserve base thickness of 5 ft (1.5 m).

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